Part 6

DOCUMENTATION FOR THE PURPOSES OF THE TRANSBOUNDARY IMPACT ASSESSMENT PROCEDURE

for the Project involving the construction and operation of the First Nuclear Power Plant in Poland with a capacity of up to 3,750MWe, in the territory of the following communes: Choczewo, or Gniewino and Krokowa

Extract from Volume IV of the EIA Report – Impact Assessment

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świadomie o atomie
energia jądrowa w Polsce

Polskie Elektrownie Jądrowe sp. z o.o.

GLOSSARY

Term/Abbreviation	Definition
AA	Appropriate Assessment
ADD	Acoustic Deterrent Devices
ASA	Administrative Site Area - an area the extent of which is determined by boundaries of the communes situated in the Site Area
ASR	Administrative Site Region - an area the extent of which is determined by boundaries of the communes situated within the Site Region
ALARA	An optimisation principle in radiological protection, according to which the exposure to ionising radiation should be reduced to a level that is as low as reasonably achievable As Low As Reasonably Achievable
aPGW	Update of water management plans
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
Avifauna	All bird species that inhabit a specific geographical area (permanently or periodically), or type of environment
B(a)P/BaP	Benzo[a]pyrene
BAT	Best Available Techniques/Technology
BD	Behavioural disturbance, behavioural disorders
CSD	Cutter suction dredger
Terrestrial invertebrates	A set of all animal groups isolated for their lack of an endoskeleton in the form of a backbone and a skull, which dwell on land
Freshwater invertebrates	A set of all animal groups isolated for their lack of an endoskeleton in the form of a backbone and a skull, which inhabit fresh waters
Biota	All species of plants and animals that are present in a given area, considered irrespective of ecological connections. It includes fauna and flora specimen, that is, plants, animals, fungi, bacteria, protozoa, etc.
CBP	Chlorination by-products
CCME	Canadian Council of Ministers of the Environment
CEMP	Construction Phase Environmental Management Plan
CFU	A colony-forming unit which determines the number of microorganisms or cells in a material analysed using a culture consisting in a possibly even distribution of a material sample on or in a growth medium, so that (in an ideal case) all microorganisms should lie alone and within a distance from one another, and form - through reproduction - one colony at a time. For example, the unit is applied to determine the concentration of the E. coli bacteria in CFU/100mL
CIEEM	Chartered Institute of Ecology and Environmental Management
CMIP5	Coupled Model Intercomparison Project Phase 5
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CO	carbon monoxide
CO2	carbon dioxide
WB	Surface water body (SWB) or groundwater body (GWB)
C6H6	Benzene
D5, D9, D13, D14, D15	According to Annex No 2 to the Act on Waste of 14 December 2012 (Journal of Laws of 2013, item 21, as amended) “Non-exhaustive list of disposal operations”, including:

Term/Abbreviation	Definition
	D5 - Specially engineered landfill (e.g. placement into lined discrete cells which are capped and isolated from one another and the environment, etc.) D9 - Physico-chemical treatment not specified elsewhere in this Annex which results in final compounds or mixtures which are discarded by means of any of the operations numbered D1 to D12 (e.g. evaporation, drying, calcination, etc.) D13 - Blending or mixing prior to submission to any of the operations numbered D1 to D12 D14 - Repackaging prior to submission to any of the operations numbered D1 to D13 D15 - Storage preceding the operations numbered D1 to D14 (excluding temporary storage by the waste producer)
dB	Decibel
dB (A)	A-weighted decibel
DMP	Dredging Management Plan
AZP Documentation	It is used to establish a national and provincial register of archaeological monuments and carry out all conservation activities in this regard.
DPD	Positive detection days
ICPD	Ingestion and commodities planning distance
EPD	Extended planning distance
DŚU	Decision on environmental conditions
DVI	Disturbance Vulnerability Index for vessel traffic
EIA Directive	Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment
Birds Directive	Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds
Habitats Directive	Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild flora and fauna
EEA	European Environmental Agency
EKOMETRIA	Biuro Studiów i Pomiarów Proekologicznych Sp. z o.o.
NPP / Nuclear power plant	The first Polish Nuclear Power Plant comprising three nuclear power units with AP1000 reactors with the capacity of up to 3,750 MWe, in the territory of the following communes: Choczewo, or Gniewino and Krokowa
EMEP	European Monitoring and Evaluation Programme
EMP	Environment Management Plan
EQS	Environmental Quality Standard, which determines pollutant concentration limits which should not be exceeded to protect human health and the environment
Structure-borne wave	Acoustic vibrations occurring in continuous media are called material structure-borne acoustic vibrations
FRRS	Fish recovery and return system
GDOŚ	General Directorate for Environmental Protection
GIOŚ	Chief Inspectorate for Environmental Protection
GES	Good environmental status
GHG	Greenhouse gases
GIS	Geographical Information System

Term/Abbreviation	Definition
Site communes	For Variant 1 – Lubiatowo - Kopalino site: rural commune of Choczewo, and for Variant 2 – Żarnowiec site: rural communes of Krokowa and Gniewino
Waste production and management	Production of waste and waste management
Waste management	Waste collection, transport and processing, including the supervision over such activities, as well as subsequent handling of waste disposal sites and operations performed by waste sellers or intermediaries in waste trading
Boundary of the planned nuclear facility	The area delimited by a circle with a radius equal to the length from the centre to the farthest point of the land property on which the nuclear facility is to be located, drawn from the centre of the land property so that the entire land property to host the nuclear facility is within the drawn circle
Taxonomic groups	Groups of organisms characterised by a certain similarity or relationship which is not characteristic for a group of organisms from another taxon
Macroscopic fungi	A group of fungi including species whose fructifications are visible to the naked eye (macrofungi)
Lichenised fungi	A group of symbiotic organisms originating as a result of a symbiosis of heterotrophic fungi with autotrophic cyanobacteria or green algae
GUS	Statistics Poland
GZWP	Main Groundwater Basin
HDD	Horizontal directional drilling
HELCOM	Helsinki Commission, Baltic Marine Environment Protection Commission
Herpetofauna	Fauna of all amphibians and reptiles present in a given area
HF	High frequency (acoustics)
HFC	Cetaceans sensitive to high sensitivity sound
HRA	Habitat regulations assessment
Hz	Hertz
Ichthyofauna	All species of fish that inhabit a specific watercourse, reservoir or area in one period
ICRP	International Commission on Radiological Protection
IEMA	Institute of Environmental Management and Assessment
IMGW - PIB	Institute of Meteorology and Water Management – National Research Institute
Auxiliary infrastructure	Auxiliary system facilities, technical, and welfare and office facilities.
Associated infrastructure	Infrastructure associated with the NPP, required for its construction and operation.
INNS	Invasive and non-native species
IO	Diatom index
IPIŚ PAN	Institute of Environmental Engineering, Polish Academy of Sciences
IPCC	Intergovernmental Panel on Climate Change
ISOK	IT Country Protection System
AI	Associated infrastructure, associated projects
SWB	Surface water body / surface water bodies
GWB	Groundwater body / groundwater bodies
Waste catalogue	Catalogue of waste with waste organised into groups, sub-groups and types, indicating hazardous waste
Bathing area	An area designated by the commune council, a sectioned off and marked portion of surface waters, used by a large number of bathers, provided that

Term/Abbreviation	Definition
	there is no permanent ban on bathing in the bathing area; and an area occasionally used for bathing is a sectioned off and marked portion of surface waters that is used for bathing, but is not a bathing area
EC	European Commission
KEO	Waste manifest form
KEON	Hazardous waste manifest form
ESR	Environmental Scoping Report
KOBIZE	National Center of Emission Balancing and Management
BWM Convention	International Convention for the Control and Management of Ships' Ballast Water and Sediments, signed on 13 February 2004
Ramsar Convention	Convention on Wetlands of International Importance, especially as Waterfowl Habitat, signed in Ramsar on 2 February 1971
Ecological corridors	Areas that facilitate migration of plants, animals or fungi
Seascape	Area of land, coast or sea, as perceived by people, whose character is the result of the action and interaction of natural or human factors.
NPS	National Power System
kV	kilovolt
KZGW	National Water Management Authority PGW Wody Polskie
L_{AE}	Sound exposure level in decibels [dB]. A measure of a single acoustic occurrence generated by, e.g. one vehicle passage. It is equal to ten logarithms of the sum of all instantaneous sound pressure values (squared and weighted by correction curve A) during the event, referred to a unit time interval of 1 second (as if every event lasted 1 second). $L_{AEk} = 10 \cdot log\left(\frac{1}{n}\sum_{i=1}^{n} 10^{0.1 \cdot L_{AEki}}\right)$ [dB]
L_{AeqD}	Equivalent A-weighted sound level for daytime.
L_{AeqN}	Equivalent A-weighted sound level for nighttime.
L_{AeqT}	Equivalent A-weighted sound level (sound level weighted with correction curve A) for time T, given in decibels [dB]. In accordance with „PN-ISO 1996-1:2006 Acoustics. Description and measurements of environmental noise. Part 1: basic values and procedures" is equal to ten decimal logarithms of the squared acoustic pressure averaged in the time unit T, related to the squared reference pressure, and the acoustic pressure is weighed by the A curve: $L_{Aeq\,T} = 10\,log_{10}\left(\frac{1}{T}\int_0^T \frac{p_A^2(t)}{p_0^2}dt\right)$ [dB] where pA(t) is the instantaneous sound pressure weighted by correction curve A for time t, and p_0 is the reference sound pressure (= 20 µPa).
land use	Use of land
LCA	Life Cycle Analysis – a method to evaluate the environmental impact of a project/product through its entire life cycle, including through taking into account the energy and materials used during production, and waste released to the environment
LC_{50}	Lethal concentration – concentration (most commonly expressed in grams or milligrams per litre of water or air) of substances causing the death of 50% of specimen in a population
L_{DWN} (L_{DEN})	Long-term average sound level A expressed in dB, determined for each day of the year taking into account time of the day, time in the evening and at night

Term/Abbreviation	Definition
LD_{50}	Lethal dose – dose of ionising radiation or toxic substance that causes the death of 50% of specimen in a population
LE,p	Sound exposure level
LV/HV/MV line/network	Low voltage (0.4 kV) / medium voltage (3-60 kV) / high voltage (110 kV) / extra high voltage (220 kV, 400 kV, 750 kV) power line/network
L_N	Long-term average sound level A expressed in dB, determined for each night of the year
Lp	Sound pressure level
Lpk	Peak pressure level
LSE	A method applied at the screening stage, to determine whether effects on European sites should be assessed further - a threshold of a likely significant effect
LVIA	Landscape and Visual Impact Assessment
Supply chain	All activities related to procurement, transport, manufacturing, and distribution of goods
m AGL	Metres above ground level
m AMSL	Metres above mean sea level
IAEA	International Atomic Energy Agency
Waste storage	Temporary storage of waste, including: a) preliminary storage of waste by their producer, b) temporary storage of waste by a waste collection entity, c) storage of waste by a waste treatment entity
MARPOL / MARPOL Convention	International Convention for the Prevention of Pollution from Ships (MARPOL), which entered into force on 2 October 1973
mGy	Milligray
MMI, MMI_PL	A multimetric index used in the assessment of the biological elements of water quality with regard to benthic macroinvertebrates
MMO	Marine mammal observers
MOLF	Marine Off-loading Facility
MPHP50	Map of the Hydrographic Division of Poland to the scale of 1:50,000
MPHP/ MPHP10	Map of the Hydrographic Division of Poland to the scale of 1:10,000
MPZP	Local Land Development Plan
MTZ	Marine traffic zone
MW	Megawatt
MWe	Megawatt electric
NCBJ	National Centre for Nuclear Research
NOAA	National Oceanic and Atmospheric Administration
NRMM	Non-road mobile machinery
NSRWR	New Surface Radioactive Waste Repository
NWW	The lowest water level in the entire measurement period
Survey area for the make-up water corridors at the Żarnowiec site	The area designated only for Variant 2 – Żarnowiec site, within the boundaries of which components of the cooling system (make-up water pipelines/channels, and also a pumping station in the vicinity of the sea) will be located. It is determined due to the situation of the Assumed Project site in this variant within approximately 12km from the Baltic Sea which is the source of the cooling water.
Marine survey area	An area that is 8.5km wide offshore, and the length of which is, respectively: from 148.5km to 179.5km along the coast for Variant 1 – Lubiatowo -

Term/Abbreviation	Definition
	Kopalino site, and from 132.0km to 159.5km along the coast for Variant 2 – Żarnowiec site
Landscape Protection Area	Areas protected due to their outstanding landscape of diverse ecosystems, valuable for offering an opportunity to satisfy needs related to tourism and leisure, or their function of ecological corridors
Site Area	The area within a 5-kilometre distance from the boundaries of the planned nuclear facility site, and, in justified cases related to the ground structure of crucial importance for its stability during the construction of the facility and after, the area extended insofar as needed to obtain sufficient data and to assess ground stability
Land field survey area	An area of an archaeological inventory which includes the Site Area, situated on land
Seascape Character Areas / SCA	Separate, individual unique geographical areas with a specific seascape character type. Each of them has their own individual character despite sharing common characteristics with other seascape character types.
Natura 2000 site	Areas considered crucial for the conservation of endangered or very rare species of plants and animals or natural habitats, which are important for the protection of European natural values
Ramsar sites	A Ramsar site is a wetland designated as a site of international importance under the Ramsar Convention, also known as the Convention on Wetlands, an international environmental treaty
Cumulative impacts	Impacts arising from the incremental and synergistic effect following the addition of the Project (NPP execution) to other past, present and reasonably anticipated activities of individual entities and projects which result in individually insignificant but collectively significant effects for the natural and socio-economic environment, including health, at a given time and place or in a given area
Waste	Any substance or object that the holder discards or intends or is required to discard
Municipal waste	Waste produced in households, and also waste containing no hazardous waste and generated by other waste producers which, considering its nature or composition, is similar to the waste generated in households
Medical waste	Waste that is generated in connection with providing health services and conducting scientific medical research and experiments
Hazardous waste	Waste that demonstrates at least one of hazardous properties (…); the properties that make waste hazardous, and the conditions of recognising waste as hazardous
Non-combustible waste	Waste other than the categories listed in Annex No 2a to the Waste Act, if it cannot undergo the combustion process (it cannot be burned) and thus it cannot affect the fire development and its power, in particular due to the manner of storage or landfill of such waste, its chemical composition or form, irrespective of the adopted waste codes (…); waste is considered (…) non-combustible on a case-by-case basis with respect to the specific situation (when designating waste as non-combustible on a voluntary basis) (…)
Inert waste	Waste that does not undergo any significant physical, chemical or biological transformations; it does not dissolve, physically or chemically react, result in environmental pollution or cause harm to human life or health, they are not biodegradable or adversely affect other matter with which it comes into

Term/Abbreviation	Definition
	contact; the total pollutant content and leachability of the waste and the ecotoxicity of the leachate are insignificant, and in particular it does not endanger the quality of surface water, groundwater or soil
Radioactive waste (OP)	Solid, liquid or gaseous materials containing radioactive substances or contaminated by such substances, further use of which is not foreseen or considered, assigned to waste categories, including spent nuclear fuel designated for storage
Construction dewatering	A process of lowering the water level in foundation trenches or foundation pits. It is based on a system of drains and grooves that collect water into collecting wells equipped with dewatering pumps. Underground dewatering systems use depression wells, wellpoints and/or horizontal drain systems.
Waste recovery	Any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function in a given plant or generally in the economy
OFREJ	Functional Area of Nuclear Power Development - Resolution no. 318/XXX/16 of the *Sejmik* (regional assembly) of the Pomorskie Voivodeship of 29 December 2016 regarding the passing of a new spatial development plan of the Pomorskie Voivodeship including the spatial development plan of the Tricity metropolitan area which constitutes a part thereof
Hydrogeological window	A discontinuity within impermeable formations that separate permeable formations filled with water, which creates direct contact between aquifers
Waste oils	Any mineral or synthetic lubrication or industrial oils which have become unfit for the use for which they were originally intended, in particular used combustion engine oils and gearbox oils, lubricating oils, oils for turbines and hydraulic oils
EIA	Environmental Impact Assessment
RUA	Restricted Use Area
Project Area / PA	The area within which the Project will be implemented and operated. The land section of the Project Area includes components land development related to the Project (except for the Associated infrastructure). The marine area section is an area within which the components of the NPP cooling water system will be constructed along with any other required installation and auxiliary equipment.
SPA	Special birds protection areas
OSPAR	OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic signed on 22 September 1992
RES	Renewable Energy Sources
SCI	Sites of Community Importance
PAA	President of the National Atomic Energy Agency/ National Atomic Energy Agency
Foundation pile	A single, long structural element of the building foundation that is sunk in the subgrade soil.
PAM	Passive Acoustic Monitoring
Landscape park	An area protected for its natural, historical and cultural values as well as landscape features, to protect and popularise those values in sustainable development conditions
Pb	Lead

Term/Abbreviation	Definition
PL	Permissible levels for substances in the air, divided by protection of human health and plant protection
PE	Parabolic Equation
PEJ	Polskie Elektrownie Jądrowe
PEP2040	Energy Policy of Poland until 2040 - the Announcement of 2 March 2021 by the Minister of Climate and Environment on the energy policy of the State until 2040
PGW, aPGW, II aPGW	Water Management Plan, update of the Water Management Plan, second update of the Water Management Plan; subsequent planning cycles in water management
PGW WP	State Water Holding Polish Waters
PIS	State Sanitary Inspection
PIT	Personal income tax
Plan	Maritime Spatial Plan of the Polish Internal Sea Waters, Territorial Sea and Exclusive Economic Zone
Health, Safety and Environmental plan (HSE/BIOZ plan)	Health, Safety and Environmental plan (HSE/BIOZ plan) prepared pursuant to the requirements of the Construction Law Act and the regulation on safety and health protection and the safety and health protection plan
PMP	Piling Management Plan
PMŚ	State Environmental Monitoring
RL	Reference level
Waste reuse	Any operation by which products or components that are not waste are used again for the same purpose for which they were conceived
Waste holder	Waste producer or a natural or legal person and an organisational entity holding no legal personality that is in possession of the waste; it is deemed that the land surface holder is the holder of the waste situated on the real property
Decision/GDOŚ Decision/Scoping Decision	Decision of the General Director for Environmental Protection of 25 May 2016 (DOOŚ-OA.4205.1.2015.23) determining the scope of the environmental impact assessment report regarding the Project involving the construction and operation of the First Nuclear Power Plant in Poland with a capacity of up to 3,750MWe, in the territory of the following communes: Choczewo, or Gniewino and Krokowa
EPL	The Environmental Protection Law Act of 27 April 2001
Surface Archaeological Investigations	Investigations intended to identify the type and chronology of sources (archaeological monuments) on the ground surface, record their location and obtain available data regarding the extent of their occurrence
PNPP	The Polish Nuclear Power Programme - Resolution No. 141 of the Council of Ministers of 2 October 2020 on updating the multi-annual programme called “The Polish Nuclear Power Programme"
PPH	Hydromorphological modification parameter
PPK/ppk	measurement and control point / measurement and control points
ppm	Parts per million
PPV	Peak Particle Velocity
Storage of radioactive waste or spent nuclear fuel	Storage of radioactive waste or spent nuclear fuel with the intention of its retrieval

Term/Abbreviation	Definition
Project	Construction and operation of the first Polish Nuclear Power Plant with the capacity of up to 3,750 MWe, in the territory of the following communes: Choczewo, or Gniewino and Krokowa
Radioactive waste processing	Process or activity intended to minimise the volume of waste, waste segregation according to waste category or subcategory and waste preparation for transport or disposal
PTS	Permanent Threshold Shift
PUWG 1992	1992 National Geodetic Coordinate System
PW	The Water Law Act of 20 July 2017
PW	Phocid pinnipeds (natural)
PZŚ	Environmental Targets Plan
PZPWP/WKZ	Land Development Plan of the Pomorskie Voivodeship / Voivodeship Monument Conservator
EIA Report	Environmental Impact Assessment Report for the project involving the construction and operation of the First Nuclear Power Plant in Poland with a capacity of up to 3,750MWe, in the territory of the following communes: Choczewo, or Gniewino and Krokowa
RDOŚ	Regional Environmental Protection Director
MSFD	Marine Strategy Framework Directive; Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy
WFD / Water Framework Directive	Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy
Waste recycling	Any recovery operation by which waste materials are reprocessed into products, materials or substances to be used for the original purpose or other purposes; it includes the reprocessing of organic material (organic recycling) but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling
Site Region	The land within a 30-kilometre distance from the boundaries of the planned location of a nuclear facility
Nature reserve	An area including ecosystems, sanctuaries and natural habitats, plant habitats, animal habitats and fungi habitats, preserved in a natural or slightly changed condition, as well as abiotic formations and components, featuring special natural, scientific, cultural or landscape values
RME	Regulation of the Minister of Energy
RMG	Regulation of the Minister of Economy
RMŚ	Regulation of the Minister of Environment
Vascular plants	A group of plants adapted to life on land which usually have a well-developed root system and grow vascular tissues
ROV	Remotely Operated Vehicle
Operational regulation	Regulation of the Council of Ministers of 11 February 2013 on requirements for the commissioning and operation of nuclear facilities
RRM	Regulation of the Council of Ministers
RZGW	Regional Water Management Authority
SDF	Standard Data Form for Natura 2000 sites
SEL	Sound Exposure Level in dB

Term/Abbreviation	Definition
SGA	Site general arrangement
Natural habitats	Land or water areas that have specific features of the natural environment (geographical, abiotic and biotic)
SIPAM	Maritime Administration Spatial Information System
SWD scale	Scale used to assess the impact of vibrations on buildings
Radioactive waste disposal	Emplacement of radioactive waste in radioactive waste disposal facility without the intention of retrieval
Landfill	Building structure designated for deposition of waste
SNAP	Selected Nomenclature for Sources of Air Pollution
DIZ	Direct impact zone
IIZ	Indirect impact zone
SAC	Special Areas of Conservation
SOx	Sulphur oxides
SO2	Sulphur dioxide
SPA	Special Protection Areas, designated according to provisions of the EU law to protect wildlife bird populations within the boundaries of which birds have favourable environmental conditions throughout their entire life, in any period or development stadium thereof
SPL	Sound pressure level in dB
Mammals	Animals that belong to vertebrates, characterised mainly by mammary glands in females, inhabiting both water and land environments.
SSP	Sound speed profile
SSW	The average water stage in the entire measurement period
Third party	A natural person, legal person or an organisational unit without legal personality, which is not bound by a given agreement, legal relationship or another relationship governed by specific provisions of the law. It is a person/ entity not directly involved in a specific situation, relationship or legal relationship
STW	Sewage treatment works
Hazardous substance	A substance classified as posing threat as a result of meeting the criteria determined in parts 2 to 5 of Annex I to Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006 (OJ L 353, 31.12.2008, p. 1, as amended), compliant with the Regulation on the catalogue of wastes
Radioactive substance	Substance containing one or more radioactive isotopes, with activity or radioactive concentration that may not be disregarded from the radiological protection viewpoint
SUiKZP	Study of Development Conditions and Directions of Spatial Planning
SUW	Water treatment plant
SWAM 99	Shallow Water Acoustic Modelling
SWD	Multi-mesh bottom-set gillnets
SWL	Sound Power Level in dB
Sv	A unit of equivalent dose and effective dose of ionising radiation (sievert)
Sheet pile / Larssen sheet pile	Excavation sheet piles consist of vertical steel elements connected to one another by specially shaped joints. Subsequent elements of the sheet piling

Term/Abbreviation	Definition
	are plunged into the soil using driving force, vibrations, or static pressing. This type of solution prevents lateral inflow of underground water and protects the excavation walls against backfilling.
Carbon footprint	A type of ecological footprint caused directly or indirectly by a specific project, defined by intensity of the carbon dioxide emission, in gCO2e/kWh (grams of the CO_2 equivalent per kilowatt-hour of the electricity generated) in the entire life cycle
TBM	The construction method related to building intake and discharge channels/pipelines of the open cooling system; Tunnel Boring Machine
TSP	Total suspended particulates
TSS	Total suspended solids
CJEU	Court of Justice of the European Union
TTS	Temporary Threshold Shift
EU	European Union
UKE	Office of Electronic Communications
Waste disposal	Any operation which is not recovery even if the secondary effect of such process is reclamation of substances or energy
US-EPA	United States Environmental Protection Agency
EIA Act	Act of 3 October 2008 on providing access to information about the environment and its protection, participation of the public in environmental protection and assessments of the environmental impact
EPL Act	Environmental Protection Law Act of 27 April 2001
Ecological area	Remnants of ecosystems important from the standpoint of preserving biodiversity - natural reservoirs, field and forest ponds, clumps of trees and bushes, swamps, peatbogs, dunes, patches of unused vegetation, oxbow lakes, rocky outcrops, embankments, bank gravels, natural habitats and sites of rare or protected species of plants, animals, and fungi, as well as their refuges and breeding places or seasonal areas of habitation
Active layer	Active surface; the layer where there is an exchange of air between the atmosphere and substrate; the processes that take place here contribute to differentiation of the local climate
WEZ	Voivodeship Register of Monuments (*Wojewódzka Ewidencja Zabytków*) – maintained by the Voivodeship Monument Conservator in the form of a set of register cards of monuments situated in the voivodeship
WHO	World Health Organization
WIOŚ	Voivodeship Inspectorate of Environmental Protection in Gdańsk
Real estate owners	Owners of real estate as well as co-owners, perpetual usufructuaries and organisational entities and persons that have real estate under their management or in use, as well as other entities holding the real estate, according to the Act on Keeping Communes Clean and Tidy
HV	High voltage
Applicant / Investor	Polskie Elektrownie Jądrowe sp. z o.o. (PEJ sp. z o.o.)
RV	Reference value
Groundwater	All waters below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil

Term/Abbreviation	Definition
Surface water	Inland waters except groundwater; transitional waters and coastal waters, except in respect of chemical status for which it shall also include territorial waters
Transitional waters	Bodies of surface water in the vicinity of river mouths which are partly saline in character as a result of their proximity to coastal waters but which are substantially influenced by freshwater flows
Coastal water	Surface water on the landward side of a line, every point of which is at a distance of one nautical mile on the seaward side from the nearest point of the baseline from which the breadth of territorial waters is measured, extending where appropriate up to the outer limit of transitional waters
Inland water	All standing or flowing water on the surface of the land, and all groundwater on the landward side of the baseline from which the breadth of territorial waters is measured
WPHk, WPHt	Hydromorphological modification score, k – based on desktop studies, t – based on field assessments
SF	Spent fuel
WRHk, WRHt	Hydromorphological diversity score, k – based on desktop studies, t – based on field assessments
WSP	Designated Project Areas
IEPZ	Internal emergency planning zone
WWW	The highest water stage in the entire measurement period
Contractor	Any natural or legal person, public entity or a group of such persons or entities, including a temporary association of entrepreneurs, who or which offers execution of construction works or a building structure, delivery of a product or provision of services
Deep excavation	Deep excavations are excavations with vertical walls protected by shoring that are more than 3m deep.
Waste producer	Anyone whose activities or presence result in waste generation (original waste producer) or anyone who carries out pre-processing, mixing or other operations resulting in a change in the nature or composition of this waste; the producer of waste resulting from provision of services in the scope of construction, demolition, renovation of buildings, cleaning of tanks or equipment, and cleaning, maintenance and repairs is the entity which renders the service, unless the service provision agreement states otherwise
Designated Project Areas	Areas in which the siting of the Nuclear Power Plant is planned in both site variants, equivalent to the Project Area
VMP	Vessel Management Plan
Assumed Project Area	Assumed Project Area was determined under the preparation of preliminary siting criteria for the NPP construction, to conduct the environmental survey and site investigation programme
Waste prevention	Measures taken with regard to a product, material or substance prior to it becoming waste, that reduce: a) the quantity of waste, including through the re-use of products or the extension of the life span of products; b) the adverse impacts of the generated waste on the environment and human health; c) the content of harmful substances in products and materials
Waste collection	Gathering of waste prior to its transport to waste processing sites, including the preliminary sorting not leading to a substantial change in the waste

Term/Abbreviation	Definition
	nature and composition, and not resulting in the waste classification change; and the temporary storage of waste
EEPZ	External emergency planning zone
µPa	Micropascal, unit of pressure and stress in the SI system, equal to 10 – 6 pascals

TABLE OF CONTENTS

Note: In the table of contents for this part of the documentation, **the blue colour** and page numbers are used to highlight those chapters that are extracted from the EIA Report, either entirely or partly

Introduction

Volume IV is the culmination of the long-term research and analyses conducted in the site variants considered for the nuclear power plant in Poland, namely, Variant 1 – Lubiatowo – Kopalino site, and Variant 2 – Żarnowiec site. An extensive research programme contributed to the substance of the environmental impact assessment report in the part regarding the impact of the planned investment on the environment. One important detail should be pointed out here: both this EIA Report and the assessment prepared hereunder refer to a unique Project that has no counterpart in our country. In this context, the extent of the environmental impact assessment was even meticulous, frequently far exceeding the framework adopted in standard reports, to provide the general public with a comprehensive overview of key aspects related to the planned Project. Certainly one can disagree with such a statement and argue that each investment project is in a way unique, and would be right to a considerable degree. However, the dimension, extent, and multifaceted nature of the Project in question, including the investment statistics themselves, prove that the scale of surveys, analyses, modelling and similar actions performed has been unprecedented in Poland. It is worth highlighting this aspect because mathematic modelling, advanced computing algorithms, GIS, neural networks, and analyses of the latest scientific knowledge available, performed for the purposes of this assessment, as well as numerous other tools, have been used at the stage when the final project assumptions have not been available yet and which will still be subject to subsequent analyses during the preparation of a building permit design of the Project which will in turn be analysed during the reassessment of the Project impact on the environment.

The impacts were identified and analysed under professional judgment conducted according to a strictly defined methodology which applied the tools referred to above.

Under provisions of the Act of 3 October 2008 on disclosure of information on the environment and its protection, participation of the public in environmental protection, and environmental impact assessments, that is, Article 66(1)(8), the EIA Report contains a description of the anticipated material impacts of the planned Project on the environment, including direct, indirect, secondary, cumulative, short-term, medium-term and long-term, permanent and momentary impacts on the environment, arising from a) the Project existence, b) use of environmental resources, and c) emissions.

In individual chapters of Volume IV which depict effects of the Project on specific environmental components, all types of impacts on the given component were presented in tables together with the impact classification taking into account the above statutory division of the impacts (unless the specific character of the factor assessed "has enforced" an alternative, more adequate classification).

The division covers the following categories and relevant assessment parameters / impact magnitude assigned to them:

– A receptor importance and receptor sensitivity have the same magnitude, that is: **Ni** – Low, **Um** – Moderate, **Wy** – High;
– Actions and their effects are presented in the form of a concise descriptive part;
– Spatial extent of the impact: **Lo** – Local, **Re** – Regional, **Kr** – National;
– Nature of the impact: **B** – Direct, **P** – Indirect, **W** – Secondary, **S** – Cumulative;
– Duration of the impact: **K** – Short-term, **Ś** – Medium-term, **D** – Long-term;
– Frequency of the impact: **St** – Permanent, **Ch** – Momentary;
– Significance of effects: **Is** – Significant, **Ne** – Insignificant.

Additionally, in order to standardize the above classification, the following assumptions were adopted to assess the impact on specific environmental components:

Within the category: **Character of effects**

B - Direct Impacts are such impacts on the environment which result directly from a project. An example of such an impact is provided in the category of **secondary** impacts.

P - Indirect Impacts are such impacts on the environment which do not directly result from a project. They often originate far away from the place of the project implementation site or are the consequence of multi-stage, diverse, sometimes apparently non-interrelated actions.

W - Secondary Impacts - is the category sometimes identified with **Indirect** Impacts described above, but there is a notion of 'secondary impacts' described as follows:

One example is water quality deterioration caused by soil erosion following tree felling in a forested area. In this case, the tree removal is a ***direct*** *impact, the soil erosion (in the place of clearance) is a* ***secondary*** *impact, while effects of the soil erosion, that is, water quality deterioration in this case, constitute an* ***indirect*** *impact* (and, as specified in the above definition, can occur away from the project implementation site).

S - Cumulative Impacts - mean the aggregate of numerous impacts that are sometimes of little significance / extent, but also of significant impacts, including consequences of other projects which cause impacts of much bigger, frequently extremely serious effects.

Within the category: **Duration of impacts**

K - Short-term Impacts - are the impacts lasting from **one year** to **seven years**.

Ś - Medium-term Impacts - are the impacts lasting from **seven** to **fifteen** years.

D - Long-term Impacts - are the impacts lasting from **fifteen** to **sixty** years.

Within the category: **Frequency of Impacts**

St - Permanent Impacts - are the impacts lasting for more than **sixty** years.

Ch - Momentary Impacts - are the impacts lasting from **seconds** to **minutes**.

The presentation of the impacts in the above manner was on the one hand aimed at a concise summary of professional judgement under which, on the basis of the Project characteristics (Volume II) and diagnosis of the current environmental status (Volume III), the Project impacts on specific environmental components were identified and characterised, while on the other - at the systematisation and standardisation of those impacts in order to further analyse them in the context of determination of significant impacts of the Project on the environment, setting the scope of potential minimisation and compensation measures, or identification of the variant most favourable for the environment (Volume V).

IV.1 Impacts on protected areas and features (land and sea)

Introduction

This chapter presents the assessment of the Project's impact on protected areas and features referred to in Article 6 item 1 of the Nature Conservation Act of 16 April 2004 [492]. The said assessment was carried out both in relation to the land and the marine part of the Project's area of impact on the basis of written sources and the results of the environmental inventories conducted. The results of the surveys of the abiotic elements of the environment, carried out for the purpose of the Project implementation, as well as of the numerical modelling (e.g. analyses of the distribution of thermal water, sediments) that determine the spatial extent of the zones of impact for particular activities related to the project were also an important source of the information used. The detailed description of the modelling conducted and the results obtained can be found in the EIA Report. The descriptions of the surveys conducted, including descriptions of the applied methodologies and results obtained, are presented in appendices to the complete EIA Report in Volume III [Appendix III.2.1 - III.2.16].

IV.1.4 Impact on protected areas and features – marine environment

IV.1.4.1 Introduction

This chapter presents, pursuant to Article 66(1)(6a) of the EIA Act [501], an assessment and comparison of impacts on forms of nature conservation referred to in Article 6(1) of the Nature Conservation Act of 16 April 2004 [492], including on the objectives and qualifying features of Natura 2000 sites, and the continuity of ecological corridors connecting them. The assessment was carried out in relation to the potential impact of the Project on the abovementioned protected areas, located in the marine part of the Project's area of impact. Due to the fact that both the Project Area, the marine survey area as well as the Project impact area are outside the national forms of nature conservation, the subjects of assessment presented in this chapter are in particular Natura 2000 sites, sites of Community importance and integrity of these sites, as well as natural habitats of Community interest.

According to Article 66(1)(9) of the above EIA Act, the EIA report should set out a description of the anticipated measures aimed at avoiding, preventing, reducing or offsetting, in terms of nature conservation, the adverse effects on the environment, in particular on the forms of nature protection referred to in Article 6(1) of the Nature Conservation Act, including for the purpose and qualifying features of Natura 2000 sites, and the continuity of wildlife corridors connecting them, along with the assessment of their efficiency during the Project's implementation, operation, occupancy or decommissioning, respectively. The activities referred to above are presented in detail in [Chapter V.5].

In the assessment of the impact on protected areas, cumulative impacts related to the associated infrastructure and other projects have also been taken into account. In this Chapter, the term "European sites" denotes Special Areas of Conservation, Special Protection Areas, Sites of Community Importance, listed and proposed Ramsar Sites, and sites identified or required as compensatory measures for adverse effects on any of these sites.

Impacts on marine protected features and areas were assessed using the Habitats Regulations Appraisal (HRA). The first stage of the habitat regulations assessment (HRA) was to determine the potential impact of the Project on European sites. If a significant impact could not be ruled out in the survey area, a full Appropriate Assessment (AA) was performed for those areas in the next step. The assessment was prepared on the basis of [456].

IV.1.4.1.1 Legislation Overview

The Habitats Directive [91] and the Birds Directive [89] provide for the designation of sites for the protection of certain species and habitats. The sites designated under these Directives are collectively termed European sites and form part of a network of protected sites across Europe (the Natura 2000 network). The Habitats and Birds Directives were transposed into the Polish legal regulations by the Nature Conservation Act which defines the goals, principles and forms of protection of animate and inanimate nature and landscapes, and Regulation of the Minister of Environment of 12 January 2011 on special bird protection sites [392].

Significant Polish legal regulations for marine environmental protection are: the Regulation of the Minister of Environment of 16 December 2016 on the protection of animal species [394] and the Regulation of the Minister of Environment of 9 October 2014 on the protection of plant species [405]. These regulations establish species that are under strict protection with indication of species requiring active protection (specified in Annex 1). The Regulation also lays down prohibitions and derogations related to individual species or groups of animals, and means of protection of species including the size of protection zones, as well as on the criteria for selecting areas eligible for recognition or designation as Natura 2000 sites. Due to the fact that the impacts described in this chapter interpenetrate to a large extent with the impacts described in chapter [Chapter IV.2], it should be considered as superior as in the case presented and explained in subchapter [Chapter IV.2.4], where the regulatory context is clarified.

IV.1.4.2 Methodology

The HRA methodology used to assess the Project impact on marine protected features and sites is described below.

IV.1.4.2.1 HRA Process

The assessment of the Project impact on marine protected features and areas included four stages:

1. Screening - identification of the significant impact of the Project on European sites taking into account associated infrastructure and other projects;
2. Appropriate Assessment (AA) - if a significant impact of the Project was identified in any of the sites, an assessment was made for that site of the NPP impact on the site conservation objectives, qualifying features, and integrity. Where negative impacts were identified, measures to minimise and mitigate those impacts were also taken into account.
3. Evaluation of alternative solutions - if an adverse effect on the integrity of the site was identified, it was examined whether there were any alternative ways of implementing the Project that would prevent adverse effects on the integrity of the entire European site.
4. Evaluation of negative impacts that cannot be excluded by applying alternative solutions - evaluation of compensatory measures that will be used in the Project.

With respect to HRA Stage 2, the integrity of a European site relates to the site's conservation objectives and has been defined in guidance as "*the coherent sum of the site’s ecological structure, function and ecological processes, across its whole area, which enables it to sustain the habitats, complex of habitats and/or populations of species for which the site is designated*" [273]. Therefore, the adverse effect on integrity is that the site is unlikely to be able to maintain its conservation status as it was when it was established. At the screening stage, a threshold of a likely significant effect (LSE) was used to determine whether effects on European sites should be assessed further. The Habitats Regulations do not define the LSE. However, in the Waddenzee case (Case C-127/02) [236], the European Court of Justice found that an LSE should be presumed and an AA carried out if it could not be excluded on the basis of objective information that the Project would not have significant effects on the conservation objectives of the site concerned, whether implemented on its own or in combination with any other project. The Advocate General’s opinion of the Sweetman case (Case C-258/11) [238] states that in order to conclude that an LSE occurred “*there is no need to **establish** such an effect... it is merely necessary to determine that there **may** be such an effect*” [emphasis in the original].

For the reasons highlighted above, the assessment process follows the precautionary principle and the word “likely” is regarded as a description of a risk (or possibility) rather than an expression of probability.

IV.1.4.2.2 Screening

Screening may be used to exclude European sites and parts of works from further evaluation. This is possible if it is determined that significant impacts are unlikely (e.g., if the sites or qualifying features are not clearly vulnerable [exposed and/or sensitive] to the effects of the Project due to the lack of any realistic possibility of impact).

The result of the screening stage is the determination of the absence of LSEs on any qualifying features of the site or the identification of LSEs (which cannot be excluded, for one or more qualifying features of the site).

If the latter is the case, an Environmental Assessment - Stage 2 HRA (Appropriate Assessment - AA) should be conducted.

On 12 April 2018, the Court of Justice of the European Union (CJEU) issued a ruling in Case C323/17 (People over Wind, Peter Sweetman v Coillte Teoranta) [237] in which it stated (in point 41):

“Article 6(3) of Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora must be interpreted as meaning that, in order to determine whether it is necessary to carry out an appropriate assessment of the implications, for a site concerned, of a plan or project, it is not appropriate, at the screening stage, to take account of the measures intended to avoid or reduce the harmful effects (mitigation) of the plan or project on that site.”

This means that any minimisation measures relating to protected sites should not be considered at the screening stage but at further HRA analysis stages in order to determine whether no adverse effects on site integrity can be demonstrated.

The screening assessment provided within this HRA takes into account the CJEU ruling on “People over Wind”. Conservative assumptions were also made, that is, if the impact of the Project on a European site is identified, the site will undergo the Appropriate Assessment (AA). This ensures all effects are captured, including *de minimis* effects.

In the screening process, only those designated qualified features and European sites were identified where it could be demonstrated that no significant impact was likely to occur.

The screening stage is characterised in the European Commission Guidelines (2001, 2018) "Assessment of plans and projects significantly affecting Natura 2000 sites: Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC” (“The European Commission Guidance”) as a four-step process. These steps are:

- Step 1. Determining whether a project or plan is directly connected with or necessary to the management of the site.
- Step 2. Description of a project or plan and the description and characterisation of other projects or plans that in combination have the potential for having significant effects on the Natura 2000 site.
- Step 3. Identification of potential impacts on the Natura 2000 site.
- Step 4. Assessment of significance of all impacts on the Natura 2000 site.

When each of these steps has been worked through there are three potential outcomes:

- The Project is directly connected with or necessary to the management of a European site or sites and therefore does not require appropriate assessment (HRA Stage 2).
- One or more LSEs on designated features of European sites are identified and the Project requires to undergo an Appropriate Assessment (AA).
- No LSEs on designated features of European sites are identified as there is no pathway by which such effects could occur, or LSEs can be excluded on the basis of objective information. Thus, there is no requirement to perform AA.

In order to determine whether the Project may cause one or more LSEs in the European site(s), it is necessary to recognize the works associated with each phase and stage of the Project, as well as the potential changes to the environment that they may cause (e.g., generation of ambient noise). Subsequently, the effects of these changes on designated European sites (e.g. disturbance of marine mammals resulting in increased energy expenditure and decreased energy intake, which may result in lower survival and productivity rates), must be determined.

By applying the above procedure and defining the parameters of the assessment, it is possible to identify European sites (and the qualified features within them) that may be subject to LSE. These parameters can be used to identify other projects that should be considered as part of the cumulative effects assessment.

IV.1.4.2.3 Identification of impacts

The European sites that should be considered within the screening process are those where, in light of the precautionary principle, the risk of likely significant effects of the Project alone and/or in combination with other plans and projects cannot be excluded on the basis of objective evidence and taking into account the Zone of Influence (ZoI).

The current guidelines on ecological assessments (CIEEM, 2018) state that: "The 'zone of influence' for a project is the area over which qualifying features may be affected by biophysical changes as a result of the proposed project and associated activities. This is likely to extend beyond the project area, for example where there are ecological or hydrological links beyond the area boundaries" and that "the zone of influence will vary for different ecological features depending on their sensitivity to an environmental change."

The zone of influence varies depending on the nature of the activities undertaken during implementation of the Project and the sensitivity of the receptor (e.g., flora, birds, terrestrial mammals) to the impact encountered.

In order to determine which European sites must be included in the analysis, it is necessary to identify: the works associated with the Project implementation, the geographic scale at which changes caused by these activities can be identified, and the type of receptors (e.g., designated qualified features) sensitive to these activities.

The process of identifying European impact-sensitive sites takes place in several steps:

- identification of the activities associated with the construction phase, operational phase and decommissioning phase which may result in changes to basic environmental parameters (for example seabed damage);
- determination of the changes that could occur as a result of the activities identified;
- determination, based on available literature and expert assessments, of the distance over which these changes may occur;
- identification of the potential qualifying features (including functional habitat requirements) that may be impacted by the changes identified.

On this basis, criteria based on potential impact pathways were specified. These can be used to identify European sites that should be included in the assessment process due to their proximity to the Project site variants under consideration, as well as due to functional links, habitats and mobile fauna.

For birds, which are the qualifying features of Natura 2000 sites, the radius of 20 km from the Project area was established, which determined the maximum range of communication for these qualifying features [437], identified with the use of European Environment Agency's Natura 2000 database [297]. Ramsar sites designated within the aforementioned radius of the Project area [358] were also included in the process of identifying impacts of the Project on European sites. In addition, the Standard Data Forms for Natura 2000 sites and Ramsar site fact sheets were analysed to identify the qualifying features that are seabirds, and that are known to use the onshore and offshore marine environment.

Seabirds or marine mammals if they are at a distance from a given European site may still interact with the Project. The following approach was adopted in order to identify species and locations where such interactions may occur.

In the case of seabirds, according to Thaxter *et al* [464] and Woodward *et al* [518], average maximum foraging distances were used to identify SPAs with breeding seabirds as designated qualifying features. For cetaceans, all European sites which include harbour porpoise as a qualifying feature were included if they fell within a range of 400km, based on the distribution of the species within the Baltic Sea, according to the HELCOM Species Information Sheet [162]. For seals, a distance of 145km was applied for grey seal [466] and 120km for harbour seal [430]. For migratory fish, all European sites which include Atlantic salmon, sea trout and sea lamprey within the Baltic Sea were included [286].

The Birds and Habitats Directives set out in general terms the designation of qualifying features of Natura 2000 sites. However, the species and habitats that are the qualifying features in a given site are determined by various designation criteria, for example the size of the population in relation to the national population. Each Natura 2000 site has a Standard Data Form which contains all the most important information, including data identifying the site (name, code), as well as natural information about the species and habitats occurring in its area, and an assessment of the importance of the site in relation to individual species and habitats, which shows which of the species are the qualifying features in that Natura 2000 site. Pursuant to the CJEU Case C-304/05 [232], the habitats and species designated with the letter D in the SDF are not the qualifying features in Natura 2000 sites. However, for completeness, all species (including habitats and species designated with the letter D on N2K data forms) are considered within this assessment.

IV.1.4.2.4 Identification of cumulative impacts

Cumulative impacts on European sites may result from the Project alone and/or in combination with other plans or projects. Assessment of cumulative effects was carried out in accordance with the guidelines of the European Commission (2001 and 2018a, 2018b, 2020) [248], [104], [105], [107] and the OSPAR Commission (2012) [329].

The identification of significant projects followed the methodology described above. Of key importance in identifying cumulative impacts is the overlap in spatial and temporal extent that may occur with the implementation of projects (e.g., overlap of impacts due to simultaneous construction activities). It is also essential to consider the areas over which potential receptors may travel (for example a bird may pass through several areas where development is planned, when moving between roosting and feeding grounds within or between designated conservation sites). Existing activities in the Project area, including shipping and fishing activities are unlikely to change significantly throughout the construction activities and are therefore discussed as part of the baseline situation.

The assessment of cumulative impacts included:

- ongoing projects;
- projects for which relevant decisions have been issued but are not yet implemented;
- submitted application(s) for which a decision has not yet been issued;
- all projects subject to appeal procedures for which a decision has not yet been issued;
- projects specified in land-use plans, including a development plan.

Following the identification of projects within the research area, an initial screening is undertaken in order to filter out:

- minor proposals (e.g. installation of marker buoys, removal of marine litter / minor dropped objects, minor maintenance of existing structures) with no potential to cause LSE in-combination;
- proposals with no potential to overlap the Project due to differing timescales for construction, operation and/or decommissioning.

Those that are to be included within the in-combination assessment are then considered with regard to the identified potential effects.

IV.1.4.2.5 Source data and studies

This assessment took into account the results of research and analyses of the marine environment components compiled in the following reports:

- Report on the characteristics and valorisation of the environment for the EIA Report and Site Evaluation Report [209];
- Final Report with survey results for the EIA Report and Site Evaluation Report regarding a phyto- and zooplankton inventory [216];
- Final Report with survey results for the EIA Report and Site Evaluation Report regarding a phytoplankton inventory [216];
- Final Report with survey results for the EIA Report and Site Evaluation Report regarding a phytobenthos inventory [211];
- Final Report with survey results for the EIA Report and Site Evaluation Report regarding a zoobenthos inventory [212];
- Final Report with survey results for the EIA Report and Site Evaluation Report regarding an ichthyofauna inventory [215];
- Final Report with survey results for the EIA Report and Site Evaluation Report regarding a avifauna inventory [213];
- Jacobs (2021) Marine Hydrodynamics and Water Quality. S.A. 10.11.04. Task 4d Report: Marine Impact Assessment Report – Lubiatowo - Kopalino. Report Reference: 209959-1011-DV10-RPT-0004-EN-2. Report for PEJ sp. z o.o., August 2021 [256];
- Jacobs (2021) Waterborne Noise and Vibration (Marine Mammals and Fish) – Impact Assessment. S.A. 05.09.03. Report reference 209891-0509-DV10-RPT-0016- EN | 3. Report for PEJ, 30 July 2021 [307];
- HELCOM map and data service (https://maps.helcom.fi/website/mapservice/) [161];
- HELCOM biodiversity database (https://maps.helcom.fi/website/biodiversity/) [160];
- Final Report with study results for the EIA Report and Site Evaluation Report regarding an inventory of marine mammals [214].

IV.1.4.3 HRA – Variant 1 – Lubiatowo - Kopalino

IV.1.4.3.1 HRA Stage 1 Screening – Step 1: Identification of the Project's relevance to the management of conservation of European sites

Stage 1 Step 1 was described in detail in the full version of the EIA Report.

IV.1.4.3.2 HRA Stage 1 Screening – Step 2: Description of the Project planned

Stage 1 Step 2 was described in detail in the full version of the EIA Report.

IV.1.4.3.3 HRA Stage 1 Screening - Step 3: Identification of potential effects on European sites

Stage 1 Step 3 was described in detail in the full version of the EIA Report.

IV.1.4.3.4 HRA Stage 1 Screening - Step 4: Assessment the significance of all potential effects on European Sites

Stage 1 Step 4 was described in detail in the full version of the EIA Report.

IV.1.4.3.5 HRA Stage 2: Identification of the need to carry out Appropriate Assessment

IV.1.4.3.5.1 Summary of screening outcomes

The Screening (HRA stage 1) has indicated that the European sites and their qualifying features presented in step 1 have potential for LSE arising from the implementation of the Project. They are also considered in the present subchapter, for the purpose of the Appropriate Assessment (AA).

For each of the designated sites, LSEs will be assessed in relation to the conservation objectives that apply to the specific protected features under consideration. Where detailed conservation objectives are not available for a European site, the following generic conservation objectives are applied, that is, avoidance of the worsening of the state of the natural habitats, as well as the habitats of flora and fauna for the protection of which the Natura 2000 has been designated, avoidance of the negative impact on the qualifying species for which the Natura 2000 site has been designated, and avoidance of the worsening of the integrity of the Natura 2000 site or its links with other sites.

IV.1.4.3.5.2 Assessment of potential effects

The potential impacts are detailed below, taking into account the minimisation measures intended to mitigate any adverse effects on the integrity of a European site and the associated conservation objectives.

Impact on European sites and habitats - seawater quality

A variety of potential effects relating to water quality parameters have been identified, including:

- changes in total suspended sediment (TSS) / increased turbidity as a result of construction activities in the marine environment;
- spills and accidental releases from vessels during dredging and construction;
- increased ambient water temperature as a result of operational effluent discharge;
- changes to water quality through operational effluent discharge;
- increased salinity from operational effluent discharge.

The modelling of the worst case scenario for sub-variant 1A demonstrated that, for both summer and winter scenarios and considering the 30-day chronic exposure period, increases in suspended sediment concentrations due to dredging works are less than 5mg outside the Project Area. This was compared with the results of the measurements carried out between 2017 and 2018 (baseline conditions), when the maximum values were 6.22mg/l and on this basis it was concluded that the changes involving increased TSS/turbidity will not adversely affect the integrity of any designated site.

In addition to all the Project-specific measures outlined within the Construction Environmental Management Plan (CEMP) (including detailed protocols and detailed plans, as required), all vessels associated with the Project would be required to adhere to international best practice. These include the guidelines laid down in the International Convention for the Prevention of Pollution from Ships (MARPOL), such as the limit of 15ppm oil in water in operational vessel discharges. Thus, no significant impacts on water quality are expected. The pollution from vessel operations will not affect the integrity of any designated European site.

The modelling of the cooling water discharge was carried out for the worst open cooling system scenario. The areas in which a specific increase in temperature is expected have been designated. Considering an increase of 2°C or more, the area affected would be approximately 7.2km^2, which is sufficiently localised to avoid affecting the integrity of any designated site.

The discharges of operational effluent arising from the individual sub-variants of the Project contain a range of individual components, the behaviour of which will vary depending on their chemical composition and their reaction with seawater, as well as the prevailing direction of water movement. The majority of constituents pose no environmental hazard, either due to their low toxicity or the fact that the relevant EQS/ELV is readily achieved. For other constituents, a wide variety of minimisation techniques are available.

- Heavy metals can be easily removed by a wide variety of standard methods of treatment, e.g. through chemical precipitation (typically using lime) or the commonly applied ion-exchange methods. In order to minimise capital costs and waste production, the treatment should be targeted at the specific effluent streams containing elevated concentrations of metals, for example effluent from the SGS blowdown system.
- Hydrazine, present in relatively high concentrations in cooling water effluent, can be mitigated by the use of precise dosing to ensure low residual concentrations, through reaction of hydrazine with oxygen in steam generators to form nitrogen and water (this is the purpose of adding hydrazine); and degradation of hydrazine to ammonia in steam generators and high-pressure heat exchangers. Moreover, in order to further reduce the concentration, hydrazine decays naturally in seawater, and will react with biocides in the effluents. Specific treatment is also available if needed, by oxidation with hydrogen peroxide (using a copper catalyst) or chlorine/hypochlorite.
- Excess biocide (assumed to be chlorine) releases can be mitigated through reduction in application. This can be achieved inter alia by a combination of dosing control and use of non-toxic biofouling control including surfactants, physical cleaning, self-polishing coatings, and antifouling paints. For the closed cooling variants, chlorine biocides can be neutralised in the cooling tower pond before effluent discharge, typically using metabisulphite.

If needed, in order to remove excess phosphorous, hydrazine, and metals, treatment and control of chlorine/TRO emissions would be introduced to ensure that the relevant EQS will be met at the point of discharge, or, at worst, that the area where EQS is exceeded will be minimal. It can therefore be concluded that chemical water quality impacts from the operational discharge would not affect the integrity of any designated sites.

The closed cooling system in sub-variants 1B and 1C will discharge brine. In order to evaluate the potential impact, considering a worst-case scenario (summer and full power operation), Delft-3D far-field modelling was carried out. The 98th percentile salinity anomaly of 0.5psu was shown to extend less than 100m, with salinity returning to ambient within several hundred metres. There would therefore be no adverse effect on the integrity of any designated site from the brine in the operational discharge.

In summary, with the adoption of the aforementioned minimisation measures, there will be no identifiable effects and therefore no adverse effect on the site integrity on any European site with regard to any qualifying feature associated with changes of the physical and chemical water quality, temperature, or salinity.

The following LSEs deriving from effects on European site habitats via marine water quality are therefore not taken any further for individual European site assessment:

- indirect impact on habitats – changes in water quality;
- indirect effects from impact on food supply - changes in water quality.

Impact on European sites and habitats - plakton communities

Potential effects due to changes in plankton populations are related to:

- changes to plankton communities as a result of changes in water quality;
- risk of eutrophication and associated phytoplankton blooms leading to environmental degradation (for example, hypoxia);
- indirect effects through changes in prey availability for fish, bird, and marine mammal species.

The impact on changes in water quality is insignificant and would not affect the integrity of any of the designated protection sites, and thus would not affect the population of the qualifying organisms.

This is also true for nutrients in the NPP operational discharge, which represent, in the worst case, a slight increase of the already high load into already eutrophic waters. The excess loading of nitrogen would, at worst, represent less than 0.05% of current inputs, while phosphorous would at worst be approximately 1.3% of current inputs from the Vistula river basin. Nutrient discharge, particularly of phosphorous, can be further mitigated as follows:

- In special cases, the doses of polyphosphates and phosphonates would be reduced to sub-standard levels. If dosing levels could be reduced to avoid adverse environmental effects while maintaining protection of the cooling water infrastructure and its functioning, the solution would be to reduce phosphates.
- Use of alternative water treatment chemicals containing little or no phosphorus. Such treatment chemicals have been developed specifically for uses where discharges of compounds containing phosphorous are restricted. Examples include organic inhibitors (e.g. those containing citric acid, some with zinc) and amidosulphonic acid.

Adjustment of dosing levels and the choice of treatment chemicals that do not contain phosphorous to further reduce nutrient loading would mean that nutrients in operational effluent would not increase the occurrence of wide-scale phytoplankton blooms and the associated hypoxia.

Thus, indirect effects on the food chain that underpins the populations for which European sites are designated would not occur. The changes in plankton will have no negative effect on the integrity of any European site.

The following LSEs deriving from effects on European site habitats via marine water quality are therefore not taken any further for individual European site assessment:

- indirect impact on habitats – changes in water quality;
- indirect effects through impact on prey availability – benthic species;
- indirect effects through impacts on prey availability – fish species.

Impact on European sites and habitats - benthos

The potential impact on benthos includes:

- direct effects on benthic populations from deteriorated water quality (including increased temperature, salinity and chemical pollution);
- habitat loss for benthic fauna, including as a result of smothering as suspended sediment resettles out of the water column; and
- indirect effects through changes in prey availability for fish, bird, and marine mammal species.

As described above, the impact on changes in water quality is insignificant and it would not affect the integrity of any of the designated protection sites, and thus would not affect the population of the qualifying organisms.

The spatial extent of any seabed smothering and consequent habitat loss is minimal. Therefore, the consequent effects on benthic populations will not affect the integrity of any European sites.

Because the population and structure of benthic communities will not be altered to any meaningful extent, the role of benthos as a prey for fish, birds, and marine mammals will not be affected, and therefore there will be no adverse effect on the site integrity of any European site supporting benthic habitats.

In view of the above, the LSEs resulting from the effect on the habitats of the considered European sites via benthic habitats are therefore not taken any further for individual European site assessment:

- Indirect effects through impact on prey availability – benthic species.

Impact on European sites - fish

Fish fauna serve as prey for several species for which European sites are designated, including predatory fish, piscivorous birds, and marine mammals. Changes in fish populations therefore have the potential to affect the integrity of these sites in the following ways:

- Impingement, entrainment and/or entrapment of fish species into cooling water intake infrastructure;
- Indirect effects through changes to prey availability (benthos or plankton) for fish;
- Effects as a result of changed physico-chemical water quality (temperature, salinity, TSS and chemical pollution);
- Injury and/or potential mortality as a result of underwater noise.

The majority of adult fish move fast enough to avoid entrainment/entrapment in the cooling water intake. For example, key prey species such as sprat have a sustained swimming speed of approximately 0.56m/s, compared to the draw velocity of the intake of 0.3m/s, allowing most fish to escape entrapment. Sandeels, which are another important food resource for piscivores, are predominantly benthic and less amenable to entrapment by the intake stream. Any ichthyoplankton entrained (assuming 100% mortality) represents an extremely small fraction of the adult stock when natural mortality rates are factored in. Accordingly, any effects of entrapment, impingement, and entrainment will not substantially affect the local fish populations.

As previously discussed, because the population and structure of planktonic and benthic communities will not be altered to any meaningful extent, the role of benthos as a prey for fish will not be affected, and therefore there will be no adverse effect on fish populations relating to prey availability.

Similarly, the impact on changes in water quality is insignificant and will not affect any of the designated protection sites, and thus would not affect the population of the qualifying organisms.

The temporary nature of construction noise and the existing level of vessel noise from local shipping and fishing activity will have no significant impact on the population of prey fish (injury or displacement). Thus, there will be no adverse impact on the integrity of any of the European sites.

Therefore, the LSEs deriving from effects on the habitats of the analysed European sites via marine water quality were not taken any further for individual European site assessment:

- Indirect effects through impacts on prey availability – fish species.

Effects of invasive species on European sites

Invasive species may substantially affect marine ecosystems and food web, and thus the integrity of the European sites. The vector for such introductions is primarily through ballast water. Particular concern surrounds the invasion of gelatinous zooplankton predators such as the ctenophore *Mnemiopsis leydyi*, that can adversely affect pelagic fish stocks through predation on larvae. However, international agreements have focused on the control of accidental introductions of invasive species. In order to control the risk of introducing INNS via ballast water, all ships associated with the Project will comply with the International Convention for the Control and Management of Ships' Ballast Water and Sediments of 2004. Ships (including dredgers and supply ships delivering abnormal loads to the MOLF) must therefore carry:

- a ballast water management plan specific to each ship, including a detailed description of the actions to be taken to implement the ballast water management requirements and supplemental ballast water management practices;
- A ballast water record book to record when ballast water is taken on board, circulated, or treated for ballast water management purposes and discharged into the sea. It should also record when ballast water is discharged to a reception facility, and accidental or other exceptional discharges of ballast water;

- An International Ballast Water Management Certificate (for ships of 400gt and above) to certify that the ship carries out ballast water management in accordance with the BWM Convention and to specify which standard the ship complies with, as well as the date of expiry of the Certificate.

Adherence to these regulations would result in no adverse effect on the integrity of any European site from the introduction of invasive species in ballast water.

The following LSEs that stem from the effects of invasive species are therefore not taken any further for individual European site assessment:

- Indirect effects via potential changes to prey availability as a result of the introduction of invasive and non-native species (INNS).

Impact on European sites and habitats - marine mammals

For all the analysed sites, potential LSEs on marine mammals associated with "Increased underwater noise levels, arising from construction activities in the marine environment", "indirect effects on marine mammals via prey availability", "disturbance through increased vessel activity", and "collision risk through increased vessel activity" were determined to have no adverse effects on any sites of qualifying features due to the adoption of a series of minimisation measures outlined below. Detailed information on the assessment of each impact pathway are presented in chapter [Chapter IV.4.2] of the EIA Report and are summarised below.

The majority of the listed European sites that serve to protect marine mammals do not overlap with the Project Area. The Mierzeja Sarbska special bird protection area is an exception, as it slightly overlaps with the Project Area, and its qualifying features include grey seal. The mobility of marine mammals could result in members of further designated populations being located within ranges in which pertinent noise disturbance thresholds are met due to the most onerous construction activities.

The European protected sites in which marine mammals are the qualifying features, and those that are believed to be potentially at risk are:

- Mierzeja Sarbska SAC
  - Grey seal.
- Ostoja Słowińska SCI
  - Grey seal
  - Harbour porpoise
- Słowiński Park Narodowy (Słowiński National Park) / Ramsar Site
  - Grey seal
  - Porpoise
- Zatoka Pucka i Półwysep Helski SCI
  - Grey seal
  - Porpoise
- Kaszubskie Klify SCI
  - Grey seal
  - Porpoise
- Hoburgs bank och Midsjöbankarna
  - Porpoise
- Pommersche Bucht SAC

  - Porpoise
- Ostoja na Zatoce Pomorskiej SCI
  - Porpoise
- Wolin i Uznam SCI
  - Porpoise
- Adler Grund og Rønne Banke SAC
  - Porpoise
- Sydvästskånes utsjövatten SAC
  - Porpoise
- Greifswalder Boddenrandschwelle und Teile der Pommerschen Bucht SAC
  - Porpoise
- Darßer Schwelle SAC
  - Porpoise
- Kadetrinne SAC
  - Porpoise
- Plantagenetgrund
  - Porpoise
- Westrügensche Boddenlandschaft mit Hiddensee
  - Porpoise
- Erweiterung Libben, Steilküste und Blockgründe Wittow und Arkona
  - Porpoise
- Greifswalder Bodden, Teile des Strelasundes und Nordspitze Usedom SAC.
  - Porpoise
- Greifswalder Boddenrandschwelle und Teile der Pommerschen Bucht
  - Porpoise
- Greifswalder Bodden, Teile des Strelasundes und Nordspitze Usedom SAC.
  - Porpoise
- Greifswalder Boddenrandschwelle und Teile der Pommerschen Bucht
  - Porpoise

The minimisation measures that will be implemented as part of the Project are:

- Adherence to the statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise. The protocol provides guidance on mitigation techniques that need to be implemented before the commencement of and during piling operations. The recommendations are described in detail in chapter [Chapter V.3] of the EIA Report;
- In addition to any Project-specific measures outlined within the Construction Environmental Management Plan (CEMP) (including detailed protocols and sub-plans, as required), all vessels associated with the Project would be required to adhere to international best practice.

- Use of technology and techniques that limit noise propagation in the water column and in the air.

The implementation of these actions is standard practice for marine development projects such as cable installations, and offshore wind farms. Therefore, it was concluded that the above measures are both possible to implement and effective at minimising the effects on individual animals, and the local populations to which they belong.

Underwater noise and disturbance effects on marine mammals are possible during the development, construction, and operational stages/phases. The assessment of the impact of underwater noise on marine mammals is discussed in detail in chapter [Chapter IV.10.2] of the EIA Report. It was concluded that once the minimisation measures are introduced, underwater noise at the construction stage will have no impact on the integrity of any European site for marine mammals.

Collisions between the Project-related vessels and marine mammals during the installation of marine infrastructure have the potential to cause injury and death, with subsequent effects at both an individual and population level. Vessels associated with the Project are unlikely to be travelling either at speed or in an erratic manner, and thus would not prevent marine mammals from avoiding collision. Thus, the potential effects resulting from the collisions between marine mammals and vessels (notably corkscrew cuts spiralling around their bodies) would not adversely affect the integrity of any European site.

The indirect effects on marine mammals due to changes in prey availability may affect individuals' ability to feed, with subsequent effects on the local population. However, based on the assessments of plankton, benthos, ichthyofauna, and marine avifauna [Chapter IV.2] of the EIA Report, the Project is considered to only have a local and short-term effect, and it would not substantially affect other trophic levels or the very population of the analysed species. Consequently, it is expected that there will be no adverse effect on the integrity of any European site due to prey availability for marine mammals.

The temporary loss of a habitat through impacts or results of the collisions will not result in a long-term change in population trend or a significant decrease in range for porpoises and seal. This is because the reduction in potential foraging area is small and therefore its temporary loss will not affect the fitness of individual porpoises or seals and will result in no adverse effect on the integrity of any European site from temporary loss of habitat.

IV.1.4.3.5.3 Predicted effects and their potential for adverse impact on site integrity

Assessments for open cooling sub-variant 1A and closed cooling sub-variants 1B and 1C during the development stage, construction phase, and operational phase have been undertaken for LSEs on habitats with regard to impact on seawater quality, plankton communities, benthic habitats, fish prey species, and invasive and non-native species (INNS). The LSE assessments within this section, carried out to inform an AA, have concluded that there are no adverse effects on the integrity of any European habitat with regard to the considered impacts and effects such as:

- potential changes in prey availability as a result of the introduction of invasive and non-native species (INNS);
- indirect effects through impact on prey availability – benthic species;
- indirect effects through impacts on prey availability – fish species;
- mutilation/fatalities and subsequent impact on the population resulting from entrapment and impingement of marine organisms in the cooling water system;
- indirect effects through impacts on prey availability – changes in water quality;
- direct impact from construction activities - underwater noise.

Moreover, it has been established that there are no adverse effects on the integrity of any European site with qualifying marine mammals for sub-variants 1A, 1B, or 1C at the development stage, in the construction phase, or in the operation phase.

The remaining LSEs associated with the development stage, the construction phase, or the operational phase that may have potential for adverse effects on European site integrity are:

- direct impact resulting from construction activity through airborne noise, light, and visual impact (development stage and construction stage);
- direct disturbance resulting from construction activity through increased vessel traffic (development stage and construction stage);
- direct impact through operation of the MOLF (construction phase).

The listed LSEs are relevant to the following qualifying features of the considered European sites, for which further assessment was undertaken:

- Przybrzeżne wody Bałtyku SPA
  - Common scoter
  - Long-tailed duck
  - Velvet scoter
  - Razorbill
- Pobrzeże Słowińskie SPA
  - Great cormorant

IV.1.4.3.5.4 Przybrzeżne wody Bałtyku SPA - common scoter, long-tailed duck, velvet scoter, and razorbill

Species baseline, distribution and abundance

In the coastal zone, surveys recorded 41 bird species with a total of 32,491 specimens [213]. Two of the most abundant species recorded were long-tailed duck (46% of total bird abundance) and velvet scoter, both of which are classified as benthivorous species (i.e. birds diving to look for zoobenthos).

In the marine zone, the most frequently recorded species were velvet scoter (66.5% of total bird abundance) and long-tailed duck (31.5%). The only other species that accounted for more than 1% of the total number of specimen recorded was common scoter (1.2%).

The highest average densities (50 birds/km^2 to 100 birds/km^2) occurred in the coastal zone, and in the central area and the south-eastern area of the coastal zone. Average densities (5 birds/km^2 to 50 birds/km^2) were recorded in the central, north-western, and north-eastern parts of the coastal zone as well as in the coastal zone. The lowest densities were observed in the western part of the marine zone and just at the coastline.

<u>Common scoter</u>

During the spring period, the average density rose above 100 birds/km^2 in only two places, at the western and at the eastern boundary of the marine survey area. Elsewhere, densities did not exceed 5 birds/km^2.

In the summer, common scoters were recorded infrequently. Those birds that were recorded were found in the eastern part of the marine survey area, with an average density below 5 birds/km^2.

During the autumn migration period, common scoters were highly dispersed across the Marine Survey Area and only locally did their average density reach 50 birds/km^2.

In the winter, the abundance of common scoters was lower than during the autumn migration and they were not recorded in the marine zone. Slightly larger concentrations of birds were recorded in the central and western part of the coastal zone with densities reaching up to 10 birds/km^2.

Long-tailed duck

During the spring period, the highest numbers were found in the coastal zone and in the central part of the marine zone. Densities exceeding 100 birds/km^2 were recorded over large areas and locally they exceeded 500 birds/km^2.

In the summer, long-tailed ducks were not recorded during any surveys. During the autumn period the average density of this species was lower than those recorded in the spring and only locally, within small areas, did the birds form groups with a density exceeding 100 birds/km^2. Within most of the marine survey area, the density of the long-tailed duck was between 1 and 5 birds/km^2.

High average density was recorded in the winter period, although the highest density, exceeding 100 birds/km^2 was less extensive than those recorded during the spring. In the marine zone, most long-tailed ducks gathered in the central part of this marine area.

Razorbill

Razorbills were highly dispersed in the marine survey area and only occurred offshore. In all periods, except for the summer, the average density there was between 0.1 and 5 birds/km^2. In the summer, this species was recorded infrequently.

Velvet scoter

During the spring velvet scoter were recorded across all of the marine survey area, although larger flocks were only observed in the south-western part of the marine zone, where the density exceeded 50 birds/km^2, whilst the average densities were below 5 birds/km^2.

In the summer, only a single velvet scoter was found within the survey area.

In the autumn, this species appeared in a greater number than in the spring. In the western and in the eastern part of the marine survey area, the average densities exceeded 100 birds/km^2, locally reaching 1,000 birds/km^2. Lower numbers of velvet scoter were observed in the central part of the marine survey area, where the densities were below 50 birds/km^2.

In the winter, velvet scoter was the most numerous species in the marine survey area. In the area covering the western and central part of the marine zone, the average density exceeded 100 birds/km^2, locally reaching 1,000 birds/km^2. A similar, albeit smaller, area with high concentrations of this species was located in the eastern part of the Site.

LSE - impacts resulting from construction activity through airborne noise, light, and visual impact (development stage)

Activities associated with the construction of the MOLF and of the construction phase STW outfall have the potential to result in displacement of marine bird features, reducing the usable foraging area for species and potentially leading to the utilisation of sub-optimal foraging or moulting areas and ultimately causing indirect habitat loss. Birds may be affected by increased noise and light created by construction activities, as well as the presence of people within the marine and coastal zone. In terms of distance from construction activity, behavioural responses vary with species, with some responding at around 500m distance for sensitive species like scoters, whilst for other species such as gulls this distance varies from 50-150m.

Based on a disturbance distance of 500m, a total area of about 2km^2 could be affected by activity at jack-up barge locations associated with the construction of the MOLF and dredging locations associated with the STW. This is equivalent to 0.1% of the area of the Przybrzeżne wody Bałtyku SPA.

It should be noted that the impacts related to vessel traffic are assessed separately below.

Over-wintering common scoters, long-tailed ducks, razorbills and velvet scoters were recorded in internationally significant numbers across the entire marine survey area and are sensitive to impacts caused by construction activity via airborne noise, light, and visual effects.

The duration of the impacts will be brief (short-term), as effects would only occur during the period that the MOLF and STW are under construction and the total area within which common scoter, long-tailed duck, razorbill, and velvet scoter would be affected by disturbance would be minimal in comparison to the total area of alternative habitat available (amounting to less than 1% of the area covered by the SPA).

It is concluded that any effects on all marine seabirds from direct impacts during the development stage would be minimal and not significant.

In terms of direct disturbance through construction activity via airborne noise, light, and visual impact during the development stage, there would be no adverse effects on common scoter, long-tailed duck, razorbill, and velvet scoter and consequently on the site integrity of the Przybrzeżne wody Bałtyku SPA.

LSE - direct impact resulting from construction activity through airborne noise, light, and visual impact (construction phase)

The area in which impacts may occur during the construction phase was based on a disturbance distance buffer of 500m and taking account of the cooling water intake and outfall locations of approximately 6km and about 3.7km from the coastline (the FRRS falls within the same footprint as the cooling water intake, and extends for approximately 1km), a total area of 9.7km^2 would be affected by activity associated with dredging locations. This is equivalent to 0.5% of the area of the Przybrzeżne wody Bałtyku SPA.

It should be noted that the impacts related to by vessel traffic are assessed separately below.

Over-wintering common scoters, long-tailed ducks, razorbills, and velvet scoters were recorded in internationally significant numbers across the marine survey area and are sensitive to impacts resulting from construction activity via airborne noise, light, and visual effects.

The duration of the impact is short-term, as effects would only occur during the construction phase of the Project, and the total area within which common scoter, long-tailed duck, razorbill, and velvet scoter would be affected by disturbance would be minimal in comparison to the total area of alternative habitat available (amounting to less than 1% of the area covered by the SPA).

It is concluded that any effects on marine seabirds arising from direct impacts during the construction stage would be negligible.

In terms of direct disturbance through construction activity via airborne noise, light, and visual impact during the construction stage, there would be no adverse effects on common scoter, long-tailed duck, razorbill, and velvet scoter and consequently on the site integrity of the Przybrzeżne wody Bałtyku SPA.

LSE - direct impact from construction activity through increased vessel traffic (development stage)

The focus of marine operations at the development stage will be around the MOLF and STW pipeline and outfall, with support and safety vessels required to attend the jack up barges during construction of the MOLF and dredging vessels associated with construction of the STW. The impacts at sea and the works associated with vessel activity may pose a threat to seabirds. The risk-avoidance behaviour of birds may reduce the time available for other activities such as feeding, resting, or mating. Observable responses by seabirds include flying off, diving, and increased alertness, which can result in loss of energy and opportunities, displacement, and habitat loss. The impacts caused by vessels may thus reduce survival and reproductive success and affect population dynamics.

Impact responses differ among species. Some species are more sensitive than others. A ship traffic disturbance vulnerability index (DVI) [456] that takes account of species' shyness, energetic cost of escape, and population metrics for a range of species in the Baltic Sea has been used to assess the potential impacts on the seabirds assessed, and is summarised in table [Table IV.1- 28].

Table IV.1- 28 Flush distances and DVI

No.	Species	Mean flush distance: individual (m)	Mean flush distance: flock (m)	DVI
1	Velvet scoter	474	444	68.4
2	Razorbill	395	330	51.3
3	Common scoter	1,600	1,015	43.3
4	Long-tailed duck	389	325	40.4

Source: [456]

Seabirds may habituate and even adapt to disturbances by ship traffic if they are able to identify vessels as non-threatening objects. There is already fishing activity within the SPA and the local area, albeit at a low level, meaning that birds would be habituated to anthropogenic presence. Any works would also be undertaken subject to best practice, and vessels associated with the works would not be travelling erratically or at speed once in the vicinity of the works. However, ships differ greatly in size, shape, speed, and engine noise, making recognising them as non-threatening objects difficult. In an environment where predation risk exists, either from natural predators or human activity, birds are thus likely to regard big moving objects as potential threats, and the potential for habituation among sensitive species is very limited.

Neither the home ports, nor the level of vessel traffic associated with the construction of MOLF and construction phase STW have currently been identified. Based on the greatest mean flush distance (common scoter) presented above it is assumed for the purposes of this assessment that the maximum range of impacts will extend 1km from any vessel so each vessel would have a 2km wide impact zone as it transits the area.

Over-wintering common scoters, long-tailed ducks, and velvet scoters were recorded in internationally significant numbers across the marine survey area and are especially sensitive to impacts resulting from increased vessel traffic during the development stage.

In order to minimise disturbance from marine vessel traffic, a 1km wide Marine Traffic Zone (MTZ) would be established. All vessel approach activity would be contained and restricted to the MTZ which would either take the shortest route through the Przybrzeżne wody Bałtyku SPA i.e. perpendicular to the coastline and would extend 1km in width from the centre-line of the construction or operation footprint or follow the least sensitive route if applicable following results of any supportive surveys. Based on the greatest flush distance (common scoter) it is assumed that the maximum range of impacts will extend 1km from both sides of the 1km MTZ.

To ensure that the MTZ is effective at minimising disturbance, an adaptive monitoring and mitigation strategy would be developed and implemented before commencement of the development stage of the Project. This strategy would combine desk-based studies with habitat and species distribution and abundance data to refine the location, extent, and justification of any MTZ.

With the implementation of the impact minimising MTZ, it is concluded that the resultant effects on common scoter, long-tailed duck, and velvet scoter, resulting from disturbance through increased vessel traffic during the development stage, would be minor.

In terms of disturbance through increased vessel traffic during the development stage, on the implementation of the proposed mitigation via the MTZ and adaptive monitoring and minimisation strategy, there would be no adverse effect on common scoter, long-tailed duck, razorbill, and velvet scoter and, consequently, on the site integrity of the Przybrzeżne wody Bałtyku SPA.

LSE - direct impact due to construction activity through increased vessel traffic (construction phase - construction stage)

Neither the home ports nor the level of vessel traffic activity associated with supporting the construction of the cooling water intake and outflow and FRRS are currently known. Based on the greatest flush distance (common scoter) presented above it is assumed that the maximum extent of disturbance will extend 1km from any vessel so each vessel would have a 2km disturbance zone along its transit route. This issue was already discussed in the chapter above, and thus repetitions were avoided here.

With the implementation of the impact minimisation MTZ, it is concluded that the resultant effects on common scoter, long-tailed duck, and velvet scoter, resulting from disturbance through increased vessel traffic during the construction stage, would be minor.

LSE - direct impact due to operational activity through increased vessel traffic (operational phase)

During the operational phase, the impacts on birds will be lower compared to those during the delivery phase. The MOLF will be used sporadically during maintenance works so vessel traffic will not be a regular occurrence. Based on the greatest flush distance (common scoter) presented above it is assumed that the maximum extent of disturbance will extend 1km from any vessel so each vessel would have a 2km disturbance zone.

Over-wintering common scoters, long-tailed ducks, and velvet scoters were recorded in internationally significant numbers across the marine survey area and could be sensitive to impacts resulting from increased vessel traffic during the construction phase. However, due to the limited and sporadic nature of any vessel activity during the operational phase, in terms of disturbance through increased vessel traffic, the Project would result in a negligible change and there would be no adverse effect on common scoter, long-tailed duck, razorbill, and velvet scoter and consequently on the site integrity of the Przybrzeżne wody Bałtyku SPA.

LSE - direct impact through operation of the MOLF (operational phase)

During the operational phase, the impacts caused by vessels should be minimal compared to the construction phase. Noise pollution from vessels is a potential effect during any maintenance work required, but this would not be a regular occurrence. Additionally, the MOLF would also only be used sporadically during any maintenance and thus would not result in any disturbance other than that already assessed for the construction phase.

Based on a disturbance distance of 500m, a total area of approximately 1km^2 would be occasionally affected by operational activity of the MOLF. This is equivalent to 0.05% of the area of the Przybrzeżne wody Bałtyku SPA.

The total area within which common scoter, long-tailed duck, razorbill, and velvet scoter may be impacted by the disturbance would be minimal in comparison to the total area of alternative habitats available (amounting to less than 0.5% of the area covered by the SPA), while this potential loss of habitat resulting from impacts would occur only occasionally during the operational phase of the Project.

It is therefore concluded that any effects on all seabirds arising from direct impacts of disturbance through operation of the MOLF would be minimal and not significant.

In terms of direct disturbance through the occasional operation of the MOLF during the operational phase, the Project would result in a negligible change and there would be no adverse effect on common scoter, long-tailed duck, razorbill, and velvet scoter, and consequently, on the site integrity of the Przybrzeżne wody Bałtyku SPA.

Assessment against conservation objectives

For the purposes of this assessment, the European Site Conservation Objectives for Przybrzeżne wody Bałtyku SPA are assumed to relate to:

- avoiding the deterioration of the habitats of the qualifying species or significant impacts on the qualifying species, thus ensuring that the integrity of the site is maintained;
- ensuring that the following are maintained in the long-term for the qualifying species:
  - population of the species as a viable component of the site;
  - structure, function, and supporting processes of habitats of the species;
  - no significant impacts on the species.

The assessment of LSE concluded that with the implementation of the proposed minimisation measures there would be no adverse effects on the integrity of the Przybrzeżne wody Bałtyku (Baltic Coastal Waters) SPA associated with:

- deterioration of the habitats of the qualifying species, thus ensuring that the integrity of the site is maintained;
- population of the qualifying species as a viable component of the site, maintained in the long term;
- distribution and extent of habitats, maintained in the long term;
- structure, function, and supporting processes of habitats, maintained in the long term.

The assessment of the remaining LSE also concluded that with the implementation of the proposed minimisation measures detailed within those assessments there would be no adverse effects on the integrity of the Przybrzeżne wody Bałtyku SPA associated with:

- population of the qualifying species as a viable component of the site, maintained in the long term;
- distribution of the species within site, maintained in the long term;
- no significant impacts on the species, maintained in the long term.

Conclusions on integrity

No adverse effects are predicted on any of the analysed qualifying features associated with the Przybrzeżne wody Bałtyku SPA, therefore the Project will not have any adverse effect on the site integrity of the Przybrzeżne wody Bałtyku SPA.

IV.1.4.3.5.5 Pobrzeże Słowińskie SPA - Great cormorant

Baseline distribution and abundance

In the coastal zone, surveys recorded 41 bird species with a total of 32,491 individuals of which great cormorant accounted for 2.9% of all individuals recorded.

During the spring period, great cormorants were observed mainly in the central and the western part of the coastal zone and in three places within the marine zone. Densities reached 5 birds/km^2, and only locally slightly exceeded this value.

In the summer and the autumn periods the number of great cormorants increased and their average density in the coastal zone exceeded the value of 10 birds/km^2 in many areas. In the marine zone, this species was recorded sporadically.

In the winter, recorded abundance decreased and most of the birds were within the coastal zone, where in several places the densities were above 5 birds/km^2 while elsewhere the average density did not reach 1 bird/km^2.

LSE - impacts resulting from construction activity through airborne noise, light, and visual impact (development stage)

Activities associated with the construction of the MOLF and construction phase STW outfall have the potential to cause impacts on and/or displacement of marine bird features, reducing the usable foraging area for species and potentially leading to the utilisation of sub-optimal foraging or moulting areas and ultimately causing indirect habitat loss. Birds may be affected by increased noise and light created by construction works, as well as the general presence of people within the marine and coastal zone. In terms of distance from construction activity, behavioural responses vary with species, with some responding at around 500m distance for sensitive species like scoters, whilst for other species such as gulls this distance varies from 50-150m.

Based on a worst case impact distance of 500m, a total area of approximately 2km^2 could be affected by activity at jack-up barge locations associated with the construction of the MOLF and dredging locations associated with the STW.

A breeding great cormorant and over-wintering great cormorant were recorded in nationally significant numbers across the marine survey area, however they are less sensitive to impacts than the previously assessed species -

common scoter, long-tailed duck, razorbill, and velvet scoter. Pobrzeże Słowińskie SPA lies 15km from the Project Area, and the great cormorant is a wide-ranging seabird species therefore there is an extensive alternative habitat available for foraging birds, and the temporary loss of $2km^2$ is negligible in terms of their overall foraging resources.

It is therefore concluded that any effects on the great cormorant arising from direct impacts through construction activity via airborne noise, light, and visual impact during development works would be negligible and not significant.

In terms of direct disturbance through construction activity via airborne noise, light, and visual impact during the development stage, there would be no adverse effects on the great cormorant, and consequently on the site integrity of the Pobrzeże Słowińskie SPA.

LSE - direct impact resulting from construction activity through airborne noise, light, and visual impact (construction phase)

Based on a disturbance distance of 500m and taking account of the cooling water intake and outfall locations of about 6km and about 3.7km from the coastline (the FRRS falls within the same footprint as the cooling water intake, and extends for approximately 1km), a total area of $9.7km^2$ would be affected by the activity associated with dredging locations.

Great cormorants were recorded in nationally significant numbers across the entire marine survey area, however they are less sensitive to impacts than the previously assessed species: common scoter, long-tailed duck, razorbill, and velvet scoter. Pobrzeże Słowińskie SPA lies 15km from the Project Area, and the great cormorant is a wide-ranging seabird species, therefore there is an extensive alternative habitat available for foraging birds, and the temporary loss of around $10km^2$ is minimal in terms of their overall foraging resources.

It is therefore concluded that any effects on the great cormorant arising from direct impacts through construction activity via airborne noise, light, and visual impacts during the construction phase would be minor, and there would be no adverse effect on great cormorant, and, consequently, on the site integrity of the Pobrzeże Słowińskie SPA.

LSE - direct impact resulting from construction activity through increased vessel traffic (development stage)

The focus of marine operations at the development stage will be around the MOLF and STW pipeline and outfall, with support and safety vessels required to attend the jack up barges during construction of the MOLF and dredging vessels associated with construction of the STW. The impacts at sea, and the works associated with the vessel activity may present a threatening stimulus to seabirds, with subsequent risk-avoidance behaviour reducing the time available for other activities such as feeding, resting, or mating. The observed responses by seabirds include flying off, diving, and increased alertness, which can result in a loss of energy and opportunities, displacement, and habitat loss. The impacts caused by vessels may thus reduce survival and reproductive success and affect population dynamics.

Impact responses differ among species, with some species more sensitive than others. A ship traffic disturbance vulnerability index (DVI) [456] that took account of species shyness, energetic cost of escape, and population metrics for a range of species in the Baltic Sea has been used to assess the potential impacts on the assessed seabirds, and is summarised in table [Table IV.1- 29].

Table IV.1- 29 Flush distances and DVI

No.	Species	Mean flush distance: individual (m)	Mean flush distance: flock (m)	DVI
1.	Great cormorant	258	287	24.4

Source: [456]

Seabirds may be able to habituate and even adapt to disturbance by ship traffic if they are able to identify vessels as non-threatening objects. There is already a fishing activity within the area, albeit at a low level, meaning that birds would be habituated to anthropogenic presence. Any works would also be undertaken subject to best practice, and vessels associated with the works would not be travelling erratically or at speed once in the vicinity of the works. However, ships differ greatly in size, shape, speed, and engine noise, making recognising them as non-threatening objects difficult. In an environment where predation risk exists, either from natural predators or human activity, birds are thus likely to regard big moving objects as potential threats, and the potential for habituation among sensitive species is very limited.

Neither the home ports nor the level of vessel traffic activity associated with supporting the construction of the MOLF and STW during construction stage have currently been identified. Based on the mean flush distance for the great cormorant, it is assumed that the maximum range of disturbance would extend to 300m from any vessel, so each vessel would have a 600m wide disturbance zone as it transits the area.

Great cormorants were recorded in nationally significant numbers across the entire marine survey area, however they are less sensitive to impacts than the previously assessed species: common scoter, long-tailed duck, razorbill, and velvet scoter. Pobrzeże Słowińskie SPA lies 15km from the Project Area, and the great cormorant is a wide-ranging seabird species, therefore there is an extensive alternative habitat available for foraging birds.

In order to minimise disturbance from marine vessel traffic, a 1km wide Marine Traffic Zone (MTZ) has been recommended for the more sensitive Przybrzeżne wody Bałtyku SPA qualifying features, i.e. common scoter, long-tailed duck, razorbill, and velvet scoter. Implementation of this MTZ and the supporting adaptive monitoring and mitigation strategy would reduce any potential effects arising from disturbance. However, for the great cormorant the implementation of an MTZ is not a requirement to avoid adverse effects due to the combined widespread foraging nature of this species, its relative tolerance to vessel activity (a disturbance buffer of around 300m) and the distance from the Pobrzeże Słowińskie SPA (15km).

In terms of disturbance through increased vessel traffic during the development stage, there would be no adverse effect on the great cormorant, and consequently, on the site integrity of the Pobrzeże Słowińskie SPA.

LSE - direct impact due to construction activity through increased vessel traffic (construction phase - construction stage)

Neither the home ports nor the level of vessel traffic activity associated with supporting the construction of the cooling water intake and outflow and FRRS are currently known. Based on the flush distance for the great cormorant of 300m, it is assumed that the maximum range of disturbance will extend 300m from any vessel, so each vessel would have a 600m disturbance zone along its transit route.

Breeding great cormorants were recorded in nationally significant numbers across the entire marine survey area, however they are less sensitive to impacts than the previously assessed species, i.e. common scoter, long-tailed duck, razorbill and velvet scoter. Pobrzeże Słowińskie SPA lies 15km from the Project Area, and the great cormorant is a wide-ranging seabird species, therefore there is an extensive alternative habitat available for foraging birds.

In order to minimise disturbance from marine vessel traffic, a 1km wide Marine Traffic Zone (MTZ) has been recommended for the more sensitive Przybrzeżne wody Bałtyku SPA qualifying features, i.e. common scoter, long-tailed duck, razorbill, and velvet scoter. Implementation of this MTZ and the supporting adaptive monitoring and mitigation strategy would reduce any potential effects arising from disturbance. However, for the great cormorant the implementation of an MTZ is not a requirement to avoid adverse effects due to the combined widespread foraging nature of this species, its relative tolerance to vessel activity (a disturbance buffer of around 300m) and the distance from the Pobrzeże Słowińskie SPA (15km).

In terms of disturbance caused by increased vessel traffic during the construction phase, there would be no adverse effect on the great cormorant, and consequently, on the site integrity of the Pobrzeże Słowińskie SPA.

LSE - direct impact through increased vessel traffic (operational phase)

During the operational phase, the impacts on birds would be lower compared to those during the delivery phase. The MOLF will be used sporadically during maintenance works so vessel traffic will not be a regular occurrence. Based on the flush distance for the great cormorant of 300m, it is assumed that the maximum range of disturbance will extend 300m from any vessel, so each vessel would have a 600m disturbance zone along its transit route.

Breeding great cormorants were recorded in nationally significant numbers across the entire marine survey area, however they are less sensitive to impacts than the previously assessed species, i.e. common scoter, long-tailed duck, razorbill and velvet scoter. Pobrzeże Słowińskie SPA lies 15km from the Project Area, and the great cormorant is a wide-ranging seabird species, therefore there is an extensive alternative habitat available for foraging birds.

Due to the combined widespread foraging nature of this species, its relative tolerance to vessel activity (a disturbance buffer of around 300m), a sporadic nature of any vessel operational activity, and the distance from the Pobrzeże Słowińskie SPA (15km), it was concluded that there would be no adverse impact on the great cormorant via direct disturbance via an increased vessel traffic during the operational phase, and consequently, no adverse effect on the site integrity of the Pobrzeże Słowińskie SPA.

LSE - direct impact through operation of the MOLF (operational phase)

During the operational phase, the impact on birds should be minimal compared to that during the delivery phase. Noise pollution from vessels is a potential effect during any maintenance work required, but this would not be a regular occurrence. Additionally, the MOLF would also only be used sporadically during any maintenance and thus would not result in any disturbance other than that already assessed for the construction phase.

Based on an impact distance of 500m, a total area of about 1km^2 would be affected by the MOLF operational activity.

Great cormorants were recorded in nationally significant numbers across the entire marine survey area, however they are less sensitive to impacts than the previously assessed species, i.e. common scoter, long-tailed duck, razorbill, and velvet scoter. Pobrzeże Słowińskie SPA lies 15km from the Project Area, and the great cormorant is a wide-ranging seabird species, therefore there is an extensive alternative habitat available for foraging birds and the temporary loss of 1km^2 is negligible in terms of their overall foraging resources.

It is therefore concluded that any effects on the great cormorant arising from direct impacts through the MOLF operation would be negligible; there would be no adverse effect on the great cormorant, and consequently, on the site integrity of the Pobrzeże Słowińskie SPA.

Assessment against conservation objectives

For the purposes of this assessment the European Site Conservation Objectives for Pobrzeże Słowińskie SPA are assumed to relate to:

- avoiding the deterioration of the habitats of the qualifying species or significant impacts on the qualifying species, thus ensuring that the integrity of the site is maintained;
- ensuring that the following are maintained in the long-term for the qualifying species:
  - population of the species as a viable component of the site;
  - distribution of the species within the site,
  - distribution and range of habitats of the species,
  - structure, function and supporting processes of habitats of the species,
  - no significant impacts on the species.

The assessment of LSE concluded that with the implementation of the proposed mitigation measures there would be no adverse effects on the integrity of the Pobrzeże Słowińskie SPA associated with:

- deterioration of the habitats of the qualifying species, thus ensuring that the integrity of the site is maintained;
- population of the qualifying species as a viable component of the site, maintained in the long term;
- distribution of the species within the site,
- distribution and extent of habitats, maintained in the long term;
- structure, function, and supporting processes of habitats, maintained in the long term.

The assessment of the remaining LSE also concluded that there would be no adverse effects on the integrity of the Pobrzeże Słowińskie SPA associated with:

- population of the qualifying species as a viable component of the site, maintained in the long term;
- distribution of the species within the site, maintained in the long term;
- no significant impacts on the species, maintained in the long term.

Conclusions on integrity

No adverse effects are predicted on any qualifying interest features associated with the Pobrzeże Słowińskie SPA, therefore the Project will not have any adverse effect on the site integrity of the Pobrzeże Słowińskie SPA.

IV.1.4.3.5.6 Assessment of cumulative effects

Scope of the assessment

As part of the overall review presented in chapter [Chapter IV.19] of the EIA Report, the following projects have been screened for further assessment of cumulative effects with the Project:

- Baltica 2 and 3 windfarms, with a capacity of 1,045.5 MW and 80-105 turbines;
- Baltic Power windfarm, with a capacity of 1,200 MW and 100 turbines;
- Bałtyk II & III windfarms, with a capacity of 1,560 and 600 MW respectively (unknown number of turbines); and
- Neptun windfarm, of as yet unknown capacity.

These projects have been included because the potential site for their respective electrical export cable landfall is situated in the proximity to the location of the marine works under the Project. Additionally, according to the information available, it is possible that the landfall works could be carried out concurrently with works for the NPP Project, although it is unlikely that the works would be carried at the same time. The remainder of this assessment has therefore been carried out on the assumption that the installation of only one of these landfalls would coincide with the marine works under the Project. For the purposes of this assessment, the following assumptions apply:

- Construction of only one of the offshore wind farms and the electrical export cable and landfall would overlap with the construction of the Project's marine infrastructure in 2025-2029.
- Potential overlap for underwater noise with deep water piling (all sites), dredging, vessel movements, seabed cable installation, and at the landfalls (for cable and landfalls adjacent to the Project).
- To construct the open cooling outfall and intake tunnels under the Project, an immersed tube method including cofferdam will be used.
- The potential landfall for the electrical export cables would be just to the east of Variant 1 - Lubiatowo - Kopalino site.

- The installation of an electrical export cable landfall for the offshore wind farms will be carried out using an open trench across the beach that includes a cofferdam, similar to the closed cooling intake and outfall construction for the NPP.
- Both the NPP Project and the Baltica 2 and 3 as well as Baltic Power offshore wind farm projects would implement standard mitigation measures, including developing and implementing a Construction Environmental Management Plan (CEMP), and general pollution prevention principles, when carrying out construction works.

The open trench method of installation for the cable landfall is likely to result in the creation of a sediment plume, as well as increased marine vessel movements. There will also be airborne and underwater noise generated from the installation of the temporary sheet piles for the cofferdam, meaning that there is potential for in-combination effects from both plumes, vessel movements, and noise on the same receptors across the Przybrzeżne wody Bałtyku SPA.

Elevated suspended sediment

The worst-case extent of the sediment plume from the dredging operations to construct the open cooling outfall and intake tunnels at the Project is approximately 40km eastwards along the coast towards Władysławowo. Such a sediment plume would represent the 24-hour mean during winter where suspended sediment concentrations are elevated above baseline levels in the range of 5 to 25mg/l. The area of exceedance of the 24-hour "acute" guideline EQS of 25mg/l would be mostly confined to the Marine Permit Area for the Project. This would potentially extend over an area of around 13km^2 which is considered not significant in the context of protected sites. Should the activities coincide, this sediment plume could therefore interact with sediment arising from an open cut installation method for the cable landfall. However, the potential sediment plume from the landfall installation works is likely to cover a much smaller area, of less than 0.2km^2. This estimate is based on the assumption that the construction method will be similar to that for the closed cooling sub-variants (sub-variants 1B and 1C). This would be a negligible addition to the sediment plume from the NPP site works. It is therefore unlikely that the plumes could combine to create a significant effect.

As a result, there are unlikely to be significant increases in suspended sediment concentrations from the construction of the marine infrastructure for the Project, either alone or in combination with the cable landfall, and the effect is considered not to affect the integrity of any European sites.

Sediment deposition

The worst-case risk of smothering outside of the immediate working area from sediment deposition on the seabed was shown to be up to 25mm over an area of 2.4km^2, which is considered insignificant. This is substantially lower than the natural variation recorded at any single point within the marine survey area of up to 1-2m. The area of fine sediment deposition potentially affected by the installation of the cable landfall, assuming a similar construction method to the closed cooling outfall and intake structures, would be around 1.31km^2 which can be considered insignificant. Given the eastwards direction of these changes, it is unlikely that the effects of these two activities would overlap. Furthermore, with such high levels of natural variation in the area, benthic habitats and species present will be habituated to such changes, and the effect of this additional level of sediment falling out of suspension onto the seabed is considered to be insignificant.

As a result, there are unlikely to be significant increases in sediment deposition from the construction of the marine infrastructure for the Project, either alone or in combination with the cable landfall, and the effect is considered not to affect the integrity of any European sites.

Release of sediment bound contaminants

Contaminant concentrations in the superficial bed sediments sampled within the marine survey area in Variant 1 - Lubiatowo - Kopalino site do not exceed limits laid down in Polish (and by extension, European) regulations. Further, for parameters listed within the Canadian sediment quality guidelines, contaminant concentrations in the sediments sampled within the marine survey area in Variant 1 - Lubiatowo - Kopalino site are lower than the Canadian interim sediment quality guidelines (ISQG). Given the relative homogeneity of the sediments between the NPP site and the potential landfall location, it is likely that sampling of sediments would reveal similar results.

With the sediments in the immediate vicinity of the works showing no significant levels of contamination, and being consistent with guideline levels, the risk of reduced water quality through disturbance of these sediments from either the NPP or landfall works, can therefore be considered as not significant. As a result, there are unlikely to be significant increases in sediment deposition from the construction of the marine infrastructure for the Project, either alone or in combination with the cable landfall, and the effect is considered not to affect the integrity of any European sites.

Availability of prey to European Site qualifying features

The individual assessments have found that any impacts to the marine environment of the construction of the Project's open cooling (and the smaller closed cooling) infrastructure fall within the range of natural variation for the receiving environment and are therefore insignificant. It is unlikely that the overlap with the activities associated with the landfall installation for either the Baltica 3 or Baltic Power offshore wind farms would make a significant contribution to these effects.

As a result, the development of the Project in combination with the cable landfall, would not result in changes to prey availability for marine predators within the area, and the effect is considered not to affect the integrity of any European sites.

Marine mammal collisions

Collisions between project-related vessels and marine mammals have the potential to cause injury and death, with subsequent effects at both an individual and population level. However, vessels associated with the NPP and the electrical export cable landfall for the offshore wind farms, once within the immediate vicinity of the Project, are unlikely to be travelling either at speed, or in an erratic manner. This allows porpoises and seals to avoid collisions with the vessel.

Should the two projects have construction activities that coincide, measures would be in place to ensure the safe manoeuvring of vessels that would further control their speed and separation, and marine mammal observers would be deployed on the ships. On this basis, the potential effects as a result of collisions between marine mammals and vessels, from the development of the Project, either alone or in-combination with the cable landfall, are considered not to affect the integrity of any European sites.

Deep water piling

Given the projected scope of works, there is potential for an overlap if piling operations in the event the NPP Project and the offshore windfarms are implemented simultaneously. This is particularly relevant if operations are carried out at Lubiatowo - Kopalino and Baltica 3 simultaneously as they are closest to each other (around 40km).

On the basis of the modelling results, the maximum reasonable marine ZoIs were considered and defined as 20km for temporary threshold shift (TTS) from each site. This is the range at which the underwater noise levels would conservatively fall below the permanent threshold shift (PTS) and TTS for the marine mammal species assessed (notably harbour porpoise).

It is assumed that the maximum reasonable marine ZoIs for the offshore windfarms will be >20km (TTS), as they are in deeper water and the noise levels are expected to propagate more freely and further (less resistance and interactions with the seabed).

Based on the conservatism in the modelling for the Project, modelled levels are below the species thresholds at 20km (TTS) and 2.5km (PTS), and similar levels are expected within the assumed offshore windfarm ZoI. Also, given the likelihood that piling events will not be occurring at exactly the same time between sites, not always along the south eastern boundary of the windfarm development boundary, and that standard mitigation measures will be implemented, the effect is considered not to affect the integrity of any European sites.

Dredging and cable installation

There is potential for overlap if dredging/cable installation at the Project and the offshore windfarms are implemented simultaneously. This is particularly relevant if operations are implemented at the Project and the export cable routes (north and east) and landfalls (east) simultaneously.

Based on the localised ZoI associated with underwater noise from dredging, i.e. marine mammals with a BI (120 decibels of pressure level [dB Lp]) at 1,800m (distance from source) and fish species TTS (158 dB LE, p) not reached, and with standard mitigation measures implemented, the effect is considered not to affect the integrity of any European sites.

IV.1.4.3.6 Summary

Potential environmental changes that could occur at the development stage, at the construction stage, and during the operational phase were analysed to determine whether LSE on European sites can be excluded on the basis of objective information.

The Project is not directly connected with, or necessary to, the management of any European site and it cannot be excluded, on the basis of objective scientific information following screening, that the Project, individually or in combination with other plans or projects, would have an LSE on the qualifying features in the following European sites:

- Przybrzeżne wody Bałtyku SPA: common scoter, long-tailed duck, velvet scoter, razorbill, common gull, European herring gull
- Mierzeja Sarbska SAC: grey seal
- Ostoja Słowińska SCI: grey seal, harbour porpoise, habitats: 1150: Coastal lakes and lagoons; 1170: Rocky seabed (reefs)
- Pobrzeże Słowińskie SPA: grey seal, great cormorant
- Słowiński Park Narodowy (Słowiński National Park) / Ramsar Site: grey seal, harbour porpoise
- Zatoka Pucka SPA: European herring gull
- Zatoka Pucka i Półwysep Helski SCI: grey seal, porpoise
- Kaszubskie Klify SCI: grey seal, harbour porpoise
- Hoburgs bank och Midsjöbankarna: harbour porpoise
- Zalew Wiślany i Mierzeja Wiślana SCI: grey seal
- Ostoja w Ujściu Wisły SCI: grey seal
- Pommersche Bucht SAC: harbour porpoise
- Ostoja na Zatoce Pomorskiej SCI: harbour porpoise
- Wolin i Uznam SCI: harbour porpoise
- Adler Grund og Rønne Banke SAC: harbour porpoise
- Sydvästskånes utsjövatten SAC: harbour porpoise
- Greifswalder Boddenrandschwelle und Teile der Pommerschen Bucht SAC: harbour porpoise
- Darßer Schwelle SAC: harbour porpoise
- Kadetrinne SAC: harbour porpoise

- Plantagenetgrund: harbour porpoise
- Westrügensche Boddenlandschaft mit Hiddensee: harbour porpoise
- Erweiterung Libben, Steilküste und Blockgründe Wittow und Arkona: harbour porpoise
- Greifswalder Bodden, Teile des Strelasundes und Nordspitze Usedom SAC: harbour porpoise
- Greifswalder Boddenrandschwelle und Teile der Pommerschen Bucht: harbour porpoise
- Greifswalder Bodden, Teile des Strelasundes und Nordspitze Usedom SAC: harbour porpoise
- Greifswalder Boddenrandschwelle und Teile der Pommerschen Bucht: harbour porpoise

The following LSEs were identified for the abovementioned qualifying features:

- Indirect effects via potential changes in prey availability as a result of the introduction of invasive and non-native species (INNS)
- Indirect effects through impact on prey availability – benthic species
- Indirect effects through impacts on prey availability – fish species
- Indirect impact on habitats – changes in water quality
- Indirect effects through impacts on prey availability – changes in water quality
- Direct impact from construction activities - underwater noise
- Direct impact resulting from construction activity - airborne noise, light pollution, and visual impacts
- Direct disturbance through construction activity – increased vessel traffic
- Direct impact due to the operation of the MOLF

Where detailed conservation objectives for a European site were not available, the following conservation objectives were applied in accordance with Article 33 of the Nature Conservation Act of 16 April 2004 (consolidated text: Journal of Laws of 2021, item 1098):

- not to worsen the status of the natural habitats or plant and animal habitats for the protection of which a Natura 2000 site has been designated; and
- not to worsen the integrity of a Natura 2000 site or its links with other sites.

The assessments of the impact for open cooling sub-variant 1A and closed cooling sub-variants 1B and 1C during the development and construction stages, and operational phase have been undertaken for LSEs on European site habitats via marine water quality, plankton communities, benthic habitats, fish prey species, and INNS. These LSE assessments concluded that there are no adverse effects on the integrity of any European site with regard to the identified:

- Indirect effects via potential changes in prey availability as a result of the introduction of invasive and non-native species (INNS)
- Indirect effects through impact on prey availability - benthic species
- Indirect effects through impact on prey availability - fish species
- Indirect effects from impact on food supply - changes in water quality
- Direct impact from construction activities - underwater noise

Moreover, it has been established that there would be no adverse effects for the integrity of any European Site with marine mammal qualifying features for sub-variants 1A, 1B, or 1C throughout the development, construction, and operational stages/phases.

The remaining LSEs associated with the development, construction, and operational stages/phases, and applicable (and of a similar magnitude) to all three sub-variants, that had potential for adverse effects on European site integrity were:

- Direct impact resulting from construction activity through airborne noise, light, and visual impact (development stage and construction stage)
- Direct impact resulting from construction activity through increased vessel traffic (development stage and construction stage)
- Direct impact through operation of the MOLF (operational phase)

These LSEs were relevant to the following European site qualifying features, for which further assessment was undertaken:

- Przybrzeżne wody Bałtyku SPA: Common scoter, long-tailed duck, velvet scoter, razorbill
- Pobrzeże Słowińskie SPA: great cormorant

Potential adverse effects were identified for Przybrzeżne wody Bałtyku SPA (common scoter, long-tailed duck, velvet scoter and razorbill) arising from impacts caused by increased vessel traffic during the development and construction stages. Mitigation was recommended to minimise these effects and avoid any adverse effect on site integrity.

The mitigation to minimise disturbance from marine vessel traffic, identified the need for an MTZ. All vessel approach activity would be contained and restricted to the MTZ that would either take the shortest route through the Przybrzeżne wody Bałtyku SPA i.e. perpendicular to the coastline and extend 1km from the centre-line of the construction or operation footprint or follow the least sensitive route if applicable following results of any supportive surveys. To ensure that the MTZ is effective at minimising disturbance, an adaptive monitoring and mitigation strategy would be developed and implemented before commencement of the development stage of the Project. This strategy would combine desk-based studies with habitat and species distribution and abundance data to refine the location, extent, or justification for any MTZ.

With the implementation of the impact mitigating MTZ, it is concluded that the resultant effects on common scoters, long-tailed ducks, and velvet scoters, resulting from impacts due to increased vessel traffic during the development stage, would be minor.

The assessment of LSE concluded that with the implementation of the recommended mitigation measures there would be no adverse effects on the integrity of the Przybrzeżne wody Bałtyku SPA associated with:

- Deterioration of the habitats of the qualifying species thus ensuring that the integrity of the site is maintained
- Population of the qualifying feature species as a viable component of the site and maintained in the long term
- Preservation of habitats in the long term
- Structure, function, and supporting processes of habitats, maintained in the long term

No adverse effects are predicted on the qualifying features and habitats associated with the Przybrzeżne wody Bałtyku SPA, therefore the Project will not have any adverse effect on the site integrity of the Przybrzeżne wody Bałtyku SPA.

For Pobrzeże Słowińskie SPA, the assessment of LSE concluded that with the implementaion of the recommended minimisation measures there would be no adverse effects on the integrity of the Pobrzeże Słowińskie SPA.

No adverse effects are predicted on any qualifying interest features and habitats associated with the Pobrzeże Słowińskie SPA, therefore the Project will not have any adverse effect on the site integrity of the Pobrzeże Słowińskie SPA.

The in-combination assessment concluded that there are unlikely to be significant increases in wildlife disturbance from the construction of the marine infrastructure for the Project, either alone or cumulatively with the Baltica 3 or Baltic cable landfall, and the in-combination effects are considered not to affect the integrity of any European sites.

This HRA has considered all European sites within the Baltic Sea region that fall within the Project's Zones of Influence and identified Zones of Influence of the species, including European sites in other countries; no adverse effects were identified for any of the European sites and therefore transboundary effects were ruled out for the Project.

To sum up the above, there will be no adverse effects on the integrity of any European sites, from the Project alone, or in combination with other plans or projects.

IV.1.4.4 HRA – Variant 2 – Żarnowiec

IV.1.4.4.1 HRA Stage 1 Screening – Step 1: Identification of the Project's relevance to the conservation management of European sites

Stage 1 Step 1 was described in detail in the full version of the EIA Report.

IV.1.4.4.2 HRA Stage 1 Screening – Step 2: Description of the Project planned

Stage 1 Step 2 was described in detail in the full version of the EIA Report.

IV.1.4.4.3 HRA Stage 1 Screening - Step 3: Identification of potential effects on European sites

Stage 1 Step 3 was described in detail in the full version of the EIA Report.

IV.1.4.4.4 HRA Stage 1 Screening - Step 4: Assessment of the significance of any effects on European sites

Stage 1 Step 4 was described in detail in the full version of the EIA Report.

IV.1.4.4.5 HRA Stage 2: Identification of the need to carry out Appropriate Assessment

IV.1.4.4.5.1 Summary of screening outcomes

The Screening (HRA Stage 1) has indicated that the European sites listed in the above chapter and their qualifying features have potential for LSE arising from the Project and therefore are taken through into this subchapter to provide background data and prepare an assessment to inform an Appropriate Assessment (AA).

For each of the designated sites, LSEs will be assessed in relation to the conservation objectives that apply to the specific attribute of the designated feature under consideration. Where detailed conservation objectives are not available for a European site, the following generic conservation objectives have been applied:

- Avoidance of deterioration of the habitats of the qualifying features or significant impacts on the qualifying species, thus ensuring that the integrity of the site is maintained;
- For the qualifying species, ensuring that the following are maintained in the long term:
  - population of the species as a viable component of the site,
  - distribution of the species within the site,
  - distribution and range of habitats of the species,
  - structure, function and supporting processes of habitats of the species,
  - no significant impacts on the species.

IV.1.4.4.5.2 Assessment of potential effects

Potential effects are described at length below, including details of mitigation measures to minimise any adverse effects on the integrity of a European site and associated conservation objectives.

Impact on European site habitats – marine water quality

A variety of potential effects relating to water quality parameters have been identified, including:

- changes in total suspended sediment (TSS) / increased turbidity as a result of construction activities in the marine environment,
- spills and accidental releases from vessels during dredging and construction,
- increased ambient water temperature through release of the operational effluent discharge,
- changes to water quality through operational effluent discharge,
- increased salinity from operational effluent discharge.

Modelling shows that increases in suspended sediment concentrations due to dredging are generally less than 5mg outside the Project Area. This compares with baseline suspended sediment conditions measured over the period 2017-2018 identified that the maximum values were 6.22mg/l. Changes to increased TSS/turbidity will therefore not adversely affect the integrity of any designated site.

In addition to any Project-specific measures outlined within the Construction Environmental Management Plan (CEMP, including detailed protocols and sub-plans, as required), all vessels associated with the Project would be required to adhere to international best practice, including that outlined within the International Convention for the Prevention of Pollution from Ships (MARPOL) such as the limit of 15 ppm oil in water in operational vessel discharges. No significant water quality impacts are thus anticipated, and pollution from vessel operations will not affect the integrity of any designated site.

The release of cooling water was modelled for the worst-case open cooling option, identifying the areas within which specific increases in temperature are predicted to arise. Considering an increase of 2°C or more, the area affected would extend approximately 2km from the outfall, which is sufficiently localised to avoid affecting the integrity of any designated site.

The operational discharge effluent arising from the individual variants of the Project contains a range of individual components, the behaviour of which will vary depending on their chemical composition, and behaviour in reaction with seawater, as well as the prevailing direction of water movement. The majority of constituents pose no environmental hazard, either due to their low toxicity or the fact that the relevant EQS/ELV will be readily achieved. For other components which can be pollutants, the following mitigation measures are planned to be applied:

- Heavy metals can be removed readily by numerous standard methods of treatment: chemical precipitation (typically using lime), or ion-exchange. In order to minimise treatment costs, the processes should be targeted at the specific effluent streams containing elevated concentrations of metals, for example effluent from the SGS blowdown system.
- The content of hydrazine, present in relatively high concentrations in cooling water effluent, can be mitigated by the use of precise dosing to ensure low residual concentrations, through reaction of hydrazine with oxygen in steam generators to obtain nitrogen and water; another method is to decompose hydrazine to ammonia in steam generators and high-pressure heat exchangers. In addition, hydrazine decomposes naturally in seawater, and reacts with biocides in the effluent which results in further reduction of concentrations. Specific treatment is also available if needed, by oxidation with hydrogen peroxide (using a copper catalyst) or chlorine/hypochlorite.
- Excess biocide (assumed to be chlorine) releases can be mitigated through reduction in application. This can be achieved inter alia by a combination of dosing control and use of non-toxic biofouling control

including surfactants, physical cleaning, self-polishing coatings and antifouling paints. For the closed cooling variants, chlorine biocides can be neutralised in the cooling tower basin before effluent discharge, typically using metabisulphite.

Provision of treatment where necessary to remove excess phosphorus, hydrazine and metals, and to control chlorine/TRO emissions would ensure that the relevant EQS will be met at the point of discharge, or the area exceeding the EQS will be minimal. It can therefore be concluded that chemical water quality impacts from the operational discharge would not affect the integrity of any designated sites.

Delft-3D far-field modelling was run to evaluate the potential impact. Considering a worst-case scenario (summer and full power operation), the 98th percentile salinity anomaly of 0.5psu was shown to extend less than 100m from the discharge point, with salinity returning to ambient within several hundred metres. There would therefore be no adverse effect on the integrity of any designated site from the brine in the operational discharge.

In summary, with the adoption of the aforementioned mitigation measures, there will be no detectable effects and therefore no adverse effect on the site integrity on any European site qualifying feature associated with changes to physical and chemical water quality, temperature or salinity.

In connection with the above, the following LSEs deriving from effects on all European site habitats via marine water quality are therefore not taken any further for individual European site assessment:

- indirect impact on habitats – changes in water quality,
- indirect effects from impact on food supply - changes in water quality.

<u>Impact on European site habitats – plankton communities</u>
Potential effects due to changes in plankton populations are related to:

- changes to plankton communities as a result of changes in water quality,
- risk of eutrophication and associated phytoplankton blooms leading to environmental degradation (for example, hypoxia),
- indirect effects through changes to prey availability for fish, bird, and marine mammal species.

As described above, the residual impact of changes in water quality, including temperature, salinity and chemical releases, would not affect the integrity of any designated site and, by extension, the populations of organisms that underpin that.

This is also true for nutrients in the NPP operational discharge, which represent, in the worst case, a fractionally increased load into already eutrophic waters. The excess loading of N at worst would represent less than 0.007% of current inputs, while P would be approximately 5.6% of current inputs from the Vistula river basin. Phosphorous in the discharge can be further mitigated as follows:

- Dosing of polyphosphates and phosphonates could be below the standard levels in the specific circumstances prevailing at the Żarnowiec site. In the event the dosing levels are reduced to avoid adverse environmental effects while maintaining protection of the cooling water infrastructure and its functioning, the solution would be to reduce phosphates.
- Use of alternative water treatment chemicals containing little or no phosphorus. Such treatment chemicals have been developed specifically for uses where discharges of compounds containing phosphorous are restricted. Examples can include organic inhibitors (e.g. those containing citric acid, some with zinc) and amidosulphonic acid.

Adjustment of dosing levels and the choice of non-phosphorous containing treatment chemicals to further reduce nutrient loadings would mean nutrients in the operational effluent would not increase the occurrence of wide-scale phytoplankton blooms and the associated hypoxic events.

Thus, indirect effects on the food chain that underpins food for the population for which European sites are designated, would not occur. The changes in plankton will have no negative effect on the integrity of any European site.

The following LSEs deriving from effects on all European site habitats via marine water quality are therefore not taken any further for individual European site assessment:

- indirect impact on habitats – changes in water quality,
- indirect effects through impact on prey availability – benthic species,
- indirect effects through impact on food supply – fish species.

Impact on European site habitats – benthos

Potential effects on benthos include:

- Direct effects on benthic populations from impaired water quality (including increased temperature, salinity and chemical pollution).
- Habitat loss for benthic fauna as a result of sedimentation of suspended solids resulting from construction works carried out.
- Indirect effects through changes in prey availability for fish, bird, and marine mammal species.

As described above, the residual impact of changes in water quality, including temperature, salinity and chemical releases, would not affect the integrity of any designated site and by extension the populations of organisms that underpin that.

The spatial extent of the Project-related sedimentation and the resultant habitat loss is minimal. Consequent effects on benthic populations will therefore not affect the integrity of any European sites.

Because the population and structure of benthic communities will not be altered to any meaningful extent, the role of benthos as a prey for fish, birds, and marine mammals will not be affected, and therefore there will be no adverse effect on the site integrity of any European site supporting benthic habitats.

The following LSEs deriving from effects on all European site habitats via benthic habitats are therefore not taken any further for individual European site assessment:

- Indirect effects through impact on prey availability for benthic species.

Impact on European sites - fish

Fish fauna serve as prey for several species for which European sites are designated, including predatory fish, piscivorous birds, and marine mammals. Changes in fish populations therefore have the potential to affect the integrity of these sites in the following ways:

- impingement, entrainment and/or entrapment of fish species into cooling water intake infrastructure,
- indirect effects through changes to prey availability (benthos or plankton) for fish,
- effects as a result of changed physico-chemical water quality (temperature, salinity, TSS and chemical pollution),
- injury and/or potential mortality as a result of underwater noise.

The majority of adult fish near the CW intake have a maximum critical sustained swimming speed that would allow them to escape entrapment. For example, species such as sprat have a sustained swimming speed of approximately 0.56 m/s, compared to the draw velocity of the intake pf 0.3m/s, which is considered good practice allowing most fish to escape entrapment. Sandeels, which are another important food resource for piscivores, are predominantly benthic and less amenable to entrapment by the intake stream. Any ichthyoplankton entrained as a result of cooling water abstraction (assuming 100% mortality) represents an extremely small fraction of the adult stock when natural mortality rates are factored in. Accordingly, any effects of entrapment and entrainment will not substantially affect the local fish populations.

As previously discussed, the population and structure of planktonic and benthic communities will not be altered to any meaningful extent, the role of benthos as a prey for fish will not be affected, and therefore there will be no adverse effect on fish populations relating to prey availability.

Similarly the residual impact of changes in water quality, including temperature, salinity and chemical releases, would not affect the integrity of any designated site and, by extension, the populations of organisms that underpin that.

The temporary nature of construction noise to be generated by the Project, and the existing level of vessel noise from local shipping and fishing activity, will have no significant impact on the population of fish (injury or displacement).

The population and structure of fish communities would not be altered to any meaningful extent, hence the role of fish as a prey for birds and marine mammals will not be affected and therefore there will be no adverse effect on the site integrity on any European site associated with supporting fish prey species.

The following LSEs deriving from effects on all European site habitats via marine water quality are therefore not taken any further for individual European site assessment:

- indirect effects through impact on food supply – fish species.

<u>Impact of invasive species on European sites</u>

Invasive species can materially affect marine ecosystems and food webs, and therefore the integrity of any designated sites. The vector for such introductions is primarily through ballast water. Particular concern surrounds the invasion of gelatinous zooplankton predators such as the ctenophore *Mnemiopsis leidyi*, that can adversely affect pelagic fish stocks through predation on larvae. However, international agreements have focused on the control of accidental introductions. In order to control the risk of introducing INNS via ballast water, all ships associated with the Project will comply with the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004. Ships (including dredgers and supply ships delivering abnormal loads to the MOLF) must therefore carry:

- A ballast water management plan specific to each ship, including a detailed description of the actions to be taken to implement the ballast water management requirements and supplemental ballast water management practices;
- A ballast water record book to record when ballast water is taken on board, circulated or treated for ballast water management purposes and discharged into the sea. It should also record when ballast water is discharged to a reception facility and accidental or other exceptional discharges of ballast water; and
- An International Ballast Water Management Certificate (for ships of 400gt and above) to certify that the ship carries out ballast water management in accordance with the BWM Convention and specifies which standard the ship is complying with, as well as the date of expiry of the Certificate.

Adherence to these regulations would result in no adverse effect on the integrity of any European site from the introduction of invasive species in ballast water.

The following LSEs that stem from the effects of invasive species are therefore not taken any further for individual European site assessment:

- Indirect effects via potential changes in prey availability as a result of the introduction of invasive and non-native species (INNS).

<u>Impact on European sites - marine mammals</u>

Potential impacts on marine mammals are associated with:

- Direct disruption from construction works - underwater noise.
- Direct disruption from construction activities - increased vessel traffic.
- Direct impact from MOLF operation.

The majority of the European sites mentioned above with marine mammals as their qualifying features, are not situated within the Project Area, except the Site of Community Importance - Mierzeja Sarbska PLH220018, which overlaps the Project Area in the near-shore part, for which the qualifying feature is the grey seal. The mobile nature of marine mammals could result in members of further designated populations being located within ranges which pertinent noise disturbance thresholds are met due to the most onerous construction activities.

The European sites with qualifying marine mammal features identified as potentially at risk are identical to those presented for Variant 1 - Lubiatowo – Kopalino site. It is related to the proximity of the sites and the same methodological approach to the assessment. The list of sites is presented in chapter [Chapter IV.1.4.4.5.2], in the section: Impact on European sites and habitats - marine mammals.

Underwater noise and disturbance effects

Underwater noise and disturbance effects on marine mammals are possible during the development, construction, and operational stages/phases. The assessment of the impact of underwater noise on marine mammals is discussed in detail in chapter [Chapter IV.10.2]. It was concluded that once the minimisation measures are introduced, underwater noise at the construction stage will have no impact on the integrity of any European site for marine mammals.

Effects of collisions with vessel traffic, which will be operated during the Project implementation, will be the same as described for Variant 1 – Lubiatowo - Kopalino site (see chapter [IV.1.4.4.5.2]) in the part concerning the impact on European sites and habitats of species - marine mammals.

Mitigation measures for impact on mammals

Marine mammal mitigation measures that will be implemented as part of the Project are:

- Adherence to the ‘Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise’ [307]. This protocol provides guidance on mitigation techniques to be implemented before commencement of and during piling operations in order to mitigate the potential of waterborne noise impacts arising from pile driving during offshore windfarm construction. The protocol has been developed to reduce the potential for injury or death to negligible levels for marine mammals in a close proximity to piling operations. This protocol is considered applicable to other industries in the marine environment that employ piling operations. Further details on the mitigation measures outlined within this protocol are provided in chapters [Chapter V.3] and [Chapter IV.10.4]; in summary, they include:
    - Use of most appropriate techniques to reduce noise generation;
    - Provision of suitably trained and equipped Marine Mammal Observers (MMOs);
    - Establishment of a mitigation zone, to be monitored for presence of marine mammals prior to the start of works;
    - Use of acoustic deterrent devices (ADDs) and/or pingers to deter marine mammals (and some fish species) from entering the mitigation zone;
    - Delay to the start of works if marine mammals are detected within the mitigation zone; and
    - Use of soft-start, or the gradual ramping-up of piling power.
- In addition to any Project-specific measures outlined within the Construction Environmental Management Plan (CEMP), (including detailed protocols and sub-plans, as required), all vessels associated with the Project would be required to adhere to international best practice.

- Use of technology and techniques that limit noise propagation in the water column and in the air.

The implementation of these actions is standard practice for marine development projects such as cable installations, and offshore wind farms. Therefore, it is considered that the above measures are both able to be implemented and are effective at mitigating effects on individual animal species.

IV.1.4.4.5.3 Predicted effects and their potential for adverse impact on site integrity

Assessments for the open cooling sub-variant 1A and closed cooling sub-variants 2A and 2B during the development and construction stages, and operational phase have been undertaken for LSEs on European site habitats via marine water quality, plankton communities, benthic habitats, fish prey species, and INNS. These LSE assessments within this section to inform an AA, have concluded that there are no adverse effects on the integrity of any European site for:

- indirect effects via potential changes to prey availability as a result of the introduction of invasive and non-native species (INNS),
- indirect effects through impact on prey availability – benthic species,
- indirect effects through impacts on prey availability – fish species,
- indirect effects through impacts on prey availability – water quality changes,
- direct disruption from construction works - underwater noise.

Furthermore, it has been established that there are no adverse effects on the integrity any European site with marine mammal qualifying features for Sub-variants 2A and 2B throughout the development, construction or operational stages/phases.

The remaining LSEs associated with the development, construction or operational stages/phases, and applicable (and of a similar magnitude) to both Variants, that may have potential for adverse effects on European site integrity, are:

- Direct impact resulting from construction activity through airborne noise, light, and visual impact (development stage and construction stage),
- Direct impact resulting from construction activity through increased vessel traffic (development stage and construction stage),
- Direct impact through operation of the MOLF (operational phase).

The listed LSEs are relevant to the following qualifying features of the European sites, for which further assessment was undertaken:

- Przybrzeżne wody Bałtyku SPA
  - Common scoter
  - Long-tailed duck
  - Velvet scoter
  - Razorbill
- Pobrzeże Słowińskie SPA
  - Great cormorant

IV.1.4.4.5.4 Przybrzeżne wody Bałtyku SPA – common scoter, long-tailed duck, velvet scoter and razorbill

Species baseline distribution and abundance

In the coastal zone, surveys recorded 40 bird species with a total of 31,746 individuals [213]. Two of the most abundant species recorded were long-tailed duck (51.7% of total bird abundance) and velvet scoter, both of which are classed as benthivorous species (i.e. diving to feed on benthic invertebrates).

In the marine zone, the most frequently recorded species were velvet scoter (52.1% of total bird abundance) and long-tailed duck (44.7%). The only other species that accounted for more than 1% of the total number of individuals recorded was common scoter (2.4%).

For the combined density estimates for common scoter, long-tailed duck and velvet scoter within the Marine Survey Area covering the period March-April 2017 and October 2017-February 2018 [213], the highest average densities (50 birds/km^2 to 100 birds/km^2) occurred in the central and western part of the near-shore zone. Average densities (5 birds/km^2 to 50 birds/km^2) were recorded in the near-shore zone as well as in the central part of the offshore zone. The lowest average densities were observed in the most northern and eastern parts of the offshore zone and next to the shoreline.

Common scoter

During the spring period densities exceeded 50 individuals/km^2 and locally 100 individuals/km^2 in the central part of the offshore zone, whilst elsewhere the average density did not exceed 5 individuals/km^2.

In the summer, common scoter was infrequent. During this period, more birds were observed in the central part of the Marine Survey Area, where average density exceeded 50 individuals/km^2.

During the autumn migration period, common scoters were highly dispersed in the Marine Survey Area and only locally did their average density reach 50 individuals/km^2.

In the winter, the abundance of common scoters was lower than during the autumn migration, and they were not recorded in the offshore zone. Concentrations were observed in the central and western part of the near-shore zone with densities reaching up to 10 individuals/km^2.

Long-tailed duck

During the spring the highest number of long-tailed ducks were found in the central and western part of the near-shore zone. High densities exceeding 500 individuals/km^2 were recorded over large areas and locally it even exceeded the value of 1,000 individuals/km^2.

In the summer period they were not recorded within the Marine Survey Area. During the autumn period the average densities of this species were clearly lower than in the spring and only locally, within small areas, did the birds form groups with a density exceeding 100 individuals/km^2. Within most of the Marine Survey Area, the long-tailed duck density reached from 1 to 5 individuals/km^2.

Higher average densities were recorded in the winter than in the autumn period, although the highest densities, exceeding 100 individuals/km^2 were less extensive than in the spring.

Razorbill

Razorbills were highly dispersed and occurred only in the offshore zone. In all periods, except for the summer period, the prevailing average density there was between 0.1 and 5 individuals/km^2. In the summer, this species was recorded infrequently.

Velvet scoter

During the spring velvet scoters were sighted across the Marine Survey Area, although larger flocks were only observed in the central part of the offshore zone, where the density exceeded 50 individuals/km^2, whilst the average densities were below 5 individuals/km^2.

In the summer period, only single velvet scoters were found within the survey area. In the autumn, this species appeared in a greater number than in the spring. In the western part of the Marine Survey Area, the average densities exceeded 100 individuals/km^2, locally reaching 1,000 individuals/km^2. Lower numbers of velvet scoters were observed in the eastern part of the Marine Survey Area.

In the winter the average density exceeded 100 individuals/km^2, locally reaching 500 individuals/km^2 within the central section of the Marine Survey Area. As in the autumn, fewer velvet scoters were recorded in the eastern part of the Marine Survey Area, where the maximum densities did not exceed 5 individuals/km^2.

LSE - direct impact resulting from construction activity through airborne noise, light, and visual impact (development stage)

Activities associated with the construction of the MOLF and construction-phase STW outfall have the potential to cause impact and/or displacement to marine bird features. Reduction of the usable foraging area for species potentially leads to the utilisation of sub-optimal foraging or moulting areas and can ultimately cause indirect habitat loss. Birds may be affected by increased noise and light created by construction works, as well as the general presence of people within the marine and coastal zone. In terms of the distance from construction activity, behavioural responses vary depending on the species, with some individuals responding at a distance of around 500m for sensitive species like scoters, whilst for other species such as gulls this distance varies from 50 to 150m.

Based on a disturbance distance of 500m, a total area of about 1.6km^2 could be affected by activity at jack-up barge locations associated with the construction of the MOLF and dredging locations associated with the STW. This is equivalent to 0.08% of the area of the Przybrzeżne wody Bałtyku SPA.

The impacts related to vessel traffic are assessed separately below, in subsequent subchapters.

Over-wintering common scoters, long-tailed ducks, razorbills and velvet scoters were recorded in internationally significant numbers across the Marine Survey Area and are sensitive to impact through construction activity via airborne noise, light, and visual effects.

The anticipated duration of the impacts is short-term, and therefore effects would only occur during the period that the MOLF and STW are under construction, and the total area within which common scoters, long-tailed ducks, razorbills, and velvet scoters would be affected by impact would be minimal in comparison to the total area of alternative habitat available (amounting to less than 0.1% of the area covered by the SPA). It is concluded that any effects on all marine seabirds from direct impacts during the development stage would be minimal.

In terms of direct disturbance through construction activity via airborne noise, light, and visual impact during the development stage, there would be no adverse effects on common scoters, long-tailed ducks, razorbills, and velvet scoters, and consequently, on the site integrity of the Przybrzeżne wody Bałtyku SPA.

LSE - direct impact resulting from construction activity through airborne noise, light, and visual impact (construction phase)

The area likely to be impacted from construction phase disturbance was determined on an impact distance buffer of 500m and taking account that the shared footprint of the cooling water intake, outfall and FRRS extends 1.3km from the shoreline, a total area of 1.3km^2 would be affected by activity associated with dredging works locations. This is equivalent to 0.06% of the area of the Przybrzeżne wody Bałtyku SPA. The impacts related to vessel traffic are assessed separately in subsequent subchapter.

Over-wintering common scoters, long-tailed ducks, razorbills and velvet scoters were recorded in internationally significant numbers across the Marine Survey Area and are sensitive to impact through construction activity via airborne noise, light, and visual effects.

The duration of the impacts is short-term, as effects would only occur at the construction stage of the Project, and the total area within which common scoters, long-tailed ducks, razorbills and velvet scoters would be impacted would be minimal in comparison with the total area of an alternative habitat available (amounting to less than 0.1% of the area covered by the SPA). It is concluded that any effects on marine seabirds arising from direct impacts during the construction stage would be negligible.

In terms of direct disturbance through construction activity via airborne noise, light, and visual impacts at the construction stage, no adverse effect on common scoters, long-tailed ducks, razorbills and velvet scoters is anticipated, and consequently, on the site integrity of the Przybrzeżne wody Bałtyku SPA.

LSE - direct impact resulting from construction works through increased vessel traffic (development stage)

The focus of marine operations in the development stage will be around the footprint of the MOLF and STW pipeline and outfall, with support and safety vessels required to attend the jack up barges during construction of the MOLF and dredging vessels associated with construction of the STW. The impacts at sea, and the works associated with the vessel activity may present a stimulus impacting seabirds, with subsequent risk-avoidance behaviour reducing the time available for other activities such as feeding, resting or mating. The observed reactions by seabirds include flying off, diving, and increased alertness, which can result in loss of energy and opportunities, displacement, and habitat loss. The impacts caused by vessels may thus reduce survival and reproductive success and affect population dynamics.

Impact responses differ among species, with some species more sensitive than others. A ship traffic disturbance vulnerability index (DVI) [456], that took account of species shyness, energetic cost of escape and population metrics for a range of species in the Baltic Sea has been used to assess the potential impacts on the marine bird features brought forward for assessment, and is summarised in [Table IV.1- 32]

Table IV.1- 32 Flush distances and DVI

	Species	Mean flush distance: individual (m)	Mean flush distance: flock (m)	DVI
1	Velvet scoter	474	444	68.4
2	Razorbill	395	330	51.3
3	Common scoter	1,600	1,015	43.3
4	Long-tailed duck	389	325	40.4

Source: [456]

Seabirds may habituate and even adapt to disturbances by ship traffic if they are able to identify vessels as non-threatening objects. There is already fishing activity within the SPA and the local area, albeit at a low level, meaning that birds would be habituated to anthropogenic presence. Any works would also be undertaken subject to best practice, and vessels associated with the works would not be travelling erratically or at speed once in the vicinity of the works. However, ships differ greatly in size, shape, speed, and engine noise, making recognising them as non-threatening objects difficult. In an environment where predation risk exists, both from natural predators and human activity, birds are likely to regard big moving objects as potential threats, and the potential for change in habits among sensitive species is very limited.

Neither the home ports nor the level of vessel traffic activity associated with supporting the construction of the MOLF and STW during construction stage have currently been identified. Based on the greatest mean flush distance (common scoter) presented above it is assumed for the purposes of this assessment that the maximum range of impacts will extend 1km from any vessel so each vessel would have a 2km wide impact zone as it transits the area.

Over-wintering common scoters, long-tailed ducks, and velvet scoters were recorded in internationally significant numbers across the Marine Survey Area and are especially sensitive to impacts through increased vessel traffic during the development stage.

In order to minimise disturbance from marine vessel traffic, a 1km wide Marine Traffic Zone (MTZ) would be established. All vessel approach activity would be contained and restricted to the MTZ which would either take the shortest route through the Przybrzeżne wody Bałtyku SPA, that is, perpendicular to the coastline and extend 1km in width from the centre-line of the construction or operation footprint, or follow the least sensitive route, if applicable, following results of any supportive surveys. Based on the greatest flock flush distance (common scoter) it is assumed that the maximum extent of impacts will extend 1km from both sides of the MTZ.

To ensure that the MTZ is effective at minimising disturbance, an adaptive monitoring and mitigation strategy would be developed and implemented before commencement of the development stage of the Project. This strategy would combine desk-based studies with habitat and species distribution and abundance data to refine the location, extent, and justification of any MTZ.

With the implementation of the impact mitigating MTZ, it is anticipated that the effects on common scoters, long-tailed ducks, and velvet scoters arising from disturbance due to increased vessel traffic during the development stage would be minor.

In terms of disturbance through increased vessel traffic during the development stage, upon the implementation of the proposed mitigation measures via the MTZ and adaptive monitoring and mitigation strategy, there would be no adverse effect on common scoters, long-tailed ducks, razorbills and velvet scoters, and consequently on the integrity of the Przybrzeżne wody Bałtyku SPA.

LSE - direct impact resulting from construction activity through increased vessel traffic (construction phase)

Neither the home ports nor the level of vessel traffic activity associated with supporting the construction of the cooling water intake and outflow are currently known. Based on the greatest flush distance (common scoter) presented above it is assumed that the maximum extent of disturbance will extend 1km from any vessel so each vessel would have a 2km disturbance zone along its transit route.

Over-wintering common scoters, long-tailed ducks, and velvet scoters were recorded in internationally significant numbers across the Marine Survey Area and would be especially sensitive to impacts through increased vessel traffic at the construction stage.

As with the development stage, in order to minimise disturbance from marine vessel traffic, a 1km wide Marine Traffic Zone (MTZ) will be established. All vessel approach activity would be contained and restricted to the MTZ which would either take the shortest route through the Przybrzeżne wody Bałtyku SPA i.e. perpendicular to the coastline and extend 1km from the centre-line of the construction or operation footprint; or follow the least sensitive route if applicable following results of any supportive surveys. Based on the greatest flush distance (common scoter), it is assumed that the maximum extent of impacts will extend 1km from the MTZ area.

To ensure that the MTZ is effective at minimising disturbance, an adaptive monitoring and mitigation strategy would be developed and implemented before commencement of the development stage of the Project. This strategy would combine desk-based studies with habitat and species distribution and abundance data to refine the location, extent, and justification of any MTZ.

With the implementation of the impact mitigating MTZ, it is concluded that the resultant effects on common scoters, long-tailed ducks, and velvet scoters arising from disturbance through increased vessel traffic during the construction stage would be minor and insignificant.

In terms of disturbance through increased vessel traffic during the construction stage, upon the implementation of the proposed mitigation via the MTZ and adaptive monitoring and mitigation strategy, the Project would result in a change of minor magnitude. The effects would be insignificant, there would be no adverse effect on common scoter, long-tailed duck, razorbill and velvet scoter, and consequently on the integrity of the Przybrzeżne wody Bałtyku SPA.

LSE - direct impact resulting from operation activities due to increased vessel traffic (operational phase)

During the operational phase, the impacts for birds should be lower than during the construction phase. The MOLF will be used sporadically during maintenance works so vessel traffic will not be a regular occurrence. Based on the greatest flock flush distance (common scoter) presented above it is assumed that the maximum extent of disturbance will extend 1km from any vessel so each vessel would have a 2km disturbance zone.

Over-wintering common scoters, long-tailed ducks, and velvet scoters were recorded in internationally significant numbers across the marine survey area and could be sensitive to impacts resulting from increased vessel traffic during the construction phase. However, due to limited and sporadic nature of any vessel activity during the operational phase, in terms of disturbance through increased vessel traffic the Project will result in a negligible change. Therefore, there would be no adverse effect on common scoters, long-tailed ducks, razorbills and velvet scoters, and consequently, on the site integrity of the Przybrzeżne wody Bałtyku SPA.

LSE - direct impact through operation of the MOLF (operational phase)

During the operational phase, the impacts caused by vessels should be minimal compared to the construction phase. Noise pollution from vessels is a potential effect during any maintenance work required, but this would not be a regular occurrence. Additionally, the MOLF would also only be used sporadically during any maintenance and thus would not result in any disturbance other than that already assessed for the construction phase.

Based on a disturbance distance of 500m, a total area of approximately 0.6km^2 would be occasionally affected by operational activity of the MOLF. This is equivalent to 0.03% of the area of the Przybrzeżne Wody Bałtyku SPA.

The total area within which common scoters, long-tailed ducks, razorbills, and velvet scoters may be impacted by the disturbance would be minimal in comparison to the total area of an alternative habitat available (amounting to less than 0.1% of the area covered by the SPA), and such a potential loss of habitat resulting from impacts would only occur occasionally during the operational phase of the Project.

It is therefore concluded that any effects on seabirds arising from direct impacts due to operation of the MOLF would be minimal.

In terms of direct disturbance through the occasional operation of the MOLF during the operational phase, there would be no adverse effect of the Project on common scoters, long-tailed ducks, razorbills and velvet scoters, and consequently, on the integrity of the Przybrzeżne wody Bałtyku SPA.

Conservation objective assessment

For the purposes of this assessment, the European Site Conservation Objectives for Przybrzeżne wody Bałtyku SPA are assumed to relate to:

- avoiding deterioration of the habitats of the qualifying species or significant impacts to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- ensuring the following conditions for the qualifying features in the long term:
  - stable structure, function, and supporting processes of habitats of the species,
  - no significant impacts on the species.

The assessment of LSE within chapters [Chapter III.7.2.1 - III.7.2.5] concluded that with the implementation of the proposed mitigation measures there would be no adverse effects on the integrity of the Przybrzeżne wody Bałtyku SPA associated with:

- deterioration of the habitats of the qualifying species, thus ensuring that the integrity of the site is maintained,
- stable population of the species maintained in the long term,
- long-term preservation of habitats,
- stable structure, function, and supporting processes of habitats, maintained in the long term.

The assessment of the remaining LSE, presented in chapter [Chapter IV.1.4.4.5.4], concluded that with the implementation of the proposed mitigation measures detailed within those assessments there would be no adverse effects on the integrity of the Przybrzeżne wody Bałtyku SPA.

Conclusions on integrity

No adverse effects are predicted on any qualifying features, their supporting habits or prey species associated with the Przybrzeżne wody Bałtyku SPA, therefore the Project will not have any adverse effect on the site integrity of the Przybrzeżne wody Bałtyku SPA.

IV.1.4.4.5.5 Pobrzeże Słowińskie SPA - Great cormorant

Baseline distribution and abundance

In the coastal zone, surveys recorded 40 bird species with a total of 31,746 individuals [213] of which great cormorant accounted for 1.8% of all individuals recorded.

During the spring, great cormorants were observed mainly in the central and western part of the near-shore zone and in one place in the north-western area of the marine zone. Densities reached 5 ind/km^2, and only locally slightly exceeded 10 ind/km^2.

In the summer the number of great cormorants increased and their average density in the littoral zone exceeded the value of 10 individuals/km^2 in many areas. In the coastal zone, this species appeared sporadically.

In the autumn great cormorants were recorded in greater numbers in the near-shore zone, where its density exceeded 10 ind/km^2 across much of the area. As with other periods, this species was found less often and only in one place was its density higher than 10 ind/km^2 in the marine zone.

In the winter, abundance decreased and most of the birds that were observed were within the near-shore zone, where in two areas in the western part of the near-shore zone the densities were above 5 ind/km^2.

LSE -- direct impact resulting from construction activity through airborne noise, light, and visual impact (development stage)

A total area of about 1.6km^2 could be affected by activity at jack-up barge locations associated with the construction of the MOLF and dredging locations associated with the STW.

Great cormorants were recorded in nationally significant numbers across the entire marine survey area, however they are less sensitive to impacts than the species assessed above, i.e. common scoter, long-tailed duck, razorbill and velvet scoter. Pobrzeże Słowińskie SPA lies 34km from the Project area, and the great cormorant is a wide-ranging sea-bird species therefore there is extensive alternative habitat available for foraging birds and the temporary loss of 1.6km^2 is negligible in terms of their overall foraging resource.

It is therefore concluded that any effects on the great cormorant arising from direct impacts through construction activity in the form of airborne noise, light, and visual disturbance during development works would be negligible. With reference to direct impacts resulting from construction works in the form of airborne noise, light, and visual disturbance during the development stage, there would be no adverse effect on the great cormorant, and consequently, on the integrity of the Pobrzeże Słowińskie SPA.

LSE - direct impact resulting from construction activity through airborne noise, light, and visual impact (construction phase)

The area likely to be impacted from construction phase disturbance was determined on an impact distance buffer of 500m and taking into account that the shared footprint of the cooling water intake, discharge and FRRS extends 1.3km from the shoreline, a total area of 1.3km^2 would be affected by activity associated with dredging works locations.

Breeding great cormorants were recorded in nationally significant numbers across the entire marine survey area, however, they are less sensitive to impacts than the previously assessed species, i.e. common scoter, long-tailed duck, razorbill, and velvet scoter. Pobrzeże Słowińskie SPA lies 34km from the Project area, and great cormorant are a wide-ranging sea-bird species therefore there is extensive alternative habitat available for foraging birds and the temporary loss of approximately 1.3km^2 is minimal in terms of their overall foraging resource.

It is therefore concluded that any effects on the great cormorant arising from direct impacts resulting from the construction activity in the form of airborne noise, light, and visual disturbance in the Project construction phase would not have an adverse impact on the great cormorant, and consequently, on the site integrity of the Pobrzeże Słowińskie SPA.

LSE - direct impact resulting from construction works through increased vessel traffic (development stage)

Impacts from construction activities due to an increased vessel traffic in Variant 2 are analogous to those described for Variant 1 [Chapter IV.1.4.3.5.5]

LSE - direct impact resulting from construction activity through increased vessel traffic (construction phase)

Impacts from construction activities due to an increased vessel traffic in Variant 2 are analogous to those described for Variant 1 [Chapter IV.1.4.3.5.5]

LSE - direct impact resulting from increased vessel traffic (operational phase)

Impacts from construction activities due to an increased vessel traffic in Variant 2 are analogous to those described for Variant 1 [Chapter IV.1.4.3.5.5]

LSE - direct impact through operation of the MOLF (operational phase)

Based on a disturbance distance of 500m, a total area of approximately 0.6km^2 would be occasionally affected by operational activity of the MOLF. This is equivalent to 0.03% of the area of the Przybrzeżne Wody Bałtyku SPA.

Breeding great cormorants were recorded in nationally significant numbers across the entire marine survey area, however, they are less sensitive to impacts than the previously assessed species, i.e. common scoter, long-tailed duck, razorbill, and velvet scoter. Pobrzeże Słowińskie SPA lies 34km from the Project area, and great cormorant are a wide-ranging sea-bird species therefore there is extensive alternative habitat available for foraging birds and the temporary loss of approximately 0.6km^2 is negligible in terms of their overall foraging resource.

It is therefore concluded that any effects on the great cormorant arising from direct impacts through the MOLF operation would be negligible; there would be no adverse effect on the great cormorant, and consequently, on the site integrity of the Pobrzeże Słowińskie SPA.

Assessment against conservation objectives

This issue is identical to the description presented in chapter [Chapter IV.1.4.3.5.5].

Conclusions on integrity

This issue is identical to the description presented in chapter [Chapter IV.1.4.3.5.5].

IV.1.4.4.5.6 In-Combination Assessment

This issue is described in chapter [Chapter IV. 2] of the EIA Report.

IV.1.4.4.6 Summary

Potential environmental changes that could result in connection with the development stage, construction stage and operational phase of the Project were analysed in order to determine whether LSE on European sites can be excluded on the basis of objective information as part of the Project individually, or in combination with other plans or projects.

It was established that the Project is not directly connected with, or necessary to, the management of any European site; however, it cannot be excluded, on the basis of objective scientific information following screening, that the Project, individually or in combination with other plans or projects, would have an LSE on the following European sites, with reference to their qualifying features, that is:

- Przybrzeżne wody Bałtyku SPA: common scoter, long-tailed duck, velvet scoter, razorbill, common gull, European herring gull

- Mierzeja Sarbska SAC: grey seal
- Ostoja Słowińska SCI: grey seal, harbour porpoise, habitats: 1150: Coastal lakes and lagoons; 1170: Rocky seabed (reefs)
- Pobrzeże Słowińskie SPA: grey seal, great cormorant,
- Słowiński Park Narodowy (Słowiński National Park) / Ramsar Site: grey seal, harbour porpoise
- Zatoka Pucka SPA: European herring gull
- Zatoka Pucka i Półwysep Helski SCI: grey seal, porpoise
- Kaszubskie Klify SCI: grey seal, harbour porpoise
- Hoburgs bank och Midsjöbankarna: harbour porpoise
- Zalew Wiślany i Mierzeja Wiślana SCI: grey seal
- Ostoja w Ujściu Wisły SCI: grey seal
- Pommersche Bucht SAC: harbour porpoise
- Ostoja na Zatoce Pomorskiej SCI: harbour porpoise
- Wolin i Uznam SCI: harbour porpoise
- Adler Grund og Rønne Banke SAC: harbour porpoise
- Sydvästskånes utsjövatten SAC: harbour porpoise
- Greifswalder Boddenrandschwelle und Teile der Pommerschen Bucht SAC: harbour porpoise
- Darßer Schwelle SAC: harbour porpoise
- Kadetrinne SAC: harbour porpoise
- Plantagenetgrund: harbour porpoise
- Westrügensche Boddenlandschaft mit Hiddensee: harbour porpoise
- Erweiterung Libben, Steilküste und Blockgründe Wittow und Arkona: harbour porpoise
- Greifswalder Bodden, Teile des Strelasundes und Nordspitze Usedom SAC: harbour porpoise
- Greifswalder Boddenrandschwelle und Teile der Pommerschen Bucht: harbour porpoise
- Greifswalder Bodden, Teile des Strelasundes und Nordspitze Usedom SAC: harbour porpoise
- Greifswalder Boddenrandschwelle und Teile der Pommerschen Bucht: harbour porpoise

The following LSEs were identified for the abovementioned qualifying features:

- Indirect effects via potential changes in prey availability as a result of the introduction of invasive and non-native species (INNS)
- Indirect effects through impact on prey availability – benthic species
- Indirect effects through impact on prey availability – fish species
- Indirect impact on habitats – changes in water quality
- Indirect effects through impacts on prey availability – changes in water quality
- Direct impact from construction activities - underwater noise
- Direct impact resulting from construction activity - airborne noise, light pollution, and visual impacts
- Direct disturbance through construction activity – increased vessel traffic

- Direct impact due to the operation of the MOLF

Where detailed conservation objectives for a European site were not available, the following conservation objectives were applied in accordance with Article 33 of the Nature Conservation Act of 16 April 2004 (consolidated text: Journal of Laws of 2021, item 1098):

- not to worsen the status of the natural habitats or plant and animal habitats for the protection of which a Natura 2000 site has been designated; and
- not to worsen the integrity of a Natura 2000 site or its links with other sites.

Assessments for the open cooling system sub-variants 2A and 2B at the development and construction stages, and operational phase have been undertaken for LSEs on European site habitats via marine water quality, plankton communities, benthic habitats, fish prey species and INNS. In addition, the LSE assessment has determined that there are no negative impacts on the integrity of any European sites in the following scopes:

- Indirect effects through potential changes in food availability as a result of the introduction of invasive and non-native species (INNS)
- Indirect effects from impact on food supply - benthis species.
- Indirect effects from impact on food supply - fish species.
- Indirect effects from impact on food supply - changes in water quality.
- Indirect effects from construction works -- underwater noise.

In addition, the assessment has determined that there are no negative impacts on the integrity of any European Marine Mammal Protection Areas for the considered sub-variants 2A and 2B, during either the development stage, construction stage or operational phase.

The remaining LSEs associated with the development and construction stages, and operational phase, which are applicable (and of a similar magnitude) to both Variants, that can impact European site integrity, are:

- Direct impacts resulting from construction activity, in the form of airborne noise, light, and visual disturbance (development stage),
- Direct impact resulting from construction activities in the form of increased vessel traffic (development stage and construction stage)
- Direct impact through the MOLF operation (operational phase).

The aforementioned impacts were relevant to the following European site qualifying features, for which further assessment was carried out:

- Przybrzeżne wody Bałtyku SPA – common scoter, long-tailed duck, velvet scoter and razorbill;
- Pobrzeże Słowińskie SPA: great cormorant.

As part of the assessment, potential adverse effects were identified for Przybrzeżne wody Bałtyku SPA (common scoter, long-tailed duck, velvet scoter and razorbill) arising from impacts caused by increased vessel traffic during the Project development stage. Mitigation measures were recommended to minimise these effects and avoid any adverse effect on site integrity.

The mitigation measures aimed at minimising disturbance from marine vessel traffic, identified the need for establishing an MTZ. All vessel approach activities would be restricted to the MTZ which would either take the shortest route through the Przybrzeżne wody Bałtyku SPA, that is, perpendicular to the coastline and extend 1km in width from the centre-line of the construction or operation footprint, or follow the least sensitive route, if applicable, following results of any supportive surveys (plus a 1km buffer on either side of MTZ). To ensure the MTZ is effective at minimising impacts, an adaptive monitoring and mitigation strategy would be developed and implemented before commencement of the Project development stage. This strategy would combine desk-based studies with habitat and species distribution and abundance data to refine the location, extent of justification of any MTZ

With the implementation of the impact-mitigating MTZ, it is concluded that the effects on common scoters, long-tailed ducks and velvet scoters, resulting from disturbance through increased vessel traffic during the development stage, will be minor.

The assessment of LSE concluded that with the implementation of the recommended mitigation measures there would be no adverse effects on the integrity of the Przybrzeżne wody Bałtyku SPA ensuring:

- no deterioration of the habitats of the qualifying species, thus ensuring that the integrity of the site is maintained,
- population of the qualifying feature species as a viable component of the site and maintained in the long term,
- long-term preservation of habitats,
- structure, function, and supporting processes of habitats, maintained in the long term.

The Project will not have any adverse effect on the site integrity of the Przybrzeżne wody Bałtyku SPA.

In the case of Pobrzeże Słowińskie SPA, the assessment of LSE concluded that with the implementation of the proposed mitigation measures there would be no adverse effects on the integrity of the Pobrzeże Słowińskie SPA.

The assessment of the remaining LSE also concluded that there would be no adverse effects on the integrity of the Pobrzeże Słowińskie SPA.

The cumulative assessment concluded that there were no cumulative effects that could affect the integrity of any of the European sites analysed.

This HRA has considered all European sites within the Baltic Sea region that fall within the Project’s Zones of Influence and identified Zones of Influence of the species, including European sites in other countries; no adverse effects were identified for any of the European sites and therefore transboundary effects were ruled out for the Project.

Therefore, there will be no adverse effects on the integrity of any European sites, either from the Project alone, or in combination with other plans or projects.

IV.2 Impacts on natural (biotic) components

IV.2.3 Impacts on natural (biotic) components – marine environment

The purpose of this chapter is to present the results of the assessment of the impact of the Project consisting in the construction of a Nuclear Power Plant (hereinafter: NPP) on marine biological receptors in Variant 1 -- Lubiatowo – Kopalino site, and in Variant 2 -- Żarnowiec site.

The assessments presented in this report are based on a number of sources, including results of the computer modelling of predicted impacts. Assessments have been undertaken in accordance with industry standards, methodologies, legal regulations in force, and the requirements of the GDOŚ Scoping Decision [348].

The assessment of the impact on seawaters in terms of biological components, within the meaning of the WFD, and organisms (fish, birds, marine mammals) constituting higher-order consumers in the marine trophic chain, as mentioned above, was carried out on the basis of sources of information, one of which was an assessment of the impact of the planned Project on the physical, chemical, hydromorphological and biological quality indicators of marine surface waters as part of [456]. The assessment of the quality indicators [456] was the basis for the assessment of the impact on the above-mentioned organisms and forms of nature protection (including the Natura 2000 sites).

While the assessment of the water quality indicators took into account, first of all, physicochemical, chemical and hydromorphological aspects with biological elements of quality only to the extent corresponding to the requirements resulting from the relevant regulations (WFD, MSDW, Water Law), the impact assessment described in this chapter took into account the results of the assessment on the quality indicators, including indicators of biological elements, and implemented them in order to carry out the assessment for the forms of nature conservation, including 'Natura 2000' sites, and protected species for which relevant areas have been established as well as their food base.

Although the assessment of impacts on the quality indicators allowed for the identification of cause-and-effect relationships between the components of the marine environment and the Project at the level of primary (autotrophic and prokaryotic) producers in terms of indicators for biological elements (phytoplankton, macroalgae, angiosperms, benthic macroinvertebrates), it was an intermediate assessment with non-conclusive results in terms of the holistic impact of the planned Project on marine biology including protected plant and animal species.

Therefore, in order to address relevant components of the living environment, this Chapter presents a holistic impact assessment to evaluate the possibility of using an open or closed cooling system with the Baltic Sea as receiver.

The results of the impact assessment presented in this Chapter should take precedence over the assessment of the impact on marine water quality indicators in any situation where the assessed biological component quality indicator would have a different assessment result.

IV.2.5 EIA methodology

The General Directorate for Environmental Protection (GDOŚ) has made available a number of resources providing guidelines for conducting environmental surveys, public consultations, preparing EIA Reports and general information on the assessment of documents (including assessment of impacts on 'Natura 2000' sites). They were used to develop the assessment methodology together with the information presented in the report defining the scope of the EIA scope report and best practices based on international guidelines for the preparation of the EIA Report documentation.

The assessment methodology is presented in a six-level approach. The following sections of this report discuss the six levels:

- **Level 1**: Exposed environmental components (receptors)

- **Level 2**: Key measures
- **Level 3**: Types of key impacts by stage
- **Level 4**: Values that determine impact directions and types
- **Level 5**: Environmental sensitivity
- **Level 6**: The importance of the impacts

This report does not include an assessment of the impact on 'Natura 2000' sites in a specific way, i.e. by assessing compliance with the requirements of the Habitats and Birds Directives. The assessment of the impact on 'Natura 2000' sites is the subject of Chapter IV.1. of this report.

In some environmental impact assessment reports (EIA Reports), the terms "impacts" and "effects" are used interchangeably, while in others these terms are given different meanings. Some use the word "impact" to mean the cause of an "effect," while others use the opposite meaning. This diversity of definitions has led to many misunderstandings related to these terms, both among the authors and readers of EIA Reports.

The terminology used in this EIA Report for the marine areas is based on the following definitions:

- **Impacts**: This term refers to the levels of exposure, pressure or change that will affect the receptor through a given range (e.g. loss of a benthic habitat before the start of construction works or an increase in underwater noise levels). In some cases, one change causes another change which, in turn, leads to environmental "effects".
- **Effects**: This term refers to the consequences of the impact on a receptor (e.g. the loss of a habitat on the seabed will result in mortality of species dependent on this habitat or the emission of underwater noise will disturb the fish and, thus, affect the availability of the food base for seabirds).

IV.2.5.1 Description of the assessment process

IV.2.5.1.1 Assessment framework

The impact assessment framework, presented in four stages in the subsequent subsections, has been defined in order to clarify the six above-mentioned levels of the EIA methodology, and to take into account the key criteria and conditions contained in the relevant EC Directives and Polish legal regulations. They follow the *"source – pathway – receptor"* model. This was used to determine the range of possible impacts and the manner in which they can cause effects on receptors in the marine water environment. The following definitions are used:

- **Source**: The source of a potential impact (for example, construction of marine infrastructure).
- **Pathway**: The means by which an impact reaches a receptor (e.g. transmission of pollutants through water, transmission of over-water noise through the air); and
- **Receptor**: A "characteristic" that is subject to impact, leading to an effect (e.g. seawater quality, designated area or structure/facility in a protected area).

Potential sources of impact were identified on the basis of the maritime infrastructure associated with the planned Project and the related construction methods (including indirect effects of construction on land). The list of potential receptors was drawn up on the basis of the natural characteristics of the marine environment, based on the results of a number of environmental surveys carried out in the marine survey areas designated for both variants considered [Chapter III.02].

The EIA methodology was prepared in order to adapt it to the multi-level approach described above (Levels 1-6) and the assessment was carried out in the following four stages:

- **Stage 1 – Identification of sources and receptors (levels 1, 2 and 5):** at this stage, sources and receptors are identified and assigned importance/value and sensitivity;

- **Stage 2 – Identification and magnitude of impact (levels 3 and 4):** at this stage, the magnitude, nature, extent, duration and frequency of impacts are determined.
- **Stage 3 – Assessment of effects (level 6)**: this stage is used to determine the magnitude of effects and their importance.
- **Stage 4 – Mitigation, and identification of residual effects**: at the final stage, mitigation measures are identified to avoid or reduce residual effects.

IV.2.5.1.2 Spatial scope

The geographic or spatial scope of the assessment of the marine environment takes into account the nature of the potential effects and the location of the receptors likely to be impacted by the Project. Regarding the land areas, the study for this assessment was limited by the land edge of the "service belt", thanks to which it also encompassed the dune system along the coast.

Therefore, for the purposes of this impact assessment, it is assumed that the marine environment includes the seabed, beaches and the coastal dune system up to the onshore edge of the service belt, as well as seawater and its biological components.

IV.2.5.1.3 Time frame

The time scope refers to the periods during which the impacts can be felt by sensitive receptors. They can be permanent, temporary, long-term, medium-term or short-term. As part of the EIA, the assessment of effects in the following phases and stages of the Project was carried out, in accordance with Chapter II:

- The Construction phase of the Project: the development stage (duration of about three years);
- The Construction phase of the Project: the construction stage (duration of about 9 years);
- The Operational phase of the Project (duration of approximately 60 years); and
- Decommissioning phase of the Project (duration of approximately 24 years).

IV.2.5.2 Stage 1: Identification of sources, pathways and receptors

IV.2.5.2.1 Sources and pathways

The first stage involves the identification of potential environmental impacts resulting from the Project and the pathways of impact that can affect the receptors. The sources, pathways and potential impacts on the marine environment that have been taken into account in this assessment are presented in [Table IV. 2-1]. This covers all the phases of the Project, although the emphasis is on the impact assessment in the Construction phase (development stage and construction stage) and the Operational phase.

The potential effects during the Decommissioning phase are expected to be similar to those occurring during the development stage and construction stage and, although likely to be of a smaller scale, may extend over a longer period of time. The decommissioning phase of the Project is associated with significant uncertainty, not only with regard to the planned decommissioning work but also with regard to the initial conditions and regulatory framework that will be in force at that time. The potential impacts on this phase of the Project are therefore assessed only in general terms.

IV.2.5.2.2 Receptors

IV.2.5.2.2.1 Identification of the key receptors and pathways

The environment may be exposed to an impact but depends on the existence of its pathway. In the context of this assessment of the impacts on the marine biological components, such a pathway could be, for example, a physical process or the release of a chemical substance. The concept of how the pathway connects the receptor to the source of the impact is shown in [Figure IV.2-5] and [Figure IV.2-4].

Figure IV.2-5: Relationship between the source, pathway and receptor

Source: developed based on [456]

IV.2.5.2.2.2 Zones of the Project's impacts

The zone of impact (hereinafter interchangeably: "ZoI") is a key element in determining the potential effects of impacts by identifying pathways between sources of effects and receptors. For example, if the underwater noise zone of impact coincides with a major population of marine mammals, the existence of this pathway can be demonstrated. Zones of impact have been defined for the following key elements of the Project:

- Increased ambient water temperature;
- Changes in water quality (using chlorine/hydrazine dispersion as a proxy indicator);
- Changes in salinity levels;
- Changes in the total amount of suspended sediments/increased turbidity;
- Increased underwater noise levels resulting from construction works;
- Increased aircraft noise levels;
- Light/visual impacts; and
- Coastal processes.

The "worst-case scenario" envelopes have been developed for each of these elements. Where appropriate (e.g. temperature or water quality components), they were based on combined summer and winter modelling results and on aggregate change calculations for the 98th percentile. These zones then formed the basis for all the impact assessments included in this report. Where appropriate, these zones of impact have been elaborated further, at the Project level, using information specific to the impact receptors, e.g. known auditory sensitivities of marine mammal species. Where the sensitivities and the zones of impact overlap, this implies the presence of a potential pathway of an impact, which will then be described and appropriately evaluated.

Increased water temperature

The release of operational discharge effluents from the outlets of the cooling water system will cause the temperature of the receiving body to rise until it is dispersed in the receiving environment. The determination of the zone of impact value for elevated temperatures was based on a temperature increase by 10°C, using the results of the modelling [456] carried out as part of the assessment of the impacts on the marine water quality indicators. [Table IV.2-141] shows the areas where a temperature increase by both 0.5°C and 2°C would be observed in accordance with [Chapter IV.8.3].

Table IV.2-141 The increase in the receiving body water temperature in the analysed site variants

No.	Variant	Increase by 0.5°C		Increase by 2°C	
		Distance from the source	Area	Distance from the source	Area
1	Lubiatowo - Kopalino, 1A, surface temperature	20.8 km	192.62 km^2	1.8 km	7.2 km^2
2	Lubiatowo - Kopalino, 1A, temperature on the seabed	20.6 km	140.81 km^2	< 1 grid cell *	< 1 grid cell
3	Lubiatowo - Kopalino, 1B, temperature on the seabed	395 m	0.13 km^2	< 1 grid cell	< 1 grid cell
4	Lubiatowo - Kopalino, 1C, temperature on the seabed	250 m	0.08 km^2	< 1 grid cell	< 1 grid cell
5	Żarnowiec, 2A, temperature on the seabed	400 m	0.15 km^2	200 m	0.04 km^2
6	Żarnowiec, 2B, temperature on the seabed	375 m	0.12 km^2	180 m	0.03 km^2

** Model grid cell*

Source: [456]

Changes in water quality

Operational discharge effluents generated by the individual variants of the Project contain a number of ingredients the behaviour of which will vary depending on their chemical composition and behaviour in reaction with seawater, as well as the prevailing direction of water movement. However, in order to understand the "typical" behaviour of the spread, the chlorine concentration was used as a suitably representative proxy for all chemical components of the effluents. Due to different operational scenarios, the chlorine concentration was modelled exclusively for the open cooling system at the Lubiatowo - Kopalino site, sub-variant 1A, representing the worst case scenario, in terms of the area occupancy, for the spread of the flow [Table IV.2 - 142].

For the purposes of the following modelling results, the temperature increase by 10°C was used to determine the spread dynamics with the determination of the concentration values and the extent of the thermo-chemical plume dispersion range given in the table below.

Table IV.2 - 142 Marine areas affected by increased chlorine concentrations

No.	Variant	0.01 mg/l		0.05 mg/l	
		Distance from the source	Area (km^2)	Distance from the source	Area (km^2)
1	Lubiatowo - Kopalino, 1A, surface concentration	23.5 km	210.78	1.6 km	4.19
2	Lubiatowo - Kopalino, 1A, concentration on the seabed	23.5 km	193.79	< 1 grid cell	< 1 grid cell

Source: [456]

Changes in salinity levels

Due to the composition of the effluent discharge, changes in the ZoI salinity, are presented in [Table IV.2 – 143]. Further details can be found in [Chapter IV.8.3] of the EIA Report.

Table IV.2 - 143 The areas affected by increased salinity

No.	Variant	0.5 psu	
		Distance from the source	Area (km²)
1	Lubiatowo - Kopalino, 1B, concentration on the seabed	< 1 grid cell	< 1 grid cell
2	Lubiatowo - Kopalino, 1C, concentration on the seabed	40 m	0.006
3	Żarnowiec, 2A, concentration on the seabed	253 m	0.06
4	Żarnowiec, 2B, concentration on the seabed	323 m	0.09

Source: [456]

Changes in the total sediment suspension/increase in turbidity

Total sediment suspension levels and associated turbidity changes have a potential to cause a number of effects in the marine environment. The total sediment suspension levels are presented in table [Table IV.2-144] and additional detailed information on the assumptions and scenarios is presented in [Chapter IV.8.3] of the EIA Report.

Table IV.2-144 The areas exposed to elevated levels of the total sediment suspension

No.	Variant/Scenario	Change in the total sediment suspension levels (area, km²)		
		25 mg/l	5 mg/l	2.5 mg/l
1	Lubiatowo - Kopalino, 1A, 24-hour average, base case	13.5864	N/A	N/A
2	Lubiatowo - Kopalino, 1A, 30d-average, base case	N/A	10.9324	25.518
3	Lubiatowo - Kopalino, 1B/C, 24-hour average, base case	0.2646	N/A	N/A
4	Lubiatowo - Kopalino, 1B/C, 30d-average, base case	N/A	< 1 grid cell *	0.42058
5	Żarnowiec, 2A/B, 24-hour average, base case	13.6	N/A	N/A
6	Żarnowiec, 24-hour average, base case	N/A	10.9	25.5

** The size of the model grid cell in the marine Project Area is 150 m². The size of the model's cell increases as the distance from the discharge point increases.*

Source: [456]

Increased underwater noise levels

The detailed description of the behaviour of underwater noise in the marine environment, and, in particular, in relation to the Project, can be found in [307] and in [Chapter IV.10.2] of the EIA Report. In all the variants, the underwater noise can result from a combination of construction works and vessel movement, e.g. ships sailing to/from the MOLF.

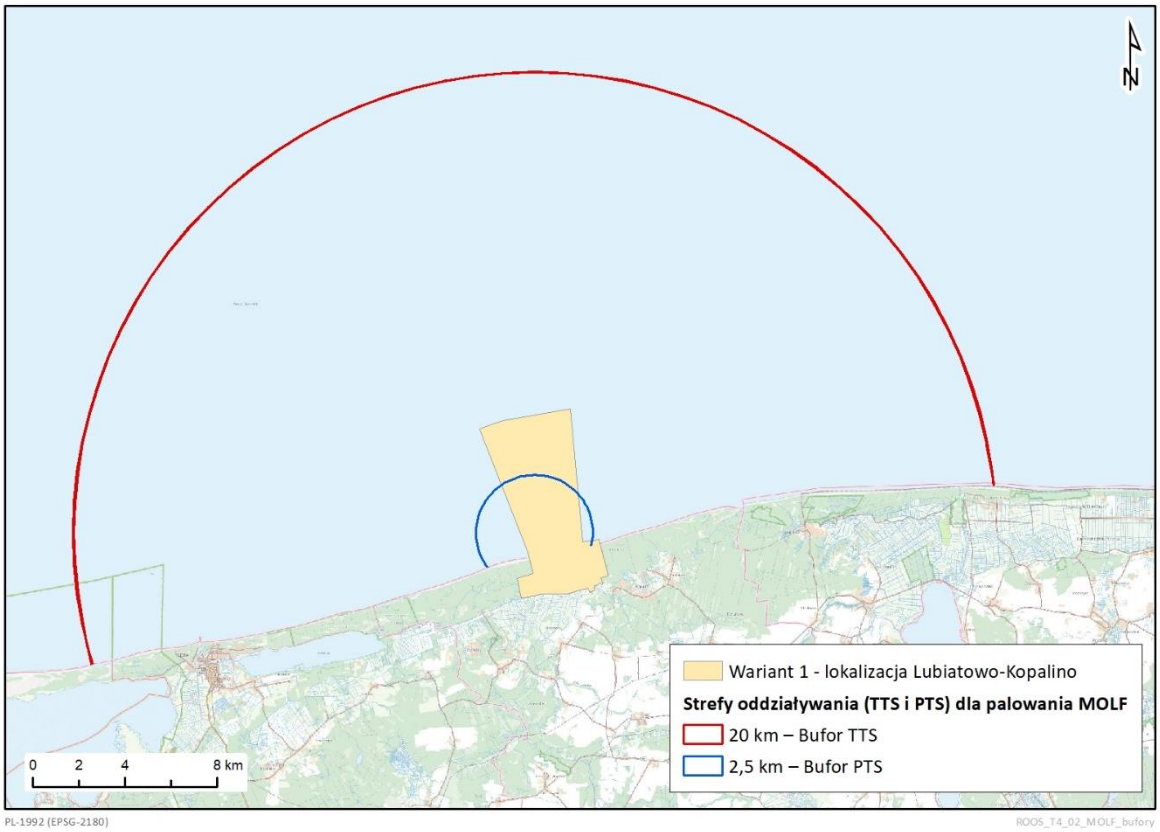
With regard to the underwater noise, the worst-case piling scenario was used, compared with the "high-frequency" auditory sensitivity of cetaceans (in this case porpoises, the only cetacean species recorded near the Project site/area). This approach is considered to be sufficiently representative to cover the potential effects also on bird and fish species. [Table IV.2-145] shows these zones of impact, based on works within the MOLF, focusing on the temporary threshold shift (TTS) and the permanent threshold shift (PTS).

Table IV.2-145: The zones affected by piling noise

No.	Variant/Scenario	Distance from the source
1	TTS as a result of impact piling within the MOLF	20 km
2	PTS as a result of impact piling within the MOLF	2.5 km

Source: [456]

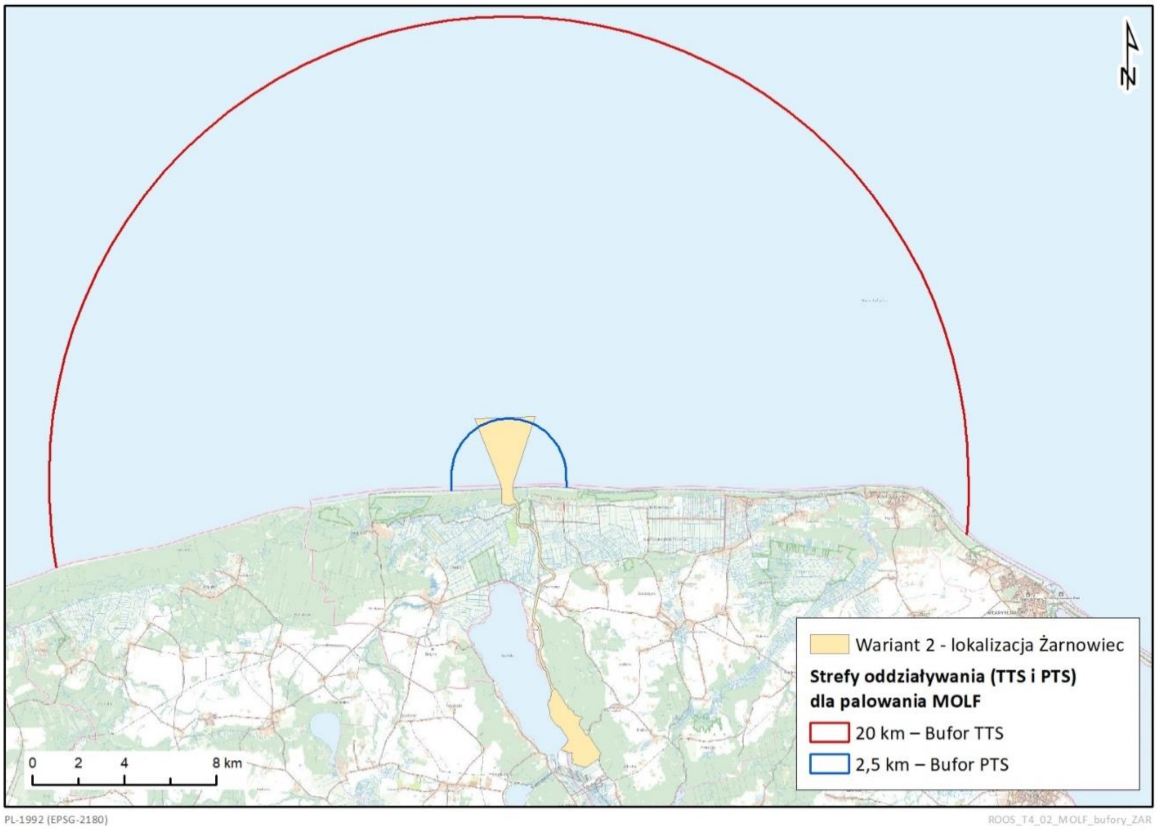
The zones of increased underwater noise levels referred to in the table above are also presented in the following figures for the analysed site variants: [Figure IV.2-6 and Figure IV.2-7].



Wariant 1 - lokalizacja Lubiatowo - Kopalino	Variant 1 – Lubiatowo - Kopalino site
Strefy oddziaływania (TTS i PTS) dla palowania MOLF	Impact zones (TTS and PTS) for MOLF piling
20 km - Bufor TTS	20 km - TTS Buffer
2,5 km - Bufor PTS	2.5 km - PTS Buffer

Figure IV.2-6 The zones of impact (TTS and PTS) for MOLF piling at the Lubiatowo - Kopalino site

Source: [456]



Wariant 2 - lokalizacja Żarnowiec	Variant 2 — Żarnowiec site
Strefy oddziaływania (TTS i PTS) dla palowania MOLF	Impact zones (TTS and PTS) for MOLF piling
20 km - Bufor TTS	20 km - TTS Buffer
2,5 km - Bufor PTS	2.5 km - PTS Buffer

Figure IV.2-7 The zones of impact (TTS and PTS) for MOLF piling at the Żarnowiec site

Source: In-house study based on [456]

The zone of impact also includes increased levels of noise from other construction works related to the Project, including, for example, dredging (and removal) of material plus increased noise levels associated with the presence of ships.

Aircraft noise, light and visual impacts

No detailed modelling of airborne noise or light distribution resulting from construction works related to the Project has been carried out as part of the impact assessment. However, based on previous experience with comparable Projects, and as a result of professional assessment, a distance of 500 m was used as the radius of the zone of impact for light and visual impacts related to the Project. This may involve activities such as works carried out in the evening or at night in bad weather in the MOLF area or in the coastal zone, as well as light impacts related to the movement of vessels in connection with the Project.

It is recognised that the impact will also include potential aviation noise issues arising from the construction works in the marine and coastal environments.

Coastal processes

Potential changes in hydrological regimes and sediment transport (collectively considered as "coastal processes") are described and assessed in chapter [Chapter IV.8.3] of this Report. The said chapter describes in detail the modelling of changes in, among others, the bathymetry of the sea in the zone affected by changes resulting from temporary and permanent works related to the implementation of the planned Project carried out in the marine environment, as well as speeds of currents, wave heights and other marine processes.

IV.2.5.2.2.3 Receptors

Identification of the key receptors and pathways

The identification of groups of marine biological receptors was based on the characteristics of individual marine biological elements (cf. [Chapter III.2] of the EIA Report) and international best practices such as those of the UK Chartered Institute of Ecology and Environmental Management (CIEEM) and the European Commission (EC).

The table below [Table IV.2-146] presents the activities, phases and potential effects that can occur as a result of the implementation of the Project, with each potential effect assigned to a specific group of impact receptors. Each significant impact or effect is described and assessed in the relevant chapters for Sub-Variants 1A, 1B or 1C (chapters [Chapter IV.2.7], [Chapter IV.2.12] and [Chapter IV.2.24] of the EIA Report, respectively) and sub-variants 2A and 2B (chapters [Chapter IV.2.34] and [Chapter IV.2.35] of the EIA Report, respectively).

If no pathway between the activity within the Project and a group of impact receptors has been identified, this is shown in the table. In such cases, no full impact assessment was carried out but a description was provided stating that no further assessment [in such scope] was necessary.

Table IV.2-146 The potential impacts between Project activities and marine biological receptor groups

No.	Activity	Phase/Stage	Receptor groups and possible relations
1	Site preparation/construction works on the main site of the Nuclear Power Plant, including site clearing	Construction phase: – Development stage – Construction stage	**Habitats / zoobenthos / macroalgae:** smothering as a result of resettlement of suspended sediments **All biotic receptors:** Changes in water quality (physical and chemical) **Birds / fish / marine mammals:** Changes in prey availability as a result of the above factors **Birds / fish / marine mammals:** Impact through introduction of increased noise and light levels. Visual impacts
2	Construction of the MOLF – offshore part (associated infrastructure/investment)	Construction phase: – Development stage	**Habitats / zoobenthos / macroalgae:** Direct loss of habitats **Habitats / zoobenthos / macroalgae:** smothering as a result of resettlement of suspended sediments. **All biotic receptors:** Introduction of invasive and non-native species (INNS) **All biotic receptors:** Changes in water quality **Birds / fish / marine mammals:** Changes in prey availability as a result of the above actions. **Birds / fish / marine mammals:** Impacts associated with increased vessel movements during the construction **Birds / fish / marine mammals:** Impacts associated with increased noise and light. Visual impacts **Marine mammals:** Potential collisions with vessels in connection with construction works.
3	Construction of the MOLF – land part (associated infrastructure/investment)	Construction phase: – Development stage	**Habitats / zoobenthos / macroalgae:** Direct loss of habitats **Habitats / zoobenthos / macroalgae:** smothering as a result of resettlement of suspended sediments. **All biotic receptors:** Changes in water quality. **Birds / fish / marine mammals:** Impacts associated with increased noise and light. Visual impacts **Birds / fish / marine mammals:** Changes in prey availability as a result of the above factors

No.	Activity	Phase/Stage	Receptor groups and possible relations
4	Construction of facilities for the discharge the final effluent from the sewage treatment plant in the construction phase (associated infrastructure/investment) – assuming the worst case scenario of outlet execution involving excavation works	Construction phase: – Development stage	**Habitats / zoobenthos / macroalgae:** Direct loss of habitats. **Habitats / zoobenthos / macroalgae:** smothering as a result of resettlement of suspended sediments. **All biotic receptors:** Introduction of invasive and non-native species **All biotic receptors:** Changes in water quality. **Birds / fish / marine mammals:** Changes in prey availability as a result of the above factors. **Birds / fish / marine mammals:** Impacts associated with increased vessel movement **Birds / fish / marine mammals:** Impacts associated with increased noise and light Visual impacts Marine mammals: Potential collisions with ships related to the construction works
5	Operation of the sewage treatment plant in the construction phase – treated sewage discharge (associated infrastructure/investment)	Operational phase	**All biotic receptors:** Eutrophication and indirect effects on the marine food chain associated with it.
6	Operation of the MOLF (associated infrastructure/investment)	Operational phase	Not applicable – see the item on vessel movement below.
7	Temporary works to enable the installation of the cooling water system's inlet and outlet tunnels/heads, and the outlet pipeline/head of the FRRS (fish return and recovery system). Assumes worst case of trenched/immersed pipe construction method. Comprises temporary cofferdams across the beach and foreshore, and shuttered trenches through the dunes, dredging trenches, laying of tunnel sections, backfilling of trenches, installation of outfall heads, and dewatering of head structure cofferdams.	Construction phase: – Construction stage	**Habitats / zoobenthos / macroalgae:** Direct loss of habitats **Habitats / zoobenthos / macroalgae:** smothering as a result of resettlement of suspended sediments. **All biotic receptors:** Introduction of invasive and non-native species (INNS). **All biotic receptors:** Changes in water quality (physical and chemical) **Birds / fish / marine mammals:** Changes in prey availability as a result of the above actions. **Birds / fish / marine mammals:** Impacts associated with increased vessel movement. **Birds / fish / marine mammals:** Impacts associated with increased noise and light. Visual impacts **Marine mammals:** Potential collisions with vessels in connection with construction works.
8	Transport and disposal of dredging material at a licensed disposal site	Construction phase: – Construction stage	**Habitats / zoobenthos / macroalgae:** local smothering as a result of resettlement of suspended sediments. **Habitats / macroalgae:** Decrease in the availability of light due to a temporary increase in water turbidity. **All biotic receptors:** Introduction of invasive and non-native species.

No.	Activity	Phase/Stage	Receptor groups and possible relations
			Birds / fish / marine mammals: Changes in prey availability as a result of the above factors. **Birds / fish / marine mammals:** Impacts associated with increased vessel movement. **Birds / fish / marine mammals:** Impacts associated with increased noise and light. Visual impacts **Marine mammals:** Potential collisions with vessels in connection with construction works.
9	Movement of ships to/from the MOLF during the construction of the Nuclear Power Plant	Construction phase: – Construction stage	**All biotic receptors:** Introduction of invasive and non-native species (INNS). **All biotic receptors:** Changes in water quality (physical and chemical) **Birds / fish / marine mammals:** Changes in the availability of prey/food. **Birds / fish / marine mammals:** Impacts associated with increased vessel movement. **Birds / fish / marine mammals:** Impacts related to increased noise, light and visual impacts. **Marine mammals:** Potential collisions with ships related to movement to/from the MOLF.
10	Presence of permanent offshore infrastructure (cooling water inlet and outlet; outfall head of the fish recovery and return system)	Operational phase	**Habitats / zoobenthos / macroalgae:** Direct loss of habitats
11	Operation of permanent offshore infrastructure (discharge from cooling water outlet)	Operational phase	**Fish:** Entrapment and entrainment into the cooling water system. **All biotic receptors:** Changes in water quality (physical and chemical, in particular eutrophication). **All biotic receptors:** Changes in thermal conditions through discharge from the cooling water outlet. **Birds / fish / marine mammals:** Changes in prey availability as a result of the above factors.
12	Movement of ships to/from the MOLF during the operation of the Nuclear Power Plant	Operational phase	**Marine mammals:** Potential collision with ships associated with the presence of the MOLF. **All biotic receptors:** Introduction of invasive and non-native species. **All biotic receptors:** Changes in water quality (physical and chemical). **Birds / fish / marine mammals:** Impact by introducing increased noise and light levels. Visual impacts **Birds / fish / marine mammals:** Changes in prey availability as a result of the above factors.
13	Decommissioning of the offshore infrastructure (it is expected that the activities will be similar to those during the construction, but with a smaller range).	Decommissioning phase	**Habitats:** Temporary disturbance of the habitat during offshore works, followed by permanent restoration of the habitat after the removal of unnecessary structures. **Habitats / zoobenthos / macroalgae:** smothering as a result of resettlement of suspended sediments. **Birds / fish / marine mammals:** Impact by introducing increased noise and light levels. **All biotic receptors:** Introduction of invasive and non-native species. **All biotic receptors:** Changes in water quality (physical and chemical) **Birds / fish / marine mammals:** Changes in prey availability as a result of the above activities.

No.	Activity	Phase/Stage	Receptor groups and possible relations
			Fish / marine mammals: Underwater noise associated with marine works. **Marine mammals:** Potential collisions with vessels in connection with marine works.

Source: [456]

Receptor importance

The importance of the receptor [Table IV.2-147] is based on several essential criteria, such as rarity, role in the provision of ecosystem services and conservation status, as well as, where appropriate, professional judgement. It contains general definitions for determining the importance of the receptor in the marine environment.

Table IV.2-147: The basic criteria for determining the importance/value of receptors in the marine environment

Receptor importance	Definition
High	• The receptor has international/national importance [significance], e.g. it is a distinctive feature of a designated site or area that meets published eligibility criteria for the designation, regardless of whether it has been accepted. It is protected based on the EU's or Polish regulations. • The receptor is protected under the EU's or national regulations. • The receptor is rare or infrequent on the international or national scale. • The receptor is a key species, plays an important role in the ecosystem or provides essential ecosystem services.
Moderate	• The receptor is of regional importance but is not protected on the national or international scale. • The receptor is rare or infrequent on the regional scale. • The receptor plays a role in the ecosystem or provides ecosystem services at the regional level.
Low	• The receptor of local importance, e.g. an element of a local wilderness area. • The receptor is relatively common. • The receptor plays a role in the ecosystem or provides ecosystem services at the local level.
Negligible	• The receptor is not designated in local regulations and plans. • The receptor is abundant. • The receptor plays little or no role in the ecosystem.

Source: [456]

Receptor sensitivity

The sensitivity of the receptor determines its ability to absorb the impact, and adapt and return to the initial state. The table [Table IV.2-148] provides general definitions of sensitivity for receptors in the marine environment, specifying the estimated capacity and time needed to restore the pre-impact state.

Table IV.2-148: The basic criteria for determining receptor sensitivity in the marine environment

Receptor sensitivity	Definition
High	The receptor is probably rare, with minimal substitution potential, and is unable to tolerate change. It is predicted that the recovery, if it occurs, will be long-lasting and will take > 10 years after the source of the change has been removed.
Average	The receptor has some ability to tolerate changes and return to normal in the medium term, within > 5 years, after the source of the change has been removed.
Low	The receptor is able to tolerate impacts to a large extent, has a relatively fast rate of regeneration, i.e. within one year of removing the source of the change.
Negligible	The receptor has a high tolerance to changes, and key parameters of the population are not exposed [vulnerable].

Source: [456]

The importance/significance of the receptor is related to the assumptions about the receptor sensitivity described above and the total value that can be taken into account in the impact assessment process.

If the significance and sensitivity are the same (e.g. a very important characteristic with high sensitivity), the value for the receptor will be equally high. Where the significance and sensitivity do not match (e.g. a very important receptor and low-sensitivity impacts), expert judgement is used to determine the overall value of the receptor.

IV.2.5.3 Stage 2 – Identification and magnitude of the impacts

IV.2.5.3.1 Identification of impacts

The second stage involved the identification of impacts and the determination of the nature, scope, duration and frequency of environmental impacts. The impact and its ability to affect the receptor in the context of general environmental conditions in the survey area are influenced by the factors described below.

IV.2.5.3.1.1 Impact range/area

The impact range/area is defined using the following terms: “local”, “regional”, “national” and “transboundary”, as defined below:

- **Local:** Impacts occurring in the buffer zone of 100 m from the Project site;
- **Regional:** Impacts occurring in the region of administrative jurisdiction (voivodeship) and < 30 km from the Project site;
- **National:** Impacts occurring in the territory of Poland, and > 30 km from the Project site;
- **Transboundary:** Impacts that would have an effect on the environment outside of the territory of the Republic of Poland.

IV.2.5.3.1.2 Impact duration

Impact duration: the period over which a change has an impact, defined as permanent, temporary, short-, medium-, and long-term, in accordance with the definitions set out below:

- **Temporary:** Effects that are clearly limited in time and would cease at the completion of an action, returning to baseline levels.
- **Short-term:** Effects that will be felt for a period of < 1 year after the completion of works under the Project, and return to baseline levels.
- **Medium-term:** Effects that will be felt for more than 6 years after the completion of the Project, and return to baseline levels.
- **Long-term:** Effects that will be felt for a period of < 12 years after the completion of the Project, and return to the initial levels.
- **Permanent:** Effects that are likely to be felt for > 12 years and throughout the anticipated operational lifetime of the Project (60 years), and the decommissioning phase of the Project (12 years), and will cause permanent changes in the exposed/vulnerable receptors.

IV.2.5.3.1.3 Impact frequency

Impact frequency: The ability of the impact to re-occur is determined by the following terms:

- **Infrequent:** E.g., a one-off event, such as the installation of the inlet heads,
- **Frequent:** E.g., regular piling during the construction of the MOLF,
- **Continuous:** E.g., discharge of effluent through the outlet of the cooling water system.

IV.2.5.3.2 Impact magnitude

The magnitude of the impact on the marine environment has been determined with due regard to the following factors:

- The nature of the impact (direct, indirect, reversible or irreversible);

- Whether the impact occurs individually, is cumulative or interactive;
- An assessment in relation to the limit values set out in the legislation or guidelines, if any;
- Confidence or certainty regarding the anticipated impact;
- Existing long-term trends and natural variability;
- Compliance with environmental regulations.

The magnitude of the impacts generated by the Project ranges from negligible to high [Table IV.2-149] based, in justified cases, on best practice guidelines (e.g. recommendations of GDOŚ or the Chartered Institute of Ecology and Environmental Management, CIEEM) and relevant legal standards. Impacts below certain thresholds (e.g. statutory EQS values) are described as "negligible" and have not been qualified for consideration in the assessment.

[Table IV.2-149] sets out the general criteria that were used to determine the impact magnitude for the assessment. Although these are general criteria, not all changes can be clearly defined using qualitative criteria. Therefore, expert assessment based on understanding of the overall system was also used to standardise the assessment and ensure consistency between receptors.

Table IV.2-149: The general criteria for determining the magnitude of receptor impacts in the marine environment

Magnitude	Definition
Negligible	• Changes caused by elements or processes of the Project would be comparable to natural variability.
Low	• Elements or processes of the Project have an effect on certain receptors that can be easily renewed by natural regeneration. • The Project affects a specific group of localised specimens within a population in a short period of time (one generation of the species or less), but does not affect other trophic levels or the population itself.
Medium	• The Project will not change integrity of the area/region in the long term, but in the short or medium term there can be a significant change in some, if not all, of the ecological characteristics, structures and functions. The area/region can be rebuilt over time through natural regeneration and restoration. • The Project affects a part of the population and can result in a change in its size and/or a reduction in distribution over one or more generations of the species, but does not threaten long-term integrity of the population or any population dependent on it. The size and cumulative nature of the consequences are also important. An impact of medium magnitude multiplied over a large area will be considered to be a high magnitude impact.
High	• The Project can adversely affect integrity of an area/region by significantly changing, in a long term, ecological features, structures or functions that enable the area to maintain its natural character, habitat complex and/or species population level. • The operation or characteristic of the Project affects the whole population or species to a degree sufficient to cause a decline and/or change in its distribution, beyond which natural regeneration (reproduction, immigration from areas not affected) will not restore that population or species, or any population or species dependent thereon, to its previous level within several generations of the species, or when it is not possible to return to the previous state.

Source: [456]

IV.2.5.4 Stage 3 – Assessment of effects

IV.2.5.4.1 Types of effects

The approach used to determine the magnitude of the impacts, and then assess their significance, is based on international good practices, but also takes into account the recommendations and guidelines from GDOŚ on conducting EIAs in accordance with the Polish law.

In accordance with the provisions of the EIA act (art. 66, par. 8) [501] the assessment methodology should contain a description of the forecasting methods used in the assessment process. In addition, a description of the likely significant environmental impacts of the planned investment is required.

In order to meet these requirements and to restore a consistent approach to expressing the results of the EIA, thus enabling comparison of the impacts on different aspects of the marine environment, the following classification of effects was used:

- **Positive**: Where the Project produces beneficial effects compared to the initial conditions for a marine resource or receptor. These effects would have a positive impact on environmental conditions, norms, targets and the state of the resource or receptor.
- **Negative:** Where the Project causes harmful or adverse effects compared to the initial conditions for a marine environment resource or receptor. These effects would have an adverse impact on environmental conditions, standards, targets and the state of the resource or receptor.

Effects can be further described using the following categories, in accordance with the standard EIA procedure:

- **Direct effects:** These result directly from the planned Project, e.g. loss of seabed elements as a result of the construction/installation of permanent infrastructure.
- **Indirect/secondary effects:** These are effects resulting from changes caused by the Project, potentially occurring later or in more distant locations than direct effects, e.g. impacts on benthic clusters due to changes in water quality.

These effects can result from activities at all stages of the Project and can be reduced by the application of mitigation measures or rehabilitation works.

Due to the location of the offshore area concerned, no **transboundary effects** are expected. However, consideration of transboundary effects is defined as a requirement of the GDOŚ, which is why they have been assessed in the context of the natural marine environment.

IV.2.5.4.2 Effect significance

If there is such a pathway, the magnitude and probability of the impact are determined. Then, when determining the significance of the resulting impact, the sensitivity of the receptor [Table IV.2-150] (i.e. the ability of the object of impact to absorb or adapt it [the impact]) is taken into account.

The significance of effects has been determined in accordance with the EIA's standard approach of classifying effects according to whether they are major, moderate, insignificant or negligible, and whether they are negative or positive. Where there are no effects, this is clearly stated in this assessment.

Expert knowledge is used to determine the significance of each effect in order to obtain an overall value for the receptor affected based on an assessment of its significance and sensitivity. The magnitude of the impacts is then linked to the receptor value using table [Table IV.2-150] to determine the significance of the effect. For example, a receptor of "**high**" value experiencing an impact of a "**medium**" magnitude will experience "**serious**" effects that will be "**major**". However, a "**high**" value receptor experiencing a "**low**" magnitude impact will experience "**moderate**" effects that will be "**potentially significant**". In this grey area it is necessary to apply expertise and consider the sensitivity of the receptor and its ability to absorb the effect, and then determine whether the effect is "**significant**" or "**insignificant**". Where this was done as part of the impact assessment, the reasons for the decision are set out in the assessment description.

Where adverse or beneficial effects were identified, they were generally assessed based on the following magnitude descriptors:

- **Negligible:** Effects imperceptible for the resources of the marine environment or the receptor (i.e. changes within the natural variability of the system).
- **Minor:** Effects short-term and/or highly local in nature, perceptible but tolerated, do not breach accepted standards and do not require mitigation measures other than those provided for in the project.
- **Moderate:** Effects local or regional, medium- or long-term, and those expected to potentially breach accepted guidelines/standards. If these changes are unfavourable, they may require additional mitigation

measures and may potentially be considered significant. In the case of moderate effects, the emphasis is on demonstrating that they have been reduced to a level as low as is reasonably practicable.

- **Major:** Changes in relation to a significant receptor, in a wide spatial extent and with a long or constant duration. They clearly breach applicable laws, guidelines or standards (or international best practices) and would need to be mitigated in order to be reduced to as low level as reasonably practicable.

Table IV.2-150: Determination of the magnitude of effects and their corresponding significance

Receptor value	Impact magnitude			
	Negligible	Low	Medium	High
Negligible	Negligible (insignificant)	Negligible (insignificant)	Negligible (insignificant)	Negligible (insignificant)
Low	Negligible (insignificant)	Minor (insignificant)	Minor (insignificant)	Moderate (potentially significant)
Medium	Negligible (insignificant)	Minor (insignificant)	Moderate (potentially significant)	Major (significant)
High	Negligible (insignificant)	Moderate (potentially significant)	Major (significant)	Major (significant)

Source: [456]

IV.2.5.5 Stage 4 – Mitigation of effects and identification or residual effects

The final stage is to identify any effects that are considered moderate and/or significantly unfavourable, and require specific additional mitigation measures to avoid or reduce their residual effects to environmentally acceptable levels, as far as reasonably practicable.

Residual effects refer to the environmental effects that are expected to remain after the mitigation measures have been applied. The application of mitigation measures within the EIA changes the risk of exposure and, therefore, requires a reassessment of the significance and, thus, the determination of the residual effect.

The initial impact assessment was carried out taking into account the mitigation measures described in [Chapter V.5] of the EIA Report.

IV.2.5.6 Cumulative and in-combination effects

Consideration of cumulative effects is a requirement of the GDOŚ decision [348] and of the EIA Act [501] and, for the purposes of this assessment, “cumulative effects” are defined as the combined action of a number of different projects, including the assessed Project, on a single receptor. This may involve multiple impacts of the same or similar type, derived from several projects/undertakings involving the same receptor. The cumulative effects assessment included an analysis of the potential interactions of the planned Project with the activities undertaken or planned as part of undertakings meeting the following criteria:

- A project/undertaking that has been completed, is in operation or is at the construction stage;
- A project/undertaking for which a decision on environmental conditions has been issued, and no construction works have yet been started at the time of preparation of the assessment; and
- A project/undertaking for which a procedure for issuing an environmental decision has been initiated but the decision has not yet been issued at the time of this assessment.

The in-combination effects are slightly different and result from the summary impact of different components and processes of the Project on the same receptor, for example, the combined impact of changes in water quality and underwater noise on fish.

IV.2.7 Impact assessment – Sub-Variant 1A - Lubiatowo - Kopalino: open cooling system

IV.2.7.4 Ichthyofauna

IV.2.7.4.1 Construction phase – Development stage

IV.2.7.4.1.1 Physical impacts as a result of construction works

A variety of fish species may be present in proximity to the MOLF and STW outfall during the the development stage and may therefore be susceptible to impact from habitat loss and physical disturbance. Species may include those of commercial importance such as such as cod, flounder, sprat and herring. Sensitive and protected species such as Atlantic salmon, sea trout, sand goby, common seasnail, river lamprey and twaite shad also frequent the locale, as well as a species that use the area as a feeding ground e.g., flounder. Sandeel are resident throughout the coastal waters off of the Lubiatowo - Kopalino site and probably use the area for spawning.

Due to the prevalence of the same or similar habitats in the area, it is anticipated that fish will show relative tolerance to disturbances and the ability to avoid them. This includes the ability of sand eels to repopulate nearby suitable sediments during and after completion of the works.

Overall, although there is potential for some direct loss of functional habitat and physical disturbance to fish within the footprint of the construction works, given that the area of loss is minimal compared to the rest of the similar habitat present in the wider vicinity of the Marine Survey Area, it is unlikely that any discernible effect to functional habitats or species populations will occur.

IV.2.7.4.1.2 Increased underwater noise during development stage construction works

Noise sources

Options for construction of the STW outfall include micro-tunnelling, HDD or the use of trenching and pipe-laying. A small cylindrical cofferdam for installing the outfall head may be required. To ensure the worst-case scenario is considered, this impact assessment will assume that trenching and a cofferdam use will be required.

The noise emissions associated with trenching will be continuous in nature. The potential effects on fish due to noise emissions from trenching activities are likely to range from Temporary Threshold Shift (TTS) in some species to behavioural effects and increased stress-related cortisol levels, depending on the species and the subsequent hearing specialism. Furthermore, although trenching may not cause noise levels that can be physiologically damaging to fish, dredging noise may mask natural sounds used by larvae to locate suitable habitat [297].

Predicted impact ranges

Impulsive construction activities

The zones of impact for fish (with swim bladder involved in hearing) indicate that noise from a single pile strike would not cause mortality and potential mortal injury or recoverable injury. Also, that the modelled noise level fell below the TTS threshold (SEL 186 cum) at 50m and behavioural disturbance (avoidance) threshold (SEL 150 dB) at 100m, and the other impact thresholds were not reached, cf. [Table IV.2-171].

Table IV.2-171: Ranges at which fish species (with swim bladder involved in hearing) thresholds are met for impact piling

No.	Criteria - Peak SPL, dB re 1µPa	Zones of impact, m	Criteria - SEL, dB re 1µPa²s	Range (m) per no. strikes and time period				
				1	10	**100** (1 min.)	**1,000** (10 mins.)	**6,000** (1 hour)
Mortality/potential fatal injuries								
1	**207**	Not achieved	207 (cum)	Not achieved	Not achieved	Not achieved	Not achieved	Not achieved
Recoverable Injury								
2	**207**	Not achieved	203 (cum)	Not achieved	Not achieved	Not achieved	Not achieved	Not achieved
TTS								
3	Not achieved	Not achieved	186 (cum)	Not achieved	Not achieved	Not achieved	Not achieved	50
Avoidance								
4	Not achieved	Not achieved	150 (per stroke)	100	N/A	N/A	N/A	N/A
Behavioural Disturbance (BD)								
5	Not achieved	Not achieved	145 (per stroke)	150	N/A	N/A	N/A	N/A

Source: [456]

Fish species without swim bladders are less sensitive to noise than fish species with swim bladders. Consequently, noise levels that fall below the threshold for fish with swim bladders, also fall below the threshold for fish without swim bladders.

- The instantaneous permanent injury criterion for the most sensitive fish types (fish with swim bladders, also for larvae and eggs) of **207 dB Lpk** is not reached at any location.
- The range for onset of recoverable injury **>186 dB LE,p** for fish (with no swim bladder and swim bladder) is not reached at any location.

There is potential for onset of TTS in fish (with swim bladder) within a range of 50m using the exposure criterion (for impact piling of the assumed maximum 1-hour duration, per driven pile).

Non-impulsive construction activity

Noise levels due to non-impulsive construction activities would not reach the assessment thresholds for recoverable injury or TTS, from the impact piling for fish, and hence would not reach the assessment thresholds for permanent injury or fatality, or PTS from the impact piling for fish. The 158 dB L_p for 12h criteria for fish with a swim bladder involved in hearing (primarily pressure detection) would be reached if sounds were being produced over a continuous 12hr period, and the fish receptor remained in the same position.

The results presented above show that noise levels due to non-impulsive construction activities would not reach the assessment thresholds for recoverable injury or TTS, from the impact piling for fish. The 158 dB L_p for 12h criteria for fish with a swim bladder involved in hearing (primarily pressure detection) would be reached if sounds were being produced over a continuous 12hr period, and the fish receptor remained in the same position.

- It is concluded that any effects on fish arising from underwater noise as a result of the construction and operation of the MOLF, and STW outfall would be minor (not significant).

IV.2.7.4.1.3 Increased volume of suspended sediment, and smothering

Construction of both the MOLF and the STW outfall will take place at the development stage. Construction activities have the potential to cause local increases in suspended sediment concentrations creating a plume within the water column.

An increase in the amount of suspended sediments, deposition and changing the geomorphology of the seabed can affect receptors (fish), leading to potential effects on survival, growth, reproduction and movement of specimens.

Marine works would be limited, potentially including a trench of small dimensions and/or possible use of a small cylindrical cofferdam for installing the outfall head (considered to represent worst-case scenario). Use of a linear cofferdam extending into the water across the beach and foreshore is not anticipated to be necessary. Because of the very small footprint and short duration of these works, compared with the installation of the infrastructure for open cooling, which was assessed as not having a significant effect on hydromorphological quality elements of Water Framework Directive and Marine Strategy Frameworks, effects arising from installation of the treated sewage outfall were to be **negligible** and **not significant.**

Pelagic species of fish are highly mobile and show behavioural avoidance of localised unfavourable conditions, with high recoverability to an area once the adverse conditions abate. Less mobile and slower moving species such as gobies and the eggs and early life-stages of other species of fish are most likely to be affected by high levels of suspended solids and subsequent smothering due to their reduced ability to avoid the adverse conditions. Ichthyoplankton surveys revealed low densities of eggs and larvae in the marine survey area, which were considered to be insignificant for the site.

Sandeel are an important prey species for piscivorous birds and fish, and are known to frequent the potential ZoI. Sandeel are adapted to live in highly dynamic environments, characterised by shifting sediments and variable turbidity, and therefore the potential for physiological damage (e.g. feeding or respiration impacts) or mortality of adult, juvenile or larval sandeel stages is considered to be limited. Although sandeel do exhibit site fidelity, this species is considered adaptable and physiologically capable of relocating to alternative adjacent habitat temporarily and recolonising suitable sediments following completion of the works.

The release and re-deposition of sediment-associated contaminants and bacteria that have a potential to impact species through acute or chronic ecotoxicological effects or bacteriological contamination were assessed as minor.

- It is concluded that any effects on fish arising from increased suspended sediment concentrations and associated smothering during the construction of the MOLF and STW outfall would be minor (not significant).

IV.2.7.4.1.4 Effects of Artificial lighting

The lighting will be incorporated into the MOLF in order to provide safe environment for employees and third parties having access to the facility. In addition, where required by health and safety regulations, navigation lighting may be required. During construction other light sources will primarily be mobile (e.g., vehicles/equipment accessing the MOLF or vessels working offshore), intermittent and localised so any effect would be temporary, short-term and intermittent.

- It is concluded that any effects on fish arising from changes in visual stimuli from artificial lighting as a result of the construction and operation of the MOLF and STW outfall would be **negligible (not significant)**.

IV.2.7.4.1.5 Effects of spillages from marine operations

Accidental leakage of fuel, oils and other chemical contaminants into the marine environment has the potential to harm local ichthyofauna.

A variety of fish species may occur in the proximity of the MOLF and STW outfall during the development works. Species may include those of commercial importance such as such as cod, flounder, sprat and herring, sensitive and protected species such as salmon, sea trout, sand goby, common seasnail, river lamprey and twaite shad, as well as a variety of species that use the area as spawning and nursery grounds.

Pelagic species of fish are highly mobile and show behavioural avoidance of localised unfavourable conditions, with high recoverability to an area once the adverse conditions abate. Less mobile and slower moving species such as gobies and the eggs and early life-stages of other species of fish are most likely to be affected by spillages due to their reduced swimming efficiency and thus reduced ability to move away from areas affected by such spillage. Ichthyoplankton studies revealed low densities of eggs and larvae in the marine survey area, suggesting that any spill-related impacts will have minor on the local ichthyoplankton population.

All vessels involved in Project development stage works will be required to adhere to international regulations and best practice, including MARPOL Convention and the Ballast Water Convention.

- It is concluded that any effects on fish arising from spillages from marine operations during the construction of the water cooling infrastructure would be **minor (not significant)**.

IV.2.7.4.2 Construction phase

IV.2.7.4.2.1 Physical impacts as a result of the construction works

At the construction stage, different species of fish may be present near cooling water channels/pipelines and may therefore be susceptible to impacts from habitat loss and physical disturbance. Species may include those of commercial importance such as such as cod, flounder, sprat and herring, sensitive and protected species such as Atlantic salmon, sea trout, sand goby, common seasnail, river lamprey and twaite shad, as well as a variety of species that use the area as spawning and nursery grounds.

Migratory fish species are highly mobile with good swimming efficiencies and show behavioural avoidance to adverse environments in open water. The works will not block any migratory corridors. Potential impacts on migratory species resulting from direct loss of habitats or physical disturbances are therefore considered negligible.

Sandeel are an important prey species for piscivorous birds and fish, and are known to frequent the potential ZoI. Sandeel are adapted to live in highly dynamic environments, characterised by shifting sediments and variable turbidity, and therefore the potential for physiological damage (e.g. feeding or respiration impacts) or mortality of adult, juvenile or larval sandeel is considered to be limited. Although sandeel do exhibit site fidelity, this species is considered adaptable and physiologically capable of relocating to alternative adjacent habitat temporarily and recolonising suitable sediments following completion of the works.

Most of the species and developmental forms known to to be present in the area are mobile and would be able to move away quickly from the site of the impact, recolonising equally rapidly once the impact abates. Owing to the widespread prevalence of the same or similar habitats within the area, it is anticipated that fish will be relatively tolerant of displacement. This includes the ability of sandeel to recolonise nearby suitable sediments during and following completion of the works.

Overall, there is potential for some direct loss of functional habitat and physical impacts to fish (excluding migratory fish) within the footprint of the construction works. Given that the area of loss is minimal compared to the rest of the habitat of similar type present in the wider vicinity of the Marine Survey Area, it is unlikely that there will be any discernible effect to functional habitats or species populations.

Accordingly, it is concluded that any effects on fish arising from habitat loss and physical disturbance as a result of the construction and operation of the cooling water infrastructure would be **negligible (not significant)**.

IV.2.7.4.2.2 Entrainment of fish during dredging operations

The installation of the cooling water infrastructure during the construction stage by immersed tube construction method will require a trench to be dredged within the seabed from the seaward end of the cofferdam to the intake heads. The construction stage for the intake and outfall tunnels are due to take place over a period of 12 months and 8 months, respectively.

The dredging works will result in physical disturbance to the bed substrate. Associated impacts may include damage, displacement and removal (including direct mortality) of fish fauna, with the potential for fish to be entrained by the suction field generated at the draghead or cutterhead during dredging operations. Impacts may result in a temporary reduction of abundance and biomass along the route of the works.Sandeel, an important prey item for avian piscivores, cod and salmonids, are considered likely to be most susceptible to entrainment, owing to their burial behaviour.

Sandeel overwinter in sandy substrate which typically occurs between autumn and winter; during this period they burrow into the substrate. Sandeel spawn during the late winter months (January) laying sticky, demersal eggs which attach to the seabed. Sandeel and their eggs are susceptible to entrainment during this period. Sandeel are however a mobile species and able to demonstrate avoidance behaviour to adverse stimuli. If not exposed to direct impact (entrainment/impingement) they are tolerant to temporary impacts with rapid recolonisation of adjacent or disturbed areas. Sandeel habitat represents approximately 95% of the area within the marine survey area.

Both gobies and juvenile flatfish may also be susceptible, due to both their size and low swimming efficiency. Flatfish e.g., flounder however show strong biological zonation along a transect perpendicular to the shore with juveniles maintaining station close to the shoreline within the surf zone with both age and size class increasing with distance offshore. This suggest that smaller, more vulnerable specimens will be located inshore of the main dredging activity. Larger, more mobile individuals would be expected to show a degree of avoidance behaviour and would be capable of returning to a given area once adverse conditions had abated. Gobies are ubiquitous throughout the marine survey area and, although like sandeel, they are tolerant of impacts, they will be vulnerable to entrainment and direct mortality. Mortality from dredging activity is likely to be high for all fish entrained.

- It is therefore concluded that any effects on fish arising from entrainment through the suction header dredging as a result of the construction of cooling water channels/pipelines would be **minor (not significant)**.

IV.2.7.4.2.3 Increased underwater noise from construction activities

At the site construction phase, the Lubiatowo - Kopalino site includes proposed structures associated with intake and outfall of cooling water, FRRS, temporary coffer dams (foreshore and offshore) or caissons (offshore) around the cooling water channels/pipelines.

The construction of the underwater infrastructure may generate impulsive underwater noise due to impact piling (if required for final pile placement), and non-impulsive underwater noise due to vibratory sheet piling, dredging, rock fill placement, vessel operations, tunnel boring and directional drilling.

- any effects on fish arising from underwater noise as a result of the construction and operation of the MOLF, cooling water intake and outfall, and FRRS would be **minor (not significant)**.

IV.2.7.4.2.4 Increased volume of suspended sediment and smothering through resettlement of suspended sediments

Activities associated with the construction of the cooling water channels/pipelines have the potential to cause local increases in suspended sediment concentrations creating a plume within the water column. Downstream of the dredging works as suspended sediments settle out of the turbid plume, the seabed may become smothered with potential changes to seabed geomorphology.

Increased suspended sediment, deposition and change to seabed geomorphology could impact receptors (fish), leading to potential effects on survival, growth, reproduction and displacement of individuals. The modelling results predict that, for both the summer and winter scenarios increases in suspended sediment concentrations due to dredging to be <5mg/l (30-day chronic exposure period). This is comparable to the background level for sediment in suspension of up to 6.22 mg/l measured in 2017-2018.

It is anticipated that pelagic fish species or life stages will move away from unfavourable conditions and will be capable of returning to an area once adverse conditions abate. Adult herring have been observed to demonstrate avoidance behaviour at relatively low levels of suspended solids, though their response seems to be dependent on the nature of the sediment (e.g. 19 ± 5 mg/l for fine sediment, and 35 ± 5 mg/l for coarser sediment). Juvenile life stages of demersal species are potentially less able to avoid adverse levels of turbidity and deposition.

Fish stocks in the coastal waters off of the Lubiatowo - Kopalino site are considered to be relatively small. Spawning is low, with sandeel likely to be the predominant spawning species along throughout the Marine Survey Area although not record on site specific ichthyoplankton surveys [215]. Any increase in suspended sediment will be localised and short-term with sediments deposited during construction predicted to be eroded following cessation of the works with any impact attenuated by the natural variation in the bathymetry along this section of the coastline.

- Any effects on fish resulting from increased concentrations of suspended sediments and associated somothering during the construction of the cooling water channels/pipelines will be **minor (negligible)**.

IV.2.7.4.2.5 Effects of artificial lighting

The effects of artificial lighting on ichthyofauna within the coastal waters off of the L-K site during the construction stage would be identical to the effects considered during the site development stage for sub-variant 1A.

IV.2.7.4.2.6 Effects of spillages from marine operations

The effects of any potential accidental spillage into the marine environment of fuel, oils and other chemical contaminants that could harm ichthyofauna in coastal waters off of the shoreline of the Lubiatowo - Kopalino site at the construction stage would be identical to those considered at the development stage for Sub-Variant 1A.

IV.2.7.4.3 Operational phase

IV.2.7.4.3.1 Physical impacts due to the presence of the permanent marine infrastructure

No further infrastructure will be introduced into the marine environment during the operational phase, so the habitat loss and physical disturbances will be limited to those associated with the permanent offshore infrastructure built at the development and construction stages. The total expected direct loss of habitats is 1,094 m^2 of the seabed in the Project Area for Variant 1 (Lubiatowo - Kopalino).

Modelling outputs illustrated the effect of the MOLF’s presence on seabed morphology, demonstrating that some deposition, but very minimal scour, would be expected both updrift and downdrift from the structure. Compared to the baseline, levels are well within the range of natural variability, recorded as up to 1.3m change in a year within the Marine Survey Area.

A variety of fish species occur within the Marine Survey Area and may therefore be susceptible to impact from permanent habitat loss. Species may include those of commercial importance such as such as cod, flounder, sprat and herring, sensitive and protected species such as salmon, sea trout, sand goby, common seasnail, river lamprey and twaite shad, as well as a variety of species that use the area as spawning grounds.

Migratory fish species are not considered to have any important functional associations with benthic habitats due to their life history strategies and transient presence. Therefore, potential effects from the permanent habitat loss are not considered further for this receptor group. The area within the boundaries of the mobile littoral sandy substrata is not considered to provide particularly important functional habitat for most non-migratory fish species. The only exception is sandeel as there is evidence to suggest that this species uses the Marine Survey Area as a nursery ground.

Nonetheless, the majority of species and life stages known to be present in the area are mobile and would be able to use other surrounding areas. Owing to the widespread prevalence of the same or similar habitats within the area, it is anticipated that fish will be relatively tolerant of displacement. This includes the ability of sandeels to recolonise nearby areas.

Overall, although areas of habitat will be permanently lost in the footprint of the infrastructure, given that the area of loss is minimal compared to the rest of the habitat present in the wider vicinity of the Marine Survey Area, it is unlikely that there will be any discernible effect to functional habitats or species populations.

- Losses and physical impacts of fish during the Operational phase will be **negligible (insignificant**).

IV.2.7.4.3.2 Effects of operational discharge

Thermal effluents

The thermal plume emanating from the cooling water outfall has the potential to impact upon both ichthyoplankton and ichthyofauna. In the assessment of these thermal impacts to waters of high ecological status (e.g., sites designated under the Habitats Directive) it was considered that a temperature uplift should not exceed a ΔT of +2°C at the edge of the agreed mixing zone for more than 2% of the time (98th percentile).

Potential effects of temperature on the biology and ecological requirements of fish included inter alia survival, growth and metabolism, activity, swimming performance, behaviour and reproductive timings. Elevating temperatures to sublethal levels may also affect fish fauna, resulting in behavioural avoidance or seeking out preferred temperature ranges. The latter behaviour may ensure optimal conditions to some species in spite of thermal pollution, although the exploitable habitat within the zone of influence may be reduced.

Where spawning areas are impacted by the thermal discharge, survival of a fish may also be compromised if local water temperatures are elevated above viable limits for reproductive success. Commercial species include sprat, herring, flounder and cod. Migratory species that are commercially exploited include salmon and sea trout.

Potential effect on migration

Thermal conditions may be particularly critical to migratory fish emigrating from or returning to natal waters in the vicinity of the proposed outfall with the potential avoidance of areas of heated water acting as a “thermal barrier”.

Within the site area and in its immediate vicinity, three rivers supporting diadromous species of fish have been identified, including the River Piaśnica, Czarna Woda and the River Łeba. Migratory species that may be particularly sensitive to any thermal barrier include the salmonids (including Atlantic salmon, sea trout and European smelt) as all members of this guild are considered Arctic-Boreal species, whereas lamperns, shads and eels are classified as Lusitanian.

The outfall has been [designed] located in such way as to prevent the +2 °C isotherm from affecting these critical migratory corridors.

Potential impacts on spawning grounds

According to the results of the ichthyofauna inventory, spawning in the marine survey area of Variant 1 - Lubiatowo - Kopalino site, is limited. The site specific ichthyofauna surveys recorded sprat and cod roe at low densities. Habitat surveys suggest that 95% of the habitat in coastal waters off of the L-K site provides suitable fine sand habitat for sandeel.

There is a paucity of data regarding sandeel spawning, however the data available suggest that big changes in hatching are not driven by temperature during the incubation period. The buoyant nature of the thermal plume will further reduce any significant direct effect on the spawning substrate.

<u>**Chemical effluents**</u>

Ichthyofauna are highly mobile and are likely to move away when they detect suboptimal water quality levels, and therefore are less sensitive to this potential impact. The worst case predictions for a plume area for concentrations of chlorine (98th percentile) that exceed a value of 0.03 mg/l^{-1} is 12.10 km^2 at the surface (0 km^2 at the bed) equivalent to 2.5% of the Marine Survey Area.

- The potential impact of effluents on the biology and ecological needs of fish in the operational phase will be **negligible (insignificant)**.

IV.2.7.4.3.3 Effects of entrainment, entrapment and impingement of fish into the cooling system

Fish entrainment

Survival of entrained organisms depends on species specific tolerance of stressors within the system, that include mechanical damage and abrasion, shear stress, pressure-related effects, temperature differentials and toxic biofouling control agents.

Ichthyoplankton surveys were undertaken bi-monthly within the marine survey area of the Lubiatowo - Kopalino site at 14 sampling stations between March 2017 and January 2018 [215]. Larvae or post larvae of 11 species of fish and the eggs of two species were detected in low numbers (Table III 6-41). Gobies (75%), sprat (13.6%), herring (5.4%), sandeel (4.5%), and flounder (1.4%) made up the majority of species of fish larvae recorded over the 12 month monitoring period.

A crude assessment of the likely impact of entrainment from the proposed cooling water abstraction is based on the 2017 survey. The presence of sprat larvae was recorded within the marine survey area of the Lubiatowo – Kopalino site from March to September (210 days). During this period they were observed to be present at a mean density 0.0596 individuals per cubic metre. A continuous intake of cooling water at a rate of $175 m^3/s$ during this period would result in the entrainment of approximately 189.5×10^6 postlarval sprat stages.

During the survey campaign sprat larvae were recorded in the length range of 3.2 to 23.44mm, which is standard length.

Applying the estimated values for entrainment, growth rates and mortality parameters as described above, allows calculation of the numbers of fish that would have survived to 1 year old (recruitment age 1) had they not been entrained. The estimated number is 5,844 specimens corresponding to a weight of 35 kg. These figures should be considered against a backdrop of the predicted recruitment of sprat at age one to the Baltic Sea in 2018 which was estimated to be 81.847×10^9 individuals.

Entrainment and impingement of fish into the cooling system

Ichthyofauna surveys undertaken throughout 2017/18 record juvenile sprat, ranging in size from 1 - 7.5 cm, remaining close inshore (c. ≤ 10m depth) within the L-K marine survey area. Larger specimens were recorded further offshore where stocks comprised primarily of two- and three-year-old fish ranging in size from 9 to 15.5 cm.

The maximum maintainable (“critical”) swimming speed of sprat is about 10-12 body lengths per second, although it changes seasonally in response to water temperature. At 10°C, a 9 cm sprat is predicted to have an average sustainable to a maximum swimming speed of c. 0.56 m/s, significantly above the predicted approach velocity for the proposed CW intakes.

Both lesser and greater sandeel were recorded during the spring, summer and autumnal months. Their preferred habitat of sand and gravel substrate into which they burrow is present throughout the marine survey area and their absence in significant numbers from the offshore surveys may reflect negative bias in the sampling strategies adopted. Both species are schooling and strongly territorial and both are important prey items for piscivorous birds and ichthyofauna.

Although occasionally forming large shoals, this is typically in response to periods of strong tidal currents when the substrate into which they burrow may become disturbed, conditions typically absent from the coastal waters off of the Lubiatiow-Kopalino site. They typically retreat to burrows within the sediment during periods of low light intensity (night and winter) to avoid predation. Their territorial behaviour and predominantly benthic lifestyle reduce their risk of entrapment in the cooling water intakes, although they may be vulnerable when shoaling.

Herring were ubiquitous throughout the marine survey area and present in all four seasons at all depths and distances from the shoreline. The average density was four fish per 1 km^2. Fish during this period ranged in sizes from 11 to 28 cm (standard length).

The swimming efficiency of herring is similar to that of sprat described earlier, with a mean maximum sustainable swimming speed of approximately 11 body lengths per second.

They are known to disperse during the night at the surface and aggregate during the day near the seabed, aggregating at dawn and dispersing at dusk at the surface. This vertical migration may make them more susceptible to entrapment although larger herring remain deeper in the water column than smaller individuals and the increased swimming efficiency of the larger specimens may help reduced their risk of entrapment.

Like sprat they become vulnerable to entrapment should they fail to detect the water intake particularly at night or in turbid waters when there are no visual cues with which to orientate; and similar to sprat survival is low once they become entrapped.

Flounder are an epibenthic species. Juveniles migrate into the shallow near shore environments to feed. Flounder occasionally move up in the water column to feed predominantly at night; however, their relatively benthic lifestyle reduces the vulnerability of entrapment in cooling water intakes.

Cod were present in all seasons although most abundant over the winter months when they were recorded at a density of 1.94 individuals per km^2. The average size of fish was smallest over the summer months (below 31 cm) with the largest specimens caught over the winter months (more than 56 cm) when there was a rather significant share of cod over 40 cm long.

Demersal species such as cod and whiting are similarly vulnerable to entrapment in offshore CW intakes although their larger size and swimming efficiencies generally affords them greater protection from entrapment, and they are typically not as numerous as sprat and herring in entrapment/entrainment studies.

The size distribution of fish caught during the surveys suggested approximately 75% of the stock would be able to exceed the approach velocities of the CW intakes during the late winter/spring increasing to 92.5% during the summer and 100% during the autumn.

Species of conservation importance include salmon, sea trout, lamprey and eels.

As anadromous fish, the early lifestages of any salmonids present in the Baltic would not be vulnerable to entrainment.

Salmonids predate on both sprat and herring and will frequent the coastal zone off of the Lubiatowo – Kopalino site as part of their home range throughout the summer months. They are not a shoaling fish and densities within the marine survey area was recorded as low.

The risk of entrapment of migratory salmonids is considered low due to their swimming efficiencies and the open water nature of the intake enabling fish to readily escape the draw zone. The offshore location of the intakes is away from any prominent estuary or river mouth where the density of migratory fish may be concentrated as they emigrate or return to their natal waters and located away from any notable salmonid river. The proposed location of the CW intakes conforms to European good practice guidance, and the low density of diadromous species frequenting the marine survey area reduces the risk of fish encountering the intake zone. Species such as eel and lamprey which are robust and are anticipated to suffer low mortality if an FRRS is installed.

- It is concluded that loss resulting from entrapment, impingement and entrainment during the operational phase would be **minor (not significant)**.

IV.2.7.4.3.4 Increased underwater noise levels caused by vessel movement

Underwater noise generated during the operation of the open cooling sub-variants of the Lubiatowo - Kopalino site by turbulent or cavitation flow (formation and collapse of bubbles due to sudden pressure changes) in outlet diffusers. It is predicted that the outlet velocity will be much lower than the threshold of occurrence of turbulence or cavitation.

- It has been therefore concluded that any effects on fish resulting from underwater noise caused by the MOLF will be **negligible (insignificant)**, as summarised below [Table IV.2-193].

IV.2.7.5 Marine avifauna

IV.2.7.5.1 Construction phase – Development stage

The following conclusions have been drawn:

- Wintering birds such as the common gull, scoter, herring gull, long-tailed duck, auk and the velvet scoter are of **high significance** because they are protected as part of the SPA of the coastal waters of the Baltic Sea, within which the marine survey area was located. They are considered to be of medium sensitivity with regard to indirect impacts on prey availability. The overall value of the receptor is **medium** in terms of international significance of these seabird species.
- The breeding population of the herring gull and the great cormorant and the wintering population of the great cormorant are of **high significance** as they are protected as part of the Natura 2000 sites network within a radius of 20 km from the marine survey area. They are **slightly sensitive** in terms of the indirect impacts on prey availability, as they are mobile species of seabirds and there are many alternative habitats available. The overall value of the receptor is **low** in terms of international significance of these seabirds.
- All other species of marine avifauna (wintering populations of the goldeneye and the great crested grebe and breeding populations of the common gull) are under strict protection, are of **high significance** and of negligible sensitivity in terms of the indirect impacts on prey availability. The overall value of the receptor is **negligible** in terms of national significance of these seabirds.
- The spatial extent of the impact is **regional**. This is due to the fact that impacts on prey availability may occur outside the Project area but it is unlikely that they will extend to more than 30 km from the Project area.
- The duration of the impacts is **short-term**, as the effects of the loss of habitats will only be felt at the development stage.
- The impact is **continuous** due to the permanent loss of habitats at this stage;
- The magnitude of the impacts is **negligible** because the whole area where prey availability will be affected will be minimal compared to the entire area of alternative habitats available for benthic and fish-eating bird species.
- It has been concluded that any impacts on seabirds resulting from indirect impacts on prey availability during the preparatory work will be **negligible (insignificant)**.

Direct impact from the construction works

Activities related to the construction of the MOLF and the sewage treatment works during the construction phase have a potential to cause impacts on, and/or movements of seabirds by reducing the prey area for species and potentially leading to the use of less-than-optimal prey or moulting areas and ultimately causing indirect loss of habitats.

Based on an impact distance of 500 m, work at jack-up barge placement sites related to the MOLF construction and at dredging sites associated with the construction of STW can affect a total area of approx. 2 km^2. This is the equivalent of 0.1% of the Przybrzeżne wody Bałtyku SPA.

- It has been concluded that any impact on marine avifauna resulting from direct impacts at the development stage will be **negligible (insignificant)**.

Impacts caused by increased ship traffic

The impacts at sea and works associated with vessel activity may present a threatening stimulus to seabirds, with subsequent risk-avoidance behaviour reducing the time available for other activities such as prey, rest, or mating. Observable reactions of seabirds include scaring, diving to escape and increased alertness, which can lead to a loss of energy and ability to move. The impacts caused by vessels may thus reduce survival and reproductive success and affect population dynamics.

Seabirds may be able to get used or even adapt to the impacts caused by the movement of ships if they are able to recognise ships as non-threatening objects. Fishing activities are already underway in this area, though sparingly, which means that birds are accustomed to presence of anthropogenic impacts.

- Any effect on all other protected seabird species (wintering goldeneyes and great crested grebes) resulting from impacts caused by the movement of sea vessels at the site preparation stage will be **negligible (insignificant)**.

IV.2.7.5.2 Construction phase

IV.2.7.5.2.1 Indirect effects on seabirds through impacts related to prey availability

The construction works in the marine environment at the construction stage are mainly related to the construction of the cooling water ducts / pipelines and the FRRS.

An assessment of indirect impact on protected seabird species was carried out based on impacts on prey availability. The following conclusions have been drawn:

- Wintering common gulls, common scoters, herring gulls, long-tailed ducks, velvet scoters and razorbills are of **high significance** because they are a part of the Przybrzeżne wody Bałtyku SPA, within which the marine survey area was located. They are considered to be of **medium sensitivity** in relation to the indirect impacts on prey availability. The overall value of the receptor is **medium** in terms of international significance of these seabird species;
- Breeding herring gulls and great cormorants and wintering great cormorants are of **high significance** as they are protected as part of the Natura 2000 sites within a radius of 20 km from the marine survey area. They are of **low sensitivity** in terms of the indirect impacts on prey availability, as they are mobile species of seabirds and there are many alternative habitats available; The overall value of the receptor is **low** in terms of international significance of these seabirds;
- All other species of seabirds (the wintering goldeneye and great crested grebes and the breeding common gull) are strictly protected species [199], of **high significance** and are considered to have **negligible sensitivity** in terms of the indirect impacts on prey availability; The overall value of the receptor is **negligible** in terms of national significance of these seabirds;
- The spatial extent of the impact is **regional;** This is due to the fact that impacts on prey availability may occur outside the Project area but it is unlikely that they will extend to more than 30 km from the Project area;
- The duration of the impacts is **short-term**, as the effects of the loss of habitats will only be noticeable at the construction stage;
- The impact is **continuous** due to the permanent loss of habitats;
- The magnitude of the impacts is **negligible** because the whole area where prey availability will be affected will be minimal compared to the entire area of alternative habitats available for benthic and fish-eating bird species.
- It has been concluded that any impact on protected seabird species resulting from indirect impacts on prey availability at the construction stage will be negligible (insignificant), which has been summarised.

IV.2.7.5.2.2 Direct impact on birds during the construction works

Based on a disturbance distance of 500 m and taking into account the cooling water inlet and outlet locations of approximately 6 and 3.7 km from the shoreline, respectively (the FRRS is located in the same impact zone as the cooling water inlet and extends over a length of approximately 1 km), dredging site activities would affect a total area of 9.7 km^2. This is an equivalent of 0.5% of the area of the Przybrzeżne wody Bałtyku SPA.

An assessment of the direct impacts on seabirds resulting from the disturbance-related impacts has been carried out. The following conclusions have been drawn:

- Wintering velvet scoters, long-tailed ducks, razorbills and common scoters are of **high significance** because they are protected as part of the Przybrzeżne wody Bałtyku SPA, within which the marine survey area is located. Their numbers recorded throughout the marine survey area are of international significance, they are sensitive to impacts and are characterised by **medium sensitivity**. The overall value of the receptor is considered to be medium;
- Common gulls and herring gulls are of **high significance** because they are protected as part of the Przybrzeżne wody Bałtyku SPA, within which the area of the marine surveys was located. Common gulls, great cormorants and wintering great cormorants are also of **high significance** because they are protected as part of the Natura 2000 sites located at a distance of 20 km from the marine survey area. Although their numbers of national significance were recorded in the entire marine survey area, they are not sensitive to impacts. These are wide-range seabird species and the available alternative habitats are extensive and characterised by **low sensitivity**, and the overall value of the receptor is low;
- All other species of seabirds (the wintering goldeneye, great crested grebe and common gull) are strictly protected species [394] and are of **high significance**. Although they are present in numbers of national significance, they are not sensitive to impacts and are characterised by **low sensitivity**. The overall value of the receptor is **negligible;**
- The spatial extent of the impact is **regional;** This is due to the fact that impacts on seabirds may occur outside the Project area, but it is unlikely that they will reach a distance of more than 30 km from the Project site;
- The duration of the impacts is **short-term**, as the effects will only be noticeable at the construction stage;
- The magnitude of the impacts is **negligible** because the whole area where seabird disturbances will occur will be minimal compared to the total area of available alternative habitats.
- It has been concluded that any impact on all the species of seabirds resulting from direct impacts in the form of disturbances at the construction stage will be **negligible (insignificant)**.

Impacts caused by increased ship traffic

Currently, home ports and the level of ship traffic related to the construction of the cooling water inlet and outlet and the FRRS are not known. Based on the maximum disturbance distance presented above (for the common scoter), it is assumed that the maximum range of disturbances will be 1 km from each ship, so each vessel will have a 2 km wide disturbance zone along its transit route.

An assessment of the impact of increased ship traffic on seabirds has been carried out. The following conclusions have been drawn:

- Wintering velvet scoters are of **high significance** because they are protected as part of the Przybrzeżne wody Bałtyku SPA, within which the marine survey area is located; Their number of international significance was recorded in the entire area of the marine surveys. They are highly sensitive to ship traffic. The overall value of the receptor is considered **high;**
- Wintering common scoters, long-tailed ducks and razorbills are of **high significance** because they are protected as part of the Przybrzeżne wody Bałtyku SPA, within which the marine survey area is located. They occur in numbers of international significance throughout the marine survey area they are of **medium sensitivity** to impacts caused by vessel traffic. The overall value of the receptor is considered to be medium;

- Wintering and breeding cormorants are protected as part of the Natura 2000 sites located at a distance of 20 km from the marine survey area. A significant number of them have been recorded on the national scale throughout the marine survey area. They are among the species least sensitive to the impacts caused by vessel traffic and are characterised by **low sensitivity**. The overall value of the receptor is considered **low;**
- All other species of seabirds (the wintering goldeneye and the great crested grebe) are strictly protected species [394] and are of **high significance**. They were recorded in numbers of national significance throughout the marine survey area. They are less sensitive to impacts caused by vessel traffic and are characterised by **low sensitivity**. The overall value of the receptor is **negligible;**
- The spatial extent of the impact is **regional.** This is due to the fact that impacts on seabirds may occur outside the Project area, but it is unlikely that they will reach a distance of more than 30 km from the Project site;
- The impacts are of a **short-term** nature since the movement of ships would occur regularly only during the works related to the construction stage of the Project.
- The impacts are **frequent** since the movement of ships will be regular during the works related to the construction stage of the Project;
- The magnitude of the impacts is **medium** as it is considered that impacts related to the vessel traffic will result in a reduction in the distribution of protected seabird species in a wide area.
- It has been found that any impact on wintering velvet scoters resulting from the impacts caused by the movement of sea vessels at the construction stage will be **major (significant)**.
- It has been concluded that any impact on wintering common scoters, long-tailed ducks and razorbills resulting from the impacts caused by the movement of sea vessels at the construction stage will be moderate (potentially significant),
- It has been concluded that any impact on wintering and breeding cormorants resulting from the impacts caused by the movement of sea vessels at the construction stage will be minor (insignificant),
- It has been concluded that any impact on all other protected seabird species (wintering goldeneyes and great crested grebes) resulting from the impacts caused by the movement of sea vessels at the construction stage will be **negligible (insignificant)**.

IV.2.7.5.3 Operational phase

Indirect effects on seabirds through impacts related to prey availability

An assessment of indirect impacts on protected seabird species through impacts on prey availability was carried out using the methodology described in chapter [Chapter IV.2.5]. The following conclusions have been drawn:

- Wintering common gulls, scoters, herring gulls, long-tailed ducks, razorbills and velvet scoters are of **high significance** because they are protected as part of the Przybrzeżne wody Bałtyku SPA, within which the marine survey area was located. They are considered to be of **medium sensitivity** in relation to the indirect impacts on prey availability. The overall value of the receptor is **medium** in terms of international significance of these seabird species;
- Breeding herring gulls, great cormorants and wintering cormorants are of **high significance** because they are protected as part of the Natura 2000 sites within a radius of 20 km from the marine survey area. They are of **low sensitivity** in terms of the indirect impacts on prey availability, as they are mobile species of seabirds and there are many alternative habitats available. The overall value of the receptor is **low** in terms of international significance of these seabirds;

- All other species of seabirds (the wintering goldeneye and great crested grebes and the breeding common gull) are strictly protected species [199], of **high significance** and are considered to have **negligible sensitivity** in terms of the indirect impacts on prey availability; The overall value of the receptor is **negligible** in terms of national significance of these seabirds;
- The spatial extent of the impact is **regional.** This is due to the fact that impacts on prey availability may occur outside the Project area but it is unlikely that they will extend to more than 30 km from the Project area;
- The impacts are long-term because the effects of the loss of habitats will last for more than 12 years.
- The impact is **continuous** due to the permanent loss of habitats;
- The magnitude of the impacts is **negligible** because the whole area where prey availability will be affected will be minimal compared to the entire area of alternative habitats available for benthic and fish-eating bird species;
- It has been concluded that any effect on protected species of seabirds resulting from indirect impacts on prey availability during the operation phase will be **negligible (insignificant)**.

Direct impact as a result of the MOLF operation

The impact on birds during the operational phase should be minimal compared to the construction phase. Noise caused by ships can have potential effects during any necessary maintenance works, but these will not occur regularly. In addition, the MOLF will be used sporadically during maintenance works, so it will not cause impacts greater than those assessed for the construction phase.

Assuming that the distance of disturbances will be 500 m, the operational activity of the MOLF will affect a total area of approximately 1 km^2. This is an equivalent of 0.05% of the Przybrzeżne wody Bałtyku SPA.

An assessment of the direct impacts on seabirds resulting from the disturbance-related impacts has been carried out. The following conclusions have been drawn:

- Wintering common scoters, long-tailed ducks, razorbills and common scoters are of **high significance** because they are protected as part of the Przybrzeżne wody Bałtyku SPA, within which the marine survey area is located. Their numbers recorded throughout the marine survey area are of international significance, they are sensitive to impacts and are characterised by **medium sensitivity**. The overall value of the receptor is considered to be medium;
- Common gulls and herring gulls are of **high significance** because they are protected as part of the Przybrzeżne wody Bałtyku SPA, within which the area of the marine surveys was located. Common gulls, great cormorants and wintering great cormorants are also of **high significance** because they are protected as part of the Natura 2000 sites located at a distance of 20 km from the marine survey area. Although their numbers of national significance were recorded in the entire marine survey area, they are not sensitive to impacts. These are wide-range seabird species and the available alternative habitats are extensive and characterised by **low sensitivity**, and the overall value of the receptor is low;
- All other species of seabirds (the wintering goldeneye and the great crested grebe, common gull) are strictly protected species [394] and are of **high significance**. Although they are present in numbers of national significance, they are not sensitive to impacts and are characterised by **low sensitivity**. The overall value of the receptor is **negligible;**
- The spatial extent of the impact is **regional.** This is due to the fact that impacts on seabirds may occur outside the Project area, but it is unlikely that they will reach a distance of more than 30 km from the Project site;
- The duration of the impacts is short-term because all effects will be felt for a period shorter than one year after the completion of the Project.

- The impact is infrequent due to occasional operation of the MOLF;
- The magnitude of the impacts is **negligible** because the whole area where seabird disturbances will occur will be minimal compared to the total area of available alternative habitats and they would have a short-term nature;
- It has been found that any impacts on seabirds resulting from direct impacts caused by disturbances in the operational phase, would be **negligible (insignificant)**.

Impacts caused by increased ship traffic

Impacts on birds in the operational phase should be lower than in the construction phase. The MOLF will be used sporadically during maintenance works, so ship traffic will not be regular. Based on the maximum disturbance distance presented above (for scoters), it is assumed that the maximum range of impacts will be 1 km from each ship, so each ship will have a 2 km wide impact zone.

An assessment of the impact of increased ship traffic on seabirds has been carried out. The following conclusions have been drawn:

- Wintering velvet scoters are of **high significance** because they are protected as part of the Przybrzeżne wody Bałtyku SPA, within which the marine survey area is located; Their number of international significance was recorded in the entire area of the marine surveys. They are highly sensitive to ship traffic. The overall value of the receptor is considered **high;**
- Wintering common scoters, long-tailed ducks and razorbills are of **high significance** because they are protected as part of the Przybrzeżne wody Bałtyku SPA, within which the marine survey area is located. They occur in numbers of international significance throughout the marine survey area they are of **medium sensitivity** to impacts caused by vessel traffic. The overall value of the receptor is considered to be medium;
- Wintering and breeding cormorants are protected as part of the Natura 2000 sites located at a distance of 20 km from the marine survey area. Significant numbers of them were recorded on the national scale throughout the marine survey area. They are among the species least sensitive to impacts caused by vessel traffic and are characterised by **low sensitivity**. The overall value of the receptor is considered **low;**
- All other species of seabirds (the wintering goldeneye and the great crested grebe) are strictly protected species [394] and are of **high significance**. Significant numbers of them were recorded on the national scale throughout the marine survey area. They are less sensitive to impacts caused by ship traffic and are characterised by **low sensitivity**. The overall value of the receptor is **negligible;**
- The spatial extent of the impact is **regional**. This is due to the fact that impacts on seabirds may occur outside the Project area, but it is unlikely that they will reach a distance of more than 30 km from the Project site;
- The impacts are of a **short-term** nature because the effects of the adjustment will last for a period shorter than one year after the completion of the Project;
- The impact is infrequent due to occasional operation of the MOLF;
- The magnitude of the impacts is negligible since it is believed that, although the movement of sea vessels will lead to a reduction in the distribution of seabirds over a large area, this will be an infrequent phenomenon;
- It has been found that any impacts on wintering velvet scoters resulting from the impacts caused by the movement of sea vessels during the operation phase will be **negligible (insignificant)**.
- It has been found that any impacts on wintering birds (the common scoter, long-tailed duck and razorbill) resulting from the impacts caused by the movement of sea vessels during the operational phase will be **negligible (insignificant)**.

- It has been found that any impacts on wintering and breeding black cormorants resulting from the impacts caused by the movement of seagoing vessels during the operation phase will be negligible (insignificant).
- It has been found that any effects on all other seabirds (the wintering goldeneye and the great crested grebe) resulting from impacts caused by the movement of seagoing vessels during the operational phase will be negligible (insignificant).

IV.2.7.6 Marine mammals

Assessment of underwater noise (development stage)

This subchapter assesses underwater noise from the construction works at the development stage (impact pile driving, vibration driving of sheet pile walls, dredging, rock material dumping, vessel traffic, tunnelling and directional drilling). The following conclusions have been drawn:

- The porpoise is of **high significance** because it is protected, rare (the estimated population in the Baltic Sea is 450 specimens) and is a qualifying feature in several SCIs. Its sensitivity is **low or medium**. Although a small population would not be resilient to major changes, individual specimen can easily avoid sources of impacts. The overall value of the receptor is therefore **medium** in terms of national and international significance of this species.
- The common seal is of **high significance** due to its national and international significance. It is of **low sensitivity**. The current population is estimated at 15,000 specimens grouped in two (2) metapopulations in the Baltic Sea. This means that the species has a potential to tolerate changes at the population level. The overall receptor value is **medium**.
- The grey seal is a species of **high significance** and **low sensitivity**. Its current population in the Baltic Sea is estimated at 30,000 specimens, so it can tolerate effects to a greater extent at the population level. The overall receptor value is **medium**.
- The ringed seal is a species of **high significance** and **low sensitivity**. Its current population in the Baltic Sea is estimated at 20,000 specimens, which is why this population can tolerate changes. The overall receptor value is **medium**.
- The spatial extent of the impacts for all the four marine mammal species assessed is **regional**. This is due to the fact that the impacts associated with underwater noise caused by the construction works can occur outside the Project Area but they are unlikely to extend beyond a distance of 30 km from the Project Site.
- The duration of the impact for all four marine mammal species assessed is t**emporary**, as effects associated with underwater noise from construction would be clearly limited in time (<12 months of underwater noise), and their effects would cease after the end of the action and return to baseline levels.
- The frequency of the impact for all four marine mammal species assessed is f**requent**, due to the potential for repeated impacts during construction works (impact piling, vibratory sheet piling, dredging, rock fill placement, vessel operations, tunnel boring and directional drilling).
- The magnitude of impact for all four marine mammal species assessed is l**ow** because it is considered that the Project has the potential to only affect localised individuals within a population over a short time period (one generation of the species or less) and would not significantly affect other trophic levels or the marine mammal population itself;
- The types of effects on all four marine mammal species assessed are considered to be **negative, direct** (individual level) and **indirect** (ecosystem effects and prey availability); and
- It is concluded that any effects on marine mammals arising from underwater noise from construction during the development stage would be **minor (insignificant)**, as summarised below.

IV.2.7.6.1 Assessment of indirect effects via prey availability (construction phase - development stage)

This subchapter assesses indirect effects on marine mammal species resulting from impacts on prey availability. The following conclusions have been drawn:

- Marine mammals are of **high** importance and **low** sensitivity in relation to indirect effects through impacts on prey availability. The overall receptor value is **medium**.
- Using fish as an example for prey availability, the **negligible** sensitivity ratings above have been set with reference to the Waterborne Noise and Vibration Assessment report which assessed impact significance to be **low** and impact importance (with embedded mitigation) to be **negligible** for key fish receptors (as described above). For the other relevant commercial fish species in the Project area i.e. plaice, mackerel, turbot, flounder, smelt, sprat and Atlantic herring, and whiting, these taxa are all of least concern or not evaluated as per the IUCN, therefore their sensitivity is considered to be **negligible** also;
- The spatial extent of the impacts for all the four marine mammal species assessed is **local**. This is due to the fact that the impacts on fish (the TTS and avoidance), for example in terms of prey availability, will occur within a 100 m buffer around the Project Area (in the worst-case scenario, during impact piling).
- The duration of the impact for all four marine mammal species assessed is **temporary**, as any effects to fish, as an example for prey availability, and associated with underwater noise from construction would be clearly limited in time (<12 months of underwater noise), and their effects would cease after the end of the activity and return to baseline levels;
- The frequency of the impact for all four marine mammal species assessed is **frequent**, due to the potential for repeated impacts on fish, as an example for prey availability, during construction works (such as impact piling, vibratory sheet piling, dredging, rock fill placement, vessel operations, tunnel boring and directional drilling);
- The magnitude of the impact on all the four marine mammal species assessed is **low** because it is considered that the Project can only affect individual fish within the population, as an example of prey availability, in a short term (one generation of the species or less), and will not significantly affect other trophic levels or the fish population as such;
- The types of effects on all four marine mammal species assessed are considered to be **negative** and **indirect** (ecosystem effects and prey availability), and
- It has been concluded that any indirect effects on marine mammals resulting from the impacts of construction works, and at the development stage, on prey availability will be **negligible (insignificant)**, as summarised below.

IV.2.7.6.2 Impacts caused by increased ship traffic (construction phase - development stage)

The use of vessels will be required at all stages of the Project. During the construction of the MOLF, water intake and discharge structures, FRRS and the temporary cofferdam underwater noise will be emitted by workboats/tugstugboats, one or more piling barges (if they work simultaneously) and a cutter suction dredger (CSD). The vessel-related noise sources include engines, on-board pumps, propellers, thrusters and spud impact.

The present subchapter assesses the effects of the disturbance caused by increased vessel traffic. The following conclusions have been drawn:

- Marine mammals are of **high** importance and **low** sensitivity in relation to increased vessel activity. The overall receptor value is medium.

- The spatial extent of the impacts for all the four marine mammal species assessed is **regional**. This is because impacts associated with impacts through increased vessel activity during construction could occur beyond the Project Area (especially during transit to and from the Project Area);
- The duration of the impact for all four marine mammal species assessed is **temporary**, as effects associated with impacts through increased vessel activity during construction would be clearly limited in time, and their effects would cease after the end of the activity and return to baseline levels;
- The frequency of the impact for all four marine mammal species assessed is **frequent**, due to the potential for repeated impacts during construction works (vessel operations);
- The magnitude of impact for all four marine mammal species assessed is l**ow** because it is considered that the Project has the potential to only affect localised individuals within a population over a short time period (one generation of the species or less) and would not significantly affect other trophic levels or the marine mammal population itself;
- The types of effects on all four marine mammal species assessed are considered to be **negative** and **direct** (individual level); and
- It is concluded that any effects associated with impacts through increased vessel activity during the development stage, would be **minor (insignificant)**, as summarised below.

IV.2.7.6.3 Collision risk through increased vessel activity (construction phase - development stage)

Collisions between ships associated with the Project and marine mammals during the installation of the marine infrastructure have a potential to cause injury or death, with consequences at both the individual and population levels. However, the vessels associated with the Project are unlikely to move at high speed or irregularly, so marine mammals will be able to adjust to their presence and avoid them if necessary. This subchapter assesses the risk of collisions due to increased vessel traffic. The following conclusions have been drawn:

- Marine mammals are of **high** importance and **low** sensitivity in relation to vessel collision. The overall receptor value is **medium**.
- The spatial extent of the impacts for all the four marine mammal species assessed is **regional**. This is because impacts associated with collision risk through increased vessel activity during construction works could occur beyond the Project Area (especially during transit to and from the Project Area);
- The duration of the impact for all four marine mammal species assessed is **long-term**, as effects associated with collision risk through increased vessel activity during construction would be experienced for a period of more than 12 years after the Project activity has been completed and return to baseline levels (related to injury and death of individuals and lifecycle of porpoise and seals);
- The frequency of the impact for all four marine mammal species assessed is **frequent**, due to the potential for repeated impacts during construction works (vessel operations);
- The magnitude of impact for all four marine mammal species assessed is **low** because the Project affects a specific group of localised individuals within a population over a short time period (one generation of the species or less) but does not affect other trophic levels or the population itself;
- The types of effects on all four marine mammal species assessed are considered to be **negative** and **direct** (individual level); and
- It is concluded that any effects associated with impacts through increased vessel activity during the development stage, would be **minor (insignificant)**, as summarised below.

IV.2.7.6.4 Impacts of underwater noise from construction works (construction phase)

The present chapter presents a final assessment of the impacts of underwater noise on the biological elements of the marine environment.

Indirect effects on marine mammal species through impacts on prey availability (construction stage)

It has been concluded that any effects on the four marine mammal species assessed, resulting from the indirect impacts of underwater noise caused by the works at the construction stage (using fish as an example of prey availability), will be the same as at the development stage (described above), that is, **minor (insignificant)**.

Impacts through increased vessel traffic (construction stage)

It has been concluded that any effects on the four marine mammal species assessed, resulting from the direct impacts of disturbances caused by increased vessel traffic at the construction stage, will be the same as at the development stage (described above), i.e. **minor (insignificant)**.

Increased risk of collision through increased vessel activity (construction stage)

It has been concluded that any effects on the four marine mammal species assessed, resulting from the risk of collisions caused by increased vessel traffic at the construction stage, will be the same as at the development stage (described above), i.e. **minor (insignificant)**.

IV.2.7.6.5 Operational phase

The operational noise caused by seawater flowing through the headworks, intake tunnel, rotary screens and pumps is considered insignificant and has therefore not been modelled or evaluated.

Underwater noise may be generated during the operation of the open cooling sub-variants of the Lubiatowo - Kopalino site by turbulent or cavitation flow (formation and collapse of bubbles due to sudden pressure changes) in outlet diffusers. However, it is expected that the noise level at the outfall diffusers would fall below the most stringent noise threshold used in this study (120 dB). It is predicted that the outlet velocity will be much lower than the threshold of occurrence of turbulence or cavitation. Additionally, measured noise levels reported in the literature show that noise from the outfall diffusers of a similar facility (the Adelaide Desalination Plant) fell below 120 dB.

It is concluded, that any effects on the four marine mammal species assessed, arising from operational activity (notably underwater noise, impacts and collision risk from vessel operations) during the operational phase would be the same, as that for the development and construction stages, i.e. **minor (insignificant)**.

IV.2.7.8 Decommissioning phase

Currently, it is expected that the decommissioning phase of the Project will last approximately 24 years, after the total life cycle of 72 years (including the development works, construction, and operation/maintenance).

At the time of preparing this document there is considerable uncertainty about the decommissioning phase of the Project, not only with regard to the proposal for decommissioning activities but also with regard to the underlying conditions and regulatory framework that will be applicable at that time. Therefore, no detailed assessment of the potential impact of the decommissioning of sub-variant 1A has been carried out. Instead, it is assumed that the effects will be similar to those that will occur at the development and construction stages, although their magnitude will be lower, but they may extend over a longer period of time. This assumption is based on the draft decommissioning plan (presented as part of the overarching description of the Project), in accordance with the Polish law. The plan assumes that similar techniques, installations and other devices will be available for decommissioning works as at the development and construction stages. It has also been assumed that although the intake / outfall heads may be removed from the seabed, the intake and outfall tunnels themselves would remain in situ following decommissioning (thereby significantly reducing the scope for marine impacts to arise). The long-term use and status of the MOLF has not been confirmed; this may be either wholly removed or repurposesd by a different user following decommissioning.

Based on the above assumptions, given that potential effects on marine ecological receptors during the site preparation, operation and delivery phases have been found to be not significant (with, where necessary, the implementation of additional mitigation, it is concluded that a similar suite of impacts during the decommissioning phase would also be **insignificant**.

IV.2.8 Impact assessment – Sub-Variant 1C - Lubiatowo - Kopalino: closed cooling system using desalinated seawater

IV.2.8.1 General information

IV.2.8.1.1 Scope of the assessment

The 1C Sub-Variant will be characterised by a closed cooling system using desalinated seawater. This section provides an assessment of the potential impacts on the marine environment resulting from this Sub-Variant. This assessment was made “by way of exception”, i.e. only where the effects differ from those described and assessed previously for Sub-Variants 1A and 1B.

IV.2.8.4 Ichthyofauna

IV.2.8.4.1 Construction phase – Development stage

The works carried out in the marine environment at the development stage in Sub-Variant 1C will be identical to those in Sub-Variant 1A, covering the construction of the MOLF and the discharge from the sewage treatment works (STW). All the potential impacts on the marine environment resulting from these works have been assessed in the subsection concerning Sub-Variant 1A. These potential impacts include:

- Loss of habitats and physical impacts as a result of the construction works;
- Increased underwater noise caused by the construction works;
- Increased amount of suspended sediments and backfilling as a result of the re-deposition of suspended sediments;
- Artificial lighting;
- Effects of spills as a result of sea operations.

To avoid repetition, these assessments are not re-quoted here. The complete assessments of significant impacts for the development stage of Sub-Variant 1C can be found in the section concerning Sub-Variant 1A. The following is a summary of the impact assessments [Table IV.2-211]:

Table IV.2-211: The summary of the results of the impact assessment at the development stage for Sub-Variant 1C

No.	Source	Receptor	Impact	Significance of effect
1	Loss of habitats and physical impacts due to the construction works	Fish species of high significance, low sensitivity and medium value	Impacts related to the loss of habitats and physical change will be local, long-term and continuous, of negligible magnitude.	Negligible (insignificant)
2	Underwater noise caused by the construction works related to the development stage	Fish species of high significance, low sensitivity and medium value	Impacts from underwater noise caused by the construction works related to the development stage of the Project will be local, temporary and frequent, of a low magnitude.	Minor (insignificant)
3	Increased amount of suspended sediments and backfilling due to the re-settling of suspended sediments	Fish species of high significance, low sensitivity and medium value	Impacts associated with increased concentrations of suspended sediments and backfilling will be local, short-term and infrequent, of negligible magnitude.	Minor (insignificant)
4	Artificial lighting	Fish species of high significance, low	Impacts associated with visual stimuli caused by artificial lighting will be local,	Negligible (insignificant)

No.	Source	Receptor	Impact	Significance of effect
		sensitivity and medium value	short-term and infrequent, of negligible magnitude.	
5	Spills from ships during sea operations	Fish species of high significance, low sensitivity and medium value	Impacts related to spills resulting from marine works will be local, short-term and infrequent, of negligible magnitude.	Minor (insignificant)

Source: [456]

IV.2.8.4.2 Construction phase

Works in the marine environment at the construction stage in Sub-Variant 1C will include the construction of the cooling water ducts / pipelines in an open trench in which prefabricated duct sections will be laid (given the worst construction scenario). The construction works that will be carried out in the marine environment at this stage will be identical to the works in Sub-Variant 1A but their extent will be smaller. All the potential impacts on the marine environment resulting from these works have been assessed in the subsection concerning Sub-Variant 1A. These potential impacts include:

- Loss of habitats and physical impacts as a result of the construction works;
- Pull-in during dredging with suction heads
- Increased underwater noise caused by the construction works;
- Increased amount of suspended sediments and backfilling as a result of the re-deposition of suspended sediments;
- Changes in visual stimuli caused by artificial lighting;
- Effects of ship spills as a result of sea operations.

In view of the similarity and smaller scale of the infrastructure required for Sub-Variant 1C, the fact that it will affect the same ichthyofauna receptors as Sub-Variant 1A and the fact that the worst-case scenario impact assessments at the construction stage of Sub-Variant 1A ended with the conclusion “negligible (insignificant)”, it has been concluded that it is not necessary to repeat the impact assessment in this subsection. See the subsection concerning Sub-Variant 1A for the full assessments of the relevant impacts on ichthyofauna receptors at the construction stage. The following [Table IV.2 -212] summarises the impact assessments:

Table IV.2-212: The summary of the results of the assessment of the construction stage for Sub-Variant 1C

No.	Source	Receptor	Impact	Significance of effect
1	Loss of habitats and physical impacts due to the construction works	Fish species of high significance, low sensitivity and medium value	Impacts related to the loss of habitats and physical changes to the seabed will be local, long-term and continuous, of negligible magnitude.	Negligible (insignificant)
2	Pull-in during dredging with suction heads	Fish species of high significance, low sensitivity and medium value	Impacts resulting from the pull-in of fish by the suction dredger will be local, short-term and infrequent, of low magnitude.	Minor (insignificant)
3	Underwater noise caused by the construction works related to the construction stage	Fish species of high significance, low sensitivity and medium value	Impacts associated with underwater noise caused by the construction works will be local, temporary and frequent on a low scale.	Minor (insignificant)
4	Increased amount of suspended sediments and backfilling due to the re-settling of suspended sediments	Fish species of high significance, low sensitivity and medium value	Impacts associated with increased concentrations of suspended sediments and backfilling will be local, short-term and infrequent, of negligible magnitude.	Minor (insignificant)
5	Artificial lighting	Fish species of high significance, low sensitivity and medium value	Impacts associated with visual stimuli caused by artificial lighting will be local, short-term and infrequent, of negligible magnitude.	Negligible (insignificant)

No.	Source	Receptor	Impact	Significance of effect
6	Spills from ships during sea operations	Fish species of high significance, low sensitivity and medium value	Impacts related to spills resulting from marine works will be local, short-term and infrequent, of negligible magnitude.	Minor (insignificant)

Source: [456]

IV.2.8.4.3 Operational phase

IV.2.8.4.3.1 Habitat loss due to the presence of permanent infrastructure

No additional marine infrastructure will be introduced to the environment during the operational phase and habitat loss and impacts will be limited to those related to the permanent infrastructure built during the previous two stages of the Project. The total direct habitat loss is 385 m^2 in the coastal area with sandy seabed. All the impacts are expected to be the same as in sub-variant 1A.

IV.2.8.4.3.2 Effects of treated technological wastewater discharge

The assessment of the effects of treated technological wastewater discharge in the operational phase of Sub-Variant 1C assumes continuous operation (of the three AP1000 reactors) at full power. Three components of the discharge have been considered: thermal load, salinity and chemical pollutants. The properties of the discharge from Sub-Variant 1C with a closed cooling system have been described earlier.

Thermal pollution

The whole volume of sewage (from the three reactors), up to 1.45 m^3/s, will be discharged from the cooling water system of Sub-Variant 1C at a distance of 1,250 m from the shoreline. This represents less than 1% of the discharge estimated for Sub-Variant 1A. The outlet of the sewage pipeline will be located at a depth of 15 m. The lift of the plume will be smaller than in Sub-Variant 1A, mainly due to the increased salinity resulting from evaporation in the closed cooling water circuit.

The discharge of heated cooling water from the circuit of Sub-Variant 1C is expected to be lower than that in the case of Sub-Variants 1A and 1B. It is expected that the ΔT of +2°C (the maximum admissible temperature rise (threshold) recommended for assessing the impact of thermal discharges on European marine areas designated under the Habitats Directive) will not extend beyond one model cell (150 m) from the discharge site, covering an area of 0.13 km^2, or 0.05% of the marine survey area.

The potential effects of this thermal anomaly in receiving waters on ichthyofauna are described in the subsection concerning Sub-Variant 1A where a negligible (insignificant) effect was found.

Salinity

Sewage from the closed cooling water system of Sub-Variant 1C will contain elevated levels of NaCl coming from sewage from the desalination plant, the DTS [by-products] and the cooling tower [blow down].

Tests of sensitivity depending on sea current velocities and water temperatures were carried out using the CORMIX modelling. In all cases, for the cooling water system operating on desalinated water, using cooling towers, ΔS below 0.5 psu is expected to be achieved in the initial mixing zone in the near field (< 40 m from the point of discharge), covering an area of 0.006 km^2. Salinity levels are expected to drop to ambient levels at a distance of several hundred metres from the discharge site.

Research on the salinity of the Baltic Sea was carried out in 2017-2018. Then, the salinity in the area of the Lubiatowo - Kopalino site ranged from 6.95 to 8.06 psu, which suggests a natural variability of 1.11 psu [208]. Based on these observations, it is predicted that a ΔS value smaller than 0.5 psu will not have a significant effect on ichthyoplankton.

This assessment is confirmed by studies of the impact of saline waste from a desalination plant with a capacity of 100 GL/y (3.17 m^3/s) on fish populations in the temperate zone. This study found no evidence that salt waste had a detrimental effect on fish populations near the point of discharge, and concluded that species diversity and abundance were comparable to those observed at reference sites.

Chemical components

A review of the potential impacts of the chemical ingredients contained in the discharge on ichthyofauna is discussed in the subsection concerning Sub-Variant 1A, where a minor (negligible) effect was found. Given the similarity of the receptor mix and the smaller magnitude of the impacts, the assessment of the chemical ingredients of sewage on ichthyofauna has not been repeated in this subsection.

IV.2.8.4.3.3 Effects of fish entrapment, entrainment and impingement

The effects of fish entrapment, entrainment and impingement in the coastal waters of the Lubiatowo - Kopalino site have been described in full in the section concerning Sub-Variant 1C and would be the same as for Sub-Variant 1C, except for the radius of the suction zone and the speed of cooling water flow, which will be much lower. Any potential impacts on the receptors have been reduced accordingly.

Sub-Variant 1C will draw a maximum of 4.5 m^3/s of water through three heads, each operating at a capacity of up to 1.5 m^3/s. In the worst case, the drawing zone, based on the same assumptions as those presented for variant 1B, would form a hemisphere with a radius of 23.8 m from the inlet head, covering an area of 1,791 m^2 where the inlet velocity would exceed 1 cm/s. The three inlet heads would form a combined inlet zone of 5,373 m^2, or about 0.002% of the marine survey area of the Lubiatowo - Kopalino site. The inlet velocity measured directly in front of the inlet opening would be the same as in Sub-Variant 1B: 0.15 m/s. Therefore, all potential impacts are assessed as less severe than those presented in the section concerning Sub-Variant 1B. A revised impact assessment, based on the smaller intake area and inlet velocity, is presented below. The following conclusions have been drawn:

- The identified receptors, i.e. ichthyofauna within the Lubiatowo - Kopalino survey area, are of **high significance** due to their importance for supporting the integrity of the ecosystem (in particular in connection with the SPA), as well as the presence of salmon, sea lamprey and zebra mussel which are features of the Słowińska Ostoja SCI, and of **medium** sensitivity, which gives the overall value of the receptor at medium level.
- The spatial extent of the impacts is **regional**, the impacts occur outside the Project Area.
- The duration of the impacts is considered to be **constant**, persisting throughout the lifetime of the NPP until it is decommissioned (and potentially later, depending on the decommissioning approach).
- The impact frequency is **continuous** because once the marine infrastructure is built, the direct loss of habitats and associated physical changes will begin.
- The magnitude of the impacts is **low** because the levels of ichthyofauna entrapment, entrainment and impingement are low compared to the overall species population in ICES sub-areas 25 and 26 and potential compensation.
- It has been found that losses caused by the entrapment, entrainment and impingement during the operational phase will be **minor (insignificant)**.

IV.2.8.4.3.4 Increased underwater noise levels caused by ship traffic

The intervention in the marine environment during the operational phase of Sub-Variant 1C will be the same as in Sub-Variant 1B, involving underwater noise related to seawater intake/discharge, pumps and vessels operating at the MOLF.

The full impact assessment of the operational phase for Sub-Variant 1B can be found in the dedicated section.

IV.2.8.5 Marine avifauna

IV.2.8.5.1 Construction phase – Development stage

The works carried out in the marine environment at the development stage in Sub-Variant 1C will be identical to the works in Sub-Variant 1B, which includes the construction of the MOLF and the discharge from the sewage treatment works (STW). These impacts include:

- Indirect impacts on prey availability for seabirds;
- Direct impacts resulting from the construction works;
- Impacts caused by increased ship traffic.

The full impact assessment relevant to the development stage of Sub-Variant 1C can be found in the section concerning Sub-Variant 1B.

IV.2.8.5.2 Construction phase

Works in the marine environment at the construction stage in Sub-Variant 1C will include the construction of the cooling water ducts / pipelines in an open trench in which prefabricated duct sections will be laid (given the worst construction scenario). The construction works that will be carried out in the marine environment at this stage will be the same as in Sub-Variant 1B, although the scope of some of them will be smaller. Their scale is not considered to alter the conclusions from the impact assessment resulting from the implementation of Sub-Variant 1B. Potential impacts include:

- Indirect impacts on prey availability for seabirds;
- Direct impacts resulting from the construction works;
- Impacts caused by increased ship traffic.

The full impact assessment relevant to the construction stage of Sub-Variant 1C can be found in the section concerning Sub-Variant 1B.

IV.2.8.5.3 Operational phase

The intervention in the marine environment during the operational phase of Sub-Variant 1C will be the same as in Sub-Variant 1B. All the potential impacts on the marine environment resulting from these works have been assessed in the subsection concerning Sub-Variant 1B. These potential impacts include:

- Indirect impacts on prey availability for seabirds;
- Direct impacts resulting from the operation of the MOLF;
- Impacts caused by increased ship traffic.

The full impact assessment relevant to the operational phase of Sub-Variant 1C can be found in the section concerning Sub-Variant 1B.

IV.2.8.6 Marine mammals

The detailed assessment of the impact on marine mammals is presented in Chapter IV.10.2, which discusses the results of the modelling of the noise level in the marine environment in relation to marine biological receptors, including marine mammals, at the individual phases of the Project.

IV.2.8.6.1 Construction phase – Development stage

The works carried out in the marine environment at the development stage in Sub-Variant 1C will be the same as in Sub-Variants 1A and 1B, including the construction of the MOLF, sewage treatment works (STW) and temporary sheet pile wall (on the foreshore and offshore) or caissons (in the marine part) near the STW pipeline and the discharge pipeline.

IV.2.8.6.2 Construction phase

The intervention in the marine environment during the implementation phase of Sub-Variant 1C will be the same as in Sub-Variants 1A and 1B, which includes structures related to the cooling water inlet and outlet, FRRS, temporary sheet pile walls (onshore and offshore) or caissons (offshore) around the cooling water ducts / pipelines.

All the potential impacts on marine mammals resulting from these activities have been discussed earlier. These potential impacts and effects include:

- Impacts of underwater noise generated by construction works;
- Indirect effects of impacts on prey availability for marine mammal species (on the example of fish);
- Impacts caused by increased ship traffic;
- Increased risk of collision as a result of increased ship activity.

The noise assessment at the construction stage is the same as for the site development stage, summarised above.

IV.2.8.6.3 Operational phase

The intervention in the marine environment during the operation phase of Sub-Variant 1C will be the same as in Sub-Variants 1A and 1B, including underwater noise related to seawater intake/ discharge, pump operation and vessels operating at the MOLF.

All the potential impacts on marine mammals resulting from these activities have been discussed earlier. These potential impacts and effects include:

- Underwater noise from seawater inlets/outlets, pump operation and ships arriving at MOLF;
- Impacts caused by increased ship traffic;
- Increased risk of collision as a result of increased ship activity.

To avoid repetition, the exhaustive discussion of the impacts on marine mammals can be found in the section concerning Sub-Variant 1A. The table also covers the source, receptor, impact magnitude and significance of the effects (underwater noise, disturbances and collision risk).

IV.2.8.8 Decommissioning phase

The decommissioning phase of Sub-Variant 1C, as in the case of Sub-Variant 1B, is still fraught with many unknowns. On this basis, the same general assumptions were made for the assessment of potential impacts. Given that the potential impacts on marine ecological receptors at the development and construction stages and at the operational phase were considered insignificant (if necessary, after the implementation of mitigation measures), it has been concluded that a similar set of impacts during the decommissioning phase will also be insignificant.

IV.2.9 Impact assessment – Sub-Variant 1B - Lubiatowo - Kopalino: closed cooling system using seawater

IV.2.9.1 General information

IV.2.9.1.1 Scope of the assessment

In Sub-Variant 1B, seawater will be used in the closed cooling system. This section provides an assessment of the potential effects of this Sub-Variant on marine ecological receptors. The assessment highlights the differences versus the impacts described and assessed earlier for Sub-Variant 1A.

IV.2.9.4 Ichthyofauna

IV.2.9.4.1 Construction phase – Development stage

The works carried out in the marine environment at the development stage in Sub-Variant 1B will be the same as in Sub-Variant 1A, covering the construction of the MOLF and the discharge from the sewage treatment works (STW). All the potential impacts on the marine environment resulting from these works have been assessed in the subsection concerning Sub-Variant 1A. These potential impacts include:

- Loss of habitats and physical impacts as a result of the construction works;
- Increased underwater noise caused by the construction works;
- Increased amount of suspended sediments and backfilling as a result of the re-deposition of suspended sediments;
- Artificial lighting;
- Effects of spills as a result of sea operations.

To avoid repetition, these assessments are not re-quoted here. The complete assessments of significant impacts for the development stage of Sub-Variant 1B can be found in the section concerning Sub-Variant 1A.

IV.2.9.4.2 Construction phase

Works in the marine environment at the construction stage in Sub-Variant 1B will include the construction of the water cooling infrastructure using submerged pipes (the worst-case scenario). Construction activities that would occur within the marine environment during this phase would be identical to the activities proposed for Variant 1A, but on a smaller scale. All the potential impacts on the marine environment resulting from these works have been assessed in the subsection concerning Sub-Variant 1A.

In view of the similarity and smaller scale of the infrastructure required for Sub-Variant 1B, the fact that Sub-Variant 1B will affect the same benthic receptors as Sub-Variant 1A, and the fact that the worst-case scenario impact assessments at the construction stage of Sub-Variant 1A ended with the conclusion "negligible (insignificant)", it has been concluded that it is not necessary to repeat the impact assessment in this subsection. See the subsection concerning Sub-Variant 1A for the full assessments of the relevant impacts on ichthyofauna receptors at the construction stage.

IV.2.9.4.3 Operational phase

IV.2.9.4.3.1 Physical impacts due to the presence of the permanent marine infrastructure

No additional marine infrastructure will be introduced into the environment during the operational phase and the loss of habitats and impacts will be limited to those related to the permanent infrastructure built during the previous two stages of the Project. A total direct loss of habitats of 385 m^2 will affect the coastal area with sandy seabed. It is expected that all the impacts will be identical as in Sub-Variant 1A. Therefore, no further detailed assessment has been repeated here.

IV.2.9.4.3.2 Effects of operational discharge

The assessment of effects of discharges for Sub-Variant 1B during the NPP operational phase is based on the completed NPP (with three AP1000 reactors) operating in power-generating mode at full capacity. Three components of the discharge have been considered: thermal load, salinity and chemical pollutants.

Thermal effluent

The whole sewage volume (from the three reactors), up to 3.1 m^3/s, will be discharged from the cooling water system of Sub-Variant 1B at a distance of 1,250 m from the shoreline. This represents approximately 1.7 % of the discharge estimated for Sub-Variant 1A. The outlet of the pipe discharging sewage into the water is located at a depth of 15 m. The lift of the plume will be smaller than in Sub-Variant 1A, mainly due to the increased salinity resulting from evaporation in the closed cooling water circuit.

Based on the modelling results, it is expected that a ΔT of +0.5°C will occur within an area of up to 395 m from the drop site. A ΔT of +2°C (the maximum admissible temperature rise (threshold) recommended for assessing the impact of thermal discharges on European marine areas designated under the Habitats Directive) is expected not to extend beyond one cell of the model (150 m) from the discharge site, covering an area of 0.13 km^2, or 0.05% of the marine survey area.

The potential effects of this thermal anomaly in receiving waters on ichthyofauna have been described in the subsection concerning Sub-Variant 1A, where a minor (insignificant) effect was found. Given the similarity of the receptor mix and the smaller magnitude of the impacts, the impact assessment of thermal effluents on ichthyofauna has not been repeated in this subsection.

Salinity

Sewage from the closed cooling water system of Sub-Variant 1B will be characterised by an increased level of salinity resulting from water losses due to evaporation and from the admixture of effluents from the desalination plant, the DTS and the cooling towers.

Tests of sensitivity depending on seawater current velocities and temperatures were performed using the CORMIX modelling, and their results are presented below [Table IV.2-242]. In all cases, the requirement of ΔS < 0.5 psu is satisfied in the initial mixing zone in the near field (< 100 m from the point of discharge) for cooling towers operating on brackish water.

Table IV.2-242: The dispersion of salt plumes in the near field

No.	Season	Time (s)	Half width	Range along the shore	Cross shore extent	Height	Δ Salinity (psu)	Dilution factor
1	Summer	144-180	6-9m	17-48m	52-91m	10m	0.30-0.46	17-26
2	Winter	252-324	6-8m	23-83m	43-81m	10m	0.22-0.44	18-36

Source: [456]

It is expected that the salinity level will drop to the ambient level within a few hundred metres from the point of discharge.

In 2017-18, salinity of the Baltic Sea in the area of the Lubiatowo - Kopalino site ranged from 6.95 to 8.06 psu, which suggests a natural variability of 1.11 psu [220]. Based on these observations, it is predicted that a ΔS < 0.5 psu will not have a significant effect on ichthyoplankton in receiving water beyond the edge of the mixing zone.

This assessment is confirmed by studies of the impact of saline waste from a desalination plant with a capacity of 100 GL/year (3.17 m^3/s-1) on fish populations in the temperate zone. This study found no evidence that salt waste had a detrimental effect on fish groups near the point of discharge and concluded that species diversity and abundance were comparable to those observed at reference sites [513].

Chemical components

As for Sub-Variant 1A, the assessment of potential changes in ambient water quality focuses on comparing the levels of potential pollutants in the whole sewage discharge volume with the respective EQS and ELV levels.

For the majority of components of the operational effluent concentrations at end-of-pipe are in line with established (or suitably equivalent) EQS or ELV levels. For those components for which this is not the case, or for which EQS / ELV standards have not been established, e.g. lithium, sulphate, hydrazine, polyacrylate, additional mitigation measures are described in Volume V.

A review of the potential impacts of the chemical components contained in the discharge on ichthyofauna has been discussed in the subsection concerning Sub-Variant 1A, where a minor (insignificant) impact was found.

Given the similarity of the receptor mix and the smaller magnitude of the impacts, the assessment of the chemical components of sewage on ichthyofauna has not been repeated in this subsection.

IV.2.9.4.3.3 Effects of fish entrapment, entrainment and impingement into the cooling system

The effects of fish entrapment, entrainment and impingement in waters off the shoreline of the Lubiatowo - Kopalino site have been fully described in the subsection concerning Sub-Variant 1A. They will be the same as for Sub-Variant 1B, except for the radius of the suction zone and the escape speed of the cooling water inlet, which will be significantly reduced. Any potential impacts on receptors would be reduced accordingly.

Sub-variant 1B will draw a maximum of 6.3 m^3s^{-1} of water through three capped radial velocity heads each drawing up to 2.1 m^3s^{-1}. In the worst-case scenario, based on the same assumptions as those presented in subsection III.6.3.4, the drawing zone will extend 33.4 m from the inlet head, covering an area of 3,509 m^2 where the escape speed exceeds 1 cm/s. The three inlet heads will form a combined intake zone of 10,5272 m^2, approx. 0.004% of the marine survey area of the Lubiatowo - Kopalino site. The escape speed directly in front of the inlet opening will be reduced to 0.15 m/s.

In order to avoid repetition, the impact assessment is not re-quoted here. The full impact assessment relevant to the construction phase of Sub-Variant 1B can be found in the subsection concerning Sub-Variant 1A. A revised impact assessment, based on the smaller drawing zone and escape speed, is presented below.

The following conclusions have been drawn:

- The identified objects of impact, i.e. commercial, recreational, protective ichthyofauna and prey species within the Lubiatowo - Kopalino survey area, are of **high significance** due to their importance for supporting the integrity of the ecosystem (in particular in connection with the SPA), as well as the presence of salmon, sea lamprey and zebra mussel, which are features of the Słowińska Ostoja SCI, and **medium** sensitivity, which gives the overall value of the receptor at the **medium** level.
- The spatial extent of the impacts is **regional**, the impacts occur outside the Project Area, but their detectability at a distance of over 30 km from the Project site is unlikely.
- The duration of the impacts is considered to be **constant**, persisting throughout the operational phase of the NPP until it is decommissioned (and potentially later, depending on the decommissioning approach).
- The impact frequency is **continuous** because the associated physical impacts will begin after the construction of the marine infrastructure.
- The scale of the impact is **low** because the levels of entrapment, entrainment and impingement are low compared to the population in ICES sub-areas 25 and 26 and the potential compensation depending on density.
- It has been found that the losses resulting from entrapment, entrainment and impingement during the operational phase will be **minor (insignificant)**.

IV.2.9.4.3.4 Increased underwater noise level caused by ship traffic

The intervention in the marine environment during the operational phase of Sub-Variant 1B will be the same as in Sub-Variant 1A, which includes underwater operational noise related to seawater intake/discharge, mechanical screens/pumps and vessels operating in the MOLF.

To avoid repetition, the impact assessment of the operational phase has been omitted here. The full impact assessment of the operational phase for Sub-Variant 1A can be found in the section concerning Sub-Variant 1A.

IV.2.9.5 Marine avifauna

IV.2.9.5.1 Construction phase – Development stage

The works carried out in the marine environment at the development stage of Sub-Variant 1B will be similar to the works proposed for Sub-Variant 1A, which includes the construction of the MOLF and the discharge from the sewage treatment works (STW). All the potential impacts on the marine environment resulting from these works have been assessed in the subsection concerning Sub-Variant 1A. These potential impacts include:

- Indirect impacts on prey availability for seabirds;
- Direct impacts resulting from the construction works;
- Impacts caused by increased ship traffic

To avoid repetition, these assessments are not re-quoted here.

IV.2.9.5.2 Construction phase

Works in the marine environment at the construction stage in Sub-Variant 1B will include the construction of the water cooling infrastructure using submerged pipes (the worst-case scenario). The construction works that will be carried out in the marine environment at this stage will be the same as in Sub-Variant 1A. Although the scope of some of them will be smaller than in the case of Sub-Variant 1A, it is unlikely that their scale could change the conclusions of the assessments concerning the implementation of Sub-Variant 1A. All the potential impacts on the marine environment resulting from these works have been assessed in the subsection concerning Sub-Variant 1A. These potential impacts include:

- Indirect impacts on prey availability for seabirds;
- Direct impacts resulting from the construction works;
- Impacts caused by increased ship traffic.

To avoid repetition, these assessments are not re-quoted here. The complete assessments of significant impacts for the construction phase of Sub-Variant 1B can be found in the section concerning Sub-Variant 1A.

IV.2.9.5.3 Operational phase

The intervention in the marine environment at the site development stage of Sub-Variant 1B would be similar to those proposed for Sub-Variant 1A. All the potential impacts on the marine environment associated with these activities have been assessed in subsection 105. These potential impacts include:

- Indirect impacts on prey availability for seabirds;
- Direct impacts resulting from the construction works;
- Impacts caused by increased ship traffic.

To avoid repetition, these assessments are not re-quoted here. The complete assessments of significant impacts for the site development stage in Sub-Variant 1B can be found in the section concerning Sub-Variant 1A.

IV.2.9.6 Marine mammals

IV.2.9.6.1 Construction phase – Development stage

The works carried out in the marine environment at the development stage of Sub-Variant 1B will be the same as in Sub-Variant 1A, which includes the construction of the MOLF, sewage treatment works (STW) and temporary sheet pile wall (on the foreshore and in the offshore part) or caissons (in the offshore part) near the STW pipeline and the discharge pipeline. Details of the impact of underwater noise on marine mammals are described in Chapter II.10.4.

All the potential impacts on the marine environment resulting from these activities and impacts include:

- Impacts of underwater noise generated by construction works;
- Indirect effects of impacts on prey availability for marine mammal species (on the example of fish);
- Impacts caused by increased ship traffic;
- Increased risk of collisions as a result of increased ship traffic.

To avoid repetition, these assessments are not re-quoted here. The complete assessments of significant impacts for the development stage of Sub-Variant 1B can be found in the section concerning Sub-Variant 1A.

IV.2.9.6.2 Construction phase

The intervention in the marine environment during the implementation phase of Sub-Variant 1B will be the same as in Sub-Variant 1A, which includes planned structures related to the cooling water inlet and outlet, FRRS, temporary sheet pile walls (onshore and offshore) or caissons (offshore) around the cooling water ducts / pipelines.

All the potential impacts on marine mammals resulting from these activities and effects include:

- Impacts of underwater noise generated by construction works;
- Indirect effects of impacts on prey availability for marine mammal species (on the example of fish);
- Impacts caused by increased ship traffic;
- Increased risk of collisions as a result of increased ship traffic.

The full discussion of the impacts related to the development stage can be found in the subchapter concerning Sub-variant 1A. The noise assessment at the construction stage is the same as for the construction site development stage.

IV.2.9.6.3 Operational phase

The intervention in the marine environment during the operational phase of Sub-Variant 1B will be the same as in Sub-Variant 1A, which includes such impacts as underwater operating noise related to seawater intake/ discharge, mechanical screens/pumps and vessels operating in the MOLF.

All the potential impacts on the four marine mammal species under assessment resulting from the above activities have been taken into account and analysed in the subsection concerning Sub-Variant 1A. These potential impacts and effects include:

- Underwater noise from seawater intake / discharge, mechanical screens/pumps and vessels operating in the MOLF;
- Impacts caused by increased ship traffic;
- Increased risk of collisions as a result of increased ship traffic.

The full discussion of the operational impacts on marine mammals can be found in the subsection concerning Sub-Variant 1A. The same table should also be consulted for the same findings regarding the source, receptor, impact magnitude and significance of the effects (underwater noise, disturbances and collision risk).

IV.2.9.8 Decommissioning phase

The decommissioning phase in sub-variant 1B, as in the case of sub-variant 1A, is still fraught with many unknowns. In view of the above, when it comes to the estimation of the potential effects, general assumptions were made. Based on the assumptions made for sub-variant 1A, and given that potential effects on marine ecological receptors during the development stage, operational phase and construction phase have been found to be insignificant (with, where appropriate, implementation of mitigation measures), it is concluded that a similar suite of impacts during the decommissioning phase would also be insignificant.

IV.2.10 Summary and conclusions – Variant 1 -Lubiatowo - Kopalino site

IV.2.10.1 Sub-Variant 1A: open cooling system

The assessment of the potential effects of the impacts associated with the construction of the marin infrastructure of the Project on receptors in the marine environment has been carried out with a breakdown into the groups of receptors and the stages of the Project.

The potential impact on each group of the receptors for Sub-Variant 1A is generally negligible and minor (insignificant) at the development and construction stages and at the operational phase of the Project, except in three cases.

- During the operational phase, the effects of the combined sewage discharge may have a medium (potentially significant) effect on plankton if additional mitigation measures are not implemented. This is due to the potentially toxic effects of biocides which can affect plankton during the operational phase of the Project (several dozen years).
- Disturbances caused by the movement of vessels may have a potentially major (significant) effect on the most sensitive wintering bird species present in the adjacent SPA, namely the velvet scoter.
- Similarly, for less sensitive wintering bird species (the common scoter, long-tailed duck and razorbill), the potential effect of disturbances caused by seagoing vessels has been assessed as medium (potentially significant).

Additional measures to mitigate potentially significant impacts will turn medium (potentially significant) effects on plankton and medium / major (significant) effects on birds into minor (insignificant) effects.

IV.2.10.2 Sub-Variant 1B: closed cooling system using seawater

Since the impacts associated with the construction of the closed cooling system are smaller than the construction of the open cooling system in Sub-Variant 1A, most of the impacts on the marine environment in Sub-Variant 1B would also be smaller.

The potential impacts on each group of receptors assessed for Sub-Variant 1B are generally negligible and minor (insignificant) at the development and construction stages and at the operational phase of the Project, except in three cases.

- During the operational phase, the effects of the process sewage discharge may have a medium (potentially significant) effect on plankton if additional mitigation measures are not implemented. This is due to the presence of biocides and biogenic components in the discharge, which could lead to changes in plankton clusters over several decades.
- Disturbances caused by the movement of seagoing vessels can have a potentially major (significant) effect on the most sensitive wintering bird species found in the adjacent SPA, namely the velvet scoter.
- For less sensitive wintering bird species (the common scoter, long-tailed duck and razorbill), the potential effect of disturbances caused by seagoing vessels has been assessed as medium (significant).

Additional mitigation measures for potentially significant impacts will turn the medium (potentially significant) effects on plankton and the medium/major (significant) effects on birds into minor (insignificant) effects.

IV.2.10.3 Sub-Variant 1C: closed cooling system using desalinated seawater

As for Sub-Variant 1B, the smaller scale of work on the construction of the closed cooling system using desalinated seawater in Sub-Variant 1C means that the impact on the marine environment is generally lower than in Sub-Variant 1A.

The potential impacts on each group of receptors assessed for Sub-Variant 1C are generally negligible and minor (insignificant) at the development and construction stages and at the operational phase of the Project, except in three cases.

- During the operational phase, the effects of the process sewage discharge may have a medium (potentially significant) effect on plankton if additional mitigation measures are not implemented. This is due to the presence of biocides and biogenic components in the discharge, which could lead to changes in plankton clusters over several decades.
- Disturbances caused by the movement of seagoing vessels can have a potentially major (significant) effect on the velvet scoter, the most sensitive wintering bird species found in the adjacent SPAs.
- For less sensitive wintering bird species (the common scoter, long-tailed duck and razorbill), the potential effect of disturbances caused by seagoing vessels has been assessed as medium (potentially significant).

Additional mitigation measures for potentially significant impacts will turn the medium (potentially significant) effects on plankton and the medium/major (significant) effects on birds into minor (insignificant) effects.

Table IV.2-251: The summary of the impacts for the selected groups (ichthyofauna, avifauna, marine mammals): Sub-Variant 1A

No.	Source	Receptor significance	Receptor sensitivity	Receptor value	Impact extent	Impact time	Impact frequency	Impact magnitude	Impact significance
Ichthyofauna									
Construction phase of the Project – development stage									
18	Loss of habitats and physical disruption due to the construction works	High	Low	Medium	Local	Long-term	Continuous	Negligible	Negligible (insignificant)
19	Underwater noise caused by the construction works related to the development stage	High	Low	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
20	Increased amount of suspended sediments and backfilling due to the re-deposition of suspended sediments	High	Low	Medium	Local	Short-term	Infrequent	Negligible	Negligible (insignificant)
21	Effects of artificial lighting	High	Low	Medium	Local	Short-term	Infrequent	Negligible	Negligible (insignificant)
22	Spills caused by operations at sea	High	Low	Medium	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
Construction phase of the Project – construction stage									
23	Loss of habitats and physical disturbances caused by the works at the construction stage	High	Low	Medium	Local	Long-term	Continuous	Negligible	Negligible (insignificant)
24	Suction during suction dredging at the construction stage	High	Low	Medium	Local	Short-term	Infrequent	Low	Minor (insignificant)
25	Underwater noise caused by the works related to the construction stage	High	Low	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
26	Increased amount of suspended sediment and backfilling due to the re-deposition of suspended sediment at the construction stage	High	Low	Medium	Local	Short-term	Infrequent	Low	Minor (insignificant)
27	Effects of artificial lighting at the construction stage	High	Low	Medium	Local	Short-term	Infrequent	Negligible	Negligible (insignificant)
28	Spills caused by activities carried out at sea during the construction stage	High	Low	Medium	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
Operational phase of the Project									
29	Loss of habitats due to the presence of the permanent infrastructure during the operational phase	High	Low	Medium	Local	Permanent	Continuous	Negligible	Negligible (insignificant)
30	Thermal discharges and discharges containing chemical pollutants during the operational phase	High	Medium	Medium	Regional	Permanent	Continuous	Low	Minor (insignificant)
31	Entrapment, damage and suction due to the intake of cooling water at the operational phase	High	Medium	Medium	Regional	Permanent	Continuous	Low	Minor (insignificant)

No.	Source	Receptor significance	Receptor sensitivity	Receptor value	Impact extent	Impact time	Impact frequency	Impact magnitude	Impact significance
32	Underwater noise caused by construction works related to the operational phase	High	Low	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
Avifauna									
Construction phase of the Project – development stage									
33	Impact on prey availability – the seabird species protected within the SPA / Ramsar sites (the wintering common gull, common scoter, herring gull, long-tailed duck, razorbill and the velvet scoter)	High	Medium	Medium	Regional	Short-term	Continuous	Negligible	Negligible (insignificant)
34	Impact on prey availability – the seabird species protected within the SPA / Ramsar areas (the common gull and the great cormorant during the breeding season and the wintering great cormorant)	High	Low	Low	Regional	Short-term	Continuous	Negligible	Negligible (insignificant)
35	Impact on prey availability – all other protected seabird species (the wintering goldeneye and the great crested grebe, the common gull during the breeding season)	High	Negligible	Negligible	Regional	Short-term	Continuous	Negligible	Negligible (insignificant)
36	Disturbances resulting from construction works related to the MOLF and the sewage treatment works in the construction phase – the seabird species protected within the SPA / Ramsar sites (the wintering common scoter, long-tailed duck, razorbill and the velvet scoter)	High	Medium	Medium	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)
37	Disturbances resulting from the construction works related to the MOLF and the sewage treatment works during the construction stage – the protected seabird species within the SPA / Ramsar sites (the wintering common gull, herring gull and great cormorant; the herring gull and the great cormorant during the breeding season)	High	Low	Low	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)
38	Disturbances resulting from the construction works related to the MOLF and the sewage treatment works at the construction stage – all other seabird species	High	Low	Negligible	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)
39	Disturbances caused by increased ship traffic – seabird species protected under the SPA (the wintering velvet scoter)	High	High	High	Regional	Short-term	Frequent	Medium	Minor (insignificant)
40	Disturbances caused by increased ship traffic – seabird species protected under the SPA	High	Medium	Medium	Regional	Short-term	Frequent	Medium	Minor (insignificant)

No.	Source	Receptor significance	Receptor sensitivity	Receptor value	Impact extent	Impact time	Impact frequency	Impact magnitude	Impact significance
	(the wintering common scoter and the razorbill)								
41	Disturbances caused by increased ship traffic – the seabird species protected within the SPA (the great cormorant while wintering and during the breeding season)	High	Low	Low	Regional	Short-term	Frequent	Medium	Minor (insignificant)
42	Disturbances caused by increased ship traffic – the seabird species protected within the SPA (the wintering goldeneye and the great crested grebe)	High	Low	Negligible	Regional	Short-term	Frequent	Medium	Negligible (insignificant)
	Construction phase of the Project – construction stage								
43	Impact on prey availability – the seabird species protected within the SPA (the wintering common gull, common scoter, herring gull, long-tailed duck, razorbill and the velvet scoter)	High	Medium	Medium	Regional	Short-term	Continuous	Negligible	Negligible (insignificant)
44	Impact on prey availability – the seabird species protected within the SPA (the common gull and the great cormorant during the breeding season and the wintering great cormorant)	High	Low	Low	Regional	Short-term	Continuous	Negligible	Negligible (insignificant)
45	Impact on prey availability – other protected seabird species (the wintering goldeneye and the great crested grebe, the common gull during the breeding season)	High	Negligible	Negligible	Regional	Short-term	Continuous	Negligible	Negligible (insignificant)
46	Disturbances resulting from the construction works related to the location of the cooling water intake and discharge structure – the seabird species protected within the SPA/Ramsar sites (the wintering common scoter, long-tailed duck, razorbill and the velvet scoter)	High	Medium	Medium	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)
47	Disturbances resulting from the construction works related to the MOLF and the sewage treatment works during the construction stage – the protected seabird species within the SPA / Ramsar sites (the wintering common gull, herring gull and great cormorant; the herring gull and the great cormorant during the breeding season)	High	Low	Low	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)
48	Disturbances resulting from construction works related to the MOLF and the sewage treatment works in the construction phase –	High	Low	Negligible	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)

No.	Source	Receptor significance	Receptor sensitivity	Receptor value	Impact extent	Impact time	Impact frequency	Impact magnitude	Impact significance
	the seabird species protected within the SPA / Ramsar sites (the wintering common scoter, long-tailed duck, razorbill and the velvet scoter)								
49	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the wintering velvet scoter)	High	High	High	Regional	Short-term	Frequent	Medium	Minor (insignificant)
50	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the wintering common scoter and the razorbill)	High	Medium	Medium	Regional	Short-term	Frequent	Medium	Minor (insignificant)
51	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the great cormorant while wintering and during the breeding season)	High	Low	Low	Regional	Short-term	Frequent	Medium	Minor (insignificant)
52	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the wintering goldeneye and the great crested grebe)	High	Low	Negligible	Regional	Short-term	Frequent	Medium	Negligible (insignificant)
	Operational phase of the Project								
53	Impact on prey availability – the seabird species protected within the SPA (the wintering common gull, common scoter, herring gull, long-tailed duck, razorbill and the velvet scoter)	High	Medium	Medium	Regional	Long-term	Continuous	Negligible	Negligible (insignificant)
54	Impact on prey availability – the seabird species protected within the SPA (the common gull and the great cormorant during the breeding season and the wintering great cormorant)	High	Low	Low	Regional	Long-term	Continuous	Negligible	Negligible (insignificant)
55	Impact on prey availability – the seabird species protected within the SPA (the wintering goldeneye and the great crested grebe, the common gull during the breeding season)	High	Negligible	Negligible	Regional	Long-term	Continuous	Negligible	Negligible (insignificant)
56	Direct disturbances caused by the MOLF – the seabird species protected within the SPA / Ramsar sites (the wintering common scoter, long-tailed duck, razorbill and the velvet scoter)	High	Medium	Medium	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
57	Direct disturbances caused by the MOLF – the protected seabird species within the SPA / Ramsar sites (the wintering common gull,	High	Low	Low	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)

No.	Source	Receptor significance	Receptor sensitivity	Receptor value	Impact extent	Impact time	Impact frequency	Impact magnitude	Impact significance
	herring gull and great cormorant; the herring gull and the great cormorant during the breeding season)								
58	Direct disturbances caused by the MOLF – the protected seabird species (the wintering goldeneye and the great crested grebe, the common gull during the breeding season)	High	Low	Negligible	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
59	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the wintering velvet scoter)	High	High	High	Regional	Short-term	Infrequent	Negligible	Minor (insignificant)
60	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the wintering common scoter and the razorbill)	High	Medium	Medium	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
61	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the great cormorant while wintering and during the breeding season)	High	Low	Low	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
62	Disturbances resulting from increased ship traffic – the protected seabird species (the wintering goldeneye and the great crested grebe)	High	Low	Negligible	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
Marine mammals									
Construction phase of the Project – development stage									
63	Impacts of underwater noise caused by the construction works – the harbour porpoise	High	Medium	High	Regional	Temporary	Frequent	Low	Medium (insignificant)
64	Impacts of underwater noise caused by the construction works – the common seal	High	Medium	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
65	Impacts of underwater noise caused by the construction works – the grey seal	High	Low	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
66	Effects of underwater noise caused by the construction works – the ringed seal	High	Medium	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
67	Indirect effects on marine mammal species resulting from impacts of the construction works on prey availability – the harbour porpoise	High	Negligible	High	Local	Temporary	Frequent	Low	Medium (insignificant)
68	Indirect effects on marine mammal species resulting from impacts of the construction works on prey availability – the common seal	High	Negligible	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
69	Indirect effects on marine mammal species resulting from impacts of the construction works on prey availability – the grey seal	High	Negligible	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)

No.	Source	Receptor significance	Receptor sensitivity	Receptor value	Impact extent	Impact time	Impact frequency	Impact magnitude	Impact significance
70	Indirect effects on marine mammal species resulting from impacts of the construction works on prey availability – the ringed seal	High	Negligible	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
71	Effects related to disturbances resulting from increased activity of vessels during the construction works – the harbour porpoise	High	Negligible	High	Regional	Temporary	Frequent	Low	Medium (insignificant)
72	Effects related to disturbances resulting from increased activity of vessels during the construction works – the common seal	High	Negligible	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
73	Effects related to disturbances resulting from increased activity of vessels during the construction works – the grey seal	High	Negligible	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
74	Effects related to disturbances resulting from increased activity of vessels during the construction works – the ringed seal	High	Negligible	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
75	Effects related to the risk of collision as a result of increased activity of vessels during the construction works – the harbour porpoise	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Medium (insignificant)
76	Effects related to the risk of collision as a result of increased activity of vessels during the construction works – the common seal	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Minor (insignificant)
77	Effects related to the risk of collision as a result of increased activity of vessels during the construction works – the grey seal	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Minor (insignificant)
78	Effects related to the risk of collision as a result of increased activity of vessels during the construction works – the ringed seal	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Minor (insignificant)
Construction phase of the Project – construction stage									
79	Impacts of underwater noise caused by the construction works – the harbour porpoise	High	Medium	High	Regional	Temporary	Frequent	Low	Medium (insignificant)
80	Impacts of underwater noise caused by the construction works – the common seal	High	Medium	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
81	Impacts of underwater noise caused by the construction works – the grey seal	High	Low	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
82	Effects of underwater noise caused by the construction works – the ringed seal	High	Medium	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
83	Indirect effects on marine mammal species resulting from impacts of the construction works on prey availability – the harbour porpoise	High	Negligible	High	Local	Temporary	Frequent	Low	Medium (insignificant)

No.	Source	Receptor significance	Receptor sensitivity	Receptor value	Impact extent	Impact time	Impact frequency	Impact magnitude	Impact significance
84	Indirect effects on marine mammal species resulting from impacts of the construction works on prey availability – the common seal	High	Negligible	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
85	Indirect effects on marine mammal species resulting from impacts of the construction works on prey availability – the grey seal	High	Negligible	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
86	Indirect effects on marine mammal species resulting from impacts of the construction works on prey availability – the ringed seal	High	Negligible	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
87	Effects related to disturbances resulting from increased activity of vessels during the construction works – the harbour porpoise	High	Negligible	High	Regional	Temporary	Frequent	Low	Medium (insignificant)
88	Effects related to disturbances resulting from increased activity of vessels during the construction works – the common seal	High	Negligible	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
89	Effects related to disturbances resulting from increased activity of vessels during the construction works – the grey seal	High	Negligible	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
90	Effects related to disturbances resulting from increased activity of vessels during the construction works – the ringed seal	High	Negligible	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
91	Effects related to the risk of collision as a result of increased activity of vessels during the construction works – the harbour porpoise	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Medium (insignificant)
92	Effects related to the risk of collision as a result of increased activity of vessels during the construction works – the common seal	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Minor (insignificant)
93	Effects related to the risk of collision as a result of increased activity of vessels during the construction works – the grey seal	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Minor (insignificant)
94	Effects related to the risk of collision as a result of increased activity of vessels during the construction works – the ringed seal	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Minor (insignificant)
Operational phase of the Project									
95	Effects related to disturbances resulting from increased activity of vessels during the operational phase – the harbour porpoise	High	Negligible	High	Regional	Temporary	Frequent	Low	Medium (insignificant)
96	Effects related to disturbances resulting from increased activity of vessels during the operational phase – the common seal	High	Negligible	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)

No.	Source	Receptor significance	Receptor sensitivity	Receptor value	Impact extent	Impact time	Impact frequency	Impact magnitude	Impact significance
97	Effects related to disturbances resulting from increased activity of vessels during the operational phase – the grey seal	High	Negligible	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
98	Effects related to disturbances resulting from increased activity of vessels during the operational phase – the ringed seal	High	Negligible	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
99	Effects related to the risk of collision as a result of increased activity of vessels during the operational phase – the harbour porpoise	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Medium (insignificant)
100	Effects related to the risk of collision as a result of increased activity of vessels during the operational phase – the common seal	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Minor (insignificant)
101	Effects related to the risk of collision as a result of increased activity of vessels during the operational phase – the grey seal	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Minor (insignificant)
102	Effects related to the risk of collision as a result of increased activity of vessels during the operational phase – the ringed seal	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Minor (insignificant)

Source: [456]

Table IV.2 -252: The summary of impacts for selected groups (ichthyofauna, avifauna, marine mammals): Sub-Variant 1B

No.	Source	Receptor significance	Receptor sensitivity	Receptor value	Impact extent	Impact time	Impact frequency	Impact magnitude	Impact significance
Ichthyofauna									
Construction phase of the Project – development stage									
18	Loss of habitats and physical disruption due to the construction works	High	Low	Medium	Local	Long-term	Continuous	Negligible	Negligible (insignificant)
19	Underwater noise caused by the construction works related to the development stage	High	Low	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
20	Increased amount of suspended sediments and smothering as a result of resettlement of suspended sediments	High	Low	Medium	Local	Short-term	Infrequent	Negligible	Minor (insignificant)
21	Effects of artificial lighting	High	Low	Medium	Local	Short-term	Infrequent	Negligible	Negligible (insignificant)
22	Spills caused by operations at sea	High	Low	Medium	Regional	Short-term	Infrequent	Negligible	Minor (insignificant)
Construction phase of the Project – construction stage									

No.	Source	Receptor significance	Receptor sensitivity	Receptor value	Impact extent	Impact time	Impact frequency	Impact magnitude	Impact significance
23	Loss of habitats and physical disturbances caused by the works at the construction stage	High	Low	Medium	Local	Long-term	Continuous	Negligible	Negligible (insignificant)
24	Suction during suction dredging at the construction stage	High	Low	Medium	Local	Short-term	Infrequent	Low	Minor (insignificant)
25	Underwater noise caused by the works related to the construction stage	High	Low	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
26	Increased amount of suspended sediment and smothering due to the resettlement of suspended sediment at the construction stage	High	Low	Medium	Local	Short-term	Infrequent	Negligible	Minor (insignificant)
27	Effects of artificial lighting at the construction stage	High	Low	Medium	Local	Short-term	Infrequent	Negligible	Negligible (insignificant)
28	Spills caused by activities carried out at sea during the construction stage	High	Low	Medium	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
Operational phase of the Project									
29	Loss of habitats due to the presence of the permanent infrastructure during the operational phase	High	Low	Medium	Local	Permanent	Continuous	Negligible	Negligible (insignificant)
30	Thermal discharges and discharges containing chemical pollutants in the operational phase	High	Medium	Medium	Regional	Permanent	Continuous	Low	Minor (insignificant)
31	Entrapment, entrainment and impingement due to the intake of cooling water at the operational phase	High	Medium	Medium	Regional	Permanent	Continuous	Low	Minor (insignificant)
32	Underwater noise caused by construction works related to the operational phase	High	Low	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
Avifauna									
Construction phase of the Project – development stage									
33	Impact on prey availability – all the protected seabird species	High	Medium - negligible	Medium - negligible	Regional	Short-term	Continuous	Negligible	Negligible (insignificant)
34	Disturbances due to the construction works – all the protected seabird species	High	Medium - negligible	Medium - negligible	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)
35	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the wintering velvet scoter)	High	High	High	Regional	Short-term	Frequent	Medium	Minor (insignificant)
35	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the	High	Medium	Medium	Regional	Short-term	Frequent	Medium	Minor (insignificant)

No.	Source	Receptor significance	Receptor sensitivity	Receptor value	Impact extent	Impact time	Impact frequency	Impact magnitude	Impact significance
	wintering common scoter and the razorbill)								
36	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the great cormorant while wintering and during the breeding season)	High	Low	Low	Regional	Short-term	Frequent	Medium	Minor (insignificant)
37	Disturbances resulting from increased vessels traffic (the wintering goldeneye and the great crested grebe)	High	Low	Negligible	Regional	Short-term	Frequent	Medium	Negligible (insignificant)
Construction phase of the Project – construction stage									
38	Impact on prey availability – all the protected seabird species	High	Medium - negligible	Medium - negligible	Regional	Short-term	Continuous	Negligible	Negligible (insignificant)
39	Disturbances due to the construction works – all the protected seabird species	High	Medium - negligible	Medium - negligible	Regional	Long-term	Continuous	Negligible	Negligible (insignificant)
40	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the wintering velvet scoter)	High	High	High	Regional	Short-term	Frequent	Negligible	Minor (insignificant)
41	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the wintering common scoter and the razorbill)	High	Medium	Medium	Regional	Short-term	Frequent	Medium	Minor (insignificant)
42	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the great cormorant while wintering and during the breeding season)	High	Low	Low	Regional	Short-term	Frequent	Medium	Minor (insignificant)
43	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the wintering goldeneye and the great crested grebe)	High	Low	Negligible	Regional	Short-term	Frequent	Medium	Negligible (insignificant)
Operational phase of the Project									
44	Impact on prey availability – all the protected seabird species	High	Medium - negligible	Medium - negligible	Regional	Long-term	Continuous	Negligible	Negligible (insignificant)
45	Direct disturbances caused by the MOLF – the seabird species protected within the SPA / Ramsar sites (the wintering common scoter, long-tailed duck, razorbill and the velvet scoter)	High	Medium - negligible	Medium - negligible	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)

No.	Source	Receptor significance	Receptor sensitivity	Receptor value	Impact extent	Impact time	Impact frequency	Impact magnitude	Impact significance
46	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the wintering velvet scoter)	High	High	High	Regional	Short-term	Infrequent	Negligible	Minor (insignificant)
47	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the wintering common scoter and the razorbill)	High	Medium	Medium	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
48	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the great cormorant while wintering and during the breeding season)	High	Low	Low	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
49	Disturbances resulting from increased ship traffic – the protected seabird species (the wintering goldeneye and the great crested grebe)	High	Low	Negligible	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
Marine mammals									
Construction phase of the Project – development stage									
50	Impacts of underwater noise caused by the construction works – the harbour porpoise	High	Medium	High	Regional	Temporary	Frequent	Low	Medium (insignificant)
51	Impacts of underwater noise caused by the construction works – the common seal, grey seal, ringed seal	High	Medium	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
52	Indirect effects on marine mammal species resulting from impacts of the construction works on prey availability – the harbour porpoise	High	Negligible	High	Local	Temporary	Frequent	Low	Medium (insignificant)
53	Indirect effects on marine mammal species resulting from impacts of the construction works on prey availability – the common seal, grey seal and ringed seal	High	Negligible	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
54	Effects related to disturbances resulting from increased activity of vessels during the construction works – the harbour porpoise	High	Negligible	High	Regional	Temporary	Frequent	Low	Medium (insignificant)
55	Effects related to disturbances resulting from increased activity of vessels during the construction works – the common seal, grey seal, ringed seal	High	Negligible	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)

No.	Source	Receptor significance	Receptor sensitivity	Receptor value	Impact extent	Impact time	Impact frequency	Impact magnitude	Impact significance
56	Effects related to the risk of collision as a result of increased activity of vessels during the construction works – the harbour porpoise	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Medium (insignificant)
57	Effects related to the risk of collision as a result of increased activity of vessels during the construction works – the common seal, grey seal, ringed seal	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Minor (insignificant)
	Construction phase of the Project – construction stage								
58	Impacts of underwater noise caused by the construction works – the harbour porpoise	High	Medium	High	Regional	Temporary	Frequent	Low	Medium (insignificant)
59	Impacts of underwater noise caused by the construction works – the common seal, grey seal, ringed seal	High	Medium	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
60	Indirect effects on marine mammal species resulting from impacts of the construction works on prey availability – the harbour porpoise	High	Negligible	High	Local	Temporary	Frequent	Low	Medium (insignificant)
61	Indirect effects on marine mammal species resulting from impacts of the construction works on prey availability – the common seal, grey seal and ringed seal	High	Negligible	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
62	Effects related to disturbances resulting from increased activity of vessels during the construction works – the harbour porpoise	High	Negligible	High	Regional	Temporary	Frequent	Low	Medium (insignificant)
63	Effects related to disturbances resulting from increased activity of vessels during the construction works – the common seal, grey seal, ringed seal	High	Negligible	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
64	Effects related to the risk of collision as a result of increased activity of vessels during the construction works – the harbour porpoise	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Medium (insignificant)
65	Effects related to the risk of collision as a result of increased activity of vessels during the construction works – the common seal, grey seal, ringed seal	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Minor (insignificant)
	Operational phase of the Project								
66	Impacts of underwater noise caused by the MOLF – the harbour porpoise	High	Medium	High	Regional	Temporary	Frequent	Low	Medium (insignificant)

No.	Source	Receptor significance	Receptor sensitivity	Receptor value	Impact extent	Impact time	Impact frequency	Impact magnitude	Impact significance
67	Effects of underwater noise caused by the MOLF – the common seal, grey seal, ringed seal	High	Medium	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
68	Effects on marine mammal species resulting from impacts caused by the construction works on prey availability – the harbour porpoise	High	Negligible	High	Local	Temporary	Frequent	Low	Medium (insignificant)
69	Effects on marine mammal species resulting from impacts caused by the construction works on prey availability – the common seal, grey seal, ringed seal	High	Negligible	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
70	Effects related to disturbances resulting from increased activity of vessels – the harbour porpoise	High	Negligible	High	Regional	Temporary	Frequent	Low	Medium (insignificant)
71	Effects related to disturbances resulting from increased activity of vessels – the common seal, grey seal, ringed seal	High	Negligible	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
72	Effects related to the risk of collision as a result of increased activity of vessels – the harbour porpoise	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Medium (insignificant)
73	Effects related to the risk of collision as a result of increased activity of vessels – the common seal, grey seal, ringed seal	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Minor (insignificant)

Source: [456]

Table IV.2 -253: The summary of impacts for selected groups (avifauna, ichthyofauna, marine mammals): Variant 1C

No.	Source	Receptor significance	Receptor sensitivity	Receptor value	Impact extent	Impact time	Impact frequency	Impact magnitude	Impact significance
Ichthyofauna									
Construction phase of the Project – development stage									
18	Loss of habitats and physical disruption due to the construction works	High	Low	Medium	Local	Long-term	Continuous	Negligible	Negligible (insignificant)
19	Underwater noise caused by the construction works related to the development stage	High	Low	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)

No.	Source	Receptor significance	Receptor sensitivity	Receptor value	Impact extent	Impact time	Impact frequency	Impact magnitude	Impact significance
20	Increased amount of suspended sediments and smothering as a result of resettlement of suspended sediments	High	Low	Medium	Local	Short-term	Infrequent	Negligible	Minor (insignificant)
21	Changes in the perception of visual stimuli caused by artificial lighting	High	Low	Medium	Local	Short-term	Infrequent	Negligible	Negligible (insignificant)
22	Spills caused by operations at sea	High	Low	Medium	Regional	Short-term	Infrequent	Negligible	Minor (insignificant)
Construction phase of the Project – construction stage									
23	Loss of habitats and physical disturbances caused by the works at the construction stage	High	Low	Medium	Local	Long-term	Continuous	Negligible	Negligible (insignificant)
24	Suction during suction dredging at the construction stage	High	Low	Medium	Local	Short-term	Infrequent	Low	Minor (insignificant)
25	Underwater noise caused by the works related to the construction stage	High	Low	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
26	Increased amount of suspended sediment and smothering due to the resettlement of suspended sediment at the construction stage	High	Low	Medium	Local	Short-term	Infrequent	Negligible	Minor (insignificant)
27	Changes in the perception of visual stimuli caused by artificial lighting at the construction stage	High	Low	Medium	Local	Short-term	Infrequent	Negligible	Negligible (insignificant)
28	Spills caused by activities carried out at sea during the construction stage	High	Low	Medium	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
Operational phase of the Project									
29	Loss of habitats due to the presence of the permanent infrastructure during the operational phase	High	Low	Medium	Local	Permanent	Continuous	Negligible	Negligible (insignificant)
30	Thermal discharges and discharges containing chemical pollutants during the operational phase	High	Medium	Medium	Regional	Permanent	Continuous	Low	Minor (insignificant)
31	Entrapment, entrainment and impingement due to the intake of cooling water at the operational phase	High	Medium	Medium	Regional	Permanent	Continuous	Low	Minor (insignificant)
32	Underwater noise caused by construction works related to the operational phase	High	Low	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
Avifauna									
Construction phase of the Project – development stage									
33	Impact on prey availability – all the protected seabird species	High	Medium - negligible	Medium - negligible	Regional	Short-term	Continuous	Negligible	Negligible (insignificant)

No.	Source	Receptor significance	Receptor sensitivity	Receptor value	Impact extent	Impact time	Impact frequency	Impact magnitude	Impact significance
34	Disturbances due to the construction works – all the protected seabird species	High	Medium - negligible	Medium - negligible	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)
35	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the wintering velvet scoter)	High	High	High	Regional	Short-term	Frequent	Medium	Minor (insignificant)
36	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the wintering common scoter and the razorbill)	High	Medium	Medium	Regional	Short-term	Frequent	Medium	Minor (insignificant)
37	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the great cormorant while wintering and during the breeding season)	High	Low	Low	Regional	Short-term	Frequent	Medium	Minor (insignificant)
38	Disturbances resulting from increased vessels traffic (the wintering goldeneye and the great crested grebe)	High	Low	Negligible	Regional	Short-term	Frequent	Medium	Negligible (insignificant)
	Construction phase of the Project – construction stage								
39	Impact on prey availability – all the protected seabird species	High	Medium - negligible	Medium - negligible	Regional	Short-term	Continuous	Negligible	Negligible (insignificant)
40	Disturbances due to the construction works – all the protected seabird species	High	Medium	Medium	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)
41	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the wintering velvet scoter)	High	High	High	Regional	Short-term	Frequent	Medium	Minor (insignificant)
42	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the wintering common scoter and the razorbill)	High	Medium	Medium	Regional	Short-term	Frequent	Medium	Minor (insignificant)
43	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the great cormorant while wintering and during the breeding season)	High	Low	Low	Regional	Short-term	Frequent	Medium	Minor (insignificant)
44	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the wintering goldeneye and the great crested grebe)	High	Low	Negligible	Regional	Short-term	Frequent	Medium	Negligible (insignificant)

No.	Source	Receptor significance	Receptor sensitivity	Receptor value	Impact extent	Impact time	Impact frequency	Impact magnitude	Impact significance
				Operational phase of the Project					
45	Impact on prey availability – all the protected seabird species	High	Medium - negligible	Medium - negligible	Regional	Long-term	Continuous	Negligible	Negligible (insignificant)
46	Direct disturbances caused by the MOLF – all seabird species	High	Medium - negligible	Medium - negligible	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
47	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the wintering velvet scoter)	High	High	High	Regional	Short-term	Infrequent	Negligible	Minor (insignificant)
48	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the wintering common scoter and the razorbill)	High	Medium	Medium	Regional	Short-term	Infrequent	Medium	Negligible (insignificant)
49	Disturbances resulting from increased ship traffic – the seabird species protected within the SPA (the great cormorant while wintering and during the breeding season)	High	Low	Low	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
50	Disturbances resulting from increased ship traffic – the protected seabird species (the wintering goldeneye and the great crested grebe)	High	Low	Negligible	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
				Marine mammals					
				Construction phase of the Project – development stage					
51	Impacts of underwater noise caused by the construction works – the harbour porpoise	High	Medium	High	Regional	Temporary	Frequent	Low	Medium (insignificant)
52	Impacts of underwater noise caused by the construction works – the common seal, grey seal, ringed seal	High	Medium	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
53	Indirect effects on marine mammal species resulting from impacts of the construction works on prey availability – the harbour porpoise	High	Negligible	High	Local	Temporary	Frequent	Low	Medium (insignificant)
54	Indirect effects on marine mammal species resulting from impacts of the construction works on prey availability – the common seal, grey seal and ringed seal	High	Negligible	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
55	Effects related to disturbances resulting from increased activity of vessels	High	Negligible	High	Regional	Temporary	Frequent	Low	Medium (insignificant)

No.	Source	Receptor significance	Receptor sensitivity	Receptor value	Impact extent	Impact time	Impact frequency	Impact magnitude	Impact significance
	during the construction works – the harbour porpoise								
56	Effects related to disturbances resulting from increased activity of vessels during the construction works – the common seal, grey seal, ringed seal	High	Negligible	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
57	Effects related to the risk of collision as a result of increased activity of vessels during the construction works – the harbour porpoise	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Medium (insignificant)
58	Effects related to the risk of collision as a result of increased activity of vessels during the construction works – the common seal, grey seal, ringed seal	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Minor (insignificant)
Construction phase of the Project – construction stage									
59	Impacts of underwater noise caused by the construction works – the harbour porpoise	High	Medium	High	Regional	Temporary	Frequent	Low	Medium (insignificant)
60	Impacts of underwater noise caused by the construction works – the common seal, grey seal, ringed seal	High	Medium	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
61	Indirect effects on marine mammal species resulting from impacts of the construction works on prey availability – the harbour porpoise	High	Negligible	High	Local	Temporary	Frequent	Low	Medium (insignificant)
62	Indirect effects on marine mammal species resulting from impacts of the construction works on prey availability – the common seal, grey seal and ringed seal	High	Negligible	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
63	Effects related to disturbances resulting from increased activity of vessels during the construction works – the harbour porpoise	High	Negligible	High	Regional	Temporary	Frequent	Low	Medium (insignificant)
64	Effects related to disturbances resulting from increased activity of vessels during the construction works – the common seal, grey seal, ringed seal	High	Negligible	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
65	Effects related to the risk of collision as a result of increased activity of vessels during the construction works – the harbour porpoise	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Medium (insignificant)

No.	Source	Receptor significance	Receptor sensitivity	Receptor value	Impact extent	Impact time	Impact frequency	Impact magnitude	Impact significance
66	Effects related to the risk of collision as a result of increased activity of vessels during the construction works – the common seal, grey seal, ringed seal	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Minor (insignificant)
Operational phase of the Project									
67	Impacts of underwater noise caused by the MOLF – the harbour porpoise	High	Medium	High	Regional	Temporary	Frequent	Low	Medium (insignificant)
68	Effects of underwater noise caused by the MOLF – the common seal, grey seal, ringed seal	High	Medium	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
69	Effects on marine mammal species resulting from impacts caused by the construction works on prey availability – the harbour porpoise	High	Negligible	High	Local	Temporary	Frequent	Low	Medium (insignificant)
70	Effects on marine mammal species resulting from impacts caused by the construction works on prey availability – the common seal, grey seal, ringed seal	High	Negligible	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
71	Effects related to disturbances resulting from increased activity of vessels – the harbour porpoise	High	Negligible	High	Regional	Temporary	Frequent	Low	Medium (insignificant)
72	Effects related to disturbances resulting from increased activity of vessels – the common seal, grey seal, ringed seal	High	Negligible	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
73	Effects related to the risk of collision as a result of increased activity of vessels – the harbour porpoise	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Medium (insignificant)
74	Effects related to the risk of collision as a result of increased activity of vessels – the common seal, grey seal, ringed seal	High	Negligible	Medium	Regional	Long-term	Frequent	Low	Minor (insignificant)

Source: [456]

IV.2.11 Impact assessment – Sub-Variant 2A - Żarnowiec: closed cooling system

IV.2.11.1 General information

IV.2.11.1.1 Scope of the assessment

This chapter provides an assessment of the potential impact resulting from the implementation of Sub-Variant 2A, including associated investments, on marine ecology receptors, taking into account the worst-case scenario for each component.

For the construction phase, the assessment took into account the cooling system based on submerged pipelines, which is the worst-case scenario in terms of seabed disturbances and associated marine environment disturbances. For comparison, the effects associated with the TBM method would be minimal and would be limited to local and temporary seabed disturbances associated with the construction of the inlet and outlet head structures.

With regard to the operational phase, the worst-case scenario assessment takes into account the operation of the Nuclear Power Plant's three AP1000 reactors at full power.

IV.2.11.4 Ichthyofauna

IV.2.11.4.1 Development stage

The works carried out in the marine environment at the development stage in Sub-Variant 2A will be the same as in Sub-Variant 1B, which includes the construction of the MOLF and the discharge from the sewage treatment works (STW). All the potential impacts on the marine environment resulting from these works have been assessed in the subsection concerning Sub-Variant 1B. These potential impacts include:

- Loss of habitats and physical impacts as a result of the construction works;
- Increased underwater noise caused by the construction works;
- Increased amount of suspended sediments and backfilling as a result of the re-deposition of suspended sediments;
- Artificial lighting;
- Effects of spills as a result of sea operations.

To avoid repetition, these assessments are not re-quoted here. The complete assessments of significant impacts for the development stage of Sub-Variant 2A can be found in the section concerning Sub-Variant 1B.

IV.2.11.4.2 Construction stage

Works in the marine environment at the construction stage in Sub-Variant 2A will include the construction of the water cooling infrastructure using the sunken pipe in open trench technology (the worst-case scenario). The construction works that will be carried out in the marine environment at this stage will be the same as in Sub-Variant 1A but on a smaller scale. All the potential impacts on the marine environment resulting from these works have been assessed in the subsection concerning Sub-Variant 1A. These potential impacts include:

- Loss of habitats and physical impacts as a result of the construction works;
- Pull-in during dredging with suction heads
- Increased underwater noise caused by the construction works;
- Increased amount of suspended sediments and backfilling as a result of the re-deposition of suspended sediments;

- Artificial lighting;
- Effects of spills as a result of sea operations.

In view of the similarity and smaller scale of the infrastructure required for Sub-Variant 2A, the fact that Sub-Variant 2A will affect the same benthic receptors as Sub-Variant 1A, and the fact that the worst-case scenario impact assessments at the construction stage of Sub-Variant 1A ended with the conclusion „negligible (insignificant)", it has been concluded that it is not necessary to repeat the impact in this subsection. See the subsection concerning Sub-Variant 1A for the full assessments of the relevant impacts on ichthyofauna receptors at the construction stage.

IV.2.11.4.3 Operational phase

IV.2.11.4.3.1 Physical impacts due to the presence of the permanent marine infrastructure

No additional marine infrastructure will be introduced into the environment during the operational phase and the loss of habitats and impacts will be limited to those related to the permanent infrastructure built during the previous two stages of the Project. A total direct loss of habitats of 274 m^2 will affect the coastal area with sandy seabed. It is expected that all the impacts will be identical as in Sub-Variant 1A. Therefore, no further detailed assessment has been repeated here.

IV.2.11.4.3.2 Effects of operational discharge

The assessment of the effects of discharges on Sub-Variant 2A during the operational phase of the Nuclear Power Plant assumes operation of the three AP1000 reactors at full power. Three components of the discharge have been considered: thermal load, salinity and chemical pollutants.

The potential impacts of the chemical ingredients contained in the discharge on ichthyofauna has been discussed in an earlier subsection, where a minor (insignificant) effect was found. Given the similarity of the receptor mix and the smaller magnitude of impacts, the assessment of the chemical ingredients of sewage on ichthyofauna has not been repeated in this subsection.

IV.2.11.4.3.3 Effects from entrapment, entrainment and impingement

The effects of fish entrapment, antrainment and impingement in waters off the shoreline of the Żarnowiec site will be the same as in Sub-Variant 1A and have been fully described in the subsection relating thereto, with the exception of the radius of the suction zone and the escape speed of the cooling water inlet, which will be significantly smaller. Any potential impacts on receptors would be reduced accordingly.

To avoid repetition, the impact assessment has been omitted here. The full assessment of the impacts relevant to the construction phase of Sub-Variant 2A can be found in the section concerning Sub-Variant 1A.

IV.2.11.4.3.4 Increased underwater noise levels caused by ship traffic

The intervention in the marine environment during the operational phase of Sub-Variant 2A will be the same as in Sub-Variant 1A, which includes underwater operational noise related to seawater intake/discharge, mechanical screens/pumps and vessels operating in the MOLF.

To avoid repetition, the impact assessment of the operational phase has been omitted here. The full impact assessment of the operational phase for Sub-Variant 2A can be found in the subsection concerning Sub-Variant 1A.

IV.2.11.5 Marine avifauna

IV.2.11.5.1 Development stage

IV.2.11.5.1.1 Indirect effects on seabirds related to impacts on prey availability

Changes in prey availability can affect individual specimens' ability to feed, and subsequently, local populations. The construction works in the marine environment are mainly related to the MOLF at the development stage and to the discharge from the STW at the construction stage. The assessment of potential impacts that may affect prey availability at the site development stage has previously been presented as **minor or negligible (insignificant)** in the following subsections:

- Plankton;
- Benthos;
- Fish.

The assessment of indirect effects on seabird characteristics resulting from impacts on prey availability has been carried out using the methodology described in [Chapter IV.2.5]. The following conclusions have been drawn:

- Wintering common gulls, scoters, herring gulls, long-tailed ducks, razorbills and velvet scoters are of **high significance** because they are protected as part of the Przybrzeżne wody Bałtyku SPA, within which the marine survey area was located. They are considered to be of **medium sensitivity** in relation to the indirect impacts on prey availability. The overall value of the receptor is **medium** in terms of international significance of these seabird species;
- Breeding black-headed gulls, cormorants and herring gulls are of **high significance** because they are protected as part of Natura 2000 sites which can be linked to the marine survey area. They are of **low sensitivity** in terms of the indirect impacts on prey availability, as they are mobile species of seabirds and there are many alternative habitats available. The overall receptor value is **low** in terms of international significance of these seabird species.
- All other protected seabird species (black-headed gulls, great crested grebes) are listed in appendix 1 to the Regulation on the protection of animal species [394], [89], are of **high significance** and have negligible sensitivity in terms of the indirect impacts on prey availability. The overall receptor value is **negligible** in terms of the national significance of these seabirds.
- The spatial extent of the impact is **regional**. This is due to the fact that impacts on prey availability may occur outside the Project area but it is unlikely that they will extend to more than 30 km from the Project area;
- The duration of the impacts is **short-term** because the effects of the loss of habitats will only last during the development stage;
- The impacts will be continuous due to the permanent loss of habitats.
- The magnitude of the impacts is negligible because the whole area where prey availability will be affected will be minimal compared to the entire area of alternative habitats available for benthic and fish-eating bird species associated with the nearby demarcated areas of conservation.
- It has been concluded that any effects on protected seabird species resulting from the indirect impacts on prey availability at the development stage will be **negligible (insignificant)**.

IV.2.11.5.1.2 Direct disturbance caused by the construction works

Activities related to the construction of the MOLF and the sewage discharge from the STW at the construction phase have a potential to cause disturbances and/or movement of seabirds, reducing the usability of species and potentially leading to the use of suboptimal feeding or moulting areas, and ultimately causing loss of habitats. They may be affected by increased noise and light from the construction works, as well as by the general presence of people in the marine and coastal zones. As regards the distance from the construction works, behavioural responses vary from species to species, with some reacting at a distance of about 500 m, in the case of sensitive species such as common scoter, while for other species, such as gulls, this distance ranges from 50 to 150 m.

Based on a disturbance distance of 500 m, works carried on at the jack-up barge locations associated with the construction of the MOLF and at the dredging locations related to the construction of the STW may affect an area with a total area of approximately 1.6 km^2. This is equivalent to 0.08% of the area of the Przybrzeżne wody Bałtyku SPA.

It should be noted that the impacts related to disturbances caused by vessel traffic are assessed separately below.

The assessment of the direct impacts on protected seabird species resulting from the disturbance-related impacts has been carried out using the previously described methodology. The following conclusions have been drawn:

- Wintering common scoters, long-tailed ducks, razorbills and velvet scoters are of **high significance** because they are qualifying features of Przybrzeżne wody Bałtyku SPA, within which the marine survey area is located. Their population found throughout the marine survey area is of international significance. They are **moderately sensitive** to disturbances. The overall value of the receptor is considered to be **medium**.
- Wintering common gulls and European herring gulls are of **high significance** because they are qualifying features of Przybrzeżne wody Bałtyku SPA, within which the marine survey area was located. Breeding black-headed gulls, cormorants and European herring gulls are also of **high significance** because they are qualifying features of Natura 2000 sites which can be linked to the marine survey area. Although there are numbers of national significance throughout the marine survey area, they are not sensitive to disturbances. These are wide-range seabird species and the available alternative habitats are extensive and characterised by **low sensitivity**, and the overall value of the receptor is **low;**
- All other protected seabird species (wintering black-headed gulls and great crested grebes) are listed in appendix 1 to the Regulation on the protection of animal species [394] and are of **high significance**. Although they are present in significant numbers on the national scale throughout the marine area surveyed, they are not sensitive to disturbances and their **sensitivity is negligible**. The overall value of the receptor is **negligible;**
- The spatial extent of the impact is **regional**. This is due to the fact that impacts on seabirds can occur outside the Project Area but it is unlikely that they will reach a distance of more than 30 km from the Project site;
- The impacts are of a **short-term** nature as they will only be noticeable during the construction of the MOLF and the STW;
- The impacts are **frequent**, due to the piling works associated with the construction of the MOLF and the STW;
- The magnitude of the impacts is **negligible** as the total area where disturbances affecting protected seabird species will occur will be minimal compared to the total area of available alternative habitats and they would have a short-term nature;
- It has been concluded that any effect on seabirds resulting from the direct impacts of disturbances at the development stage will be **negligible (insignificant)**.

IV.2.11.5.1.3 Disturbances caused by increased vessel traffic

The offshore works at the development stage will focus on the area affected by the MOLF, by the pipeline and by the discharge from the STW, taking account of auxiliary and safety-assurance vessels required to operate jack-up barges during the construction of the MOLF and dredging vessels during the construction of the STW. Disturbances at sea and works related to the activities of vessels can dangerously stimulate seabirds, and the resulting risk-avoidance behaviours can limit the time available for other activities such as feeding, resting or mating. Observable seabird responses include flying off, diving to escape, and increased alertness, which can lead to loss of energy, migration and a net loss of habitats. Disturbances caused by ships can therefore reduce the odds for survival and reproduction and affect the population dynamics.

Responses to disturbances vary from species to species, some species being more sensitive than others. The disturbance vulnerability index for vessel traffic (DVI) [122], which takes into account species skittishness, escape energy costs and population indicators for a number of species in the Baltic Sea, was used to assess the potential impacts on seabirds reported for the assessment and summarised below [Table IV.2-280]. It was assumed that there was no impact pathway for common gull and European herring gull because it is known that these species are attracted by surface vessels.

Table IV.2-280 Birds flush distances and DVI

No.	Species	Mean flush distance: individual (m)	Mean flush distance: flock (m)	DVI
1	Velvet scoter	474	444	68.4
2	Razorbill	395	330	51.3
3	Common scoter	1,600	1,015	43.3
4	Long-tailed duck	389	325	40.4
5	Great cormorant	258	287	24.4
6	Great crested grebes	308	288	21.7

Source: [456]

Seabirds may be able to get used and even adapt to disturbances caused by the movement of ships if they are able to recognise ships as non-threatening objects. There is already fishing activity within the area, albeit at a low level, meaning that birds would be habituated to anthropogenic presence. Any work would also be carried out in accordance with best practices and ships involved in the works would not move irregularly or at high speed in the vicinity of the works. However, ships vary widely in size, shape, speed and noise of their engines, which makes it difficult to recognise them as non-threatening objects. In an environment where there is a risk of predation, both natural and anthropogenic, birds are likely to perceive large moving objects as a potential threat and the potential for getting used to them is very limited among sensitive species.

Black-headed gulls, common gulls and European herring gulls have been excluded from the scope of the related impacts because they are not sensitive to disturbances caused by vessel traffic and are often attracted by marine vessels due to their opportunistic feeding behaviours.

Currently, home ports and the level of vessel traffic related to the construction of the MOLF and the STW are not known. Based on the greatest flush distance shown above (for common scoters), it is assumed that the maximum disturbance range will be 1 km from each ship, so each vessel will have a 2 km wide disturbance zone.

The assessment of the effect of the increased vessel traffic on seabirds has been carried out using the methodology described in [Chapter IV.2.5]. The following conclusions have been drawn:

- Wintering common scoters are of **high significance** because they are qualifying features of Przybrzeżne wody Bałtyku SPA, within which the marine survey area is located. Their number was internationally significant throughout the marine survey area. They are sensitive to disturbances related to vessel traffic and are **highly sensitive**. The overall value of the receptor is considered **high**;
- Wintering common scoters, long-tailed ducks and razorbills are of high significance because they are protected as part of Przybrzeżne wody Bałtyku SPA, within which the marine survey area is located. Their number is internationally significant throughout the area of the marine surveys, they are sensitive to disturbances caused by vessel traffic and are characterised by **medium sensitivity**. The overall receptor value is considered **medium;**
- Breeding great cormorants are of **high significance** because they are qualifying features of Natura 2000 sites which can be linked to the marine survey area. The wintering great crested grebe is listed in appendix

1 to the Regulation on the protection of animal species [394], [89], and is of **high significance**. The populations of these species are numerous both nationally and through the marine survey area. They are less sensitive to disturbances caused by vessel traffic and are characterised by **low sensitivity**. The overall value of the receptor is **negligible;**

- The spatial extent of the impact is **regional**. This is due to the fact that impacts on seabirds can occur outside the Project Area but it is unlikely that they will reach a distance of more than 30 km from the Project site;
- The impacts are of a **short-term** nature as they will only be noticeable during the construction of the MOLF and the STW;
- The impacts are **frequent** because the movement of ships will be regular during the Project execution;
- The magnitude of the impacts is **medium** as it is considered that the vessel traffic will result in a reduction in the distribution of protected seabird species across a wide area.
- It has been concluded that any impact on wintering common scoters resulting from disturbances caused by the marine vessel traffic at the development stage will be **major (significant)**.
- It has been concluded that any effects on wintering common scoters, long-tailed ducks and razorbills resulting from impacts from disturbances caused by the movement of seagoing vessels at the development stage will be **moderate (potentially significant)**.
- It has been concluded that any impact on breeding cormorants and wintering great crested grebes, resulting from disturbances caused by the marine vessel traffic during the development works, would be **negligible (insignificant)**.

IV.2.11.5.2 Construction stage

IV.2.11.5.2.1 Indirect effects on seabirds related to impacts on prey availability

The construction works in the marine environment at the construction stage are mainly related to the construction of the cooling water channels / pipelines and the FRRS. As in the case of the development stage, the assessment of potential impacts that may affect the prey availability at the construction stage has been recognised as **minor or negligible (insignificant)** in the following subchapters:

- Plankton;
- Benthos, and
- Fish.

The assessment of indirect effects on marine bird features resulting from impacts on prey availability has been carried out using the methodology described in chapter [Chapter IV.2.5]. The following conclusions have been drawn:

- Wintering common gulls, scoters, European herring gulls, long-tailed ducks, razorbills and velvet scoters are of **high significance** because they are protected as part of Przybrzeżne wody Bałtyku SPA, within which the marine survey area was located. They are considered to be **moderately sensitive** in terms of the indirect impacts on prey availability. The overall value of the receptor is **medium** in terms of international significance of these seabird species;
- Breeding black-headed gulls, cormorants and European herring gulls are of **high significance** because they are qualifying features of Natura 2000 areas which can be linked to the marine survey area. They are of **low sensitivity** in terms of the indirect impacts on prey availability, as they are mobile species of seabirds and there are many alternative habitats available. The overall value of the receptor is **low** in terms of international significance of these seabird species.

- All other marine bird features (black-headed gulls, great crested grebes) are listed in annex 1 to the Regulation on the protection of animal species [394]. They are of **high significance** and of **negligible sensitivity** in terms of the indirect impacts on prey availability. The overall value of the receptor is **negligible** in terms of the national significance of these seabirds;
- The spatial extent of the impact is **regional**. This is due to the fact that impacts on prey availability may occur outside the Project Area but it is unlikely that they will extend to more than 30 km from the Project Site;
- The duration of the impacts is **short-term**, as the effects of the loss of habitats will only be noticeable at the construction stage;
- The impacts will be continuous due to the permanent loss of habitats;
- The magnitude of the impacts is **negligible** because the whole area where prey availability will be affected will be minimal compared to the entire area of alternative habitats available for benthivorous and piscivorous bird species associated with the nearby designated areas of conservation.
- It has been concluded that any effect on marine bird features resulting from indirect impacts on prey availability at the construction stage will be **negligible (insignificant)**.

IV.2.11.5.2.2 Direct disturbances caused by the construction works

Based on a disturbance distance of 500 m, the common trace of cooling water inlet / outlet and of the FRRS extends for 1.3 km from the shoreline. This is equivalent to 0.06% of Przybrzeżne wody Bałtyku SPA, which is subject to disturbances related to the operation of dredgers.

The assessment of the direct impacts on protected seabird species resulting from the disturbance-related impacts has been carried out using the methodology described in [Chapter IV.2.5]. The following conclusions have been drawn:

- Wintering common scoters, long-tailed ducks, razorbills and velvet scoters are of **high significance** because they are qualifying features of Przybrzeżne wody Bałtyku SPA, within which the marine survey area is located. Their population found throughout the marine survey area is of international significance. They are **moderately sensitive** to disturbances. The overall receptor value is considered **medium;**
- Common gulls and European herring gulls are of **high significance** because they are qualifying features of Przybrzeżne wody Bałtyku SPA, within which the marine survey area was located. Breeding black-headed gulls, great cormorants and European herring gulls are also of **high significance** because they are qualifying features of Natura 2000 sites which can be linked to the marine area. Although there are numbers of national significance throughout the marine survey area, they are not sensitive to disturbances. These are wide-range seabird species and the available alternative habitats are extensive and characterised by **low sensitivity**, and the overall value of the receptor is **low;**
- All other protected seabird species (wintering black-headed gulls and great crested grebes) are listed in appendix 1 to the Regulation on the protection of animal species [394] and are of **high significance**. Although they are present in significant numbers on the national scale throughout the marine area surveyed, they are not sensitive to disturbances and their **sensitivity is negligible**. The overall value of the receptor is **negligible;**
- The spatial extent of the impact is **regional**. This is due to the fact that impacts on seabirds can occur outside the Project Area but it is unlikely that they will reach a distance of more than 30 km from the Project site;
- The duration of the impacts is **short-term** because the effects will only be noticeable during the implementation period;
- The impacts are **infrequent** because the activity will be limited to the construction stage;

- The magnitude of the impacts is **negligible** as the total area where disturbances affecting protected seabird species will occur will be minimal compared to the total area of available alternative habitats and they would have a short-term nature;
- It has been concluded that any effect on all the protected seabird species resulting from direct impacts in the form of disturbances at the construction stage will be **negligible (insignificant)**.

IV.2.11.5.2.3 Disturbances caused by increased vessel traffic

Home ports and the level of vessel traffic related to the construction of the cooling water intake and discharge structures and the FRRS are not known. Based on the greatest flush distance shown above (for common scoters), it is assumed that the maximum disturbance range will be 1 km from each ship, so each vessel will have a 2 km wide disturbance zone.

The assessment of the effect of the increased vessel traffic on seabirds has been carried out using the methodology described in [Chapter IV.2.5]. The following conclusions have been drawn:

- Wintering common scoters are of **high significance** because they are qualifying features of Przybrzeżne wody Bałtyku SPA, within which the marine survey area is located. Their number was internationally significant throughout the marine survey area. They are sensitive to disturbances related to vessel traffic and are **highly sensitive**. The overall value of the receptor is considered **high**;
- Wintering common scoters, long-tailed ducks and razorbills are of high significance because they are protected as part of Przybrzeżne wody Bałtyku SPA, within which the marine survey area is located. Their number is internationally significant throughout the area of the marine surveys, they are sensitive to disturbances caused by vessel traffic and are characterised by **medium sensitivity**. The overall receptor value is considered **medium;**
- Breeding great cormorants are of **high significance** because they are qyalifying features of Natura 2000 sites which can be linked to the marine survey area. The wintering great crested grebe is listed in appendix 1 to the Regulation on the protection of animal species [394], [89], and is of **high significance**. The populations of both species are numerous both nationally and through the marine survey area. They are less sensitive to disturbances caused by vessel traffic and are characterised by **low sensitivity**. The overall value of the receptor is **negligible;**
- The spatial extent of the impact is **regional**. This is due to the fact that impacts on seabirds can occur outside the Project Area but it is unlikely that they will reach a distance of more than 30 km from the Project site;
- The effects are **short-term** because the impacts will only be noticeable at the construction stage;
- The impacts are **frequent** because the vessel traffic will be regular during the Project execution;
- The magnitude of the impacts is **medium** as it is considered that the vessel traffic will result in a reduction in the distribution of protected seabird species across a wide area.
- It has been concluded that any effects on wintering velvet scoters resulting from disturbances caused by the marine vessel traffic at the construction stage will be **major (significant)**.
- It has been concluded that any effects on wintering common scoters, long-tailed ducks and razorbills resulting from impacts from disturbances caused by the movement of seagoing vessels at the construction stage will be **moderate (potentially significant)**;
- It has been found that any effects on breeding great cormorants and wintering great crested grebes resulting from disturbances caused by the marine vessel traffic at the construction stage, will be **negligible (insignificant)**.

IV.2.11.5.3 Operational phase

IV.2.11.5.3.1 Indirect effects on marine bird features from impacts on prey availability

As in the case of the development and construction stages, the assessment of potential impacts that may affect prey availability during the operational phase has been assessed as **minor or negligible (insignificant)** in the following parts:

- Plankton;
- Benthos;
- Fish.

The assessment of indirect effects on marine bird features resulting from impacts on prey availability has been carried out using the methodology described in [Chapter IV.2.5]. The following conclusions have been drawn:

- Wintering common gulls, scoters, European herring gulls, long-tailed ducks, razorbills and velvet scoters are of **high significance** because they are protected as part of Przybrzeżne wody Bałtyku SPA, within which the marine survey area was located. They are considered to be **moderately sensitive** in terms of the indirect impacts on prey availability. The overall value of the receptor is **medium** in terms of international significance of these seabird species;
- Breeding black-headed gulls, cormorants and European herring gulls are of **high significance** because they are qualifying features of Natura 2000 areas which can be linked to the marine survey area. They are of **low sensitivity** in terms of the indirect impacts on prey availability, as they are mobile species of seabirds and there are many alternative habitats available. The overall value of the receptor is **low** in terms of international significance of these seabird species.
- All other marine bird features (black-headed gulls, great crested grebes) are listed in annex 1 to the Regulation on the protection of animal species [394]. They are of **high significance** and of **negligible sensitivity** in terms of the indirect impacts on prey availability. The overall value of the receptor is **negligible** in terms of the national significance of these seabirds;
- The spatial extent of the impact is **regional**. This is due to the fact that impacts on prey availability may occur outside the Project Area but it is unlikely that they will extend to more than 30 km from the Project Site;
- The impacts are **long-term** because the effects of the loss of habitats will last for more than 12 years;
- The impacts will be continuous due to the permanent loss of habitats;
- The magnitude of the impacts is **negligible** because the whole area where prey availability will be affected will be minimal compared to the entire area of alternative habitats available for benthivorous and piscivorous bird species associated with nearby designated conservation areas;
- It has been concluded that any effect on marine bird features resulting from indirect impacts on prey availability during the operational phase will be **negligible (insignificant).**

IV.2.11.5.3.2 Direct disturbance through operation of MOLF

Disturbances for birds should be minimal during the operational phase compared to the construction stage. Noise caused by ships may have potential effects during the performance of service / maintenance works, but they will not be done regularly. In addition, the MOLF will be used sporadically during service / maintenance works, so it will not cause more disturbance than that assessed during the construction stage.

Based on a disturbance distance of 500 m, a total area of 0.6 km^2 will be affected by the operation of the MOLF. This is equivalent to 0.03% of the area of Przybrzeżne wody Bałtyku SPA.

The assessment of the direct impacts on protected seabird species resulting from the disturbance-related impacts has been carried out using the methodology described in [Chapter IV.2.5]. The following conclusions have been drawn:

- Wintering common scoters, long-tailed ducks, razorbills and velvet scoters are of **high significance** because they are qualifying features of Przybrzeżne wody Bałtyku SPA, within which the marine survey area is located. Their population found throughout the marine survey area is of international significance. They are **moderately sensitive** to disturbances. The overall receptor value is considered **medium;**
- Common gulls and European herring gulls are of **high significance** because they are qualifying features of Przybrzeżne wody Bałtyku SPA, within which the marine survey area was located. Breeding black-headed gulls, great cormorants and European herring gulls are also of **high significance** because they are qualifying features of Natura 2000 sites which can be linked to the marine area. Although there are numbers of national significance throughout the marine survey area, they are not sensitive to disturbances. These are wide-range seabird species and the available alternative habitats are extensive and characterised by **low sensitivity**, and the overall value of the receptor is **low;**
- All other protected seabird species (wintering black-headed gulls and great crested grebes) are listed in appendix 1 to the Regulation on the protection of animal species [394] and are of **high significance**. Although they are present in significant numbers on the national scale throughout the marine area surveyed, they are not sensitive to disturbances and their **sensitivity is negligible**. The overall value of the receptor is **negligible;**
- The spatial extent of the impact is **regional**. This is due to the fact that impacts on seabirds can occur outside the Project Area but it is unlikely that they will reach a distance of more than 30 km from the Project site;
- The duration of the impacts is **short-term** because any effects on habituation will last for less than one year after the completion of the Project:
- The impacts are **infrequent** because the vessel traffic will be occassional;
- The magnitude of the impacts is **negligible** as the total area where disturbances affecting protected seabird species will occur will be minimal compared to the total area of available alternative habitats and they would have a short-term nature;
- It has been concluded that any effect on all the marine bird features resulting from direct impacts in the form of disturbances in the operational phase will be **negligible (insignificant)**.

IV.2.11.5.3.3 Disturbances caused by increased vessel traffic

Disturbances to birds during the operational phase should be less severe than in the construction stage. The MOLF will be used sporadically during maintenance works, so vessel traffic will not be regular. Based on the greatest flush distance shown above (for common scoters), it is assumed that the maximum disturbance range will be 1 km from each ship, so each vessel will have a 2 km wide disturbance zone.

The assessment of the effect of the increased vessel traffic on seabirds has been carried out using the methodology described in [Chapter IV.2.5]. The following conclusions have been drawn:

- Wintering common scoters are of **high significance** because they are qualifying features of Przybrzeżne wody Bałtyku SPA, within which the marine survey area is located. Their number was internationally significant throughout the marine survey area. They are sensitive to disturbances related to vessel traffic and are **highly sensitive**. The overall value of the receptor is considered **high**;
- Wintering common scoters, long-tailed ducks and razorbills are of high significance because they are protected as part of Przybrzeżne wody Bałtyku SPA, within which the marine survey area is located. Their number is internationally significant throughout the area of the marine surveys, they are sensitive to

disturbances caused by vessel traffic and are characterised by **medium sensitivity**. The overall receptor value is considered **medium;**

- Breeding great cormorants are of **high significance** because they are qyalifying features of Natura 2000 sites which can be linked to the marine survey area. The wintering great crested grebe is listed in appendix 1 to the Regulation on the protection of animal species [394] and is of **high significance**. The populations of both species are numerous both nationally and through the marine survey area. They are less sensitive to disturbances caused by vessel traffic and are characterised by **low sensitivity**. The overall value of the receptor is **negligible;**
- The spatial extent of the impact is **regional**. This is due to the fact that impacts on seabirds can occur outside the Project Area but it is unlikely that they will reach a distance of more than 30 km from the Project site;
- The duration of the impacts is short-term because any effects on habituation will last for less than one year after the end of the activities:
- The impacts are **infrequent** because the vessel traffic will not be regular during activities related to the implementation of the Project;
- The magnitude of the impacts is negligible because it is considered that, although the marine vessel traffic will lead to a reduction in the distribution of seabird species in an area of 35 km^2, this will happen rarely;
- It has been found that the effects on wintering common scoters resulting from disturbances caused by the marine vessel traffic during the operational phase would be **minor (negligible)**;
- It has been found that the effects on wintering birds (common scoters, long-tailed ducks and razorbills) resulting from disturbances caused by the movement of seagoing vessels during the operational phase will be **negligible (insignificant)**.
- It has been found that the effects on breeding great cormorants or wintering great crested grebes resulting from disturbances caused by the marine vessel traffic in the operational phase, would be **negligible (insignificant)**.

IV.2.11.6 Marine mammals

IV.2.11.6.1 Development stage

IV.2.11.6.1.1 Sources of underwater noise caused by the construction works

The design of the Żarnowiec site includes proposed structures related to the MOLF, the sewage treatment works and the temporary sheet pile wall (at the shore and at sea) or caissons (offshore) near the pipeline and the discharge point of the sewage treatment works.

The construction of the underwater infrastructure will generate impulsive underwater noise caused by the pile driving and non-impulsive underwater noise caused by the vibration hammering of sheet pile walls, dredging, dumping of crushed stone, formation of rock embankments, use of ships, tunneling and directional drilling.

IV.2.11.6.1.2 Hearing thresholds, duration times, modelling, noise sources and results

The technical guidelines of the U.S. Department of Commerce's (National Oceanic and Atmospheric Administration, NOAA) *for assessing effects of anthropogenic sounds on marine mammal hearing* (Technical Memorandum NMFS-OPR-59, April 2018, NOAA) set thresholds for assessing the emergence of the permanent threshold shift (PTS), the temporary threshold shift (TTS) and the behavioural disturbance (BD) in marine mammals as a result of exposure to underwater noise [303].

The NOAA guidelines specify noise levels LE,p and Lpk at which the PTS, TTS and BD may occur at low, medium and high frequency in cetaceans (HFC) and in phocid pinnipeds (PW). The following [Table IV.2 -286] presents the animal types (HFC and PW), the potential impact (injury, dysfunction and/or behavioural impairment), the nature of the sound source (impulsive and non-impulsive) and noise levels.

Table IV.2-286 Marine mammal sound exposure criteria for impulsive and non-impulsive sound sources

No.	Animal type	PTS – permanent injury		TTS – impairment		BD – behavioural disorders	
		Impulsive	Non-impulsive	Impulsive	Non-impulsive	Impulsive	Non-impulsive
1	High frequency cetaceans (HFC)	**202 dB Lpk** 155 dB LE,p	173 dB LE,p	**196 dB Lpk** 140 dB LE,p	153 dB LE,p	**160 dB Lp**	**120 dB Lp**
2	Phocid pinnipeds (PW)	232 dB Lpk 203 dB LE,p	201 dB LE,PW,24hr	212 dB Lpk 170 dB LE,p	181 dB LE,p		

Source: [456]

The Waterborne Noise and Vibration Assessment Report [307] identifies significance of marine mammals and the associated Natura 2000 sites. The impact magnitude, significance and weight, and cumulative impacts of underwater noise on marine mammals were also determined.

With regard to the magnitude of the impacts, the value / status of geographic protection (exposure scale), the duration of underwater noise (for individual phases of the Project), intensity (species criteria, noise levels and impact zone) were determined based on modelling and comparison with ambient conditions and during impulsive and non-impulsive pile driving. The key receptors included in the impact assessment were receptors with a geographic conservation value / status associated with the adjacent Natura 2000 sites and those that are sensitive to underwater noise (hearing, sound pressure and exposure levels, thresholds, detection and frequency). In the case of the time of duration, this referred in particular to the time stages of the Project.

On this basis, the following definitions / estimates were used for the actual operating periods during which underwater noise may be generated:

- Short-term = 15-24 months;
- Medium-term = 30-48 months; and
- Long-term = 60-90 months.

This was related to the time range, where the construction phase was planned for 8-10 years (the worst-case scenario: 120 months) and the decommissioning phase for 10-15 years (the worst-case scenario: 180 months). Assuming an estimated % of the time for actual underwater noise, amounting to 10% of the total construction and decommissioning programme, an estimated range of 12 months in the worst-case scenario (construction) to 18 months in the worst-case scenario (decommissioning) was obtained. It is also assumed that most of the underwater noise (piling, dredging, rock material dumping, pile extraction, infrastructure removal and the use of watercraft) will take place during the first 24 months of the construction programme and the 36 months of the decommissioning programme. Therefore, estimating at 10%, this would mean that underwater noise would be generated mainly by 50% of the available time at the beginning of each of the programmes.

Detailed modelling of underwater sources of noise from the construction works has been carried out and discussed in the Waterborne Noise and Vibration Assessment Report [307]. The results of this previous study are summarised below.

IV.2.11.6.1.3 Impulsive construction noise sources

The following [Table IV.2-287] shows the ranges in which the noise level caused by the driving of piles at the Żarnowiec site falls below the estimation thresholds (high-frequency sensitive cetaceans).

The impact zones indicate that the noise coming from driving of a single pile will not cause injury (the appearance of PTS) in high-frequency sensitive cetaceans. However, due to the repetitive noise generation during works, the impact zones for the PTS-onset extend up to 200m for 100 strokes (1 minute duration) to 1km for 1,000 strokes (10 minutes duration). 6,000 strokes (within 1 hour) can cause the PTS in high-frequency sensitive cetaceans, which remain at a distance of 2,500m from piling.

Noise produced by driving a single pile exceeds the TTS for high-frequency sensitive cetaceans at a distance of 150m from the source. The cumulative TTS zones extend to 1,100m for the duration of the piling exposure of 1 minute (100 strokes), exceed 7,500m for a duration exceeding 10 minutes (1,000 strokes) and exceed 20,000m for a duration exceeding 1 hour (6,000 strokes).

The impact zones resulting from the cumulative SEL are based on the worst-case scenario assumptions, including the assumption that high-frequency sensitive cetaceans remain at certain distances from the sound source for a specified period of time. In fact, high-level impulsive noise, such as that generated by the driving of piles, is expected to result in avoidance behaviours whereby these animals will avoid, or move away from, the sound source. The threshold of behavioural disorders has not been reached in any site.

Table IV.2-287 The ranges in which the thresholds are reached for high-frequency sensitive cetaceans in the case of impact piling

No.	Criterion	Peak SPL, dB re 1 µPa	Impact zones, m	Criteria – SEL, dB re 1 µPa²s	Impact zones, m (per number of strokes/period)				
					1	10	100 (1 min)	1,000 (10 min)	6,000 (1 hr)
1	PTS on-set	202	Not achieved	155	50	100	200	1,000	2,500
2	TTS on-set	196	Not achieved	140	150	300	1,100	7,500	20,000
3	Behavioural disorders	160 (RMS SPL dB re 1 µpa)	Not achieved	N/A	N/A	N/A	N/A	N/A	N/A

Source: [456]

Permanent bodily injury, death or the PTS

The results presented in the table above show that there is a potential for onset of PTS in high-frequency sensitive cetaceans, within a range of up to 2,500m, due to the exposure to the impact piling of the assumed maximum duration (1 hour).

Noise exposure estimates are highly conservative and are unlikely to represent the actual noise exposure of mobile transient marine fauna. The exposure criterion (LE,p) is a cumulative measure depending on the number of strokes to the piles during the day and on the presence of a noise-receiving animal remaining in the area during the time covered by the assessment. The LE,p modelling is based on the assumption that the animal is constantly exposed to such noise levels at a fixed point. More realistically, animals would not stay in the same place or within the same range for 24 hours. Therefore, the specified radius of the LE,p criteria does not mean that every animal travelling within this radius from the source will be injured, but rather that it could be injured if it remained within this range for the period covered by the assessment.

The remaining estimation thresholds for the PTS have not been reached. The estimation threshold for the occurrence of the PTS caused by peak sound pressure levels (high-frequency sensitive cetaceans, Lpk 202 dB) has not been reached anywhere.

Reversible injuries and the TTS

The results presented in the table above show that the potential for the onset of TTS in high-frequency sensitive cetaceans (such as harbour porpoises) extends to 20,000m. As discussed above, noise exposure estimates are very conservative and are unlikely to reflect the actual exposure of mobile transient marine fauna.

At no point has the criterion of immediate reversible injuries and of the TTS for high-frequency sensitive cetaceans (Lpk 196 dB) been achieved.

Behavioural disorders

The single stroke / impulse criterion (Lp 160 dB) for the onset of behavioural disorders in high-frequency sensitive cetaceans and pinnipeds has not been achieved.

IV.2.11.6.1.4 Non-impulsive construction noise sources

Table IV.2-288 The ranges in which the criteria for non-impulsive construction noise sources are met.

No.	Non-impulsive construction sources	Range in metres (the maximum distance from the threshold levels of impacts) – as defined in the criterion of behavioural disorders (Lp 120 dB)
1	Vibration driving of sheet pile walls (the Baltic Sea)	Not achieved
2	Dredging (CSD)	1,800
3	Rock backfill dumping	50

Source: [456]

Permanent bodily injury, death or the PTS

The results presented above show that the source noise levels used in the modelling (**LE,p 185 dB**), caused by non-impulsive construction works, will not reach the assessment thresholds for the permanent injury or death.

Reversible injuries and the TTS

The results presented above show that the source noise levels used in the modelling (**LE,p 185 dB**), caused by non-impulsive construction works, would not reach the assessment thresholds for recoverable injuries or for the TTS in the case of marine mammals.

Behavioural disorders

The results presented above [Table IV.2-288] show that the source noise levels used in the modelling (**LE,p 185 dB**), caused by non-impulsive construction works, will be lower than the criterion of the onset of behavioural disturbances for high-frequency sensitive cetaceans (**Lp 120 dB**) within a range of 1,800m (CSD dredging) and 50m in the case of rock material dumping.

IV.2.11.6.1.5 Assessment of underwater noise (development stage)

This subchapter assesses underwater noise from the construction works at the development stage (impact pile driving, vibration driving of sheet pile walls, dredging, rock material dumping, vessel traffic, tunnelling and directional drilling) using the methodology described in Chapter III.3. The conclusions are as follows:

- The porpoise is **highly significant** because it is protected, rare (the estimated population size in the Baltic Sea is 450 specimens) and is a qualifying feature in several Sites of Community Importance (SCI). Its sensitivity is **low or medium**. Although a small population would not be resilient to major changes, these animals can easily avoid sources of impacts. The overall value of the receptor is therefore **medium** in terms of national and international significance of this species.
- The common seal is of **high significance** in terms of its national and international significance. It is of **low sensitivity**. The current population is estimated at 15,000 specimens grouped in two (2) metapopulations in the Baltic Sea. This means that the species has a potential to tolerate changes at the population level. The overall value of the receptor is **medium**.
- The grey seal is a species of **high significance** and **low sensitivity**. Its current population in the Baltic Sea is estimated at 30,000 specimens, so it can tolerate effects to a greater extent at the population level. The overall value of the receptor is **medium**.
- The ringed seal is a species of **high significance** and **low sensitivity**. Its current population in the Baltic Sea is estimated at 20,000 specimens, which is why this population can tolerate changes. The overall value of the receptor is **medium**.
- The spatial extent of the impacts for all the four marine mammal species assessed is **regional**. This is due to the fact that the impacts associated with underwater noise caused by the construction works can occur outside the Project Area but they are unlikely to extend to a distance of more than 30 km from the Project Site.

- The impacts on all the four marine mammal species assessed are **temporary** as the effects related to underwater noise caused by the construction works will be strictly limited in time (< 12 months) and the effects will cease at the end of the activities and well return to the baseline levels.
- The impacts on all the four marine mammal species assessed are **frequent** due to the possibility of repeated strokes during the construction works (pile driving, vibration driving sheet pile walls, dredging, rock material dumping, vessel traffic, tunnelling and directional drilling).
- The magnitude of the impacts on all the four marine mammal species assessed is **low** because it is considered that the Project can only affect localized individuals within the population, during a short period of time (one generation of the species or less), and will not significantly affect other trophic levels or the marine mammal population as such.
- It has been concluded that any effects on the marine mammals resulting from impacts from underwater noise caused by the construction works at the site development stage will be **minor (insignificant)**.

IV.2.11.6.1.6 Indirect effects on marine mammal species resulting from impacts on prey availability

Changes in prey availability can affect individual specimens' ability to feed, and subsequently, local populations. The assessment of potential impacts that may affect prey availability at the development stage has been assessed as **negligible**.

Using fish as a prime example of prey availability, the acoustic criteria for noise caused by the pile driving, navigation, and other continuous sound sources are taken from the Sound Exposure Guidelines for Fishes [364].

This section assesses indirect effects on marine mammal species resulting from impacts on prey availability, using the methodology described in [Chapter IV.2.5]. The following conclusions have been drawn:

- The porpoise is of **high significance** because it is protected, rare (the estimated population in the Baltic Sea is 450 specimens) and is a qualifying feature in several SCIs. Its sensitivity is **low or medium**. Although a small population would not be resilient to major changes, these animals can easily avoid sources of impacts. Seals have larger and more sturdy populations in the Baltic Sea and, therefore, their sensitivity is **low**. The overall receptor value for all these marine mammals is **medium**.
- The spatial extent of the impacts for all the four marine mammal species assessed is **local**. This is due to the fact that the impacts on fish (the TTS and avoidance), for example in terms of prey availability, will occur within a 100 m buffer around the Project Area (in the worst-case scenario, during the driving of piles).
- The duration of the impacts on all the four marine mammal species assessed is **temporary** because any effects on fish, for example in terms of prey availability, related to underwater noise caused by the construction works will be strictly limited in time (< 12 months of underwater noise) and their effects will disappear upon completion of the works and return to the baseline levels;
- The impacts on all the four marine mammal species assessed are **frequent** due to the possibility of repeated impacts on fish, such as prey availability, during the construction works (pile driving, vibration driving of sheet pile walls, dredging, rock material dumping, vessel traffic, tunneling and directional drilling);
- The magnitude of the impact on all the four marine mammal species assessed is **low** because it is considered that the Project can only affect localized fish within the population, as an example of prey availability, in a short term (one generation of the species or less), and will not significantly affect other trophic levels or the fish population as such.
- It has been concluded that any indirect effects on marine mammals resulting from the impacts from the development and construction works on prey availability will be **negligible (insignificant)**.

IV.2.11.6.1.7 Disturbances caused by increased vessel traffic

Watercraft will be required at all stages of the Project. During the construction of the MOLF, water intake and discharge structures, FRRS and the temporary sheet pile wall underwater noise will be emitted by boats / tugs, one or more piling barges (if they work simultaneously) and a cutter suction dredger (CSD). The ship-related noise sources include engines, on-board pumps, propellers, manoeuvring motors and self-supporting barges. The noise source levels for the auxiliary barge were taken from Wyatt (2008) [524] and were based on the work of a barge laying pipes in a shallow aquatic environment.

It was assumed that the noise source levels for boats / tugs handling sheet pile walls would be the same as for a gravel-pushing barge (Wyatt, 2008) [524], with the same acoustic spectrum as the barges supporting the piling machines. An example of a spot source of underwater noise propagation from ship-based work (CSD) in the inlet chamber can be found in the Waterborne Noise and Vibration Assessment Report.

This subchapter assesses the effects of disturbances caused by increased vessel traffic using the methodology described in [Chapter IV.2.5]. The following conclusions have been drawn:

- The porpoise is of **high significance** because it is protected, rare (the estimated population in the Baltic Sea is 450 specimens) and is a qualifying feature in several SCIs. Its sensitivity is **low or medium**. Although a small population would not be resilient to major changes, these animals can easily avoid sources of impacts. Seals have larger and more sturdy populations in the Baltic Sea and, therefore, their sensitivity is **low**. The overall receptor value for all these marine mammals is **medium**.
- The spatial extent of the impacts for all the four marine mammal species assessed is **regional**. This is due to the fact that the impacts related to disturbances generated by increased vessel traffic during the construction works can occur outside the Project Area (especially when moving to the Project Area and back);
- The impacts on all the four marine mammal species assessed are **temporary** because the effects of disturbances caused by increased vessel traffic during the construction works will be strictly limited in time and their effects will cease at the end of the operations and will return to the baseline levels.
- The impacts on all the four marine mammal species assessed are **frequent** due to the possibility of repeated generation of noise during the construction works (vessel traffic);
- The magnitude of the impacts on all the four marine mammal species assessed is **low** because it is considered that the Project can only affect localized individuals within the population, during a short period of time (one generation of the species or less), and will not significantly affect other trophic levels or the marine mammal population as such.
- It has been concluded that any effects resulting from the disturbances caused by increased vessel traffic during the development and construction stages will be **minor (insignificant)**.

IV.2.11.6.1.8 Risk of collisions as a result of increased vessel traffic

Collisions between ships associated with the Project and marine mammals during the installation of the marine infrastructure have a potential to cause injury or death, with consequences at both the individual specimen and population levels.

The vessels associated with the Project are unlikely to move at high speed or irregularly, so marine mammals will be able to become aware of their presence and avoid them if necessary. The species of marine mammals found in the marine survey area of the Żarnowiec site are the harbour porpoise and the grey seal, both of which are characterised by fast reaction time and good manoeuvrability. On this basis, the potential effects of collisions between ships and marine mammals (especially spirally inflicted wounds) have been considered **insignificant** in the assessment report on marine hydrodynamics and water quality [456].

This subchapter assesses the risk of collisions due to increased vessel traffic using the methodology described in Chapter III.3. The following conclusions have been drawn:

- The porpoise is of **high significance** because it is protected, rare (the estimated population in the Baltic Sea is 450 specimens) and is a qualifying feature in several SCIs. Its sensitivity is **low or medium**. Although a small population would not be resilient to major changes, these animals can easily avoid sources of impacts. Seals have larger and more sturdy populations in the Baltic Sea and, therefore, their sensitivity is **low**. The overall receptor value for all these marine mammals is **medium**.
- The spatial extent of the impacts for all the four marine mammal species assessed is **regional**. This is due to the fact that impacts related to the risk of collision as a result of increased vessel activity during the construction can occur outside the Project Area (especially during transit to and from the Project Area).
- The duration of the impacts for all the four marine mammal species assessed is **temporary** because the impacts related to the risk of collisions due to increased vessel traffic during the construction will last for more than 12 years after the completion of the Project and the return to the baseline levels (related to injuries and deaths of specimens and the life cycles of porpoises and seals).
- The impacts on all the four marine mammal species assessed are **frequent** due to the possibility of repeated generation of noise during the construction works (vessel traffic), although the probability of collision is very low.
- The magnitude of the impacts for all the four marine mammal species assessed is **low** because the Project affects a specific group of localized individuals in the population, in a short period of time (one generation of the species or less), but does not affect other trophic levels or the population as such.
- It has been concluded that any effects resulting from disturbances caused by increased vessel traffic during the development and construction stages will be **minor (insignificant)**.

IV.2.11.6.2 Construction stage

IV.2.11.6.2.1 Impact of underwater construction noise (construction)

The construction at the Żarnowiec site will involve the structures related to the intake and discharge of cooling water, the FRRS, the temporary sheet pile walls (at the shore and at sea) or caissons (offshore) around the cooling water channels / pipelines.

The construction of the underwater infrastructure can generate impulsive underwater noise associated with pile driving (if required for the final insertion of piles), and non-impulsive underwater noise associated with vibration driving of sheet pile walls, dredging, rock material dumping, vessel traffic, tunnelling and directional drilling. The full description of these noise-generating preparatory works is given in the previous subchapter.

It has been concluded that any effects on the four marine mammal species assessed, resulting from the direct and indirect impacts of underwater noise caused by the construction works, will be less severe than at the development stage due to the absence of the piling associated with the construction of the MOLF and, therefore, in the worst case, **minor (insignificant)**.

- The porpoise is of **high significance** because it is protected, rare (the estimated population in the Baltic Sea is 450 specimens) and is a qualifying feature in several SCIs. Its sensitivity is **low or medium**. Although a small population would not be resilient to major changes, these animals can easily avoid sources of impacts. Seals have larger and more sturdy populations in the Baltic Sea and, therefore, their sensitivity is **low**. The overall receptor value for all these marine mammals is **medium**.
- The spatial extent of the impacts for all the four marine mammal species assessed is **regional**. This is due to the fact that the impacts associated with underwater noise caused by the construction works can occur outside the Project Area but they are unlikely to extend to a distance of more than 30 km from the Project Site.

- The impacts on all the four marine mammal species assessed are **temporary** as the effects related to underwater noise caused by the construction works will be strictly limited in time (< 12 months) and the effects will cease at the end of the activities and well return to the baseline levels.
- The impacts on all the four marine mammal species assessed are **frequent** due to the possibility of repeated strokes during the construction works (pile driving, vibration driving sheet pile walls, dredging, rock material dumping, vessel traffic, tunnelling and directional drilling).
- The magnitude of the impacts on all the four marine mammal species assessed is **low** because it is considered that the Project can only affect localized individuals within the population, during a short period of time (one generation of the species or less), and will not significantly affect other trophic levels or the marine mammal population as such.
- It has been concluded that any effects on the marine mammals resulting from impacts from underwater noise caused by the construction works during the site preparation stage will be **minor (insignificant)**, as summarised below.

IV.2.11.6.2.2 Indirect effects on marine mammal species from impacts on prey availability (construction stage)

It has been concluded that any effects on the four marine mammal species assessed, resulting from the indirect impacts of underwater noise caused by the construction works (using fish as an example of prey availability), will be the same as at the development stage, that is, **minor (insignificant)**.

- The porpoise is of **high significance** because it is protected, rare (the estimated population in the Baltic Sea is 450 specimens) and is a qualifying feature in several SCIs. Its sensitivity is **low or medium**. Although a small population would not be resilient to major changes, these animals can easily avoid sources of impacts. Seals have larger and more sturdy populations in the Baltic Sea and, therefore, their sensitivity is **low**. The overall receptor value for all these marine mammals is **medium**.
- The spatial extent of the impacts for all the four marine mammal species assessed is **local**. This is due to the fact that the impacts on fish (the TTS and avoidance), for example in terms of prey availability, will occur within a 100 m buffer around the Project Area (in the worst-case scenario, during the driving of piles).
- The duration of the impacts on all the four marine mammal species assessed is **temporary** because any effects on fish, for example in terms of prey availability, related to underwater noise caused by the construction works will be strictly limited in time (< 12 months of underwater noise) and their effects will disappear upon completion of the works and return to the baseline levels;
- The impacts on all the four marine mammal species assessed are **frequent** due to the possibility of repeated impacts on fish, such as prey availability, during the construction works (pile driving, vibration driving of sheet pile walls, dredging, rock material dumping, vessel traffic, tunneling and directional drilling);
- The magnitude of the impact on all the four marine mammal species assessed is **low** because it is considered that the Project can only affect localized fish within the population, as an example of prey availability, in a short term (one generation of the species or less), and will not significantly affect other trophic levels or the fish population as such.
- It has been concluded that any indirect effects on marine mammals resulting from the impacts of construction works, and at the development stage, on prey availability will be **negligible (insignificant)**.

IV.2.11.6.2.3 Disturbances from increased vessel traffic (construction stage)

It has been concluded that any effects on the four marine mammal species assessed, resulting from the direct impacts of disturbances caused by increased vessel traffic at the construction stage, will be the same as at the development stage, i.e. **minor (insignificant)**.

- The porpoise is of **high significance** because it is protected, rare (the estimated population in the Baltic Sea is 450 specimens) and is a qualifying feature in several SCIs. Its sensitivity is **low or medium**. Although a small population would not be resilient to major changes, these animals can easily avoid sources of impacts. Seals have larger and more sturdy populations in the Baltic Sea and, therefore, their sensitivity is **low**. The overall receptor value for all these marine mammals is **medium**.
- The spatial extent of the impacts for all the four marine mammal species assessed is **regional**. This is due to the fact that the impacts related to disturbing the peace by increased activity of ships during the construction can occur outside the Project Area (especially during transit to and from the Project Area).
- The impacts on all the four marine mammal species assessed are **temporary** because the effects of disturbances caused by increased vessel traffic during the construction works will be strictly limited in time and their effects will cease at the end of the operations and will return to the baseline levels.
- The impacts on all the four marine mammal species assessed are **frequent** due to the possibility of repeated generation of noise during the construction works (vessel traffic);
- The magnitude of the impacts on all the four marine mammal species assessed is **low** because it is considered that the Project can only affect localized individuals within the population, during a short period of time (one generation of the species or less), and will not significantly affect other trophic levels or the marine mammal population as such.
- It has been concluded that any effects resulting from disturbances caused by increased vessel during the development and construction stages will be **minor (insignificant)**.

IV.2.11.6.2.4 Increased risk of collisions due to increased ship activity (construction stage)

It has been concluded that any effects on the four marine mammal species assessed, resulting from the risk of collisions caused by increased vessel traffic at the construction stage, will be the same as at the development stage, i.e. **minor (insignificant)**.

- The porpoise is of **high significance** because it is protected, rare (the estimated population in the Baltic Sea is 450 specimens) and is a qualifying feature in several SCIs. Its sensitivity is **low or medium**. Although a small population would not be resilient to major changes, these animals can easily avoid sources of impacts. Seals have larger and more sturdy populations in the Baltic Sea and, therefore, their sensitivity is **low**. The overall receptor value for all these marine mammals is **medium**.
- The spatial extent of the impacts for all the four marine mammal species assessed is **regional**. This is due to the fact that impacts related to the risk of collision as a result of increased vessel activity during the construction can occur outside the Project Area (especially during transit to and from the Project Area).
- The duration of the impacts on all the four marine mammal species assessed is **long-term** because the effects related to the risk of collisions due to increased vessel traffic during the construction works will last for more than 12 years after the completion of the Project and the return to the baseline levels (related to injuries and deaths of specimens and the life cycles of porpoises and seals).
- The impacts on all the four marine mammal species assessed are **frequent** due to the possibility of repeated generation of noise during the construction works (vessel traffic);
- The magnitude of the impacts for all the four marine mammal species assessed is **low** because the Project affects a specific group of localized individuals in the population, in a short period of time (one generation of the species or less), but does not affect other trophic levels or the population as such.

- It has been concluded that any effects related to disturbances caused by increased vessel traffic during the development and construction stages will be **minor (insignificant)**.

IV.2.11.6.3 Operational phase

IV.2.11.6.3.1 Operational noise

The operational noise caused by seawater flowing through the headworks, intake tunnel, rotary screens and pumps is considered insignificant and has therefore not been modelled or evaluated.

Underwater noise can also be generated during the operation of the Żarnowiec site's cooling variant based on the turbulent or cavitation flow (formation and collapse of bubbles due to sudden pressure changes) in the outlet diffusers. However, the noise level on the outlet diffusers is expected to fall below the most stringent noise threshold used in this survey (120 dB). The outlet velocity is expected to be much lower than the magnitudes at which turbulence or cavitation could occur. In addition, the measured noise levels provided in the literature show that the noise from the outlet diffusers of a similar facility (Adelaide Desalination Plant) is below 120 dB [365].

The ranges in which the noise generated by vessels operating at the MOLF do not exceed the assessment threshold. The modelled noise levels are below the PTS (the permanent threshold shift) thresholds of high frequency and the thresholds for behavioural disorders in cetaceans.

IV.2.11.6.3.2 Other operational impacts

It has been concluded that any effects on the four marine mammal species assessed resulting from activities during the operational phase will be the same as at the development and construction stages, but less severe, i.e. **minor (insignificant)**.

IV.2.11.8 Decommissioning phase

Currently, it is expected that the decommissioning phase of the Project will last approximately 24 years, after the total life cycle of 72 years (including the development works, construction, and operation/maintenance).

At the time of drafting this document there is considerable uncertainty about the decommissioning phase of the Project, not only with regard to the proposal for decommissioning activities but also with regard to the underlying conditions and regulatory framework that will then apply. Therefore, no detailed assessment of the potential impact of the decommissioning of sub-variant 2A has been carried out. Instead, it is assumed that the effects will be similar to those that will occur at the development and construction stages, although their magnitude will be lower, but they may extend over a longer period of time. This assumption is based on the draft decommissioning plan (presented as part of the overarching description of the Project), in accordance with the Polish law. The plan assumes that similar techniques, installations and other devices will be available for decommissioning works as at the development and construction stages. It was also assumed that, although the inlet / outlet heads could be removed from the seabed, the inlet and outlet tunnels themselves would remain in place after the decommissioning (which significantly reduces the possibility of marine impacts). The long-term use and status of the MOLF have not been confirmed. After the decommissioning of the power plant, it may be completely removed or sold and used for another purpose by another user.

Based on the above assumptions, given that the potential impacts on the marine ecological receptors during the development and construction stages and the operational phase were considered insignificant (if necessary, with the use of additional mitigation measures), it has been concluded that a similar set of impacts in the decommissioning phase will also be **insignificant**.

IV.2.12 Impact assessment – Sub-variant 2B -Żarnowiec: closed cooling system using desalinated seawater

IV.2.12.1 General information

IV.2.12.1.1 Scope of the assessment

This chapter provides an assessment of the potential impacts on the marine ecology receptors resulting from the implementation of sub-variant 2B, including associated investments, taking into account the worst-case scenario for each component.

For the construction phase, the assessment has taken into account the cooling system based on submerged pipelines, which is the worst-case scenario in terms of seabed disturbances and associated marine environment disturbances. In comparison, the effects associated with the TBM method would be minimal and would be limited to local and temporary seabed disturbances associated with the construction of the inlet and outlet head structures.

With regard to the operational phase, the worst-case scenario assessment takes into account the operation of the NPP's three AP1000 reactors operating at full power.

IV.2.12.4 Ichthyofauna

IV.2.12.4.1 Development stage

The works carried out in the marine environment at the development stage of sub-variant 2B will be the same as in sub-variant 2A, which includes the construction of the MOLF and the discharge from the sewage treatment works (STW). All the potential impacts on the marine environment resulting from these works have been assessed in the subchapter concerning sub-variant 2A. These potential impacts include:

- loss of habitats and physical disturbances as a result of the construction works;
- increased underwater noise caused by the construction works;
- increased amount of suspended sediments and smothering as a result of resettlement of suspended sediments;
- changes in visual stimuli caused by artificial lighting;
- effects of spills as a result of activities at sea.

To avoid repetition, these assessments have been omitted here. The complete assessments of significant impacts for the development stage of sub-variant 2B can be found in the subchapter concerning sub-variant 2A.

IV.2.12.4.2 Construction stage

Works in the marine environment at the construction stage in sub-variant 2B will include the construction of the water cooling infrastructure using submerged pipes (as the worst-case scenario of the construction). The construction works that will be carried out in the marine environment at this stage will be the same as in sub-variant 2A but their extent will be smaller. The works in sub-variant 2B will affect the same benthic receptors as in sub-variant 2A. All the potential impacts on the marine environment resulting from these works are listed below:

- loss of habitats and physical disturbances due to the construction works
- entrainment through suction header dredging
- increased underwater noise caused by the construction works;
- increased suspended sediment and smothering through resettlement of suspended sediments

- changes in visual stimuli caused by artificial lighting;
- effects of spills as a result of activities at sea.

In view of the similarity and smaller scale of the infrastructure required for sub-variant 2B, the fact that sub-variant 2B will affect the same benthic receptors as sub-variant 2A and the fact that the worst-case scenario impact assessments at the construction stage of sub-variant 2A ended with the conclusion '**negligible (insignificant)'**, it has been concluded that it is not necessary to repeat the impact assessment in this subchapter.

IV.2.12.4.3 Operational phase

IV.2.12.4.3.1 Loss of habitats due to the presence of the permanent infrastructure

No additional marine infrastructure will be introduced into the environment during the operational phase and the loss of habitats and the disturbances will be limited to those related to the permanent infrastructure built during the previous two stages of the Project. The total direct loss of habitats, amounting to 274m^2, concerns the coastal area with sandy seabed. All the impacts are expected to be the same as in sub-variant 2A.

IV.2.12.4.3.2 Effects of operational discharge

The assessment of the effects of discharges for sub-variant 2B in the operational phase assumes operation of the three AP1000 reactors at full power. Three components of the discharge have been considered: thermal load, salinity and chemical pollutants.

Thermal effluents

The thermal effluents discharged from the outlet of the planned sub-variant 2B with the closed cooling system are less severe than in sub-variant 2A. The plume described by a ΔT of +2°C is expected to extend no more than 180m from the end of the outlet pipe, covering an area of 0.04km^2, i.e. <0,02 % of the marine survey area. The potential impacts of any thermal anomalies in the receiving body of water on ichthyofauna have been described in the subchapter concerning sub-variant 2A.

Based on the above findings, an assessment of the impacts on ichthyofauna of thermal effluents discharged in the operational phase from the outlet of sub-variant 2B in the operational phase of the Project was carried out. The following conclusions have been drawn:

- The identified receptors, that is, the fish species within the marine survey area of the Żarnowiec site, are of **high significance** due to their importance for supporting ecosystem integrity (in particular in connection with the SPA) and **low sensitivity**, which gives a **medium** overall value of the receptor.
- The spatial extent of the impacts is **regional**, limited to about 100m from the construction site, and largely included in the Project Area.
- The duration of the impacts is considered to be **permanent**, perpetuating throughout the life cycle of the Project until the decommissioning.
- The frequency of the impacts is **continuous** because, after the construction of the marine infrastructure, thermal effluents will be discharged throughout the life cycle of the Project.
- The magnitude of the impacts is **low** and the plume will not affect the spawning substrate or migration routes and will not increase the temperature to the UILT value for any of the recorded species. The area of the mixing zone is relatively small compared to the area of the immediately adjacent comparable habitats.
- It has been concluded that the potential impacts of thermal effluents on the biology and ecological needs of fish in the operational phase will be **minor (insignificant)**.

Salinity

The use of desalinated seawater in the cooling towers, rather than seawater, means increased salinity of the discharge, which will contain brine from the desalination. Although the flow rates will be smaller than in the case of sub-variant 2A, the total content of dissolved solids will therefore be similar in both sub-variants. Although the plume from sub-variant 2B will spread to a greater extent on the seabed than that from sub-variant 2A, this will only happen after a significant dilution [decrease in the concentration].

Sensitivity tests for the seawater current velocity range and ambient temperature were performed using the CORMIX modelling. In all cases, for the cooling water system operating on desalinated water, using cooling towers, a ΔS of less than 0.5 psu is expected to be achieved in the initial mixing zone, in the near field (<40 m from the point of discharge), covering an area of 0.006 km^2. Salinity levels are expected to decrease to ambient levels at a distance of several hundred metres from the discharge site. It is expected that a ΔS of less than 0.5 psu will not generate significant impacts on fish or ichthyoplankton in the receiving waters outside the mixing zone.

Chemical components

As for sub-variant 2A, most of the composition of the operational effluents complies with the established or equivalent EQS or ELV levels, respectively. The main exception is boron, for which both the EQS and the ELV values at the end of the pipe are expected to be exceeded. However, the overrunning of the limit for boron is mainly due to the fact that this element is already present in seawater and taken with make-up water. However, based on dilution values of 18-27 for summer discharges and 19-37 for winter discharges, the environmental quality standards will be met in the initial mixing zone, within a radius of 100 m from the point of discharge. Therefore, the impacts on environmental quality of water would not be significant. For other chemical components, where the EQS or ELV limit values (e.g. lithium, sulphate, hydrazine and polyacrylate) can be exceeded, or have not been set, additional mitigation measures have been identified to manage their discharge.

Similarly as for sub-variant 2A, the adoption of appropriate mitigation measures would mean that any effects of the chemicals contained in the combined operational effluents would be minor (insignificant).

IV.2.12.4.3.3 Effects from entrapment, entrainment and impingement

The effects of fish entrapment, entrainment and impingement in waters off the shoreline of the Żarnowiec site have been described in full in the subchapter concerning sub-variant 2A and these effects would be the same, except for the radius of the intake zone and the escape speed of the cooling water inlet, which would be significantly smaller. Any potential impacts on the receptors will be reduced accordingly.

Sub-variant 2B will draw a maximum of 4.5 m^3s^{-1} of water through three capped radial velocity heads each drawing up to 1.5 m^3s^{-1}. In the worst-case scenario, the drawing zone will extend 23.8m from the inlet head, covering an area of 1,791 m^2 where the escape speed will exceed 1 cm/s. The three inlet heads will form a 5,373 m^2 entrainment zone, which represents about 0.002% of the marine survey area of the Żarnowiec site. The escape speed directly in front of the inlet opening will be < 0.15 m/s. All the potential impacts on the marine environment resulting from these works have been assessed in the subchapter concerning sub-variant 2A.

To avoid repetition, the impact assessment has not been presented here in detail. The full assessment of the impacts relevant to the construction phase of sub-variant 2B can be found in the subchapter concerning sub-variant 2A. An assessment based on the reduction of the intake zone and escape speed is presented below. The following conclusions have been drawn:

- The identified receptors are of **high significance** due to their importance in supporting the wider ecosystem and the presence of the salmon, sea lamprey and twaite shad which are features of Ostoja Słowińska SCI. Their sensitivity is **low** due to their mobility and ability to avoid impacts, which gives a **medium** overall value of the receptor.
- The spatial range of the impacts is **regional**. The impacts occur outside the Project Area but their detectability at a distance of more than 30 km from the Project Site is rather unlikely.

- The duration of the impacts is considered to be **permanent**, lasting throughout the operational life-cycle of the Project until the decommissioning (and potentially later, depending on the approach to the decommissioning).
- The impact frequency is **continuous** because, once the marine infrastructure is built, direct loss of habitats and associated physical disturbances will begin.
- The magnitude of the impacts is **low** because the levels of entrapment, entrainment and impingement are low compared to the population in ICES sub-areas 25 and 26 and the potential compensation depending on density.
- It has been found that the losses resulting from entrapment, entrainment and impingement during the operational phase will be **minor (insignificant)**.

IV.2.12.4.3.4 Increased underwater noise levels caused by service vessels

The intervention in the marine environment during the operational phase of sub-variant 2B will be the same as in sub-variant 2A, which includes underwater noise related to seawater intake / discharge, mechanical screens / pumps and vessels operating at the MOLF.

To avoid repetition, the impact assessment of the operational phase is not mentioned here again. See the subchapter concerning sub-variant 2A for the full discussion of the impacts of the operational phase.

IV.2.12.5 Marine avifauna

IV.2.12.5.1 Development stage

The works carried out in the marine environment at the development stage in sub-variant 2B will be the same as in sub-variant 2A, which includes the construction of the MOLF and the discharge from the sewage treatment works (STW). All the potential environmental impacts on seabirds resulting from these works have been assessed in the subchapter concerning sub-variant 2A. These potential impacts include:

- Indirect effects on seabirds from the impacts on prey availability;
- Direct disturbances resulting from the construction activities; and
- Disturbances caused by increased vessel traffic.

To avoid repetition, these assessments have been omitted here. The complete assessments of significant impacts for the development stage of sub-variant 2B can be found in the subchapter concerning sub-variant 2A.

IV.2.12.5.2 Construction stage

Works in the marine environment at the construction stage in sub-variant 2B will include the construction of the water cooling infrastructure using submerged pipes (as the worst-case scenario of the construction). The construction works that will be carried out in the marine environment at this stage will be the same as in sub-variant 2A. All the potential impacts on seabirds resulting from these works have been assessed in the subchapter concerning sub-variant 2A. These potential impacts include:

- Indirect effects on seabirds from the impacts on prey availability;
- Direct disturbances resulting from the construction activities; and
- Disturbances caused by increased vessel traffic

To avoid repetition, these impact assessments have been omitted here. The complete assessments of significant impacts for the construction phase of sub-variant 2B can be found in the subchapter concerning sub-variant 2A.

IV.2.12.5.3 Operational phase

The intervention in the marine environment during the operational phase of sub-variant 2B will be the same as in sub-variant 2A. All the potential impacts on seabirds, resulting from these activities, have been assessed in the subchapter concerning sub-variant 2A. These potential impacts include:

- Indirect effects on seabirds from the impacts on prey availability;
- Direct disturbances resulting from the construction activities; and
- Disturbances caused by increased vessel traffic.

To avoid repetition, these impacts have not been discussed in detail here. See the subchapter concerning sub-variant 2A for the full discussion of the operational impacts.

IV.2.12.6 Marine mammals

IV.2.12.6.1 Development stage

The works carried out in the marine environment at the development stage in sub-variant 2B will be the same as in sub-variant 2A, which includes the construction of the MOLF, the sewage treatment works (STW) and the temporary sheet pile wall (on the foreshore and in the marine part) or caissons (in the marine part) near the STW's pipeline and the discharge pipeline. The impacts on the marine mammals are further elaborated in Chapter IV.10.02.

This is the same position as where the underwater noise modelling and assessment focused on the most significant underwater noise sources associated with the Project (the piling, dredging and rock material dumping), and no difference was made between the sub-variants considered (the open or the closed system) when assessing the actual noise sources.

All the potential impacts on the four marine mammal species assessed resulting from these activities are discussed in the subchapter concerning sub-variant 2A. These potential impacts and effects include:

- Effects of underwater construction noise;
- Indirect effects on the marine mammal species from the impacts on prey availability (on the example of fish);
- Disturbances caused by increased vessel traffic; and
- Increased risk of collisions as a result of increased vessel traffic.

To avoid repetition, the impact assessment has not been presented here in detail. The full assessment of the impacts relevant to the development stage can be found in the subchapter concerning sub-variant 2A.

IV.2.12.6.2 Construction stage

The work to be done in the marine environment at the development stage of sub-variant 2B will be the same as in sub-variant 2A, which includes the inlet and outlet structures of the cooling water system, the FRRS, the temporary sheet pile walls (onshore and offshore) or caissons (offshore) near the cooling water channels / pipelines.

All the potential impacts on the marine mammals resulting from these works have been assessed in the subchapter concerning sub-variant 2A. These potential impacts and effects include:

- Effects of underwater construction noise;
- Indirect effects on the marine mammal species from the impacts on prey availability (on the example of fish);
- Disturbances caused by increased vessel traffic; and

- Increased risk of collisions as a result of increased vessel traffic.

The full discussion of the impacts related to the development stage can be found in the subchapter concerning sub-variant 2A. The assessment of noise at the construction stage is the same as for the development stage, summarised above.

IV.2.12.6.3 Operational phase

The intervention in the marine environment during the operational phase of sub-variant 2B will be the same as in sub-variant 2A, which includes underwater noise related to seawater intake / discharge, mechanical screens / pumps and vessels operating at the MOLF. These potential impacts and effects include:

- Underwater noise from seawater inlets / outlets, mechanical screens / pumps and vessels operating at the MOLF;
- Disturbances caused by increased vessel traffic; and
- Increased risk of collisions as a result of increased vessel traffic.

To avoid repetition, the full discussion of the operational impacts on the marine mammals can be found in the subchapter concerning sub-variant 2A. Also, reference is made here to the foregoing table, for the same findings regarding the sources, receptors, impact magnitudes and significance of the effects (underwater noise, disturbances and collision risk).

IV.2.13 Summary and conclusions – Variant 2 – Żarnowiec site

IV.2.13.1 Sub-variant 2A: closed cooling system using seawater

The assessment of the potential effects of the impacts associated with the construction of the marine infrastructure of the Project on the receptors in the marine environment has been carried out with a breakdown into the groups of receptors and the stages of the Project.

The detailed assessments of the potential impacts resulting from the Project have been presented in the previous chapter: in most cases, given the application of the proposed mitigation measures, the effects will be negligible or minor and insignificant.

- For the operational phase of sub-variant 2A, it has been found that the effects of the release of nutrients in the discharge of process effluents from the cooling water system would be medium (potentially significant) due to the effects on phytoplankton and the associated impacts on eutrophication. However, if additional mitigation measures are implemented, the severity of these effects can be reduced to minor (insignificant).
- Similarly, the concentration of certain chemical ingredients in the process effluent discharge, including biocides, has a potential to affect plankton communities, with effects considered to be medium (potentially significant). Here, too, the implementation of the described additional mitigation measures would reduce their severity to minor (insignificant).
- In the case of avifauna and, in particular, the qualifying features of the SPA, it has been found that disturbances caused by increased vessel traffic are of medium to high significance and are therefore significant for certain bird species, including the wintering velvet scoter, common scoter, long-tailed duck and razorbill. However, if additional mitigation measures are implemented, the severity of these effects can be reduced to minor (insignificant).

In conclusion, the analysis of sub-variant 2A has not identified any significant adverse environmental impacts on the receptor groups in the marine environment.

IV.2.13.2 Sub-Variant 2B: closed cooling system using desalinated seawater

The assessment of the potential effects of the impacts associated with the construction of the Project's marine infrastructure on the receptors in the marine environment has been carried out with the breakdown into the groups of receptors and the stages of the Project.

The potential impacts of sub-variant 2B on each group of the receptors are generally negligible and minor (insignificant) at the development and construction stages and at the operational phase of the Project, except in three cases.

- During the operational phase, the effects of the process effluent discharge may have a medium (potentially significant) effect on plankton if additional mitigation measures are not implemented. This is due to the presence of biocides and biogenic components in the process effluent discharge, which could lead to changes in plankton communities over several decades.
- Disturbances caused by the marine vessel traffic can have a potentially major (significant) effect on the common white-winged scoter, the most sensitive wintering bird species found in the adjacent SPA.
- For less sensitive wintering bird species (the common scoter, long-tailed duck and razorbill), the potential effect of disturbances caused by seagoing vessels has been assessed as moderate (potentially significant).

Additional mitigation measures for the potentially significant impacts will turn the medium (potentially significant) effects on plankton and the medium / major (significant) effects on birds into minor (insignificant) ones.

Table IV.2-315 The summary of impacts for selected groups (ichthyofauna, avifauna, marine mammals, non-native species): sub-variant 2A

No.	Source	Receptor importance	Receptor sensitivity	Receptor value	Range of impact	Impact time	Impact frequency	Impact magnitude	Impact significance
Ichthyofauna									
Construction phase of the Project – development stage									
19	Loss of habitats and physical disturbance due to the construction works	High	Low	Medium	Local	Long-term	Continuous	Negligible	Negligible (insignificant)
20	Underwater noise caused by the construction works related to the development stage	High	Low	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
21	Increased amount of suspended sediments and smothering due to the resettlement of suspended sediments	High	Low	Medium	Local	Short-term	Infrequent	Low	Minor (insignificant)
22	Changes in the perception of visual stimuli caused by artificial lighting	High	Low	Medium	Local	Short-term	Infrequent	Negligible	Negligible (insignificant)
23	Spills caused by operations at sea	High	Low	Medium	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
Construction phase of the Project – construction stage									
24	Loss of habitats and physical disturbances caused by the works at the construction stage	High	Low	Medium	Local	Short-term	Infrequent	Negligible	Negligible (insignificant)
25	Impingement during suction dredging at the construction stage	High	Low	Medium	Local	Short-term	Infrequent	Low	Minor (insignificant)
26	Underwater noise caused by the works at the construction stage	High	Low	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
27	Increased amount of suspended sediment and smothering due to the resettlement of suspended sediment at the construction stage	High	Low	Medium	Local	Short-term	Infrequent	Low	Minor (insignificant)
28	Changes in the perception of visual stimuli caused by artificial lighting at the construction stage	High	Low	Medium	Local	Short-term	Infrequent	Negligible	Negligible (insignificant)
29	Spills caused by activities carried out at sea during the construction stage	High	Low	Medium	Regional	Short-term	Infrequent	Negligible	Minor (insignificant)
Operational phase of the Project									
30	Loss of habitats due to the presence of the permanent infrastructure during the operational phase	High	Low	Medium	Local	Long-term	Continuous	Negligible	Negligible (insignificant)

No.	Source	Receptor importance	Receptor sensitivity	Receptor value	Range of impact	Impact time	Impact frequency	Impact magnitude	Impact significance
31	Thermal discharges and discharges containing chemical pollutants in the operational phase	High	Low	Medium	Regional	Long-term	Continuous	Low	Minor (insignificant)
32	Entrapment, entrainment and impingement due to the intake of cooling water at the operational phase	High	Low	Medium	Regional	Long-term	Continuous	Low	Minor (insignificant)
33	Underwater noise caused by service vessel activities related to the operational phase	High	Low	Medium	Local	Long-term	Frequent	Negligible	Negligible (insignificant)
Avifauna									
Construction phase of the Project – development stage									
34	Impact on food availability – the marine bird features of SPA / Ramsar sites (the wintering common gull, common scoter, European herring gull, long-tailed duck, razorbill and velvet scoter)	High	Medium	Medium	Regional	Short-term	Continuous	Negligible	Negligible (insignificant)
35	Impact on food availability – marine bird features of SPA / Ramsar sites (the black-headed gull, great cormorant and European herring gull during the breeding season)	High	Low	Low	Regional	Short-term	Continuous	Negligible	Negligible (insignificant)
36	Impact on prey availability – other marine bird features (the wintering black-headed gull and great crested grebe)	High	Negligible	Negligible	Regional	Short-term	Continuous	Negligible	Negligible (insignificant)
37	Disturbances resulting from construction works related to the MOLF and the sewage treatment works in the construction phase – the marine bird features of SPA / Ramsar sites (the wintering common scoter, long-tailed duck, razorbill and velvet scoter)	High	Medium	Medium	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)
38	Disturbances resulting from the construction works related to the MOLF and the sewage treatment works during the construction stage – marine bird features of SPA / Ramsar areas (the wintering	High	Low	Low	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)

No.	Source	Receptor importance	Receptor sensitivity	Receptor value	Range of impact	Impact time	Impact frequency	Impact magnitude	Impact significance
	common gull, European herring gull and great cormorant; the European herring gull and the great cormorant during the breeding season)								
39	Disturbances resulting from the construction works related to the MOLF and the sewage treatment works in the construction phase – other marine bird species (the wintering black-headed gull and the great crested grebe)	High	Negligible	Negligible	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)
40	Disturbances caused by increased vessel traffic – marine bird features of the SPA (the wintering velevet scoter)	High	High	High	Regional	Short-term	Frequent	Medium	Major (significant) reduced to minor (insignificant) given mitigation measures
41	Disturbances caused by increased vessel traffic – the marine bird features of the SPA (the wintering common scoter and the razorbill)	High	Medium	Medium	Regional	Short-term	Frequent	Medium	Medium (potentially significant) reduced to minor (insignificant) given mitigation measures
42	Disturbances caused by increased vessel traffic – the marine bird features of the SPA (the great cormorant while wintering and during the breeding season)	High	Low	Negligible	Regional	Short-term	Frequent	Medium	Negligible (insignificant)
Construction phase of the Project – construction stage									
43	Impact on prey availability – the marine bird features of SPA (the wintering common gull, common scoter, European herring gull, long-tailed duck, razorbill and velvet scoter)	High	Medium	Medium	Regional	Continuous	Short-term	Negligible	Negligible (insignificant)
44	Impact on prey availability – marine bird features of SPA (the black-headed gull, great cormorant and the European herring gull during the breeding season)	High	Low	Low	Regional	Continuous	Short-term	Negligible	Negligible (insignificant)
45	Impact on prey availability – other marine bird features (the wintering black-headed gull and great crested grebe)	High	Negligible	Negligible	Regional	Continuous	Short-term	Negligible	Negligible (insignificant)

No.	Source	Receptor importance	Receptor sensitivity	Receptor value	Range of impact	Impact time	Impact frequency	Impact magnitude	Impact significance
46	Disturbances resulting from the construction works related to the construction stage – marine bird features of SPA / Ramsar sites (the wintering common scoter, long-tailed duck, razorbill and velvet scoter)	High	Medium	Medium	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)
47	Disturbances resulting from the construction works related to the construction stage – marine bird features of SPA / Ramsar sites (the wintering common gull and the European herring gull; the black-headed gull, great cormorant and the European herring gull during the breeding season)	High	Low	Low	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)
48	Disturbances resulting from the construction works related to the construction stage – marine bird features of SPA / Ramsar areas (the wintering black-headed gull and the great crested grebe)	High	Negligible	Negligible	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)
49	Disturbances resulting from increased vessel traffic – the marine bird features of the SPA (the wintering velvet scoter)	High	High	High	Regional	Short-term	Frequent	Medium	Major (significant) but can be reduced to minor (insignificant) given mitigation measures
50	Disturbances resulting from increased vessel traffic – the marine bird features of the SPA (the wintering common scoter and razorbill)	High	Medium	Medium	Regional	Short-term	Frequent	Medium	Medium (potentially significant) reduced to minor (insignificant) given mitigation measures
51	Disturbances resulting from increased vessel traffic – the marine bird features of the SPA (the great cormorant during the breeding season and the wintering great crested grebe)	High	Low	Negligible	Regional	Short-term	Frequent	Medium	Negligible (insignificant)
Operational phase of the Project									
52	Impact on prey availability – the marine bird features of SPA (the wintering common gull, common	High	Medium	Medium	Regional	Long-term	Continuous	Negligible	Negligible (insignificant)

No.	Source	Receptor importance	Receptor sensitivity	Receptor value	Range of impact	Impact time	Impact frequency	Impact magnitude	Impact significance
	scoter, European herring gull, long-tailed duck, razorbill and velvet scoter)								
53	Impact on prey availability – marine bird features of SPA (the black-headed gull, great cormorant and the European herring gull during the breeding season)	High	Low	Low	Regional	Long-term	Continuous	Negligible	Negligible (insignificant)
54	Impact on prey availability – marine bird features of SPA (the wintering black-headed gull and the great crested grebe)	High	Negligible	Negligible	Regional	Long-term	Continuous	Negligible	Negligible (insignificant)
55	Direct disturbances caused by the MOLF – the marine bird features of the SPA / Ramsar sites (the wintering common scoter, long-tailed duck, razorbill and velvet scoter)	High	Medium	Medium	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
56	Direct disturbances caused by the MOLF – the marine bird features of the SPA / Ramsar sitrs (the wintering common gull, European herring gull and great cormorant; the European herring gull and the great cormorant during the breeding season)	High	Low	Low	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
57	Direct disturbances caused by the MOLF – the marine bird features (the wintering goldeneye and the great crested grebe, the common gull during the breeding season)	High	Negligible	Negligible	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
58	Disturbances resulting from increased vessel traffic – the marine bird features of the SPA (the wintering velvet scoter)	High	High	High	Regional	Short-term	Infrequent	Negligible	Minor (insignificant)
59	Disturbances resulting from increased vessel traffic – the marine bird features of the SPA (the wintering common scoter and razorbill)	High	Medium	Medium	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
60	Disturbances resulting from increased vessel traffic – the	High	Low	Negligible	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)

No.	Source	Receptor importance	Receptor sensitivity	Receptor value	Range of impact	Impact time	Impact frequency	Impact magnitude	Impact significance
	marine bird features of the SPA (the great cormorant during the breeding season and the wintering great crested grebe)								
	Marine mammals								
	Construction phase of the Project – development stage								
61	Impacts of underwater noise caused by the construction works – the harbour porpoise	High	Low to medium	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
62	Impacts of underwater noise caused by the construction works – the harbour seal, grey seal, ringed seal	High	Low	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
63	Indirect effects on marine mammal species resulting from impacts of the construction works on prey availability – all the species	High	Low	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
64	Effects related to disturbances resulting from increased vessel activity during the construction works – all the species	High	Low	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
65	Collision-related effects due to increased activity of vessels during the construction works – all the species	High	Low	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
	Construction phase of the Project – construction stage								
66	Impacts of underwater noise caused by the construction works – the harbour porpoise	High	Low to medium	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
67	Impacts of underwater noise caused by the construction works – the harbour seal, grey seal, ringed seal	High	Low	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
68	Indirect effects on marine mammal species resulting from the impacts of the construction on prey availability – the harbour porpoise	High	Low to medium	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
69	Indirect effects on marine mammal species resulting from the impacts of the construction on prey availability – the harbour seal, grey seal, ringed seal	High	Low	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)

No.	Source	Receptor importance	Receptor sensitivity	Receptor value	Range of impact	Impact time	Impact frequency	Impact magnitude	Impact significance
70	Effects related to disturbances resulting from increased activity of vessels during the construction works – the harbour porpoise	High	Low to medium	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
71	Effects related to disturbances resulting from increased activity of vessels during the construction works – the harbour seal, grey seal, ringed seal	High	Low	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
72	Effects related to the risk of collision as a result of increased activity of vessels during the construction works – the harbour porpoise	High	Low to medium	Medium	Regional	Long-term	Frequent	Low	Minor (insignificant)
73	Effects related to the risk of collision as a result of increased activity of vessels during the construction works – the harbour seal, grey seal, ringed seal	High	Low	Medium	Regional	Long-term	Frequent	Low	Minor (insignificant)
Operational phase of the Project									
74	Impacts of underwater noise – the harbour porpoise	High	Low to medium	Medium	Regional	Temporary	Infrequent	Negligible	Negligible (insignificant)
75	Impacts of underwater noise – the harbour seal, grey seal, ringed seal	High	Low	Medium	Regional	Temporary	Infrequent	Negligible	Negligible (insignificant)
76	Indirect effects on marine mammal species resulting from impacts on prey availability – the harbour porpoise	High	Low to medium	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
77	Indirect effects on marine mammal species resulting from impacts on prey availability – the harbour seal, grey seal, ringed seal	High	Low	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
78	Effects related to disturbances resulting from increased activity of vessels – the harbour porpoise	High	Low to medium	Medium	Regional	Temporary	Infrequent	Negligible	Negligible (insignificant)
79	Effects related to disturbances resulting from increased activity of vessels – the harbour seal, grey seal, ringed seal	High	Low	Medium	Regional	Temporary	Infrequent	Negligible	Negligible (insignificant)
80	Effects related to the risk of collision as a result of increased	High	Low to medium	Medium	Regional	Long-term	Infrequent	Negligible	Negligible (insignificant)

No.	Source	Receptor importance	Receptor sensitivity	Receptor value	Range of impact	Impact time	Impact frequency	Impact magnitude	Impact significance
	activity of vessels – the harbour porpoise								
81	Effects related to the risk of collision as a result of increased activity of vessels – the harbour seal, grey seal, ringed seal	High	Low	Medium	Regional	Long-term	Infrequent	Negligible	Negligible (insignificant)
Invasive non-native species (INNS)									
82	Introduction of invasive non-native species (INNS) – all the receptors	Various	Various	Various	Regional	Permanent	Infrequent	Low	Minor (insignificant)

Source: [456]

Table IV.2-316 The summary of the impacts for the selected groups (ichthyofauna, avifauna, marine mammals): sub-variant 2B

No.	Source	Receptor importance	Receptor sensitivity	Receptor value	Range of impact	Impact time	Impact frequency	Impact magnitude	Impact significance
Ichthyofauna									
Construction phase of the Project – development stage									
19	Loss of habitats and physical disturbance due to the construction works	High	Low	Medium	Local	Long-term	Continuous	Negligible	Negligible (insignificant)
20	Underwater noise caused by the construction works related to the development stage	High	Low	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
21	Increased amount of suspended sediments and smothering due to the resettlement of suspended sediments	High	Low	Medium	Local	Short-term	Infrequent	Low	Minor (insignificant)
22	Changes in the perception of visual stimuli caused by artificial lighting	High	Low	Medium	Local	Short-term	Infrequent	Negligible	Negligible (insignificant)
23	Spills caused by operations at sea	High	Low	Medium	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
Construction phase of the Project – construction stage									
24	Loss of habitats and physical disturbances caused by the works at the construction stage	High	Low	Medium	Local	Short-term	Infrequent	Negligible	Negligible (insignificant)
25	Impingement during suction dredging at the construction stage	High	Low	Medium	Local	Short-term	Infrequent	Low	Minor (insignificant)
26	Underwater noise caused by the works at the construction stage	High	Low	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
27	Increased amount of suspended sediment and smothering due to the	High	Low	Medium	Local	Short-term	Infrequent	Low	Minor (insignificant)

No.	Source	Receptor importance	Receptor sensitivity	Receptor value	Range of impact	Impact time	Impact frequency	Impact magnitude	Impact significance
	resettlement of suspended sediment at the construction stage								
28	Changes in the perception of visual stimuli caused by artificial lighting at the construction stage	High	Low	Medium	Local	Short-term	Infrequent	Negligible	Negligible (insignificant)
29	Spills caused by activities carried out at sea during the construction stage	High	Low	Medium	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
Operational phase of the Project									
30	Loss of habitats due to the presence of the permanent infrastructure during the operational phase	High	Low	Medium	Local	Permanent	Continuous	Negligible	Negligible (insignificant)
31	Thermal discharges and discharges containing chemical pollutants in the operational phase	High	Low	Medium	Regional	Long-term	Continuous	Low	Minor (insignificant)
32	Entrapment, entrainment and impingement due to the intake of cooling water at the operational phase	High	Low	Medium	Regional	Long-term	Continuous	Low	Minor (insignificant)
33	Underwater noise caused by service vessel activities related to the operational phase	High	Low	Medium	Local	Long-term	Frequent	Negligible	Negligible (insignificant)
Avifauna									
Construction phase of the Project – development stage									
34	Impact on food availability – the marine bird features of SPA / Ramsar sites (the wintering common gull, common scoter, European herring gull, long-tailed duck, razorbill and velvet scoter)	High	Medium	Medium	Regional	Short-term	Continuous	Negligible	Negligible (insignificant)
35	Impact on food availability – marine bird features of SPA / Ramsar sites (the black-headed gull, great cormorant and European herring gull during the breeding season)	High	Low	Low	Regional	Short-term	Continuous	Negligible	Negligible (insignificant)
36	Impact on prey availability – other marine bird features (the wintering black-headed gull and great crested grebe)	High	Negligible	Negligible	Regional	Short-term	Continuous	Negligible	Negligible (insignificant)
37	Disturbances resulting from construction works related to the MOLF and the sewage treatment works in the construction phase – the marine bird features of SPA / Ramsar sites (the wintering common scoter,	High	Medium	Medium	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)

No.	Source	Receptor importance	Receptor sensitivity	Receptor value	Range of impact	Impact time	Impact frequency	Impact magnitude	Impact significance
	long-tailed duck, razorbill and velvet scoter)								
38	Disturbances resulting from the construction works related to the MOLF and the sewage treatment works during the construction stage – marine bird features of SPA / Ramsar areas (the wintering common gull, European herring gull and great cormorant; the European herring gull and the great cormorant during the breeding season)	High	Low	Low	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)
39	Disturbances resulting from the construction works related to the MOLF and the sewage treatment works in the construction phase – other marine bird species (the wintering black-headed gull and the great crested grebe)	High	Negligible	Negligible	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)
40	Disturbances caused by increased vessel traffic – marine bird features of the SPA (the wintering velevet scoter)	High	High	High	Regional	Short-term	Frequent	Medium	Major (significant) reduced to minor (insignificant) given mitigation measures
41	Disturbances caused by increased vessel traffic – the marine bird features of the SPA (the wintering common scoter and the razorbill)	High	Medium	Medium	Regional	Short-term	Frequent	Medium	Medium (potentially significant) reduced to minor (insignificant) given mitigation measures
42	Disturbances caused by increased vessel traffic – the marine bird features of the SPA (the great cormorant while wintering and during the breeding season)	High	Low	Negligible	Regional	Short-term	Frequent	Medium	Negligible (insignificant)
	Construction phase of the Project – construction stage								
43	Impact on prey availability – the marine bird features of SPA (the wintering common gull, common scoter, European herring gull, long-tailed duck, razorbill and velvet scoter)	High	Medium	Medium	Regional	Continuous	Short-term	Negligible	Negligible (insignificant)
44	Impact on prey availability – marine bird features of SPA (the black-headed gull, great cormorant and the	High	Low	Low	Regional	Continuous	Short-term	Negligible	Negligible (insignificant)

No.	Source	Receptor importance	Receptor sensitivity	Receptor value	Range of impact	Impact time	Impact frequency	Impact magnitude	Impact significance
	European herring gull during the breeding season)								
45	Impact on prey availability – other marine bird features (the wintering black-headed gull and great crested grebe)	High	Negligible	Negligible	Regional	Continuous	Short-term	Negligible	Negligible (insignificant)
46	Disturbances resulting from the construction works related to the construction stage – marine bird features of SPA / Ramsar sites (the wintering common scoter, long-tailed duck, razorbill and velvet scoter)	High	Medium	Medium	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)
47	Disturbances resulting from the construction works related to the construction stage – marine bird features of SPA / Ramsar sites (the wintering common gull and the European herring gull; the black-headed gull, great cormorant and the European herring gull during the breeding season)	High	Low	Low	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)
48	Disturbances resulting from the construction works related to the construction stage – marine bird features of SPA / Ramsar areas (the wintering black-headed gull and the great crested grebe)	High	Negligible	Negligible	Regional	Short-term	Frequent	Negligible	Negligible (insignificant)
49	Disturbances resulting from increased vessel traffic – the marine bird features of the SPA (the wintering velvet scoter)	High	High	High	Regional	Short-term	Frequent	Medium	Major (significant) but can be reduced to minor (insignificant) given mitigation measures
50	Disturbances resulting from increased vessel traffic – the marine bird features of the SPA (the wintering common scoter and razorbill)	High	Medium	Medium	Regional	Short-term	Frequent	Medium	Medium (potentially significant) reduced to minor (insignificant) given mitigation measures
51	Disturbances resulting from increased vessel traffic – the marine bird features of the SPA (the great cormorant during the breeding season and the wintering great crested grebe)	High	Low	Negligible	Regional	Short-term	Frequent	Medium	Negligible (insignificant)
Operational phase of the Project									

No.	Source	Receptor importance	Receptor sensitivity	Receptor value	Range of impact	Impact time	Impact frequency	Impact magnitude	Impact significance
52	Impact on prey availability – the marine bird features of SPA (the wintering common gull, common scoter, European herring gull, long-tailed duck, razorbill and velvet scoter)	High	Medium	Medium	Regional	Long-term	Continuous	Negligible	Negligible (insignificant)
53	Impact on prey availability – marine bird features of SPA (the black-headed gull, great cormorant and the European herring gull during the breeding season)	High	Low	Low	Regional	Long-term	Continuous	Negligible	Negligible (insignificant)
54	Impact on prey availability – marine bird features of SPA (the wintering black-headed gull and the great crested grebe)	High	Negligible	Negligible	Regional	Long-term	Continuous	Negligible	Negligible (insignificant)
55	Direct disturbances caused by the MOLF – the marine bird features of the SPA / Ramsar sites (the wintering common scoter, long-tailed duck, razorbill and velvet scoter)	High	Medium	Medium	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
56	Direct disturbances caused by the MOLF – the marine bird features of the SPA / Ramsar sitrs (the wintering common gull, European herring gull and great cormorant; the European herring gull and the great cormorant during the breeding season)	High	Low	Low	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
57	Direct disturbances caused by the MOLF – the marine bird features (the wintering goldeneye and the great crested grebe, the common gull during the breeding season)	High	Negligible	Negligible	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
58	Disturbances resulting from increased vessel traffic – the marine bird features of the SPA (the wintering velvet scoter)	High	High	High	Regional	Short-term	Infrequent	Negligible	Minor (insignificant)
59	Disturbances resulting from increased vessel traffic – the marine bird features of the SPA (the wintering common scoter and razorbill)	High	Medium	Medium	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)
60	Disturbances resulting from increased vessel traffic – the marine bird features of the SPA (the great	High	Low	Negligible	Regional	Short-term	Infrequent	Negligible	Negligible (insignificant)

No.	Source	Receptor importance	Receptor sensitivity	Receptor value	Range of impact	Impact time	Impact frequency	Impact magnitude	Impact significance
	cormorant during the breeding season and the wintering great crested grebe)								
Marine mammals									
Construction phase of the Project – development stage									
61	Impacts of underwater noise caused by the construction works – the harbour porpoise	High	Low to medium	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
62	Impacts of underwater noise caused by the construction works – the harbour seal, grey seal, ringed seal	High	Low	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
63	Indirect effects on marine mammal species resulting from impacts of the construction works on prey availability – all the species	High	Low	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
64	Effects related to disturbances resulting from increased vessel activity during the construction works – all the species	High	Low	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
65	Collision-related effects due to increased activity of vessels during the construction works – all the species	High	Low	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
	Construction phase of the Project – construction stage								
66	Impacts of underwater noise caused by the construction works – the harbour porpoise	High	Low to medium	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
67	Impacts of underwater noise caused by the construction works – the harbour seal, grey seal, ringed seal	High	Low	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
68	Indirect effects on marine mammal species resulting from the impacts of the construction on prey availability – the harbour porpoise	High	Low to medium	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
69	Indirect effects on marine mammal species resulting from the impacts of the construction on prey availability – the harbour seal, grey seal, ringed seal	High	Low	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
70	Effects related to disturbances resulting from increased activity of vessels during the construction works – the harbour porpoise	High	Low to medium	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)
71	Effects related to disturbances resulting from increased activity of	High	Low	Medium	Regional	Temporary	Frequent	Low	Minor (insignificant)

No.	Source	Receptor importance	Receptor sensitivity	Receptor value	Range of impact	Impact time	Impact frequency	Impact magnitude	Impact significance
	vessels during the construction works – the harbour seal, grey seal, ringed seal								
72	Effects related to the risk of collision as a result of increased activity of vessels during the construction works – the harbour porpoise	High	Low to medium	Medium	Regional	Long-term	Frequent	Low	Minor (insignificant)
73	Effects related to the risk of collision as a result of increased activity of vessels during the construction works – the harbour seal, grey seal, ringed seal	High	Low	Medium	Regional	Long-term	Frequent	Low	Minor (insignificant)
Operational phase of the Project									
74	Impacts of underwater noise – the harbour porpoise	High	Low to medium	Medium	Regional	Temporary	Infrequent	Negligible	Negligible (insignificant)
75	Impacts of underwater noise – the harbour seal, grey seal, ringed seal	High	Low	Medium	Regional	Temporary	Infrequent	Negligible	Negligible (insignificant)
76	Indirect effects on marine mammal species resulting from impacts on prey availability – the harbour porpoise	High	Low to medium	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
77	Indirect effects on marine mammal species resulting from impacts on prey availability – the harbour seal, grey seal, ringed seal	High	Low	Medium	Local	Temporary	Frequent	Low	Minor (insignificant)
78	Effects related to disturbances resulting from increased activity of vessels – the harbour porpoise	High	Low to medium	Medium	Regional	Temporary	Infrequent	Negligible	Negligible (insignificant)
79	Effects related to disturbances resulting from increased activity of vessels – the harbour seal, grey seal, ringed seal	High	Low	Medium	Regional	Temporary	Infrequent	Negligible	Negligible (insignificant)
80	Effects related to the risk of collision as a result of increased activity of vessels – the harbour porpoise	High	Low to medium	Medium	Regional	Long-term	Infrequent	Negligible	Negligible (insignificant)
81	Effects related to the risk of collision as a result of increased activity of vessels – the harbour seal, grey seal, ringed seal	High	Low	Medium	Regional	Long-term	Infrequent	Negligible	Negligible (insignificant)
Invasive non-native species (INNS)									
82	Introduction of invasive non-native species (INNS) – all the receptors	Various	Various	Various	Regional	Permanent	Infrequent	Low	Minor (insignificant)

Source: [456]

IV.8 Assessment of impacts on surface waters

IV.8.1 Anticipated emissions to inland surface waters and marine waters

The following chapter contains the description of anticipated emissions to inland surface waters and marine waters related to the execution of the planned Project.

IV.8.1.2 Anticipated emissions to marine waters

IV.8.1.2.1 Variant 1 – Lubiatowo – Kopalino site

IV.8.1.2.1.1 Construction phase

At the construction stage, temporary marine structures will also be necessary to enable building the Project infrastructure, including the cooling water system and FRRS elements. Such temporary works may potentially block the transportation of sediments and the water flow regimes or cause washout of the seabed, which may in turn alter the existing characteristics of the marine environment, coastal as well as intertidal, and translate into potential impacts on marine fauna and flora.

In the case of the submerged pipelines technology, temporary effects are possible from sediment mobilisation in the pelagic zone during dredging of the pipeline trench in the seabed, and subsequent deposition of sediment away from the excavation, as well as from the temporary presence of an open trench. Further dredging may be required over small areas in relation to assembly of seawater intake and discharge chambers as well as recovery of small volumes of material from the trench directly before placing the pipeline sections, if sand settles in since original excavation works.

Release of sediment bound contaminants is also possible. In the case where sediments in the Project area are polluted, all construction works disrupting such sediments may lead to the release of such pollutants, affecting the quality of waters in the vicinity of the site. The use of construction equipment in marine environment creates the risk of impacts on the environment from accidental release/spill of pollutants.

In the case of cooling water infrastructure built with the submerged pipeline technology and in relation to laying other pipeline elements on the surface, it will be necessary to dig trenches across the technical belt and to cause a direct (temporary) impact on the morphology of dunes and the forest cover of dunes.

Potential effects of the impact on the marine environment will result from the discharges of surface water or water from the drainage of the main NPP site to the sea. Accidental releases/spillage of pollutants from construction works conducted on land during the construction stage may also be a source of environmental impacts. Discharges of turbid waters or pollutants from surface drains, excavation drainage or spills will be controlled through the construction, at an early stage of works, of a water drainage and water management system including pollution control measures and sediment drying beds as well as introduction of best practice related to pollution control - minimising pollution in all aspects of construction works, and including the development of Environmental Management Plan.

The table [Table IV.8.1- 15] presents a summary of findings for the construction stage.

Table IV.8.1- 15 Summary of effects at the construction stage of sub-variant 1A

Receptor	Receptor significance	Receptor sensitivity	Source of Impact	Magnitude of impact	Range of impact	Time / Frequency of Impacts	Effect	Significance of effect
Coastal processes and hydromorphology								
Coastal processes and bathymetry	High	Low	Submerged structures	Negligible	Local	Permanent	Negligible	Insignificant
Coastal dunes and forest	Average	Medium	Operational NPP	None	None	None	None	Insignificant
Coastal area management	Average	Low	Operational NPP	None	None	None	None	Insignificant
Quality of sea water								
Physicochemical elements Surface water body as per FWD Surface water body as per MSFD Natura 2000 sites	High	Low	Thermal load from cooling water discharge	Medium	Regional:	Long-term Continuous	Average	Potentially significant
			Waste water discharge	Medium	Regional:	Long-term Continuous	Average, may be reduced to negligible	Potentially significant, may be reduced to insignificant
			Biocides	Medium	Regional:	Long-term Continuous	Average, may be reduced to negligible	Potentially significant, may be reduced to insignificant
			Processed wastewater discharge	Negligible	Regional:	Long-term Continuous	Negligible	Insignificant
			Total wastewater	Medium	Regional:	Long-term Continuous	Average	Potentially significant
Marine ecology								
Plankton and eutrophication	High	Low	Nutrients in operational discharges	Negligible	Regional:	Long-term Continuous	Negligible	Insignificant
Habitats	High	Medium	Direct loss	None	None	None	Negligible	Insignificant
Macroalgae	Average	Medium	Habitat loss	None	None	None	None	Insignificant
			Changes in nutrient status	Negligible	Local	Long-term	Negligible	Insignificant
Zoobenthos	High	Medium	Habitat loss	Negligible	Local	Long-term	Negligible	Insignificant
			Changes to water quality	Low	Local	Long-term	Minor	Insignificant
Migratory fish	High	Low	Impingement and entrapment	Negligible	Transboundary, regional	Long-term Continuous	Negligible	Insignificant
Pelagic and demersal fish	Minor	Low	Impingement and entrapment	Low	Local	Long-term Continuous	Minor	Insignificant
Benthic fish	Minor	Low	Impingement and entrapment	Negligible	Local	Long-term Continuous	Negligible	Insignificant
Protection significant fish species	High	Low	Impingement and entrapment	Negligible	Regional:	Long-term	Negligible	Insignificant
Overall fish populations (as food source)	High	Low	Impingement and entrapment	Low	Regional:	Long-term	Average	Potentially significant
			Changes to water quality	Low	Regional:	Long-term	Negligible	Insignificant

Receptor	Receptor significance	Receptor sensitivity	Source of Impact	Magnitude of impact	Range of impact	Time / Frequency of Impacts	Effect	Significance of effect
Marine mammals	High	Low	Underwater noise	Negligible	Regional:	Long-term Rare	Negligible	Insignificant
			Ship collisions	Negligible	Local	Long-term Rare	Negligible	Insignificant
			Reduced availability of prey species	Negligible	Regional:	Long-term Continuous	Negligible	Insignificant
Overall birds	High	Low	Disruption	Negligible	Local	Long-term Rare	Negligible	Insignificant
Piscivorous birds			Reduced availability of prey species of fish	Medium	Regional:	Long-term Continuous	Average	Potentially significant
Benthos-eating birds			Reduced availability of benthic prey species	Negligible	Local	Long-term Continuous	Negligible	Negligible

Source: In-house study

Table IV.8.3- 4 Summary of effects at the construction stage: sub-variants 1B and 1C

Receptor	Receptor significance	Receptor sensitivity	Source of Impact	Magnitude of impact	Range of impact	Time / Frequency of Impacts	Effect	Significance of effect
Coastal processes and hydromorphology								
Coastal processes and bathymetry	High	Low	Construction works at sea	Negligible	Local	Medium-term Continuous	Negligible	Insignificant
Coastal dunes and forest	Average	Medium	Loss/damage from excavation works	Negligible	Local	Medium-term Rare	Negligible	Insignificant
Coastal area management	High	Low	Changes to coastline and sediment transport	Low	Regional:	Medium-term Continuous	Minor	Insignificant
Quality of sea water								
Overall physicochemical elements Surface water body as per FWD Surface water body as per MSFD Natura 2000 sites	High	Low	Construction works at sea	Negligible	Regional:	Temporary Short-term	Negligible	Insignificant
			Removal of dredge spoil	Negligible	Regional:	Temporary Short-term	Negligible	Insignificant
			Accidental spill from works at sea	Negligible	Local	Short-term Rare	Negligible	Insignificant
			Construction works on land	Negligible	Local	Continuous long-term	Negligible	Insignificant
Marine ecology								
All biological receptors	High	Low	Changes in water quality due to construction activities	Low	Local	Temporary	Negligible (minor effects possible from temporary loss of benthic habitats)	Insignificant

Source: In-house study

IV.8.1.2.2 Variant 1 – Lubiatowo – Kopalino site

IV.8.1.2.2.1 Operational phase

In terms of the quality of seawater, key potential effects are related to the discharge of waste water, mainly the thermochemical stream from the NPP cooling water system, but also from the site's main wastewater treatment plant. A contribution is also present from service wastewater, discharged through the water discharge chambers. Wherever necessary, discharges of water were assessed for the end-of-pipe concentrations/Emission Level Value and the EQS standards [83] (based on predicted no-effect concentration [PNEC], on the basis of toxicity results and other considerations) in the receiving marine waters. In the case where the water discharge meets EQS for specific substances at the point of discharge, such substances may be excluded from further analysis and assessment. For other substances, discharge of water and effects of sediment mobilisation were evaluated by comparing the anticipated concentrations in the environment with EQS and the guidelines values. For wastewater discharge EQS was included for microbiological parameters. Potential impact on physical processes at sea and the shoreline geomorphology during operation are expected to be limited to the impacts on waves, currents and sediment transport resulting from long-term presence and operation of the NPP infrastructure. The changes may lead to local washout (if protection elements are not installed). Impact on marine ecological characteristics is also plausible through changes in water quality and/or geomorphology of the coastline.

It should be noted that ELV were introduced mainly on the basis of a best available technique (BAT) definition for individual industries [108], to ensure the implementation of BAT so that in the case of wastewater discharges the release of pollutants to the environment can be minimised. This aids in the achievement of the WFD targets in terms of restrictions on releases of dangerous substances to waters. Therefore, while ELV compliance aids in the achievement of WFD goals, the assessment of environmental impacts in the individual parts of water bodies is still required, also when the ELV are met.

Potential effects for physical processes at sea and the shoreline geomorphology during operation are expected to be limited to the effects on waves, currents and sediment transport resulting from long-term presence and operation of the NPP infrastructure. The changes may lead to a local washout (if protection elements are not installed). Impact on marine ecological characteristics is also plausible through changes in water quality and/or geomorphology of the coastline.

The tables below present the impact of the Project execution on individual components of the marine surface water environment.

Table IV.8.3- 3 Summary of effects during the operation of sub-variant 1A

Receptor	Receptor significance	Receptor sensitivity	Source of Impact	Magnitude of impact	Range of impact	Time / Frequency of Impacts	Effect	Significance of effect
Coastal processes and hydromorphology								
Coastal processes and bathymetry	High	Low	Submerged structures	Negligible	Local	Permanent	Negligible	Insignificant
Coastal dunes and forest	Average	Medium	Operational NPP	None	None	None	None	Insignificant
Coastal area management	Average	Low	Operational NPP	None	None	None	None	Insignificant
Quality of sea water								
Physicochemical elements Surface water body as per FWD Surface water body as per MSFD Natura 2000 sites	High	Low	Thermal load from cooling water discharge	Medium	Regional	Long-term Continuous	Average	Potentially significant
			Waste water discharge	Medium	Regional	Long-term Continuous	Average, may be reduced to negligible	Potentially significant, may be reduced to insignificant
			Biocides	Medium	Regional	Long-term Continuous	Average, may be reduced to negligible	Potentially significant, may be reduced to insignificant
			Processed wastewater discharge	Negligible	Regional	Long-term Continuous	Negligible	Insignificant
			Total wastewater	Medium	Regional	Long-term Continuous	Average	Potentially significant
Marine ecology								
Plankton and eutrophication	High	Low	Nutrients in operational discharges	Negligible	Regional	Long-term Continuous	Negligible	Insignificant
Habitats	High	Medium	Direct loss	None	None	None	Negligible	Insignificant
Macroalgae	Average	Medium	Habitat loss	None	None	None	None	Insignificant
			Changes in nutrient status	Negligible	Local	Long-term	Negligible	Insignificant
Zoobenthos	High	Medium	Habitat loss	Negligible	Local	Long-term	Negligible	Insignificant
			Changes to water quality	Low	Local	Long-term	Minor	Insignificant
Migratory fish	High	Low	Impingement and entrapment	Negligible	Transboundary, regional	Long-term Continuous	Negligible	Insignificant

<table>
<tr><th>Receptor</th><th>Receptor significance</th><th>Receptor sensitivity</th><th>Source of Impact</th><th>Magnitude of impact</th><th>Range of impact</th><th>Time / Frequency of Impacts</th><th>Effect</th><th>Significance of effect</th></tr>
<tr><td>Pelagic and demersal fish</td><td>Minor</td><td>Low</td><td>Impingement and entrapment</td><td>Low</td><td>Local</td><td>Long-term Continuous</td><td>Minor</td><td>Insignificant</td></tr>
<tr><td>Benthic fish</td><td>Minor</td><td>Low</td><td>Impingement and entrapment</td><td>Negligible</td><td>Local</td><td>Long-term Continuous</td><td>Negligible</td><td>Insignificant</td></tr>
<tr><td>Protection significant fish species</td><td>High</td><td>Low</td><td>Impingement and entrapment</td><td>Negligible</td><td>Regional</td><td>Long-term</td><td>Negligible</td><td>Insignificant</td></tr>
<tr><td rowspan="2">Overall fish populations (as food source)</td><td rowspan="2">High</td><td rowspan="2">Low</td><td>Impingement and entrapment</td><td>Low</td><td>Regional</td><td>Long-term</td><td>Average</td><td>Potentially significant</td></tr>
<tr><td>Changes to water quality</td><td>Low</td><td>Regional</td><td>Long-term</td><td>Negligible</td><td>Insignificant</td></tr>
<tr><td rowspan="3">Marine mammals</td><td rowspan="3">High</td><td rowspan="3">Low</td><td>Underwater noise</td><td>Negligible</td><td>Regional</td><td>Long-term Rare</td><td>Negligible</td><td>Insignificant</td></tr>
<tr><td>Ship collisions</td><td>Negligible</td><td>Local</td><td>Long-term Rare</td><td>Negligible</td><td>Insignificant</td></tr>
<tr><td>Reduced availability of prey species</td><td>Negligible</td><td>Regional</td><td>Long-term Continuous</td><td>Negligible</td><td>Insignificant</td></tr>
<tr><td>Overall birds</td><td rowspan="3">High</td><td rowspan="3">Low</td><td>Disruption</td><td>Negligible</td><td>Local</td><td>Long-term Rare</td><td>Negligible</td><td>Insignificant</td></tr>
<tr><td>Piscivorous birds</td><td>Reduced availability of prey species of fish</td><td>Medium</td><td>Regional</td><td>Long-term Continuous</td><td>Average</td><td>Potentially significant</td></tr>
<tr><td>Benthos-eating birds</td><td>Reduced availability of benthic prey species</td><td>Negligible</td><td>Local</td><td>Long-term Continuous</td><td>Negligible</td><td>Negligible</td></tr>
</table>

Source: In-house study

Table IV.8.3- 4 Summary of effects at the construction stage: sub-variants 1B and 1C

<table>
<tr><th>Receptor</th><th>Receptor significance</th><th>Receptor sensitivity</th><th>Source of Impact</th><th>Magnitude of impact</th><th>Range of impact</th><th>Time / Frequency of Impacts</th><th>Effect</th><th>Significance of effect</th></tr>
<tr><td colspan="9">Coastal processes and hydromorphology</td></tr>
<tr><td>Coastal processes and bathymetry</td><td>High</td><td>Low</td><td>Operation of Sub-variant 1B</td><td>Negligible</td><td>Local</td><td>Permanent</td><td>Negligible</td><td>Insignificant</td></tr>
<tr><td colspan="9">Quality of sea water</td></tr>
<tr><td rowspan="2">Overall physicochemical elements
Surface water body as per FWD
Surface water body as per MSFD
Natura 2000 sites</td><td rowspan="2">High</td><td rowspan="2">Low</td><td>Thermal load from cooling water discharge</td><td>Negligible</td><td>Local</td><td>Continuous</td><td>Negligible</td><td>Insignificant</td></tr>
<tr><td>Waste water discharge (other than nutrients)</td><td>Medium, may be reduced to negligible</td><td>Regional</td><td>Long-term Continuous</td><td>Average, may be reduced to negligible</td><td>Potentially significant, may be reduced to insignificant</td></tr>
</table>

Receptor	Receptor significance	Receptor sensitivity	Source of Impact	Magnitude of impact	Range of impact	Time / Frequency of Impacts	Effect	Significance of effect
			Biocide discharge	Low	Regional	Long-term Continuous	Minor	Insignificant
			Processed wastewater discharge	Negligible	Regional	Long-term Continuous	Negligible	Insignificant
			Saline discharge	Low	Local	Long-term Continuous	Minor	Insignificant
			Overall discharge	Low to negligible	Local	Long-term Continuous	Negligible	Insignificant
Marine ecology								
Biogenic conditions	High	Low	Nutrients in operational discharges	Medium	Regional	Long-term Continuous	Average, may be reduced to negligible	Potentially significant, may be reduced to insignificant
Plankton	High	Low		Low	Regional	Long-term Continuous		
Macroalgae	Average	Medium	Habitat loss and smothering	Negligible	Regional	Long-term Continuous	Negligible	Insignificant
Zoobenthos	High	Medium	Habitat loss	Negligible	Local	Long-term Continuous	Negligible	Insignificant
			Changes to water quality	Low to negligible	Local	Long-term Continuous	Negligible	Insignificant
Fish	High	Low	Impingement and entrapment	Negligible	Local	Long-term Continuous	Negligible	Insignificant
Marine mammals	High	Low	Operation of Sub-variant 1B	Negligible	Local	Long-term	Negligible	Insignificant
Birds	High	Low	Operation of Sub-variant 1B	Negligible	Local	Long-term	Negligible	Insignificant

Source: In-house study

Table IV.8.3- 5 Summary of effects during the operation of sub-variant 1C (only differences from 1B shown)

Receptor	Receptor significance	Receptor sensitivity	Source of Impact	Magnitude of impact	Range of impact	Time / Frequency of Impacts	Effect	Significance of effect
Coastal processes and hydromorphology								
Coastal processes and bathymetry	High	Low	Operation of Sub-variant 1C	Negligible	Local	Permanent	Negligible	Insignificant
Coastal waters	Average	Medium	Operation of Sub-variant 1C	None	None	None	None	Insignificant
Coastal area management	High	Low	Operation of Sub-variant 1C	None	None	None	None	Insignificant

Receptor	Receptor significance	Receptor sensitivity	Source of Impact	Magnitude of impact	Range of impact	Time / Frequency of Impacts	Effect	Significance of effect
Quality of sea water								
Overall physicochemical elements Surface water body as per FWD Surface water body as per MSFD Natura 2000 sites	High	Low	Thermal load from cooling water discharge	Negligible	Regional	Continuous	Negligible	Insignificant
			Waste water discharge (other than nutrients)	Medium, may be reduced to low	Regional	Long-term Continuous	Medium, may be reduced to minor	Potentially significant, may be reduced to insignificant
			Saline discharge	Low	Local	Long-term Continuous	Minor	Insignificant
			Overall discharge	Low to negligible	Local	Long-term Continuous	Negligible	Insignificant
Marine ecology								
Biogenic conditions	High	Low	Nutrients in operational discharges	Medium	Regional	Long-term Continuous	Average, may be reduced to negligible	Potentially significant, may be reduced to insignificant
Plankton	High	Low		Low	Regional	Long-term Continuous		
Habitats	High	Medium	Direct loss	Negligible	Local	Long-term Continuous	Negligible	Insignificant
Macroalgae	Average	Medium	Habitat loss and smothering	Negligible	Local	Long-term	Negligible	Insignificant
Zoobenthos	High	Medium	Habitat loss	Negligible	Local	Long-term	Negligible	Insignificant
			Changes to water quality	Negligible	Local	Long-term	Negligible	Insignificant
Fish	High	Low	Impingement and entrapment	Negligible	Local	Long-term	Negligible	Insignificant

Receptor	Receptor significance	Receptor sensitivity	Source of Impact	Magnitude of impact	Range of impact	Time / Frequency of Impacts	Effect	Significance of effect
Marine mammals	High	Low	Operation of Sub-variant 1B	Negligible	Local	Long-term	Negligible	Insignificant
Birds	High	Low	Operation of Sub-variant 1B	Negligible	Local	Long-term	Negligible	Insignificant

Source: In-house study

IV.8.1.2.2.2 Decommissioning phase

Potential effects to shoreline geomorphology and marine waters during decommissioning of the Project will depend on the planned scope of decommissioning in the marine environment. Although the decommissioning of an NPP is generally well understood, there is no information available as to which elements of marine infrastructure will be removed and which will remain in place.

Due to a significant shortage of confirmed information regarding the decommissioning phase, not only in relation to the planned activities but also in reference to environmental conditions and regulatory framework to be binding at the time, detailed impact assessment was not conducted. However, based on the experience from other projects of a similar character, the potential effects are anticipated to be similar to those at the development and construction stages, although smaller in scope.

On this basis, and considering the fact that potential impacts on the quality of marine waters, coastal geomorphology and marine ecology at development and construction stages are found insignificant, it can also be assumed that such impacts during decommissioning will also be insignificant.

IV.8.1.2.3 Variant 2 – Żarnowiec site

IV.8.1.2.3.1 Construction phase

During execution, temporary marine structures will also be necessary to enable the construction of the Project infrastructure, including the cooling water/makeup water system and FRRS elements. Such temporary works may potentially block the transportation of sediments and the water flow regimes or cause washout of the seabed, which may in turn alter the existing characteristics of the marine environment, coastal as well as intertidal, and translate into potential impacts on marine fauna and flora.

In the case of cooling water/makeup water infrastructure built in open excavations, it will be necessary to dig trenches across the technical belt and to cause a direct (temporary) impact on the morphology of dunes and the forest cover of dunes. Temporary effects in the marine environment are also possible from sediment mobilisation to the pelagic zone during dredging of the pipeline trench in the seabed, and subsequent deposition of sediments away from the excavation, as well as from the temporary presence of an open trench. Further dredging may be required over small areas in relation to assembly of inlets and outlets as well as removal of small volumes of material from the trench directly before placing the pipeline sections, due to natural sedimentation.

A release was also possible (including accidental) of pollutants, which in the case of sediments may affect the quality of marine waters in the direct vicinity of the Project.

The final potential effect from impacts on the marine environment would result from wastewater discharge from activities related to drainage of the NPP site and surface water flow to the sea. Accidental releases/spillage of pollutants from construction works conducted on land during construction phase may also be a source of environmental impacts. Discharges of turbid drainage waters or pollutants from spills will be controlled through the construction, at an early stage of works, of a water drainage and water management system including pollution control measures and sediment drying beds as well as introduction of best practice related to pollution control in all aspects of construction works.

Summary of impacts related to the construction stage of sub-variants 2A and 2B is presented below.

Table IV.8.3- 6 Summary of impacts at the construction stage: sub-variants 2A and 2B

Receptor	Receptor significance	Receptor sensitivity	Source of Impact	Magnitude of impact	Range of impact	Time / Frequency of Impacts	Effect	Significance of effect
Coastal processes and hydromorphology								
Hydromorphological characteristics	High	Low	Changes to hydrography, sediment transport and morphology of seabed from construction works at sea	Low	Regional	Continuous mid-term	Minor	Insignificant
Coastal dunes and associated forest	High	Medium	Loss/damage from excavation works	Low	Local	Mid-term, rare	Minor	Insignificant
Coastal area management (beach and dune morphology)	Major to moderate	Medium to good	Changes to coastline and sediment transport regime	Low	Regional	Continuous mid-term	Minor	Insignificant
Quality of sea water								
Overall physicochemical elements Surface water body as per FWD Surface water body as per MSFD Natura 2000 sites	High	Low	Construction works at sea	Negligible	Local	Short-term, rare	Negligible	Insignificant
			Removal of dredge spoil	Negligible	Regional	Short-term, temporary	Negligible	Insignificant
			Accidental spill from works at sea	Negligible	Regional	Short-term, rare	Negligible	Insignificant
			Construction works on land	Negligible	Local	Continuous long-term	Negligible	Insignificant
Marine ecology								
Habitats	High	Medium	Direct loss (permanent)	Negligible	Local	Long-term	Negligible	Insignificant
			Direct loss (temporary)	Low	Regional	Medium-term	Negligible	Insignificant
Plankton	High	Low	Eutrophication from construction works	Negligible	Local	Short-term (dredging), mid-term-term (discharge from site), continuous	Negligible	Insignificant

Receptor	Receptor significance	Receptor sensitivity	Source of Impact	Magnitude of impact	Range of impact	Time / Frequency of Impacts	Effect	Significance of effect
Macroalgae	Average	Medium	Direct loss	None	None	None	None	Insignificant
			Smothering	Negligible	Local	Short-term, rare	Negligible	Insignificant
Zoobenthos	High	Medium	Disruption of seabed and smothering	Negligible	Local	Mid-term, rare	Negligible	Insignificant
Fish	High	Low	Changes to water quality	Negligible	Local	Short-term, rare	Negligible	Insignificant
			Underwater noise	Low	Regional	Temporary, frequent	Minor	Insignificant
Marine mammals	High	Low	Underwater noise	Low	Regional	Temporary, frequent	Minor	Insignificant
			Collisions with ships	Negligible	Local	Temporary, rare	Negligible	Insignificant
			Reduced availability of prey	Negligible	Regional	Temporary, frequent	Negligible	Insignificant
Birds	High	Low	Disruption	Negligible	Local	Temporary, frequent	Negligible	Insignificant
			Reduced availability of prey	Negligible	Regional	Continuous mid-term	Negligible	Insignificant

Source: In-house study

IV.8.1.2.3.2 Operational Phase

Potential effects for physical processes at sea and the shoreline geomorphology during operation are expected to be limited to the effects on waves, currents and sediment transport resulting from long-term presence and operation of the NPP infrastructure. The changes may lead to local washout (if protection elements are not installed). Impact on marine ecological characteristics is also plausible through changes in water quality and/or geomorphology of the coastline.

In terms of the quality of seawater, key potential effects are related to the discharge of waste water, mainly the thermochemical plume from the NPP cooling water system, but also from the site's main wastewater treatment plant. A contribution is also present from service wastewater, discharged through the cooling water discharge chambers. Wherever necessary, discharges of water were assessed for the emission level values (ELV) at end-of-pipe and the EQS standards (based on predicted no-effect concentration [PNEC] on the basis of toxicity results and other considerations) in the receiving marine waters. In the case where the water discharge meets EQS for specific substances at the point of discharge, such substances may often be excluded from further analysis and assessment. For other substances, discharge of water and effects of sediment mobilisation were evaluated by comparing the anticipated concentrations in the environment with EQS and the guidelines values. For wastewater discharge EQS was included for microbiological parameters.

It should be noted that ELV were introduced mainly on the basis of a best available technique (BAT) definition for individual industries, to ensure BAT applications so that in the case of discharges to water the release of pollutants to the environment can be minimised. This aids in the achievement of the WFD targets in terms of restrictions on releases of dangerous substances to the water. Therefore, while ELV compliance aids in the achievement of WFD goals, the assessment of environmental impacts in the individual surface water bodies is still required, also when the ELV are met.

Summary of impacts related to the operation of sub-variants 2A and 2B is presented below.

Table IV.8.3- 7 Summary of impacts during the operational phase: sub-variant 2A

Receptor	Receptor significance	Receptor sensitivity	Source of Impact	Magnitude of impact	Range of impact	Time / Frequency of Impacts	Effect	Significance of effect
Coastal processes and hydromorphology								
Coastal processes and bathymetry	High	Low	Operation of sub-variant 2A	Negligible	Local	Permanent, continuous	Negligible	Insignificant
Coastal dunes and associated forest	High	Medium	Operation of sub-variant 2A	None	None	None	None	Insignificant
Coastal area management (beach morphology)	High	Medium	Operation of sub-variant 2A	None	None	None	None	Insignificant
Quality of sea water								
Overall physicochemical elements Surface water body as per FWD Surface water body as per MSFD Natura 2000 sites	High	Low	Thermal load from cooling water discharge	Low	Local to regional	Continuous long-term	Minor	Insignificant
			Waste water discharge (other than nutrients)	Medium, may be reduced to negligible	Regional	Continuous long-term	Medium, may be reduced to negligible	Potential significant, may be reduced to insignificant
			Biocide discharge	Low	Regional	Continuous long-term	Minor	Insignificant
			Processed wastewater discharge	Negligible	Regional	Continuous long-term	Negligible	Insignificant
			Saline discharge	Low	Local to regional	Continuous long-term	Minor	Insignificant
			Overall discharge	Low to negligible	Local to regional	Continuous long-term	Negligible to minor	Insignificant
Marine ecology								
Eutrophication Biogenic conditions	High	Low	Nutrients in operational discharges	Medium	Regional	Continuous long-term	Medium, may be reduced to negligible	Potential significant, may be reduced to insignificant
Plankton	High	Low	Nutrients in operational discharges	Low	Regional	Continuous long-term	Medium, may be reduced to negligible	Potentially significant, may be reduced to insignificant
Macroalgae	Medium	Medium	Direct loss	Negligible	Local	Permanent, continuous	Negligible	Insignificant

Receptor	Receptor significance	Receptor sensitivity	Source of Impact	Magnitude of impact	Range of impact	Time / Frequency of Impacts	Effect	Significance of effect
			Changes in nutrient status	Negligible	Regional	Continuous long-term	Negligible	Insignificant
			Changes in water temperature	Negligible	Regional	Continuous long-term	Negligible	Insignificant
Zoobenthos	High	Medium	Habitat loss	Negligible	Local	Continuous long-term	Negligible	Insignificant
			Changes to water quality	Low to negligible	Local to regional	Continuous long-term	Negligible	Insignificant
Fish	High	Low	Underwater noise	Negligible	Regional	Long-term, rare	Negligible	Insignificant
			Impingement and entrapment	Low to negligible	Local	Continuous long-term	Minor	Insignificant
Marine mammals	High	Low	Underwater noise	Negligible	Regional	Short-term, rare	Negligible	Insignificant
			Increased marine traffic and risk of collision	Negligible	Local	Short-term, rare	Negligible	Insignificant
			Reduced availability of prey	Negligible	Local	Short-term, continuous	Negligible	Insignificant
Birds	High	Low	Disruption	Negligible	Local	Short-term, rare	Negligible	Insignificant
			Reduced availability of prey	Negligible	Local	Continuous long-term	Negligible	Insignificant

Source: In-house study

Table IV.8.3- 8 Summary of impacts during the operational phase: sub-variant 2B (only differences from sub-variant 2A shown)

Receptor	Receptor significance	Receptor sensitivity	Source of Impact	Magnitude of impact	Range of impact	Time / Frequency of Impacts	Effect	Significance of effect
Coastal processes and hydromorphology								
Coastal processes and bathymetry	High	Low	Operation of Sub-variant 2B	Negligible	Local	Permanent	Negligible	Insignificant
Coastal dunes and associated forest	High	Medium	Operation of Sub-variant 2B	None	None	None	None	Insignificant
Coastal area management (beach morphology)	High	Low	Operation of Sub-variant 2B	None	None	None	None	Insignificant
Quality of sea water								
Overall physicochemical elements Surface water body as per FWD Surface water body as per MSFD Natura 2000 sites	High	Low	Thermal load from cooling water discharge	Low	Local to regional	Continuous	Minor	Insignificant
			Waste water discharge (other than nutrients)	Medium, may be reduced to low	Regional	Continuous long-term	Medium, may be reduced to minor	Potentially significant, may be reduced to insignificant
			Processed wastewater discharge	Negligible	Regional	Continuous long-term	Negligible	Insignificant
			Saline discharge	Low	Local to regional	Continuous long-term	Minor	Insignificant
			Overall discharge	Low, may be reduced to negligible	Regional	Continuous long-term	Minor, may be reduced to negligible	Insignificant
Marine ecology								
Biogenic conditions	High	Low	Nutrients in operational discharges	Medium, may be reduced to low	Regional	Continuous long-term	Medium, may be reduced to minor	Potentially significant, may be reduced to insignificant
Plankton	High	Low	Nutrients in operational discharges	Medium, may be reduced to low	Regional	Continuous long-term	Medium, may be reduced to minor	Potentially significant, may be reduced to insignificant
Macroalgae	Average	Medium	Direct loss	Negligible	Local	Permanent, continuous	Negligible	Insignificant

Receptor	Receptor significance	Receptor sensitivity	Source of Impact	Magnitude of impact	Range of impact	Time / Frequency of Impacts	Effect	Significance of effect
			Changes to water temperature and chemical quality	Negligible	Local to regional	Continuous long-term	Negligible	Insignificant
Zoobenthos	High	Medium	Habitat loss	Negligible	Local	Continuous long-term	Negligible	Insignificant
			Changes to water quality	Low to negligible	Local to regional	Continuous long-term	Negligible	Insignificant
Fish	High	Low	Underwater noise	Negligible	Regional	Long-term, rare	Negligible	Insignificant
			Impingement and entrapment	Low to negligible	Local	Continuous long-term	Minor	Insignificant
Marine mammals	High	Low	Reduced availability of prey	Negligible	Local	Continuous long-term	Negligible	Insignificant
			Increased marine traffic and risk of collision	Negligible	Local	Short-term, rare	Negligible	Insignificant
			Disruption	Negligible	Local	Short-term, rare	Negligible	Insignificant
Birds	High	Low	Disruption	Negligible	Local	Short-term, rare	Negligible	Insignificant
			Reduced availability of prey	Negligible	Local	Continuous long-term	Negligible	Insignificant

Source: In-house study

IV.8.1.2.3.3 Decommissioning phase

Potential effects to shoreline geomorphology and marine waters during decommissioning of the Project will depend on the planned scope of decommissioning in the marine environment. Although the decommissioning of an NPP is generally well understood, there is no information available as to which elements of marine infrastructure will be removed and which will remain in place.

Due to a significant shortage of confirmed information regarding the decommissioning phase, not only in relation to the planned activities but also in reference to environmental conditions and regulatory framework to be binding at the time, detailed impact assessment was not conducted. However, based on the experience from other projects of a similar character, the potential effects are anticipated to be similar to those at the development and construction stages, although smaller in scope.

On this basis, and considering the fact that potential impacts on the quality of marine waters, coastal geomorphology and marine ecology at development and construction stages are found insignificant, it can also be assumed that such impacts during decommissioning will also be insignificant.

IV.8.3 Impacts on marine surface waters

This chapter presents the results of the sub-variant assessment of the impacts of the planned Project on marine surface waters.

As explained in [Chapter IV.2.3] of this report, the assessment of the impacts on seawaters in terms of biological elements, within the meaning of the WFD, and organisms (fish, birds, marine mammals) constituting higher-order consumers in the marine trophic chain, as mentioned above, has been carried out based on sources of information, one of which was the assessment of the impacts of the planned Project on the quality indicators of marine surface waters: physical, chemical, hydromorphological and biological as part of [456]. The assessment of the quality indicators [456] was the basis for the assessment of the impacts on the above-mentioned organisms and on the forms of nature protection (among others, Natura 2000 sites).

IV.8.3.1 Variant 1 – Lubiatowo - Kopalino site

IV.8.3.1.5 Impact assessment: Sub-Variant 1A – open cooling system

IV.8.3.1.5.1 Construction phase

Development stage

<u>Effects on coastal processes and hydromorphology</u>

Construction works at sea have a potential to affect a number of elements of coastal processes and hydromorphology. Changes in the wave or sea current patterns can change the sediment transport balance and erosion / deposition patterns, which can ultimately affect the morphology of the seabed (including coastal spits), beaches and coastal dune systems.

The works considered in this chapter concern land clearing and earthworks in the land part of the technical belt, during which there will be no direct physical disturbances of the marine environment. There is also no potential cause-and-effect relationship between the impacts and there are no effects on coastal processes and hydromorphology.

<u>Effects on seawater quality</u>

At the development stage, in order to prepare the site for the construction of the Project at the construction stage, it will be necessary to carry out a number of works on land. These will probably include works related to land clearing, forest felling, removal of topsoil and change of the terrain profile, which will allow to provide a safe base for the main works related to the implementation of the Project.

All works would be carried out on land, but they could have a potential to affect seawater quality if surface run-offs are diverted to the sea. Surface run-offs from the construction site can potentially cause a change in the quality of seawater directly adjacent to Variant 1 – Lubiatowo - Kopalino site. However, the cause-and-effect relationship of such impacts is limited, especially taking into account the fact that, before commencement of the works, an Environmental Management Programme will be developed to determine appropriate pollution control measures (such as sediment control) that will be implemented as part of all the works related to the Project. The quality of seawater is of **high significance** but **low sensitivity**, and any impacts would be **local**, **infrequent** and **short-term**, of a **negligible magnitude**. Any impacts on seawater quality associated with the preparatory works will be **negligible** and, therefore, **insignificant**.

Effects on marine ecology

The effects on the marine biology at the development stage, unrelated to the MOLF and the sewage treatment works at the construction stage, are limited to the effects resulting from the land construction works and, above all, surface run-offs from the construction site, if they are directed to the marine environment.

By implementing appropriate control measures to mitigate the release of potentially contaminated surface run-offs [Chapter V.3], the pathways for impacts on the marine ecological receptors will be significantly reduced, so the effects will occur less frequently and on a smaller scale. The effects are therefore considered **negligible** and **insignificant**.

Construction stage

General information

At the construction stage, temporary marine structures will be necessary to facilitate the construction of the Project's infrastructure, including the cooling water system and the FRRS components. Such temporary works have a potential to block sediment transport and water flow patterns, or cause washout of the seabed, which can subsequently change existing features of the marine and coastal environment, as well as translate into possible effects on marine flora and fauna.

In the case of the submerged channel technology, transient effects can occur in connection with the sediment mobilisation in the pelagic zone during the dredging of the trench in the seabed, in which the channel will be laid, and subsequent deposition of sediment away from the trench, as well as the very fact of the presence of this trench for some time. Further dredging would be necessary in small areas due to the installation of the seawater intake and discharge chambers and, probably, when re-extracting small amounts of material from the trench immediately before the laying of the submerged channel segments, if sand accumulates in the trench since the first dredging.

Sediment-related pollutants could also be released. If sediments in the Project Area are contaminated, any construction works affecting these sediments could lead to the release of these pollutants, thus affecting the quality of seawater in the immediate vicinity of the site. The use of construction equipment in the marine environment would also entail a risk of environmental impacts resulting from the accidental release / spillage of pollutants.

In the case of the cooling water infrastructure (the submerged channel), and in connection with the laying of other elements of pipes on the surface, it would be necessary to make excavations through the Technical Belt, which would lead to direct (although temporary) morphological impacts on dunes and dune forests.

The last of these potential impacts on the marine environment results from the discharge of surface waters or waters from the drainage of the main NPP site into the sea. Also, an accidental release / spillage of pollutants from the land construction works at the construction stage could be a source of environmental impacts. Discharges of turbid water from surface drainage and from trench drainage, or discharges of spills, would be controlled by the water drainage and management system (built at an early stage of the works), including measures for controlling pollution and the resettlement of suspended sediments, and through implementation of good practices on pollution control measures in all aspects of the construction works, as set out in [ChapterV.3].

Effects on coastal processes and hydromorphology

This chapter assesses the impacts of new structures in the coastal environment on coastal processes, morphological features of the coastal zone, as well as bathymetry. The assessment focuses on the impacts of the works on the characteristics of the dunes, as well as on the cumulative impact on the integrity of the coastal system as a whole (defined in relation to the entire technical belt) and the resulting implications for coastal management.

Effects on hydrodynamics and sediment transport

At the construction stage of the Project, there will be a number of temporary infrastructure elements in the marine environment, including the dyke, sheet piles (sheet pile walls) installed across the beach and the coast for the construction of the cooling water channels and the FRRS, including possible smaller cylindrical cofferdams located further from the shore for the purposes of the cooling water intake and discharge structures and the FRRS outlet chamber.

Sediments in the marine environment outside the Project Area will be transported mainly in the eastern direction. Due to the disturbance of the sediment transport patterns and the reduction in the speed of the seawater current, it is expected that sediments will accumulate west of the temporary dykes. The predicted intensification of currents at the end of the dyke from the sea side will increase the local erosion throughout the time of the dyke's presence.

The anticipated erosion and deposition during the peak of the changes, due to the presence of the marine infrastructure, are within the limits of the natural variability recorded in the marine survey area, and it is expected that, by the end of the recovery period, many areas where erosion / accumulation was more severe will already be restored to the baseline levels and the residual impacts will continue to disappear. Based on this, it can be assumed that after 36 months the regeneration process will be ongoing, since the accumulated material will be incorporated into the existing sediment transport patterns.

The predicted scale of erosion and deposition of surface sediments caused by the presence of structures is generally within the limits of the natural variability predicted in the baseline state model for comparable periods. A further analysis has been carried out, focusing on areas affected by the erosion / accumulation of material, where the change exceeded 0.25m. The area affected was the largest in the 24^{th} month, after four months of regeneration, when it was 2.4 km^2.

Altogether, the hydromorphological features described above, which jointly make the parameters of the water body within the meaning of the WFD and the MSFD, are of high significance due to the presence of the nature protection areas (Przybrzeżne wody Bałtyku SPA) and the potential of impacts on fauna and flora supporting important features of this site due to changes in hydromorphological conditions. The highly dynamic nature of the seabed and the shoreline means that the environment exposed to the impacts will better tolerate the change and will return to its former state relatively quickly (within a maximum of 1-5 years), which means that it is considered to be an environment with low sensitivity.

The spatial range of the changes in the current and wave patterns, and consequently the direction of sediment transport and the morphology of the seabed, would be regional, based on the area undergoing the change extending beyond the area in the immediate vicinity of the place of construction of the marine infrastructure. The impacts would be continuous and medium-term, and of low magnitude due to the relatively limited seabed area affected by morphological changes and the scale of these changes compared to the levels of the natural variability recorded in the marine survey area of the Project site.

The effects are therefore **minor (insignificant)** because, despite their importance, the water bodies, within the meaning of the WFD and the MSFD, would be able to absorb this change, which is within the limits of the natural variability.

<u>Direct physical impacts in the coastal dune zone</u>

The types of construction works in the coastal zone, on beaches and in the dune system would depend on the chosen construction methods. However, in the worst-case scenario of using the submerged channel technology, it would be necessary to make temporary excavations leading from the site of the Project through the technical belt to the sea, in which the inlet tunnels and the cooling water outlet tunnel would be placed, and which would pass directly through the dunes. The digging of excavations would require the use of longitudinal formworks (overlapping sheet pile walls) to prevent collapse, extending deep into the sea, as well as drainage (at least when casting sections of the tunnel). It has been assumed that the smaller FRRS's outlet pipeline, if laid in the excavation, would be placed in the same trenches.

Due to the need to remove trees and dig trenches, there will also be direct impacts on the dune area. It is predicted that the inlet channels will require the digging of a trench about 30m wide, which will exist for about 12 months, while a similar trench for the outlet channel will be about 17m wide and will exist for about 8 months [456]. It has been assumed that a 5-6 m wide access roads would be required on both sides of each trench, allowing access for formwork installation equipment, so the total width of the forest cut-through in the service belt for the two excavations would be about 70 m.

Given the short-term and transient nature of the impacts, and the relatively small area of dunes and forests affected by them, the potential effects would be **insignificant**.

<u>Effects on coastal management requirements</u>

The beaches located a little further away from the Project are covered by ongoing restoration / replenishment programmes using locally obtained sediments as a source material. Similar works may be required near the site of the Project in the future, depending on changes in the shoreline and management strategy. The effects of the construction works of the construction phase on the seawater current velocity, wave height, sediment transport patterns and subsequent erosion / accumulation patterns on the seabed are **minor** in terms of the magnitude and, therefore, **insignificant**.

The modelling results show that the effects of the temporary disturbance of the coastal sediment transport as a result of the presence of the marine infrastructure would contribute little to the shoreline erosion and build-up, within the limits of their natural variability. Due to natural processes, any changes caused by the construction of the Project would be temporary and the situation would begin to return to normal after the cessation of the works. Therefore, the impacts magnitude would be **low**. The impacts on the coastal erosion and coastal management would probably be **minor** and insignificant.

Effects on seawater quality

<u>Effects of the construction works at sea</u>

The modelling scenarios described in this chapter address the option based on the submersed tunnel technology, as this is considered the worst-case scenario from the perspective of the impacts on the marine water environment.

Modelling has been carried out to determine the amounts of sediments that would be moved from the seabed and released within the overflow from the dredgers during the installation of the cooling water intake and discharge channels and the FRRS channel. As mentioned above, the modelling was based on the assumption of construction by the open excavation method, which is the worst-case scenario when it comes to mobilising sediments as a result of digging the trenches for the cooling water intake and discharge channels, running from the dyke to the location of the water intake and discharge chambers. The main source of sediment agitation on the seabed, associated with the use of a cutting-suction dredger (CSD), is the "dredge plume" raised by the suction drag head. However, the levels of sediment disturbance on the seabed are negligible compared to the overflow plume generated by the dredges and barges onto which the excavated material is loaded. Dredging in small areas would also be necessary when installing the water intake and discharge chambers, which also leads to overflow streaks.

- This can affect locally the quality indicators: phytoplankton and phytobenthos for biological elements within the meaning of the WFD, as well as fish. The maximum exposure area is 12.7 km^2 for the normal dredging scenario. Such overruns are temporary in nature and are largely limited to the site area [204] [456].
- The results of the modelling show that the increase in the concentrations of suspended sediments due to the dredging works is less than 5 mg outside the area of Variant 1 – Lubiatowo - Kopalino site. This can be compared with the measurements of the initial conditions of suspended sediments carried out in 2017-2018, which showed a maximum value of 6.22 mg/l [209].
- It has been concluded that the effects on the quality of seawaters in the identified receptors (i.e. the designated water bodies, within the meaning of the WFD, and the MSFD) resulting from the impacts during the construction phase of the facility would be insignificant.

Effects of re-use or discharge of material from dredging

The excess material excavated during the construction of the entire marine infrastructure would need to be re-used (for example, for beach nourishment) or dumped in a place agreed with the Maritime Office in Gdynia.

Based on the above comparisons with the guidelines, it can therefore be concluded that the seabed surface sediments in the marine survey area for Variant 1 – Lubiatowo - Kopalino site can be considered uncontaminated and suitable for discharge at a dump site agreed with the Maritime Office in Gdynia. For the purposes of the assessment it has been assumed that if the surface sediments are not contaminated, the deeper sediments will also be pollution-free. As a consequence, no modelling of disposal activities has been carried out and, based on currently available research data, it has been concluded that any effects of the discharge of spoil would be **insignificant**.

Effects of spills from operations at sea

Diesel and lubricating oils from marine facilities (and beach equipment), concrete or mortar spills, construction waste and dust can be potential sources of pollution resulting from marine operations.

Spills can be of concern when actively carrying out works in the marine environment, also during the operational phase if supplies are required, and when loading / unloading vessels at the MOLF supplying equipment and materials for land construction works. However, since the risk of the occurrence of such events, which are random and inherently unplanned, cannot be classified for the purposes of this assessment, these impacts are considered to be infrequent and short-term.

All relevant / significant pollution control measures will be specified in the ETP for the Project. Thanks to compliance with the assumptions of the ETP, the impacts would be **negligible**: they would be short-term, their spatial range would be local, and material spills would quickly disperse in the wider marine environment.

In particular, with regard to the aspects of water quality in water bodies, within the meaning of the WFD and the MSFD, and the possibility of their being affected by pollution from accidental spills, it has been established that the identified receptors, that is, the physico-chemical elements supporting water bodies, within the meaning of the WFD, and parameters 5 and 8 of water bodies, within the meaning of the MSFD, are of high significance due to the presence of the nature protection areas (Przybrzeżne wody Bałtyku SPA) and the possibility of affecting the flora and fauna supporting important features of this site, as a result of changes in water quality. However, as described above, they are believed to have low sensitivity.

Although, at this stage, it is not possible to determine the exact degree of dilution and coverage area for each instance of spill, due to the unplanned nature of such events in the coastal zone, the spatial extent of the impacts resulting from possible spills is considered to be **local**.

Assuming the application of the foregoing mitigation measures, it is considered that the effects of an accidental spill would be **negligible** and **insignificant**.

Effects of onshore construction works

Due to the proximity of the Project site to the shoreline, it is likely that the land construction works will affect the marine environment both on the area of the main Project site and within the coastal beach / dunes.

Preliminary estimates of the volume of water discharges from drainage during the construction phase were made based on the existing groundwater modelling. It is assumed that all groundwater from the drainage would be discharged into the Baltic Sea through the same outlet as the effluents, provided that during the construction phase these two streams would merge downstream the sewage treatment works.

Surface run-offs from roads, paved areas of parking lots, building roofs and areas of land transformation would be intercepted by a network of drains on the site.

The effluent associated with the TBM or HDD drilling is usually recycled to recover the drilling fluid and other additives, at the Slurry Treatment Plant (STP) which would be located on the surface, near the tunnel boring machine [456]. The STP operates in a closed circuit without the need for discharging liquid effluent during operation. Once the tunnelling and the decommissioning of the Slurry Treatment Plant have been completed, it is likely that it will be necessary to remove small amount of liquid impurities that can be treated and removed using other available water treatment systems or stored in off-site tanks so as to avoid potential impacts on inland or coastal surface water bodies.

Similarly, it is assumed that all concrete batching plants located on the construction site will operate in a closed circuit system and, therefore, there will be no discharges of highly alkaline cement milk into the local drainage system.

It has been therefore concluded that any impacts on the water bodies, within the meaning of the WFD and the MSFD, and the related requirements / indicators / objects protected during the construction phase, resulting from the land construction works, will be **insignificant**.

IV.8.3.1.5.3 Effects on marine biology

Loss of habitats

The loss of habitats as a result of the Project can potentially affect zoobenthos and phytobenthos occupying these habitats and, indirectly, also the wider marine ecosystem. The area of the lost seabed was established both for the temporary works and for the target occupancy – permanent impacts.

The direct loss of habitats during the construction phase would occur as a result of the dredging works, as well as the installation of permanent and temporary buildings and structures related to the cooling system, and the fish return and recovery system (FRRS). The calculation of the loss of habitats was based on the assumption that the cooling water system would consist of the submerged tunnel laid using the 500m long dyke. For sub-variant 1A, the total direct loss of habitats is as follows:

- temporary: 893,516 m^2; and
- permanent: 781 m^2.

Based on these calculations, it can be established that the temporary works during the construction phase would result in a temporary total loss of a habitat of approximately 0.894 km^2. The temporary loss of habitats will be **medium-term**, with local and reversible effects, and the permanent loss will be **long-term**, for the duration of the life-cycle of the Project, but with a minimum range. In addition, given the **average** sensitivity of these habitats to disturbances and the fact that after the installation of the water cooling tunnels, the seabed will be restored to its previous state, the impact on habitats is considered to be **minor** and **insignificant**.

Effects on phytoplankton

The construction phase would involve the performance of works that could affect the physical constituents of water quality (fore example, transparency). Although there would be a short-term peak increase in the level of the total suspension to 250 mg/l in the immediate work area in the initial 24-hour period after completion of the construction works, the modelling of the mean thirty-day value of the suspension concentration shows that the suspension level is not expected to increase by more than 25 mg/l after this period, within the immediate work area, without an observable increase outside this area.

The dredging and other activities that disturb the seabed would result in a temporary, short-term, local and reversible increase in the suspension concentrations, as well as a temporary, short-term, local and reversible decrease in the level of the primary productivity of autotrophic organisms, a part of which is phytoplankton, due to the limited amount of light reaching the deeper layers of the water column. Therefore, it is envisaged that the effects of the impacts in this respect will be **negligible** and, therefore, **insignificant**, without a material impact on the status under the WFD and MSFD.

The discharge of waters into the marine environment during the construction phase will be associated, among others, with the drainage of the dyke. Since this is a release of accumulated unprocessed and additive-free seawater, the chemical and biogenic compositions of the water will be the same as those of the receiving seawater. There can also be discharges of surface waters and groundwater from the land construction works but it is envisaged that they will be reduced thanks to the implementation of environmental control measures, including those described in the ETP. Therefore, the effects are expected to be **negligible** and **insignificant**.

The main discharge of waters into the sea during the construction phase will come from land drainage but will not contain elevated nutrient levels and will be treated to control turbidity. Therefore, there will be no possibility of affecting plankton.

Impacts on macroalgae

As macroalgae areas do not coincide with the area of the planned marine infrastructure, there is no possibility of the occurrence of effects. There are therefore **no effects** on macroalgae populations in the form of a direct loss of habitats.

Activities related to the construction phase can potentially cause a local increase in the concentration of suspended solids due to the excitation of sediments and the transition of the fine fraction to the water column. If particles of higher granulation precipitate from the suspension, they can cover the macroalgae. The dredging related to the installation of the cooling water system can potentially have the greatest impacts on the level of the total suspension, with open excavations being the worst-case scenario involving the greatest impacts on the aquatic environment. The highest risk of covering the algae (by the deposition of small particles) with a layer up to 10 cm thick occurs in the area of the works and in immediate proximity, decreasing to 2.5cm in the rest of the Project Area. According to the results of the investor's research carried out in the marine survey area, the thickness of the layer is much smaller than the natural variability occurring in the area of the slope, amounting to up to 1.3m.

Given the high level of this natural variability in the affected area, it is expected that the marine flora inhabiting the area under consideration tolerates changes in the levels of suspension and sedimentation. The effect of an additional increase in the amount of sediments suspended and settling on the seabed beyond the baseline level of the natural change is considered **negligible** and **insignificant**.

Effects on zoobenthos

Populations of zoobenthos organisms inhabiting the circalittoral fine sand in the marine part of the Project Area, with the characteristic fauna of opportunistic bivalves and polychaetes, generally quickly recover from environmental perturbations, showing high resilience and low sensitivity to erosion or physical disturbances of the seabed surface. Similarly, populations inhabiting fine infralittoral sand can also rapidly recolonise if there are source populations in the immediate vicinity, as is the case here, with large areas of both habitats occurring in the wider marine survey area. Therefore, although these habitats are of high significance due to their medium sensitivity, the loss of habitats would be **insignificant**.

The dredging related to the construction of the marine infrastructure will contribute to resuspension of sediments. Zoobenthos in the affected zone may become covered when material precipitates from the suspension, with the worst-case scenario being an increased mortality of specimens staying in the area. The degree of the predicted deposition of material on the seabed is within the limits of the natural variability, and zoobenthos inhabiting these areas is accustomed to such changes. In addition, the material that is likely to settle on the seabed is similar in composition and quality to the sediments that these organisms already inhabit.

The dredging spoil can also be pumped to the sides which can also cause the covering. However, the deposition levels resulting from this activity are also considered to be within the range of the natural variability for the slope area of the seabed tidal zone. The impacts of this additional level of sediments precipitating from the suspension and settling on the seabed would be **local**, **infrequent**, **short-term** and reversible after the end of the dredging. On this basis, it is considered that the effects will be **negligible** and **insignificant**.

Summary of the effects during construction of Sub-Variant 1A

The table below [Table IV.8.3-1] provides a summary of the assessment for the construction stage.

Table IV.8.3-21 The summary of effects during the construction stage of sub-variant 1A*

Receptor	Receptor importance	Receptor sensitivity	Impact source	Impact magnitude	Range of impact	Impact time / frequency	Effect	Effect significance
Coastal processes and hydromorphology								
Coastal processes and bathymetry	High	Low	Presence of submerged structures	Negligible	Local	Permanent	Negligible	Insignificant
Coastal dunes and associated forest	Medium	Medium	Presence of the functional NPP	None	None	None	None	Insignificant
Coastal area management	Medium	Low	Presence of the functional NPP	None	None	None	None	Insignificant
Seawater quality								
Physico-chemical elements Water body as defined by the WFD Water body as defined by the MSFD Natura 2000 sites	High	Low	Thermal load from cooling water discharges	Medium	Regional	Long-term Continuous	Medium	Potentially significant
			Discharges of process effluents	Medium	Regional	Long-term Continuous	Medium, but may be reduced to negligible	Potentially significant but may be reduced to insignificant
			Biocides	Medium	Regional	Long-term Continuous	Medium, but may be reduced to negligible	Potentially significant but may be reduced to insignificant
			Processed wastewater discharge	Negligible	Regional	Long-term Continuous	Negligible	Insignificant
			Combined discharge of effluents	Medium	Regional	Long-term Continuous	Medium	Potentially significant
Marine ecology								
Plankton and eutrophication	High	Low	Nutrients in operational discharges	Negligible	Regional	Long-term Continuous	Negligible	Insignificant

Receptor	Receptor importance	Receptor sensitivity	Impact source	Impact magnitude	Range of impact	Impact time / frequency	Effect	Effect significance
Habitats	High	Medium	Direct loss	None	None	None	Negligible	Insignificant
Macroalgae	Medium	Medium	Loss of habitats	None	None	None	None	Insignificant
			Changes in nutrient status	Negligible	Local	Long-term	Negligible	Insignificant
Zoobenthos	High	Medium	Loss of habitats	Negligible	Local	Long-term	Negligible	Insignificant
			Changes in water quality	Low	Local	Long-term	Minor	Insignificant
Migratory fish	High	Low	Impingement and entrapment	Negligible	Transboundary, regional	Long-term Continuous	Negligible	Insignificant
Pelagic and demersal fish	Low	Low	Impingement and entrapment	Low	Local	Long-term Continuous	Minor	Insignificant
Benthic fish	Low	Low	Impingement and entrapment	Negligible	Local	Long-term Continuous	Negligible	Insignificant
Fish species important from the point of view of conservation	High	Low	Impingement and entrapment	Negligible	Regional	Long-term	Negligible	Insignificant
All fish communities (as a source of food)	High	Low	Impingement and entrapment	Low	Regional	Long-term	Medium	Potentially significant
			Changes in water quality	Low	Regional	Long-term	Negligible	Insignificant
Marine mammals	High	Low	Underwater noise	Negligible	Regional	Long-term Infrequent	Negligible	Insignificant
			Vessel collisions	Negligible	Local	Long-term Infrequent	Negligible	Insignificant
			Reduced availability of prey species	Negligible	Regional	Long-term Continuous	Negligible	Insignificant
All birds	High	Low	Disturbance	Negligible	Local	Long-term	Negligible	Insignificant

Receptor	Receptor importance	Receptor sensitivity	Impact source	Impact magnitude	Range of impact	Impact time / frequency	Effect	Effect significance
						Infrequent		
Ichthyophagous birds			Reduced availability of fish prey species	Medium	Regional	Long-term Continuous	Medium	Potentially significant
Benthophagous birds			Reduced availability of zoobenthos prey species	Negligible	Local	Long-term Continuous	Negligible	Negligible

** In the event of a discrepancy in the assessment of the elements of marine ecology, the results of the assessment presented in [Chapter IV.2.3] should be interpreted as overriding.*

Source: [19]

IV.8.3.1.5.4 Operational phase

General information

From the seawater quality perspective, the main potential effects would be related to the discharge of effluents through the outlet system – mainly the thermo-chemical pollutant stream coming from the water in the NPP's cooling system – as well as from the main sewage treatment works at the NPP site. Process effluents would also contribute, which would also be discharged by water outlet chambers. Where necessary, water discharges have been assessed against the established end-of-pipe concentrations / Emission Level Values at the point of discharge and the environmental quality standards (EQS) (based on the predicted no-effect concentration (PNEC) values based on toxicity studies and other considerations) in the seawater receiving the discharge. Where a water discharge meets the EQS for the individual substances at the point of discharge, then it may be justified to exclude these substances from further consideration in the assessment. For other substances, water discharges and sediment agitation effects have been assessed by comparing predicted environmental concentrations with the EQS and the guideline values. For effluent discharges, EQS for microbiological parameters has been taken into account. The potential impacts on the physical processes taking place in the sea and on the geomorphology of the coast in the operational phase is expected to be limited to impacts on waves, flows and transport of sediments as a result of the long-term presence and operation of the NPP infrastructure. These changes can lead to a local washout (if no washout protection is installed). Marine ecological characteristics are also likely to be affected by changes in water quality and/or coastal geomorphology.

The potential impacts on marine physical processes and coastal geomorphology in the operational phase are expected to be limited to impacts on waves, currents and sediment transport as a result of the long-term presence and operation of the NPP infrastructure. These changes can lead to a local washout of the seabed (if no washout protection is installed). There is also a likelihood of impacts on marine ecological characteristics through changes in water quality and/or coastal geomorphology.

Effects on coastal processes and hydromorphology

<u>Effects on the hydrodynamics and morphology of the seabed</u>

During the operational phase of the Project, numerous elements of permanent infrastructure will be present in the marine environment, including water intake and discharge chambers associated with the cooling water system and the FRRS.

During the configuration of hydromorphological modelling, both the inlet chamber and the outlet chamber were excluded from the model due to their small scale and the location in the less dynamic zone – more distant from the shore [456]. There are likely to be small local changes in the patterns of waves and sea currents, resulting in changes in erosion and deposition processes around the structure. Local washout of the seabed associated with the operation of cooling water pipeline structures can also occur. This will be discussed later in the detailed design, and the Project engineers will refine the final design of the chambers in such a way as to minimise the washout, or by installing appropriate washout protections as part of the construction stage. It is believed that the small size and the location of the water intake and discharge chambers will not cause significant changes in the speed of currents or the wave pattern, which could affect the directions of sediment transport outside their immediate vicinity. The effects on the hydrodynamics and sediment transport patterns, as well as the seabed morphology, resulting from the continuous presence and operation of the water intake and discharge infrastructure and the FRRS associated with the cooling water system is considered **insignificant**.

<u>Direct physical impacts in the coastal dune zone</u>

For the purposes of this assessment, it has been assumed that after the completion of the construction works related to the excavation of the trenches within the service belt, the area of beaches and dunes will be restored to its original state. In addition, since no significant changes in the marine hydrodynamics and sediment transport system within the offshore area of Sub-Variant 1 are anticipated, it is considered that no changes in the morphology of the coastal beaches or dunes will occur as a result of the operation of the Project and, therefore, no impacts will occur. On this basis, it is considered that the impacts on the coastal dune system during the operational phase will be **negligible**.

<u>Effects on coastal management requirements</u>

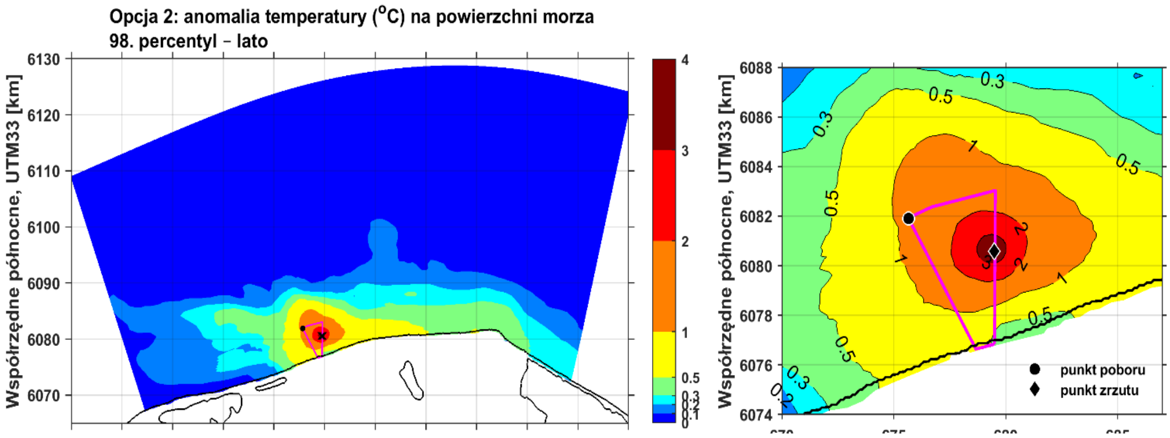
The impacts on the speed of current, wave height, sediment transport and subsequent erosion / accumulation patterns along the seashore in the vicinity of Variant 1 – Lubiatowo - Kopalino site occurring during the operational phase have been determined as **insignificant**.

Effect of discharges on the ambient water temperature

In the case of the open cooling system in Sub-Variant 1A, the cooling water discharge temperature has been determined to be 10°C above the seawater temperature (that is, ΔT = 10°C, where the delta is the difference between the temperature of the receiver and the temperature of the discharge) and, on this basis, flows required to ensure the necessary heat uptake have been calculated [457].

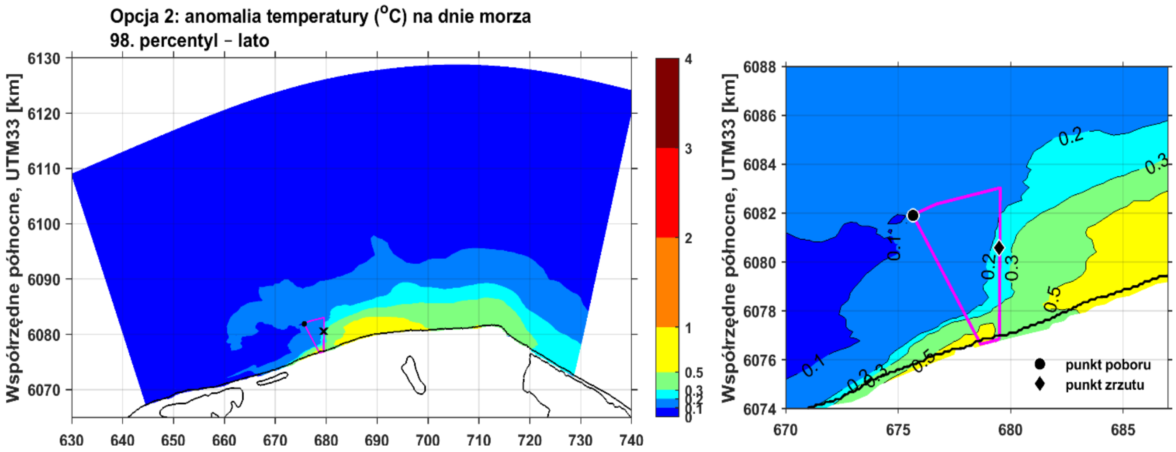
Modelling of cooling water discharges for the proposed location of the cooling water outlet has been carried out, for the open cooling system sub-variant, identifying areas where specific temperature increases are predicted to occur. Particular emphasis was placed on areas where ambient temperature is expected to increase by 2°C or more. Detailed results of this modelling are presented in [457].

A summary of the results of this modelling for Sub-Variant 1A is presented on a seasonal basis in [Figure IV.8.3- 25], [Figure IV.8.3-26], [Figure IV.8.3-27] and [Figure IV.8.3-28] which show the extent of the contour of the temperature increase by 2°C (ΔT) on the sea surface and on the seabed under summer and winter conditions. They show results for the 98th percentile, aggregated on the seasonal scale and, therefore, represent a conservative view of the total range of the thermal impacts.



Opcja 2: anomalia temperatury (°C) na powierzchni morza 98. percentyl - lato	Variant 2: Temperature anomaly (°C) on the sea surface 98th percentile - summer
punkt poboru	intake point
punkt zrzutu	discharge point
Współrzędne północne, UTM33 [km]	Northern coordinates, UTM33 [km]

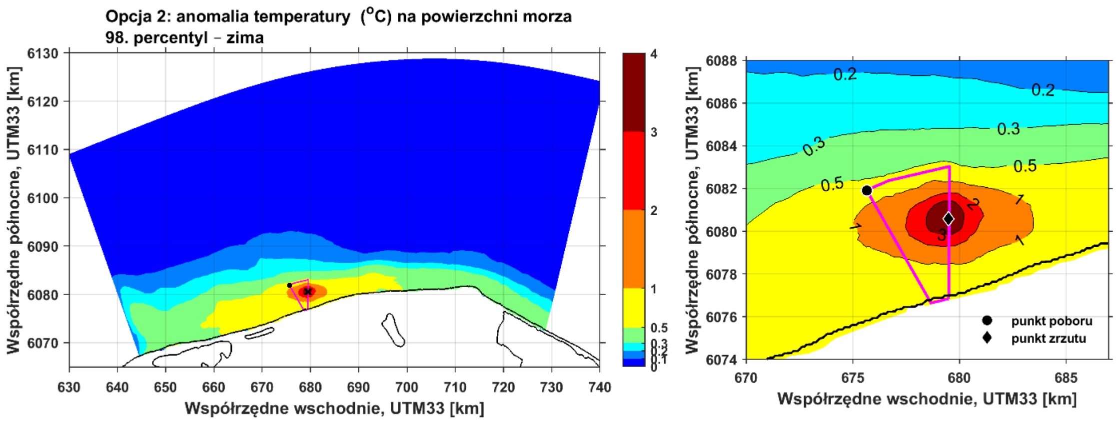
Figure IV.8.3-25 98th percentile of ΔT, on the sea surface (in the surface layer of the water column), in summer
Source: [456]



Opcja 2: anomalia temperatury (°C) na powierzchni morza 98. percentyl - lato	Variant 2: Temperature anomaly (°C) on the sea surface 98th percentile - summer
punkt poboru	intake point
punkt zrzutu	discharge point
Współrzędne północne, UTM33 [km]	Northern coordinates, UTM33 [km]

Figure IV.8.3-26 98th percentile of ΔT, on the seabed (water column bottom), in summer

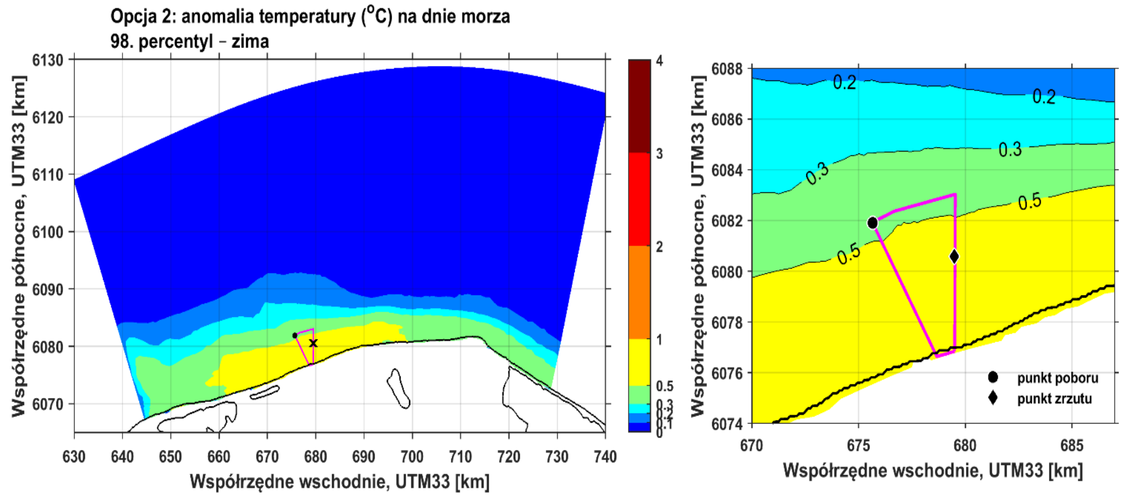
Source: [456]



Opcja 2: anomalia temperatury (°C) na powierzchni morza 98. percentyl - zima	Variant 2: Temperature anomaly (°C) on the sea surface 98th percentile - winter
punkt poboru	intake point
punkt zrzutu	discharge point
Współrzędne północne, UTM33 [km]	Northern coordinates, UTM33 [km]
Współrzędne wschodnie, UTM33 [km]	Eastern coordinates, UTM33 [km]

Figure IV.8.3-27 98th percentile of ΔT, on the sea surface (water column top), in winter

Source: [456]



Opcja 2: anomalia temperatury (°C) na powierzchni morza 98. percentyl - zima	Variant 2: Temperature anomaly (°C) on the sea surface 98th percentile - winter
punkt poboru	intake point
punkt zrzutu	discharge point
Współrzędne północne, UTM33 [km]	Northern coordinates, UTM33 [km]
Współrzędne wschodnie, UTM33 [km]	Eastern coordinates, UTM33 [km]

Figure IV.8.3-28 98th percentile of ΔT, on the seabed (water column bottom), in winter

Source: [456]

It should be noted that heated waters have a greater buoyancy potential than the ambient receiving waters. For this reason, the area where the ΔT would exceed 2°C is larger on the sea surface than on the seabed, which means that the demersal fauna and flora near the point of discharge is not exposed to the highest values of ΔT, due to the aforementioned buoyancy and the speed and direction of the discharge from the diffuser's port – parallel to the bottom and towards the north, perpendicular to the shoreline. In none of the modelling scenarios did the 2°C change reach the shoreline, meaning that no adverse effects are expected on the coast, where a thermal plume in surface waters could affect the seabed and its zoobenthos.

Based on the above modelling, the following conclusions have been drawn:

- The identified receptors – the physico-chemical supporting elements (within the meaning of the WFD and descriptors 5 and 8 within the meaning of the MSFD for the considered SWB) – are of high significance due to the presence of the nature protection areas (Przybrzeżne wody Bałtyku SPA) and the possibility of affecting the biological elements as a result of changes in water quality. Thanks to the dynamic nature of the environment, its assimilation capacity and its ability to regenerate relatively quickly, its **sensitivity** is **low**.
- The spatial range of the 2°C increase in the seawater temperature can be considered regional. Although the modelling shows a wider zone of impact in the case of lower values of the temperature increase, potentially to the regional level, these changes are much smaller in scale.
- As the discharge of cooling water is an essential element of the impacts for the operational phase, the impacts are considered to be continuous and long-term (in the NPP life cycle) in terms of frequency.
- The range – both horizontal (surface spread) and vertical (water column) – of the sea area affected by the temperature rise above 2°C is limited. Although the temperature increase in the affected offshore area would occur in the long term, it would have a local range for the change by up to 2°C and a regional range for the change by less than 2°C and would affect a small part of coastal and marine water bodies.
- The range of the maximum temperature increase of 10°C at the point of discharge would not cause the contour of the temperature increase by 2°C to cover the coastal region and would quickly disperse in the receiving waters (convection, advection).

Since the overall effect of the thermal discharge on water quality would be noticeable against the background of the ambient variability, although limited, it is considered **moderate** and **potentially significant**.

Effects of the discharges on the receiving water body quality

Changes in the ambient water quality resulting from the discharge of process effluents

The process effluents would contain residues of chemicals used in the Nuclear Power Plant to control pH levels, inhibit corrosion, reduce boiler scale formation and remove oxygen from the reactor and steam generator systems, as well as metals resulting from corrosion and oxidation of heat transfer components (the heat exchanger of the reactor and the secondary system of the steam turbine).

For most corrosion products it is assumed that the concentrations at the time of discharge will meet the EQS when diluted with the stream of discharged cooling water. Where necessary, appropriate mitigation measures would be applied – through pre-discharge treatment to reduce concentrations of metallic pollutants in the discharge to acceptable levels – so that the impacts on seawater quality would be **insignificant**.

The treatment of appropriate effluent streams, where necessary, will result in the achievement of the required ELV and EQS levels for all chemical ingredients of the process effluent discharge, so that changes in the ambient water quality as a result of the discharge of process effluents would be **insignificant**.

Changes in the ambient water quality resulting from the discharge of biocides

In order to minimise biofouling under the Project, it may be necessary to use a disinfectant (probably chlorine). The discharge concentration of TRO (as chlorine) was assumed to be 0.2 mg/l. This is the default target concentration at the condenser outlet to prevent biofouling in condensers and upstream [95], and can be considered representative of the typical best practice in the energy sector. If this concentration were maintained until the discharge, it would meet the ELV requirements [372], which are 0.2 mg/l for free chlorine and 0.4 mg/l for combined chlorine (TRO).

Changes in the ambient water quality resulting from the discharge of treated municipal wastewater (sewerage)

During the operational phase, municipal wastewater would be treated by the treatment plant at the NPP site and discharged mixed with cooling water through the cooling water discharge chamber.

The treated effluent from the operational phase would be diluted at least 36,000 times. Therefore, for discharges containing 15 mg/l of total nitrogen and 0.1 mg/l of total phosphorus [20], the concentration for the treated effluent at the point of discharge would be < 0.42 µg/l for total nitrogen and < 3 ng/l for total phosphorus, respectively. These values are within the EQS of 0.3 mg/l (mean in summer for nitrogen) and 0.03 mg/l (mean in summer for phosphorus).

Assessment of the total discharge of effluents to the Baltic Sea

- The identified receptors – the physico-chemical elements supporting water bodies within the meaning of the WFD and parameters 5 and 8 of water bodies within the meaning of the MSFD – are of high significance due to the presence of protected bathing waters and protected nature areas (Przybrzeżne wody Bałtyku SPA) and because of the possibility of causing impacts on flora and fauna supporting important features of this location, as a result of changes in water quality.
- The spatial range of the identified impacts is regional. This is due to the fact that the predicted, measurable changes in the concentrations remain within a radius of 30 km from the point of discharge both in summer and in winter;
- The impact is long-term because the discharge of effluents from the combined processes will continue throughout the operational lifetime of the NPP;
- The impact is continuous because the discharge of effluents from the combined processes will continue throughout the operational lifetime of the NPP;

- Except for chlorine / TRO, for which further mitigation measures are required to bring the adverse impacts to a low or negligible magnitude, and provided that treatment is provided, if necessary, to remove hydrazine and corrosion products, the magnitude of the impacts on water quality would be negligible as the modelled concentrations of chemical ingredients in the effluent discharge from the combined processes would comply with the EQS at the point of discharge or would be within the normal range of concentrations measured in the sea area after the discharge.

Effects on marine ecology

General information

The effects on marine ecology during the operational phase are primarily related to the discharge of effluents and the potential impingement of fish (ichthyofauna, ichthyoplankton) through the water intake chamber. The assessment of the marine ecology has been presented in [Chapter IV.2].

Impacts on plankton and eutrophication

Eutrophication occurs when a body of water is enriched with mineral nutrients, which often leads to blooms of phytoplankton and nuisance algae. The main potential of effects on the nutrient status of the receiving water body is associated with an increased load of nitrogen and phosphorus entering the sea, which affects the existing eutrophication processes in the Baltic Sea [158]. Small amounts of phosphorus-containing compounds will be introduced from the discharge of treated effluents. Receiving waters have already been classified as eutrophic and the EQS values for most nutrient parameters are exceeded (based on the authors' own research from 2017-2018) [219].

Normalised nitrogen loads discharged into Polish territorial waters from the Vistula river basin area amounted to a total of 86,354 tons/year (in the form of N) in 2015. The estimated net additional nitrogen load from the NPP (that is, the load increased by the addition of ammonium nitrogen, hydrazine and morpholine) would be 6.1 tonnes/year (as N), representing a 0.007% increase in the nitrogen content.

The relevant phosphorus values [222] indicate a non-standardised phosphorus content in these seawaters, of 5,476 tonnes/year (as P), with the discharge from the NPP contributing 4 kg/year (as P), representing an increase of 0.00007% compared to the current content.

In addition to introducing nutrients into the system, elevated temperatures could potentially alter the original productivity in the affected area. However, due to the relatively small area affected by increased thermal loads at the operational phase of the Project, the risk of increased primary productivity is considered **insignificant**.

On this basis, the effect of nutrient discharges on phytoplankton growth and the associated zooplankton food chain is expected to be **negligible** and, therefore, **insignificant**.

Effects on macroalgae

It is estimated that 781 m^2 of habitat will be lost as a result of the presence of the permanent infrastructure above the seabed, including six intake chambers, three discharge chambers and one FRRS chamber. The areas of occurrence of macroalgae do not coincide with the area of the proposed marine infrastructure. On this basis, it is considered that the effects will be **negligible** and **insignificant**.

Changes in nutrient concentrations due to the NPP operation will be negligible, so the impacts on marine macrophytes will be **insignificant**.

As a result of the discharge of cooling water, there would be an increase in the ambient water temperature. This can result in increased primary productivity in the immediate area, leading to faster growth of any macroalgae populations. The modelling of the plume shows a slight (< 0.5°C) increase in temperature on the seabed, covering a large area, with potential interaction with macroalgae habitat areas, but this is not expected to have significant effects on the species present there. In addition, the increased temperature of the plume and the design of the outlet head will make it more buoyant compared to the receiving water bodies, which will limit the potential damage to the seabed habitats. On this basis, the effects would be **insignificant**.

Effects on zoobenthos

As in the case of marine flora, the degree of the loss of habitats due to the presence of the infrastructure is minimal and is considered **insignificant**.

Elevated receiver water temperatures associated with the cooling water discharge can potentially affect zoobenthos through, for example, increased metabolic and growth rates. In addition, there may be changes in the entire population in terms of abundance and diversity of species, as species that tolerate thermal changes become more dominant. In addition, the temperature increase can lead to greater primary productivity in the area and a related increase in organic matter available to benthic species. However, no species of particular conservation concern or high sensitivity have been identified during the marine surveys [Chapter III.3.7]. Therefore, although the NPP operational phase will cause a moderate temperature increase at the local level, a smaller increase in temperature, by < 0.5°C, is predicted on a wider scale, in particular on the seabed, in winter. Although this effect has been classified as moderate, benthic communities are not very sensitive to elevated temperatures, especially of so small magnitude, so this effect is considered **insignificant**.

Summary of the impacts from the operation of Sub-Variant 1A

A summary of the operational effects is provided in table [Table IV.8.3-18]

Table IV.8.3-18 The summary of the effects of the operation of sub-variant 1A*

Receptor	Receptor importance	Receptor sensitivity	Impact source	Impact magnitude	Range of impact	Impact time / frequency	Effect	Effect significance
Coastal processes and hydromorphology								
Coastal processes and bathymetry	High	Low	Presence of submerged structures	Negligible	Local	Permanent	Negligible	Insignificant
Coastal dunes and associated forest	Medium	Medium	Presence of the functional NPP	None	None	None	None	Insignificant
Coastal area management	Medium	Low	Presence of the functional NPP	None	None	None	None	Insignificant
Seawater quality								
Physico-chemical elements Water body as defined by the WFD Water body as defined by the MSFD Natura 2000 sites	High	Low	Thermal load from cooling water discharges	Medium	Regional	Long-term Continuous	Medium	Potentially significant
			Discharges of process effluents	Medium	Regional	Long-term Continuous	Medium, but may be reduced to negligible	Potentially significant but may be reduced to insignificant
			Biocides	Medium	Regional	Long-term Continuous	Medium, but may be reduced to negligible	Potentially significant but may be reduced to insignificant
			Processed wastewater discharge	Negligible	Regional	Long-term Continuous	Negligible	Insignificant
			Combined discharge of effluents	Medium	Regional	Long-term Continuous	Medium	Potentially significant
Marine ecology								
Plankton and eutrophication	High	Low	Nutrients in operational discharges	Negligible	Regional	Long-term Continuous	Negligible	Insignificant

Receptor	Receptor importance	Receptor sensitivity	Impact source	Impact magnitude	Range of impact	Impact time / frequency	Effect	Effect significance
Habitats	High	Medium	Direct loss	None	None	None	Negligible	Insignificant
Macroalgae	Medium	Medium	Loss of habitats	None	None	None	None	Insignificant
			Changes in nutrient status	Negligible	Local	Long-term	Negligible	Insignificant
Zoobenthos	High	Medium	Loss of habitats	Negligible	Local	Long-term	Negligible	Insignificant
			Changes in water quality	Low	Local	Long-term	Minor	Insignificant
Migratory fish	High	Low	Impingement and entrapment	Negligible	Transboundary, regional	Long-term Continuous	Negligible	Insignificant
Pelagic and demersal fish	Low	Low	Impingement and entrapment	Low	Local	Long-term Continuous	Minor	Insignificant
Benthic fish	Low	Low	Impingement and entrapment	Negligible	Local	Long-term Continuous	Negligible	Insignificant
Fish species important from the point of view of conservation	High	Low	Impingement and entrapment	Negligible	Regional	Long-term	Negligible	Insignificant
All fish communities (as a source of food)	High	Low	Impingement and entrapment	Low	Regional	Long-term	Medium	Potentially significant
			Changes in water quality	Low	Regional	Long-term	Negligible	Insignificant
Marine mammals	High	Low	Underwater noise	Negligible	Regional	Long-term Infrequent	Negligible	Insignificant
			Vessel collisions	Negligible	Local	Long-term Infrequent	Negligible	Insignificant
			Reduced availability of prey species	Negligible	Regional	Long-term Continuous	Negligible	Insignificant
All birds	High	Low	Disturbance	Negligible	Local	Long-term	Negligible	Insignificant

Receptor	Receptor importance	Receptor sensitivity	Impact source	Impact magnitude	Range of impact	Impact time / frequency	Effect	Effect significance
						Infrequent		
Ichthyophagous birds			Reduced availability of fish prey species	Medium	Regional	Long-term Continuous	Medium	Potentially significant
Benthophagous birds			Reduced availability of zoobenthos prey species	Negligible	Local	Long-term Continuous	Negligible	Negligible

** In the event of a discrepancy in the assessment of the elements of marine ecology, the results of the assessment presented in [Chapter IV.2] should be interpreted as overriding.*

Source: [456]

IV.8.3.1.5.5 Decommissioning phase

The potential effects on the geomorphology of the coast and seawaters during decommissioning of the Project would depend on the planned level of decommissioning in the marine environment. Although it is rather well known what the decommissioning of the NPP entails, it is still uncertain which elements of the marine infrastructure will be preserved and which will be removed during the decommissioning.

Due to the significant uncertainty associated with the decommissioning phase, not only with regard to the planned work but also with regard to the initial environmental conditions and the regulatory framework that will be in force at that time, no detailed impact assessment has been carried out. However, based on experience from other projects of a similar nature, the potential effects are expected to be similar to those occurring during the development and construction stages, but to a lesser extent.

On this basis, taking into account the fact that the potential impacts on seawater quality, coastal geomorphology and marine ecology at the development and construction stages were considered insignificant, it has been concluded that a similar set of the impacts during decommissioning will also be **insignificant**.

Effect on compliance with the Water Framework Directive

An assessment of the open cooling system in sub-variant 1A has been carried out in order to identify potential effects that can occur in water bodies within the meaning of the WFD. The assessment has determined whether the receptors are at risk as a result of activities related to the development, construction, and commissioning stages, as well as operational and decommissioning phases. The assessment according to the WFD takes into account both the ecological status and the chemical status of the coastal water bodies.

The full assessment according to the WFD and the potential effects on the ecological status according to the WFD as a result of the implementation of Sub-Variant 1A with the open cooling system is presented in detail in [Appendix IV.8.3-2], including the step-by-step methodology and additional information on whether the construction of the Project may jeopardise the achievement of future environmental objectives. A summary of the conclusions of the assessment is presented in the table [Table IV.8.3-27] below.

Table IV.8.3-27 The potential effects on the ecological status according to the WFD as a result of Sub-Variant 1A with the open cooling system

<table>
<tr><th>Area</th><th>WFD’s source document number</th><th>Element</th><th>Assessment summary</th></tr>
<tr><td rowspan="3">Marine ecology</td><td>I</td><td>Phytoplankton</td><td rowspan="3">Based on an assessment of the effects on phytoplankton and eutrophication, macroalgae, zoobenthos, and benthic macroinvertebrates, it has been concluded that, despite the loss of habitats due to the construction of the marine infrastructure, the overall impact on marine ecological elements I, II and III within the meaning of the WFD, will be insignificant.
Accordingly, no adverse impact on the body of water, as defined by the WFD, is expected.</td></tr>
<tr><td>II</td><td>Other aquatic flora (macroalgae and angiosperms)</td></tr>
<tr><td>III</td><td>Benthic macroinvertebrates</td></tr>
<tr><td rowspan="2">Coastal hydromorphology</td><td>IV</td><td>Hydromorphological elements – tidal system</td><td rowspan="2">Changes in the hydromorphological patterns are primarily associated with the temporary presence of the sheet pile wall during the installation of the cooling water system. However, after the completion of the construction stage, these changes are minimal and insignificant throughout the life cycle of the Project.
On this basis, no adverse impact on the body of water, as defined by the WFD, is expected.</td></tr>
<tr><td>V</td><td>Hydromorphological elements – morphological conditions</td></tr>
<tr><td>Seawater quality</td><td>VI</td><td>Physico-chemical elements – general information</td><td>The impacts include elevated suspension levels as a result of sediment agitation during</td></tr>
</table>

Area	WFD's source document number	Element	Assessment summary
	VII	Physico-chemical elements – specific synthetic pollutants	the construction phase but are mainly related to the release of discharge effluents down the outlet system during the operational phase. The assessment of these potential impacts was based on environmental quality standards and other environmental standards, where appropriate and available, after which it has been concluded that the effects throughout the life cycle of the Project would be negligible.
	VIII	Physico-chemical elements – specific non-synthetic pollutants	

Source: [456]

With regard to the chemical status, the assessment and compliance with the EQS and other limit values set out in the legislation has shown that there are no significant chemical effects and, as a result, no effects on the future condition.

No adverse effects are expected in connection with the Project on the current ecological or chemical status of the water body as defined by the WFD, or on the achievement of good status in the future, as provided for in the Water Management Plan for Sub-Variant 1A. The implementation of the Project would also not pose a risk to the designated bathing areas in terms of the need to comply with appropriate environmental quality standards.

Effect on compliance with the Marine Strategy Framework Directive

Considerations on the effects on marine water bodies, as determined in accordance with the MSFD, focus on the eleven parameters presented in table [Table IV.8.3-1], and on related environmental objectives. These parameters form the basis of the MSFD, determining what constitutes good environmental status for each of the components considered important for the overall health of the marine aquatic environment.

The description of the assessment of Sub-Variant 1A with the open cooling system has been written using expert judgement for each of these descriptors and objectives, taking into account whether the Project has a potential to result in a reduction where good environmental status has been achieved or prevent the achievement of good environmental status where it has not yet been achieved.

Based on the assessment carried out for each parameter, it can be concluded that, for most of the criteria and indicators, the implementation of the Project Sub-Variant 1A, will not affect either the current classification of status or the potential of the water bodies to achieve good status in the future. At this stage, the possibility of a moderate effect on fish populations in the vicinity of the Project in the operational phase cannot be ruled out. In addition, this effect can indirectly affect the qualifying features of Przybrzeżne wody Bałtyku SPA, in particular dive birds that feed on fish (see [Chapter IV.2]).

IV.8.3.1.6 Impact assessment: Sub-Variant 1B – Closed cooling system using seawater

IV.8.3.1.6.1 Description of the Sub-Variant and scenarios assessed

To avoid repetition, the impact assessment for sub-variant 1B has been presented taking into account the information already presented during the assessment of sub-variant 1A.

With particular reference to the assessment of the marine environmental impacts, the key differences between sub-variant 1A with the open cooling system and sub-variant 1B with the closed seawater cooling system are as follows:

- The infrastructure is smaller in size. The cooling water inlet and outlet pipelines are much shorter and have a smaller diameter. The dimensions of the chamber structure are also smaller.
- It is envisaged for the worst-case scenario that in Sub-Variant 1B all cooling water pipelines and the FRRS pipeline can be laid in a "common construction line". This means that only one trench and one dyke across

the dunes, beach and tidal zone will be required, while for Sub-Variant 1A two dykes would be required (one for the inlet pipeline and one for the outlet pipeline). In addition, due to the smaller dimensions, the scale of the dredging works required to lay the pipeline in the sea from the dyke side is also smaller in the case of Sub-Variant 1B compared to Sub-Variant 1A.

- The demand for water in the closed cooling water system used during operation of Sub-Variant 1B is much lower than in the case of the open (single-flow) cooling system in Sub-Variant 1A. In addition, since water is retained in the closed cooling circuit and losses occur as a result of evaporation in the cooling towers, discharges into the sea have a smaller volume compared to continuous flows. However, as a result of the water losses due to evaporation, salt is concentrated in the system and the discharges have a different chemical composition. Therefore, the discharge characteristics of spent cooling water from Sub-Variant 1B differ significantly from those of Sub-Variant 1A.

For the construction stage, the assessment considered the excavation method in connection with the installation of the cooling water system in order to take into account the worst-case scenario in terms of seabed disturbance and related marine sediment disturbances (and impacts on seawater quality). The impacts on the marine environment and the coastal zone resulting from the alternative construction method using mini-TBM/HDD would be minimal compared to the above, given the limitation to the local and temporary disturbance of the seabed due to the installation of the intake and discharge chamber structures. These effects are considered **negligible** and, therefore, **insignificant**, so there is no need for a further detailed assessment.

The assessment of the operational phase assumes that the NPP operation with three AP1000 reactors at full power, with the cooling water system using seawater with two concentration cycles (CoC), is the worst possible scenario.

Development stage

Few works in the marine environment are anticipated at the development stage and, therefore, the impacts at this stage are limited to the following activities:

- The development works on land (including removal of vegetation and preliminary earthworks);
- The construction of the MOLF and the associated service road providing access to the NPP; and
- The construction of the sewage treatment works for the construction phase.

Construction stage

General

The scope of the works and temporary structures required for the construction of the closed cooling water system in sub-variant 1B would be smaller than that required for the open cooling water system of sub-variant 1A. Nevertheless, these structures can still affect physical processes, geomorphology, seawater quality and ecology nearby the land and coast.

Effects on coastal processes and hydromorphology

<u>Impacts of temporary structures on coastal processes and bathymetry</u>

It is anticipated that only one dyke will be needed for the construction of Sub-Variant 1B and all makeup / cooling water pipelines and the FRRS pipeline will be laid in the single trench. The dyke and the associated formwork on the beaches / dunes are expected to remain in place for a total of eight months.

Based on the modelling for the individual Sub-Variants, in relation to changes in coastal geomorphology during the construction phase, the following conclusions have been drawn.

- The identified receptors, that is, the hydromorphological characteristics of the water bodies, as defined by the WFD, and descriptors 6 and 7 of water bodies, within the meaning of the MSFD, are of **high significance** due to the presence of the nature protection areas (Przybrzeżne wody Bałtyku SPA) and the potential of affecting the fauna and flora characteristics for the site due to changes in the hydromorphological conditions.

- The spatial range of the impacts is **direct**, as the anticipated maximum area where erosion / accumulation greater than 0.25m will occur will be limited to 1.31 km^2 around the structure at the end of the 12-month modelling period.
- The impacts is defined as **medium-term**, based on the 12-month modelling period outlined above, and its effects are anticipated to return to the baseline conditions after a longer recovery period.
- Impact frequency has been classified as **continuous** because the construction works, including the construction of the sheet pile wall for the construction of the inlet / FRRS and the outlet, will last eight months.
- The impact magnitude is **negligible** due to the small area of the seabed affected by the morphological changes and the scale of these changes compared to the levels of the natural variability recorded in the marine survey area off the Project site.
- The magnitude of the effects is **negligible** due to the limited affected area and the comparison with the natural variability within this area.

Based on the above conclusions, it can be concluded that the impacts of changes in the geomorphology of the coastal zone, which will result from the construction of the cooling water system carried out on the beach and in the tidal zone in sub-variant 1B, on the characteristics of the water bodies, as defined by the WFD and MSFD, is **insignificant**.

Direct physical impacts in the coastal dune zone

The construction methodology for Sub-Variant 1B is described in chapter [Chapter II.3.1.5]. The worst-case scenario would be to excavate one trench running through the technical belt and the seabed – similar but smaller than the one proposed for Sub-Variant 1A, which provides for the two excavations. Based on the assessment for Sub-Variant 1A, where these impacts have been recognised as insignificant, it has been concluded that the effects resulting from the implementation of Sub-Variant 1B, which includes only one smaller trench, will also be **insignificant**.

Effects on coastal management requirements

Based on the modelling results for Sub-Variant 1A, it has been shown that the impacts of the construction of Sub-Variant 1A and the effects of the temporary disturbance of the coastal sediment transport resulting from the presence of the temporary sheet pile walls would be likely to contribute to a minor or negligible erosion of the shoreline, within the limits of the natural variability. Although it has been assumed that these effects are unlikely to be significant, the uncertainty of the modelling results was recognised and further mitigation actions have been recommended in the form of the monitoring programme leading to corrective measures, if necessary. Given that the number and lifetime of the sheet pile walls in Sub-Variant 1B with the closed cooling system would be smaller / shorter than in Sub-Variant 1A with the open cooling system, it is anticipated that the impacts on the implemented beach management strategies associated with the implementation of Sub-Variant 1B would be **insignificant**.

Effects on seawater quality

Effects of the construction works at sea

Dredging would be necessary in the worst-case scenario (the excavation method) for Sub-Variant 1B with the closed cooling system. It would be similar to the case evaluated for Sub-Variant 1A with the open cooling system, but would have a much smaller scale due to the smaller length of the inlet and outlet pipelines and the fact that they would be laid together with the FRRS outlet in the single trench.

The concentrations of fine sediments in plumes generated during the dredging in the case of the closed cooling system of Sub-Variant 1B are significantly lower than in the case of the open cooling system of Sub-Variant 1A. The areas where the values given in the guidelines are negligibly small (less than 0.2 km^2) for both seasons, so a detailed assessment is not included here, as the effects were considered **negligible** and, therefore, **insignificant**.

On this basis, and with reference to the conclusions of the assessment of the equivalent effects of the construction of the open cooling system in Sub-Variant 1A, it can be concluded that, due to its short-term, transient nature and small area, the potential effects would be **negligible** and, therefore, **insignificant**.

Effects of re-use or discharge of material from the dredging

The material excavated throughout the construction of the marine infrastructure would need to be re-used or disposed. For the purposes of this assessment, it is assumed that any required discharge will take place at duly approved sites for which a detailed impact assessment has already been carried out to ensure that these sites are fit for this purpose.

This assessment has not modelled the excavated material disposal activities but, based on the above, it has been concluded that the impacts on water quality resulting from the disposal or re-use of dredging spoil would be **insignificant**.

Effects of spills from marine structures and materials used on site or onboard of the equipment used for marine works

The impacts of the potential effects of an accidental spill / release of pollutants as a result of the construction works for Sub-Variant 1A is considered to be **negligible** and **insignificant**. Since construction works at sea will also be carried out in Sub-Variant 1B (although their overall scale will be smaller), the same conclusion is considered appropriate for this Sub-Variant.

Effects of onshore construction works

The impacts of discharges from the onshore construction works on seawater quality for Sub-Variant 1A are considered to be **negligible** and **insignificant**. Since similar construction works will also be carried out on land in Sub-Variant 1B, no further assessment is required and the same conclusion is considered appropriate for this Sub-Variant.

Effects on marine ecology

The detailed assessment of the impacts on marine ecology is presented in the chapter on the implementation of Sub-Variant 1A. It has considered the impacts on the individual receptors of marine ecological formations, including plankton and eutrophication, macroalgae and angiosperms, zoobenthos, fish, marine mammals and birds. The effects on all these receptors resulting from the construction works during the construction phase of the Project have turned out to be **negligible** and **insignificant**.

The implementation of Sub-Variant 1B would involve the same or very similar construction processes and activities, although some of them would be of a smaller scale than in the case of Sub-Variant 1A. They would also be carried out in the same marine area. It is therefore considered that the conclusions of the assessment on the implementation of Sub-Variant 1A (i.e. that all the impacts on the marine environment would be **insignificant**) apply also to Sub-Variant 1B and there is no need to repeat the assessments for the individual receptors.

Summary of the impacts of the implementation of Sub-Variant 1B

Table [Table IV.8.3-20] provides a summary of the effects of the implementation of sub-variant 1B.

Table IV.8.3-28 The summary of the effects of the implementation of sub-variant 1B*

Receptor	Receptor importance	Receptor sensitivity	Impact source	Impact magnitude	Range of impact	Impact time / frequency	Effect	Effect significance
Coastal processes and hydromorphology								
Coastal processes and bathymetry	High	Low	Construction works carried out at sea	Negligible	Local	Medium-term Continuous	Negligible	Insignificant
Coastal dunes and associated forest	Medium	Medium	Loss / damage due to excavation	Negligible	Local	Medium-term Infrequent	Negligible	Insignificant
Coastal area management	High	Low	Changes to coastline and sediment transport	Low	Regional	Medium-term Continuous	Minor	Insignificant
Seawater quality								
All physico-chemical elements Water body as defined by the WFD Water body as defined by the MSFD Natura 2000 sites	High	Low	Construction works carried out at sea	Negligible	Regional	Temporary Short-term	Negligible	Insignificant
			Removal of dredge spoil	Negligible	Regional	Temporary Short-term	Negligible	Insignificant
			Accidental spills from operations at sea	Negligible	Local	Short-term Infrequent	Negligible	Insignificant
			Construction works carried out on land	Negligible	Local	Long-term Continuous	Negligible	Insignificant
Marine ecology								
All biological receptors	High	Low	Changes in water quality due to the construction works	Low	Local	Temporary	Negligible (minor effects can occur with regard to temporary loss of benthic habitats)	Insignificant

** In the event of a discrepancy in the assessment of the elements of marine ecology, the results of the assessment presented in [Chapter IV.2] should be interpreted as overriding.*

Source: In-house study

IV.8.3.1.6.2 Operational phase

General information

The operational phase of the Project is the longest one (about 60 years) during which there will be a number of permanent components of the marine infrastructure. From the perspective of coastal processes and geomorphology, this infrastructure can result in blocking waves and flows, which can lead to changes in sediment transport systems.

Regarding water quality, the discharges were reassessed according to the established emission limit values (ELV) and the environmental quality standards (EQS). These aspects are the main subject matter of this assessment, with the difference between Sub-Variant 1A (the open cooling system) and Sub-Variants 1B/1C (the closed cooling system) being the discharge of effluents in the operational phase.

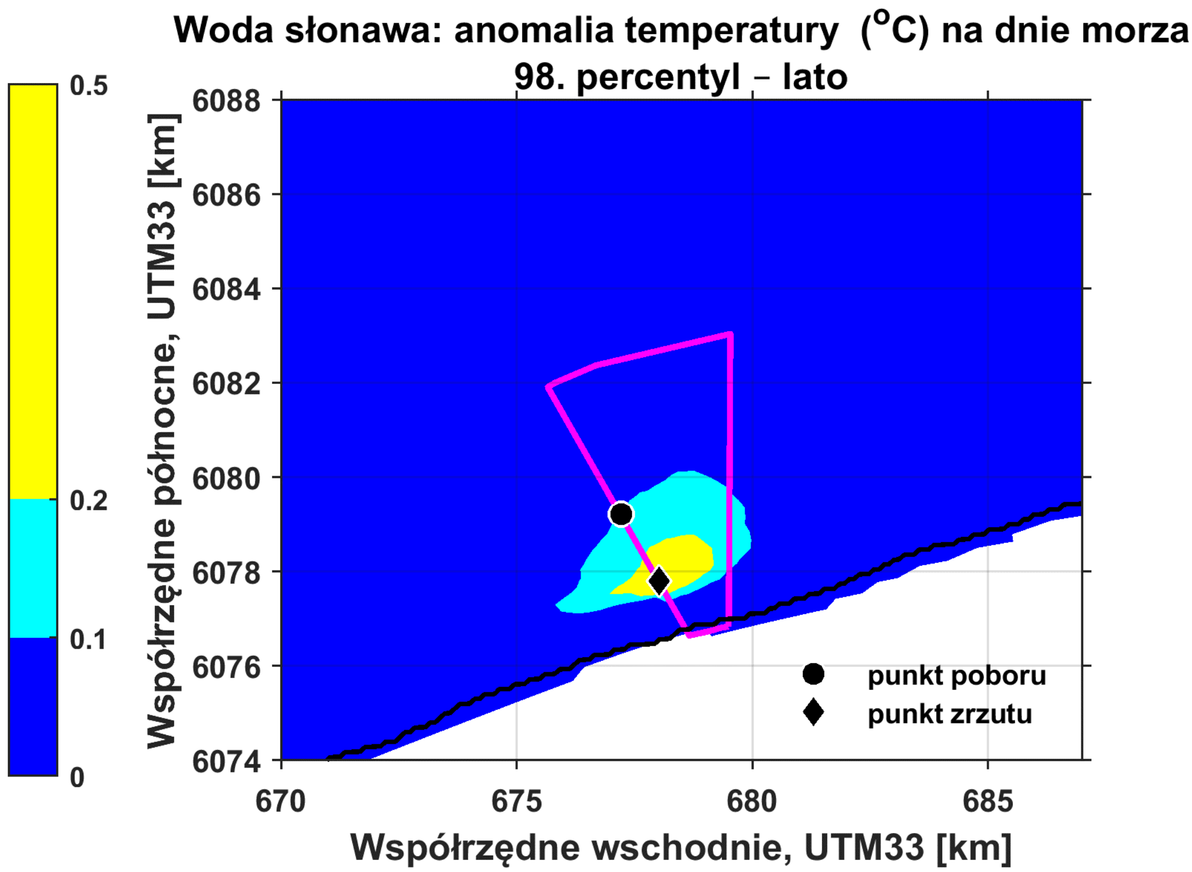
Effects on coastal processes and hydromorphology

During the operational phase of Sub-Variant 1B fixed infrastructure elements in the marine environment would be similar to those presented for Sub-Variant 1A, that is, the inlet and outlet heads of the cooling water system plus the FRRS and MOLF systems. Generally speaking, the heads present throughout the operational lifetime of the NPP in Sub-Variant 1B have a much smaller scale and there are fewer of them than in the case of Sub-Variant 1A, while the impacts of the MOLF design is the same, identical in all the Sub-Variants. On this basis, the effects described and presented for Sub-Variant 1A can be considered the worst-case, restrictive scenario for Sub-Variant 1B. Consequently, given that the impacts of the operational phase have been recognised as **insignificant** for Sub-Variant 1A, the same conclusion on the **insignificant** effects was made for Sub-Variant 1B.

Effects on seawater quality

Effect of discharges on the ambient water temperature

The volumetric discharge rate for the closed seawater cooling option considered in sub-variant 1B is also more than 50 times smaller than in sub-variant 1A with the open cooling system. Temperature anomalies resulting from the discharge of cooling water in sub-variant 1B are shown in [Figure IV.8.3-35]. They present scores at the 98th percentile, aggregated on a seasonal scale and, therefore, represent a conservative view of the total extent of plumes.



Woda słonawa: anomalia temperatury (°C) na dnie morza 98. percentyl - lato	Brackish water: temperature anomaly (°C) at the seabed 98th percentile - summer
punkt poboru	intake point
punkt zrzutu	discharge point
Współrzędne wschodnie, UTM33 [km]	Eastern coordinates, UTM33 [km]
Współrzędne północne, UTM33 [km]	Northern coordinates, UTM33 [km]

Figure IV.8.3-35 Technical Sub-Variant 1B, 98th percentile of thermal water anomaly (°C) at the seabed, the cooling water system

Source: [456]

As shown by the modelling results, due to direct mixing in the marine environment, the temperature increase at the seabed never reaches an abnormal level, that is, an increase by 2°C. In addition, no change by more than 0.1°C directly affects the shoreline of Variant 1 – Lubiatowo - Kopalino site.

With particular regard to the water bodies to which the WFD and MSFD apply, and the potential effects of temperature changes on them, the following conclusions have been drawn.

- The identified receptors, i.e. the physico-chemical elements supporting water bodies, as defined by the WFD and descriptors 5 and 8 of water bodies, within the meaning of the MSFD, are of **high significance** due to the presence of the nature protection areas (Przybrzeżne wody Bałtyku SPA) and the potential of affecting aquatic biology as a result of changes in water quality.
- The spatial extent of the ambient water temperature rise by > 2°C can be considered **local** because it is limited to the initial dilution zone directly around the point of discharge.
- Due to the fact that the discharge of cooling water is a part of the NPP operation, although the actual discharge can occur periodically, the overall impacts are perceived as **continuous**.
- The magnitude of the impacts is negligible because, although immediately after the discharge the temperature would exceed the limits of the natural variability in this place, the discharge would disperse in the immediate vicinity and there would be no significant increase in temperature outside the initial

dilution zone. Therefore, the area of of temperatures that exceed the accepted environmental quality standards (EQS) would be very small and limited to the initial dilution zone.

Taking into account the above, the scale of the effects resulting from these changes in the temperature of the ambient water as a result of the release of the thermal plume into the marine environment adjacent to the area of Variant 1 – Lubiatowo - Kopalino site is **negligible** and, therefore, **insignificant**.

Effects of discharges on ambient water quality

<u>Changes in the ambient water quality resulting from the discharge of process effluents</u>

The process effluents would contain residues of chemicals used in the NPP to control the pH level, inhibit the corrosion process, limit scale deposition in, and remove oxygen from, the reactor and steam generator, limit the process of scale deposition and control the biofouling in the cooling tower, and remove metals resulting from corrosion and oxidation of reactor components involved in heat exchange, components of the auxiliary system of steam turbines and components of the cooling towers.

It is considered that by combining approaches to additional mitigation measures, including the treatment of specific effluent streams, where necessary, it would be possible to achieve appropriate ELV and EQS levels for all chemicals contained in the process effluent discharge, and that changes caused in the ambient water quality as a result of the process effluent discharge would be **insignificant**.

<u>Changes in the ambient water quality resulting from the discharge of biocides</u>

Due to the closed circuit of the cooling system and the possibility of using batch purging to neutralise chlorine before discharge from the closed system, the concentration of biocides can be reduced before the discharge, if necessary. On this basis, it can be concluded that, with appropriate mitigation measures, in the case of the closed cooling system, it would be possible to ensure that the effects of biocide discharges would be **insignificant**.

<u>Changes in the ambient water quality resulting from the discharge of treated effluent</u>

As discussed for Sub-Variant 1A, effluents would be treated to a level that allows it to be discharged into the sea without the need for dilution with cooling water. The only difference here is the distance of the outlet from the shoreline, which, however, exceeds the required distance of 1 km from the shore [300], so the impact assessment would be the same as for the Sub-Variant 1A.

The impacts of the discharge of treated effluents during the operational phase on the ambient water quality would be **insignificant**.

<u>Changes in the ambient water quality resulting from the discharge of brine</u>

The modelling has been carried out using the CORMIX model, for the near field, and the Delft-3D model, for the far field – for the summer and winter flow rates, for the blowdown with salinity of 15.03 psu.

- The identified receptors, i.e. the physico-chemical elements supporting water bodies, as defined by the WFD, and descriptors 5 and 8 of water bodies, within the meaning of the MSFD, are of **high significance** due to the presence of the nature protection areas (Przybrzeżne wody Bałtyku SPA) and the potential of affecting the biota supporting the attractive features of this location, as a result of changes in water quality.
- The spatial extent of the increase in the ambient water salinity by 0.5 psu can be considered **local** because it is limited to the initial dilution zone of the near field directly around the point of discharge.
- Due to the fact that the discharge of cooling water is a part of the NPP operation, although the actual discharge can occur periodically, the overall impacts are perceived as **continuous**.
- The magnitude of the impacts is **low** because, despite the fact that salinity immediately after the discharge would be higher than the natural variability at this point, the discharge would disperse in the immediate vicinity, without a significant increase or excess above the assumed EQS values outside the initial dilution zone of the near field.

Given the above, the potential magnitude of the effects resulting from the anticipated changes in the ambient water salinity as a result of the operation of Sub-Variant 1B is **minor** and, therefore, **insignificant**.

Changes in the ambient water quality resulting from the total discharge of process effluents

- The identified receptors, that is, the physico-chemical elements supporting water bodies, as defined by the WFD, and descriptors 5 and 8 of water bodies, within the meaning of the MSFD, are of **high significance** due to the presence of protected bathing waters and protected nature areas (Przybrzeżne wody Bałtyku SPA) and the potential of water biology being affected as a result of changes in water quality.
- The spatial range of the impacts is **local**. This is because, with the application of the mitigation measures identified, it would be possible to ensure that substances the concentrations of which exceed the EQS values in summer and in winter comply with the EQS values before the discharge, except for phosphorus compounds.
- The impacts is **long-term** because discharges of combined process effluents would take place throughout the operational life-cycle of the NPP.
- The impacts are **continuous** because the discharges of combined process effluents would take place throughout the operational life-cycle of the NPP.
- The magnitude of the impacts of substances other than phosphorus would be **negligible**, subject to mitigation measures described in chapter [Chapter V.3.1.5] of the EIA Report, since the concentrations of chemicals in effluent discharges from combined processes could be reduced to values lower than the EQS value at the point of discharge.
- The effects of discharges of substances other than phosphorus are therefore negligible because, despite **high significance** of the receptors, the water bodies, as defined by the WFD and the MSFD, together with the associated bathing sites and protected areas, are able to absorb this **long-term**, **continuous** impacts of **negligible magnitude**, which fall within the range of the natural variability.
- Therefore, it can be concluded that, if the mitigation measures described in chapter [Chapter V.3.1.5] of the EIA Report are applied, the effects resulting from the impacts during the operational phase of the facility on the identified receptors will be **insignificant**.

Effects on marine ecological formations

Where appropriate, the impact assessment in this Chapter is based on the findings of the assessment of the operational phase of sub-variant 1A.

Effects on plankton and eutrophication

In the case of the closed cooling system in sub-variant 1B, additional loads of nitrogen-containing compounds would be present in the discharge, which would involve an addition of nitrogen from treated effluents to cooling water and the use of ammonium compounds, hydrazine and monoethanolamine as process chemicals. However, most of the nitrogen in the discharge will come from seawater taken up. This nitrogen will be concentrated by evaporation in the cooling towers.

The effect of nutrient discharges on phytoplankton development and on the associated zooplankton food chain is expected to be **negligible** and, therefore, **insignificant**.

Additional phosphorus loads would also be present in the discharge due to the application of polyphosphates and phosphonates used to control corrosion and scale formation in the cooling circuit, as well as small amounts of phosphorus-containing compounds in treated effluents.

The significance of the receptor is **high** due to the presence of the international protected area (Przybrzeżne wody Bałtyku SPA) and the sensitivity is low due to the assimilation capacity of the environment and the ability of plankton populations to regenerate rapidly. The adverse effects of phosphorus discharges on phytoplankton growth and on the associated zooplankton food chain are classified as **moderate** and **potentially significant**.

Therefore, if this cooling water system option (Sub-Variant 1B) were to be chosen, additional mitigation measures would be required. Assuming that these measures are implemented, it can be considered that the residual impact can be reduced to **negligible** and **insignificant** levels.

Effects on macroalgae

As in the case of sub-variant 1A, there is no risk of the direct loss of macroalgae due to the impacts of sub-variant 1B. Despite the possibility of other effects due to changes in water quality, it was considered **negligible** and **insignificant**.

Effects on zoobenthos

As regards the direct loss of habitats, the effects associated with sub-variant 1A are **negligible** and **insignificant**. Given the smaller scale of the infrastructure, the impacts of sub-variant 1B will be even smaller and, therefore, the effects can also be considered **negligible** and **insignificant** by extrapolation.

The exposure of the seabed to increased salinity will be strictly local and, therefore, this impact on biota will be **negligible** and **insignificant**. The effect of the discharges has been assessed as **insignificant** and, therefore, its effect on biota will similarly be **insignificant**.

Effects on fish

The flow rate of water in the case of the closed cooling system provided for in sub-variant 1B will be small compared to that in sub-variant 1A. Also smaller will be the risk of entrainment and impingement of fish populations occurring in the vicinity of the Project's site. Despite the smaller scale of the effects, it is proposed, in line with the Good European Practice [408], to use a fish recovery and return system (FRRS) which will be a part of the water intake and discharge system, which will further reduce the risk of endangering fish in the area. As a result, the potential effects turn out to be **negligible** and **insignificant**.

Effects on marine mammals

The effects are expected to be the same as those presented for Sub-Variant 1A but their scale will be smaller, so they are considered **negligible** and **insignificant**.

Effects on birds

In the case of birds, the main potential impact would be related to changes in population sizes or in the distribution of their prey species. As mentioned above, it is expected that the magnitude of these effects for Sub-Variant 1B will be smaller than for Sub-Variant 1A and, given the relevant mitigation measures, they are considered **negligible** and **insignificant**.

Summary of the effects of the operational phase in Sub-Variant 1B

Table [Table IV.8.3-31] provides a summary of the effects during the operation of Sub-Variant 1B.

Table IV.8.3-31 The summary of the effects during the operation of Sub-Variant 1 B*

Receptor	Receptor importance	Receptor sensitivity	Impact source	Impact magnitude	Range of impact	Impact time / frequency	Effect	Effect significance
Coastal processes and hydromorphology								
Coastal processes and bathymetry	High	Low	Operation of Sub-Variant 1B	Negligible	Local	Permanent	Negligible	Insignificant
Seawater quality								
All physico-chemical elements Water body as defined by the WFD Water body as defined by the MSFD Natura 2000 sites	High	Low	Thermal load from cooling water discharges	Negligible	Local	Continuous	Negligible	Insignificant
			Discharge of process effluents (other than nutrients)	Medium, but may be reduced to negligible	Regional	Long-term Continuous	Medium, but may be reduced to negligible	Potentially significant but may be reduced to insignificant
			Discharges of biocides	Low	Regional	Long-term Continuous	Minor	Insignificant
			Processed wastewater discharge	Negligible	Regional	Long-term Continuous	Negligible	Insignificant
			Discharges of brine	Low	Local	Long-term Continuous	Minor	Insignificant
			Total discharge	Low to negligible	Local	Long-term Continuous	Negligible	Insignificant
Marine ecology								
Biogenic conditions	High	Low	Nutrients in operational discharges	Medium	Regional	Long-term Continuous	Medium, but may be reduced to negligible	Potentially significant but may be reduced to insignificant
Plankton	High	Low		Low	Regional	Long-term Continuous		
Macroalgae	Medium	Medium	Habitat loss and smothering	Negligible	Regional	Long-term	Negligible	Insignificant

Receptor	Receptor importance	Receptor sensitivity	Impact source	Impact magnitude	Range of impact	Impact time / frequency	Effect	Effect significance
						Continuous		
Zoobenthos	High	Medium	Loss of habitats	Negligible	Local	Long-term Continuous	Negligible	Insignificant
			Changes in water quality	Low to negligible	Local	Long-term Continuous	Negligible	Insignificant
Fish	High	Low	Impingement and entrapment	Negligible	Local	Long-term Continuous	Negligible	Insignificant
Marine mammals	High	Low	Operation of Sub-Variant 1B	Negligible	Local	Long-term	Negligible	Insignificant
Birds	High	Low	Operation of Sub-Variant 1B	Negligible	Local	Long-term	Negligible	Insignificant

** In the event of a discrepancy in the assessment of the elements of marine ecology, the results of the assessment presented in [Chapter IV.2] should be interpreted as overriding.*

Source: [19]

IV.8.3.1.6.3 Decommissioning phase

Given the significant uncertainty regarding the decommissioning phase, no detailed impact assessment has been carried out. However, based on experience from other projects of a similar nature, the potential effects are expected to be similar to those occurring during the development and construction stages, but to a lesser extent. It can be concluded that a similar impact in the decommissioning phase would also be **negligible** and **insignificant**.

Effect on compliance with the Water Framework Directive

An assessment has been carried out for Sub-Variant 1B with the closed cooling system using seawater to identify potential effects on the WFD water bodies. The assessment has determined whether the receptors are at risk as a result of activities related to the development, construction and commissioning stages of the construction phase, and in the operational and decommissioning phases. The assessment according to the WFD takes into account the environmental status of surface waters.

The full assessment from the point of view of the WFD is provided in [Table IV.8.3-32].

Table IV.8.3-32 The summary of the potential effects of Sub-Variant 1B with the closed cooling system using seawater according the WFD

Area	WFD's source document number	Element	Assessment summary
Marine ecology	I	Phytoplankton	As a result of the assessment of the effects on biological elements and of eutrophication, paying particular attention to phytoplankton, it has been concluded that, although there will be a very slight loss of habitats due to the construction of the marine infrastructure, the overall impact on elements of marine ecology I, II and III, as defined by the WFD, will be insignificant. The effects of process discharges, in particular the impacts of nutrient emissions on phytoplankton growth and on the associated zooplankton food chain, were initially assessed as moderate and significant. However, it has been recognised that the implementation of the additional mitigation measures referred to in [Chapter V.3.1.5] of the EIA Report would reduce the residual impacts to negligible levels and that the overall impact on marine elements I, II and III, as defined by the WFD, would be negligible. As for the additional loads of nutrients, the new nutrient inflow from effluents generated in connection with the implementation of the Project is very small in relation to the existing loads on the scale of the river basin. The increased inflow of nutrients from this source is likely to be at least partially offset by a drop in the volume of untreated municipal wastewater in this area due to the migration of labour from other areas of the Vistula river basin, who will use sanitary facilities that eventually discharge municipal wastewater into the Baltic Sea. In addition, the additional amounts of phosphorus generated by Sub-Variant 1B can be eliminated by alternative measures to prevent scaling. In general, the effects of the Project will therefore be very small in relation to the reduction of the total inflow of nutrients, which will occur as a result of the implementation of the corrective measure
	II	Other aquatic flora (macroalgae and angiosperms)	
	III	Benthic macroinvertebrates	

Area	WFD's source document number	Element	Assessment summary
			programmes under the IIaPGW and the KPOŚK set out in [Appendix IV.8.3-2] – the elimination of the risk of not being able to achieve an improvement in the good status in the future. Accordingly, no adverse impact on the body of water, as defined by the WFD, is expected.
Coastal hydromorphology	IV	Hydromorphological elements – tidal system	The assessment of the impacts on hydromorphological elements has shown that the changes in the hydromorphological conditions are primarily related to the works carried out during the installation of the makeup / cooling water system. However, after the completion of the construction stage, these changes are minimal and insignificant throughout the life cycle of the Project. On this basis, no adverse impact on the body of water, as defined by the WFD, is expected.
	V	Hydromorphological elements – morphological conditions	
Seawater quality	VI	Physico-chemical elements – general information	The impact assessment covered the increased level of general suspension as a substitute for physico-chemical elements characterising the physical state in the construction phase, but are mainly related to the discharge of effluents in the operational phase. The potential effect assessment was based on the EQS values and has concluded that the summer and winter EQS values for total phosphorus / phosphates at the point of discharge would be exceeded in the body of water where eutrophication reduces the status from GES to sub-GES, meaning that the effects would be significant. However, it has been recognised that the implementation of the additional mitigation measures described in [Chapter V.3.1.5] of the EIA Report would reduce this impact to an **insignificant** level. The use of the additional mitigating measures applies in particular to discharges of hydrazine and corrosion products.
	VII	Physico-chemical elements – specific synthetic pollutants	
	VIII	Physico-chemical elements – specific non-synthetic pollutants	

Source: [456]

As regards the chemical status, the assessment and adjustment to the EQS values and other regulatory limits have shown that in the case of Sub-Variant 1B there are no significant effects on the chemical parameters or subsequent effects on the future state of the water, provided that additional mitigation measures for hydrazine and corrosion products are applied.

There was no adverse impact in connection with the implementation of sub-variant 1B on the current status of the WFD water bodies, nor on the possibility of achieving the objectives set out in the Water Management Plan enabling the achievement of good ecological status (WFD) and environmental status (MSFD).

In conclusion, the WFD assessment for sub-variant 1B for all the stages showed that **there will be no significant adverse impacts** on the biological, hydromorphological and/or physico-chemical quality elements that could jeopardise the current state according to the WFD for the water bodies in which the works are carried out.

Effect on compliance with the Marine Strategy Framework Directive

In the case of sub-variant 1B with the closed cooling system using seawater, an assessment has been developed for each of these descriptors and objectives, taking into account whether the planned Project has a potential to cause deterioration where good environmental status (GES) has been achieved or prevent the achievement of good environmental status (sub-GES) where it has not yet been achieved. The results of this assessment are presented in table [Table IV.8.3-33].

Table IV.8.3-33 The potential effects on the state of the environment, within the meaning of the MSFD, as a result of the implementation of sub-variant 1B with the closed cooling system using seawater in Variant 1 (Lubiatowo - Kopalino site)

Descriptor	Potential effects on the state of the environment, within the meaning of MSFD, as a result of the implementation of Sub-Variant 1B with the closed cooling system using seawater
D1 – Biodiversity	In terms of biodiversity, both MSFD areas, 62 and 27, have been classified as having an unsatisfactory environmental status (sub-GES). Therefore, it should be proven that the construction of the Project will not prevent the achievement of the GES in the future. As a result of the impact assessment carried out in terms of potential indirect effects on biodiversity as a result of the construction of the Project, it has been concluded that no significant impact is expected. Based on the above findings and the larger scale of the Project in Sub-Variant 1A compared to Sub-Variant 1B, and the related fact that there are no significant impacts, it can be concluded that there will be no adverse effects on the ability of the water bodies to achieve the GES.
D2 – Non-indigenous species	It has been recognised for Sub-Variants 1B and 1A that there are no differences in risks / approaches to non-native species. Therefore, as outlined in the MSFD assessment for Sub-Variant 1A, assuming the application of the best practices during the work, there will be no adverse effects on the ability of the water bodies to achieve the good environmental status (GES).
D3 – Commercially exploited fish and shellfish	It has been recognised that, in the case of Sub-Variants 1B and 1A, there are no differences in the potential effects on commercially exploited fish and shellfish populations. Therefore, it can be concluded that there will be no effects on the ability of the water bodies to achieve the good environmental status (GES);
D4 – Marine food webs	It has been recognised for Sub-Variants 1B and 1A that there are no differences in the potential effects on marine food webs. Therefore, it has been concluded that the ability of the water bodies to achieve the good environmental status (GES) will not be affected.
D5 – Eutrophication	Area MSFD 62 currently has the good environmental status (GES) and Area 27 is classified as sub-GES. The key issues to consider when it comes to eutrophication are the release of nutrients and the increase in temperature. The assessment has shown that the EQS values for phosphorus levels are exceeded and additional mitigation measures will be necessary to control them (as set out in [Chapter V.3.1.5] of the EIA Report). Assuming the application of the additional mitigation measures, no significant increase in nutrient levels or a significant increase in temperature is predicted. Therefore, it has been concluded that the discharges of effluents from the Project will not adversely affect the potential of these water bodies to achieve the good environmental status (GES) in terms of eutrophication.
D6 – Sea-floor integrity	During the initial assessment it has been found that the status of Areas 62 and 27 is sub-GES in terms of sea-floor integrity. Given that Sub-Variant 1B provides for the closed cooling system, it has been concluded that the area of the seabed where a temporary change in bathymetric levels greater than 25 cm occurs will be smaller than that predicted for Sub-Variant 1A, which remains the worst-case scenario in terms of environmental effects, on which assessments can be based.

Descriptor	Potential effects on the state of the environment, within the meaning of MSFD, as a result of the implementation of Sub-Variant 1B with the closed cooling system using seawater
	The calculations for Sub-Variant 1A served to estimate the worst-case scenario for the temporary loss of habitats in the marine and coastal zone of 0.894 km^2 due to the implementation of Sub-Variant 1A. The permanent loss of physical habitats is minimal. As shown, the scale of the infrastructure in Sub-Variant 1B is smaller than in Sub-Variant 1A, therefore the loss of habitats will also be smaller, without adversely affecting the ability of the water bodies to achieve the good environmental status (GES) in the future. Based on these findings, it has been concluded that no adverse effects of the marine infrastructure of the Lubiatowo - Kopalino site on the see-floor integrity in Areas 62 and 27 are expected. Therefore, no impacts on benthic habitats and associated biocenoses are expected. This is why there will be no adverse effects on the ability of the water bodies to achieve the GES.
D7 – Change in hydrographical conditions	Based on the preliminary assessment, it has been concluded that Areas 62 and 27 have the good environmental status (GES), although it should be borne in mind that the assessment was based on expert judgement and not on measurable data. The aim for the water bodies is therefore to ensure that they retain this status and that their conditions do not deteriorate. Taking into account both the permanent and the temporary changes in the seabed, the percentage of water bodies affected by the changes will not exceed 1%. Based on the calculations presented above, it can be concluded that the construction of the Project will not cause deterioration of the status of any of the water bodies covered by the MSFD.
D8 – Concentrations of pollutants	It has been recognised for Sub-Variants 1B and 1A that there are no differences in the potential effects on marine food webs. Therefore, as set out in [Table IV.8.3-63], it has been concluded that there will be no deterioration in Area 27, nor in the ability of Area 62 to achieve the good environmental status (GES).
D9 – Contaminants in fish and other seafood for human consumption	The preliminary assessment of the two bodies of water covered by the MSFD has shown that Areas 62 and 27 have achieved the good environmental status (GES) and, therefore, the objective in both cases would be to ensure that work carried out within these water bodies does not result in a deterioration of this status. Unless other pollutants are introduced into the marine system, no significant impacts on the levels of contaminants in fish and other seafood are anticipated. Therefore, it has been concluded that the Project under construction will not contribute to deterioration of the status of the water bodies covered by the MSFD.
D10 – Marine litter	It has been recognised for Sub-Variants 1B and 1A that there are no differences in risks / approaches to marine litter and, assuming the application of the best practices, there will be no adverse effects on the ability of the water bodies to achieve the good environmental status (GES).
D11 – Energy, including underwater noise	A number of activities related to the construction of the Project may contribute to the occurrence of increased underwater noise in the marine environment. The detailed assessment of the potential effects of noise and vibration resulting from the Project is presented in [32]. The results of this assessment have shown that, with appropriate mitigation measures (described in chapter [Chapter V.3.1.5] of the EIA Report), the effects on marine mammals and fish species in the vicinity of the Project will be negligible.

Source: [456]

Based on the above assessments carried out for each descriptor, it can be concluded for most of the criteria and indicators that the construction of Sub-Variant 1B, will not affect either the current GES classification or the potential of the water bodies to achieve the good environmental status (GES) in the future. In addition, it has been found that there is a potential for an increase in nutrient levels and the subsequent increase in eutrophication. However, assuming appropriate mitigation measures, these effects can be reassessed and considered insignificant. Therefore, it can be concluded in general terms that no adverse effects on the water bodies of the MSFD are expected.

IV.8.3.1.7 Impact assessment: Sub-Variant 1C – closed cooling system using desalinated seawater

IV.8.3.1.7.1 Description of Sub-Variant 1C and assessed scenarios

For the construction stage, the assessment considered the excavation method in connection with the installation of the makeup / cooling water system in order to address the worst-case scenario of seabed disturbance and associated marine sediment disturbances (and impacts on seawater quality). The impacts on the marine environment and the coastal zone resulting from the alternative construction method using mini-TBM/HDD would be minimal compared to the above, given the limitation to local and temporary disturbance of the seabed due to the installation of the intake and discharge head structures. These effects are considered **negligible** and, therefore, **insignifica**nt, so there is no need for a further detailed assessment.

During the assessment of impacts in the operational phase, the worst-case scenario was considered to be the operation of the NPP that comprises three AP1000 reactors at full power, with the cooling water system using desalinated water on the principle of five concentration cycles (CoC).

Development stage

Few works in the marine environment are anticipated at the development stage and, therefore, the impacts at this stage of the construction phase are limited to those resulting from construction / installation activities:

- The development works on land (including removal of vegetation and preliminary earthworks);
- The construction of the MOLF and the associated service road providing access to the NPP; and
- The construction of the sewage treatment works for the construction phase.

Construction stage

In the case of Sub-Variants 1B and 1C there are no noticeable differences in the construction phase, the inlet and outlet infrastructure is located in the same locations and the same construction methods are used.

IV.8.3.1.7.2 Operational phase

General information

The operational phase of the Project is the longest one, during which there will be a number of permanent components of the marine infrastructure. From the perspective of the geomorphology of the coastal zone, this infrastructure can interfere with waves and flows, which can lead to changes in sediment transport systems. Except for water quality in the operational phase, the assessment is largely the same as that presented for Sub-Variant 1B with the closed cooling system.

As regards water quality, the discharges were reassessed according to the established emission limit values (ELV) and the environmental quality standards (EQS). These aspects are the main subject matter of this assessment, with the difference between sub-variants 1B and 1C with the closed cooling system being the discharge of effluents in the operational phase.

Impacts on hydrodynamics, coastal processes and geomorphology

During the operational phase of Sub-Variant 1C, the fixed infrastructure elements in the marine environment would be the same as those presented for sub-variant 1B, that is, the inlet and outlet heads of the makeup / cooling water system plus the FRRS and MOLF systems.

Therefore, the effect on marine physical processes, bathymetry and hydromorphology is considered insignificant.

With regard to the subsequent effects that can occur as a result of changes in the hydromorphological environment, it has been assumed that after the completion of the construction works all disturbed coastal habitats would return to their initial state, and the effects on dunes in the coastal belt would be considered **negligible** and **insignificant**.

Except for the possible need for additional dune care when restoring the forest to its pre-construction state, the effects on the coastal zone management requirements are considered **negligible** and **insignificant**.

Impacts on seawater temperature and quality

Effects of discharges on the ambient water temperature

The temperature of the receiving water is the key factor affecting water quality – the qualification of the state based on indicators that characterise physical conditions. The approach to modelling of cooling water discharges in Sub-Variant 1C, for a closed cooling system using desalinated seawater. As shown, the temperature of discharges of desalinated water in summer would be up to 35.7°C, while in winter it would be the same as the ambient temperature, as in the case of Sub-Variant 1B using brackish water or seawater.

Given that the cooling water discharge in Sub-Variant 1C accounts for about a half of the stream in Sub-Variant 1B, it has been concluded that the scale of the effects resulting from these changes in ambient water temperature as a result of the release of the thermal plume into the marine environment adjacent to the Project site is **negligible** and, therefore, the effect on water temperature is **insignificant**.

In the absence of a significant effect resulting from the changes in the ambient water temperature in the vicinity of sub-variant 1C, it can be concluded that also nearby designated nature protection areas will not be significantly affected.

Effects of discharges on ambient water quality

The approach to assessing the effects of discharge of added process chemicals for Sub-Variant 1C is identical to that for Sub-Variant 1B.

It is considered that by combining approaches to additional mitigation measures, including the treatment of specific effluent streams, where necessary, it would be possible to achieve appropriate ELV and EQS levels for all chemicals contained in the process effluent discharge, and that changes caused in the ambient water quality as a result of the process effluent discharge would be **insignificant**.

Changes in the ambient water quality resulting from the discharge of brine from cooling towers using desalinated water.

The potential magnitude of the effects resulting from the anticipated changes in the ambient water salinity as a result of the discharge of brine directly into the marine environment adjacent to the area of Variant 1 – Lubiatowo - Kopalino site are **minor** and, therefore, **insignificant**.

Changes in the ambient water quality resulting from the total discharge of process effluents

Because, assuming the application of the mitigation measures, it would be possible to ensure that substances the concentration of which the EQS values in summer and in winter comply with the EQS values prior to the discharge, except for phosphorus compounds, where an assessment of the impacts of changes in nutrient loads discharged into the sea has been carried out.

Therefore, it can be concluded that, if the mitigating measures set out in chapter [Chapter V.3.1.5] of the EIA Report are applied, the effects resulting from the impacts during the operational phase of the facility on the identified receptors will be **insignificant**.

Effects on marine ecology

Phytoplankton and eutrophication

The main potential for effects on the environmental status of the receiving water bodies is associated with an increased load of nutrients (nitrogen and phosphorus) entering the sea, which will contribute to the ongoing eutrophication in the Baltic Sea [158].

The net increase in the nitrogen load for cooling water in Sub-Variant 1C is estimated at 37.0 tonnes/year (as N), which means an increase in the nitrogen content by 0.043%.

The effect of nutrient discharges on phytoplankton development and on the associated zooplankton food chain is expected to be **negligible** and, therefore, **insignificant**.

As for phosphorus loads, the corresponding total values indicated in [222] are 5,476 tonnes/year, with the discharge from the NPP representing additional 72 tonnes/year of the net load, an increase by 1.31% compared to the current load.

Since the additional load represents an increase by only 1.31% from the baseline, the effect of phosphorus discharge on phytoplankton growth and on the associated zooplankton food chain is expected to be **negligible** and, therefore, **insignificant**.

Other marine biological communities

In the case of Sub-Variant 1C with the cooling water system using desalinated seawater in the cooling towers (rather than seawater), salinity levels in the discharge will be higher than in Sub-Variant 1B. However, the jets of discharged water will be smaller than in Sub-Variant 1B, which means that the loads of dissolved solids will be similar in both Sub-Variants. The effects of the discharge on the salinity of the receiving water bodies will be similar and will be strictly local, so these effects on biota will be **negligible** and **insignificant**.

The effects of discharges of substances other than phosphorus has been assessed as **insignificant**, subject to the application of the mitigation measures, and, therefore, their effects on biota will be **insignificant**.

Other types of effects on marine ecological clusters during the operational phase for Sub-Variant 1C will have the same scale as those described and assessed for Sub-Variant 1B, which have been assessed as **insignificant**. On this basis, these effects have not been described in detail here. However, they are believed to be **insignificant**.

[Table IV.8.3-35] provides a summary of the effects during the operation of Sub-Variant 1C.

Table IV.8.3-35 The summary of the effects during the operation of Sub-Variant 1C (only features distinguishing from 1B are shown)*

Receptor	Receptor importance	Receptor sensitivity	Impact source	Impact magnitude	Range of impact	Impact time / frequency	Effect	Effect significance
Coastal processes and hydromorphology								
Coastal processes and bathymetry	High	Low	Operation of Sub-Variant 1C	Negligible	Local	Permanent	Negligible	Insignificant
Coastal waters	Medium	Medium	Operation of Sub-Variant 1C	None	None	None	None	Insignificant
Coastal area management	High	Low	Operation of Sub-Variant 1C	None	None	None	None	Insignificant
Seawater quality								
All physico-chemical elements Water body as defined by the WFD Water body as defined by the MSFD Natura 2000 sites	High	Low	Thermal load from cooling water discharges	Negligible	Regional	Continuous	Negligible	Insignificant
			Discharge of process effluents (other than nutrients)	Medium but can be reduced to low	Regional	Long-term Continuous	Medium, may be reduced to minor	Potentially significant but can be reduced to insignificant
			Discharges of brine	Low	Local	Long-term Continuous	Minor	Insignificant
			Total discharge	Low to negligible	Local	Long-term Continuous	Negligible	Insignificant
Marine ecology								
Biogenic conditions	High	Low	Nutrients in operational discharges	Medium	Regional	Long-term Continuous	Medium, but may be reduced to negligible	Potentially significant but can be reduced to insignificant
Plankton	High	Low		Low	Regional	Long-term Continuous		
Habitats	High	Medium	Direct loss	Negligible	Local	Long-term Continuous	Negligible	Insignificant
Macroalgae	Medium	Medium	Habitat loss and smothering	Negligible	Local	Long-term	Negligible	Insignificant

Receptor	Receptor importance	Receptor sensitivity	Impact source	Impact magnitude	Range of impact	Impact time / frequency	Effect	Effect significance
Zoobenthos	High	Medium	Loss of habitats	Negligible	Local	Long-term	Negligible	Insignificant
			Changes in water quality	Negligible	Local	Long-term	Negligible	Insignificant
Fish	High	Low	Impingement and entrapment	Negligible	Local	Long-term	Negligible	Insignificant
Marine mammals	High	Low	Operation of Sub-Variant 1B	Negligible	Local	Long-term	Negligible	Insignificant
Birds	High	Low	Operation of Sub-Variant 1B	Negligible	Local	Long-term	Negligible	Insignificant

** In the event of a discrepancy in the assessment of the elements of marine ecology, the results of the assessment presented in [Chapter IV.2] should be interpreted as overriding.*

Source: [19]

IV.8.3.1.7.3 Decommissioning phase

The impacts in the decommissioning phase would be **insignificant**.

Effect on compliance with the Water Framework Directive

The assessment has been carried out for Sub-Variant 1C with the closed cooling system using desalinated seawater to identify potential effects on the WFD water bodies. The assessment has determined whether the receptors are at risk as a result of activities related to the development and construction stages, and the operational and decommissioning phases. The assessment according to the WFD takes into account the environmental status of surface waters including coastal bodies.

As regards the chemical status, the assessment and alignment with the EQS and other regulatory limits has shown for Sub-Variant 1C that there are no significant effects on the chemical properties or subsequent effects on the future status of the waters, provided that additional mitigation measures set out in chapter [Chapter V.3.1.5] of the EIA Report, for hydrazine and corrosion products are applied.

In conclusion, the WFD assessment of all stages of sub-variant 1C stages has shown that there would be **no significant adverse impacts** on elements of biological, hydromorphological and/or physico-chemical quality that could jeopardise the current WFD status of the water bodies in which the works are carried out.

Effect on compliance with the Marine Strategy Framework Directive

In the case of sub-variant 1C with the closed cooling system using desalinated seawater the assessment has been done for each of these descriptors and objectives, taking into account whether the planned Project has a potential to downgrade the assessment where the good environmental status (GES) has been achieved or prevent the achievement of the GES where it has not yet been achieved.

For most criteria and indicators, the construction of Sub-Variant 1C, will not affect either the current GES classification or the potential of the water bodies to achieve the good environmental status (GES) in the future.

IV.8.3.1.8 Summary and conclusions

The results of the impact assessment for sub-variants 1A, 1B and 1C with and without taking into account the described mitigation measures are presented below. The cumulative impact assessment of intra-Project impacts including those related to the planned Project, the associated infrastructure and third-party investments is presented in [Chapter IV.19.4]. In the following chapters, as well as in the whole chapter, it is assumed that, due to cause-and-effect relationships, the impacts related to environmental changes at the development stage as a result of the implementation of the associated infrastructure have been presented as an element related to the essential scope of the planned Project – a change in the existing state (a new existing state) of the environment as a result of the implementation of the associated infrastructure (the MOLF, the service road, the sewage treatment works and the outlet in the sea) and as cumulative impacts – the formal fulfilment of the requirements resulting from the EIA Act [501] and from the GDOŚ decision of 25 May 2016 on setting the scope of the EIA Report [348].

IV.8.3.1.8.1 Sub-Variant 1A

Most of the works to be carried out in the marine environment during the development stage are related to the associated infrastructure [Chapter IV.19.4]. The effects of discharges into the sea caused by the onshore construction works have also been assessed as **negligible** and **insignificant**, provided that the water drainage systems described in Volume II of the EIA Report (Project Description) are used and the best practices in the area of pollution control specified in chapter [Chapter V.3.1.5] of the EIA Report are applied during the construction phase. In conclusion, the effects of the preparatory works on the marine environment have been assessed as **negligible** and **insignificant**.

The worst possible environmental scenario in the case of the construction works carried out at this stage has been modelled. The scenario assumes the sunken tunnel as part of the cooling water system infrastructure requiring the installation of the temporary sheet pile walls and deepening of trenches for the inlet and outlet structures. The construction and the presence of the dyke along the beaches and the coast may affect coastal geomorphology as a result of change in the coastal hydrodynamics and debris movement, which may lead to differences in sediment accumulation and to erosion occurring in the immediate vicinity of the structure. This can affect the degree of stability of the shoreline and have locally limited, direct effects on dune systems. The modelling of the temporary dykes (and the MOLF) has shown that their impact on coastal bathymetry and shoreline location is temporary and locally limited. The modelling has also shown that the process of returning to the initial state should begin within one year from removing this structure. The changes would mostly not go beyond the extent of natural transformations in the marine survey area of Variant 1 (Lubiatowo - Kopalino site) and in some places would cover an area of up to 2 m. The effects on the hydromorphological status of these coastal waters have been assessed as **negligible** and **insignificant** due to the small scale and transience of the anticipated effects.

The construction works can affect the quality of seawaters both due to the direct introduction of pollutants into the environment (even accidentally) and because of the release of such substances embedded in the seabed (e.g. during the dredging). In addition, treated surface run-offs and groundwater from land drainage from the onshore construction works at the main NPP location would also be discharged into the sea through the outlet of the sewage treatment plant (STW) operating during the construction phase. It is assumed that all adequate pollution control measures specified in the ETP will be applied throughout the construction works at this stage. Taking into account the effects on water quality, the environmental quality standards (EQS) or other environmental standards have been implemented, where possible, in accordance with the applicable law and/or recommendations. The analysis of the initial level of pollutants present on the surface of bottom sediments, taking into account legal requirements, has shown that the sediments are not polluted and are therefore unlikely to be a source of pollution at the time of their agitation during the construction works. The modelling has also shown that the elevated level of suspended sediment concentrations caused by the dredging during the construction phase will exceed the EQS only in a small area, in the immediate vicinity of the works. Therefore, the effects occurring during the construction stage are assessed as **negligible** and **insignificant**.

The discharges of thermo-chemical sewage and their impact on water quality and temperature have the greatest potential in terms of impact on water quality in the operational phase of the Project. The assessment of these effects focuses (where applicable) on their comparison with the EQS and other criteria established by the relevant legislation and guidelines. The effects associated with the increase in temperature have been analysed for the area where its increase would be 2°C. On the other hand, the analysis of changes in water quality caused by the discharge of sewage focuses on the discharge of process effluents, biocides, saline water and domestic sewage from the Project. The effects have been assessed as **insignificant**, subject, however, to the development of specific measures to mitigate the potential effects of the discharge of biocides, hydrazine and corrosion products, as described in [Chapter V.3.1.5] of the EIA Report.

Once the construction stage has been completed, no additional infrastructure will be introduced into the marine environment. Therefore, the effects caused during the operational phase of the Project are related to the presence of permanent structures, mainly the MOLF and the inlet/outlet heads, which may cause local disturbances in hydrodynamics or debris, which may lead to differences in sediment accumulation and to erosion occurring in the immediate vicinity of the structures. However, the analysis of the results of the modelled scenario for the MOLF and the qualitative assessment of the designs associated with the heads have shown that these changes would be **negligible** and **insignificant**.

The main environmental effects associated with the implementation of Sub-Variant 1A are related to the accumulation of nutrients from discharges of treated sewage during the construction and operational phases, the risk of fish entrapment by the water intake of the cooling system and the increase in the temperature of the surrounding water. The increased presence of nutrients can intensify the ongoing eutrophication, which is an important issue throughout the Baltic Sea. However, the comparison of the anticipated additional amounts of nutrients generated during the construction and operation phases of the NPP to the current levels of these substances entering the Baltic Sea from the Vistula drainage area shows that they would be **negligible** and **insignificant**. Hence, it is predicted that their effects on the level of eutrophication would also be **insignificant**.

However, **medium** and **potentially significant** effects would be generated by the entrapment of fish by the open cooling system – due to the importance of the fish environment in the immediate vicinity of the Project and the risk that the fish will be sucked in by the cooling system at different stages of their development. This impact can also pose a direct risk to ichthyophagous birds in the area – mainly dive birds in the Przybrzeżne wody Bałtyku SPA. This effects will be subject to an additional assessment as part of the Project assessment taking into account art. 6.3 of the Habitats Directive, which may result in a need to implement additional mitigation measures. The assessment in this regard has been presented in [Chapter IV.2].

The modelling of the temperature increase near the outlet of the cooling water system has been carried out, demonstrating that the effects can be **moderate** from the point of view of the environmental quality standards (EQS). However, due to low sensitivity of the habitats present in the area and the larger area of these habitats, the overall effects on the marine ecology are considered **insignificant**.

Exact plans related to the decommissioning phase of the Project were not yet known at the time of writing this document. However, the effects during the decommissioning phase are expected to be comparable or less significant than those anticipated for the development stage and construction phase and have therefore been assessed as **insignificant**.

Based on the above, no adverse significant effects on the water bodies, as defined by the WFD and the MSFD, are expected and the objectives of both directives concerning water quality improvement will not be jeopardised. However, this conclusion assumes that the inherent mitigation measures described in [Chapter V.3.1.5] of the EIA Report will be implemented. It also requires an assessment of effects of the fish entrapment on the achievement of the objectives set for the Przybrzeżne wody Bałtyku SPA, which will be presented as part of the assessment taking into account art. 6.3 of the Habitats Directive.

IV.8.3.1.8.2 Sub-Variant 1B

The scope of the works in the marine environment related to the implementation of Sub-Variant 1B is considered comparable to, or smaller than, that related to the implementation of Sub-Variant 1A. Therefore, the effects of Sub-Variant 1B would be very similar or smaller. Hence, the impact assessment presents only these effects that would differ from those presented for Sub-Variant 1A to such an extent that they required a different method of modelling and assessment. The summary is based on the same approach.

The activities carried out at the development stage and their effects would be the same as those described for Sub-Variant 1A. Therefore, they are assessed as **insignificant**. The key differences regarding the construction stage consist in the need to build only one sheet pile wall and in a much smaller scale of the dredging related to the construction of the makeup / cooling water system than in the case of Sub-Variant 1A. The effects on all the receptor classes (coastal processes and geomorphology, water quality and ecology) have been assessed as **insignificant**.

The main differences between Sub-Variants 1A and 1B in the operational phase consist in the volumetric, thermal and chemical characteristics of the cooling water discharge. The amount of cooling water discharged by Sub-Variant 1B is smaller, however, the salt contained in it is concentrated by the evaporation process taking place in the cooling towers, and the different profile of chemical process effluent is a result of different purification requirements compared to the open cooling system proposed for Sub-Variant 1A. The analysis of the concentration of the most of the cooling water ingredients at the point of discharge, the assessment of salinity dispersion and temperature modelling show that the effects on seawater quality would be **negligible** and **insignificant**. However, there is a potentially significant impact associated with the phosphorus discharge, which would result in an increase in eutrophication levels. The recommendations for further assessment and the application of mitigation measures, if necessary, to reduce the effects to **insignificant**, have been presented in [Chapter V.3.1.5] of the EIA Report. The effects associated with the discharge of process chemicals have been assessed as **insignificant**.

The effects on the marine ecology during the operational phase have also been assessed as **insignificant**. However, in the case of phytoplankton this conclusion requires the application of the additional mitigation measures described in chapter [Chapter V.3.1.5] of the EIA Report. This includes the issue of fish being sucked in by the makeup water system, which has been assessed as potentially significant in Sub-Variant 1A. This issue has been assessed as **negligible** and **insignificant** in Sub-Variant 1B due to the smaller water intake, which does not require the application of additional mitigation measures.

As in the case of Sub-Variant 1A, the effects associated with the decommissioning phase of Sub-Variant 1B have been assessed as **insignificant**.

Based on the above, no adverse significant effects on the water bodies, as defined by the WFD and the MSFD, are expected and the objectives of both directives (water quality improvement) will not be jeopardised. However, this conclusion assumes that the inherent mitigation measures described in chapter [Chapter V.3.1.5] of the EIA Report are applied.

IV.8.3.1.8.3 Sub-Variant 1C

Sub-Variants 1B and 1C are also so similar that the impact assessment notes only minimal differences between the proposed closed cooling system options. The anticipated impacts on the development and construction stages and the decommissioning phase of Sub-Variant 1C are identical to those of Sub-Variant 1B and, therefore, assessed as **insignificant**. The impacts on the coastal geomorphology and on the marine ecology during the operational phase have also been assessed as **insignificant**. The only noticeable difference was the potential effects on water quality during the operational phase due to the use of desalinated seawater by the closed cooling system. However, analysis of these effects proved the impact to be **insignificant**. The potentially important issue of the phosphorus discharge by Sub-Variant 1B is not a problem in Sub-Variant 1C. However, it is recommended to apply additional mitigation measures in the case of the discharge of hydrazine and corrosion products.

Based on the above analyses, no adverse significant effects on the water bodies, as defined by the WFD and the MSFD, are expected and the objectives of both directives concerning water quality improvement will not be jeopardised. However, this conclusion assumes the use of the inherent mitigation measures described in chapter [Chapter V.3.1.5] of the EIA Report.

IV.8.3.2 Variant 2 - Żarnowiec site

IV.8.3.2.3 Impact assessment – Sub-Variant 2A

The NPP in Sub-Variant 2A is equipped with the closed cooling water system, using seawater in the cooling circuits of the reactors and in the cooling towers' pond.

The assessment has considered the excavation method in connection with the installation of the makeup/cooling water system to address the worst-case scenario for seabed disturbance and associated marine sediment disturbances (and effects on seawater quality). The effects on the marine environment and on the coastal zone resulting from the alternative construction method using mini-TBM/HDD would be minimal compared to the above, given the limitation to local and temporary disturbance of the seabed by the installation of the intake and discharge head structures. These effects are considered negligible and insignificant, so there is no need for further detailed assessment.

In addition, since water is retained in the closed cooling circuit, and losses occur as a result of evaporation in the cooling towers, the total discharge into the sea has a smaller volume than the intake. However, as a result of water losses due to evaporation, salt is concentrated in the system and in the discharge. It has been assumed for the assessment of the operational phase that the operation of the NPP's three AP1000 reactors at full power with the cooling water system using seawater in two concentration cycles (CoC) is the worst possible scenario.

IV.8.3.2.3.2 Development stage

IV.8.3.2.3.4 Effects on coastal processes and hydromorphology

Construction works at sea have a potential to affect a number of elements of coastal processes and hydromorphology. Changes in the wave or sea current patterns can change the sediment transport balance and erosion/deposition patterns, which can ultimately affect the morphology of the seabed (including coastal spits), beaches and coastal dune systems.

Since the works considered in this section concern only land clearing and earthworks in the onshore part of the service belt, there will be no direct physical disturbances of the marine environment. Therefore, there is no potential pathway for effects, and consequently, there are no effects on coastal processes and hydromorphology.

IV.8.3.2.3.5 Impacts on seawater quality

It will be necessary to carry out a number of works on land at the development stage in order to prepare the site for the construction of the Project. Work on land, at the main NPP facility or in the case of other associated onshore investments, is not taken into account due to the lack of a pathway for impacts on the marine receptors.

The works at and around the onshore pumping station would proceed towards the land, starting from the dune ridge forming the service belt. However, they could potentially affect the seawater quality if surface run-offs and groundwater from excavations are diverted to the sea. However, as part of the preparatory work, an internal drainage system will be built for the pumping station construction site. The risk of polluting the receiving waters as a result of the construction works will therefore be minimal.

Accordingly, although seawater quality is highly significant, it is slightly sensitive and any impacts would be local, infrequent, short-term and negligible. Any effects on seawater quality associated with the preparatory works will be negligible and, therefore, insignificant.

IV.8.3.2.3.6 Impact on the marine ecology

The effects of the impacts on the marine ecology at the development stage (excluding the MOLF and the sewage treatment works at the construction stage, discussed earlier) are limited to the effects resulting from the onshore construction works and from the surface run-offs from the construction site, if they are directed to the marine environment. The surface run-offs can affect both the transparency of the water column and the levels of specific contaminants, leading to subsequent effects such as the burying of benthos in re-deposited sediments. Ecological receptors can also be exposed to indirect effects resulting from changes in water quality and, in the case of predatory species, from changes in prey availability.

However, by implementing appropriate control measures described in Volume V [Chapter V.3.1.5] of the EIA Report, in order to mitigate the release of potentially polluted surface run-offs, the pathways affecting marine ecological receptors will be significantly reduced, so impacts will occur less frequently and on a smaller scale. Any accidental (and, therefore, inherently infrequent) spills are likely to have only local and short-term impacts, and any pollution will quickly dilute in the coastal waters. On this basis, the potential effects are therefore considered negligible and insignificant.

IV.8.3.2.3.7 Construction stage of the Project

General information

During the construction phase, temporary marine structures will be necessary to enable the construction of the Project’s infrastructure, including the complementary/cooling water system and the FRRS elements. Such temporary works have a potential to block sediment transport and distort flow patterns or cause washout, which can then change existing features of the marine and coastal environment, as well as translate into possible effects on the marine flora and fauna.

In the case of cooling water/makeup water infrastructure built in open excavations, it will be necessary to dig trenches across the technical belt and to cause a direct (though temporary) impact on the morphology of dunes and the forest cover of dunes. Transient effects on the marine environment can also occur in connection with the release of sediments into the water during the trench dredging process, and then their deposition outside the outline of the trench, as well as the very fact of the existence of this trench for some time. Further dredging would be necessary in small areas due to the installation of the inlet and outlet heads and, probably, when re-extracting small amounts of material from the trench immediately before the installation of the submerged tunnel sections due to natural backfilling.

A release was also possible (including accidental) of pollutants, which in the case of sediments may affect the quality of marine waters in the direct vicinity of the Project.

The last potential effect on the marine environment would result from the discharge of sewage from the NPP's drainage system and from the surface water run-off into the sea. Also, the accidental release/spillage of pollutants from the onshore construction works during the construction phase could have environmental consequences. Discharges of turbid run-off and drainage water or spills would be controlled by would be controlled by the water drainage and management system (built at an early stage of the work), including measures for controlling pollution and the re-deposition of suspended sediments, and through implementation of good practices on pollution control measures in all aspects of the construction works.

Impacts on coastal processes and hydromorphology

This chapter assesses the impacts of new structures in the coastal environment on coastal processes, components and bathymetry. The assessment focuses on the impacts of the works on the dune elements, as well as on the cumulative impacts on the integrity of the coastal system as a whole (defined in relation to the entire service belt) and the resulting consequences for the coastal management.

Impacts on hydrodynamics and sediment transport

During the construction phase of the Project, a number of temporary infrastructure elements will be built in the marine environment, such as longitudinal dykes installed across the beach and shoreline for the construction of the complementary/ cooling water tunnel and the FRRS, including possible smaller cylindrical sheet pile walls located further from the shore for the installation of the complementary/cooling water intake and discharge and the FRRS outlet head.

As part of the modelling study, Scenario 1 presents the overall effects of temporary structures on the marine environment for the modelled period of 12 months during which the inlet/outlet heads, the FRRS and the sheet pile walls would stay in place for 8 months, with a period of 4 months of natural regeneration following the removal of the sheet pile walls.

Due to the disturbance of the sediment transport patterns and the reduction of current velocities, it is predicted that sediments will accumulate west of the temporary sheet pile wall structure, since transport takes place mainly in the eastern direction. Erosion caused by the increased current velocity is visible at the top of the structure, in particular on the inlet sheet pile wall. The eroded material is deposited at a short distance down from the erosion site. Finally, down the sheet pile wall structure there is some erosion of the seabed compared to the baseline scenario, caused by a reduced stream of sediments from the west.

The natural regeneration is limited during the first four months after the removal of the structure (i.e. 12 months of the simulation) because this period of four months is a quiet period in terms of sediment transport (spring). It is predicted that the regeneration will occur to a greater extent in more dynamic months (autumn, winter). Given that the transport along the shore is only temporarily disrupted and the permanent construction of the MOLF has minimal and local effects, it is expected that the natural regeneration will continue after this 12-month period as the accumulated sediments are reprocessed and transported to the area as a result of the prevailing transport processes in the sandy shoal zone.

The results of the modelling therefore show that the effects of the temporary disturbances of the sediment transport along the shore resulting from the presence of the Project structures would contribute slightly to the erosion of the shoreline, within the limits of the natural variability reported as part of the baseline studies.

It should be noted that the model does not solve the problem of structures smaller than 25 m^2, therefore the temporary works required for the installation of the inlet/outlet heads has not been included in the modelling, since their diameter would be about 15 m. It can be assumed that the effects of the presence of the sheet pile walls for the installation of the inlet/outlet heads on current velocities and on the sediment transport system would be the same as shown, when modelling, around larger sheet pile walls for the installation of the submersed tunnel system, although their scale would be smaller. This would result in the deposition of material on the leeward side of these structures and the possibility of aerodynamic shadow/washout during their presence. However, these changes would be small and temporary, and the current velocity, sediment transport and other effects on geomorphology are likely to return to the baseline levels once the temporary structures are removed. The inlet/outlet heads and the FRRS would be permanent and would exist throughout the life cycle of the Project. However, due to their size, no long-term significant hydromorphological changes are predicted.

Sediments mobilised during the dredging in the case of the submersed tunnel option would precipitate from the suspension and would settle again on the seabed around the work areas. The quantitative assessment of this process has been carried out using hydrodynamic modelling of overflow streaks generated by the CSD, described in detail in the chapter devoted to Variant 1 (Lubiatowo - Kopalino site). Although this modelling has been carried out for the works planned for Variant 1 (Lubiatowo - Kopalino site), the results are equally significant for the area of the marine surveys for Variant 2 (Żarnowiec site) due to the similarity of both the types of works and the hydrographic conditions. The modelling of an analogous cooling water system for Sub-Variant 1B (for the installation of the infrastructure of the closed cooling system in Variant 1 - Lubiatowo - Kopalino site) shows that the sediment layer on the seabed would not exceed a thickness of 25 mm outside the direct work area [456]. This is comparable to the natural variability of up to 1.3 m on the slope of the tidal zone, which is observed on an annual basis. It is therefore unlikely that the deposition of sediments mobilised as a result of the dredging works will affect the characteristics of the seabed in this area.

In general, the hydromorphological features described above, which together constitute the parameters of the WFD and MSFD, are of high significance due to the presence of the nature protection areas (Przybrzeżne wody Bałtyku SPA) and the possibility of the occurrence of impacts on flora and fauna supporting important features of this location as a result of changes in the hydromorphological conditions. The highly dynamic nature of the seabed (including the breaking wave barriers) and the shoreline means that the environment exposed to the impacts will better tolerate the change and will return to its former state relatively quickly (within a maximum of 1-5 years), which makes this an environment of low sensitivity.

The spatial extent of the changes in the current and wave patterns and, consequently, in the sediment transport pathways and in the seabed morphology, would be regional, based on the area undergoing morphological change beyond the area in the immediate vicinity of the place of construction of the marine infrastructure. The impacts would be continuous and medium-term, of a small magnitude, due to the relatively small seabed area affected by the morphological changes and the scale of these changes compared to the levels of the natural variability recorded in the marine survey area of the Project.

The modelling for the Sub-Variant with the closed cooling system has shown that there will be no significant increase in the sediment deposition after the dredging has ended. Since a deposition far above the natural levels is unlikely to extend beyond 100 m from the footprint, it is considered to be local. The impact frequency has been classified as continuous because the construction works, including the construction of the sheet pile wall for the construction of the inlet/outlet heads and the FRRS will continue for more than a year. As regards the duration of the impacts, they will be medium-term and it is expected that a return to the baseline conditions will occur within the Water Management Plan’s cycle. The magnitude of the impacts is small due to the relatively small amount of sediments compared to the levels of the natural variability recorded in the marine survey area of the Project and the reversibility of the impacts after the completion of the dredging.

The effects are minor (insignificant) because, despite their high significance, the water bodies, as defined by the WFD and the MSFD, would be able to absorb this change which is within the limits of the natural variability.

Based on the above conclusions, the effects on the marine hydromorphological quality elements of water bodies, as defined by the WFD and the MSFD, resulting from the construction works carried out at sea off the coast of the Project would be insignificant.

Direct physical impact on coastal dune zones

Only impacts on the receptors in the service belt are taken into account in this report. The direct effects of felling and onshore construction works in the service belt area will be discussed in a separate onshore impact assessment.

The types of construction works in the coastal zone, on beaches and in the dune system would depend on the chosen construction methods. However, in the worst-case scenario of the excavation construction method, the single temporary trench would have to be dug through the dune system, through the service belt to the sea, in which the inlet and outlet pipes of the complimentary/ cooling water system and the FRRS's pipe would be placed. The digging of excavations would require the use of appropriate formworks using overlapping steel piles along their length, preventing the collapse of the side walls, extending deep into the sea, which may require drainage at least during the period in which it would be present.

The dune system and the associated forests within the service belt are of high significance because they are part of the Piaśnickie Łąki SCI. The dune system as a whole also plays an important role in flood protection, and the beach and the area adjacent to it are of socio-economic importance. It is estimated that sensitivity of the dunes is moderate because the natural variability observed in the system of beaches and dunes in this area is large, and the receptor has some ability to tolerate changes and regenerate, however, forest renewal would take more than 5 years from the planting of the trees.

- The spatial extent of the impacts is local because any disturbance/damage to the dune system would be limited to the immediate vicinity of the work site.
- The installation of the complimentary water infrastructure, the sewage run-off and the FRRS outlet would take about 18 months, which means that the impacts are medium-term.
- The impacts are infrequent and, after the completion of the works, the area is to be restored to its pre-construction state.
- The impact magnitude is small: 0.625 ha of overgrown dune habitats.
- The effects would therefore be minor and insignificant.

On this basis, it can be concluded that, given the short-term and transient nature of the impacts and the relatively small area of dunes and forests covered by it, the potential effects would be negligible.

Impacts on coastal management requirements

The beaches located a little further away from the Project are covered by ongoing restoration/replenishment programmes using locally obtained sediments as source material. Similar works may be required near the site of the Project in the future, depending on changes in the shoreline and management strategy. The modelling has shown that the effects of the construction works on the seawater current velocity, wave height, sediment transport patterns and subsequent erosion and accumulation patterns on the seabed are negligible and, therefore, insignificant.

The results of the modelling show that the effects of temporary disturbances of the sediment transport along the shore resulting from the presence of the structures built as part of the Project would contribute slightly to the erosion of the shoreline (< 50 m), within the limits of the natural variability reported as part of the baseline state studies (10-100 m). A slight erosion of the shoreline is attributed to sediments bypassing the dyke, as well as the fact that it will only be in place for a certain period of time. A part of this difference can also be attributed to the natural change in the water level by about 0.1 m. Any changes caused by the construction of the Project will be temporary and reversible due to natural recovery processes after the cessation of the activities, so the impacts will be minor. Therefore, the impacts on the coastal erosion and coastal management are likely to be negligible and insignificant.

IV.8.3.2.3.8 Impacts on seawater quality

Impacts of the construction works at sea

The modelling and its results for Variant 1 (Lubiatowo - Kopalino site) were also used in relation to the analyses in this chapter due to the fact that the hydrodynamic conditions are similar in both locations.

The cross-section of the trench in the case of Sub-Variant 1B would be the same as in the case of Sub-Variant 2A (upper width 35 m and cross-sectional area 96 m^2) but the length of the dredged trench would be 1,900 m in the case of Sub-Variant 1B, while in the case of Sub-Variant 2A it would be 825 m.

Any excess of the short-term indicative EQS for TSS in Sub-Variant 1B will be limited to the duration and immediate vicinity of the works and will not extend beyond the Project Area (< 0.2 km^2). However, in winter the increase in the short-term TSS concentrations below the EQS can reach up to 10 km east along the seashore. The modelling did not show any overrun of the indicative long-term EQS due to its short duration. These results should be considered in the context of the maximum TSS concentration from the baseline conditions studies: 6.64 mg/l for the Żarnowiec marine survey area ([Table IV.8.3-4-3] in [Enclosure IV.8.3-4]). In addition, the depth of the re-deposition of fine settlements at the end of the dredging operation for Sub-Variant 1B was **negligible**.

- The identified receptors, i.e. the physico-chemical elements supporting water bodies, as defined by the WFD, and descriptive elements 5 and 8 of water bodies, within the meaning of the MSFD, are of high significance due to the presence of the nature protection areas (Przybrzeżne wody Bałtyku SPA) and the possibility of the occurrence of effects on flora and fauna supporting important features of this location, as a result of changes in water quality. The ability of the receiving waters to absorb, and regenerate after impacts means that they are of **low sensitivity**.
- The spatial extent of the impacts is local, based on very small overruns of the short-term EQS in the Project Area, not exceeding the long-term EQS, and negligible depth of the re-deposition of fine sediments outside the immediate work area. Under certain conditions, a plume with a very low concentration (below the acute EQS of 5 mg/l) with a regional range would be detectable **outside the Project Area**.
- The duration of the impacts is short-term, as the effects are limited to the duration of the works (probably less than one month). Limited and targeted additional dredging may be necessary to remove possible new deposits from the dredged trenches before the completion of the pipeline installation and to facilitate the installation of the head structure, but the duration of the effects of this work will be, similarly, **short-term**.
- The occurrence of the impacts has been classified as **infrequent** since the main dredging work would be carried out only once, during the construction phase, although it should be noted that for this type of short, temporary effects frequency is not the key parameter of the impact assessment.
- The impact magnitude is negligible because changes exceeding the EQS are local, **temporary** and **infrequent**.

Effects of re-use or discharge of material from the dredging

Excess material excavated during the construction of the entire marine infrastructure would need to be re-used (e.g. for extending the beach) or disposed of. For the purposes of this assessment it is assumed that any required dumping will take place at approved sites for which a detailed impact assessment has already been carried out to ensure that these sites are suitable for this purpose.

Based on the above comparisons with the guidelines, it can therefore be concluded that the seabed surface sediments in the marine survey area of the Żarnowiec site can be considered pollutant-free and suitable for disposal at a licensed landfill. Given the lack of large harbour and industrial infrastructure on this section of the

Polish coast and the dynamic nature of the seabed near the Project Area, it seems reasonable to assume that if the surface sediments are not polluted, the deeper sediments are also pollutant-free. As a consequence, no modelling of disposal activities has been carried out as part of this assessment and, based on the currently available research data, it has been concluded that any effects of the disposal of dredging spoil would be insignificant.

Impacts of activities in the maritime area

Potential sources of pollution from marine works may include diesel and lubricating oils from the marine infrastructure (and beach equipment), concrete or mortar spills, construction waste and dusts. These types of materials can affect the quality of seawater, which in turn can affect flora and fauna.

Accidental pollution (e.g. fuel spills from ships) can occur during the work but risks for such events (incidental and unplanned) cannot be classified for the purposes of this assessment and, therefore, these impacts are considered **infrequent** and **short-term**.

Given the mitigation measures, it is considered that the effects of an accidental spill would be negligible and insignificant. In the absence of significant impacts on water quality resulting from pollution caused by leakage in the vicinity of the Project, it has been concluded that nearby bathing sites or designated nature protection areas located along the shoreline will not be affected.

Impacts of onshore construction works

Due to the short distance of the complimentary water pumping station construction site from the shore, it is likely that the onshore construction works at this location can affect the marine environment.

As far as groundwater quality is concerned, there seems to be no problem with the existing (initial) groundwater quality that would call for preliminary groundwater treatment in order to remove pollutants before the discharge [19].

The identified receptors, i.e. the physico-chemical elements supporting water bodies, as defined by the WFD, and the descriptive elements 5 and 8 of water bodies, within the meaning of the MSFD, are of high significance due to the presence of the nature protection areas (Przybrzeżne wody Bałtyku SPA) and the possibility of the occurrence of impacts on flora and fauna which support important features of this location, but are of low sensitivity.

The spatial extent of the deterioration of water quality as a result of discharges from the onshore construction works is of a local nature, based on the following conclusions.

- Since the planned pumping station site is an undeveloped land, it is assumed that the soils are not polluted and, therefore, any surface water run-offs will not contain pollutants that could adversely affect the marine environment;
- Groundwater pumped from excavations or surface water run-offs from onshore areas would be treated at the NPP before being discharged into the sea. The deposition in lagoons and oil separators may be used for this purpose. Such control measures would reduce the risk of deterioration of the current quality of seawater.
- Concrete batching plants and plants treating sludge from tunnel operations would operate as closed-loop systems, without routine sewage discharges. Accidental leakage of other pollutants (such as fuel, lubricants or process chemicals) would generally be controlled by means of following good operational and maintenance practices as defined and agreed in advance in the ETP.
- Due to the geology of the substrate (prevailing aeolian sands), surface water run-off is expected to be small, even during periods of heavy rainfall.

The duration of the impacts, although strictly temporary, can occur throughout the construction stage and should therefore be considered as long-term.

These impacts can be continuous throughout the construction stage, during the construction works, although it is expected that the discharge volume will vary depending on the run-off of rainwater and melt water, as well as in accordance with the construction requirements for excavation drainage.

The magnitude of the impacts is negligible for all elements of onshore construction works due to the mitigation measures that will be applied to treat discharges before they are released into seawaters, as well as the high capacity of the seawater reservoir to absorb the discharge. In addition, it should be noted that discharges of run-off and ground water from the Project site are likely to be offset by reduction of run-offs and primary flows into nearby watercourses and, therefore, by reduction of inflow from watercourses to the sea. The effects are therefore considered negligible and insignificant.

IV.8.3.2.3.9 Impact on the marine ecology

Habitat loss

The installation of the marine infrastructure associated with the Project can potentially result in loss of seabed habitats, together with their zoobenthos and phytobenthos, and, indirectly, also the wider marine ecosystem. The area of the lost seabed has been established for both the temporary and the permanent marine works/ infrastructure associated with the Project.

The direct loss of habitats during the construction phase would occur as a result of the dredging and during the installation of the permanent and temporary structures including the inlet and outlet heads and the sheet pile walls. The calculation of the temporary loss of habitats is based on the installation of the complimentary/cooling water system using the submerged tunnel technique, with a single sheet pile wall large enough to accommodate the complimentary/cooling water system and the FRRS pipelines (500 m long and 14 m wide) and the seabed belt covered by the dredging works approximately 850 m long and 50 m wide. The result is the following estimates of the total direct loss of habitats:

- Losses resulting from a temporary footprint of approximately 48,258 m^2 (including 7,000 m^2 for sheet pile walls, 41,250 m^2 for the dredging spoil dumping site and 8 m^2 for the outlet of the sewage treatment works);
- Permanent loss of approximately 274 m^2 (including 202 m^2 for the MOLF's support piles and 72 m^2 for the cooling water heads and the FFRS).

Based on the above calculations, it can be established that the temporary works during the construction phase would result in a temporary total loss of a habitat of about 0.04 km^2, resulting in the loss of an extremely small part of fine circalittoral sand and fine infralittoral sand. If we compare the extent of these two habitats in a broader, regional context, the loss would be minimal. The dynamic nature of the seabed means that these habitats are naturally disturbed and the fauna that makes them up can quickly repopulate them. Therefore, although these habitats are of high significance due to their ecological role supporting the characteristics of the designated areas, they are of medium sensitivity. For context, the area of the temporary loss within the body of water, as defined by the WFD, represents 0.6 % of the fine infralittoral sand within the boundaries. The temporary loss of habitats will be medium-term, with local and reversible effects, and the permanent loss will be long-term, for the duration of the Project's life cycle, but with a minimum extent. In addition, given the medium sensitivity of these habitats to disturbances and the fact that the seabed will be restored to its previous state once the complimentary/cooling water pipelines have been installed, the effects on the habitats are considered to be minor and insignificant.

Impacts on plankton and eutrophication

During the construction phase work will be carried out that could affect the physical constituents of water quality (e.g. transparency), with implications for phytoplankton development. The worst-case scenario modelling (based on Sub-Variant 1B discussed earlier) shows that there would be a short-term increase in suspended sediment levels in the immediate vicinity of the dredging works: up to 50 mg/l in the initial 24-hour period after completion of marine work, with an increase by less than 5 mg/l over a larger area.The dredging and other activities disturbing the seabed would result in a local, temporary and short-term increase in turbidity, as well as a temporary local reduction in its primary productivity. On this basis, it is envisaged that the effects will be negligible and, therefore, insignificant, without any material effects on the WFD or MSFD status.

Some discharges into the marine environment would be associated with the drainage of the sheet pile walls. Since it is simply the release of untreated collected seawater, the nutrient content of the discharge would be the same as that of the ambient seawater and would have no effect on the eutrophication potential. The main continuous discharge into the sea during the construction phase will come from the drainage of the onshore pumping station construction site, but it will not contain elevated nutrient levels and will be treated to control turbidity. Therefore, there will be no effect on plankton or on the eutrophication state. Therefore, the effects will be negligible and insignificant.

Impacts on macroalgae

No significant direct loss of macroalgae habitats is expected as a result of the construction of complimentary/cooling water infrastructure and the FRRS. Activities related to the construction stage can potentially indirectly affect macroalgae in two ways.

The dredging associated with the installation of the complimentary/cooling water system would be the activity that could potentially have the greatest impacts on the level of suspended sediments, open excavations being the worst-case scenario in terms of the amount of material. The greatest risk of seabed covering occurs in the work area and directly outside it, although the modelling has shown that the re-deposition of material from the dredging would be minimal. Given the high level of the natural variability of the analysed area, it is expected that the marine flora present in it will tolerate short periods of large loads of suspended sediments and the re-deposition of transported sediments (as, for example, occurs naturally during storms), and the effect of this additional level of sediment precipitated from the suspension on the seabed is considered negligible and insignificant.

Impacts on zoobenthos

The dredging related to the construction of the marine infrastructure would disrupt bottom sediments, resulting in the suspension of finer material in the water column. Zoobenthos in the affected zone may be covered when the material precipitates from the suspension, the worst-case scenario being the death of specimens in the area. However, as discussed above for macroalgae, the magnitude of the predicted deposition of material on the seabed is within the limits of the natural variability, and zoobenthos in this area is accustomed to such changes. In addition, the material that could settle on the seabed would have composition and quality similar to those of the sediments that these organisms already inhabit.

In addition, dredging spoils may be pumped to the sides, when the material directly around the dredge is relocated, which can also cause the covering. However, the deposition levels resulting from this activity are also considered to be within the range of the natural variability for the slope area of the seabed tidal zone, which has been shown to vary by a maximum of 1.3 m. The effect of this additional sediment falling from the suspension on the seabed would be **local**, **infrequent**, **short-term** and reversible after the end of the dredging. On this basis, the effects are considered to be **negligible** and **insignificant**. This is not expected to cause any disturbance or significant impacts on the body of water as defined by the WFD or MSFD.

IV.8.3.2.3.10 Summary of the impacts related to the implementation of Sub-Variant 2A

A summary of the impacts related to the implementation of Sub-Variant 2A is presented in table [Table IV.8.3-37]

Table IV.8.3-45: The summary of the impacts related to the implementation of Sub-Variant 2A*

Receptor	Receptor significance	Receptor sensitivity	Impact source	Impact magnitude	Impact extent	Impact time / frequency	Effects	Effect significance
Coastal processes and hydromorphology								
Hydromorphological features	High	Low	Changes in hydrography, sediment transport and seabed morphology due to the construction works at sea	Low	Regional	Medium-term, continuous	Minor	Insignificant
Coastal dune zone and associated forest	High	Medium	Loss/damage due to excavation	Low	Local	Medium-term, infrequent	Minor	Insignificant
Coastal area management (morphology of beaches and dunes)	Major to medium	Medium to minor	Changes in the shoreline and the sediment transport patterns	Low	Regional	Medium-term, continuous	Minor	Insignificant
Seawater quality								
All physico-chemical elements Body of water as defined by the WFD MSFD water body Natura 2000 sites	High	Low	Construction works carried out at sea	Negligible	Local	Short-term, infrequent	Negligible	Insignificant
			Removal of material from the dredging	Negligible	Regional	Short-term, temporary	Negligible	Insignificant
			Accidental spills from operations at sea	Negligible	Regional	Short-term, infrequent	Negligible	Insignificant
			Construction works carried out on land	Negligible	Local	Long-term, continuous	Negligible	Insignificant
Marine ecology								
Habitats	High	Medium	Direct loss (permanent)	Negligible	Local	Long-term	Negligible	Insignificant
			Direct loss (temporary)	Low	Regional	Medium-term	Negligible	Insignificant
Plankton	High	Low	Eutrophication resulting from the construction works	Negligible	Local	Short-term (dredging), medium-term (site discharges), continuous	Negligible	Insignificant
Macroalgae	Medium	Medium	Direct loss	None	None	None	None	Insignificant

Receptor	Receptor significance	Receptor sensitivity	Impact source	Impact magnitude	Impact extent	Impact time / frequency	Effects	Effect significance
			Covering	Negligible	Local	Short-term, infrequent	Negligible	Insignificant
Zoobenthos	High	Medium	Disturbance of the seabed and covering	Negligible	Local	Medium-term, infrequent	Negligible	Insignificant
Fish	High	Low	Changes in water quality	Negligible	Local	Short-term, infrequent	Negligible	Insignificant
			Underwater noise	Low	Regional	Temporary, frequent	Minor	Insignificant
Marine mammals	High	Low	Underwater noise	Low	Regional	Temporary, frequent	Minor	Insignificant
			Collisions with ships	Negligible	Local	Temporary, infrequent	Negligible	Insignificant
			Reduced prey availability	Negligible	Regional	Temporary, frequent	Negligible	Insignificant
Birds	High	Low	Disturbance	Negligible	Local	Temporary, frequent	Negligible	Insignificant
			Reduced prey availability	Negligible	Regional	Medium-term, continuous	Negligible	Insignificant

** In the event of a discrepancy in the assessment of the elements of marine ecology, the results of the assessment presented in [Chapter IV.2] should be interpreted as overriding.*

Source: [19]

IV.8.3.2.3.11 Operational phase

General information

The operational phase is the longest period (about 60 years) in the life cycle of the Project, during which there will be a number of permanent elements of the marine infrastructure in place.

The potential impacts on marine physical processes and coastal geomorphology during the operational phase are expected to be limited to effects on waves, flows and sediment transport as a result of the long-term presence and operation of the NPP infrastructure. These changes can lead to a local washout (if no washout protection is installed). There is also a likelihood of impacts on marine ecological characteristics through changes in water quality and/or coastal geomorphology.

From the point of view of marine water quality, the main potential effects would be related to the discharge of effluents through the run-off, mainly clouds of thermo-chemical pollutants coming from the cooling system, as well as from the main sewage treatment works on site. Process sewage discharged through the outlet of the cooling water system would also make a contribution. Where necessary, water discharges have been assessed against the established emission limit values (ELV) at the time of discharge and against the environmental quality standards (EQS) (based on the predicted no-effect concentration (PNEC) values from toxicity studies and other considerations) in the receiving seawater. Where the water discharge meets the EQS for the individual substances at the point of discharge, it can often be justified to exclude these substances from further consideration. For other substances, water discharges and sediment agitation effects have been assessed by comparing predicted environmental concentrations with the EQS and the guideline values. The EQS for microbiological parameters have been taken into account for sewage discharges.

It should be noted, however, that the ELV have been developed mainly based on the definition of the best available techniques (BAT) for each industrial sector, in order to ensure the application of the BAT so as to minimise the release of pollutants into the environment in the case of discharges into water. This helps to achieve the WFD’s objective of reducing the release of hazardous substances into water. Thus, while compliance with the ELV contributes to the achievement of the objective of the WFD, an assessment of the environmental effects on individual water bodies is still required even if the ELV are met.

Impacts on coastal processes and hydromorphology

Impacts on hydrodynamics and seabed morphology

During the operational phase of the Project, numerous elements of permanent infrastructure will be present in the marine environment, including water intake / discharge heads of the makeup / cooling water system and the FRRS.

There are likely to be small local changes in the patterns of waves and sea currents, resulting in changes in erosion and deposition processes around the structure. Local washout of the seabed associated with the operation of the cooling water offtake structures can also occur. This will be discussed later in the detailed design stage and the Project engineers will refine the final design of the heads in such a way as to minimise the washout or by installing appropriate washout protections as part of the construction stage. It is believed that the small size and the location of the inlet and outlet heads will not cause significant changes in the speed of currents or the wave patterns, which could affect the pathways of sediment transport outside their immediate vicinity. The impacts on the hydrodynamics, sediment transport patterns and seabed morphology, resulting from the continuous presence and operation of the water intake and discharge infrastructure and the FRRS associated with the makeup / cooling water system will be considered insignificant.

Direct physical effects in coastal dune zones

For the purposes of this assessment it has been assumed that the area of beaches and dunes will be restored to its original state after the completion of the construction works related to the excavation of the trenches within the service belt during the construction stage. In addition, as noted above, since no significant changes in the marine hydrodynamics and sediment transport system within the marine survey area in Variant 2 – Żarnowiec site, are anticipated, it is considered that, as a result of the operation of the Project no changes in the morphology of the coastal beaches or dunes will occur via the sea pathway and, therefore, no effects will occur. On this basis, it is considered that the effects on the coastal dune system during the operational phase will be negligible.

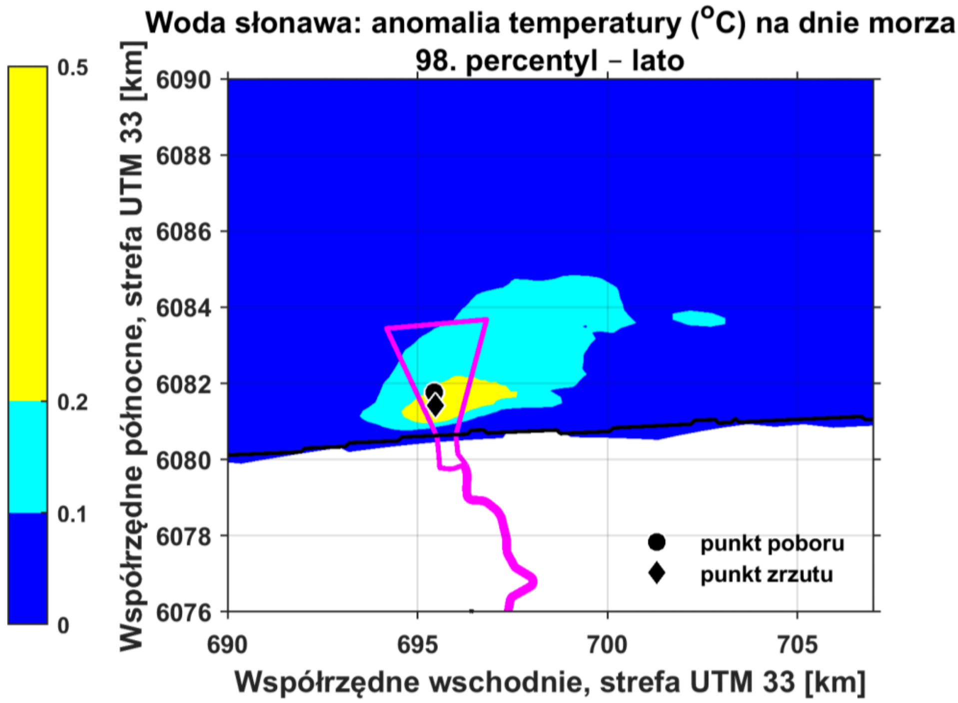
Impacts on coastal management requirements

As noted above, the effects of the impacts during the operational phase on the speed of current, wave height, sediment transport and subsequent erosion / accumulation patterns along the seashore in the vicinity of Variant 2 has been recognised as insignificant. Therefore, no changes to the requirements of the existing beach management strategy are anticipated. Additional work may be needed to maintain the dunes while the forest grows back, but the scope of this work is currently not possible to estimate. In general, the effects on the requirements for coastal zone management will be insignificant during the operational phase of the Project.

Impacts on seawater temperature and quality

Impacts of discharges on water temperature

Temperature anomalies resulting from the discharge of cooling water in Sub-Variant 2A are shown for the worst season scenario (summer) in [Figure IV.8.3-62] [19]. The results shown in the figure concern the seabed. The 98th percentile of results aggregated on the seasonal scale represents a conservative view of the total extent of the plume.



Woda słonawa: anomalia temperatury (°C) na dnie morza 98. percentyl - lato	Brackish water: temperature anomaly (°C) at the seabed 98th percentile - summer
punkt poboru	intake point
punkt zrzutu	discharge point
Współrzędne wschodnie, UTM33 [km]	Eastern coordinates, UTM33 [km]
Współrzędne północne, UTM33 [km]	Northern coordinates, UTM33 [km]

Figure IV.8.3-62: The 98th percentile of the thermal water anomaly (°C) at the seabed, for Sub-Variant 2A with the closed cooling system using seawater (the purple line delineates the Project Area)
Source: [456]

The identified receptors, i.e. the physico-chemical elements supporting water bodies, as defined by the WFD, and descriptive elements 5 and 8 of water bodies, within the meaning of the MSFD, are of high significance due to the presence of the nature protection areas (Przybrzeżne wody Bałtyku SPA) and the possibility of the occurrence of impacts on flora and fauna supporting important features of this location, as a result of changes in water quality. The sensitivity is low due to the dynamic nature of the environment and its assimilation capacity.

The spatial extent of the ambient water temperature increase by > 2°C can be considered local because it is limited to the initial dilution zone directly around the point of discharge, although smaller changes (below the EQS) can be detected at a greater distance (regional).

Due to the fact that the discharge of cooling water is a part of the operational work of the NPP, although the actual discharge can occur periodically, the overall impacts are perceived as long-term and continuous.

The magnitude of the impacts is small because, although immediately after the discharge the temperature would exceed the limits of the natural variability at this point, the discharge would disperse in the immediate vicinity and there would be no significant increase in temperature outside the initial dilution zone. Therefore, the area of the occurrence of temperatures exceeding the accepted environmental quality standards (EQS) would be very small and limited to the initial dilution zone.

Taking into account the above, the scale of the effects resulting from these changes in the temperature of the surrounding water as a result of the release of heated cooling water into the marine environment from Sub-Variant 2A in Żarnowiec (closed cooling system using seawater) is low and, therefore, insignificant.

Impacts of discharges on water quality

Changes in the quality of the surrounding water resulting from the discharge of process sewage

The process sewage would contain residues of chemicals used in the NPP to control the pH level, inhibit the corrosion process, limit scale deposition in, and remove oxygen from, the reactor and steam generator, reduce the scale deposition and control the phenomenon of biofouling in the cooling tower installation, and remove metals resulting from corrosion and erosion of reactor components involved in heat exchange, components of the auxiliary system of steam turbines and components of the cooling towers.

The discharge from the NPP will increase the amount of nutrients in the sea, and any significant amount added can adversely affect phytoplankton development and, consequently, eutrophication of a larger sea area, potentially leading to ecological deterioration. Nutrient discharges in the concentrations in excess of the EQS can therefore potentially cause significant adverse effects. As explained, tighter control of the dosage and/or use of purification chemicals containing small amounts of phosphorus or not containing phosphorus creates opportunities to reduce phosphate concentrations in the process discharge. Assuming the application of appropriate mitigation measures, taking into account availability of alternative products, as discussed in chapter [Chapter V.3.1.5] of the EIA Report, the effects on seawater quality would be negligible.

For most of these corrosion products it is assumed that the concentrations at the time of discharge will meet the EQS when diluted with the stream of discharged cooling water. However, especially in the case of nickel and zinc, there is a danger that the situation can be different in the case of the closed system. Further checks on these and other metals are necessary.

It is considered that by combining approaches to additional mitigation measures, described in chapter [Chapter V.3.1.5] of the EIA Report, including the treatment of specific effluent streams, where necessary, it would be possible to achieve appropriate ELV and EQS levels at the point of discharge for all chemicals contained in the process effluent discharge, and that changes in the quality of the surrounding water as a result of the process effluent discharge would be negligible.

Changes in the quality of the surrounding water resulting from the discharge of biocides

In order to minimise the phenomenon of biofouling within the Project, it may be necessary to use a disinfectant (probably chlorine). Another issue to be considered in the case of the closed cooling system is the possibility of the formation of biofilm in cooling tanks and on structures, which can develop in about six hours and lead to macrofouling, which can cause structural damage in the cooling towers.

Dilution factors for cooling water in Sub-Variant 2A for conservative discharge components (such as salinity) shows the dilution factor by more than 18 times at a distance of less than 100 m from the point of discharge under all the modelled conditions. In fact, TRO concentrations are expected to dilute in seawater, so the concentration reduction will be greater than the modelling suggests.

Using the precautionary approach, it has been found that the impacts could be mitigated if a chemical batching regimen is established that ensures the presence of no more than 0.2 mg/l of TRO in the discharge. Given an at least 18-fold dilution, this would result in a reduction in the concentration to 0.011 mg/l or less in the initial dilution zone.

Due to the closed circuit of the cooling system and the possibility of using batch purging to neutralise chlorine before the discharge from the closed system, the concentration of biocides can be reduced before the discharge, if necessary. On this basis, it can be concluded that, with appropriate mitigation measures, in the case of the closed cooling system such as the one proposed for Sub-Variant 2A, it would be possible to ensure that the effects of biocide discharges would be negligible.

Changes in the quality of the surrounding water resulting from the discharge of treated sewage

Compared to the discharge of treated sewage during the construction phase, treated sewage in the operational phase:

- have a much lower flow rate, estimated at an average of 283 m^3/d, compared to 1,785 m^3/d estimated for the peak of the construction phase;
- will be purified to the same extent as during the construction stage [20] (total nitrogen 15 mg N/l; total phosphorus 0.1 mg P/l) so as to meet the requirements [372], with the same concentrations of bacteria predicted in the treated sewage;
- will be diluted to a large extent with water from the cooling system before discharge into the sea;
- will be discharged at approximately the same distance from the shore as during the construction phase (however, by the cooling water outlet from the NPP and not by the outlet from the treatment plant at the construction phase);
- will be discharged during a much longer period.

Although the discharge of sewage in the operational phase will take place over a much longer period than during the construction phase, all elements of concern in domestic sewage discharges are labile, reactive or, in the case of bacteria, subject to rapid decline, therefore the discharge will not lead to any cumulative effects over this long period. The direct comparison of the discharge in the operational phase with the assessment for the construction phase is therefore considered correct.

This confirms the conclusion that, if the proposed conventional treatment option were used, by comparison with the assessment based on the detailed modelling carried out for the sewage discharges at the construction phase, including the higher flow of treated effluents, without dilution before the discharge, the effects on ambient water quality resulting from the discharge of the treated sewage during the operational phase would be negligible.

<u>Changes in the quality of the surrounding water resulting from the discharge of brine</u>

Discharges of brine from desalination stations in some parts of the world are a problem because dense brine sinks to the seabed and slowly mixes with the surrounding seawater, leading to adverse effects on benthic and epibenthic flora and fauna.

Based on the research carried out in 2017-2018 at the sampling sites in the marine survey area, it has been found that there is a natural variability of the salinity of the Baltic Sea in the area of Variant 2 – Żarnowiec site, which amounts to 2.02 psu. On this basis, it can be concluded that with an increase in salinity in the water receiver at the edge of the mixing zone corresponding to the initial dilution zone of the brine discharge with ≤ 1 psu, no significant impacts on the environment are to be expected.

Based on the discharge limits for the Bay of Puck, and in the context of the natural salinity variability exceeding one unit of salinity, it is considered that a ΔS of 0.5 psu at the edge of the initial mixing zone of the near field is an appropriate prudent EQS target value for discharges from Variant 2 – Żarnowiec site, which would allow protection against adverse impacts on the marine flora and fauna.

The modelling has been carried out using the CORMIX model, for the near field, and the Delft-3D model, for the far field - for the summer and winter flow rates, for the blow-off with salinity of 15.03 psu.

In all the cases, the suggested target ΔS of less than 0.5 psu was achieved in the zone of initial mixing of the near field (at a distance of < 100 m from the point of discharge) for the cooling towers operating with brackish water.

- The identified receptors, i.e. the physico-chemical elements supporting water bodies, as defined by the WFD, and descriptive elements 5 and 8 of water bodies, within the meaning of the MSFD, are of high significance due to the presence of the nature protection areas (Przybrzeżne wody Bałtyku SPA) and the possibility of the occurrence of impacts on flora and fauna supporting important features of this location, as a result of changes in water quality. They have low sensitivity due to their ability to tolerate change.
- The spatial extent of the increase in salinity of the surrounding water by 0.5 units can be considered local because it is limited to the initial dilution zone of the near field. Although the plume can extend beyond this area (within the regional range), the salinity anomaly is close to the background level (less than 0.1 psu).
- Due to the fact that the discharge of cooling water is a part of the operation of the NPP, although the actual discharge can occur periodically, the overall impacts are perceived as continuous.
- The magnitude of the impacts is small because, although the salinity immediately after the discharge would be higher than the natural variability at this point, it would be dispersed in the immediate vicinity, without a significant increase or overrun of the accepted EQS values outside the zone of initial mixing of the near field.

Changes in the quality of the surrounding water resulting from the total discharge of process sewage

The assessment of changes in the quality of the surrounding water, resulting from the release of chemical ingredients of process sewage, has been carried out in the previous sections. The following is an assessment of how sewage from the combined processes would affect the receiving environment, with particular regard to the effects on the water bodies, as defined by the WFD and MSFD.

- The identified receptors, i.e. the physico-chemical elements supporting water bodies, as defined by the WFD, and descriptive elements 5 and 8 of water bodies, within the meaning of the MSFD, are of high significance due to the presence of protected bathing waters and protected nature areas (Przybrzeżne wody Bałtyku SPA) and the possibility of the occurrence of impacts on flora and fauna supporting important features of this location, as a result of changes in water quality. They have low sensitivity due to their ability to tolerate change.
- The spatial extent of the identified impacts is regional. This is because, with the additional mitigation measures identified, it would be possible to ensure that substances the concentrations of which could otherwise exceed the EQS values in summer and in winter comply with the EQS values before the discharge. Changes in the temperature and salinity would be below the EQS values within a radius of 100 m from the discharge site, although anomalies (below the EQS) would extend more than 100 m from the Project's footprint.
- The impacts is long-term, as discharges of combined process sewage would take place throughout the entire operational phase of the NPP.
- These are continuous impacts because the discharge of combined process sewage would take place throughout the lifetime of the NPP.

- Provided that the mitigation measures discussed in [Chapter V.3.1.5] of the EIA Report are applied, the concentrations of most substances other than phosphorus could be reduced to values lower than the EQS values at the point of discharge, which would have a negligible impact. It is not possible to limit the phosphorus discharge to less than the EQS values because the concentration in the surrounding seawater at the inlet is close to, or exceeds, the EQS. Changes in the temperature and salinity below the EQS would be slightly more extensive and, therefore, the overall impact of the combined discharge is assessed as negligible.
- The effect of the discharge of substances other than phosphorus is therefore negligible because, despite the high significance of the receptors, the water bodies, as defined by the WFD and the MSFD, together with associated bathing sites and protected areas, are able to absorb the impacts which fall within the range of their natural variability.
- Discharges of biocides can be easily controlled in the case of closed cooling systems and mitigation measures will be applied, if necessary, to ensure that the effects of the discharges are negligible.

Therefore, it can be concluded that, if the mitigating measures are applied, the effects resulting from the impacts on the identified receptors during the operational phase of the facility will be insignificant.

IV.8.3.2.3.12 Impacts on marine biology

Impacts on plankton and eutrophication

The main potential for the impacts on the environmental status of the receiving waters is related to the increased load of biogenic substances (nitrogen and phosphorus) entering the sea, which will contribute to the ongoing eutrophication in the Baltic Sea [158].

The aggregate normalised nitrogen loads discharged into Polish territorial waters in the immediate vicinity of the Vistula drainage basin in 2015 amounted to 86,354 tons/year. The net increase in the nitrogen load for cooling water in Sub-Variant 1B is estimated at 6.0 tonnes/year (as N), which means an increase in the nitrogen content by 0.007%. This represents the worst-case scenario, as some of the load contributed by treated sewage would probably be transferred from other locations in the same river drainage basin with workers moving to the new NPP.

The total phosphorus load is 5,476 tons/year [222] while the discharge from the NPP represents additional 306 tonnes/year of the net load, which means an increase by 5.59% compared to the current load. Most of the additional charges result from the estimated use of polyphosphates to control the scaling process in the cooling tower circuit.

The significance of the receptor is high, due to the presence of the international protected area (Przybrzeżne wody Bałtyku SPA), and the sensitivity is low due to the assimilation capacity of the environment and the ability of plankton populations to regenerate rapidly. Adverse effects of phosphorus discharges on phytoplankton growth and on the associated zooplankton food chain are classified as medium and potentially significant. Therefore, if this cooling water system option (Sub-Variant 2A) were to be chosen, additional mitigation measures would be required. This would entail optimising the use of phosphorus-based chemicals or using available alternatives to reduce phosphorus discharges to an acceptable level. Assuming that these measures are implemented, it can be considered that the residual impact can be reduced to a small and insignificant level.

Impacts on macroalgae

Although a habitat of red algae was found in the area of the marine surveys in Sub-Variant 2, it has a very limited range and the areas of the occurrence of macroalgae do not significantly coincide with the footprint of the marine infrastructure. On this basis, it is assessed that the direct loss of macroalgae would be negligible and insignificant.

Changes in the state of nutrients resulting from the operation of the NPP will be negligible, provided that the recommended additional mitigation measures are applied. Therefore the impacts on marine macrophytes caused by changes in the state of nutrients will be insignificant.

As a result of the discharge of cooling water in the immediate vicinity of its outlet, there would be a local increase in the temperature of the surrounding water. However, macroalgae populations do not coincide with either the marine infrastructure or the direct thermal plume with a temperature of > 2°C. The modelling of the plume has shown a slight (< 0.5°C) increase in the temperature on the seabed, covering a large area (up to about 2 km from the discharge site), with potential interaction with the macroalgae habitat areas. However, this is not expected to have significant effects on the species present there. Therefore, the impacts will be insignificant.

Impacts on zoobenthos

The degree of the loss of habitats due to the permanent infrastructure is minimal and is considered insignificant.

Elevated ambient temperatures associated with the cooling water outlet can potentially affect zoobenthos through, for example, increased metabolic rate and growth rates [209]. No species of particular sensitivity or conservation requirements have been identified within the marine survey area. A slight increase in the temperature, by < 0.5°C, is expected on a wider scale: to about 2 km from the discharge site. The impacts of the combined discharge on water quality have been assessed as negligible or minor, and benthic populations are characterised by low sensitivity due to their ability to regenerate after changes. Therefore, the impacts are considered insignificant.

Summary of the impacts of the operational phase: Sub-Variant 2A

The impacts of operation of Sub-Variant 2A are summarised in table [Table IV.8.3-46] below

Table IV.8.3-46: The summary of the impacts of operation of Sub-Variant 2A*

Receptor	Receptor significance	Receptor sensitivity	Impact source	Impact magnitude	Impact extent	Impact time / frequency	Effects	Effect significance
Coastal processes and hydromorphology								
Coastal processes and bathymetry	High	Low	Operation of Sub-Variant 2A	Negligible	Local	Permanent, continuous	Negligible	Insignificant
Coastal dune zone and associated forest	High	Medium	Operation of Sub-Variant 2A	None	None	None	None	Insignificant
Coastal area management (beach morphology)	High	Medium	Operation of Sub-Variant 2A	None	None	None	None	Insignificant
Seawater quality								
All physico-chemical elements Body of water as defined by the WFD MSFD water body Natura 2000 sites	High	Low	Thermal load from cooling water discharges	Low	Local to regional	Long-term, continuous	Minor	Insignificant
			Discharge of process effluents (other than nutrients)	Medium, can be reduced to negligible	Regional	Long-term, continuous	Moderate, can be reduced to negligible	Potentially significant, can be reduced to insignificant
			Discharge of biocides	Low	Regional	Long-term, continuous	Minor	Insignificant
			Discharges of process sewage	Negligible	Regional	Long-term, continuous	Negligible	Insignificant
			Saline discharge	Low	Local to regional	Long-term, continuous	Minor	Insignificant
			Total discharge	Minor to negligible	Local to regional	Long-term, continuous	Negligible to low	Insignificant
Marine ecology								
Eutrophication / Biogenic conditions	High	Low	Nutrients in in-service discharges	Medium	Regional	Long-term, continuous	Medium but can be reduced to low	Potentially significant, can be reduced to insignificant
Plankton	High	Low	Nutrients in in-service discharges	Low	Regional	Long-term, continuous	Medium but can be reduced to low	Potentially significant, can be reduced to insignificant
Macroalgae	Medium	Medium	Direct loss	Negligible	Local	Permanent, continuous	Negligible	Insignificant

Receptor	Receptor significance	Receptor sensitivity	Impact source	Impact magnitude	Impact extent	Impact time / frequency	Effects	Effect significance
			Change in the state of nutrients	Negligible	Regional	Long-term, continuous	Negligible	Insignificant
			Change in water temperature	Negligible	Regional	Long-term, continuous	Negligible	Insignificant
Zoobenthos	High	Medium	Loss of habitats	Negligible	Local	Long-term, continuous	Negligible	Insignificant
			Changes in water quality	Minor to negligible	Local to regional	Long-term, continuous	Negligible	Insignificant
Fish	High	Low	Underwater noise	Negligible	Regional	Long-term, rare	Negligible	Insignificant
			Collisions and suction	Minor to negligible	Local	Long-term, continuous	Minor	Insignificant
Marine mammals	High	Low	Underwater noise	Negligible	Regional	Short-term, infrequent	Negligible	Insignificant
			Increased ship traffic and collision risk	Negligible	Local	Short-term, infrequent	Negligible	Insignificant
			Reduced prey availability	Negligible	Local	Short-term, continuous	Negligible	Insignificant
Birds	High	Low	Disturbance	Negligible	Local	Short-term, infrequent	Negligible	Insignificant
			Reduced prey availability	Negligible	Local	Long-term, continuous	Negligible	Insignificant

** In the event of a discrepancy in the assessment of the elements of marine ecology, the results of the assessment presented in [Chapter IV.2.3] should be interpreted as overriding.*

Source: [456]

IV.8.3.2.3.13 Decommissioning phase

The potential impacts of the decommissioning of the Project on the geomorphology of the coast and seawaters would depend on the planned level of decommissioning in the marine environment. Although it is rather well known what the decommissioning of the NPP entails, there is no information on exactly which elements of the marine infrastructure will be preserved and which will be removed during the decommissioning.

Due to the significant lack of confirmed information on the decommissioning phase, not only for the planned work, but also for the initial environmental conditions and regulatory framework that will then apply, no detailed impact assessment has been carried out. However, based on experience from other projects of a similar nature, the potential effects are expected to be similar to those occurring during the development and construction stages, but to a lesser extent.

On this basis, taking into account the fact that the potential impacts on seawater quality, coastal geomorphology and marine ecology during the development and construction stages were considered insignificant, it has been concluded that a similar set of the impacts during decommissioning will also be insignificant.

Impact on compliance with the Water Framework Directive in Sub-Variant 2A

The assessment has been carried out for Sub-Variant 2A with the closed cooling system using seawater to identify potential effects on the water bodies according to the WFD. The assessment has determined whether the receptors are at risk as a result of activities related to the development and construction stages and the operational and decommissioning phases. The assessment according to the WFD takes into account the environmental status of surface waters including coastal bodies.

As regards the chemical status, the assessment and alignment with the EQS and other regulatory limits have shown for Sub-Variant 2A that are no significant effects on the chemical properties, so no effect on the future state of water, provided that additional mitigation measures for hydrazine and corrosion products are applied.

As a result of the impact assessment of the Project, no residual adverse effects of the construction of Sub-Variant 2A on the current state of water bodies according to the WFD, nor on the possibility of achieving the objectives set out in the Water Management Plan enabling the achievement of the good environmental status, have been found.

In conclusion, the WFD assessment for Sub-Variant 2A for all the stages has shown that there would be no significant adverse impacts on elements of biological, hydromorphological and/or physico-chemical quality that could jeopardise the current WFD state of the water bodies in which the works are carried out. In addition, the activities related to the construction and operation of the Project will not affect the implementation of the planned state improvement measures specified for the body of coastal waters in the current River Basin Management Plan for the Second Cycle (2016-2021) [417] or in the draft Water Management Plan for the Third Cycle for the Vistula river basin area [352]. The assessment also concludes that Sub-Variant 2A will not have a significant adverse impact on marine protected areas (Natura 2000 sites or designated bathing sites), although final conclusions on the effects of the Project on the integrity of Natura 2000 sites will be drawn once the impact assessment under the Habitats Directive has been completed.

Impact on compliance with the Marine Strategy Framework Directive

The effects on marine water bodies designated under the MSFD involve eleven parameters set out in table [Table IV.8.3- 33] and related environmental objectives set out in detail in the chapter [Chapter IV.8.3.1] of the EIA Report. Unlike the Water Framework Directive (WFD), the Marine Strategy Framework Directive (MSFD) does not define a purely formal approach to carrying out assessments. Instead, it relies on a description-based and expert opinion-based approach, using the overarching EIA results and aligning them with the MSFD parameters. The parameters form the basis of the MSFD, determining what constitutes the good environmental status for each of the components considered important for the overall health of the marine aquatic environment.

The assessment for Sub-Variant 2A with the closed cooling system using seawater has been developed for each of these descriptive indicators and related objectives, taking into account whether the Project has a potential to downgrade the assessment where the good environmental status (GES) has been achieved or to prevent the achievement of the good environmental status (GES) where it has not yet been achieved.

IV.8.3.2.4 Impact assessment – Sub-Variant 2B

The operation of the NPP's three AP1000 reactors at full power, with the cooling water system using desalinated seawater over a cycle of five concentration cycles (CoC) was considered during the assessment of impacts to be the scenario that could cause the most significant environmental effects

Development stage

Few works in the marine environment are anticipated at the development stage and, therefore, the effects are limited to activities related to the following:

- The preparatory work on land (including removal of vegetation and preliminary earthworks);
- The construction of the MOLF and the associated service road providing access to the NPP;
- The construction of the sewage treatment works in the construction phase.

The above effects on coastal hydromorphology, seawater quality and marine ecology will coincide with those described earlier for Sub-Variant 2A.

IV.8.3.2.4.2 Operational phase

General

The operational phase is the longest period in the life cycle of the Project, during which a number of permanent elements of the marine infrastructure will operate. From the perspective of the geomorphology of the coastal zone, such infrastructure can interfere with waves and flows, which may lead to changes in sediment transport patterns. With the exception of the quality of process water, the assessment is largely the same as that presented for Sub-Variant 2A.

As regards water quality, the discharges were reassessed according to the established emission limit values (ELV) and the environmental quality standards (EQS). These aspects are the main subject matter of this assessment, with the difference between Sub-Variants 2A and 2B with the closed cooling system being the discharge of process sewage.

Impacts on hydrodynamics, coastal processes and coastal geomorphology

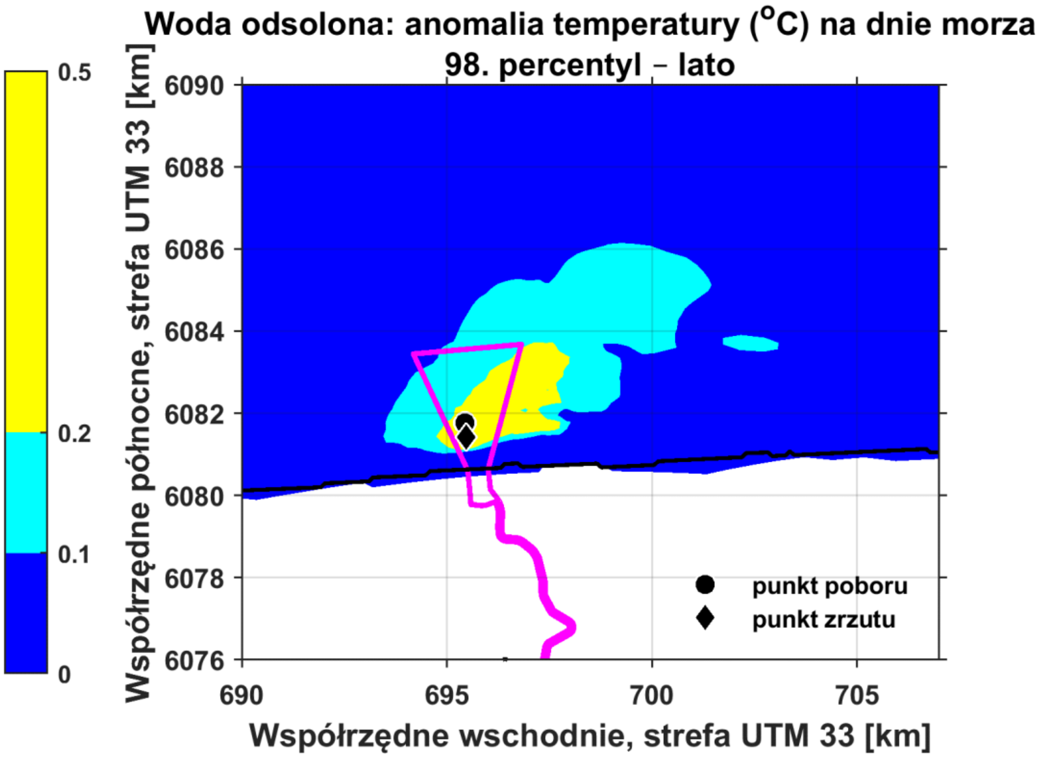
During the operation phase, the permanent elements of the Sub-Variant 2B infrastructure embedded in the marine environment coincide with those presented for Sub-Variant 2A, i.e. the inlet and discharge heads of the complimentary/cooling water system plus the FRRS and MOLF. Therefore, the impacts on marine physical processes, bathymetry and hydromorphology and the resulting effects that could arise from these impacts would be the same as described earlier for Sub-Variant 2A and considered insignificant.

Impacts on seawater temperature and quality

Impacts of discharges on ambient water temperature

The temperature of the surrounding water is the key factor affecting water quality. The temperature of discharges of desalinated water in summer would be up to 35.7°C, and in winter 12°C – the same as in the case of Sub-Variant 2A using brackish water or seawater. However, the discharge stream in Sub-Variant 2B will be approximately one half smaller. Temperature anomalies resulting from the discharge of cooling water from the cooling towers using desalinated seawater are shown taking into account the worst-season scenario in [Figure IV.8.3-66].

The CORMIX modelling results show that the ΔT is < 2°C at the end of the momentum-driven near field mixing zone, at a distance of several tens of metres to the side of the outlet. As shown by the results of the Delft-3D far-field modelling, at no point does the temperature increase on the seabed reach a level of environmental concern, i.e. an increase by 2°C. In addition, no change above 0.1°C directly affects the shoreline.



Woda odsolona: anomalia temperatury (°C) na dnie morza 98. percentyl - lato	Desalinated water: temperature anomaly (°C) at the seabed 98th percentile - summer
punkt poboru	intake point
punkt zrzutu	discharge point
Współrzędne wschodnie, UTM33 [km]	Eastern coordinates, UTM33 [km]
Współrzędne północne, UTM33 [km]	Northern coordinates, UTM33 [km]

Figure IV.8.3-66: The 98th percentile of the thermal water anomaly (°C) at the seabed – Sub-Variant 2B with the closed cooling system using desalinated seawater (the purple line delineates the Project Area)
Source: [456]

The extent of a slight (< EQS) temperature increase on the seabed in the case of Sub-Variant 2B is slightly larger than in the case of Sub-Variant 2A due to the higher salinity (and, therefore, higher density) of discharge in Sub-Variant 2B. However, this broader temperature anomaly remains well below the EQS and based on the same arguments regarding the receptor value and the magnitude of the impacts that have been presented for Sub-Variant 2A. It has been concluded that the effects resulting from changes in ambient water temperature as a result of the release of the thermal plume into the marine environment are in the worst-case scenario minor and insignificant.

Impacts of discharges on water quality

Changes in the quality of the surrounding water resulting from the discharge of process sewage

The discharge from the planned NPP will increase the amount of nutrients in the sea, and any significant amount added can adversely affect phytoplankton development and, consequently, eutrophication of a larger sea area. Nutrient discharges in the concentrations in excess of the EQS can therefore potentially cause significant adverse effects. Assuming that appropriate mitigation measures are applied, taking into account availability of alternative products, the effects on seawater quality would be negligible.

- It is assumed for most corrosion products that the concentrations at the time of discharge will meet the EQS when diluted with the stream of discharged cooling water. However, particularly in the case of nickel and zinc, there is a danger that this may be not the case with the closed system Sub-Variant. Further checks on these and other metals are needed, by reference to other comparable power plants, when the Project is ready and it is already known what materials will be used.

It is considered that by combining approaches to additional mitigation measures, including the treatment of specific effluent streams, where necessary, it would be possible to achieve appropriate ELV and EQS levels at the point of discharge for all chemicals contained in the process effluent discharge, and that changes in the quality of the surrounding water as a result of the process effluent discharge would be negligible.

Changes in the quality of the surrounding water resulting from the discharge of biocides

Changes in the quality of the surrounding water resulting from the discharge of treated sewage

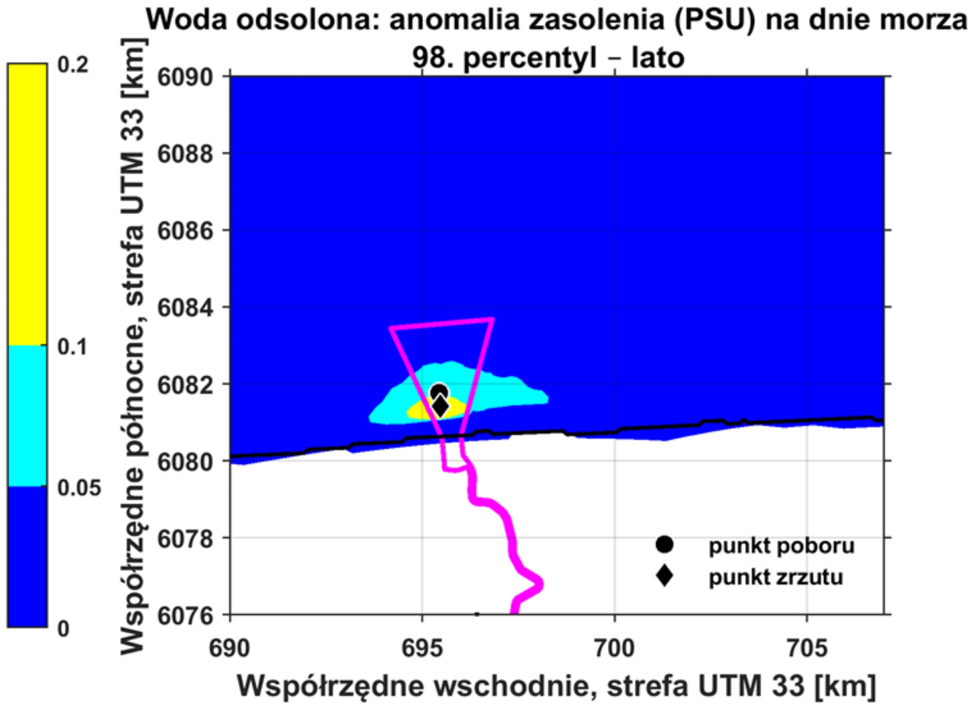
For Sub-Variant 2B (coinciding with the previously described Sub-Variant 2A), municipal wastewater would be re-treated at the sewage treatment works at the NPP site and discharged mixed with cooling water through the cooling water outlet. Therefore, comparisons made previously with the discharge of treated sewage during the construction phase continue to apply, although the degree of dilution provided by slightly smaller cooling water flows for Sub-Variant 2B would be lower compared to Sub-Variant 2A. However, the dilution would still be more than 900 times with all NPP's units in operation or more than 600 times during the down time of one reactor.

Based on the fact that the numerical modelling has not shown any significant adverse effects of the discharge of treated sewage at the construction stage and that the effects of the discharge of treated effluents during the operational phase are expected to be smaller, for the reasons mentioned above, it can be concluded that the effects on the quality of ambient water resulting from the discharge of treated sewage during the operational phase will be negligible.

Changes in the quality of the surrounding water resulting from the discharge of brine

The salinity in the cooling water discharge for Sub-Variant 2B is higher than for Sub-Variant 2A because the main cooling water system uses water desalinated at 5°C, as opposed to 2°C for Sub-Variant 2B using seawater. Discharges from the cooling tower are therefore less frequent and the total discharge from the cooling water outlet in the case of Sub-Variant 2B is consequently smaller (by about one half). However, since water drawn into the cooling circuit is desalinated, there is additional waste from the desalination plant in the cooling water discharge, which means that it has a higher salinity.

The results from this far field model were analysed by plotting the 98th percentile of the salinity anomaly, as shown in figure [Figure IV.8.3-67]. These results show that the excess salinity is further dispersed to the ambient levels in the area of several hundred metres from the place of discharge. The results for the bottom of the water column have been presented as the worst-case scenario because, due to the higher density of the brine discharge, the resulting plume remains close to the seabed. As for temperature, the range of salinity anomalies below EQS on the seabed for Sub-Variant 2B is slightly larger than for Sub-Variant 2A due to the higher discharge density.



Woda odsolona: anomalia zasolenia (PSU) na dnie morza 98. percentyl - lato	Desalted water: salinity anomaly (PSU) at the seabed 98th percentile - summer
punkt poboru	intake point
punkt zrzutu	discharge point
Współrzędne wschodnie, UTM33 [km]	Eastern coordinates, UTM33 [km]
Współrzędne północne, UTM33 [km]	Northern coordinates, UTM33 [km]

Figure IV.8.3-67: Sub-Variant 2B – 98th percentile of salinity anomaly (psu) at the seabed (the purple line delineates the Project Area)

Source: [456]

Based on the same arguments that have been presented earlier, the potential effect resulting from the anticipated changes in the salinity of the surrounding water as a result of the discharge of brine into the marine environment adjacent to Variant 2 is small and, therefore, insignificant.

<u>Changes in the quality of the surrounding water resulting from the total discharge of process sewage</u>

It has been found that, provided that mitigation measures are applied, the concentrations of most substances other than phosphorus could be reduced to values lower than the EQS values at the point of discharge, which would have a negligible effect. The EQS value for phosphorus cannot be reached before the discharge because the concentrations in the surrounding seawater at the inlet are already close to, or higher than, the EQS values. Therefore, the assessment of effects of changes in the total nutrient load discharged into the sea has also been carried out. Changes in the temperature and salinity below the EQS would be slightly more extensive and, therefore, the overall impact of the combined discharge is assessed as minor.

Discharges of biocides can be easily controlled in the case of closed cooling systems and mitigation measures will be applied, if necessary, to ensure that the effects of the discharges are insignificant.

Therefore, it can be concluded that, if the mitigating measures are applied, with the exception of discharges of phosphorus compounds, the effects of the impacts on the identified receptors during the operational phase of the facility will be insignificant.

IV.8.3.2.4.3 Impact on the marine ecology

Phytoplankton and eutrophication

The main potential for the impacts on the environmental status of the receiving waters is related to the increased load of biogenic substances (nitrogen and phosphorus) entering the sea, which will contribute to the ongoing eutrophication in the Baltic Sea [158].

The aggregate load of phosphorus is 5,476 tons/year and the discharge from the NPP represents additional 72 tons/year of the net load, which means an increase by 1.31% compared to the current load. The increased load means an increase by only 1.31% from the baseline and it is predicted that the effects of the phosphorus discharge on phytoplankton growth and on the associated zooplankton food chain will be negligible and, therefore, insignificant.

However, in the light of the current efforts to reduce rather than increase nutrient loads entering the Baltic Sea [155], if Sub-Variant 2B were to be chosen, it is recommended to minimise phosphorus discharges as far as possible by implementing appropriate further mitigation measures.

Other marine biological aggregations

The use of desalinated seawater in the cooling towers rather than ordinary seawater means that salinity levels in the discharge will be higher than in Sub-Variant 2A, although the flow rates will be smaller. The total load of dissolved solids will therefore be similar in both Sub-Variants. Although the denser streak in the case of Sub-Variant 2B will spread to a greater extent on the seabed than in the case of Sub-Variant 2B, this will occur only after significant dilution, and both temperature and salinity will be significantly lower than the respective EQS values. Thus, the effects on flora and fauna are considered negligible and insignificant.

The effects of the discharges have been assessed as negligible, subject to the application of the mitigation measures, and, therefore, their impact on flora and fauna will be negligible.

Other types of effects on marine ecological clusters during the operational phase of Sub-Variant 2B will have the same scale as those described and assessed for Sub-Variant 2A, which have been assessed as insignificant. On this basis, the effects of the impacts are not described here in detail, but are considered insignificant.

IV.8.3.2.5 Summary of the impacts of the operational phase: Sub-Variant 2B

The impacts of the operation of Sub-Variant 2B differ slightly from those related to Sub-Variant 2A and are summarised in [Table IV.8.3-39].

Table IV.8.3-39: The summary of the effects of the operation of Sub-Variant 2B (only the features different than in Sub-Variant 2A are shown)*

Receptor	Receptor significance	Receptor sensitivity	Impact source	Impact magnitude	Impact extent	Impact time / frequency	Effects	Effect significance
Coastal processes and hydromorphology								
Coastal processes and bathymetry	High	Low	Operation of Sub-Variant 2B	Negligible	Local	Permanent	Negligible	Insignificant
Coastal dune zone and associated forest	High	Medium	Operation of Sub-Variant 2B	None	None	None	None	Insignificant
Coastal area management (beach morphology)	High	Low	Operation of Sub-Variant 2B	None	None	None	None	Insignificant
Seawater quality								
All physico-chemical elements Body of water as defined by the WFD MSFD water body Natura 2000 sites	High	Low	Thermal load from cooling water discharges	Low	Local to regional	Continuous	Minor	Insignificant
			Discharge of process sewage (other than nutrients)	Medium but can be reduced to low	Regional	Long-term, continuous	Medium, may be reduced to minor	Potentially significant, can be reduced to insignificant
			Discharges of process sewage	Negligible	Regional	Long-term, continuous	Negligible	Insignificant
			Saline discharge	Low	Local to regional	Long-term, continuous	Minor	Insignificant
			Total discharge	Low, may be reduced to negligible	Regional	Long-term, continuous	Minor, may be reduced to negligible	Insignificant
Marine ecology								
Biogenic conditions	High	Low	Nutrients in in-service discharges	Medium but can be reduced to low	Regional	Long-term, continuous	Medium, may be reduced to minor	Potentially significant, can be reduced to insignificant
Plankton	High	Low	Nutrients in in-service discharges	Medium but can be reduced to low	Regional	Long-term, continuous	Medium, may be reduced to minor	Potentially significant, can be reduced to insignificant
Macroalgae	Medium	Medium	Direct loss	Negligible	Local	Permanent, continuous	Negligible	Insignificant

Receptor	Receptor significance	Receptor sensitivity	Impact source	Impact magnitude	Impact extent	Impact time / frequency	Effects	Effect significance
			Change in the temperature and chemical quality of water	Negligible	Local to regional	Long-term, continuous	Negligible	Insignificant
Zoobenthos	High	Medium	Loss of habitats	Negligible	Local	Long-term, continuous	Negligible	Insignificant
			Changes in water quality	Minor to negligible	Local to regional	Long-term, continuous	Negligible	Insignificant
Fish	High	Low	Underwater noise	Negligible	Regional	Long-term, rare	Negligible	Insignificant
			Collisions and suction	Minor to negligible	Local	Long-term, continuous	Minor	Insignificant
Marine mammals	High	Low	Reduced prey availability	Negligible	Local	Long-term, continuous	Negligible	Insignificant
			Increased ship traffic and collision risk	Negligible	Local	Short-term, infrequent	Negligible	Insignificant
			Disturbance	Negligible	Local	Short-term, infrequent	Negligible	Insignificant
Birds	High	Low	Disturbance	Negligible	Local	Short-term, infrequent	Negligible	Insignificant
			Reduced prey availability	Negligible	Local	Long-term, continuous	Negligible	Insignificant

** In the event of a discrepancy in the assessment of the elements of marine ecology, the results of the assessment presented in [Chapter IV.2] should be interpreted as overriding.*

Source: [456]

IV.8.3.2.5.1 Decommissioning phase

As discussed earlier, given the significant gaps in information with regard to the decommissioning phase of the investment, no detailed impact assessment has been carried out. However, based on experience from other projects of a similar nature, the potential effects are expected to be similar to those occurring during the development and construction stages, but to a lesser extent. It can be concluded that similar impacts in the decommissioning phase of Sub-Variant 2B would also be negligible and insignificant.

Impact on compliance with the Water Framework Directive

The assessment has been carried out for Sub-Variant 2B with the closed cooling system using desalinated seawater in order to identify potential effects on the water bodies according to the WFD. The assessment has determined whether the receptors are at risk as a result of activities related to the development, construction and commissioning stages and the operation and decommissioning phases. The assessment according to the WFD takes into account the environmental status of surface waters including coastal bodies.

As regards the chemical status, the assessment and alignment with the EQS values and other regulatory limits have shown that in the case of Sub-Variant 2B there are no significant effects on the chemical properties and no effects on the future state of the waters, provided that additional mitigation measures for hydrazine and corrosion products are applied.

In principle, no adverse impacts resulting from the construction of Sub-Variant 2B on water bodies according to the WFD are expected.

In conclusion, the WFD assessment for all the stages and phases of Sub-Variant 2B has shown that there will be significant adverse impacts on elements of biological, hydromorphological and/or physico-chemical quality that could jeopardise the current WFD state of the water bodies in which the works are carried out.

Impact on compliance with the Marine Strategy Framework Directive

The MSFD assessment for Sub-Variant 2B coincides with the assessment for Sub-Variant 2A and focuses on the 11 parameters described in detail earlier.

IV.8.3.2.6 Summary and conclusions

IV.8.3.2.6.1 Sub-Variant 2A

Most of the works to be carried out in the marine environment at the development stage are related to the associated investments. The effects of the discharges into the sea caused by the onshore construction works have also been assessed as **negligible** and **insignificant**, provided that the water drainage systems described in Volume II of the EIA Report are used and the best practices for pollution control specified in the Environmental Management Plan during the construction phase are applied during the construction phase. In conclusion, the effects of the preparatory works on the marine environment have been assessed as **negligible** and **insignificant**.

The worst-case environmental scenario has been assessed for the construction works carried out during the construction phase, which included the submerged tunnel option as part of the complimentary/cooling water system infrastructure. This requires temporary sheet pile walls and dredging works along the route of the inlet and outlet pipelines.

The structure and the presence of the sheet pile walls along the beaches and the shore can affect coastal geomorphology, also by disrupting coastal hydrodynamics and causing rubble movement, which can lead to differences in sediment accumulation and to erosion occurring in the immediate vicinity of the structure. This can affect the degree of stability of the shoreline and have locally limited, direct effects on dune systems. The modelling of the temporary sheet pile walls for the construction of the complimentary/cooling water (and MOLF) pipelines has shown that their impact on coastal bathymetry and shoreline location is temporary and locally limited. The modelling has also shown that the process of returning to the initial state should begin within one year from removing this structure. It has also been shown that the changes are basically within the range of the natural variability occurring in the marine survey area, which can be up to ± 2 m in the breaking wave barrier zone and 1.3 m on the coastal slope.

The effects on the hydromorphological status of these coastal waters in the meaning of the WFD have been assessed as **negligible** and **insignificant** due to the small scale and transience of the anticipated effects. However, it has been noted that there is uncertainty in relation to the modelling results related to the impacts of the sheet pile wall on stability of the shoreline. Although it is considered unlikely that the effects will be significant, it is recommended to run a monitoring programme during and after the construction and to implement proactive methods to ensure restoration of the initial state of the shoreline morphology if the impacts prove to be more serious and long-term than those envisaged in the model.

The construction works can affect the quality of seawaters both due to the direct introduction of pollutants into the environment (even accidentally) and because of the release of such substances embedded in the seabed (e.g. during the dredging). It is assumed that all adequate pollution control measures specified in the ETP will be applied throughout the construction works. Taking into account the effects on water quality, the environmental quality standards (EQS) or other environmental standards have been implemented, where possible, in accordance with the applicable law and/or recommendations. The analysis of the initial level of pollutants present on the surface of the seabed sediments taking into account the relevant standards has shown that the sediments are not polluted and are therefore not likely to be a source of pollution at the time of their disturbance during the construction works. The relatively small scale of the works and the fact that the seabed in this area is expected to be predominantly sandy lead to a conclusion that the increased concentrations of suspended sediments resulting from the dredging during the construction stage would exceed the guidelines for EQS only on a small area, in the immediate vicinity of the works. Therefore, the effects occurring during the construction stage are assessed as **negligible** and **insignificant**.

Similarly, the effects of the construction stage on habitats and fauna and flora have been recognised as **insignificant**.

The effects caused during the operational phase of the Project would be related to the presence of the permanent structures, mainly the MOLF and the inlet/outlet heads, which may cause local disturbances of hydrodynamics or rubble, which can lead to differences in sediment accumulation and to erosion occurring in the immediate vicinity of the structure. However, the analysis of the results of the modelled scenario for the MOLF, as well as the qualitative assessment of the structures associated with the heads, have shown that these changes would be **negligible** and **insignificant**.

The discharges of heated sewage have the greatest potential of affecting water quality in the operational phase of the Project. The assessment of these impacts focuses (where applicable) on their comparison with the EQS and other criteria established by the applicable law and guidelines. The effects associated with the increase in temperature have been analysed for the area where its increase would be 2°C. On the other hand, the analysis of changes in water quality caused by the discharge of sewage focuses on the discharge of process sewage, biocides, saline water and domestic sewage from the Project.

Although the volume of cooling water in the Sub-Variant with the closed cooling system is relatively small, the concentration of salt in the discharge increases as a result of water losses associated with evaporation in the cooling towers. The analysis of the concentrations of most of the cooling water ingredients at the point of discharge, the assessment of salinity dispersion and temperature modelling show that the effects on seawater quality would be insignificant. However, there is a **potentially significant** effect associated with the phosphorus discharge and the resulting impacts on eutrophication, which is considered a problem in the Baltic Sea. Recommendations for further assessments and the application of mitigation measures could be required to reduce the effects to **insignificant**. The effects associated with the discharge of process chemicals have been assessed as **insignificant**. However, subject to the development of specific measures to mitigate the potential effects of the discharge of hydrazine and corrosion products.

The impacts on the marine ecology during the operational phase have also been assessed as negligible.

The impacts associated with the decommissioning phase of Sub-Variant 2A have been assessed as **insignificant**.

Based on the above, no adverse significant effects on the water bodies, as defined by the WFD and the MSFD, are expected and the objectives of both directives (water quality improvement) will not be jeopardised. However, this conclusion assumes that the inherent mitigation measures presented in chapter [Chapter V.3.1.5] of the EIA Report will be implemented.

IV.8.3.2.6.2 Sub-Variant 2B

Sub-Variants 2A and 2B are also so similar that the impact assessment has noted only minimal differences between the proposed closed cooling system options. The anticipated impacts on the development and construction stages and the decommissioning phase of Sub-Variant 2B are the same as for Sub-Variant 2A and, therefore, assessed as **insignificant**. The impacts on the coastal geomorphology and marine ecology during the operational phase have also been assessed as **insignificant**. The only noticeable difference is the potential effects on water quality during the operational phase due to the use of desalinated seawater by the closed cooling system. However, the analysis of these differences has led to a conclusion that the effects are **insignificant**. The potentially significant effect associated with the phosphorus discharge by Sub-Variant 2A is smaller in the case of Sub-Variant 2B. However, control of the dosing and/or the use of chemicals containing small amounts of phosphorus, or not containing it at all, for treatment remains a solution to reduce the concentration of phosphates in the discharge of process sewage. It is also recommended to apply additional mitigation measures in the case of the discharge of hydrazine and corrosion products.

Based on the above, no adverse significant effects on the water bodies, as defined by the WFD and the MSFD, are expected and the objectives of both directives (water quality improvement) will not be jeopardised.

IV.14 Impacts related to ionising radiation

The present chapter presents the radiation impacts of the nuclear power plant in operational states, i.e. impacts related to ionising radiation in conditions of normal operation or anticipated operational occurrences. The results of the calculations and analyses presented in this chapter have been taken from reports [11], [12], [299] developed by NCBJ (Polish National Centre for Nuclear Research). In turn, the methodology used in these reports is presented in chapter [Chapter V.1.13].

IV.14.1 Project construction phase

IV.14.1.1 Development stage

At the development stage, there are no impacts associated with ionising radiation since the sources of ionising radiation will be present at the NPP site directly before the physical commissioning of the nuclear reactor which is carried out at the last stage of the Project construction phase.

IV.14.1.2 Construction stage

However, before physical commissioning commences, it is possible to carry out engineering and construction works with the use of methods involving radioactive materials. Mostly closed sources are used for this purpose, such as those in smoke detectors or flaw detectors. Flaw detectors are components that are used for the so-called non-destructive testing of joints, welds, and construction materials that may (but do not have to) use ionising radiation. These would then be called radiation defect detection methods that may rely either on X radiation (x-ray tube which does not emit radioactive substances) or gamma radiation in the case of much thicker materials. In this last case, it is mainly the iridium-192 isotope that is used, but, in such a case, emissions of radioactive substances may be practically ruled out.

IV.14.1.3 Commissioning stage

At the construction stage, the impacts associated with ionising radiation will occur at the time of the physical commissioning of the first power unit of the NPP which will be the beginning of nuclear commissioning. According to the adopted assumptions, the maximum duration of unit startup will not exceed one year. The estimated emissions of radioactive substances into the environment during the nuclear commissioning of a given power unit will not exceed half of the average emissions from a single unit of the NPP in operational states.

IV.14.2 Operational phase

In operational states, there are routine emissions of radioactive substances (with technical measures for mitigating and controlling these emissions being implemented):

- into the air (mostly radioactive noble gases), especially through the gaseous radioactive waste system, but also through the ventilation systems of the facilities and rooms of the “nuclear island”.
- into groundwater – from the liquid radioactive waste system: with the discharge of heated cooling water (in the open cooling system) or with the discharge of desalinated water (in the closed cooling system).

The doses resulting from emissions into the air depend on the adopted height of the ventilation shaft. Given the specificity of the topography in Variant 1 - Lubiatowo - Kopalino site, the standard height of 75m was adopted in accordance with the data for the generic UK AP1000 design [18]. In Variant 2 - Żarnowiec site, the height is 150m (due to the height of the hills in the vicinity).

Detailed information on the radioactive isotopes released into the air and surface waters are provided in chapters [Chapter II.10.2] and [Chapter II.10.4] respectively.

To assess the impact of the emissions of radioactive substances on people and the environment in operational states of the nuclear power plant, it is necessary to analyse them with regard to the different criteria laid down in the Polish law and in international standards.

IV.14.2.1 Assessment of total annual effective doses from individual exposure pathways for various age groups, resulting from the projected annual volumes of emissions of radioactive substances into the environment during operational states

The criteria (dose limits) assumed for the analyses of the radiological impact of the nuclear power plant in operational states (comprising normal operation and anticipated operational occurrences) required by the Polish regulations [499 and the regulations of European power companies are presented below: EUR Rev. D [109] and EUR Rev. E [110].

- **RUA1**: In operational states, the effective dose from all exposure pathways in the restricted use area (RUA) around the NPP cannot exceed 0.3mSv/year (Art. 36f item 2, point 1 of the Atomic Law Act [499);
- **EUR-E-EKS**: The dose for members of the public in operational states, resulting from the radiological impact of the entire nuclear power plant, cannot exceed 0.3m Sv/year. The value is the same irrespective of the nuclear power plant's rated power (Volume 2, Chapter 1, section 2.1 2.2.2 [110]);
- **EUR-D-EKS:** The dose resulting from direct exposure (radiation from the NPP structures) in operational states cannot exceed 10μSv/year per nuclear unit. The value is the same irrespective of the nuclear power plant's rated power (Section 1.4 3, item 7 [109]).

The annual doses from emissions into the air and into surface water are given separately for both site variants due to the different conditions (e.g. height of the stack, local meteorological conditions). In turn, given the fact that the locations of the releases of liquid radioactive substances into the sea for the pipelines at both sites are not far apart from each other, and that the obtained results of the analyses are at very low levels, it was assumed that the same values will be presented for both sites (the higher values were adopted in accordance with the pessimisation principle).

The table below [Table IV.14-13] presents the maximum annual doses in operational states resulting from the emissions of gaseous or liquid radioactive substances from the NPP into the environment in the case of Variant 1 - Lubiatowo - Kopalino site. All doses are much lower than the dose limits specified earlier (by more than one order of magnitude). The adopted conservative approach means that the real doses (i.e. doses received by people during the operation of the nuclear power plant) will not be higher than the calculated doses provided below.

Table IV.14-13 Maximum annual effective doses during operational states resulting from emissions of radioactive substances into the environment from three NPP units in Variant 1 - Lubiatowo - Kopalino site. In each case, the distance from the source of emissions corresponding to the maximum effective dose was 0m.

Criterion	Value of the effective dose criterion [mSv/year]	Maximum effective dose value [mSv/year]
RUA1 / EUR-E-EKS	0.3	4.80E-03
RUA1 adults	0.3	3.50E-03
RUA1 children	0.3	3.50E-03
RUA1 infants	0.3	4.80E-03

Source: [11]

The conversion of the maximum annual effective dose values specified in the table above into lifetime effective doses yields the following values:

- 0.175mSv from the day of NPP start-up, over the adopted lifetime of 50 years for an adult person,
- 0.346mSv adopted as exposure from the moment of birth (over the lifetime of 70 years).

The two lifetimes are related to the international radiological protection standards [201].

In turn, the table below [Table IV.14-14] presents the values of the maximum annual effective doses from all exposure pathways in operational states in the case of Variant 2 - Żarnowiec site. All doses are much lower than the dose limits specified earlier. The adopted conservative approach means that the real doses (i.e. doses received by people during the operation of the nuclear power plant) will not be higher than the calculated doses provided below.

Table IV.14-14 Maximum annual effective doses during operational states resulting from emissions of radioactive substances into the environment from three NPP units in Variant 2 - Żarnowiec site. In each case, the distance from the source of emissions corresponding to the maximum effective dose was 0m.

Criterion	Value of the effective dose criterion [mSv/year]	Maximum effective dose value [mSv/year]
RUA1 / EUR-E-EKS	0.3	3.05E-03
RUA1 adults	0.3	2.30E-03
RUA1 children	0.3	2.30E-03
RUA1 infants	0.3	3.05E-03

Source: [12]

The conversion of the maximum annual effective dose values specified in the table above into lifetime effective doses yields the following values:

- 0.115mSv from the day of NPP start-up, over the adopted lifetime of 50 years for an adult person,
- 0.162mSv adopted as exposure from the moment of birth (over the lifetime of 70 years).

The two lifetimes are related to the international radiological protection standards [201].

In the case of emissions of liquid radioactive substances, only the doses resulting from the contamination of marine waters need to be estimated. The effective dose quantities resulting from exposure through the aquatic pathway for people residing in the coastal region after a year are 2.09E-05mSv. In the next year, the emissions from the previous year result in further 2.05E-05 mSv, while in the subsequent year it is only 0.32E-05 mSv [Figure IV.14-1]. Thus, the determined value of 4.46E-05 mSv after 3 years is a good approximation of the annual dose during operation since it additionally takes into account the doses from the residual emissions from previous years (the maximum quantity from both sites was adopted as the representative quantity for both).

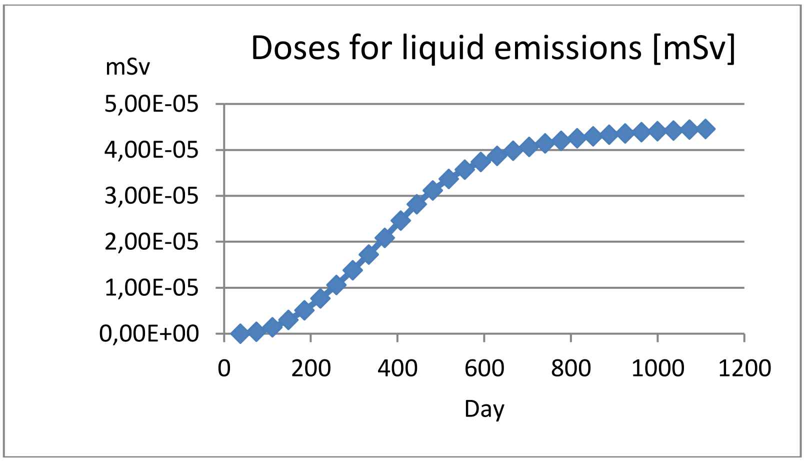


Figure IV.14-1 Effective dose rates from liquid emissions of radioactive substances, taking into account all radionuclides, over the three successive years (determined value of 4.46E-02µSv is a good approximation of the annual dose during operation since it additionally takes into account the doses from the residual emissions from the previous years)

Source: [11]

The table below [Table IV.14-15] presents the maximum activity concentrations of selected radionuclides for fish, zooplankton, and sedimentation layer.

Table IV.14-15 The maximum activity concentration of selected radionuclides, associated with the liquid emissions of radioactive substances (for both site variants)

Criterion	Cs-137	Cs-134	I-131	Sr-90	H-3
Water [Bq/m^3]	3.79E-05	1.08E-05	1.13E-07	4.1E-07	5.39E+01
Non-predatory fish [Bq/kg]	1.44E-04	4.61E-05	3.25E-05	2.15E-07	8.2E+01
Predatory fish [Bq/kg]	1.21E-04	3.87E-05	7.26E-07	6.58E-08	8.54E+01
Zooplankton [Bq/kg]	8.5E-05	2.71E-05	1.2E-03	3.55E-07	3.83E+01
Sedimentation layer [Bq/kg]	4.81E-05	1.22E-05	2.25E-07	3.13E-07	3.63E+00

Source: [11]

Summing up, one should state that:

- the maximum annual effective doses in operational states occurring at the NPP site will be almost 100 times lower than the limit of 0.3 mSv/year (the lower values at the Żarnowiec site than at the Lubiatowo - Kopalino site stem from the fact that the assumed height of the stack is much higher: 150m - i.e. around 50m above the peaks of the surrounding hills; in turn, in the case of the Lubiatowo - Kopalino site, the stack height of 75m was assumed - i.e. the standard height in the generic AP1000 design),
- while the contribution to the doses from emissions of liquid radioactive substances is very low and amounts to around 1% of the dose from the emissions into the atmosphere.

IV.14.2.2 Assessment of the annual thyroid dose for various age groups resulting from the projected annual releases of iodine isotopes into the environment

The maximum annual iodine thyroid doses during normal operation are very low and their quantities are as presented in the tables below [Table IV.14-16] and [Table IV.14-17].

Table IV.14-16 Maximum annual iodine thyroid dose quantities in operational states at the Lubiatowo - Kopalino site

Dose type	Dose [mSv]		
	Adults	Children	Infants
Thyroid equivalent doses [mSv]	9.71E-05	1.79E-04	6.45E-04
Thyroid absorbed doses [mGy]	8.48E-05	1.56E-04	5.63E-04

Source: In-house study based on [11]

Table IV.14-17 Maximum annual iodine thyroid dose quantities in operational states at the Żarnowiec site

Dose type	Dose [mSv]		
	Adults	Children	Infants
Thyroid equivalent doses [mSv]	4.17E-05	7.71E-05	2.80E-04
Thyroid absorbed doses [mGy]	3.64E-05	6.73E-05	2.44E-04

Source: In-house study based on [12]

Doses as low as those listed above have no negative impact on the health of the general public.

IV.14.2.3 Assessment of the fulfillment of the criterion related to the dose resulting from direct radiation from the NPP structures

The criterion related to the dose quantity resulting from direct exposure (radiation from NPP buildings) in **EUR-D-EKS** operational states is not related to site conditions. The fulfillment of this criterion was estimated on the basis of the information included in the pre-construction safety report [18]. The document provides dose rates at a distance of 30m, 50m, 70m, and 150m from the reactor building, stressing that the maximum dose rate occurs at 50m.

The table below [Table IV.14-18] presents these quantities, as well as the extrapolated values for 100m, 200m, 300m, 400m, and 500m.

Table IV.14-18 Dose rate quantities from direct exposure from a single reactor building

Distance [m]	30	50	70	100	150	200	300	400	500
Dose rate [µSv/h]	0.0056	0.0061	0.0047	0.0033	0.0015	0.00078	0.00052	0.00039	0.00031
Annual dose [µSv/a]	49.056	53.436	41.172	28.908	13.14	6.798	4.532	3.399	2.719

Source: [18]

Assuming that, in accordance with EUR Rev. D [109] the occupancy factor is 1/30 for the distance of 100m, and 1 for the distance of 300m, the resulting annual doses are, respectively, 0.96µSv/year for 100m, and 4.53µSv/year for 300m, i.e. they are lower than the adopted limit. The dose quantities provided above are two orders of magnitude lower than the ionising radiation background [Chapter III.3.11].

Assuming the occupancy factor value is 1 for the distance between 150m and 200m, based on the above data it can be estimated that the criterion of a dose <10µSv/year is met within the distance > approximately 175m, that is within the boundaries of the NPP site.

IV.14.2.4 Analysis of the possible accumulation of radioactive substances in the elements of the environment, including flora and fauna

The accumulation of radioactive substances in the elements of the environment as a result of NPP operation is so low that its assessment by measuring methods is very problematic. A spread of the level of activity of radioactive substances in various elements of the natural environment [Chapter III.3.11] does not make it easy to measure the changes. However it can be forecasted through calculations.

First of all it should be emphasised that there are no criteria regarding the assessment of the accumulation of radioactive substances in the environment. There are certain models based on the source-pathway-receptor approach that are applied to hazards associated with toxic chemical substances. Indicators used include EHI (Environmental Harm Index) or ESI (Environmental Severity Index), yet they refer to severe accidents, that is accidents the consequences of which consequences might include lethal effects for the ecosystem (e.g. they refer to doses or concentrations causing a 50% fatality rate - based on LD_{50} or LC_{50} indices).

Additionally, it should also be noted that the assessment of the environmental effects is quite complicated due to the immense diversity of the existing species and significant differences in the impact of ionising radiation on them, which is related to their varying radiosensitivity and radiosusceptibility. Additionally, considering the abovementioned negligible amount of operational releases, the diagnosis of the impact of radioactive substances on the environment is frequently qualitative rather than quantitative. Yet in this context it should be noted that the impact of radioactivity on those elements of the environment which may become foodstuffs or are used in the production of foodstuffs, has been best investigated. The impact is expressed by human dietary intakes derived from specific types of plants and animals. It should be emphasised that models of doses comprise a very wide array of products - basically, an entire spectrum of food types is represented. Furthermore, all the transport mechanisms of gaseous radioactive substances have been taken into account - from the contamination of the environment to the consumption of a contaminated product.

The concentrations of radioactive substances have been calculated in various soil layers, as well as for a number of agricultural products such as fish, cow's milk and meat, green vegetables, fruit, root vegetables, grass, and others [11] [12] [299].

Estimated maximum annual doses from basic groups of products in both sites are presented below ([Table IV.14-19] and [Table IV.14-20]):

Table IV.14-19 Maximum annual doses from basic product groups for Variant 1 - Lubiatowo – Kopalino site

Product type	Dose [mSv]
Products of bovine origin	3.62E-03
Fruit	4.61E-04
Cereals	2.14E-03
Leafy vegetables	3.78E-04
Root vegetables	6.13E-04

Source: In-house study based on [11]

Table IV.14-20 Maximum annual doses from basic product groups for Variant 2 - Żarnowiec site

Product type	Dose [mSv]
Products of bovine origin	1.75E-03
Fruit	1.72E-04
Cereals	7.98E-04
Leafy vegetables	1.41E-04
Root vegetables	2.29E-04

Source: In-house study based on [12]

To assess the increase in doses resulting from the accumulation in soil, the impact of specific substances in a five-year period has been analysed. The results for the key isotopes are presented below [Table IV.14-21].

Table IV.14-21 Doses from the accumulation of selected isotopes, for both site variants

Dose type	Dose [mSv]	
	Lubiatowo – Kopalino,	Żarnowiec
Cs-134	3.3E-08	1.4E-08
Cs-137	5.7E-08	2.3E-08
Sr-90	4.47E-08	1.92E-08

Source: In-house study based on [11] i [12]

For the Lubiatowo - Kopalino site, the total dose increase is approximately 1.7E-07mSv, which translates into the estimated annual level of about 4.25E-08mSv. For the Żarnowiec site, the total dose increase is approximately 8.5E-08mSv, which results in the estimated annual level of about 2.125E-08mSv. Therefore, the impact of the accumulation of radionuclides on doses is negligible, i.e. lower by five orders of magnitude than the level (also very low) of annual effective doses in the vicinity of the NPP for operational states, the maximum values of which are provided in [Table IV.14-13] and in [Table IV.14-14].

For the emissions of liquid radioactive substances, the dose accounts for approximately 1% of the dose originating from the emissions to the atmosphere, whereas the maximum values of activity concentrations in fish and zooplankton, and in the sedimentation layer are presented in [Table IV.14-15] and they are also very low.

With respect to radioactive concentrations in soil, an estimation for the period of 60 years in various soil layers to the depth of 1m is presented in the table below [Table IV.14-22]. The calculations were made assuming a conservative approach that the total deposition from operational emissions will occur only in the area of 64 km^2 around the NPP (that is, within a square corresponding to a distance of 4km from the cooling tower in the east-west and north-south directions). The results obtained pertain to both site variants.

Table IV.14-22 Average activity concentrations in various soil layers after 60 years [Bq/m^2]

Isotope	0m – 0.01m	0.01m – 0.05m	0.05m – 0.15m	0.15m – 0.3m	0.3m – 1m
Co-58	3.80E+01	2.54E+00	4.42E-02	4.81E-04	1.87E-06
Co-60	1.46E+02	1.83E+02	6.75E+01	1.79E+01	1.85E+00
Cr-51	4.20E-01	1.11E-02	7.60E-05	3.24E-07	4.94E-10
Cs-134	2.50E+01	1.53E+01	2.55E+00	2.84E-01	1.17E-02
Cs-137	8.35E+01	2.34E+02	2.19E+02	1.48E+02	3.39E+01
I-131	1.13E+02	8.73E-01	1.74E-03	2.16E-06	9.54E-10

Isotope	0m – 0.01m	0.01m – 0.05m	0.05m – 0.15m	0.15m – 0.3m	0.3m – 1m
I-133	2.05E+01	1.71E-02	3.67E-06	4.91E-10	2.34E-14
Mn-54	2.60E+00	7.25E-01	5.36E-02	2.54E-03	4.36E-05
Nb-95	3.59E+00	2.11E-01	3.26E-03	3.18E-05	1.11E-07
Sr-89	3.45E+00	3.15E-01	3.91E-03	3.04E-05	8.44E-08
Sr-90	1.54E+01	8.21E+01	7.68E+01	5.28E+01	1.24E+01
Zr-95	1.51E+00	9.14E-02	1.44E-03	1.41E-05	4.97E-08

Source: [11], [12]

Additionally, in order to more accurately examine long-term trends in changes of activity concentrations of various radionuclides in the elements of the environment, calculations were made for the period from 1 to as much as the hypothetical 80 years of operation [299], adopting also pessimistic assumptions.

The obtained concentration values are very low - the highest ones for I-131 are in the order of 1E-2Bq/kg. Having analysed changes over time, it can be noted that for the majority of substances - despite the continued emission - the values stabilise on a certain level after a certain period of time. Only for Sr-90 an increase can be observed throughout the entire period examined - though it becomes smaller over time. For Cs-137 and Co-60, after 20 years there is practically no material increase in concentrations. On the one hand, it is related to the permanent migration of substances in soil - especially into the deeper layers - which results in their gradual movement outside the root layer and a progressively smaller uptake of some of the nuclides by roots. On the other hand, obviously, it depends on the half-life of radioactive substances.

For example, the concentration of Cs-137 in beef after 60 years of NPP operation will increase by a mere 0.0018 Bq/kg (as compared to the much higher natural background [Chapter III.3.11]). In turn, in the cow's milk the expected increase in the Cs-137 concentration is a mere 0.00035 Bq/kg (also after 60 years of NPP operation). For green vegetables, the calculated increase in concentration is 0.0003Bq/kg, while - as shown by the calculations - it is greater in the case of I-131 and it stands at 0.013Bq/kg.

The results of the calculations show a negligible impact of the radionuclides released into the environment on the change in the time of their activity concentration in specific elements of the environment.

IV.14.3 Decommissioning phase

During the decommissioning phase, there will be impacts related to the ionising radiation resulting from emissions of radioactive substances, and radioactive waste. Impacts related to radioactive waste and spent nuclear fuel are described in chapter [Chapter IV.16.3]. The expected emissions of radioactive substances during the NPP decommissioning process will be determined in the safety report for the decommissioning stage, therefore during the EIA Report development such an impact cannot be assessed.

IV.14.4 Table of impacts

The table below [Table IV.14-23] presents a summary of the influence of the radiation impacts in operational states of the NPP on individual receptors in each of the three phases of Project implementation.

Table IV.14-23 Table of radiation impacts in operational states of the NPP

Receptor	Receptor significance	Receptor sensitivity	Activities and their effects	Spatial extent of the impact	Nature of the impact	Impact duration	Impact frequency	Significance of effect
1.	2.	3.	4.	5.	6.	7.	8.	9.
CONSTRUCTION PHASE								
Commissioning stage								
Human receptors	Wy	Wy	Emissions of radioactive substances into the environment	Lo	P	S	St	Ni
NPP staff	Wy	Wy	Emissions of radioactive substances into the environment and the direct impact of the NPP structures	Lo	B	S	Co	Is
Environment (surface water, groundwater, ground pollution, air pollution)	Wy	Um	Emissions of radioactive substances into the environment	Lo	P	S	St	Ni
OPERATIONAL PHASE								
Human receptors	Wy	Wy	Emissions of radioactive substances into the environment	Lo	P	D	St	Ni
NPP staff	Wy	Wy	Emissions of radioactive substances into the environment and the direct impact of the NPP structures	Lo	B	S	Co	Is
Environment (surface water, groundwater, ground pollution, air pollution)	Wy	Um	Emissions of radioactive substances into the environment	Lo	P	D	St	Ni
DECOMMISSIONING PHASE								
Human receptors	Wy	Wy	Emissions of radioactive substances into the environment	Lo	P	S	Sp	Ni
NPP staff	Wy	Wy	Emissions of radioactive substances into the environment and the direct impact of the NPP structures	Lo	B	S	Co	Is
Environment (surface water, groundwater, ground pollution, air pollution)	Wy	Um	Emissions of radioactive substances into the environment	Lo	P	S	Sp	Ni

** Oddz. - impact, Wy-high, Um-moderate, Lo-local, B-direct, P-indirect, K-short-term, S-medium-term, D-long-term, St-permanent, Ch-momentary, Co-daily, Sp-sporadic, Is-significant, Ni-insignificant*

Source: In-house study

IV.14.5 Summary

The impact of the NPP on the environment begins with the nuclear commissioning of the first power unit, i.e. when the nuclear reaction starts in the reactor core. When this process commences, the NPP begins to exert an impact on the environment in a direct way, through direct exposure (radiation from NPP structures), and in an indirect way, through emissions of radioactive substances into the air and into surface water. When it comes to the impact on humans, the magnitude of impact is represented by calculating the dose that a person within the NPP's zone of impact could potentially receive due to exposure, i.e. a process in which a human organism is irradiated by ionising radiation from the NPP. The impact on the environment is represented by calculating the degree of the accumulation of radioactive substances in the elements of the environment as a result of the operation of the NPP. The results of the analyses of the impacts on humans have shown that the maximum annual effective doses in operational states will be almost 100 times lower than the limit of 0.3mSv/year. The calculations of the concentrations of radioactive substances in layers of the soil and in various food products have shown that the impact of the released radioactive substances on changes in the time of their activity concentration in the individual elements of the environment is negligible.

IV.15 Impacts on human health and life

The present chapter analyses the potential impact of the planned Project on human health and life. The methodology for the assessment of the impact on health is presented in chapter [Chapter V.1].

Conventional emissions will be the potential sources of the impact on human health and life, including: emissions of pollutants into the air, noise emissions, water pollution, or wastewater disposal that may physically affect human health. Given the type of the Project (nuclear power plant), one should also consider the impact of ionising radiation on human health. This impact is approached as a separate impact category, peculiar to the NPP. The impact of the Project on aspects such as quality of life of the public and mental health of individual social groups, and especially the local community and employees directly involved in the development of the NPP were also analysed. The impact of the Project on healthcare and social protection systems in the Administrative Site Area and the Administrate Site Region was also analysed. The analyses were carried out for all phases of NPP development on the basis of expert methods and of the experience from other projects involving the development of nuclear facilities in Europe [309], with the reservation that the present chapter describes the impacts during the operational states of the nuclear power plant. The issues related to the projected environmental impact in the event of a severe accident and its effects on health and life are presented in chapter [Chapter IV.17], and the issues related to the potential transboundary impacts with regard to human health and life - in Chapter V.

The measures mitigating the impacts and the proposed monitoring are presented in Volume V in chapters [Chapter V.3] and [Chapter V.7] respectively.

IV.15.1 Variant 1 – Lubiatowo - Kopalino site

The Project's impact on human health and life was analysed with due consideration of the site variant without detailed differentiation into the considered sub-variants due to the lack of significant elements that may have an impact on the differentiation of the scope and magnitude of the impact.

IV.15.1.1 Effects of emissions on human health and life

IV.15.1.1.4 Safety of food - sea products - in relation to the discharge of liquid radioactive substances into water

IV.15.1.1.4.1 Construction phase

Liquid radioactive substances will not be generated during the construction phase. At its final stage, i.e. during nuclear commissioning, the first liquid emissions that will be discharged into the sea may occur [Chapter II.10.4]. Their volume will, however, be lower in the operational phase.

At the commissioning stage, activities involving the monitoring of discharges of liquid radioactive substances into the sea, as well as their impact on health and quality of life, will be carried out. These activities are described in chapter [Chapter V.7].

IV.15.1.1.4.2 Operational phase

During the operational phase, liquid radioactive substances will be discharged into the Baltic Sea. Their volume, concentrations, and the methods for controlling and discharging them (at a distance of several kilometres into the sea) will be selected in such a way as to ensure that the impact on water quality is negligible, taking into account the half-life [Chapter IV.14]. It should especially be noted that the very large dilution of the discharged radioactive substances will eliminate the risk of marine animal contamination. The issue of emissions of liquid radioactive substances is described in detail in chapter [Chapter II.10.4] that also specifies the maximum activity concentrations of selected radionuclides for fish, zooplankton, and in the sedimentation layer.

It should also be noted that the emissions of liquid radioactive substances into the sea are dominated by radioactive isotopes that normally occur in the environment, i.e.: tritium that accounts for 99.98% of the total emissions; and the C-14 carbon isotope that accounts for 59% of the activity of the remaining (apart from tritium) radionuclides.

During the operational phase of the Project, activities involving the monitoring of discharges of liquid radioactive substances into the sea (radiological monitoring), as well as their impact on health and quality of life, will be carried out. These activities are described in chapters [Chapter V.7] and [Chapter V.3].

IV.15.1.1.4.3 Decommissioning phase

During the decommissioning phase, no impacts related to the Project's influence on food of marine origin are expected.

IV.15.1.1.5 Safety of food - sea products - in relation to the use of chemicals in the cooling water system

IV.15.1.1.5.1 Construction phase

Risks to life and health at the workplace, associated with marine activity during the installation of intake and discharge pipelines, will be considered in the safety and health protection plan at the construction stage.

IV.15.1.1.5.2 Operational phase

During the operational phase of the NPP, seawater will be subjected to several different chemical processes involving i.a. the removal of pollutants or addition of chemical substances that are meant to prevent corrosion and microbial growth in the cooling water system. This process is described for each of the sub-variants in chapter [Chapter II.11.3]. The discharged cooling water will contain residual concentrations of chemicals added to the cooling water (biocides, oxidising agents, and potentially other substances containing chlorine). In view of the above, concerns related to the impact of the said substances on seawater and food of marine origin (mainly fish) may arise among the public. When it comes to the safety of products of marine origin, EDF [10], [309] conducted surveys that included a review of toxicological studies related to the discharge of cooling waters, which show that CBP concentrations were far below (by two to three orders of magnitude) the level at which significant, toxic impact related to the exposure of the marine environment to these compounds could occur [309]. Detailed information on the impact of the discharge of cooling water is presented in chapter [Chapter IV.8.2]. During the operational phase of the Project activities involving the monitoring of wastewater disposal, discharge of liquid radioactive substances into the sea, as well as their impact on human health and life, will be carried out. These activities are described in chapter [Chapter V.7].

IV.15.1.1.5.3 Decommissioning phase

During the decommissioning phase, no impacts related to the Project's influence on food, and thus on the health of the public, are expected.

IV.15.1.1.6 Safety of food of non-marine origin in relation to the emissions of gaseous radioactive substances

IV.15.1.1.6.1 Construction phase

During the construction phase there will be no emissions of gaseous radioactive substances, but, at its final stage, i.e. during nuclear commissioning, the first gaseous emissions that may be discharged into the air may occur [Chapter II.10.2]. Their volume will, however, be lower than in the operational phase.

At the commissioning stage, activities involving the monitoring of discharges of gaseous radioactive substances into the air, as well as their impact on health and quality of life, will be carried out. These activities are described in chapters [Chapter V.3] and [Chapter V.7].

IV.15.1.1.6.2 Operational phase

During the operational phase, gaseous radioactive substances will be discharged into the air. Their volume, concentrations, and the methods for controlling and discharging them will be selected in such a way as to ensure that the impact on air quality is negligible, taking into account the half-life. It should especially be noted that the very large dilution of the discharged radioactive substances will eliminate the risk of contaminating breeding animals and agricultural products. The issue of the emission of radioactive substances into the air is described in detail in chapter [Chapter II.10.2] of the present EIA Report.

It should be noted that the emissions of radioactive substances into the air are dominated by radioactive noble gases (around 69% of the total emissions) that do not result in the contamination of land surface or surface waters and do not enter into chemical reactions with other substances. Quantitatively, tritium is the second radionuclide emitted into the air (share of around 15%), and it occurs naturally in the environment (in air and in seawater). Apart from that, the C-10 carbon isotope that occurs naturally in the air is also emitted, albeit in a lower volume (share of around 5%).

A more detailed description of the effects of the radiological impact of the nuclear power plant on food is presented in chapter [Chapter IV.14]. Additionally, appendix [Appendix IV.15-1] to the present chapter provides the maximum activity concentrations of selected radionuclides for selected agricultural products (of plant and of animal origin, taking into account their variability (accumulation). The calculations were based on the highly conservative assumption that the total emission is deposited in a limited area of 8km x 8km around the power plant during the entire operating lifetime. The obtained concentration values are very low – the highest ones for I-131 are in the order of 1E-2Bq/kg. Having analysed changes over time, it can be noted that for the majority of substances – despite the continued emission – the values stabilise after a certain period of time. Only for Sr-90 an increase can be observed throughout the entire period examined – though it becomes smaller over time. For Cs-137 and Co-60, after 20 years there is practically no material increase in concentrations. On the one hand, this is related to the permanent migration of substances in soil – especially into the deeper layers – which results in their gradual movement outside the root layer and an increasingly lower uptake of some of the nuclides by roots. On the other hand it depends on the half-life of the radioactive substances.

Summing up the detailed results of the calculations presented in appendix [Appendix IV.15-1], one may conclude that the operational emissions will result in a completely insignificant increase in concentrations of radioactive substances in agricultural products, and their accumulation is limited by two factors, apart from the magnitude of the emission itself: the constant migration of radionuclides in soil, and radioactive decay. This means that there will be no negative health effects, both for humans and for animals.

During the operational phase of the Project, activities involving the monitoring of discharges of gaseous radioactive substances into the air (radiological monitoring), as well as their impact on health and quality of life, will be carried out. These activities are described in chapters [Chapter V.7] and [Chapter V.3].

IV.15.1.1.6.3 Decommissioning phase

During the decommissioning phase, no impacts related to the Project's influence on agricultural products, and thus on the health of the public, are expected.

IV.15.1.1.7 Impact of ionising radiation on health

Ionising radiation is a permanent element of the human environment. It occurs commonly around us, and it is an element of i.a. the natural background radiation that has been studied in detail for the purpose of the Project and described in chapter [Chapter III.3.11]. Apart from the radiation from the natural background, there is also ionising radiation from anthropogenic, i.e. artificial, sources. According to the popular opinion, the difference between nuclear power plants and other energy sources is that the former emit ionising radiation and radioactive substances. Plants burning fossil fuels – especially coal-powered plants – also emit radioactive substances into the environment (uranium, thorium, and their decay products - especially radium and radon) that are contained in the combustion waste (ash and slag). This is due to the fact that, on average, coal contains 2.9ppm of natural uranium and 7.4ppm of Th-232 [168], [333]. It is estimated that the emissions of such ash result in annual effective doses of radiation of 0.15-18mSv [171], [277]; thus, it constitutes a radiological impact that is much greater (even around 30-50 times) than that of a nuclear power plant [Chapter IV.14.3.3].

Ionising radiation may have a significant impact on people, and it is thus one of the main topics of interest for the NPP staff and a source of concern for the local community. Given the fact that ionising radiation is effectively impossible to detect with human senses, and given the memory of various nuclear power plant accidents in other countries, as well as of the use of nuclear weapons against the Japanese cities of Hiroshima and Nagasaki during World War II and numerous tests of such weapons, it is fully understandable that such issues raise concern and doubts.

In view of the above, for the purpose of the present EIA Report, the impact of ionising radiation in operational states on health (of both the NPP staff and the local population) was analysed and is presented below. The current ionising radiation background as well as the current incidence of cancer are described in chapters [Chapter III.3.11] and [Chapter III.4.7] respectively. In turn, the description of the impact in the event of a severe accident is presented in chapter [Chapter IV.17].

IV.15.1.1.7.1 Construction phase

Development stage and construction stage

During the construction phase of the nuclear power plant, engineering and construction tasks that are solved with methods involving the use of radioactive materials – especially flaw detection – may emerge. Flaw detectors are components that are used for the so-called non-destructive testing of joints, welds, and construction materials that may (but do not have to) use ionising radiation. These would then be called radiation defect detection methods that may rely either on X radiation (X-ray tube) or gamma radiation in the case of much thicker materials. In this last case, it is mainly the iridium-192 isotope that is used, most often in the services provided by an external company specialised in flaw detection. Moreover, one cannot rule out the need to apply standard smoke detectors that may contain radioactive isotopes, but these detectors are secured in such a way that their radiological impact on humans (staff) is negligible.

During the construction phase, the Project’s impact on the health and life of the local community with regard to ionising radiation is negligible due to the fact that the nuclear reactor will not be operated.

At the construction stage, the exposure of employees to ionising radiation is only limited to the cases described above.

Commissioning stage

During the commissioning, the non-nuclear commissioning of the power unit will take place, involving commissioning works carried out prior to the first loading of nuclear fuel into the reactor core, during which pre-operational tests specified in §27 item 1 of the Regulation of the Council of Ministers of 11 February 2013 on requirements for the commissioning and operation of nuclear facilities [416], and during which there will be no impact associated with ionising radiation, will be carried out.

During the nuclear commissioning of the power unit, physical commissioning and power commissioning of the unit will take place [416] during which the first potential exposure of the NPP staff to ionising radiation will occur. This will happen after reactor criticality is achieved, and, in practice - after the generator of the first nuclear power unit is synchronised with the national power system, and then its power is gradually increased. For the purpose of the analyses, the average exposure occurring during the operation of the NPP was adopted as the representative exposure.

During the commissioning, the level of staff exposure approaches the level of exposure during the operational phase, but it will be much lower than the average exposure during NPP operation.

The impact on health and life of the local community during the reactor commissioning is similar to (though significantly lower) the impact during the operational phase for which all the impacts related to ionising radiation have been described in detail.

IV.15.1.1.7.2 Operational phase

Nuclear power plants emit ionising radiation in two ways: directly (i.e. radiation emitted by the nuclear reactor and the “nuclear island” facilities in which radioactive substances are located), and indirectly - through emissions of radioactive substances into the environment. Given the above, the question of the Project’s radiological impact on human health may be considered separately for those living in the vicinity of the power plant, and for its employees, as specified in the latter part of the chapter.

Direct exposure to ionising radiation from NPP structures is described in the AP1000 Pre-Construction Safety Report [18], as described in detail in chapter [Chapter IV.14] of the present EIA Report. For instance, at a distance of 500m from the reactor, the annual effective dose rate will be around 2.7µSv/year, a value that is around a thousand times lower than the average value for radiation background in Poland. At a distance greater than 500m from the reactor, the radiation dose rate for direct exposure drops sharply, and exposure may be completely omitted.

In the case of exposure associated with emissions of radioactive substances from the power plant into the environment, one may distinguish between two release pathways: into the air (as described in chapter [Chapter II.10.2]) and into the Baltic Sea (as described in chapter [Chapter II.10.4]). The other emission pathways are ruled out due to the applied design solutions. The detailed information related to the radiological impact of the nuclear power plant resulting from the emissions of radioactive substances into the environment, including the estimated dose quantities, is provided in the previous chapter [Chapter IV.14]. In particular, the maximum annual effective doses that a member of the public could receive are: 3.5µSv/year - for children and adults, and 4.8µSv/year for infants [11], [12].

The radiological impact of a nuclear power plant with an AP1000 reactor on the environment in operational states is negligible – the additional annual effective dose does not exceed 1% of the natural ionising radiation background, the average value of which is around 2.4mSv/year in Poland (this value fluctuates by around ±0.5mSv/year depending on the location [Chapter III.3.11]).

Nevertheless, in order to be able to carry out a full assessment of this impact on human health and life, it is necessary to carry out an analysis of the health risk associated with exposure to ionising radiation, the so-called radiation risk.

During the operational phase of the Project, monitoring activities will be carried out, i.e. radiation monitoring of the NPP site and its surroundings that is meant to measure the current concentrations of radioactive isotopes, as well as the impact on health and quality of life. These activities are described in chapters [Chapter V.7] and [Chapter V.3].

Impact of ionising radiation on NPP staff

During the operational phase, all the staff will be subject to the strict provisions of the Polish radiological protection law [499]. These provisions are in line with both European and international guidelines and regulate in detail every activity related to exposure to ionising radiation. The provisions related to radiological protection are based on the optimisation principle that is the equivalent of the international ALARA principle (as low as reasonably achievable) according to which the radiation should be reduced to a level as low as reasonably achievable, taking into account the economic, social, and health-related factors. The concept of dose limits that cannot be exceeded, save for exceptional situations, is one of the results of this principle [499].

Persons that are occupationally exposed to ionising radiation are generally divided into two categories:

- category A (in which the effective dose limit is 20mSv/year),
- category B (with an effective dose limit of 6mSv/year).

Apart from the dose limits which constitute the upper limit of the possible exposure, the so-called dose constraints are also set that are generally lower than the dose limits and apply to specific actions to be carried out or specific positions.

As at the day of developing the present EIA Report, it is not possible to precisely determine the specific dose constraint values for the staff of the projected power plant. They will be laid down in the future, either in a relevant secondary act to the Atomic Law Act, or in the technical recommendations of the PAA President, or in the operating licence.

The so-called collective dose concept, i.e. a dose that is the sum of the doses incurred by members of a given group, is an important criterion in assessing the radiation exposure of the staff. This dose helps optimise the radiation exposure through appropriate reductions of the collective dose for a given task, i.e. by reducing the time of exposure or increasing the number of employees involved in a given task.

In the case of a power unit with an AP1000 reactor, the collective dose quantities are small, and the largest among the doses are related to inspections, repairs, or maintenance of various elements within the containment.

Table [Table IV.15- 1] presents sample effective collective dose quantities (measured in man-mSv) for selected tasks for the plant staff, and table [Table IV.15- 2] presents radiation risks (tumour induction risk) for employees between 18 and 65 years of age. It is important that the employees never exceed their individual doses; this is continuously monitored by a set of two dosimeters: passive (integrating dosimeter that shows the accumulated dose) and active (showing the dose rate). If needed, measurements relying on retrospective dosimetry (e.g. measurements of concentrations in saliva, urine, and faeces, as well as cytogenetic blood tests) are also carried out. In the event of exceedance of the dose limit, the employee is subjected to medical testing and may be temporarily excluded from work involving exposure to ionising radiation.

Table IV.15- 1 Sample effective collective dose quantities (measured in man-mSv) for selected tasks carried out by the staff of a power plant with an AP1000 nuclear unit

Task	Maximum effective collective dose (man-mSv)
Reactor operation and oversight	39.3
Routine control and maintenance	44.9
Operational inspections	60.2
Special maintenance	30.1
Radioactive waste processing	23.2
Refuelling	41.3

Source: In-house study based on [18]

Table IV.15- 2 Radiation risk (i.e. probability of inducing a tumour) for employees between 18 and 65 years of age (the adopted standard of the International Commission on Radiological Protection, ICRP), professionally exposed to ionising radiation, by individual organs affected by potential neoplastic lesions

Organ affected by neoplasm	Radiation risk [%/Sv]	Annual radiation risk [%/year] for the assumed dose of 2.5mSv/year	Radiation risk [%] for the dose of 2.5mSv/year and the assumed 47 years of professional work
Oesophagus	0.16	4.00E-04	1.88E-02
Stomach	0.6	1.50E-03	7.05E-02
Colon	0.5	1.25E-03	5.88E-02
Liver	0.21	5.25E-04	2.47E-02
Lung	1.27	3.18E-03	1.49E-01
Bones	0.05	1.25E-04	5.88E-03
Skin	6.7	1.68E-02	7.87E-01
Breast	0.49	1.23E-03	5.76E-02
Ovary	0.07	1.75E-04	8.23E-03
Urinary bladder	0.42	1.05E-03	4.94E-02
Thyroid	0.09	2.25E-04	1.06E-02
Bone marrow	0.23	5.75E-04	2.70E-02
Other	0.88	2.20E-03	1.03E-01
Gonads (hereditary diseases)	0.12	3.00E-04	1.41E-02

Source: Study [201]

It should be noted that, in practice, the individual doses received by the staff are much lower than the dose limits. For instance, the maximum individual effective doses for selected activities in the case of an AP1000 reactor are: works related to the reactor vessel - 2mSv, works related to the handling of fuel assemblies - 0.54mSv, decontaminations of components within the containment - 0.12mSv, removal of the locking elements of the reactor vessel head (before its removal) - 0.5mSv, cleaning of the reactor vessel head - 0.27mSv [18]. The effective doses generally do not exceed around 2.5mSv, a quantity that is much lower than the dose limits (in a year).

The doses received by the staff of a nuclear power plant with an AP1000 reactor will thus be consistent with the Polish regulations.

The conducted radiation risk analysis, i.e. analysis of the risk of the occurrence of negative health effects (with the use of the method described below, related to the impact of ionising radiation on the local population) has shown that the received doses exclude the risk of the occurrence of deterministic effects among the staff. Similarly, the risk of occurrence of stochastic effects is negligible, and is thus consistent with the ALARA principle mentioned earlier. The sample radiation risk values for neoplastic diseases of selected organs are presented in table [Table IV.15- 3].

Despite the negligible risk of the occurrence of diseases related to ionising radiation, the staff of the nuclear power plant working in conditions of radiation exposure will be regularly controlled by specialised medical personnel. This is especially aimed at prophylaxis, and, in the event of an illness, at rapid diagnostics and dedicated treatment.

The level and the exacerbation of the negative effects that may occur due to exposure to ionising radiation mostly depend on the dose, but also on the time of exposure. It is clear that high doses of radiation pose a health hazard. In the case of low doses (conventionally below 100mSv) there is a problem of statistical reliability of the data showing the dependence between the risk of occurrence of a neoplastic disease and the dose. This is especially important since the vast majority of cases involving radiation exposure in medicine or industry (also in the nuclear power industry) involve low doses. For this reason, detailed studies, both epidemiological and radiobiological, devoted to the issue of the impact of low doses of ionising radiation on health, and especially on tumour induction risk, are carried out all over the globe.

Occupational diseases may also occur among the staff of the power plant, as in the case of the other professional groups exposed to ionising radiation (e.g. medical diagnostics and radiotherapy, industrial use e.g. in non-destructive testing of materials and joints). The Institute of Occupational Medicine in Łódź keeps the Central Register of Organisational Diseases. According to the Register, six cases of non-neoplastic diseases and 56 cases of neoplastic diseases defined as occupational diseases induced by ionising radiation were reported between 2010 and 2019. The data did not contain information on the geographic location of these cases. When it comes to non-neoplastic diseases, at most, individual cases, e.g. radiation cataract, were recorded in all the analysed years. Two cases of such diseases were only recorded in 2019. In turn, a higher number of cases of neoplastic diseases was recorded. The highest number of such diseases was recorded in 2010 and 2011 (12 and 16 cases respectively). In the last period, the incidence of neoplastic diseases was much lower and it oscillated between 1 and 3 cases per year. The problem of occupational diseases related to ionising radiation is thus marginal and restricted to sporadic radiological events in the field of nuclear medicine and the industrial trade in radioactive sources.

One should also be aware of the fact that neoplastic diseases exist irrespective of radiation, while other environmental (e.g. tobacco, selected chemicals) or genetic factors are relatively far more carcinogenic. This is reflected by the results related to the health of the population, together with the spatial variation of the incidence of diseases, developed for the analyses of the current status with regard to the health and life of the local population [Chapter III.4.7].

In the operational phase of the Project, the following monitoring activities will be carried out: continuous dosimetric control of the personnel (system of components measuring the level of exposure to ionising radiation) and regular medical examination. These activities are described in chapter [Chapter V.7] of the present EIA Report.

Impact of the NPP's ionising radiation on local population

From the perspective of the environmental impact of the nuclear power plant, its radiological impact on the local population is also important, although its magnitude is much lower than in the case of the NPP staff. As indicated above, the maximum annual effective doses that a member of the public living in the vicinity of a power plant with an AP1000 nuclear unit may receive are around: 3.5µSv/year for children and adults and 4.8µSv/year for infants [11], [12].

Two analyses of radiation risk for people living in the vicinity of the NPP are presented below: the first one involves the comparison of the quantities of the abovementioned doses with current regulations, while the second one involves the analysis of health risk from a medical perspective.

Analysis of the compliance of the projected doses to the public with current regulations

The Polish regulations do not specify the limit of the annual effective dose for members of the public, resulting from the radiological impact of the nuclear power plant; it does, however, lay down the following values:

- 1mSv/year as the general dose limit for members of the public - in accordance with the current radiological protection standards [499], [90], [357],
- 0.3mSv/year as the dose in operational states at the boundaries of the restricted use area around the nuclear power plant [499],
- 0.1mSv/year as the limit of the annual effective dose around the radioactive waste disposal facility (Article 53a, item 1 of the Atomic Law Act [499]) or as the limit for people living in the building of the x-ray laboratory.

In turn, the most recent revision of the European Utility Requirements EUR Rev. E [110] lays down the limit of 0.3mSv/year for the entire NPP.

In a conservative approach, one should thus adopt the lowest of the abovementioned values for the NPP, i.e. 0.1mSv/year for the entire NPP.

This means that the maximum annual effective doses for members of the public, originating from the power plant with an AP1000 reactor are over 20 times lower than the current limits.

Analysis of the radiation risk of the occurrence of deterministic and stochastic effects

According to the radiological protection standards, the effects of ionising radiation are divided into deterministic and stochastic.

Deterministic effects, i.e. early effects, may be induced in the case of medium and large doses, while for low doses they are practically impossible. According to the BEIR VII criterion [296], 100mSv/year may be conservatively adopted as the limit of a low dose. It should thus be noted that the estimated doses to the population originating from the power plant with an AP1000 reactor practically exclude the possibility of occurrence of deterministic effects among the local population.

When it comes to stochastic effects, which mostly include neoplastic diseases, the radiological protection standards are based on an averaged radiation risk of 5%/Sv [201]. This means that the risk of incidence of a neoplastic disease induced by ionising radiation increases by 5% for every 1Sv of effective dose received. If the linear extrapolation to low doses is conservatively assumed, a simple calculation for the abovementioned dose of 3.5µSv/year shows that the risk is around 0.000018%/year (for 70 years of life: around 0.001%), a value that may be completely neglected given the fact the current probability of inducing a neoplastic disease over the entire period of human life is around 15-25% (due to reasons unrelated to radiation). Additionally, the table below [Table IV.15- 3] presents the calculated radiation risks for individual organs (types of tumours). This means that the risk of occurrence of stochastic effects among the people living in the vicinity of a nuclear power plant with an AP1000 reactor is completely negligible.

Table IV.15- 3 Radiation risk (i.e. probability of inducing tumour) for members of the public, by organs affected by neoplastic changes

Organ affected by neoplasm	Radiation risk [%/Sv]	Annual radiation risk [%/Sv] for the dose of 3.5μSv/year	Radiation risk for [%] the dose of 3.5μSv/year and 70 years of life	Radiation risk [%] for 70 years of life (taking into account the infancy)
Oesophagus	0.15	5.25E-07	3.68E-05	3.69E-05
Stomach	0.79	2.77E-06	1.94E-04	1.95E-04
Colon	0.65	2.28E-06	1.59E-04	1.60E-04
Liver	0.3	1.05E-06	7.35E-05	7.39E-05
Lung	1.14	3.99E-06	2.79E-04	2.81E-04
Bones	0.07	2.45E-07	1.72E-05	1.72E-05
Skin	10	3.50E-05	2.45E-03	2.46E-03
Breast	1.12	3.92E-06	2.74E-04	2.76E-04
Ovary	0.11	3.85E-07	2.70E-05	2.71E-05
Urinary bladder	0.43	1.51E-06	1.05E-04	1.06E-04
Thyroid	0.33	1.16E-06	8.09E-05	8.13E-05
Bone marrow	0.42	1.47E-06	1.03E-04	1.03E-04
Other	1.44	5.04E-06	3.53E-04	3.55E-04
Gonads (hereditary diseases)	0.2	7.00E-07	4.90E-05	4.93E-05

Source: Study [201]

During the operational phase of the Project, the following monitoring activities will be carried out: radiation monitoring of the NPP site and its surroundings that is meant to measure the current concentrations of radioactive isotopes, as well as the impact on health and quality of life. These activities are described in chapters [Chapter V.7] and [Chapter V.3].

IV.15.1.1.7.3 Decommissioning phase

During the decommissioning phase, exposure to ionising radiation decreases due to the lack of fission reactions taking place inside the reactor. As such, the exposure of the personnel will mainly occur due to works on spent fuel, decontamination (including the removal of reactor vessel), or in dismantling and demolition works. It is expected that exposure will generally be lower than in the operational phase, mainly due to the possibility of using specialised equipment for such works. Likewise, this will also be true in the case of people living in the vicinity of the power plant.

The following monitoring activities will be carried out during the decommissioning phase of the Project: radiation monitoring during the decommissioning phase, analogous to the radiation monitoring during the operational phase.

IV.15.2 Variant 2 – Żarnowiec site

The Project's impact on human life and health was analysed without detailed differentiation into sub-variants 2A and 2B, due to the lack of significant elements that may have an impact on the scope and magnitude of the impact.

IV.15.2.1 Effects of emissions on human health and life

IV.15.2.1.4 Safety of food - sea products - in relation to the discharge of liquid radioactive substances

IV.15.2.1.4.1 Construction phase

The impact will be the same as for Variant 1 – Lubiatowo – Kopalino site.

IV.15.2.1.4.2 Operational phase

The impact will be the same as for Variant 1 – Lubiatowo – Kopalino site.

IV.15.2.1.4.3 Decommissioning phase

The impact will be the same as for Variant 1 – Lubiatowo – Kopalino site.

IV.15.2.1.5 Safety of food - sea products - in relation to the use of chemicals in the cooling water system

The impact will be the same as for Variant 1 – Lubiatowo – Kopalino site.

IV.15.2.1.6 Safety of food of non-marine origin in relation to the emissions of gaseous radioactive substances

The impact will be the same as for Variant 1 – Lubiatowo – Kopalino site.

IV.15.2.1.7 Impact of ionising radiation on health

IV.15.2.1.7.1 Construction phase

The impact will be the same as for Variant 1 – Lubiatowo – Kopalino site.

IV.15.2.1.7.2 Operational phase

In the operational phase, the radioactive impacts will be principally the same as in Variant 1 – Lubiatowo - Kopalino site. The only difference will be associated with the values of maximum annual effective doses from emissions that a member of the public can receive, which will approximately be 2.3µSv/year for children and adults, and 3.05µSv/year for infants [11], [12]. These values are slightly lower than the ones for Variant 1 – Lubiatowo - Kopalino site, which is due to different meteorological and geographical conditions. Furthermore, based on calculations analogous to the above, the risk of stochastic effects is estimated at approximately 0.000012%/year, which with reference to 70 years of life gives about 0.0004%. Again, these values are lower than in Variant 1 - Lubiatowo - Kopalino site. The table below [Table IV.15- 5] presents the calculated radiation risks for individual organs (types of tumours), similarly as in Variant 1 - Lubiatowo - Kopalino site.

Table IV.15- 5 Radiation risk (i.e. probability of inducing tumour) for members of the public, by organs affected by neoplastic changes

Organ affected by neoplasm	Radiation risk [%/Sv]	Annual radiation risk [%/Sv] for the dose of 2.3µSv/year	Radiation risk for [%] the dose of 2.3µSv/year and 70 years of life	Radiation risk [%] for 70 years of life (taking into account the infancy)
Oesophagus	0.15	3.45E-07	2.42E-05	2.43E-05
Stomach	0.79	1.82E-06	1.27E-04	1.28E-04
Colon	0.65	1.50E-06	1.05E-04	1.05E-04
Liver	0.3	6.90E-07	4.83E-05	4.85E-05
Lung	1.14	2.62E-06	1.84E-04	1.84E-04
Bones	0.07	1.61E-07	1.13E-05	1.13E-05
Skin	10	2.30E-05	1.61E-03	1.62E-03
Breast	1.12	2.58E-06	1.80E-04	1.81E-04
Ovary	0.11	2.53E-07	1.77E-05	1.78E-05
Urinary bladder	0.43	9.9E-07	6.92E-05	6.96E-05
Thyroid	0.33	7.59E-07	5.31E-05	5.34E-05
Bone marrow	0.42	9.66E-07	6.76E-05	6.79E-05
Other	1.44	3.31E-06	2.32E-04	2.33E-04
Gonads (hereditary diseases)	0.2	4.60E-07	3.22E-05	3.24E-05

Source: Study [201]

It should be mentioned here that due to a different land relief (nearby moraine hills) in Variant 2 - Żarnowiec site, it will be necessary to increase the height of the plant ventilation stack to approximately 150m (from about

75m assumed in Variant 1 - Lubiatowo - Kopalino site). The higher stack will result in a slight decrease in the values of maximum doses which will even more reduce the postulated radiation risk for the local population.

IV.15.2.1.7.3 Decommissioning phase

The impacts are similar to those in Variant 1 - Lubiatowo - Kopalino site, taking into account the aspects described for the operational phase.

IV.15.3 Summary

Analyses of the Project's impact on health show that emissions of a conventional nature, i.e., air pollution, noise emissions, and water pollution and wastewater discharge that will physically affect human health, are within the required standards. It should be noted, however, that the appearance of noise sources and air pollutants primarily during the Construction phase will be noticeable to those implementing the Project and those in the vicinity of the NPP construction [site]. In the case of Variant 1 - Lubiatowo - Kopalino site, it is likely that people living in houses located in the vicinity of the NPP, e.g. residents of Choczewo and nearby localities such as Kopalino, Lubiatowo, Biebrowo and Słajszewo, will be affected by noise generated by the Project and by increased air pollution and dust emissions. In the case of Variant 2 - Żarnowiec site, the residents of Sobieńczyce, Karlikowo, Lubocino, Tyłowo and Czymanowo will be exposed to such impacts. Activities during the Construction phase can lead to stress and anxiety especially among the elderly and particularly vulnerable groups.

With respect to food safety, including seafood, due to the use of chemicals in the cooling water system, it should be noted that seawater will undergo several different treatment processes, including, i.a., removal of contaminants, addition of chemicals to prevent corrosion and microbial growth in the cooling water system. The discharged cooling water will contain residual concentrations of chemicals added to the cooling water (biocides, oxidising agents, and potentially other substances containing chlorine). Applying the mitigating measures described in [Chapter V.3], no significant impact to human health are anticipated. Detailed information on the impact of the discharge of cooling water is presented in chapter [Chapter IV.8.2].

In the case of impact associated with ionizing radiation, two main groups of people should be distinguished: employees of the power plant and local residents. In the case of employees, specific radiological protection regulations for occupational exposure will apply, in particular workers will not exceed a dose limit of 20 mSv/year (effective dose) and in practice, they are not expected to receive doses greater than 2.5 mSv. In contrast, the general population (i.e., the local community living near the power plant) may be exposed to doses of several µSv/year at most (in the worst-case scenario). The associated radiation risk is completely negligible. This means that from the perspective of ionizing radiation, the impact on human health and life is not significant. Similarly, radiological impact on food, both of marine and terrestrial origin, have been analysed - in both cases the impact will be completely insignificant.

The Project itself will raise many concerns and doubts, which may result in increased stress and anxiety in the surrounding communities in particular, due to the possibility of beliefs about the negative impact of the NPP on health. Additionally, the issue of changes in the way and quality of life for residents will appear. This can have a negative influence on the quality and mental health of some residents (fear of change, loss of jobs, need to adjust to new conditions, concerns about employee behaviour toward local residents etc.). There may also be a positive effect resulting from opportunities generated by such type of investment, in particular the development of the commune's potential, employment or new business opportunities. Living conditions may be improved and as a result stress levels will decrease, which may have a positive impact on mental health, family and social relations. In the latter aspect, the risk of tensions between visitors and the local community must be taken into account, especially during the Construction phase; however, an appropriate social policy and the cooperation of the commune’s authorities with the entities implementing the Project may significantly reduce the negative aspect of this phenomenon.

When comparing the impacts of the two site variants [309], it should be noted that with respect to the local population that could potentially be exposed to NPP emissions or be affected in terms of access to areas previously used for recreational purposes, etc., Variant 1 - Lubiatowo - Kopalino site (Sub-variant 1A, 1B and 1C) appears to be the better variant due to the smaller number of people living within a 5 km radius (rural area with low population density). Analysing the increased use of local social protection facilities by the incoming workforce and potential changes in waiting times for medical consultations, examinations, diagnostics and treatments, it can be concluded that Variant 2 - Żarnowiec site (sub-variants 2A and 2B) is more favourable. With respect to impacts related to traffic volume/intensity increase, traffic accidents, and ambulance response times, it should be pointed out that the closest hospital to both sites is Szpital Pomorski Sp. z o.o. The hospital is equipped with ambulances, traumatic incidents response measures, and provides medical services paid for with both public and private funds. The hospital is located closer to the Żarnowiec area (Variant 2) and therefore ambulances are less likely to experience traffic disruption in connection with construction traffic, compared to Variant 1 - Lubiatowo - Kopalino site. An additional aspect is the construction of the cooling water pipeline (approximately 10 km) in Variant 2 - Żarnowiec site, where construction works will involve linear excavation for the pipelines and the use of construction machinery and cranes, resulting in higher impacts and accident risks than in Variant 1 - Lubiatowo - Kopalino site, in which the construction area for the pipelines is close to the coastline and the works will be on a much smaller scale and in a more controllable area.

The key difference between the two site variants is primarily due to the population living within a 5 km radius of the NPP site. The implementation of the Project in Variant 1 - Lubiatowo - Kopalino site results in the exposure of a smaller number of people to potential changes in their immediate vicinity, exposure to road traffic emissions and noise, and changes in existing habits and as well as in the current life of the public. In this variant, there would be no increased risk to local community's health and safety associated with the construction of the 10-km cooling water pipelines. The advantage of Variant 2 -- Żarnowiec site, is that the NPP would be located at a closer distance to the hospital with emergency response resources; however, as mentioned earlier, due to the smaller number of people affected by the NPP, Variant 1 -- Lubiatowo - Kopalino site is considered more favourable from the perspective of impacts on human health and life [309].

IV.16 Impacts associated with waste management

IV.16.2 Nuclear waste and spent nuclear fuel

This chapter concerns the Project's environmental impacts related to handling radioactive waste and spent nuclear fuel (SNF) generated in the operational and decommissioning phases of the Project, respectively, with respect to both site variants. It should be emphasised that neither the quantity of the radioactive waste and spent nuclear fuel generated, nor the manner of their handling, depends on the Project site or type of the cooling system used.

The management of radioactive waste and SNF generated during the various phases of the Project is described in chapter [Chapter II.11.6] of the present EIA Report.

The main aim of this chapter is to present the possible radiological impacts related to handling the radioactive waste and SNF, minimised thanks to the application of the Best Available Techniques (BAT). The optimisation will concern the aggregate quantities of radioactive waste and low level waste: transitional and short lived waste classified ultimately as non-radioactive waste (according to the criteria determined in the regulation [181]), so that the environmental impact of the Project can be reduced to a minimum.

In order to minimise the environmental impacts related to the waste transport, the nearest facilities will be used to the maximum extent. In the Operational Phase, possible interrelations will be analysed between radwaste disposal facilities situated on the plant site and off the plant site, in order to further optimise the handling of radioactive waste.

Data on the carbon footprint related to the handling of radioactive waste and spent nuclear fuel are also provided, expressed as the amount of greenhouse gas emissions per unit of electricity generated (gCO_2e/kWh).

As indicated in chapter [Chapter II.11.6], design solutions applied in the NPP and plans regarding handling of radioactive waste and SNF are based on the handling strategy aimed at a reduction of waste generation, waste reuse or recycling wherever possible, and the application of solutions that would limit any emissions to the environment.

The present chapter estimates impacts related to:

- treatment of low level and intermediate level radioactive waste (RW), both wet (semi-liquid) and solid, at the NPP into a form that meets the acceptance criteria for disposal at the New Surface Radioactive Waste Repository (NSRWR);
- transport of low level and intermediate level RW to the NSRWR;
- handling and storage of spent nuclear fuel (SNF) in the NPP: in spent fuel pools located in auxiliary buildings of individual units, and in an interim spent fuel storage for the entire NPP.

IV.16.2.1 Variant 1 — Lubiatowo-Kopalino site

IV.16.2.1.1 Construction phase

During the construction phase, no radioactive waste or spent nuclear fuel is generated. At its final stage, i.e. during the nuclear commissioning at the commissioning stage, first radioactive waste can be generated to be then processed already in the operational phase, therefore the impact related to the handling of such waste is taken into account in the operational phase.

IV.16.2.1.2 Operational phase

IV.16.2.1.2.1 Radiological impact

Radioactive substances that are emitted into the atmospheric air through main plant vents originate from the facilities (and their parts) of individual units in which low level and intermediate level RW is treated and SNF is stored - in spent fuel pools. These are the following facilities or their parts:

- auxiliary building;
- fuel handling area in the auxiliary building;
- radwaste building.

The processes of liquid and solid RW treatment are described in chapters [Chapter II.11.6.3.3.2] and [Chapter II.11.6.3.3.3].

In the fuel handling area in the auxiliary building, spent fuel assemblies are also moved from the spent fuel pool (after being stored in the pools for a maximum of 10 years) to sealed capsules made of stainless steel and filled with inert gas (helium). The sealed capsules are then moved (with the use of a special transport device) to a temporary, dry underground SNF storage and placed in suitable storage slots [Chapter II.11.6.4.2.1].

On the basis of data provided by the AP1000 reactor plant vendor [324], it may be estimated (using a conservative approach) that the total emissions of radioactive substances (in gaseous and aerosol form) into the air, related to the treatment of RW and storage of SNF (in the auxiliary and radwaste building, respectively), constitute no more than 21% of the total emissions of radioactive substances from the NPP into the atmosphere.

As a result of the treatment of liquid RW, effluents containing radioactive substances (mainly tritium - 99.98% of the total activity of the emissions of radioactive substances into the sea water) and solidified waste (containing spent ion exchangers and filtering beds) are left in the WLS. Emissions of radioactive substances into the atmosphere, related to the process of liquid RW treatment processes, are considered in the abovementioned reports [324], and waste water containing radioactive substances will be discharged into the sea water in a controlled way [Chapter II.11.4].

Treated RW is placed in sealed containers, the surfaces of which are decontaminated, and then subjected to a dosimetry check so as to confirm that a given waste package meets the acceptance criteria for disposal at the NSRWR.

Thus prepared, RW may be moved to an appropriate buffer storage (respectively: intermediate level and low level RW), or directly shipped (from the manageable storage) to the NSRWR. During the storage of treated RW on the plant site in low level waste and intermediate level RW storage facilities (common for the entire power plant), there will be no emissions of radioactive substances into the environment. Off the plant site, there be no exposure to radiation from the stored RW, either.

Also during the transport of RW to a disposal facility there are no emissions of radioactive substances into the environment, and only a relatively insignificant radiological impact associated with the radiation emitted by the RW packaged in sealed containers, according to the provisions of law applicable in Poland. As mentioned in chapter [Chapter II.11.6.1], the Radioactive Waste Management Plant (RWMP) will be responsible for collecting radioactive waste from the NPP and transporting it to the repository (NSRWR).

Criteria of the annual effective dose for the exposure to radiation related with the transport of radioactive waste are specified in IAEA publication No. SSR-6 (Rev. 1) [363] at 5 mSv/year for workers and at 1 mSv/year for members of the general public. However, the actual expected doses are much lower. In the 2008 UNSCEAR report [483], the maximum doses of radiation that may be received by members of the public in connection with the transport (by road or rail) of low level and intermediate level RW are estimated at **below 4 µSv/year** (that is 4 x 10^{-3} mSv/year). By contrast - the average dose received from background ionising radiation in Poland is **around 2.4 mSv/year**.

By the same token, the transport of SNF in sealed capsules and its storage in a dry, underground SNF storage practically does not lead to radioactive emissions into the atmospheric air, and protection against radiation is ensured by: a shielded transport container, concrete walls of the storage channels, the foundation slab and walls of the storage, as well as the surrounding soil. Thanks to such solutions, there is no off-site exposure to ionising radiation due to the SNF stored in the interim spent fuel store.

The results of the calculations of the radiological impact of the NPP on the environment during operational states [Chapter IV.14] [11], [12] point to the fact that the maximum radiation dose associated with off-site emissions of radioactive substances in operational states will be: 7.90 x 10^{-3} mSv/year – in Variant 1 - Lubiatowo-Kopalino site, and 3.05 x 10^{-3} mSv/year – in Variant 2 – Żarnowiec site. However, the contribution, associated with the aquatic exposure pathway, to the total doses of radiation is below 1%. It should therefore be noted that the doses associated with the radiological impact of the NPP on the environment during operational states are very low (almost negligible) – they are two orders of magnitude lower than the average background radiation dose in Poland.

If one adopts the conservative estimate that 21% of these dose values are associated with the management of RW and SNF, it can be assumed that the radiological impact around the NPP, related to on-site treatment and storage of RW and storage of SNF, results in off-site doses of approximately: **1.66 x 10^{-3} mSv/year** – for Variant 1 - Lubiatowo – Kopalino site, and **6.41 x 10^{-4} mSv/year** – for Variant 2 – Żarnowiec site.

Thus the estimated radiological impact associated with the management of RW and SNF, including transport of low level and intermediate level RW is negligibly low and therefore cannot have a negative effect on human health or on the environment.

IV.16.2.1.2.2 Carbon footprint

Results of the carbon footprint estimation related to the handling of radioactive waste and spent nuclear fuel are presented below.

The available study reports do not single out greenhouse gas emissions associated with the management of RW and SNF (except for long-term storage of SNF in the interim storage), and the emissions are included in the total carbon footprint for the operational phase of the NPP.

Greenhouse gas emissions during the operational phase of the Project were estimated at **0.20 gCO_2e/kWh** (for the sub-variant with an open cooling system) and **0.21 gCO_2e/kWh** (for the sub-variant with a closed cooling system) [59].

In turn, greenhouse gas emissions associated with the storage of SNF in an interim storage are conservatively estimated at **0.08 gCO_2e/kWh** (irrespective of the cooling system sub-variant) [59].

Greenhouse gas emissions are also estimated for disposal of RW and SNF in appropriate repositories (NSRWR/MRWR): **1.0 gCO_2e/kWh** (irrespective of the cooling system sub-variant) [59].

It is worth noting that the estimated greenhouse gas emissions during the life cycle of the Project [59], i.e. **6.01-6.60 gCO_2e/kWh** (depending on the cooling system sub-variant) are among the lowest when compared to alternative sources of electricity generation, with only hydroelectric generation resulting in lower emissions (**4.49 gCO_2e/kWh**) [60], [Chapter II.11.1].

IV.16.2.1.3 Decommissioning phase

In the decommissioning phase, the radiological impact on the environment related to radioactive waste and spent nuclear fuel will be smaller than in the operational phase, which in terms of radiation doses is negligible.

Due to a large volume of waste from the decommissioning process which in the vast majority will be non-radioactive, the handling of such waste will still result in higher greenhouse gas emissions than in the operational phase: **0.27 gCO_2e/kWh** (for the sub-variant with an open cooling system) and **0.28 gCO_2e/kWh** (for the sub-variant with a closed cooling system) [59] [Chapter II.11.1].

IV.16.2.1.4 Tables of impacts

The table below [Table IV.16- 3] presents the expected impact of the planned Project related to the generation of radioactive waste and spent nuclear fuel in Variant 1 – Lubiatowo - Kopalino site.

Table IV.16- 3 Table of impacts related to handling radioactive waste (RW) and spent nuclear fuel (SNF). Variant 1 - Lubiatowo-Kopalino site

Receptor	Receptor importance	Receptor sensitivity	Activities and the resulting effects	Extent of the impact	Type of impact	Duration of the impact	Frequency of the impact	Significance of effect
1.	2.	3.	4.	5.	6.	7.	8.	9.
CONSTRUCTION PHASE								
Commissioning Stage								
Human receptors (total)	Wy	Wy	On-site handling of RW and SNF (no transfer of the RW or SNF off the NPP site at this stage)	Lo	P	K	St	Ni
Human receptors (workers responsible for the RW and SNF handling process)	Wy	Wy	On-site handling of RW and SNF (no transfer of the RW or SNF off the NPP site at this stage)	Lo	B	K	Ch	Is
The environment (surface water, groundwater, soils, air)	Wy	Um	On-site handling of RW and SNF (no transfer of the RW or SNF off the NPP site at this stage)	Lo	B	S	St	Ni
OPERATIONAL PHASE								
Human receptors (total)	Wy	Wy	On-site handling of RW and SNF (possible transfer of the RW off the NPP site in this phase; no transfer of SNF off the NPP site in this phase)	Lo	P	D	St	Ni
Human receptors (workers responsible for the RW and SNF handling process)	Wy	Wy	On-site handling of RW and SNF (possible transfer of the RW off the NPP site in this phase; no transfer of SNF off the NPP site in this phase)	Lo	B	K	Ch	Is
Environment (surface water, groundwater, soil, air)	Wy	Um	On-site handling of RW and SNF (possible transfer of the RW off the NPP site in this phase; no transfer of SNF off the NPP site in this phase)	Lo	B	S	St	Ni
DECOMMISSIONING PHASE								
Human receptors (total)	Wy	Wy	On-site handling of RW and SNF (transfer of the RW and SNF off the NPP site in this phase)	Lo	P	S	St	Ni
Human receptors (workers responsible for the RW and SNF handling process)	Wy	Wy	On-site handling of RW and SNF (transfer of the RW and SNF off the NPP site in this phase)	Lo	B	S	K	Is
Environment (surface water, groundwater, soil, air)	Wy	Um	On-site handling of RW and SNF (transfer of the RW and SNF off the NPP site in this phase)	Lo	B	S	St	Ni

***Ni** – Low, **Um** – Moderate, **Wy** – High, **Lo** – Local, **Re** – Regional, **Kr** – National, **B** – direct, **P** – indirect, **W** – secondary, **S** – cumulative, **K** – short-term, **Ś** – medium-term, **D** – long-term, **St** – permanent, **Ch** – temporary, **Is** – Significant, **Ne** – Insignificant, **ND** – not applicable, **NZ** – unknown.*

Source: In-house study

IV.16.2.2 Variant 2 – Żarnowiec site

The impacts are the same as for Variant 1 – Lubiatowo – Kopalino site.

IV.16.2.2.1 Tables of impacts

The tables of impacts are the same as in Variant 1 – Lubiatowo – Kopalino site.

IV.17 Determining the projected environmental impacts in the event of a severe accident

This chapter presents and discusses the results of the analysis of the radiological impact of the NPP in accident conditions carried out for both site variants by the National Centre for Nuclear Research [11], [12], at the Investor's behest.

IV.17.1 Variant 1 – Lubiatowo - Kopalino site, and Variant 2 – Żarnowiec site

The analysis of the data presented in appendix to chapter [Chapter II.11.4] of this EIA Report [Appendix II.11.4- 2] shows that, irrespective of the selected site variant and [technical] sub-variant, the NPP will be categorised as a plant that is at risk of a major industrial accident. The analyses carried out by the Investor point to the fact that the stored ammonium hydroxide, hydrazine, and sodium hypochlorite have the main impact on the qualification of non-nuclear hazards in accordance with the Regulation of the Minister of Economy of 29 January 2016 on the types and amounts of hazardous substances, which are decisive in classifying an establishment as an establishment with a high or increased risk of a major industrial accident [374]. However, even the effects of a major industrial accident - unlike in the case of a severe nuclear accident - will not go beyond the nuclear power plant site. Moreover, activities meant to prevent the occurrence of a major industrial accident will already be taken at the building permit design stage, as described in chapter [Chapter II.11.4.5.2] of the EIA Report.

In view of the above, the present chapter describes the radiological impacts of the nuclear power plant during the occurrence of a severe nuclear accident resulting in a significant release of radioactive substances into the environment. Radiological impacts in operational states, i.e. during normal NPP operation and its anticipated operational occurrences, are described in chapter [Chapter IV.14].

The definition of severe accidents is described in chapter [Chapter II.11.4] of the present EIA Report:

- Major industrial accidents are described in chapter [Chapter II.11.4.1];
- Construction disasters are defined in chapter [Chapter II.11.4.4];
- Severe nuclear accidents are described in chapter [Chapter II.11.4.2].

IV.17.1.1 Construction phase

IV.17.1.1.1 Development stage

Given the abovementioned definitions and the projected scope of works for this stage, it should be stated that it is not possible for a severe accident to occur at the Project development stage.

IV.17.1.1.2 Construction stage and Commissioning stage

At the Project Construction stage, should events understood as an industrial accident or a construction disaster occur, their impact will not extend beyond the area enclosed by the fencing of the construction site.

No nuclear accident is possible until the delivery of nuclear fuel to the NPP site commences. Moreover, thanks to the applied technical measures (safeguards) and procedures, one may also rule out the occurrence of a criticality accident during new fuel handling in the course of: its delivery and acceptance inspection, displacement and storage, as well as during the loading of fuel assemblies into the reactor core of the first of the constructed nuclear power units (and further on, also of the subsequent units) [18].

In turn, the maximum radiological effects of an accident that could occur at the Commissioning stage during the active commissioning – from the moment the first criticality of the reactor is achieved until the end of the commissioning of the power unit - would be much lower than the radiological effects of potential accidents that may occur during the Operational phase due to much lower burnup of nuclear fuel and, as a consequence, lower amount of radioactive substances accumulated in the reactor core and coolant. Thus, the radiological effects of an accident that may occur at the Operational phase (described below) constitute an envelope of the NPP's radiological impact on the environment in accident conditions.

IV.17.1.2 Operational phase

The impact of a severe nuclear accident is presented below in the form of assumptions, and results of calculations and analyses of the radiological impact around the NPP in the event of the occurrence of accident conditions (as per the Atomic Law Act [499]) associated with significant releases of radioactive substances into the environment.

IV.17.1.2.1 Scope of and assumptions for the analyses of the NPP's radiological impact on the environment

In order to assess the NPP's radiological impact on the environment in accident conditions one must define the assumptions related to the representative type of an accident that may potentially occur during the NPP operation, and adopt criteria for the assessment of the doses of ionising radiation for the general public due to accident releases of radioactive substances. The descriptions of severe accidents resulting in the contamination of the environment with radioactive substances are presented in chapter [Chapter II.12.4.2] of this EIA Report. It should be emphasised that in accident conditions, releases of radioactive substances through process ventilation or into surface waters (especially through the cooling systems) are excluded by the design. This points to the fact that in accordance with the provisions of Article 86m item 1, and Article 86n item 4 of the Atomic Law Act [499] the emergency planning zones and distances are determined on the basis of the *results of safety analyses of the potential effects of accidents with a probability of occurrence equal to or greater than once per* 10^7 *years.*

On the basis of the information acquired from the NPP vendor [511], two accidents belonging to the following categories were adopted for the purpose of analyses of the radiological impact of the NPP in conditions of a severe nuclear accident:

1) accident without core melt: a design basis accident (DBA) that is bounding in terms of the radiological impact has been adopted, which, in the case of an AP1000 reactor, is a large-break loss-of-coolant accident (LB LOCA);
2) severe accident with core melt considered in design extension conditions (DEC) which is, at the same time, representative for the purpose of emergency planning.

In the case of both these categories of accidents, it was assumed that the releases of radioactive substances will occur at the level of the plant site – which is a conservative assumption that results in the pessimisation of the results of the analyses of the NPP's radiological impact on the environment (in particular, in the area within the 30km range).

For the purpose of the analyses of the radiological impact, the criteria for the assessment of the impact of ionising radiation on people included in relevant national regulations and IAEA guidelines were adopted.

For the purpose of the calculations, the most unfavourable meteorological conditions conducive to large exposures (of people to ionising radiation) and depositions (of radionuclides on the land surface, resulting in radioactive contamination), defined on the basis of historical data from the multi-year period (1973-2016) with the use of a methodology consulted with the PAA, described in chapter [Chapter V.1.13] of the present EIA Report [256], [532]. As a result of the analyses carried out in accordance with the abovementioned methodology, 2010 was selected as the reference year in which the most unfavourable meteorological conditions occurred (also taking into account the local rainfall) [257]. The results of the dedicated monitoring carried out in both site variants (from the April 2018 - March 2020 period) were also taken into account - they do not affect the selection of the reference year.

The source terms were based on the information received from the plant vendor [511]. They were verified on the basis of the results of the analyses of the of the AP1000 reactor technology carried out by the British nuclear regulator (Office for Nuclear Regulation [ONR]). The data are consistent with the guidelines of the U.S. nuclear regulator (Nuclear Regulatory Commission [NRC]) pertaining to the requirements for conducting analyses of the release of radioactive substances from light-water reactors [306], and they are based on conservative assumptions.

The results of the analyses of the radiological impacts of the NPP in accident conditions are used to determine the extent of the emergency planning areas, zones, and distances.

IV.17.1.2.2 Criteria for the determination of the extent of the restricted use area, emergency planning zones and distances, and intervention activities

The criteria adopted in order to carry out analyses of the radiological impact of the nuclear power plant in accident conditions are described in detail below. The calculations and analyses were conducted with the use of the criteria set out in the current Polish legal regulations, i.e. the Atomic Law Act [499] and the Regulation on intervention levels [419], as well as the criteria laid down in IAEA GSR Part 7 [394], and the safety criteria recommended by WENRA for the new generation NPPs [509]. It should be stressed that the criteria provided in the Regulation on intervention levels [419] are consistent especially with Council Regulation (Euratom) 2016/52 of 15 January 2016 laying down maximum permitted levels of radioactive contamination of food and animal feed following a nuclear accident or any other case of radiological incident.

IV.17.1.2.2.1 Criteria for the determination of the extent of the restricted use area, and emergency planning zones and distances

A1. RUA2. Restricted use area

The criteria for the determination of the restricted use area (RUA) around a nuclear facility were laid down in Article 36f items 2 and 3 of the Atomic Law Act [499].

The following requirements laid down in the abovementioned regulations are the most important for the calculations and analyses of the radiological impact carried out in order to determine the range of the RUA in the event of a severe accident: *The RUA covers the area outside of which, in the event of an accident without core melt, the* ***annual effective dose for all exposure pathways [i.e. taking into account ingestion - ed. note] will not exceed 10 mSv****. In the estimation of the effective dose, the data and information pertaining to the location of the nuclear facility are taken into account (...)* ***including the most unfavourable meteorological conditions****, hydrological conditions, (...) in the area of the nuclear facility.*

The results of the calculations and analyses associated with the above criterion of an annual effective dose for accidents without core melt (marked with the RUA2 symbol) is presented in four variants differing in terms of taking the food dose for internal exposure into account, and the quantile considered in order to determine the most unfavourable meteorological conditions.

A2. IEPZ Internal emergency planning zone

The criterion related to the selection of the category of accidents for the analyses stems from Article 86m item 1 of the Atomic Law Act [499]. The zone is determined with the assumption that the probability of occurrence of an accident is equal to or greater than once per 10^7 years (severe accident with core melt). The precautionary action zone (PAZ), also called the “internal zone”, is one of the emergency planning zones. For the purpose of determining the internal zone, the following criteria were defined on the basis of the guidelines included in IAEA GSR Part 7 [349] and with due consideration of the draft of the technical recommendations of the PAA President in this regard [533]:

Sub-criterion A2.1 (**IEPZ_1):** for external exposure at any time during the 10 hours after the accident – for all exposure pathways:

- for red bone marrow - equivalent dose ≥ 1Sv;
- for skin - calculated as the average value for any exposed part of the skin surface with an area of 100cm^2 - equivalent dose at a depth of 0.4mm ≥ 10Sv;

Sub-criterion A2.2 (**IEPZ_2)**: for internal exposure at any time during 30 days – for all exposure pathways:

- for red bone marrow:

- from all radioactive isotopes - equivalent dose ≥ 2Sv,

- from isotopes with atomic number Z ≥ 90 - equivalent dose ≥ 0.2Sv,

- for thyroid - equivalent dose ≥ 2Sv;
- for lungs - equivalent dose ≥ 30Sv.

A3. EEPZ External emergency planning zone

The criterion related to the selection of the category of accidents for the analyses stems from Article 86m item 1 of the Atomic Law Act [499]. The urgent protective action planning zone (UPZ), also called the "external zone", is one of the emergency planning zones. The zone is determined with the assumption that the probability of occurrence of an accident is equal to or greater than once per 10^7 years (severe accident with core melt). For the purpose of determining the external zone, the following criteria were defined on the basis of the guidelines included in IAEA GSR Part 7 [349] and with due consideration of the draft of the technical recommendations of the PAA President [533]:

Sub-criterion A3.1 (EEPZ_1): The projected dose, without any intervention activities being carried out, within the first 7 days after the accident: effective dose (for all exposure pathways) ≥ 100mSv;

Sub-criterion A3.2 (EEPZ_2): The projected dose, without any intervention activities being carried out, within the first 7 days after the accidents: equivalent dose to the thyroid due to intakes (through inhalation or ingestion) of radioactive iodine isotopes ≥ 50mSv.

A4. EPD Extended planning distance

The criterion related to the selection of the category of accidents for the analyses stems from Article 86n item 1 of the Atomic Law Act [499]. The extended planning distance is a zone that is determined with the assumption that the probability of occurrence of an emergency is equal to or greater than once per 10^7 years (severe accident with core melt). The extended planning distance is determined on the basis of the following criterion, in accordance with the guidelines included in the IAEA GSR Part 7 [349] and with due consideration of the draft of the technical recommendations of the PAA President [533]: during the first year following an accident, without any intervention activities being carried out, effective dose (for all exposure pathways) ≥ 100mSv.

A5. ICPD Ingestion and commodities planning distance

The criterion related to the selection of the category of accidents for the analyses stems from Article 86n item 4 of the Atomic Law Act [499]. The ingestion and commodities planning distance is a zone that is determined with the assumption that the probability of occurrence of an accident is equal to or greater than once per 10^7 years (severe accident with reactor core melt). The ingestion and commodities planning distance is determined on the basis of the following criterion, in accordance with the guidelines included in IAEA GSR Part 7 [349] and with due consideration of the draft of the technical recommendation of the PAA President [533]: during the first year following an accident, without any intervention activities being carried out, dose of 10mSv for the ingestion of food and water, taking into account the local diet.

IV.17.1.2.2.2 Criteria for the determination of the range of individual types of intervention activities

B1. RPI_EVA. Evacuation following an accident without core melt

The criteria resulting from the Regulation of the Council of Ministers of 27 April 2004 on the intervention level values for particular intervention actions, and on the criteria for cancellation of these actions [419]. The evacuation zone is determined on the basis of the criterion in which in the event of foregoing evacuation in the exposed area, any person present in it, could receive a total effective dose of at least 100mSv over the next 7 days due to external and internal exposure, with the exception of the intake of radioactive substances through ingestion. The zone was determined for the occurrence of an accident without core melt.

B2. GSR_EVA. Evacuation following an accident without core melt

Criterion in accordance with IAEA GSR Part 7 [349]. The evacuation zone is determined on the basis of the criterion in which in the event of foregoing evacuation in the exposed area, any person present in it, could receive a total effective dose of at least 100mSv over the next 7 days due to external and internal exposure. The zone was determined for the occurrence of an accident without core melt.

B3. RPI_SCH. Sheltering following an accident without core melt

The criteria resulting from the Regulation of the Council of Ministers on the intervention level values for particular intervention actions and on the criteria for revoking these actions [419]. The sheltering zone is determined on the basis of the criterion in which, in the event that this activity is foregone, any individual person in the exposed area could receive a total effective dose of at least 10mSv over the next 2 days due to external and internal exposure, with the exception of the intake of radioactive substances through ingestion. The zone was determined for the occurrence of an accident without core melt.

B4. RPI_JOD. Administration of preparations containing stabilised iodine following an accident without core melt

The criteria resulting from the Regulation of the Council of Ministers on the intervention level values for particular intervention actions and on the criteria for revoking these actions [419]. The zone in which the preparations containing stabilised iodine will have to be administered is determined on the basis of a criterion in which, in the event of an exposure event, any person in the exposed area could receive a thyroid absorbed dose of 100mGy. The zone was determined for the occurrence of an accident without core melt.

B5. GSR_JOD. Administration of preparations containing stabilised iodine following an accident without core melt

Criterion in accordance with IAEA GSR Part 7 [349]. The zone in which the preparations containing stabilised iodine will have to be administered is determined on the basis of a criterion in which, in the event of an exposure event, any person in the exposed area could receive an equivalent dose to thyroid of 50mSv. The zone was determined for the occurrence of an accident without core melt.

B6. AC_RPI_EWA. Evacuation following an accident with core melt

The criteria resulting from the Regulation of the Council of Ministers on the intervention level values for particular intervention actions and on the criteria for revoking these actions [419]. The evacuation zone is determined on the basis of the criterion in which in the event of foregoing evacuation in the exposed area, any person present in it, could receive a total effective dose of at least 100mSv over the next 7 days due to external and internal exposure, with the exception of the intake of radioactive substances through ingestion. The zone was determined for the occurrence of a severe accident (with core melt) considered in design extension conditions and one that is representative for emergency planning.

B7. AC_GSR_EVA. Evacuation following an accident with core melt

Criterion in accordance with IAEA GSR Part 7 [349]. The evacuation zone is determined on the basis of the criterion, in which in the event of foregoing evacuation in the exposed area, any individual person residing in it could receive a total effective dose of at least 100mSv over the next 7 days due to external and internal exposure. The zone was determined for the occurrence of a severe accident (with core melt) considered in design extension conditions and one that is representative for emergency planning.

B8. AC_RPI_SCH. Sheltering following an accident with core melt

Criterion resulting from the regulation on intervention levels [419]. The sheltering zone is determined on the basis of the criterion in which, in the event that this activity is foregone, any individual person in the exposed area could receive a total effective dose of at least 10mSv over the next 2 days due to external and internal exposure, with the exception of the intake of radioactive substances through ingestion. The zone was determined for the occurrence of a severe accident (with core melt) considered in design extension conditions and one that is representative for emergency planning.

B9. AC_RPI_JOD. Administration of preparations containing stabilised iodine following an accident with core melt

The criteria resulting from the Regulation of the Council of Ministers on the intervention level values for particular intervention actions and on the criteria for revoking these actions [419]. The zone in which the preparations containing stabilised iodine will have to be administered is determined on the basis of a criterion in which, in the event of an exposure event, any person in the exposed area could receive a thyroid absorbed dose of 100mGy. The zone was determined for the occurrence of a severe accident (with core melt) considered in design extension conditions and one that is representative for emergency planning.

B10. AC_GSR_JOD. Administration of preparations containing stabilised iodine following an accident with core melt

Criterion in accordance with IAEA GSR Part 7 [349]. The zone in which the preparations containing stabilised iodine will have to be administered is determined on the basis of a criterion in which, in the event of an exposure event, any person in the exposed area could receive an equivalent dose to thyroid of 50mSv. The zone was determined for the occurrence of a severe accident (with core melt) considered in design extension conditions and one that is representative for emergency planning.

B11. AC_RPI_CPRZ. Temporary relocation following an accident with core melt

The criteria resulting from the Regulation of the Council of Ministers on the intervention level values for particular intervention actions and on the criteria for revoking these actions [419]. The temporary population relocation zone is determined on the basis of the criterion in which, in the event that this activity is foregone, any individual person in the exposed area could receive a total effective dose of at least 30mSv over the next 30 days due to external and internal exposure, with the exception of the intake of radioactive substances through ingestion. The zone was determined for the occurrence of a severe accident (with core melt) considered in design extension conditions and one that is representative for emergency planning.

B12. AC_RPI_SPRZ. Permanent relocation following an accident with core melt

The criteria resulting from the Regulation of the Council of Ministers on the intervention level values for particular intervention actions and on the criteria for revoking these actions [419]. The permanent relocation zone is determined on the basis of the criterion in which, in the event that such activity is foregone, any person in the exposed area could receive a total effective dose exceeding 1Sv over their entire life, understood as 50 years for adults and 70 years for children, (sub-criterion **B12.1**) or 10mSv over the next 30 days between the 24th and 25th month after the accident (sub-criterion **B12.2**) due to external and internal exposure, with the exception of the intake of radioactive substances through ingestion. The zones were determined for the occurrence of a severe accident (with core melt) considered in design extension conditions and one that is representative for emergency planning.

B13. AC_RPI_ZYW. Restriction of the consumption of local food following an accident with core melt

The criteria resulting from the Regulation of the Council of Ministers on the intervention level values for particular intervention actions and on the criteria for revoking these actions [419]. The zone of the ban on or restriction of the consumption of contaminated food and contaminated water intended for human consumption (sub-criterion **B13.1**) is determined on the basis of a criterion in which the concentration of radioactive substances in the contaminated food or contaminated water intended for human consumption exceeds the values laid down in Appendix 1 to abovementioned Regulation [419].

The zone of the ban on feeding animals with contaminated animal feed and providing them with contaminated water, as well as on grazing animals in contaminated areas (sub-criterion **B13.2**), is determined on the basis of a criterion in which the concentration of radioactive substances exceeds the values laid down in Appendix 2 to the abovementioned Regulation [419]. These zones were determined on the basis of calculations of concentrations of radioactive substances in food products after a year from the occurrence of a severe accident (with core melt) considered in design extension conditions and one that is representative for emergency planning.

B14. AC_GSR_ZYW. Restriction of the consumption of local food following an accident with core melt

Criterion in accordance with IAEA GSR Part 7 [349]. The zone of the ban on or restriction of the consumption of contaminated food and contaminated water intended for human consumption is determined on the basis of a criterion in which, in the event that such activity is foregone, any person from the exposed area could receive a total effective dose of at least 10mSv and a total equivalent dose to the foetus of 10mSv due to external and internal exposure. The zone was determined for the occurrence of a severe accident (with core melt) considered in design extension conditions and one that is representative for emergency planning.

IV.17.1.2.3 Results of calculations and analyses of radiological impacts within a distance of up to 30km from the NPP

The results of the analyses of the radiological impacts in the form of the maximum range of the restricted use area, emergency planning zones and distances, and individual types of intervention activities are presented below. These ranges were calculated on the basis of the annual effective dose limits or - in the case of thyroid - equivalent or absorbed doses that members of the general public could receive during the first year following the so-called “major nuclear accident”, if measures (referred to as “intervention actions”) meant to prevent or mitigate the negative health effects among such people due to exposure to ionising radiation (exceeding the specified dose limits) were not applied. The above limits were set in relevant Polish legal regulations or international standards.

The analyses took into account radiation impacts related to emergency releases of radioactive substances from the NPP to the environment in the event [any of] the following two categories of severe nuclear accidents should occur: 1) a bounding design basis accident, in terms of the radiological impact, which for an AP1000 reactor is a large-break loss-of-coolant accident (LB LOCA); 2) a severe accident with core melt considered in design extension conditions, which is at the same time representative for emergency planning according to the criteria set out in the Atomic Law Act [499], and in line with the data received from the NPP technology vendor [364].

The calculations have proved in particular that even for a severe core melt accident considered in design extension conditions and one that is representative for emergency planning, the extent of intervention actions that are most severe for the population, related to relocation (evacuation, temporary relocation, permanent relocation), would be limited to the near vicinity of the NPP. Detailed results of the calculations are presented below.

IV.17.1.2.3.1 Variant 1 – Lubiatowo – Kopalino site

The table below [Table IV.17-24] presents the results of calculations and analyses of the doses, the extent of the restricted use area (RUA) and emergency planning zones and distances, carried out for Variant 1 of the NPP site - Lubiatowo – Kopalino, in accordance with the criteria laid down in the Atomic Law Act [499], and in the IAEA GSR Part 7 [349], taking into account the draft of the technical recommendations of the PAA President [533]. In turn, the table [Table IV.17-25] presents the results of the calculations of the range of individual types of intervention actions, in accordance with the criteria laid down in the Regulation of the Council of Ministers on the intervention level values for particular intervention actions and on the criteria of revoking these actions [419], and in IAEA GSR Part 7 [349].

Both tables provide results of the calculations both for a single reactor and the entire NPP, taking into account the planned arrangement of the reactor buildings on the NPP site. In this case, 260m was added to the distances determined for the single reactor (situated in the centre of the specific reactor building). The above is due to the assumption that the analysis concerns an accident of only one reactor, any of the three reactors installed in the NPP.

Table IV.17-24 Collation of the results of calculations of the extent of the restricted use area (RUA) and emergency planning zones and distances for Variant 1 - Lubiatowo - Kopalino site, in accordance with the criteria laid down in the Atomic Law Act, as well as in IAEA GSR Part 7, taking into account the draft of the technical recommendations of the PAA President.

Criterion	Criterion value [mSv]	Maximum distance [m] from the centre of:	
		one reactor	three reactors*
Restricted use area (RUA)			
A1.1 (RUA2_1) – with food dose, 100% quantile of meteorological conditions	10	3521	3871
A1.2 (RUA2_2) – with food dose, 95% quantile of meteorological conditions	10	1686	1946
A1.3 (RUA2_3) – without food dose, 100% quantile of meteorological conditions	10	230	490
A1.4 (RUA2_4) – without food dose, 95% quantile of meteorological conditions	10	0	0
The determined maximum size of the RUA		**3521**	**3871**
Internal emergency planning zone (IEPZ)			
IEPZ_1 - bone marrow	1000	0	0
A2.1 (IEPZ_1 – skin)	10000	89	349
IEPZ_2 - bone marrow	2000	0	0
IEPZ_2 - LA>90 isotopes	200	0	0
A2.2 (IEPZ_2 – thyroid)	2000	2056	2316
IEPZ_2 - lungs	30000	0	0
The determined maximum size of the IEPZ		**2056**	**2316**
External emergency planning zone (EEPZ)			
A3.1 (EEPZ_1 – 7-day effective dose)	100	1153	1413
A3.2 (EEPZ_2 – 7-day equivalent dose to the thyroid)	50	11710	11970
The determined maximum size of the IEPZ		**11710**	**11970**
Extended planning distance (EPD)			
A4 (EPD – annual effective dose)	100	2195	2455
Ingestion and commodities planning distance (ICPD)			

Criterion	Criterion value [mSv]	Maximum distance [m] from the centre of:	
		one reactor	three reactors*
A5 (ICPD – annual dose from the ingestion of contaminated food and water)	10	8597	8857

** Geometric centre point for three NPP reactor buildings*
The abbreviations used and the related criteria for the calculations are explained in chapter [Chapter IV.17.1.2.2] above.
Source: In-house study based on [11]

Summary of the results of the calculations and analyses provided in the above table [Table IV.17-24].

Thanks to the technical solutions applied, and primarily to the safety systems used, even in the event of the occurrence of a bounding design basis accident and an extremely unlikely severe accident, the significant radiological impact would be restricted to the close surroundings of the NPP:

1. In the event of the occurrence of an accident without core melt that is bounding in terms of the radiological impact (LB LOCA):
   a. Assuming the most conservative criterion, i.e. an annual effective dose (including exposure due to ingestion) of ≥10mSv, and taking into account the most unfavourable meteorological conditions (100% quantile), the maximum extent of the RUA calculated for Variant 1 - Lubiatowo - Kopalino site is 3,871m;
   b. In turn, excluding the dose resulting from exposure due to ingestion results in a spatial range of the RUA that is so small (490m) that it would be restricted to the boundaries of the NPP site, even taking into consideration the most unfavourable meteorological conditions (100% quantile). The additional adoption of 95% quantile of meteorological conditions results in a range of the RUA equal to zero.

   Details regarding the designation of RUA are specified in chapter [Chapter V.6] of this EIA Report.
2. In the event of the occurrence of a severe accident with core melt considered in design extension conditions that would also be representative for emergency planning purposes:
   a. the maximum range of the internal emergency planning zone (IEPZ): around 2.3km (the IEPZ range is determined by the limit for the equivalent dose to the thyroid for deterministic effects, specified in IAEA GSR Part 7 [349]);
   b. the maximum range of the external emergency planning zone (EEPZ): around 12km (the EEPZ range is determined by a fairly strict limit for the equivalent dose to the thyroid for stochastic effects, specified in IAEA GSR Part 7 [349]);
   c. the maximum range of the extended planning distance (EPD): around 2.5km;
   d. the maximum range of the ingestion and commodities planning distance (ICPD): around 8.9km.

Table IV.17-25 Collation of results of the calculations of the range of individual types of intervention actions, for Variant 1 - Lubiatowo - Kopalino site, in accordance with the criteria specified in the Regulation of the Council of Ministers on the intervention level values for particular intervention actions and on the criteria of revoking these actions and in IAEA GSR Part 7.

Criterion	Criterion value [mSv]	Maximum distance [m] from the centre of:	
		one reactor	three reactors*
Accidents without core melt			
Evacuation			
B1 (RPI_EWA)	100	0	0
B2 (GSR_EWA)	100	452	712

Criterion	Criterion value [mSv]	Maximum distance [m] from the centre of:	
		one reactor	three reactors*
Sheltering			
B3 (RPI_SCH)	10	0	0
Thyroid iodine prophylaxis			
B4 (RPI_JOD) 1)	100	676	936
B5 (GSR_JOD)	50	7053	7313
Severe accident with core melt			
Evacuation			
B6 (AC_RPI_EWA)	100	308	568
B7 (AC_GSR_EWA)	100	1153	1413
Sheltering			
B8 (AC_RPI_SCH)	10	3902	4162
Thyroid iodine prophylaxis			
B9 (AC_RPI_JOD) 1)	100	1153	1413
B10 (AC_GSR_JOD) 2)	50	11710	11970
Temporary relocation			
B11 (AC_RPI_CPRZ)	30	1396	1656
Permanent relocation			
B12.1 (AC_RPI_SPRZ_1) 3)	1000	370	630
B12.2 (AC_RPI_SPRZ_2) 4)	10	180	440
Long-term restrictions on the consumption of contaminated food			
B13.1 (AC_RPI_ZYW_1) 5)	Depends on the nuclide and the food or water	2951	3211
B13.2 (AC_RPI_ZYW_2)5)	Depends on the type of feed and the species of animals	8838	9098
B14 (AC_GSR_ZYW) 7)	10	8597	8857

** Geometric centre point for three NPP reactor buildings*

1) The value of this criterion is provided in [mGy]
2) This criterion is more restrictive than the analogous criterion determined in the Polish regulation on intervention levels [419], but thyroid iodine prophylaxis does not result in applying any restrictions to using real estate
3) Lifetime dose
4) 30-day dose 24 months after the accident
5) Activity concentrations of various radionuclides in food and potable water for humans
6) Activity concentrations of the Cs-134 and Cs-137 isotopes in animal feed
7) Effective dose from the consumption of contaminated food and potable water within the first year following an accident, or the total equivalent dose to the foetus.
The abbreviations used and the related criteria for the calculations are explained in chapter [Chapter IV.17.1.2.2] above.
Source: In-house study based on [11]

Summary of the results of the calculations and analyses provided in the above table [Table IV.17-25].

Thanks to the technical solutions applied, and primarily to the safety systems used, even in the event of the occurrence of a bounding design basis accident and an extremely unlikely severe accident, the necessary intervention actions would be limited to the close surroundings of the NPP, except the zones for administration of preparations with stabilised iodine determined according to criteria B5 and B10 taken from IAEA GSR Part 7 [349]:

1. In the event of the occurrence of an accident without core melt that is bounding in terms of the radiological impact (LB LOCA): as the detailed analyses of the distribution of towns in the vicinity of the NPP suggest – there would be no need to move the residents (evacuation, temporary or permanent relocation) or even no need for sheltering, and the intervention actions would be restricted to thyroid iodine prophylaxis within a distance of around 7.3km from the NPP.
2. In the event of the occurrence of a severe accident with core melt considered in design extension conditions that would also be representative for emergency planning purposes:
    a. the distance in which the residents would have to be evacuated would be around 1.4 km from the NPP, while the distance in which the residents would have to be temporarily relocated would be approximately 1.65km from the NPP; it should be emphasised that according to the data as at 30 September 2021 [507], [508] there are no permanent residents in the area in question;
    b. sheltering: up to around 4.2km from the NPP;
    c. thyroid iodine prophylaxis: up to around 12km from the NPP;
    d. there would be no need for permanent relocation of the residents, because there are no residents within 630m from the reactor [507], [508];
    e. long-term restrictions on the consumption of contaminated food would be needed at a distance of up to around 8.9km from the NPP, while the restrictions pertaining to feeding animals would extend to 9.1km.

The results of the calculations and analyses conducted regarding the NPP radiological impact (Variant 1 – Lubiatowo - Kopalino Site) on the environment in accident conditions, which are presented in the tables above [Table IV.17-24] and [Table IV.17-25], generally confirm that the safety criteria recommended by WENRA for the new generation NPPs [509] are met, with the exception of thyroid iodine prophylaxis in the event of a bounding accident without core melt, determined assuming the intervention level specified in IAEA GSR Part 7 [349], which criterion is stricter than the level specified in the current provisions of the Polish Regulation on the intervention level values for particular intervention actions and on the criteria of revoking these actions [419]. Adoption of the criterion laid down in the abovementioned IAEA regulation results in a maximum spatial range of thyroid iodine prophylaxis of around 7.3km, while applying the criterion laid down in the current Polish Regulation on intervention level results in a spatial range of such an intervention activity of slightly less than 950m (which means that in practice, iodine prophylaxis would not be necessary).

It should be stressed that all the WENRA recommendations related to restricting the spatial range of the most acute intervention actions related to moving people (evacuation, temporary relocation, permanent relocation) are met.

The figure below [Figure IV.17-2] presents maximum extents of intervention action zones in the event of a series core melt accident, representative for emergency planning, taking into account three nuclear units.

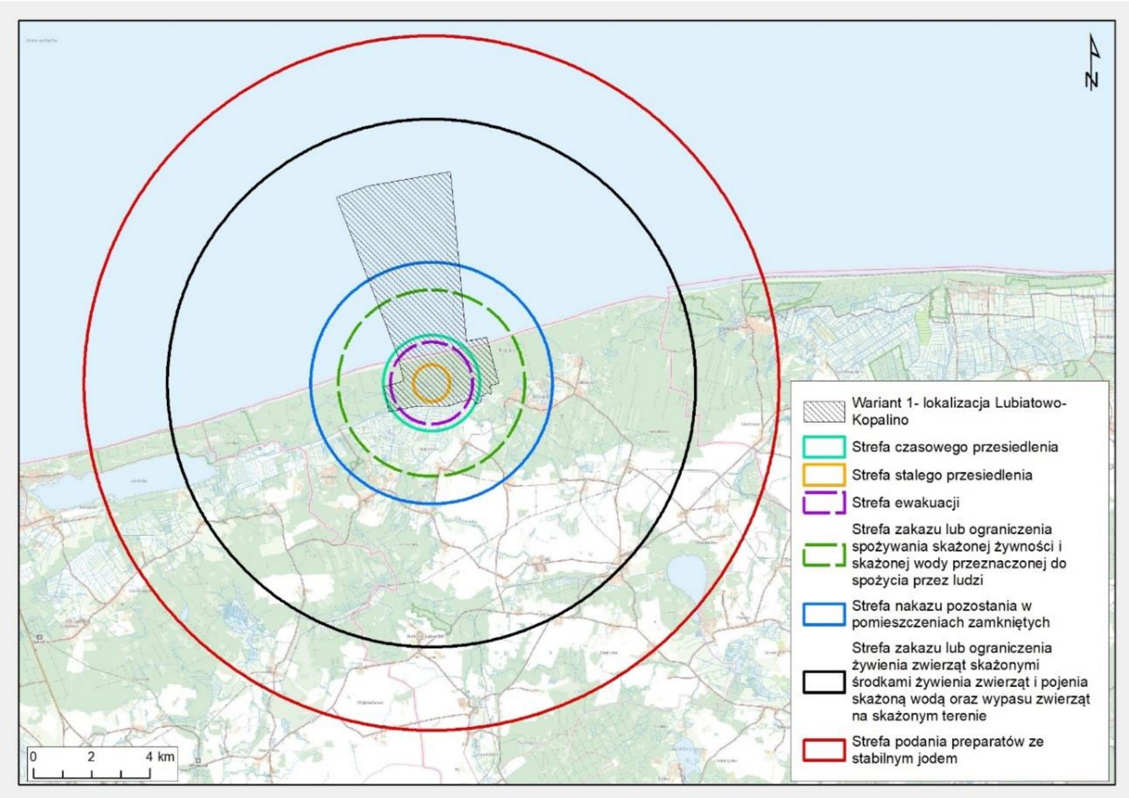


Figure IV.17-2 Maximum ranges of intervention action zones in the event of a series core melt accident, representative for emergency planning for individual types of such actions, taking into account three nuclear units. Variant 1 – Lubiatowo - Kopalino site

Source: In-house study

Polish	English
Variant 1 – lokalizacja Lubiatowo - Kopalino	Variant 1 Lubiatowo - Kopalino site
Strefa czasowego przesiedlenia	Temporary relocation zone
Strefa stałego przesiedlenia	Permanent relocation zone
Strefa ewakuacji	Evacuation zone
Strefa zakazu lub organiczenia spożywania skażonej żywności i skażonej wody przeznaczonej do spożycia przez ludzi	The zone of prohibition of or restriction on consumption of contaminated food and contaminated water intended for human consumption
Strefa nakazu pozostania w pomieszczeniach zamkniętych	Sheltering zone
Strefa zakazu lub ograniczenia żywienia zwierząt skażonymi środkami żywienia zwierząt i pojenia skażoną wodą oraz wypasu zwierząt na skażonym terenie	Zone of prohibition of or restriction on feeding animals with contaminated animal feed and watering them with contaminated water, as well as grazing animals in the contaminated area
Strefa podania preparatów ze stabilnym jodem	Zone of administration of preparations with stabilised iodine

It should be emphasised that the thyroid iodine prophylaxis does not entail any restrictions whatsoever to using real estate in the zone of administration of preparations with stabilised iodine.

IV.17.1.2.3.2 Variant 2 – Żarnowiec site

The table below [Table IV.17-26] presents the results of calculations and analyses of the doses, the extent of the restricted use area (RUA) and emergency planning zones and distances, carried out for Variant 2 of the NPP site - Żarnowiec, in accordance with the criteria laid down in the Atomic Law Act [499], and in the IAEA GSR Part 7 [349], taking into account the draft of the technical recommendations of the PAA President [533]. In turn, the table [Table IV.17-27] presents the results of the calculations of the range of individual types of intervention actions, in accordance with the criteria laid down in the Regulation of the Council of Ministers on the intervention level values for particular intervention actions and on the criteria of revoking these actions [419] and in IAEA GSR Part 7 [349].

The two tables provide results of the calculations both for a single reactor and the entire NPP, taking into account the planned arrangement of the reactor buildings on the NPP site. In this case, 1,203m was added to the distances determined for the single reactor (situated in the centre of the specific reactor building). The above is due to the assumption that the analysis concerns an accident of only one reactor, any of the three reactors installed in the NPP.

Table IV.17-26 Collation of the results of calculations of the extent of the restricted use area (RUA) and emergency planning zones and distances for Variant 2 - Żarnowiec site, in accordance with the criteria laid down in the Atomic Law Act, as well as in IAEA GSR Part 7, taking into account the draft of the technical recommendations of the PAA President.

Criterion	**Criterion value [mSv]**	**Maximum distance [m] from the centre of:**	
		one reactor	**three reactors***
Restricted use area (RUA)			
A1.1 (RUA2_1) – with food dose, 100% quantile of meteorological conditions	10	4095	5298
A1.2 (RUA2_2) – with food dose, 95% quantile of meteorological conditions	10	3158	4361
A1.3 (RUA2_3) – without food dose, 100% quantile of meteorological conditions	10	175	1378
A1.4 (RUA2_4) – without food dose, 95% quantile of meteorological conditions	10	0	0
The determined maximum size of the RUA		**4095**	**5298**
Internal emergency planning zone (IEPZ)			
IEPZ_1 - bone marrow	1000	0	0
A2.1 (IEPZ_1 – skin)	10000	0	0
IEPZ_2 - bone marrow	2000	0	0
IEPZ_2 - LA>90 isotopes	200	0	0
A2.2 (IEPZ_2 – thyroid)	2000	3247	4450
IEPZ_2 - lungs	30000	0	0
The determined maximum size of the IEPZ		**3247**	**4450**
External emergency planning zone (EEPZ)			
A3.1 (EEPZ_1 – 7-day effective dose)	100	2234	3437
A3.2 (EEPZ_2 – 7-day equivalent dose to the thyroid)	50	13123	14326
The determined maximum size of the EEPZ		**13123**	**14326**
Extended planning distance (EPD)			
A4 (EPD – annual effective dose)	100	3247	4450
Ingestion and commodities planning distance (ICPD)			
A5 (ICPD – annual dose from the ingestion of contaminated food and water)	10	9126	10329

** Geometric centre point for three NPP reactor buildings*
The acronyms/abbreviations used and the related criteria for the calculations are explained in chapter [Chapter IV.17.1.2.2] above.
Source: In-house study based on [12]

<u>Summary of the results of the calculations and analyses provided in the above table [Table IV.17-26].</u>

Thanks to the technical solutions applied, and primarily to the safety systems used, even in the event of the occurrence of a bounding design basis accident and an extremely unlikely severe accident, the significant radiological impact would be restricted to the close surroundings of the NPP:

1. In the event of the occurrence of an accident without core melt that is bounding in terms of the radiological impact (LB LOCA):
   a. Assuming the most conservative criterion, i.e. an annual effective dose (including exposure due to ingestion) ≥10mSv, and taking into account the most unfavourable meteorological condition (100% quantile), the maximum extent of the RUA calculated for the Żarnowiec site is 5,298m;

b. In turn, excluding the dose resulting from exposure due to ingestion results in a spatial range of the RUA that is so small (1,378m) that it would be restricted mostly to the boundaries of the NPP site, even taking into consideration the most unfavourable meteorological conditions (100% quantile). The additional adoption of 95% quantile of meteorological conditions results in a range of the RUA equal to zero.

Details regarding the RUA are specified in chapter [Chapter V.6] of this EIA Report.

2. In the event of the occurrence of a severe accident with core melt considered in design extension conditions that would also be representative for emergency planning purposes:

   a. the maximum range of the internal emergency planning zone (IEPZ): around 4.5km;

   b. the maximum range of the external emergency planning zone (EEPZ): around 14.3km;

   c. the maximum range of the extended planning distance (EPD): around 4.5km;

   d. the maximum range of the ingestion and commodities planning distance (ICPD): around 10.3km.

Table IV.17-27 Collation of the results of calculations of the range of individual intervention activities for Variant 2 - Żarnowiec site, in accordance with the criteria laid down in the Regulation on intervention levels [419] and in IAEA GSR Part 7 [349].

Criterion	Criterion value [mSv]	Maximum distance [m] from the centre of:	
		one reactor	three reactors*
Accidents without core melt			
Evacuation			
B1 (RPI_EWA)	100	0	0
B2 (GSR_EWA)	100	905	2108
Sheltering			
B3 (RPI_SCH)	10	173	1376
Thyroid iodine prophylaxis			
B4 (RPI_JOD) 1)	100	1054	2257
B5 (GSR_JOD)	50	5480	6683
Severe accident with core melt			
Evacuation			
B6 (AC_RPI_EWA)	100	198	1401
B7 (AC_GSR_EWA)	100	2234	3437
Sheltering			
B8 (AC_RPI_SCH)	10	1488	2691
Thyroid iodine prophylaxis			
B9 (AC_RPI_JOD) 1)	100	2401	3604
B10 (AC_GSR_JOD) 2)	50	13122	14325
Temporary relocation			
B11 (AC_RPI_CPRZ)	30	632	1835
Permanent relocation			
B12.1 (AC_RPI_SPRZ_1) 3)	1000	750	1953
B12.2 (AC_RPI_SPRZ_2) 4)	10	0	0
Long-term restrictions on the consumption of contaminated food (more than a year from the accident)			
B13.1 (AC_RPI_ZYW_1) 5)	Depends on the nuclide and the food or water	5384	6587
B13.2 (AC_RPI_ZYW_2) 6)	Depends on the type of feed and the species of animals	16546	17749
B14 (AC_GSR_ZYW) 7)	10	9700	10903

** Geometric centre point for three NPP reactor buildings*
1) The value of this criterion is provided in [mGy]
2) This criterion is more restrictive than the analogous criterion determined in the Polish regulation on intervention levels [419], but thyroid iodine prophylaxis does not result in applying any restrictions to using real estate
3) Lifetime dose
4) 30-day dose 24 months after the accident
5) Activity concentrations of various radionuclides in food and potable water for humans
6) Activity concentrations of the Cs-134 and Cs-137 isotopes in animal feed
7) Effective dose from the consumption of contaminated food and potable water within the first year following an accident, or the total equivalent dose to the foetus.
The abbreviations used and the related criteria for the calculations are explained in chapter [Chapter IV.17.1.2.2] above.
Source: In-house study based on [12]

Summary of the results of the calculations and analyses provided in the above table [Table IV.17-27].

Thanks to the technical solutions applied, and primarily to the safety systems used, even in the event of the occurrence of a bounding design basis accident and an extremely unlikely severe accident, the necessary intervention actions would be limited to the close surroundings of the NPP, except the zones for administration of preparations with stabilised iodine determined according to criteria B5 and B10 taken from IAEA GSR Part 7 [349]:

1) In the event of the occurrence of an accident without core melt that is bounding in terms of the radiological impact (LB LOCA): as the detailed analyses of the distribution of towns in the vicinity of the NPP suggests – there would be no need to move the residents (evacuation, temporary or permanent relocation) or even need for sheltering, and the intervention activities would be restricted to thyroid iodine prophylaxis within a distance of around 6.7km from the NPP.
2) In the event of the occurrence of a severe accident with core melt considered in design extension conditions that would also be representative for emergency planning purposes:
    a. the range of evacuation of population would be around 3.4km from the NPP, while the maximum range of temporary relocation of population would be around 1.8km from the NPP;
    b. sheltering: up to around 2.7km from the NPP;
    c. thyroid iodine prophylaxis: up to around 14.3km from the NPP;
    d. the maximum range of permanent relocation of population would be 1.95km from the NPP;
    e. long-term restrictions on the consumption of contaminated food would be needed at a distance of up to around 10.9km from the NPP, while the restrictions pertaining to feeding animals would extend to 17.7km.

The results of the calculations and analyses conducted regarding the NPP radiological impact (Variant 2 – Żarnowiec site) on the environment in accident conditions, which are presented in the tables above [Table IV.17- 26] and [Table IV.17-27], generally confirm that the safety criteria recommended by WENRA for the new generation NPPs [509] are met, with the exception of thyroid iodine prophylaxis in the event of a bounding accident without core melt, determined assuming the intervention level specified in IAEA GSR Part 7 [349], which criterion is stricter than the level specified in the current provisions of the Polish Regulation on the intervention level values for particular intervention actions and on the criteria of revoking these actions [419]. Adoption of the criterion laid down in the abovementioned IAEA regulation results in a maximum spatial range of thyroid iodine prophylaxis of around 6.7km, while applying the criterion laid down in the current Polish Regulation on intervention level results in a spatial range of such an intervention activity of around 2.3km.

It should be stressed that all the WENRA recommendations related to restricting the spatial range of the most acute intervention actions related to moving people (evacuation, temporary relocation, permanent relocation) are met.

The figure below [Figure IV.17-3] presents maximum extents of intervention action zones in the event of a series core melt accident, representative for emergency planning, taking into account three nuclear units.

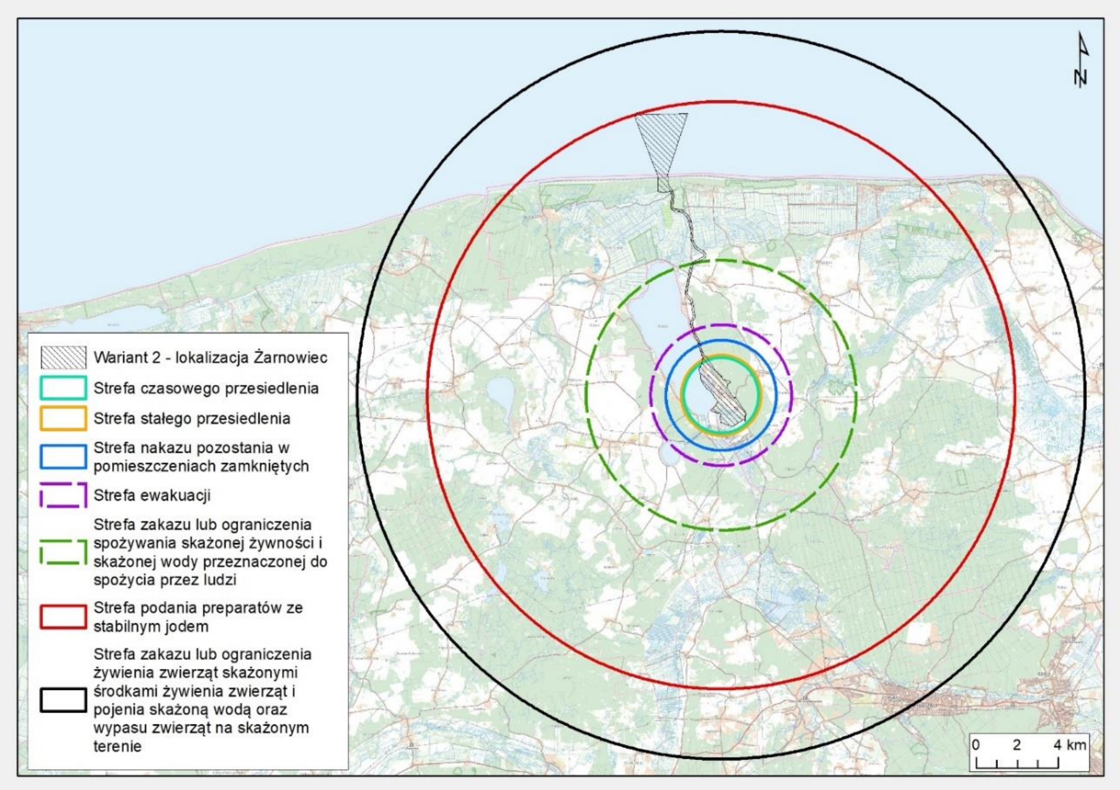


Figure IV.17-3 Maximum ranges of intervention action zones in the event of a series core melt accident, representative for emergency planning for individual types of such actions, taking into account three nuclear units. Variant 2 – Żarnowiec site

Source: In-house study

Polish	English
Variant 2 – lokalizacja Żarnowiec	Variant 1 Żarnowiec site
Strefa czasowego przesiedlenia	Temporary relocation zone
Strefa stałego przesiedlenia	Permanent relocation zone
Strefa nakazu pozostania w pomieszczeniach zamkniętych	Sheltering zone
Strefa ewakuacji	Evacuation zone
Strefa zakazu lub organiczenia spożywania skażonej żywności i skażonej wody przeznaczonej do spożycia przez ludzi	The zone of prohibition of or restriction on consumption of contaminated food and contaminated water intended for human consumption
Strefa podania preparatów ze stabilnym jodem	Zone of administration of preparations with stabilised iodine
Strefa zakazu lub ograniczenia żywienia zwierząt skażonymi środkami żywienia zwierząt i pojenia skażoną wodą oraz wypasu zwierząt na skażonym terenie	Zone of prohibition of or restriction on feeding animals with contaminated animal feed and watering them with contaminated water, as well as grazing animals in the contaminated area

It should be emphasised that the thyroid iodine prophylaxis does not entail any restrictions whatsoever to using real estate in the zone of administration of preparations with stabilised iodine.

IV.17.1.2.4 Results of calculations and analyses of radiological impacts in the areas situated further than 30km from the NPP

The analysis of the radiological impacts at a distance of more than 30km from the NPP was carried out for the purposes of the assessment of the effects of an accident that is representative for emergency planning. These impacts may be divided into domestic impacts (described in the present chapter) and impacts on neighbouring countries and certain other potentially exposed countries (known as transboundary impacts, described separately in chapter [Chapter V.4]) of this EIA Report.

The basic aim of making the calculations of dose rates at a distance of more than 30km from the nuclear power plant in the event of the occurrence of an accident that is representative for emergency planning is to assess the level of hazard for the Polish public in areas distant from the NPP (i.e. for cities - capitals of voivodeships and locations situated at the boundaries of each voivodeship).

The following calculation scheme was adopted for the analysis carried out (the detailed methodology for the calculations is presented in chapter [Chapter V.1.18] of this EIA Report):

- For each of the receptors (i.e. the boundaries of the voivodeships and the largest cities in Poland), an analysis of meteorological data was carried out by designating the trajectory in order to select meteorological sequences that would result in the contaminated cloud moving to the receptor under discussion in the shortest time possible.
- On the basis of an analysis of the trajectories carried out in such a way, sets of meteorological data for long-range calculations with the use of the MATCH model, which is one of the modules of the RODOS system, were prepared.
- Simulation calculations of the transport and dispersion of radioactive substances in the environment were made with the use of the MATCH model, with the assumption of data on emergency releases representative for emergency planning for the AP1000 reactor technology, for the NPP in both site variants considered.
- The results of the MATCH model simulations were then used in calculations of the doses resulting from the ingestion pathway, made with the use of the FDMT model of the RODOS system, so that the estimation of the doses considers all exposure pathways (i.e. also the ingestion pathway).

Detailed results of the calculations are included in appendices [Appendix IV.17-1 and Appendix IV.17-2], regarding the MATCH and FDMT models, respectively. The discussion of the additional assumptions that have been adopted may be found in chapter [Chapter V.4] on the transboundary impact.

The results show that even for the receptors located at a closest distance to the planned NPP, irrespective of the site variant, the projected maximum doses from all exposure pathways are at a low level - e.g. the lifetime effective doses for adults and children are much lower than 1 mSv. Thus, the doses are even lower than the annual limits for planned exposure situations (i.e. the operational states of the nuclear power plant) defined for members of the public in: IAEA GSR Part 3 [357], Directive 2013/59/EURATOM [90], and in the Atomic Law Act [499].

The main conclusion drawn from the calculations is that an accident representative for emergency planning will pose no hazard for human health in areas located far from the site (irrespective of the site variant considered).

IV.17.1.2.4.1 MATCH model results

The main results that can be obtained from the MATCH model are dose rates and estimations of doses from external exposure. The doses are designated for the end of exposure. In turn, the doses from all exposure pathways in different periods are designated with the use of the FDMT model (see below). When analysing the results of the calculations for both NPP site Variants [300]: Variant 1 - Lubiatowo - Kopalino site, and Variant 2 - Żarnowiec site, one may draw the following conclusions with regard to exposure in the analysed receptors:

- The maximum dose rates range from 1.29E-4 mSv/h for the Zachodniopomorskie voivodeship up to 6.1E-07 mSv/h for the Podkarpackie voivodeship. One should add that the Pomorskie voivodeship was not considered as both site variants are located within it.
- The maximum doses from external exposure resulting from accident range from 7.8E-04 mSv for the Zachodniopomorskie voivodeship to 5.4E-06 mSv for the Podkarpackie voivodeship. At the same time, values similar to those for the Zachodniopomorskie voivodeship were also observed for the following voivodeships: Kujawsko-Pomorskie, Warmińsko-Mazurskie, and Wielkopolskie. In turn, values similar to those for the Podkarpackie voivodeship occur in the following voivodeships: Lubelskie, Małopolskie, Opolskie and Świętokrzyskie (in the range of E-06 mSv). Generally, the maximum doses are lower than any dose limits or limits associated with the introduction of countermeasures following a nuclear accident.

It is also worth adding that the average annual dose rate from natural background radiation in Poland is around 2.4 mSv/year (i.e. about 0.3 µSv/h), which means that for the Zachodniopomorskie voivodeship the received dose as a result of nuclear accident would constitute 0.03% of the average annual background radiation dose.

In the case of cities, the results are as follows:

- The maximum observed dose rates were the highest in Gdynia (6.35E-05mSv/h) and similar in Gdańsk, Toruń, and Bydgoszcz, and the lowest in Rzeszów (4.2E-07 mSv/h) and slightly higher in Lublin.
- The maximum doses from external exposure are the highest in Gdynia (6.87E-04 mSv) and slightly lower in Gdańsk, Bydgoszcz, and Toruń. The values are the lowest for Wrocław (4.1E-06 mSv), Rzeszów (4.5E-06 mSv), and Lublin (5.1E-06 mSv).

The figures below [Figure IV.17-4] and [Figure IV.17-5] show the bounding points for voivodeships, in which the maximum dose rates and doses for releases from both potential NPP Site Variants occurred. The geographical coordinates of these bounding points represented by the centres of the calculation grid meshes and the values of dose rates and doses are presented in the appendix [Appendix IV.17-1] to this chapter, with release dates, which allows for the identification of a specific meteorological scenario.

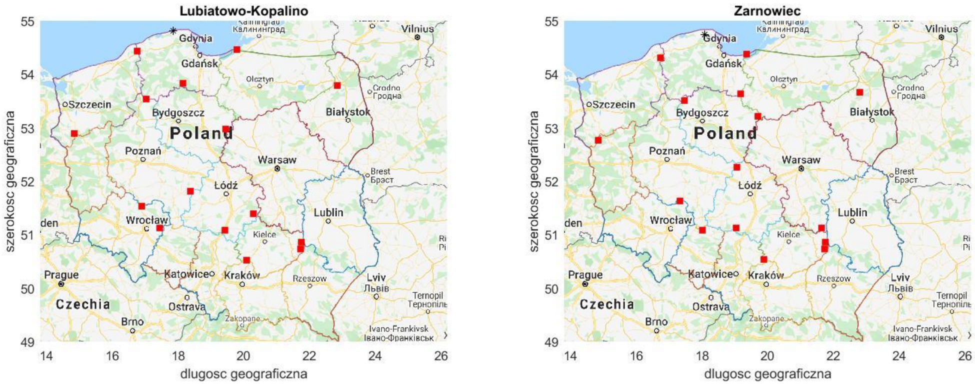


Figure IV.17-4 Points of occurrence of the maximum dose rates for emergency radioactive releases from the NPP (for voivodeships) Variant 1 - Lubiatowo - Kopalino site (left) and Variant 2 – Żarnowiec site (right)

Source: [300]

Polish	English
szerokość geograficzna	latitude
długość geograficzna	longitude

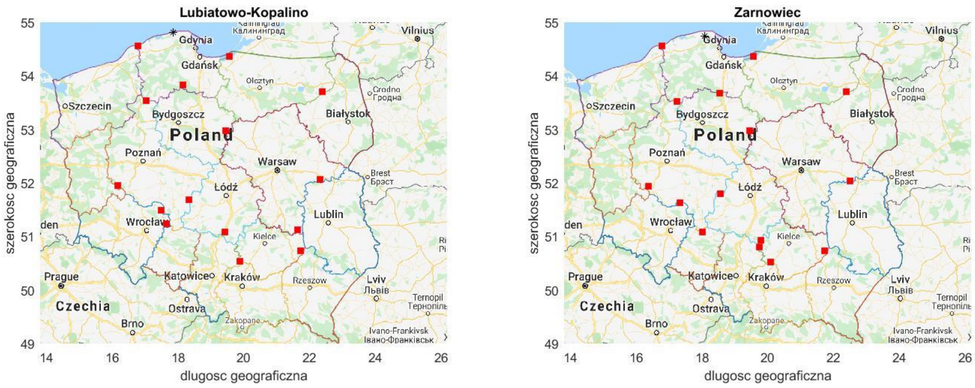


Figure IV.17-5 Points of occurrence of the maximum doses for emergency radioactive releases from the NPP (for voivodeships). Variant 1 - Lubiatowo - Kopalino site (left) and Variant 2 – Żarnowiec site (right)

Source: [300]

Polish	English
szerokość geograficzna	latitude
długość geograficzna	longitude

IV.17.1.2.4.2 FDMT model results

The doses from all exposure pathways were estimated with the help of the FDMT model for various periods, and for both adults and children. In the case of thyroid, the standard is to determine the equivalent doses. Since the regulations refer to absorbed doses, the effective doses were converted to absorbed doses with the use of the conversion coefficients included in the ICRP-116 publication “Conversion Coefficients for Radiological Protection Quantities for External Radiation Exposures” (Annexes A and B with due consideration of the corrected data in Corrigenda for Publication ICRP 116) [200].

Thus, the following doses were determined:

- effective dose: 2-day, 7-day, annual, and lifetime,
- thyroid absorbed dose: 2-day, 7-day, annual, and lifetime.

The results are presented in [Appendix IV.17-2] to this EIA Report – additionally, 14-day and monthly doses were also determined.

The effective doses for adults were first determined, and the values for extreme scenarios were as follows (for voivodeships, with the exception of the Pomorskie voivodeship):

- the maximum 2-day doses would occur in the Wielkopolskie voivodeship (9.79E-03 mSv), the doses are slightly lower for the Zachodniopomorskie voivodeship and the Kujawsko-Pomorskie voivodeship, and in the same range for the Warmińsko-Mazurskie, Lubuskie, and Dolnośląskie voivodeships, with the doses being the lowest for the Podkarpackie voivodeship (9.35E-05 mSv);
- the maximum 7-day doses occurred in the Wielkopolskie voivodeship (2.22E-02 mSv), slightly smaller in the Kujawsko-Pomorskie and Zachodniopomorskie voivodeships, and the lowest in the Podkarpackie voivodeship 1.74E-04 mSv;
- the maximum annual doses occur in the Zachodniopomorskie voivodeship (8.94E-02 mSv) and Kujawsko-Pomorskie voivodeship (8.06E-02 mSv), slightly lower for the Wielkopolskie, Warmińsko-Mazurskie voivodeship, Lubuskie, Mazowieckie, and Dolnośląskie voivodeships. The lowest values occurred in the Podkarpackie voivodeship (1.97E-05 mSv);
- the maximum lifetime doses were observed in the Zachodniopomorskie (3.59E-01 mSv) and Kujawsko-Pomorskie (2.0E-01 mSv), Wielkopolskie, and Warmińsko-Mazurskie voivodeships, while the lowest values were observed in the Podlaskie (9.13E-03 mSv), and Podkarpackie (9.54E-03 mSv) voivodeships.

In the case of effective doses for children:

- the maximum 2-day doses would occur in the Wielkopolskie voivodeship (5.42E-02 mSv), the doses are slightly lower in the Zachodniopomorskie, Kujawsko-Pomorskie, and Lubuskie, and the lowest for the Podkarpackie voivodeship (2.17E-04 mSv);
- the maximum 7-day doses are similar - the doses are in the 1.03E-01 mSv to 3.93E-04 mSv range;
- the maximum annual doses occur in the Wielkopolskie voivodeship (1.86E-01 mSv), they are slightly lower for the Kujawsko-Pomorskie, Zachodniopomorskie, and Lubelskie voivdeships. The lowest values occurred in the Podkarpackie voivodeship (3.16E-03 mSv);
- the maximum lifetime doses were observed in the Zachodniopomorskie (4.46E-01 mSv), Kujawsko-Pomorskie, Wielkopolskie, and Lubuskie voivodeships, while the lowest were observed in the Podlaskie (1.14E-02 mSv), and Podkarpackie (1.19E-02 mSv) voivodeships.

For thyroid absorbed doses for adults, the results are as follows:

- the maximum 2-day doses occur in the Wielkopolskie (1.1E-02 mGy), Kujawsko-Pomorskie, Zachodniopomorskie, Lubuskie, and Dolnośląskie voivodeships, and the lowest occur in the Podkarpackie voivodeship (1.05E-04 mGy);
- the maximum 7-day doses are similar - the doses are in the 2.49E-02 mGy to 1.95E-04 mGy range;

- the maximum annual doses occur in the Zachodniopomorskie voivodeship (1.0E-01 mGy), while the lowest values were observed in the Podlaskie (2.0E-03 mGy) and Podkarpackie (2.21E-03 mGy) voivodeships;
- the maximum lifetime doses were observed in the Zachodniopomorskie (4.02E-01 mGy), slightly lower in the Kujawsko-Pomorskie, Wielkopolskie, Warmińsko-Mazurskie, Lubuskie, Mazowieckie, and Dolnośląskie voivodeships, while the lowest were observed in the Podlaskie (1.02E-02mGy) and Podkarpackie (1.07E-02 mGy).

For thyroid absorbed doses for children, the results are as follows:

- the maximum 2-day doses occur in the Wielkopolskie (6,56E-02 mGy), Kujawsko-Pomorskie, Zachodniopomorskie, Lubuskie, while the lowest occur in the Podkarpackie voivodeship (2.63E-04 mGy);
- the maximum 7-day doses are similar - the doses are in the 1.25E-01 mGy to 4.76E-04 mGy range;
- the maximum annual doses occur in the Wielkopolskie voivodeship (2.25E-01 mGy), they are slightly lower for the Kujawsko-Pomorskie, and Lubuskie voivdeships. The lowest values occurred in the Podkarpackie (3.82E-03) and Podlaskie (3.92E-03 mGy) voivodeships;
- the maximum lifetime doses were observed in the Zachodniopomorskie (5.4E-01 mGy), Kujawsko-Pomorskie (3.75E-01 mGy), Wielkopolskie, and Lubuskie voivodeships, while the lowest values were observed in the Podkarpackie (1.38E-02 mGy) and Podlaskie (1.44E-02 mGy) voivodeships.

To sum up, one may state that the doses generally differ by two orders of magnitude. The largest doses, occurring in the voivodeships that border with the two sites: Kujawsko-Pomorskie, Wielkopolskie, and Zachodniopomorskie, differ only slightly and none of them are a basis for introducing remedial measures in the event of a severe accident. The lifetime effective doses for all exposure pathways are significantly below 1 mSv for adults and for children.

In turn, the following effective doses for adults were obtained for city-receptors:

- the maximum 2-day doses occur in Gdynia (2.06E-02 mSv) and in Gdańsk (1.02E-02 mSv), while the lowest occur in Lublin (3.46E-05 mSv) and in Rzeszów (3.54 E-05 mSv);
- by the same token, the maximum 7-day doses occur in Gdynia (3.1E-02 mSv) and in Gdańsk (1.61E-02 mSv), and the lowest occur in Lublin (3.69E-05 mSv) and in Rzeszów (5.99E-05 mSv);
- the maximum annual doses occur in Gdynia (2.06E-01 mSv) and in Gdańsk (1.13E-01 mSv), while the lowest occur in Lublin (6.42E-04 mSv) and in Rzeszów (6.59E-04 mSv);
- the maximum lifetime doses were observed in Gdynia (7.41E-01 mSv) and in Gdańsk (4.32E-01 mSv), while the lowest were observed in Lublin (2.02E-03 mSv) and in Rzeszów (2.43E-03 mSv).

As can be seen, the maximum doses in Gdynia and in Gdańsk are higher than in other cities, while doses lower by one order of magnitude may occur in Bydgoszcz, Toruń, and in Poznań.

In the case of all the other doses for cities, the situation is similar - hence, only the maximum doses for Gdynia and Gdańsk will be provided - and thus, in terms of effective doses for children:

- the maximum 2-day doses are: 3.08E-02 mSv in Gdynia and 1.75E-02mSv in Gdańsk;
- the maximum 7-day doses are: 5.28E-02 mSv in Gdynia and 3.05E-02 mSv in Gdańsk;
- the maximum annual doses are: 3.09E-01 mSv in Gdynia and 1.77E-01 mSv in Gdańsk;
- the maximum lifetime doses are: 9.06E-01 mSv in Gdynia and 5.35E-01 mSv in Gdańsk.

For thyroid absorbed doses for adults, the results are as follows:

- the maximum 2-day doses are: 2.31E-02 mGy in Gdynia and 1.14E-02 mGy in Gdańsk;
- the maximum 7-day doses are: 3.48E-02 mGy in Gdynia and 1.8E-02 mGy in Gdańsk;

- the maximum annual doses are: 2.31E-01 mGy in Gdynia and 1.27E-01 mGy in Gdańsk;
- the maximum lifetime doses are: 8.3E-01 mGy in Gdynia and 4.84E-01 mGy in Gdańsk.

For thyroid absorbed doses for children, the results are as follows:

- the maximum 2-day doses are: 3.73E-02 mGy in Gdynia and 2.12E-02 mGy in Gdańsk;
- the maximum 7-day doses are: 6.39E-02 mGy in Gdynia and 3.69E-02 mGy in Gdańsk;
- the maximum annual doses are: 3.74E-01 mGy in Gdynia and 2.14E-01 mGy in Gdańsk;
- the maximum lifetime doses are: 1.1E+0 mGy in Gdynia and 6.47E-01 mGy in Gdańsk.

To sum up, one may conclude that the maximum doses from all considered receptors were obtained in Gdynia and in Gdańsk - these are quantities that reach 1 mSv for lifetime effective doses for children and adults, while the maximum thyroid absorbed dose is around 1 mGy; thus, the doses are much lower than for the intervention levels. It should also be noted that in remote receptors, the doses may be similar to doses at locations close to the NPP, but this pertains to 2-day and 7-day doses (which are smaller than the lifetime doses by at least one order of magnitude). This is connected to a meteorological situation in which the cloud is quickly transported in the atmosphere, reaching a remote receptor within several hours. However, annual doses, and even more so, lifetime doses at remote receptors are much lower than the doses at receptors closer to the NPP. On the one hand, this is associated with the fact that, ultimately, at larger distances, the dispersion of the cloud covers an increasingly larger area, and, on the other hand, with the fact that when a cloud quickly reaches the receptor, it usually also passes over it quickly.

IV.17.1.2.5 The legal requirements related to the development of internal and external contingency plans and procedures as well as early notification of neighbouring countries in case of an accident

The contingency plans for radiological emergencies in nuclear facilities, and especially NPPs, in Poland are subject to a range of legal regulations based on international conventions (Convention on Early Notification of a nuclear Accident [255], Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency [254]), IAEA guidelines (especially those included in GSR Part 7 [349]), the 2013/59/EURATOM Directive [90], and the practice in countries that have long been involved in the development of nuclear power.

In the amendment to the Atomic Law Act [816] adopted in 2019, new regulations were introduced pertaining to the radiological emergency planning and response, largely based on the new IAEA guidelines[823], which took into consideration the conclusions drawn from the accident at the Japanese Fukushima Dai-ichi NPP.

In particular, the provisions of the amended Atomic Law [499] define in particular:

- contingency plans (Art. 82): internal - for the facility, and external - voivodeship and regional (also covering events with transboundary effects); and specified the persons responsible for their development and implementation (art. 84 items 1, 1a, 1d, and 1e);
- values of reference levels for effective doses in the event of a radiological emergency for: the emergency response personnel (art. 20 items 3 and 4), and members of the general public (art. 83e item 3);
- emergency planning zones - internal and external (art. 86l), and emergency planning distances - the extended emergency planning distance and the ingestion and commodities planning distance (art. 86n); also specifying the criterion of an accident that needs to be assumed for the purpose of emergency planning (art. 86m, art. 86n item 4), i.e. an accident with a probability of occurrence equal to or greater than once per 10^7 years.

Depending on range of the effects of the radiological emergency, the person in charge of the actions aimed at containing the hazard and dealing with its effects is the head of the unit (plant event), the voivode in cooperation with the voivodeship state sanitary inspector (voivodeship event), or the Minister of Interior and Administration with the support of the PAA President (national event). In all cases, the PAA President, through the Radiation Emergency Centre (CEZAR) that they manage, serves a consultative role, also with regard to the assessment of dose and containment level, as well as other expert opinions and actions at the site of the event, formulation of information for the communities exposed as a result of the event, and providing information to international organisations and to countries in which significant effects of a radiological emergency may occur (24-hour National Information Point). Art. 84d of the Atomic Law act [499] describes the procedures on the notification of countries in which significant effects of a radiological emergency may occur.

It should be emphasized that the aforementioned emergency response plans must be developed and implemented at the time of filing an application with the PAA President for issuing the nuclear power plant commissioning license.

Two new regulations were issued on the basis of the amended Atomic Law Act [499]:

1) Regulation of the Council of Ministers of 30 November 2020 on intervention activities carried out in the external zone and the operational values of intervention levels [422],
2) Regulation of the Council of Ministers of 25 May 2021 on contingency plans [418].

Regulation [422] sets out the types of intervention activities, including immediate intervention activities, carried out in the external emergency planning zone and the reference values of operational intervention levels that serve as the basis for introducing these activities in the external emergency planning zone. In turn, Regulation [418] specifies the detailed contents of the plant, voivodeship, and national contingency plans.

Moreover, the following previously issued Regulations related to radiological emergency planning and response are still in force:

1) Regulation of the Council of Ministers of 27 April 2004 on the intervention level values for particular intervention actions and on the criteria for revoking such actions [419.
2) Regulation of the Council of Ministers of 27 April 2004 on specifying the entities competent for performing inspections of food and animal feed following a radiological emergency in terms of the compliance with the maximum allowed levels of radioactive contamination [420],
3) Regulation of the Council of Ministers of 27 April 2004 on prior information for the general public in the event of a radiological emergency [421].

The Regulation [419] defines the values of the intervention levels for the individual types of intervention activities, i.e.:

- evacuation;
- sheltering;
- administration of preparations with stabilised iodine;
- ban on or restriction of:
- the consumption of contaminated food and contaminated water intended for human consumption,
- feeding animals with contaminated animal feed and watering them with contaminated water, as well as grazing animals in the contaminated area;
- temporary relocation;
- permanent relocation.

The Regulation [420] specifies the entities competent for:

- inspections of food and animal feed following a radiological emergency in terms of the compliance with the maximum allowed levels of radioactive contamination;

- issuing decisions on non-admittance into trading or on the ban on exports to countries that are not Member States of the European Union of food and animal feed whose radioactive contamination exceeds the permissible maximum levels of radioactive contamination;
- informing the European Commission about every instance in which the maximum allowed levels of radioactive contamination of food and animal feed are exceeded.

The Regulation [420] specifies:

- population groups that receive advanced notice;
- the entities competent for developing and providing prior information;
- the scope of the prior information, and the manner and the frequency with which it is provided;
- types of activities that may, in the event of a radiological emergency, lead to the exposure of population to a dose of ionising radiation in excess of the dose limit.

IV.17.1.3 Decommissioning phase

Prior to decommissioning, the reactor is placed in a cold shutdown state [Chapter II.6.1], and as part of the first stage of decommissioning works, all nuclear fuel is unloaded from the reactor and transferred to a spent fuel pool (cf. [Chapter II.7]). During this phase, the nuclear reactor remains permanently shut down. Therefore, there is no possibility of a major nuclear accident as described above in chapter [Chapter IV.17.1.2.3].

According to international nuclear safety standards (modified to take into account the experience of the Fukushima accident) [425], NPP design solutions must practically exclude the possibility of nuclear fuel degradation outside the containment. In the case of AP1000 reactor the applied technical measures are described in chapter [Chapter II.3.3.5.2.2].

Thus, during the decommissioning phase, only radiation events related to nuclear fuel handling accidents, intermediate and low-level radioactive waste management, decontamination and dismantling of NPP facilities, systems, and equipment containing radioactive substances could potentially occur.

However, potential effects and impact range of such radiological incidents would be significantly lower than that of major accidents described in chapter [Chapter IV.17.1.2.3]. Apart from the fuel handling accidents they would be limited to the NPP site. From safety analyses of the AP1000 reactor [18] it can be concluded, in particular that radiation effects of fuel handling accidents are lower than the results of an accident related to the loss of large quantity of reactor coolant (LB LOCA).

IV.17.2 Summary

This chapter presents and discusses the results of the analysis of the radiological impact of the NPP in accident conditions carried out for both site variants by the National Centre for Nuclear Research [11] [12] at the Investor's behest. In particular, the maximum ranges of intervention action zones in the event of a serious core melt accident, representative for emergency planning for individual types of such actions have been designated. Thanks to the technical solutions applied, and primarily to the safety systems used, even in the event of the occurrence of a bounding design basis accident and an extremely unlikely severe accident, the necessary intervention actions would be limited to the close vicinity of the NPP, except the zones for administration of preparations with stabilised iodine and restricted zones for consumption of contaminated food and restrictions in animal feeding. Outside this area, which in extreme cases could extend to several kilometres from the NPP, the radiological impact of the NPP in the event of a severe accident with melting of the reactor core would be insignificant.

IV.19 Cumulative impacts

IV.19.1 Methodology for the assessment of cumulative impacts

According to the European Commission's "Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions" [149], three types of the impacts can be distinguished that cause the accumulation of adverse effects in the environment:

- Indirect impacts – environmental impacts which are not a direct result of the implementation or operation of a project, often occurring at a considerable distance from the source. A direct impact on one element of the environment may have an indirect effect on another element of the environment.

Przesięwzięcie	Project
Interakcja	Interaction
Oddziaływanie A	Impact A
Oddziaływanie B	Impact B
Oddziaływanie C	Impact C

- Cumulative impacts – intensification of changes in the environment caused by the "stacking" of impacts of the same type from the project with impacts from other investments, including those active in the past and planned.

Przesięwzięcie	Project
Interakcja	Interaction
Oddziaływanie A	Impact A
Oddziaływanie B	Impact B
Oddziaływanie C	Impact C

- Interactions of impacts – reactions between different types of the impacts coming from the same or different investments, leading to the emergence of a new type of adverse impacts on the environment.

Przesięwzięcie	Project
Interakcja	Interaction
Oddziaływanie A	Impact A
Oddziaływanie B	Impact B
Oddziaływanie C	Impact C

In accordance with the EIA Act [501], the EIA report should contain information on links with other projects, in particular the accumulation of impacts from existing, ongoing and/or planned projects for which decisions on environmental conditions (DEC) have been issued, located in the area where the project is planned to be implemented, and in the area of impacts of the Project or the impacts of which fall within the area of impact of the planned project – to the extent that their impacts can lead to the accumulation of the impacts with those of the planned project.

This chapter discusses specifically cumulative impacts and interactions. Indirect impacts (if they occurred) are described in particular in the chapters presenting the individual impacts ([Chapters IV.1 – IV.18]), however, they have also been analysed in this chapter, depending on the context of the description.

IV.19.1.1 Formal and legal aspects

Cumulative impact requirements have been addressed in:

- EU regulations (also implemented into Polish law), i.e. in Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/52/EU on the assessment of effects of certain public and private projects on the environment [84]. "Annex IV: Information" referred to in art. 5(1)(5)(e) of the aforementioned Directive (information contained in reports on environmental impacts of projects) provides that the impact assessment is required to contain *"A description of the likely significant impacts of the project on the environment resulting, among others, from the accumulation of effects with effects of other projects already implemented or approved, taking into account current environmental problems concerning areas of particular environmental importance likely to be affected by the implementation of the project, or taking into account the use of natural resources. [...] The description should take into account the environmental protection objectives relevant to the Project set at the Union or the Member State level*".
- EU Guidelines: Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions of 1999 [149], mentioned in the introduction to the methodology, which indicate the approach to be used in the analysis of cumulative impacts, as well as methods and tools for identifying these impacts.
- IAEA Guidelines: Managing Environmental Impact Assessment for Construction and Operation in New Nuclear Power Programmes [195], which assume that a description of other projects should be prepared and the combined impact resulting from the implementation of the NPP and these projects should be presented as part of analyses carried out for the purposes of environmental impact assessment. The guidelines also show that an analysis of cumulative impacts resulting from the future impact of the NPP on environmental elements that will be continuously affected by the NPP and other projects should be carried out.
- Act of 3 October 2008 on providing access to information about the environment and its protection, participation of the public in the environment protection and assessments of the environmental impact [501]. Art. 66(1)(3)(b) provides that the EIA Report should contain *"Information on links with other projects, in particular the accumulation of the impacts of projects <u>existing, ongoing or planned</u> for which a decision on environmental conditions has been issued, located in the area where the Project is planned to be implemented, and in the area of impact of the Project or the impacts of which fall within the area of impacts of the planned Project – in the extent to which their impacts can lead to an accumulation of the impacts with the planned Project"*.
- Decision of GDOŚ of 25 May 2016, ref. DOOŚ-OA.4205.2015.23 [348], which defines the scope of the Environmental Impact Report for the Project consisting in the construction and operation of the first Nuclear Power Plant in Poland with an electric power of up to 3,750 MWe in the area of the municipalities (communes) of Choczewo or Gniewino and Krokowa. Pursuant to point IV of this decision, the EIA Report should take into account *"A description of the expected cumulative impacts of the Project on the environment with other existing and planned investments and emission sources, in particular taking into account:*

  (a) associated investments;

  (b) transport and communication in the investment area;

  (c) electric power engineering infrastructure;

(d) the pumped-storage power plant in Żarnowiec;

(e) extraction of fossil raw materials (e.g. oil, natural gas, shale gas);

(f) activities undertaken in the marine area."

IV.19.1.2 Assumptions for the cumulative impact analysis

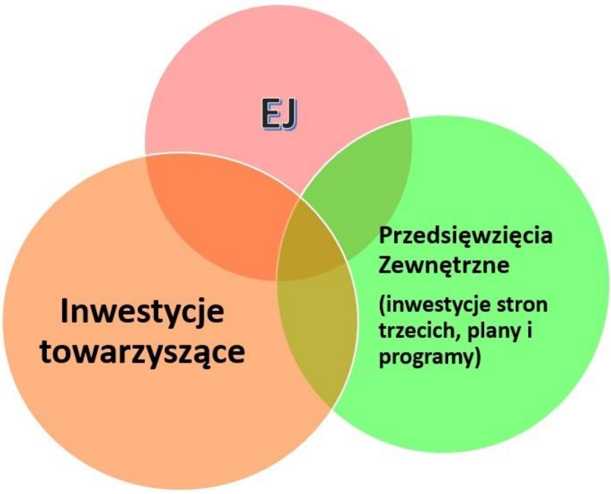
Taking into account the above-mentioned requirements of the laws of Poland [501] and the EU [84], the guidelines from the EU [149] and IAEA [195], provisions of the GDOŚ's decision [348] and good international practices, the following main assumptions for the analysis of cumulative impacts have been adopted:

- Cumulative impacts are impacts resulting from the incremental and synergistic effects of the impacts after the addition of the Project (implementation of the NPP) to other past, present and reasonably anticipated activities of individual entities and projects resulting in individually insignificant, but collectively significant, impacts on the natural, social or socio-economic environment, including health, at a given time and place, or in a given area.
- Cumulative impacts and, then, their effects result from actions taken (implementation of projects) which, by themselves, may not cause significant impacts but, in a collective perspective, the impacts caused by them through the effect of overlaying/adding/ strengthening can become significant, due to the time, area and types of impacts and the sensitivity of the environmental component.
- The analysis of the possibility of occurrence of cumulative impacts, as part of this EIA Report, has been carried out taking into account the possibility of occurrence of cumulative effects of the nature of impacts in the relationship between the environmental component (receptor) and the impacts (stressor). This impact is related to the implementation of a given stage/ phase of the Project, related projects (associated investments) and projects existing, ongoing and planned by third parties in the Project Area and in the area of the forecasted impacts from the planned Project, and their assessment focuses on the key, i.e. significant, impacts and elements of the environment sensitive to them.
- When analyzing cumulative impacts, the spatial and temporal extent of the impacts (depending on the impact factor) was taken into account, taking also into account their nature and the type of receptor and its sensitivity, which the cumulative effect will be able to impact;
- For the purposes of the assessment, the available information on the investment was taken into account, including, among others, location, type of activity, main emissions and the extent of impact, for:
  - third-party investments at the construction stage (under construction) and at the stage of operation (completed) for which a decision on environmental conditions has been issued or the procedure for issuing a DEC has been initiated (an ESR or EIA Report has been submitted – if during the proceedings the process entered the next stage of assessment);
  - associated infrastructure/investments carried out for the purposes of construction and operation of the NPP, for which, in accordance with the Act of 29 June 2011 on the development and execution of investments in a nuclear power facility and associated infrastructure/investments [498], DECs will be issued based on a separate procedure, and the implementation of which, due to the zones of impact and time convergence of the implementation with the scope of the main Project, will be associated with the possibility of a significant cumulative effect,
  - of the main Project in the construction and operational phases.
- In addition to regional and local impacts on land and sea, the cumulative impacts of the planned Project will be related to a broader aspect both in terms of area and time reflected in the Polish Nuclear Power Programme adopted by the Resolution of the Council of Ministers of 2 October 2020 [351] and in the Energy Policy of Poland until 2040 adopted by the Resolution of the Council of Ministers on 2 February 2021 [343]. Therefore, a general reference is made in this EIA Report to the cumulative impacts within

the scope of the implementations of the changes assumed in the above-mentioned documents, related to Poland's phase-out of fossil fuels consumption for the power industry needs (as described in Volume I). A more detailed discussion of this issue has been presented in the Strategic Environmental Impact Assessment for the draft Energy Policy of Poland until 2040 [442] and in the Environmental Impact Forecast for the Polish Nuclear Power Programme [350].

The cumulative analyses take into account potential regional and local impacts (if such impacts occurred for a given environmental component) regarding [Figure IV.19-1]:

1. cumulative impacts of the **planned Project resulting from the strategic documents** – plans and programmes;
2. cumulative impacts of the **planned Project with the associated infrastructure/investments** and with **third-party investments** (existing, ongoing and planned for which the DECs have been issued or are in the process of being obtained) – as the combined cumulative impacts, as shown on the map in the appendix [Appendix IV.19-2].



EJ	NPP
Przedsięwzięcia Zewnętrzne (inwestycje stron trzecich, plany i programy)	External projects (third-party investments, plans and programmes)
Inwestycje towarzyszące	Accompanying investments

Figure IV.19-1: Cumulative impacts diagram
Source: In-house study

The cumulation of impacts concerned impacts resulting from the works during development, construction and commissioning stages and the operational phase of the NPP (including both direct and indirect impacts related to the road and rail traffic, as well as local, regional and national impacts). The decommissioning phase has not been analysed in terms of cumulative impacts. If in a few decades it is necessary to decommission the NPP, it is assumed that most of the associated infrastructure will remain to serve the residents of the region.

The cumulation of impacts of the associated infrastructure/investments with impacts of third-party investments for which DECs have been or will be obtained has not been taken into account. These impacts will be analysed during the procedure for the obtainment of DECs for these investments.

Breakdown of cumulative impacts

The cumulative impact is based on the individual impacts of the Project and it has been defined, as in the case of the individual impacts, in a quantitative way (if it was possible to determine the exact result of cumulation, e.g. emissions) and in a qualitative way (when it was not possible to accurately calculate the cumulation). Depending on the environmental component, the cumulative impact has been divided in accordance with the following criteria:

Cumulation area:

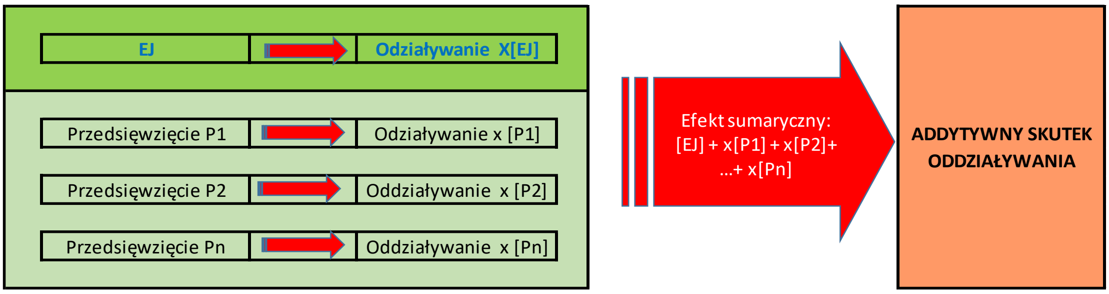
- Land area;
- Marine area;

Impact categories:

- Intra-Project impacts – resulting from one or more activities included in the planned Project, covering the NPP and the associated infrastructure/investments; and
- Inter-project impacts – arising in connection with the planned Project and one or more external investments that are in progress or that are planned and have obtained decisions on environmental conditions or are in the process of obtaining them.

The analysis has also taken into account the nature of the cumulative effects:

- additive (aggregate) – the effect of impacts is equal to the sum of the values of the individual impacts;

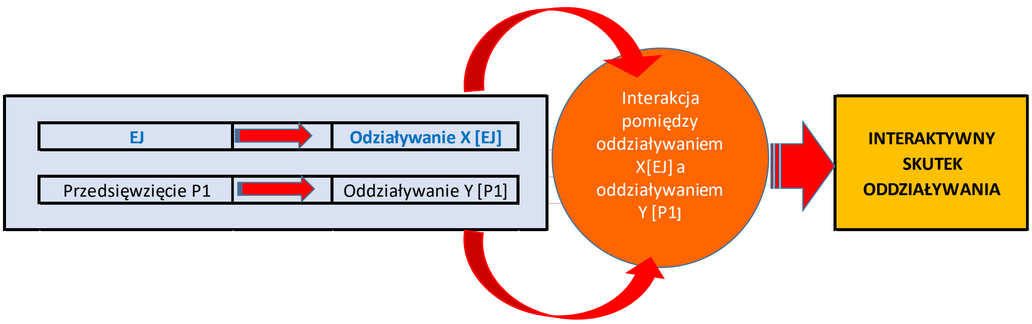


EJ	NPP
Odziaływanie X[EJ]	Impact X [NPP]
Przedsięwzięcie P1	Project P1
Przedsięwzięcie P2	Project P2
Przedsięwzięcie Pn	Project Pn
Odziaływanie x [P1]	Impact x [P1]
Oddziaływanie x [P2]	Impact x [P2]
Oddziaływanie x [Pn]	Impact x [Pn]
Efekt sumaryczny: [EJ] + x[P1] + x[P2]+ ...+ x[Pn]	Summary effect: [NPP] + x[P1] + x[P2]+ ...+ x[Pn]
ADDYTYWNY SKUTEK ODDZIAŁYWANIA	ADDITIVE EFFECT OF THE IMPACT

Figure IV.19-2: The additive effect of impacts

Source: In-house study

- interactive – the effects of impacts are caused by interactions between the impacts;



EJ	NPP
Odziaływanie X [EJ]	Impact X [NPP]
Przedsięwzięcie P1	Project P1
Oddziaływanie Y [P1]	Impact Y [P1]
Interakcja pomiędzy oddziaływaniem X [EJ] a oddziaływaniem Y [P1]	Interaction between X [NPP] and Y [P1]
INTERAKTYWNY SKUTEK ODDZIAŁYWANIA	INTERACTIVE IMPACT EFFECT

Figure IV.19-3: The interactive effect of impacts

Source: In-house study

IV.19.1.3 Impact resulting from strategic documents

In the case of potential cumulative impacts which result from the provisions presented in the strategic documents, it should first be pointed out that the spatial extent of impacts may concern the area of the entire country and the time range of the multi-year period described in these strategic documents and even the period after this multi-year period. According to the provisions presented in the Environmental Impact Forecast for the Polish Nuclear Power Programme [350], *"the probability the occurrence of cumulative impacts also applies to the implementation of the Polish Nuclear Power Programme together with the implementation of other strategic documents in the country. They include documents assuming the diversification of energy sources and the promotion of sources other than nuclear energy."* In addition, it should be stated that the diversification of energy sources is directly related to ensuring energy security which is one of the pillars of the Polish Nuclear Power Programme (hereinafter PNPP) [351]. The subject of the above-mentioned strategic documents has been discussed in Volume I.

Due to the fact that the analysed Project is a part of the PNPP, its implementation may cause impacts that may indirectly accumulate with investments provided for in other sectoral strategic documents including those concerning energy, water or climate change. If a cumulation of impacts occurred in connection with a given strategic document and the Project in relation to a given environmental component, this was described in the cumulative impact area for a given environmental component in a qualitative manner.

IV.19.1.4 Cumulative impacts of the planned Project with the associated investments and third-party investments

The analyses covered the impacts identified during the analyses related to the assessment of the impacts of the Project on individual components of the environment in relation to the potential impacts that can occur during the construction and operation of the associated investments, and investments of third parties. The map of the associated investments and third-party investments is presented in [Appendix IV.19-2].

The types, duration and extent of impacts resulting from the Project, the associated infrastructure/investments and the investments of third parties were taken into account in these analyses. Attention was also paid to the period of implementation of the individual investments in connection with the period of the implementation of the Project, as well as to their location in relation to the Project.

IV.19.1.4.1 Cumulative impacts with the associated investments

The analysis covered impacts within the construction and operational phases of the Project, identified during the assessments of impacts on the individual components of the environment (as presented in [Chapters IV.1 – IV.18]), in relation to potential impacts that can occur as part of the associated investments. The types, sizes and locations of the associated investments are described in detail in [Chapter II.12]. The territorial extent of the impacts from the individual associated investments and the initially assumed technical and process solutions and estimated emissions that can result from the construction works and processes during the operation of the individual associated investments were analysed from the point of view of the impacts of the Project with the associated investments.

Where the extents of impacts from the planned Project and the associated investments on a given component of the environment coincided, the possibility of cumulative impact was analysed. The analysis took account of impacts on components of the biotic and abiotic environments and on humans (socio-economic aspects). Additive effects and interactive effects were also taken into account.

IV.19.1.4.2 Cumulative impacts with third-party investments

The analysis included the impacts of the construction and operational phases of the Project, identified during the impact assessments, on individual components of the environment in relation to the potential impacts that can occur as part of the implementation of third-party investments. Pursuant to art. 66(1) of the Act of 3 October

2008 on providing access to information about the environment and its protection, participation of the public in the environment protection and assessments of the environmental impact [501], the analysis covered investments of third parties for which DECs have been issued and, additionally, those investments for which a procedure for obtaining a DECs is underway.

The third-party investments include:

- existing third-party investments for which DECs have been issued and are under construction or operation, and their potential impact extent falls within the area of the impacts of the NPP;
- investments for which DECs have been issued and are in the process of being implemented – it is assumed that they have obtained building permits or other permit that consummates the DEC;
- investments for which DEC issuance procedures have been initiated but the DECs has not yet been issued (their implementation has not yet begun).

As in the case of impacts cumulated with the associated infrastructure/investments, the following were also analysed here: the territorial extent of impacts from the individual third-party investments, the technical and process solutions, and emissions.

The process of obtaining information on third-party investments

Information on these investments was obtained for the purposes of this EIA Report from public administration bodies which, in accordance with art. 75 of the Act of 3 October 2008 on providing access to information about the environment and its protection, participation of the public in the environment protection and assessments of the environmental impact [501] are responsible for issuing DECs:

- head of communes/municipalities and city mayors;
- the Regional Director for Environmental Protection in Gdańsk;
- the Maritime Office in Gdynia.

The information was obtained for the area demarcated by the boundary of ASA (Administrative Site Area) and ASR (Administrative Site Region) – i.e. all the communes located within the Variant 1 - Lubiatowo - Kopalino site, and Variant 2 - Żarnowiec site [Table IV.19-1]. In addition, the boundaries of the analyses have been extended up to the boundaries of these communes, taking into account their entire areas (and not their parts up to the intersection of the boundaries of the Areas and Regions of both site variants), thus establishing the Administrative Areas and Regions shown in [Figure IV.19-4].

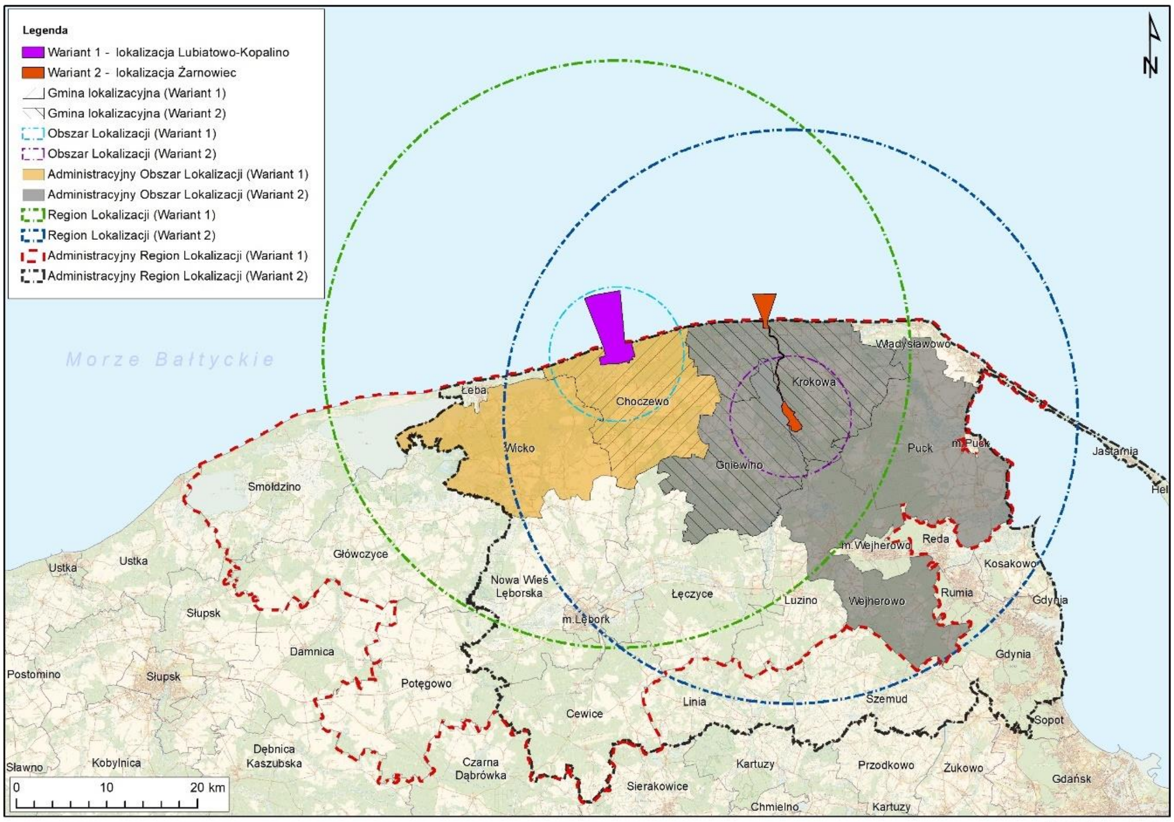
Table IV.19-1: The communes within the ASA and the ASR for which information about third-party investments has been obtained

No.	Variant 1 – Lubiatowo - Kopalino site	Area classification ASA/ASR	Variant 2 – Żarnowiec site	Area classification ASA/ASR
	Communes – ASA and ASR		Communes – ASA and ASR	
1	Lębork (u)	ASR	Lębork (u)	ASR
2	Łeba (u)	ASR	Łeba (u)	ASR
3	Cewice (r)	ASR	Cewice (r)	ASR
4	Nowa Wieś Lęborska (r)	ASR	Nowa Wieś Lęborska (r)	ASR
5	Wicko (r)	ASA	Wicko (r)	ASR
6	Władysławowo (u-r)	ASR	Władysławowo (u-r)	ASR
7	Krokowa (r)	ASR	**Krokowa (r) – NPP site com.**	**ASA**
8	Puck (r)	ASR	Puck (r)	ASA
9	Wejherowo (u)	ASR	Wejherowo (u)	ASR
10	**Choczewo (r) – NPP site com.**	**ASA**	Choczewo (r)	ASR
11	Gniewino (r)	ASR	**Gniewino (r) – NPP site com.**	**ASA**
12	Luzino (r)	ASR	Luzino (r)	ASR
13	Łęczyce (r)	ASR	Łęczyce (r)	ASR
14	Wejherowo (r)	ASR	Wejherowo (r)	ASA

No.	Variant 1 – Lubiatowo - Kopalino site	Area classification ASA/ASR	Variant 2 – Żarnowiec site	Area classification ASA/ASR
	Communes – ASA and ASR		Communes – ASA and ASR	
15	Główczyce (r)	ASR	Jastarnia (r)	ASR
16	Potęgowo (w)	ASR	Puck (u)	ASR
17	Smołdzino (r)	ASR	Kosakowo (r)	ASR
18			Reda (r)	ASR
19			Rumia (u)	ASR
20			Linia (r)	ASR
21			Szemud (r)	ASR
22			Gdynia (u)	ASR

ASA – Administrative Site Area; ASR – Administrative Site Region; com. – commune; u – urban commune; r – rural commune, u-r – urban-rural commune

Source: In-house study



Legenda	Legend
Wariant 1 - lokalizacja Lubiatowo - Kopalino	Variant 1 – Lubiatowo - Kopalino site
Wariant 2 - lokalizacja Żarnowiec	Variant 2 — Żarnowiec site
Gmina lokalizacyjna (Wariant 1)	Site commune (Variant 1)
Gmina lokalizacyjna (Wariant 2)	Site commune (Variant 2)
Obszar Lokalizacji (Wariant 1)	Site Area (Variant 1)
Obszar Lokalizacji (Wariant 2)	Site Area (Variant 2)
Administracyjny Obszar Lokalizacji (Wariant 1)	Administrative Site Area (Variant 1)
Administracyjny Obszar Lokalizacji (Wariant 2)	Administrative Site Area (Variant 2)
Region Lokalizacji (Wariant 1)	Site Region (Variant 1)
Region Lokalizacji (Wariant 2)	Site Region (Variant 2)
Administracyjny Region Lokalizacji (Wariant 1)	Administrative Site Region (Variant 1)
Administracyjny Region Lokalizacji (Wariant 2)	Administrative Site Region (Variant 2)

Figure IV.19-4: The communes within the ASR and ASA for which information on the third-party investments was obtained

Source: In-house study

The information on the third-party investments (existing, under construction and planned) for which DECs have been issued and investments for which the DEC issuance procedures have been initiated for Variant 1 and Variant 2 relate to the period from 1 January 2013 to 30 June 2020, i.e. to the day on which the first inquiry was sent to public administration bodies. At the time when the Investor applied for the above information, there was a COVID-19 pandemic and the state of epidemiological emergency was introduced in Poland. It considerably extended the period of obtaining information from offices, and the Investor received the last responses from the public administration bodies at the end of 2020. Then the Investor reapplied to the public administration bodies for the update of the aforesaid information. The responses were again much delayed due to the pandemic. As the above information was needed to perform analyses of cumulative impacts, and especially the modelling of impacts on atmospheric air, noise and water bodies, and given the fact that the conduct of such analyses required time, the information obtained earlier for the period from 1 January 2013 to 30 June 2020 was used.

Due to the anticipated longer period of the procedure regarding the issuance of the Decision on environmental conditions (DEC) and the fact that, when issuing the DEC, the public administration body should take into account the factual and legal status applicable as at the date of the decision issuance, during the procedure for the DEC issuance the Investor will gradually supplement the EIA Report with analyses and conclusions regarding the cumulative impact of the planned third party projects in the vicinity of the Project in Variant 1 – Lubiatowo - Kopalino site and Variant 1 – Żarnowiec site, for which the DECs were issued.

It should be highlighted that this timeframe has been determined based on the fact that on 1 January 2013 amendments to the Act of 3 October 2008 on providing access to information about the environment and its protection, participation of the public in the environment protection and assessments of the environmental impact [501] entered into force, setting the validity of the decision on environmental conditions for 10 years from the day on which the decision became final. It was assumed that information would be obtained about investments that were granted such decisions after the effective date of this amendment – art. 72(3), (4) and (4b) [501].

Thanks to this, all the decisions that were obtained have already been consummated or still can be consummated by investors. Information on about 500 investments was obtained for this time period for both location variants in the Administrative Site Regions of the Lubiatowo - Kopalino and Żarnowiec sites. Due to a large number of the investments, it was finally decided to present in this EIA Report information on third-party investments situated within the communes in which the analysed variants are located and within the communes where the associated infrastructure/investments exist or are ongoing (in the case of roads, the junction in Strzebielino connecting the planned road with the S6 route was considered to be the destination). The following communes were finally taken into account for the analysis: Choczewo, Krokowa, Gniewino, the town of Lębork, Wicko, the city of Wejherowo, Luzino, Łęczyce and Nowa Wieś Lęborska. Small-infrastructure investments the scope of which has or will have a local dimension, and the impacts from which are small and will not cumulate with the impacts of the Project have been rejected from the list of about 500 third-party investments disclosed by public administration bodies. The rejects included, among others, the construction/modification of sewers and the construction of buildings within a single locality.

Finally, the analysis of cumulative impacts for most environmental components covered 263 investments and the focus was placed on large infrastructural investments (mainly linear investments such as roads and railway lines), the renewable energy sector (wind and photovoltaic farms) and overhead transmission lines (110 and 400 kV). The list of the third-party investments in these communes is presented in tabular form in [Appendix IV.19-1]. The indicative locations of the individual third-party investments is presented in [Appendix IV.19-2]. Next, investments that could potentially interact with the construction and operation of the Nuclear Power Plant have been selected from the list of the a/m 263 investments, for each environmental component (biotic and abiotic). The cumulative analyses in terms of land development took account of a larger number of investments than that specified above because, in addition, external investments were also identified based on the applicable local land development plans. The list of land development investments for both location variants is presented in [Appendix IV.19-14 and Appendix IV.19-15].

The information on the third-party investments was related to the following sectors, among others:

- Agriculture (poultry farms, fish ponds, barns, fruit warehousing);
- Biogas-fired combined heat and power plant;
- Environmental protection (facilities near the Słowiński National Park) and small retention projects in forests);
- Housing;
- Industrial facilities;
- Infrastructural projects (mainly repairs and extensions of roads, upgrades of railway lines, expansion of public facilities, some projects regarding capacity of fuel storage facilities, tourist infrastructure);
- Mining (exploitation of aggregate deposits);
- Photovoltaics;
- Recreation;
- Wind farms;
- Waste collection and treatment;
- Water and wastewater management systems;
- Distribution of electricity.

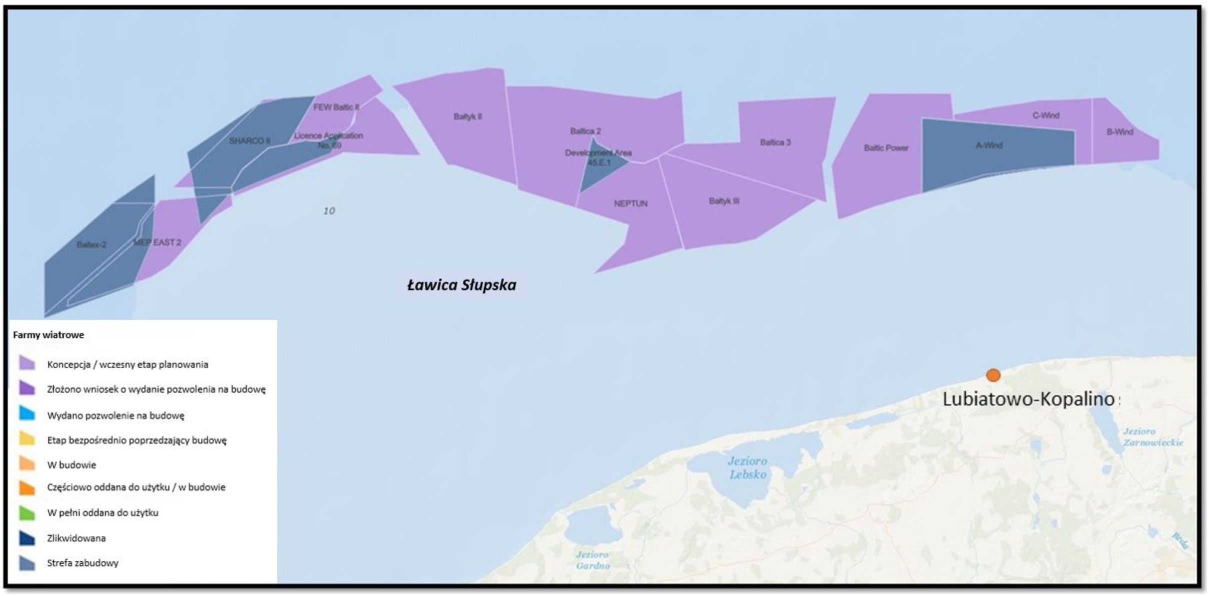
IV.19.1.4.3 Establishment of the zone of cumulative impacts in the marine area

In order to take into account the assessment of the cumulative effects with other investments, plans and programmes, a maximum geographic area around the Project and the associated infrastructure/investments has been delineated, where there is a possibility of the occurrence of impacts on the marine environment. Although the area of the zone of impact varies, depending on environmental focus, the maximum relevant offshore area of the zone of impact has been taken into account for the Project for the purposes of data collection. This area has been defined based on the results of the assessment and modelling (impacts) of the marine environment.

Variant 1 — Lubiatowo - Kopalino site

It has been determined that short-term (24-hour) deviations from the normal concentrations of suspended sediments caused by the dredging of the trenches for the inlet ducts for the open cooling system can extend up to approx. 40 km east of the site in the direction of Władysławowo. This defined the maximum search area for other plans and projects to be included in a long list of other undertakings requiring initial consideration.

In the course of the search for other investments to be included in the cumulative impact assessment it was not possible to find any large projects being implemented in the zone of impact, worth taking account of in the baseline state. There were also no investments scheduled to be completed before the start of the Project, which should be included as part of the future baseline state. However, the review of the spatial development plan for Polish maritime areas defined the areas of the concession blocks for offshore wind farms as “permissible tasks”, as shown in [Figure IV.19-5]. It covers certain projects outside the zone of impact but they have been included where they are considered to have pathways of potential cumulative effects. They are limited only to offshore wind farms which are to be located in the area of the Polish territorial waters, for which the exit points of power cables would be located along the shoreline between Władysławowo in the east and Ustka in the west.

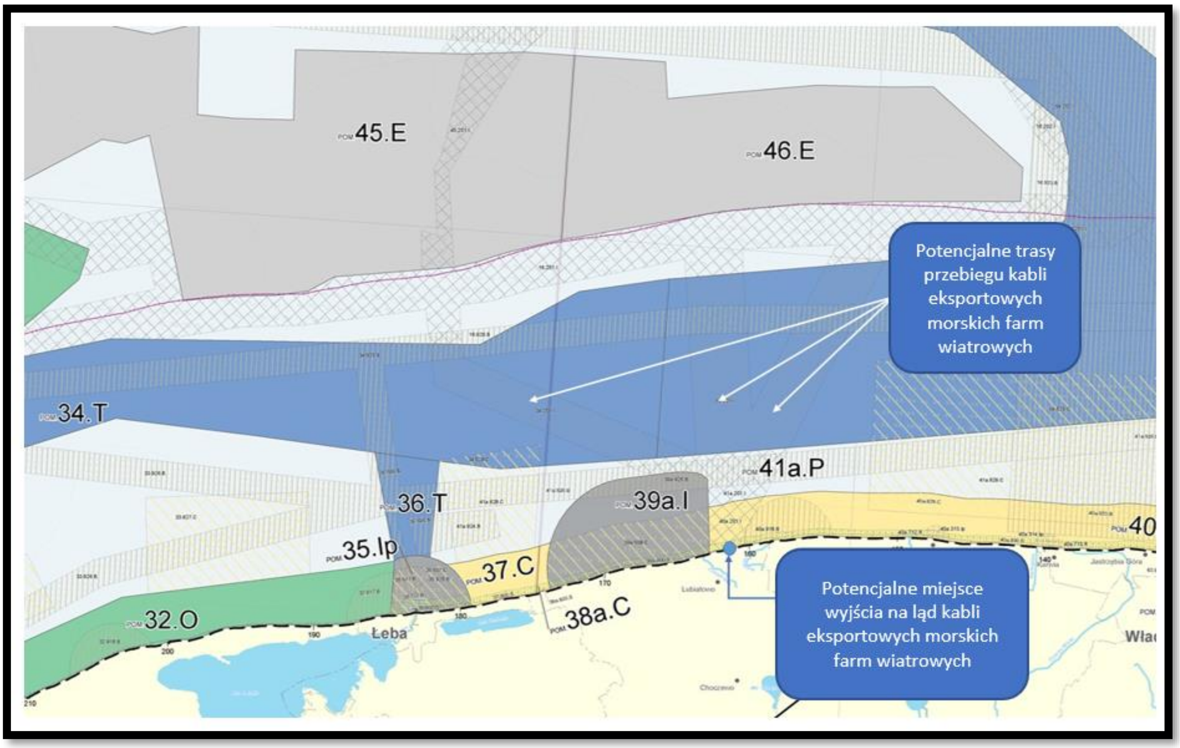


Farmy wiatrowe	Wind farms
Koncepcja / wczesny etap planowania	Concept / early planning stage
Złożono wniosek o wydanie pozwolenia na budowę	An application for a building permit has been submitted
Wydano pozwolenie na budowę	Building permit issued
Etap bezpośrednio poprzedzający budowę	Stage immediately preceding construction
W budowie	Under construction
Częściowo oddana do użytku / w budowie	Partially commissioned / under construction
W pełni oddana do użytku	Fully commissioned
Zlikwidowana	Decommissioned
Strefa zabudowy	Building zone
Ławica Słupska	Słupsk Bank

Figure IV.19-5: The locations of offshore wind farm projects

Source: [183]

As shown in [Figure IV.19-6], the spatial development plan for Polish maritime areas, Variant 1 - Lubiatowo - Kopalino site was defined as a protected location for “technical infrastructure” (area POM.39a.l). The plan shows also the points of exit from the sea and routes of electrical cables from the planned offshore wind farms (areas POM.45.E and POM.46.E).



Potencjalne trasy przebiegu kabli eksportowych morskich farm wiatrowych	Potential routes for offshore wind farm export cables
Potencjalne miejsce wyjścia na ląd kabli eksportowych morskich farm wiatrowych	Potential offshore wind farms export cables landfall

Figure IV.19-6: An excerpt from the spatial development plan for Polish maritime areas

Source: [456]

[Figure IV.19-7] shows a more extensive map of potential areas of land-bound exit points and routes of power cables from the planned offshore wind farms. Some of the cable routes landfall about 60 km west of the Project, near Ustka. The route of the Harmony Link 750 MW submarine power cable connecting Dębki (Poland) with Darbenai (Lithuania), running about 40 km east along the coast towards Władysławowo, is also shown.

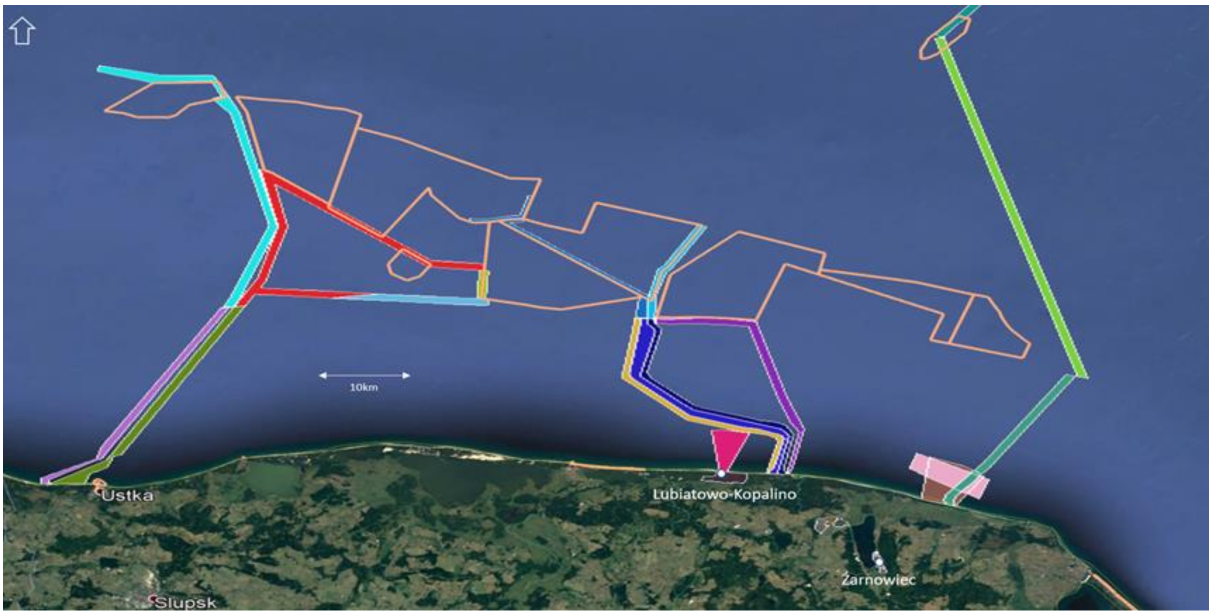


Figure IV.19-7: Permits issued for the laying and maintenance of cables or pipelines for locations within zones of impact designated for assessment purposes

Source: [456]

Variant 2 — Żarnowiec site

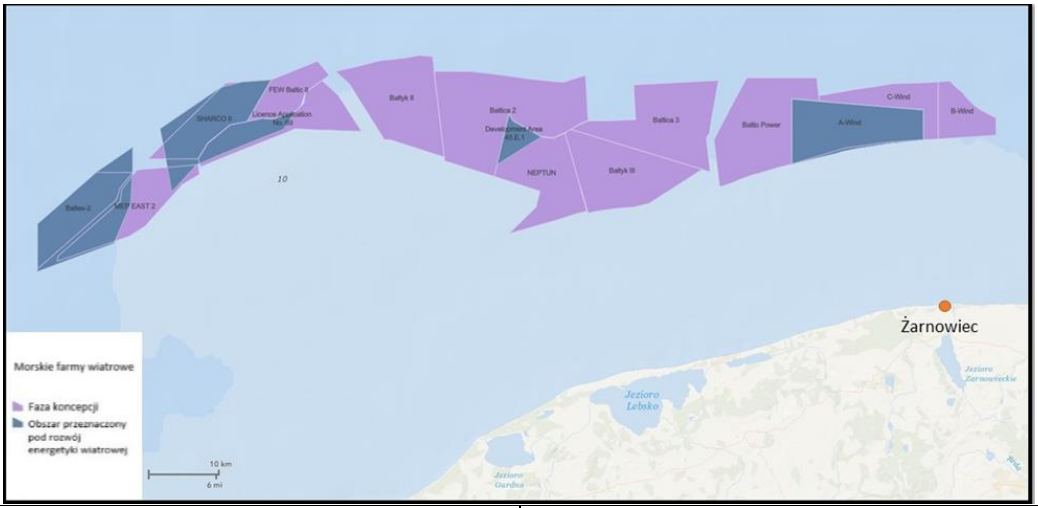
With regard to the possibility of occurrence of cumulative impacts on the environment, the relevant zones of impact are those related to the dispersion of suspended sediments occurring as a result of the dredging works and to underwater noise generated by the piling.

The modelling carried out to assess the potential effects of the dredging works concluded that, in the worst-case scenario, short-term (24-hour) deviations from the baseline concentrations of suspended sediments would occur during the dredging of the single trench for the intake and discharge pipelines and for the fish recovery and return system (FRRS), although the occurrence of values exceeding the environmental quality standards (EQS) for the priority substances and for certain other pollutants would be limited to the Project Area. However, in winter, short-term increases in total sediment suspension (TSS) concentrations close to the permitted EQS values can extend over an area of up to 10 km east of the site, towards Jastrzębia Góra. Areas where sediment plumes from another project carrying out similar work could overlap have been analysed.

Based on the modelling results for underwater noise, the maximum reasonably justified marine zones of impact have been taken into account, the extent of which for the temporary hearing threshold shift (TTS) is 20 km from each site of work related to the Project. This is the distance at which underwater noise levels would fall slightly below the permanent hearing threshold shift (PTS) and the TTS for the marine mammal species (especially porpoises) covered by the assessment. This means that if the piling carried out as part of another project coincides with the installation of the tubular piles for the MOLF and of the sheet pile walls, there can be an overlap of the impacts from pile works if the projects are less than 40 km apart from each other.

This has defined the maximum search area of 40 km for other plans and projects which should be included in the long list of projects to be considered.

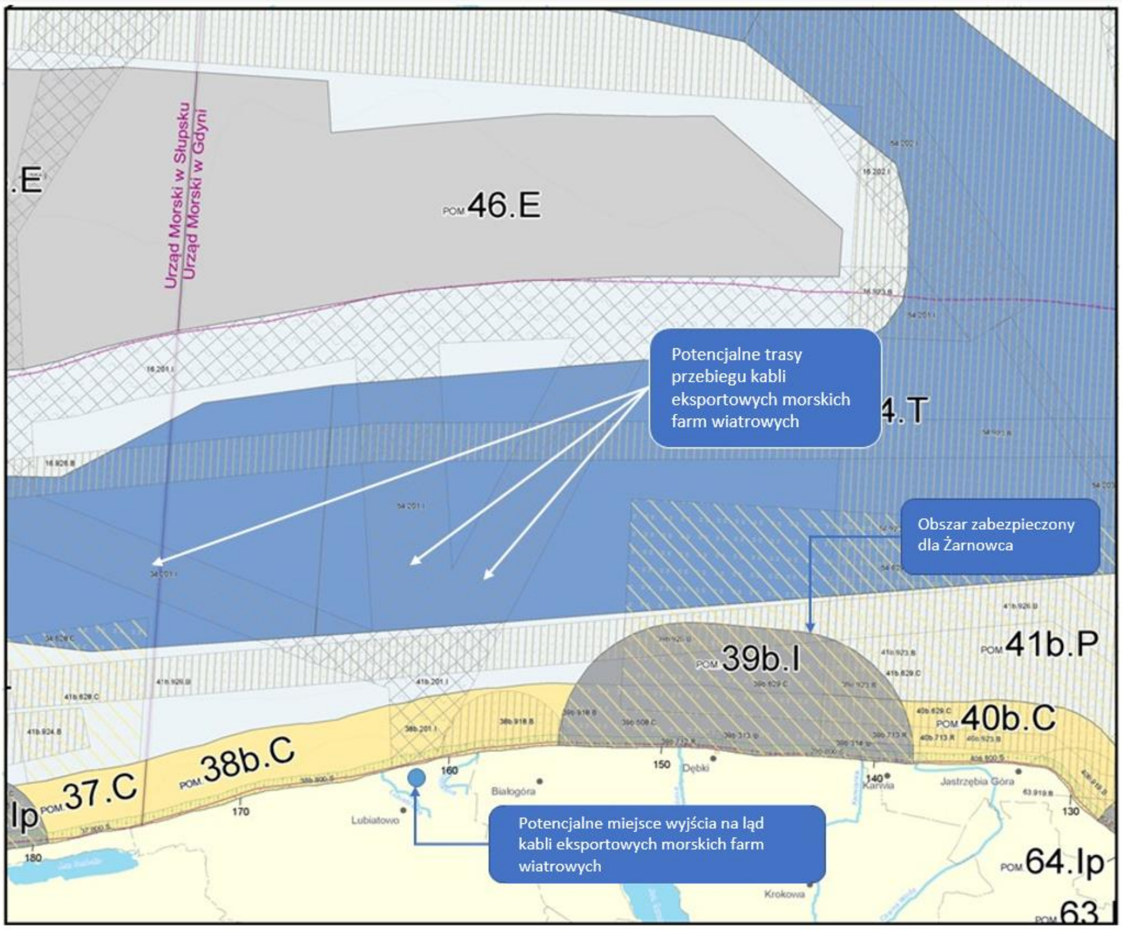
In the course of the search for projects to be included in the cumulative impact assessment it was not possible to find any major projects the zone of impact which should be treated as part of the baseline state. Nor have any projects been identified that would be completed before the start of the Project, which should be considered as part of the future baseline state. However, the review of the land development plan for Polish coastal areas has shown that the areas reserved for offshore wind farm concession blocks should be taken into account. This includes some projects located outside the zone of impact. However, they were taken into account when it had been recognised that they could have pathways of potential cumulative effects. However, they are limited to possible offshore wind farms located in the Polish territorial waters, where the exit points of the electric cables to land are located on the shoreline between Władysławowo in the east and Ustka in the west.



Morskie farmy wiatrowe	Offshore wind farms
Faza koncepcyjna	Conceptual phase
Obszar przeznaczony pod rozwój energetyki wiatrowej	Area dedicated to the development of wind energy

Figure IV.19-8: The locations of offshore wind farm project areas
Source: [183]

As shown in [Figure IV.19-9], the spatial development plan for Polish maritime areas, Variant 2 - Żarnowiec site was defined as a reserved location for “technical infrastructure” (area POM.39b.I). The potential area of the landfall points and the routes of electric export cables from the planned concession areas of offshore wind farms (POM.46.E area) are also shown.

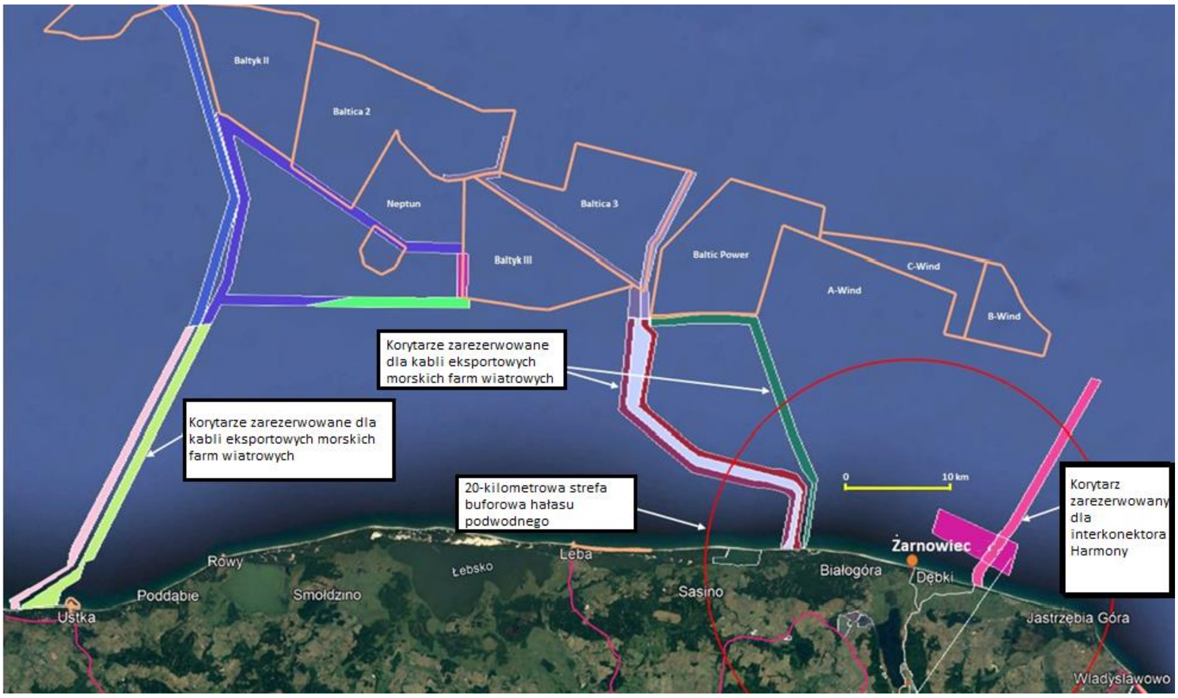


Urząd Morski w Słupsku	Maritime Office in Słupsk
Urząd Morski w Gdyni	Maritime Office in Gdynia
Potencjalne trasy przebiegu kabli eksportowych morskich farm wiatrowych	Potential routes for offshore wind farm export cables
Obszar zabezpieczony dla Żarnowca	Area secured for Żarnowiec
Potencjalne miejsce wyjścia na ląd kabli eksportowych morskich farm wiatrowych	Potential place of outlet of export cables of offshore wind farms

Figure IV.19-9: An excerpt from the spatial development plan for Polish maritime areas

Source: [456]

[Figure IV.19-10] shows a broader view of the potential routes and landfall areas for output cables from the planned offshore wind farm concession areas. Some of the routes of these cables landfall in Ustka, about 84 km west of the Project Area. The route of the Harmony Link 750 MW submarine power cable connecting Dębki (Poland) with Darbenai (Lithuania), running about 6 km east along the coast towards Jastrzębia Góra, is also shown.



Korytarze zarezerwowane dla kabli eksportowych morskich farm wiatrowych	Corridors reserved for offshore wind export cables
Korytarze zarezerwowane dla kabli eksportowych morskich farm wiatrowych	Corridors reserved for offshore wind export cables
Korytarz zarezerwowany dla interkonektora Harmony	Corridor reserved for Harmony interconnector
20-kilometrowa strefa buforowa hałasu podwodnego	20 km underwater noise buffer zone
Bałtyk II	Baltic II
Baltica 2	Baltica 2
Neptun	Neptun
Bałtyk III	Baltic III
Baltica 3	Baltica 3
Baltic Power	Baltic Power
A-Wind	A-Wind
C-Wind	C-Wind
B-Wind	B-Wind

Figure IV.19-10: Permits issued for the laying and maintenance of cables or pipelines for locations within the zones of impact designated for assessment purposes

Source: [456]

IV.19.2 Natural environment

IV.19.2.2 Marine area

Since the cumulative impacts in relation to the natural environment overlap to a large extent with the cumulative impacts described for seawaters in the qualitative sense, they should therefore be regarded as the same group of impacts. The above-mentioned impacts (regarding the natural environment and seawaters) differ only in specific fragments; however, it was decided to describe them comprehensively in order not to lose valuable information, and to maintain consistency and transparency of the assessment. Where impacts differed, the larger-magnitude impact was always given priority.

IV.19.2.2.1 Variant 1 — Lubiatowo - Kopalino site

Establishment of the zone of cumulative impacts

In order to take into account the assessment of effects cumulated with those of other projects, plans and programmes, an appropriate maximum geographic area has been designated around the main Project site and around the locations of the associated infrastructure/investments where there is a possibility of affecting the marine environment. This area has been designated as the zone of impact. The offshore projects, among others the locations of areas of projects related to offshore wind farms, and existing permits for laying and maintaining cables or pipelines, which have been analysed, are presented in chapter [Chapter IV.19.1.4.3] of the EIA Report, concerning the methodology of the cumulative assessment, where the procedure for the establishment of the zone of cumulative impact in the offshore area has been described.

Analysis of projects, plans and programmes

Each of the investments listed in [Table IV.19-4] presented in the EIA Report has been considered in terms of whether it can cause impacts that could produce effects cumulated with those of the Project. The result of this process is presented in the EIA Report. Where justified, the analysis takes into account the worst-case scenario.

The analysis presented in table [Table IV.19-4] in the EIA Report shows that the investment projects for the construction of offshore wind farms Baltica-2, Baltica-3 and Baltic Power has been included in the further assessment of the cumulative impacts for the Project. These investments have been considered because the potential land-bound exit of one power output cable is located near the Project-related offshore works sites. In addition, the available information shows that works related to the cable exit point may be carried out in parallel with the works under the Project. However, it is unlikely the works related to the offshore wind farm's cable exits will be carried out at the same time as the work related to the Project. The remainder of this assessment was therefore carried out on the assumption that the installation of only one of these cable landfall coincides with the offshore works at the site of the Project. Therefore, the table below [Table IV.19-5] presents the assessment of the potential cumulative impacts that may arise from the simultaneous construction of the Project and the installation of the single point of exit of the power cable from the offshore wind farm.

Table IV.19-5: The assessment of the impacts cumulated with marine environment components for Variant 1 of the Project (Lubiatowo - Kopalino site)

Project	Scope	Assessment
Location names: Baltica-2 and Baltica-3 **Responsible entity:** PGE Polska Grupa Energetyczna S.A., Ørsted A/S (formerly DONG Energy AS) **Power:** 1,045.5 MW **Number of turbines:** 80-105 **Location Name:** Baltic Power **Responsible entity:** PKN ORLEN SA, NP BALTIC WIND B.V. **Power:** 1,200 MW **Number of turbines:** 100 **Location name:** Bałtyk II and III **Responsible entity:** Equinor and Polenergia **Power:** 1,560 MW and 600 MW **Number of turbines:** Unknown **Location Name:** NEPTUN **Responsible entity:** OceanWinds SL. **Power:** Unknown **Number of turbines:** Unknown	The following assumptions have been made for the purposes of this assessment: The construction of only one offshore wind farm with the output power cable and the onshore exit point may overlap with the construction of the Project's offshore infrastructure in the years 2025-2029. The possibility of accumulation of underwater noise generated during the piling (in all locations), dredging, movement of vessels, installation of the submarine cable and its onshore exit point (if the cable and its onshore exit are adjacent to the Project). The submerged duct/pipeline and the sheet pile walls will be built at the Project site for the intake and discharge channels of the open cooling system. The potential landfall for the electrical export	**Elevated concentrations of suspended sediments:** The extent of the sediment plume associated with the dredging during the construction of the intake and discharge tunnels of the open cooling system at the Project site is about 40 km east along the seashore, towards Władysławowo, in the worst-case scenario. This sediment plume would represent the 24-hour mean during winter where suspended sediment concentrations are elevated above baseline levels in the range 5-25mg/l. The area of exceeding the 24-hour "acute" EQS value contained in the guidelines (25 mg/l) would be mostly limited to the area covered by the water-law permit for the Project. Potentially, this area would extend over approximately 13 km^2, which would represent 9.19% of the water bodies, as defined by the WFD, and 0.02% of the water bodies within the meaning of the MSFD, respectively, so the impacts are considered **insignificant**. The sediment plume will interact with the sediment rising as a result of the installation method in the open trench for the purpose of bringing the power cable ashore, provided that these operations coincide. However, the potential sediment plume from the landfall installation works is likely to cover a much smaller area, of less than 0.2km^2. This estimate is based on the methodology for carrying out construction works similar to that provided for variants of the closed cooling system (technical Sub-Variants 1B and 1C). This would be a negligible addition to the sediment plume coming from the NPP works area. It is therefore unlikely that the plumes will be able to merge and produce a significant effect. As a result, a significant increase in the concentrations of sediments suspended due to the construction of the offshore infrastructure for the Project is unlikely, whether alone or in combination with running the cable ashore, so the impacts are considered **insignificant**. **Deposition of sediments:** It has been shown that the highest possible column of the sediment deposition on the seabed is up to 25 mm in an area of 2.4 km^2 outside the immediate work area, which would represent respectively 1.7% of the water bodies as defined by the WFD and 0.003% of the water bodies within the meaning of the MSFD, so the impacts are considered **insignificant**. This value is much lower than the natural variability recorded at any single point in the marine survey area, which is 1-2 m. The area of the deposition of fine sediments, potentially affected by the installation of the cable at the point of its exit to land, assuming a similar methodology for carrying out construction works as in the case of closed intake and discharge systems, would be approximately 1.31 km^2, which would represent respectively 0,9% of the water bodies as defined by the WFD and 0.0001% of the

Project	Scope	Assessment
	cables would be located just to the east of Variant 1 - Lubiatowo - Kopalino site. The onshore exit cable will be laid in an open trench excavated on the beach. The excavation of the trench will involve the driving of sheet pile walls, as will be the case with the construction of the water intake and discharge of the NPP's closed cooling system. Both the NPP Project and the Baltica 2 and 3 as well as Baltic Power offshore wind farm projects would implement standard mitigation measures, including developing and implementing a Construction Environmental Management Plan (CEMP), and general pollution prevention principles, when carrying out construction works. The open trench method of installation for the cable landfall is likely to result in the creation of a sediment plume, as well as increased marine vessel movements. There will also be airborne and underwater noise generated from the installation of the temporary sheet piles for the cofferdam, meaning that there is potential for cumulative effects from both plumes, vessel movements, and noise on the same receptors across the Przybrzeżne wody Bałtyku SPA. Habitats and species are therefore considered to be the key receptors in this assessment of the cumulative impact of Baltica-2, Baltica-3, Baltic Power and the Project. The receptors in this area include the qualifying features of the SPA.	water bodies within the meaning of the MSFD, the impacts are therefore considered **insignificant**. Given the eastern direction of propagation of these changes, it is unlikely that the effects of these two activities will overlap. In addition benthic habitats and species are accustomed to these high levels of the natural variability in the area, and the effects of the deposition of this additional sediment, is considered **insignificant**. As a result, a significant increase in the sediment deposition due to the construction of the offshore infrastructure for the Project is unlikely, whether alone or in combination with the running ashore the power cable, so the impacts are considered **insignificant**. **Release of sediment bound contaminants:** The concentrations of pollutants in the seabed surface sediments sampled in the marine survey area of the Lubiatowo - Kopalino site, do not exceed the limits imposed by the regulation. Given the relative homogeneity of sediments between the location of the NPP and the potential landfall location of the wind farm's power cable, it is likely that sediment sampling for the purposes of the laying of the cable will yield similar quality measurement results. Given that the sediments in the immediate vicinity of the works show no significant levels of contamination and are within guideline levels, the risk of reduced water quality through disturbance of these sediments from either the NPP or landfall works, can therefore be concluded as **not significant**. As a result, a significant increase in the sediment deposition due to the construction of the offshore infrastructure for the Project is unlikely, whether alone or in combination with the running ashore the power cable, so the impacts are considered **insignificant**. **Coastal area management:** The impacts on the speed of current, wave height, sediment transport and subsequent erosion/accumulation as a result of the construction of the offshore infrastructure in Variant 1 – Lubiatowo - Kopalino site have been described as **negligible**. It is assumed that the construction of the exit point of the offshore wind farm's cable will be similar to the construction of the closed cooling water intake and discharge system for technical Sub-Variants 1B and 1C. It can therefore be assumed that the impact magnitude is **negligible** due to the small area of the seabed affected by the morphological changes and the scale of these changes compared to the levels of the natural variability recorded in the marine survey area off the Project site. It is therefore unlikely that negligible impacts of these construction works could have significant cumulative effects on the hydrogeomorphology of the coast. Therefore, no changes are anticipated to the requirements of the existing beach management strategy and no significant effects will occur. **Availability of prey for qualifying features in the SPA:** There are numerous protection zones in the vicinity of the marine survey area in the Lubiatowo - Kopalino site and the entire offshore infrastructure associated with the NPP and the wind farm's power output cable exit point will be located in the Przybrzeżne Wody Bałtyku SPA designated for numerous species of birds feeding on fish, among others. Marine mammals are also observed in nearby special habitat protection areas and studies carried there have confirmed the presence of porpoises and seals, though in small numbers. All these species can be potentially exposed to indirect adverse impacts related to the impacts on their food base. Changes in prey availability may affect individuals' ability to feed, with subsequent effects on local populations. The individual assessments presented in **Chapter IV.2** have shown that the changes in the marine environment due to the construction of the open cooling system, or the smaller closed system, are within the range of the natural environmental variability and are therefore **insignificant**. It is unlikely that additional activities associated with the landfall installation of power cable for either the Baltica 3 or Baltic Power offshore wind farms will make a significant contribution to these effects. As a result, the implementation of the Project, whether alone or in combination with the effects of the landfall installation of the power cable, will not affect the prey population of marine predators. The impacts are considered **insignificant**. **Marine mammals:** Possible collisions between ships and marine mammals in particular, can cause injury and death, which can affect both individual specimens and the population as a whole. However, ships associated with the NPP and with of the landfall of the power cables for offshore wind farms, upon arrival in the area of works, are unlikely to move either at high speed or irregularly. Furthermore, it was observed that the marine mammals recorded in the Marine Survey Area, namely harbour porpoise and seal species, which are animals with faster response times and greater manoeuvrability, compared to larger, slower-moving baleen whales, for

Project	Scope	Assessment
		example. In the event that the construction works under the two projects overlap, measures are likely to be put in place to ensure safe manoeuvring of ships, control of their speed, and presence of marine mammal observers. On this basis, it is expected that the potential effects caused by collisions between marine mammals and ships, resulting from the implementation of only the Project, or the Project and the landfall of the power cable, will be **insignificant**. **Impacts on fauna:** Due to the temporary nature of the works and the light traffic of vessels, no significant increase in light, noise or vibration intensity associated with the activities of vessels from the NPP and from the power cable landfall is expected, particularly when compared to the busy shipping route along the Baltic coast [157]. Existing populations of migratory fish, swimming birds and marine mammals in the Przybrzeżne Wody Bałtyku SPA have become accustomed to a certain level of impacts, noise and vibration resulting from the current vessel movement. Therefore, it is anticipated that the temporary increase in the light, noise and vibration intensity caused by NPP-related activities of vessels, whether alone or in combination with installation of the offshore wind farm's power cable, will not have a significant effect on migratory fish, swimming birds or marine mammals. The mitigation measures provided for the Project will be implemented during the construction to mitigate the effects of noise on marine fauna. As a result, a significant increase in the impacts on fauna in connection with the construction of the offshore infrastructure for the Project is unlikely, whether alone or in combination with the power cable landfall, so the impacts are considered **insignificant**. **Piling** It is possible that the works related to the piling may overlap in the case of simultaneous implementation of the Project and the offshore wind farms. This applies in particular to the simultaneous performance of the works for the Lubiatowo - Kopalino site and for the Baltica-3 wind farm, because they are located close to each other (approx. 40 km) Based on the modelling results, maximum marine zones of impact have been taken into account, the extent of which in terms of the temporary hearing threshold shift (TTS) has been identified as 20 km from each location. This is the distance at which underwater noise levels would fall slightly below the permanent hearing threshold shift (PTS) and the TTS for the marine mammal species (especially porpoises). It is assumed that the maximum zones of impact for offshore wind farms will be >20 km (TTS), as they are located in deeper waters and the noise is anticipated to propagate more freely and over longer distances (less resistance and interactions with the seabed). Based on a conservative to the modelling for the Project, the modelled levels are below the species thresholds at 20 km (TTS) and 2.5 km (PTS), and similar values are predicted within the assumed zones of impact of the offshore wind farm. In addition, given the likelihood that the piling will not be done at exactly the same time in different locations, and will not always take place along the south-eastern boundary of the wind farm, and that standard mitigation measures will be implemented, these impacts are considered **insignificant**. **Dredging and cable installation** There is a possibility of overlapping of works if the dredging/cable laying works are carried out parallel to the Project. Based on the local zone of impact associated with underwater noise from the dredging, i.e. the fact that BI value for marine mammals (sound pressure level of 120 decibels [dB Lp]) at a distance of 1,800 m (from the source) and the TTS value for fish species (158 dB LE,p) have not been achieved, and with the standard mitigation measures implemented, the impacts are considered **insignificant**. **WFD** The WFD assessment for technical Sub-Variant 1A for all implementation stages has shown that **there will be no significant adverse effects** on elements of biological, hydromorphological and/or physico-chemical quality that could jeopardise the current state of the water bodies in which the works are to be carried out. In addition, the activities related to the construction and operation of the Project would not affect the implementation of the proposed corrective actions specified for the uniform body of coastal waters in the Vistula River Basin Management Plan. There would also be no risk either for sites designated for their ecological importance or for designated bathing areas. As has already been mentioned, it is assumed that the construction of the wind farm's power output cable will be similar to the construction of the closed cooling water system intake and discharge points for technical Sub-Variants 1B and 1C. The assessment of the closed cooling water intake and discharge system has shown that the impacts on the ecological and chemical status, as defined by the

Project	Scope	Assessment
		WFD, will be **insignificant** and will generally not have an adverse effect on the current status of the water bodies or on the future achievement of the objectives of the Water Management Plan for the Vistula River Basin in order to achieve the good environmental status. It is therefore unlikely that cumulative impacts will occur. Therefore, the assessment has shown that both the Project alone and the Project in combination with the landfall of the power cable, will not contribute to any possible failure to comply with the WFD. **MSFD** The MSFD compliance assessments for the open cooling system (Sub-Variant 1A) and for the closed cooling system (Sub-Variant 1B) have shown that none of the Sub-Variants would have an adverse effect on the 11 descriptors and targets used to verify compliance with the MSFD. In general, therefore, it is unlikely that the two projects could interact with each other and have an adverse effect that could result in either a deterioration, where the good environmental status has been achieved, or an inability to achieve the good environmental status, where it has not yet been achieved. Therefore, the assessment has shown that the Project itself, or in combination with the construction of power cable landfall, will not contribute to any possible failure to comply with the MSFD.

Source: [456]

IV.19.2.2.2 IV.19.2.2 Variant 2 – Żarnowiec site

Establishment of the Zone of impact

In order to take into account the assessment of effects cumulated with those of other projects, plans and programmes, an appropriate maximum geographic area has been designated around the main Project site and around the locations of the associated infrastructure/investments where there is a possibility of affecting the marine environment. This area has been designated as the zone of impact. The offshore projects, among others the locations of areas of projects related to offshore wind farms, and existing permits for laying and maintaining cables or pipelines, which have been analysed, are presented in chapter [Chapter IV.19.1.4.3], concerning the methodology of the cumulative assessment, where the procedure for the establishment of the zone of cumulative impact in the offshore area has been described.

Analysis of projects, plans and programmes

Taking into account the GDOŚ Decision and using specific maps to consider the spatial relation with the Project at the Żarnowiec site, each of the other projects has been considered in terms of whether it could cause impacts likely to cumulate with the effects of the Project. The result of this process is shown in [Table IV.19-6] of the EIA Report. On the basis of the above analysis, all identified projects were excluded from further assessment of cumulative effects with the Project. This is due to the low probability of potential overlap of impact zones for sediment plumes and underwater noise from dredging works.

Assessment summary

Based on the detailed analysis of the projects presented in the EIA Report, all these projects have been excluded from the further assessment of effects cumulative with the Project. This is due to the fact that even if such works were carried out in parallel to the Project, it is very unlikely that the zones of impact for sediment plumes from dredging works and underwater noise would coincide.

IV.19.4 Marine waters

This chapter presents an assessment of the cumulative effects that may arise as a result of offshore activities related to the implementation of the Project. This chapter should be read together with the description of the components of the planned Project, taking account the open and closed sub-variants of the cooling system that are likely to affect the marine environment.

The cumulative impact assessment contains a number of public sector guidelines and industry guidelines but there is currently no single agreed industry standard assessment methodology. Cumulative effects are defined in the EC's guidelines on the assessment of indirect and cumulative impacts and interactions of impacts as "Impacts resulting from gradual changes caused by other past, present or foreseeable project-related activities".

The UK's Institute of Environmental Management and Assessment (IEMA) offers a similar definition: "… the environmental impact that results from the increasing impacts of an activity when added to other past, present and foreseeable future activities…" [468].

However, the consideration of cumulative effects is a requirement of the GDOŚ decision and, for the purposes of this assessment, "cumulative effects" are defined as "the combined effect of a number of different projects, including the Project under the assessment, on a single receptor. This may involve multiple impacts of the same or similar type, coming from multiple projects affecting the same receptor."

Data collection and methodology

The overriding intention in carrying out the cumulative impact assessment was to ensure that the Project is considered in the full context of the existing (current) and expected (planned) projects, plans and programmes. In practice, the main issues were the projects to be considered and the methods to be used when assessing cumulative impacts in order to identify significant effects. An important practical issue was whether other projects, plans and programmes were the main part or whether they were dealt with in the chapter on cumulative effects, as this issue [should] not be covered in both parts.

The cumulative effect assessment focused on the assessment of other projects, as well as projects and activities identified in the spatial development plan for Polish maritime areas [221]. This assessment is also based on the findings of the assessments related to the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD).

The associated infrastructure/investments (the MOLF, the construction stage of the sewage treatment plant, etc.) are considered to be the main part of the impact assessment due to their proximity and because they are inextricably linked to the implementation of the NPP. However, due to the formal aspect and the need for consistency, it has been decided that the impacts on the associated infrastructure will be presented in this chapter.

The cumulative effect assessment has therefore been carried out for projects meeting the following criteria:

- A project that has been built, is under construction or in operational phase;
- A project/undertaking for which a decision on environmental conditions has been issued, and no construction works have yet been started at the time of preparation of the EIA Report; and
- A project/undertaking for which a procedure for issuing an environmental decision has been initiated but the decision has not yet been issued at the time of this EIA Report.

As part of this process, two project lists, B1 and B2, were compiled. List B1 identifies all small and medium-sized projects that meet the above criteria while list B2 identifies all major projects. These two lists have been reviewed to identify projects that can be considered to have a point of contact between the marine environment and the Project's infrastructure. An overview of these projects is presented in table [Table IV.19-34] of the EIA Report. The following sections present the results of the assessment of effects cumulated with other projects.

Limitations and assumptions adopted for this assessment

No limitations have been identified in this cumulative impact assessment but the following assumptions have been made:

- Other planned or launched projects with overlapping construction programmes will implement standard mitigation measures in line with the best practices during the construction (such as the ETP) in order to minimise adverse effects and, thus, reduce the likelihood of significant cumulative effects. Where appropriate, this principle applies to mitigation measures during the operational phase.

- The assessment has been carried out based on publicly available information on other planned and started investments.
- In the absence of details of a project, plan or programme, where quantitative assessment could not be performed, qualitative assessment has been carried out and expert judgement has been applied.
- The assessment assumes that the main risk of cumulative effects is a result of coincidence of construction works in the marine environment. Due to the nature of the Project and other projects identified, cumulative effects at the operational phase would occur only if other large industrial projects related to discharges into the marine environment were located within the zone of impact. No such projects have been identified.

IV.19.4.1 Variant 1 — Lubiatowo - Kopalino site

IV.19.4.1.1 Impacts external to the Project

Establishment of the zone of impact

In order to take into account the assessment of effects cumulated with those of other projects, plans and programmes, an appropriate maximum geographic area has been designated around the main Project site and around the locations of the associated infrastructure/investments where there is a possibility of affecting the marine environment. This area has been designated as the zone of impact. The offshore projects, such as the locations of projects related to offshore wind farms and issued permits for the laying and maintaining of cables or pipelines, covered by the analysis have been presented in the chapter concerning the cumulative assessment methodology [Chapter IV.19.1.4.3], where the process of establishing the cumulative zone of impact in the offshore area has been described.

Analysis of projects, plans and programmes

Taking into account the GDOŚ Decision and using the identified maps to consider the spatial relation with the Project at the Lubiatowo - Kopalino site, each of the other projects has been considered in terms of whether it could cause impacts likely to cumulate with the effects of the Project. The result of this process is presented in [Table IV.19-34] in the EIA Report. This analysis takes into account, where justified, the worst-case scenario.

Assessment of cumulative effects

The analysis presented in table [Table IV.19-52] in the EIA Report shows that the Baltica-2, Baltica-3 and Baltic Power offshore wind farm projects have been included in the further cumulative impact assessment for the NPP Project. These projects have been taken into account because their potential power output cable exit point on the shore is located near the offshore work areas of the Project. In addition, based on the available information, the works related to the power cable landfall may be carried out in parallel to the works under the planned programme. However, it is highly unlikely that the works related to the cable landfall point for both offshore wind farms will be performed at the same time. The remainder of this assessment was therefore carried out on the assumption that the installation of only one of these cable landfall points coincides with the offshore works at the site of the Project. Accordingly, table [Table IV.19-35] provides an assessment of the potential cumulative effects that may arise from the construction of the NPP, simultaneously with the installation of wind farm's power evacuation cable landfall.

Table IV.19-35: The assessment of the cumulative effects on the marine environment for the Lubiatowo - Kopalino site

Project	Scope	Assessment
Location name: Baltica-2 and Baltica-3 Responsible entity: PGE Polska Grupa Energetyczna S.A., Ørsted A/S (formerly DONG Energy AS) Power: 1,045.5 MW Number of turbines: 80-105 Location Name: Baltic Power Responsible entity: PKN ORLEN SA, NP BALTIC WIND B.V. Power: 1,200 MW Number of turbines: 100 Location name: Bałtyk II and III Responsible entity: Equinor and Polenergia Power: 1,560 MW and 600 MW Number of turbines: Unknown Location Name: NEPTUN Responsible entity: OceanWinds SL. Power: Unknown Number of turbines: Unknown	The following assumptions have been made for the purposes of this assessment: The construction of only one offshore wind farm with the output power cable and the landfall point may overlap with the construction of the Project's offshore infrastructure in the years 2025-2029. The possibility of cumulation of underwater noise generated by the piling in deep water (all locations), dredging works, movement of vessels, laying of the submarine cable and its landfall point (if the cable and the landfall point are adjacent to the Project). The submerged channel/pipeline method, and a cofferdam will be built at the Project site for the construction of intake and discharge channels of the open cooling system. The potential landfall for the electrical power export cables would be located just to the east of Variant 1 - Lubiatowo - Kopalino site. The installation of the power export cable landfall point will use an open trench excavation method on the beach, including a cofferdam, as will also be the case with the construction of the water intake and discharge of the NPP's closed cooling system. Both in the case of the Project and the offshore wind farm projects (Baltica-2, Baltica-3 and Baltic Power), standard mitigation measures would be implemented, including the development and implementation of the ETP, and of general pollution prevention principles, when carrying out construction works.	**Elevated concentrations of suspended sediments:** The extent of sediment plume associated with the dredging for the purpose of construction of the intake and discharge channels of the open cooling system at the Project site is, in the worst-case scenario, about 40 km east along the seashore, towards Władysławowo. This sediment plume would represent the daily average in winter, when the concentrations of suspended sediments are above the baseline levels within the range of 5-25 mg/l. The area of exceeding the 24-hour "acute" EQS value contained in the guidelines (25 mg/l) would be mostly limited to the area covered by the water-law permit for the Project. Potentially, this area would extend over approximately 13 km^2, which would represent 9.19% of the water bodies, as defined by the WFD, and 0.02% of the water bodies within the meaning of the MSFD, respectively, so the impacts are considered **not significant**. The sediment plume will therefore interact with the sediment rising as a result of the open trench method used for the purpose of power cable landfall installation, provided that these operations coincide. However, the potential sediment plume from the landfall installation works is likely to cover a much smaller area, of less than 0.2km^2. This estimate is based on the methodology for carrying out construction works similar to that provided for variants of the closed cooling system (Sub-Variants 1B and 1C). This would be a negligible addition to the sediment plume coming from the NPP works area. It is therefore unlikely that the plumes will be able to merge and produce a significant effect. As a result, a significant increase in the concentrations of sediments suspended due to the construction of marine infrastructure for the Project is unlikely, whether alone or in combination with cable landfall installation effects, so the impacts are considered **not significant**. **Deposition of sediments:** It has been shown that the highest possible column of the sediment deposition on the seabed is up to 25 mm in an area of 2.4 km^2 outside the immediate work area, which would represent respectively 1.7% of the water bodies as defined by the WFD and 0.003% of the water bodies within the meaning of the MSFD, so the impacts are considered **not significant**. This value is much lower than the natural variability recorded at any single point in the marine survey area, which is 1-2 m. The area of the deposition of fine sediments, potentially affected by the installation of the cable at the point of its exit to land, assuming a similar methodology for carrying out construction works as in the case of closed intake and discharge systems, would be approximately 1.31 km^2, which would represent respectively 0,9% of the water bodies as defined by the WFD and 0.0001% of the water bodies within the meaning of the MSFD, the impacts are therefore considered not significant. Given the eastern direction of propagation of these changes, it is unlikely that the effects of these two activities will overlap. In addition benthic habitats and species are accustomed to these high levels of the natural variability in the area, and the effects of the deposition of this additional sediment, is considered **not significant**. As a result, a significant increase in the sediment deposition due to the construction of marine infrastructure for the Project is unlikely, whether alone or in combination with cable landfall installation effects, so the impacts are considered **not significant**. **Release of sediment bound contaminants:**

Project	Scope	Assessment
	The open trench method of installation for the cable landfall is likely to result in the creation of a sediment plume, as well as increased marine vessel movements. There will also be airborne and underwater noise generated from the installation of the temporary sheet piles for the cofferdam, meaning that there is potential for cumulative effects from both plumes, vessel movements, and noise on the same receptors across the Przybrzeżne Wody Bałtyku SPA. Marine ecology habitats and species are therefore considered the key receptors in this assessment of the cumulative impacts of Baltica-2, Baltica-3, Baltic Power, and of the Project. Marine ecology receptors in this area include the qualifying features of the SPA.	Compared to the requirements of Polish law, concentrations of pollutants in the seabed surface sediments sampled in the marine survey area of the Lubiatowo - Kopalino site, do not exceed the limits imposed by the regulation. In addition, for the parameters listed in the Canadian Sediment Quality Guidelines, the concentrations of contaminants in sediment samples taken from the marine survey area at the Lubiatowo - Kopalino site are lower than the Canadian Interim Sediment Quality Guidelines (ISQG). Given the relative homogeneity of sediments between the location of the NPP and the potential landfall location of the wind farm's power cable, it is likely that sediment sampling will yield similar results. Given that the sediments in the immediate vicinity of the works show no significant levels of contamination and are within guideline levels, the risk of reduced water quality through disturbance of these sediments from either the NPP or landfall works, can therefore be concluded as not significant. As a result, a significant increase in the sediment deposition due to the construction of marine infrastructure for the Project is unlikely, whether alone or in combination with cable landfall installation effects, so the impacts are considered **not significant**. **Coastal area management:** The impacts on the speed of current, wave height, sediment transport and subsequent erosion/accumulation as a result of the construction of the marine infrastructure in Variant 1 - Lubiatowo - Kopalino site, have been described as **negligible**. It is assumed that the construction of the exit point of the offshore wind farm's cable will be similar to the construction of the closed cooling water intake and discharge system for Sub-Variants 1B and 1C. The assessment of the closed cooling water intake and discharge system has shown that the impacts are negligible due to the small area of the seabed affected by morphological changes and because of the scale of these changes compared to the levels of the natural variability recorded in the marine survey area of the Project's location in Lubiatowo - Kopalino. |It is therefore unlikely that the negligible effects of each of these construction works could have significant cumulative effects on the hydrogeomorphology of the coast. Therefore, no changes are anticipated to the requirements of the existing beach management strategy and **no significant effects** will occur. **Availability of prey for qualifying features in the SPA:** There are numerous protection zones in the vicinity of the marine survey area in the Lubiatowo - Kopalino site and the entire offshore infrastructure associated with the NPP and the wind farm's power output cable landfall point will be located in the Przybrzeżne Wody Bałtyku SPA designated for numerous species of birds feeding on fish, including gaviiformes (loons). A little further on, marine mammals are also observed in nearby special habitat protection areas and studies carried out there have confirmed the presence of porpoises and seals, albeit in small numbers. All such species are potentially exposed to indirect adverse impacts related to the impacts on their prey, regardless of whether this concerns abundance, distribution or species composition. Changes in prey availability may affect individuals' ability to feed, with subsequent effects on local populations. The assessment of the elements of water status qualification shows the changes in the marine environment due to the construction of the open cooling system, or the smaller closed system, are within the range of the natural environmental

Project	Scope	Assessment
		variability and are therefore insignificant. It is unlikely that additional activities related to the installation of the power cable landfall for the offshore wind farm (Baltica-3 or Baltic Power) will significantly contribute to these effects. As a result, there are no pathways of effects between the implementation of the Project, whether alone or in combination with cable landfall point, which could result in changes in the availability of prey to marine predators in the said area, and the effect is defined as **insignificant**. **Marine mammals:** Possible collisions between ships associated with the Project and marine mammals in particular, can cause injury and death, which can affect both individual specimens and the population as a whole. However, ships associated with the NPP and with of the offshore wind farms power cable landfall point, upon arrival in the vicinity of the Project, are unlikely to move either at high speed or irregularly, thus allowing slower marine mammals to notice them [ships] and, if necessary, avoid them. Furthermore, it was observed that the marine mammals recorded in the Marine Survey Area, namely harbour porpoise and seal species, which are animals with faster response times and greater manoeuvrability, compared to larger, slower-moving baleen whales, for example. In the event that the construction works under the two projects overlap, measures are likely to be put in place to ensure safe manoeuvring of ships, control of their speed, traffic isolation and presence of marine mammal observers. On this basis, it is expected that the potential effects caused by collisions between marine mammals and ships, resulting from the implementation of only the Project, or the Project and the landfall of the power cable, will be insignificant. **Disturbance of fauna:** Due to the temporary nature of the works and the light traffic of vessels, no significant increase in light, noise or vibration intensity associated with the activities of vessels from the NPP and from the power cable landfall is expected, particularly when compared to the busy shipping base along the Baltic coast [413]. Existing populations of migratory fish, swimming birds and marine mammals in the Przybrzeżne Wody Bałtyku SPA have become accustomed to a certain level of disturbances, noise and vibration resulting from the current vessel movement levels. Therefore, it is anticipated that the temporary increase in the light, noise and vibration intensity caused by NPP-related activities of vessels, whether alone or in combination with installation of the offshore wind farm's power cable, will not have a significant effect on migratory fish, swimming birds or marine mammals. The mitigation measures provided for the Project will be implemented during the construction to mitigate the effects of noise on marine fauna. As a result, a significant increase in disturbance of fauna due to the construction of marine infrastructure for the Project is unlikely, whether alone or in combination with cable landfall installation effects, so the impacts are considered **not significant**. **Deep water piling:** It is possible that the works related to the piling may overlap in the case of simultaneous implementation of the Project and the offshore wind farms. This applies in particular to the simultaneous performance of the works for the Lubiatowo - Kopalino site and for the Bałtyk III wind farm, because they are located close to each other (approx. 40 km)

Project	Scope	Assessment
		Based on the modelling results, maximum reasonably justified marine zones of impact have been taken into account, the extent of which in terms of the temporary hearing threshold shift (TTS) has been determined at 20 km from each location. This is the distance at which underwater noise levels would fall slightly below the permanent hearing threshold shift (PTS) and the TTS for the marine mammal species (especially porpoises), to which the assessment applies. It is assumed that the maximum reasonably justified marine zones of impact for offshore wind farms will be >20 km (TTS), as they are located in deeper waters and the noise is anticipated to propagate more freely and over longer distances (less resistance and interactions with the seabed). Based on a conservative approach to the modelling for the Project, the modelled levels are below the species thresholds at 20 km (TTS) and 2.5 km (PTS), and similar values are expected within the assumed zones of impact of the offshore wind farm. In addition, given the likelihood that the piling will not be done at exactly the same time in different locations, and will not always take place along the south-eastern boundary of the wind farm project, and that standard mitigation measures will be implemented, this effect is considered **not significant**. **Dredging and cable installation:** There is a possibility of overlapping of works if the dredging/cable laying works are carried out parallel for the needs of the Project and offshore wind farms. This applies in particular to the simultaneous performance of the works for the Project and for the routing of power output cables (north and east) with their landfall points (east). Based on the local zone of impact associated with underwater noise from the dredging, i.e. the fact that BI value for marine mammals (sound pressure level of 120 decibels [dB Lp]) at a distance of 1,800 m (from the source) and the TTS value for fish species (158 dB LE,p) have not been achieved, and with the standard mitigation measures implemented, the effect is considered insignificant. **WFD:** The WFD assessment for Sub-Variant 1A for all the stages has shown that there would be no significant adverse impacts on elements of biological, hydromorphological and/or physico-chemical quality that could jeopardise the current WFD state of the water bodies in which the works are carried out. In addition, the activities related to the construction and operation of the Project would not impact the implementation of the proposed remedy measures specified for the uniform body of coastal waters in the Vistula River Basin Management Plan. There would also be no risk either for sites designated for their ecological importance or for designated bathing areas. As already mentioned, it is assumed that the construction of the landfall point of the offshore wind farm's cable will be similar to the construction of the closed cooling water intake and discharge system for technical Sub-Variants 1B and 1C. The assessment of the closed cooling water intake and discharge system has shown that the impacts on the ecological and chemical status, as defined by the WFD, will be insignificant and will generally not have an adverse effect on the current status of the water bodies or on the future achievement of the objectives of the Vistula River Basin Management Plan in order to achieve the good environmental status. It is therefore unlikely that the insignificant effects of each of these construction works could have a significant cumulative effect.

Project	Scope	Assessment
		Therefore, the assessment has shown that both the Project alone, and/or in combination with the power cable landfall, will not contribute to any possible failure to comply with the WFD. **MSFD** The MSFD compliance assessments for the open cooling system (Sub-Variant 1A) and for the closed cooling system (Sub-Variant 1B) have shown that none of the Sub-Variants would have an adverse effect on the 11 parameters and targets used to verify compliance with the MSFD. In general, therefore, it is unlikely that the two projects could interact with each other and have an adverse effect that could result in either a deterioration, where the good environmental status has been achieved, or an inability to achieve the good environmental status, where it has not yet been achieved. Therefore, the assessment has shown that both the Project alone, and/or in combination with the power cable landfall, will not contribute to any possible failure to comply with the MSFD.

Source: [19]

IV.19.4.1.2 Impacts internal to the Project

Elements of the existing environment that are likely to be affected by the Project at the development and construction stages, and at the operational phase are discussed in detail in chapter [Chapter IV.8.3]. This section presents interactions that can occur between potential effects generated by different marine infrastructure components. The marine environment is characterised by the fact that impacts between all the marine infrastructure components are potentially possible and/or can occur to some extent for most activities.

The key interactions have been identified for the development and construction stages of the construction phase, and for the operational phase of the Project, with the worst-case scenario also being taken into account here. They are as follows:

Construction phase

<u>Development stage</u>

Effects on coastal processes and hydromorphology resulting from the construction of the MOLF structure and the discharge point of the sewage treatment plant (associated infrastructure/investment).

<u>Construction stage</u>

- Effects on coastal processes and hydromorphology resulting from the presence of the MOLF structures and cofferdam for the purposes of the construction of water intake of the open cooling system.
- Effects on coastal processes and hydromorphology resulting from the presence of the MOLF structures and from the dredging of excavations for the cooling water channels/pipelines.
- Effects of the discharges from the sewage treatment plant (associated infrastructure/investment), discharges from the construction site and the dredging of excavations for the needs of cooling water channels/pipelines on water quality.

<u>Operational phase</u>

- Effects on coastal processes and hydromorphology resulting from the presence of the MOLF, cooling water inlet and outlet structures, and the outlet structures of the municipal wastewater treatment plant (associated infrastructure/investment).
- Effects of cooling water and process effluent discharges, and discharges from the municipal wastewater treatment plant (associated infrastructure/investment) on water quality.

The identified key environmental interactions are discussed in more detail in [Table IV.19-36]

Table IV.19-36: The summary of intra-Project effects

Marine infrastructure components	Environmental interactions
Development stage	
Construction of the MOLF + the outlet structure of the sewage treatment plant	**Effects on coastal processes and hydromorphology** Although the MOLF is not a permanent structure, there is a possibility that foundation piles that protrude above the seabed throughout the depth of the water column can affect hydrodynamics in their immediate vicinity by, for example, washing out the seabed around the pile base or blocking/disturbing the existing sediment transfer scheme in the coastal zone. Potential changes in seabed bathymetry due to the presence of the permanent MOLF structure have been modelled using the numerical hydrodynamic model (Delft-3D). The modelling has taken into account the likely effect of the offshore infrastructure on coastal processes and bathymetry. Although this modelling scenario applies to the start of the operation, the cooling water inlet and outlet structures and the outlet structures of the sewage treatment plant are too small to be considered using the modelled grid and, therefore, the scenario effectively takes into account only the effects of the presence of the MOLF structure. The modelling shows that the impacts of the very presence of the MOLF structure on the morphology of the seabed after 12 months leads to the deposition of a certain amount of material as a result of both

Marine infrastructure components	Environmental interactions
	ascending and descending currents. The modelling of the initial state suggests, however, that the scale of erosion and deposition of surface sediments caused by the presence of the structures is generally within the limits of the natural variability over comparable periods. In the longer term, even taking into account climate change, a balance is expected to be achieved between the slight accretion trend associated with the presence of the MOLF structures and the erosion trends resulting from storms, as well as local washout around the structure. It is therefore very unlikely that there would be any intra-Project effects resulting from the presence of the MOLF and the outlet structures of the sewage treatment plant and, therefore, no significant effects would occur. The only interactions with the marine environment at the development stage will be related to the associated infrastructure/investments, while there will be no intra-Project effects generated by the Project.
Construction stage of the Project	
MOLF + cofferdam required for the construction of the open cooling system and the FRRS	**Effects on coastal processes and hydromorphology** At the construction stage of the Project, there will be a number of temporary infrastructure elements in the marine environment, including cofferdams for the construction of the cooling water channel and the FRRS, and caissons for the installation of the cooling water intake and discharge structures, and the FRRS outlet chamber. Each of these, alone or in combination with other aspects, could potentially change the initial conditions. A number of scenarios have been modelled in detail to predict how the infrastructure associated with the Project could change the existing hydrological regimes in the area. The modelling covers the first 12 months of the construction, when the cofferdam for the construction of the intake, FRRS and MOLF would already exist. The modelling results identify the effects of the open cooling system construction on erosion / deposition at the end of each milestone (i.e. at the end of the construction of the water intake cofferdam/ FRRS system, at the end of the construction of the cofferdam for the construction of the outlet structure, after four months of natural regeneration and after 16 months of natural regeneration), with the MOLF structure permanently present throughout the period of natural regeneration. These scenarios provide an effective representation of the intra-Project impact assessment. The assessment concludes that the impact magnitude is negligible due to the small area of the seabed affected by the morphological changes and the scale of these changes compared to the levels of the natural variability recorded in the marine survey area off of the Project site. The assessment also shows that most of the effects are due to the cofferdam and that the effect of the MOLF structure is minimal and negligible. It is therefore very unlikely that there would be any intra-Project effects resulting from the presence of the MOLF and the cofferdam for the construction of the cooling water inlet structures / the FRRS and, therefore, no significant effects would occur.
MOLF + trench dredging for the water intake of the open cooling system / the FRRS	**Effects on coastal processes and hydromorphology** In addition to the presence of offshore structures, sediments would be mobilised during the dredging in the case of the submerged channel option, when it would precipitate from the suspension and would settle again on the seabed around the work areas. However, the modelling results in this regard show that the extra sediment layer on the seabed would not be thicker than 25 mm outside the immediate working area. This is comparable to the natural variability of up to 1.3 m on the slope of the tidal zone, which is observed on an annual basis. It is therefore unlikely that the deposition of sediments mobilised as a result of the dredging works will affect the characteristics of the seabed in the area or the fauna associated with it. The assessment also shows that most of the effects are due to the dredging and that the effect of the MOLF on morphological aspects is minimal and negligible. It is therefore very unlikely that there would be any intra-Project effects affecting coastal processes and hydromorphology resulting from the presence of the MOLF and from the dredging of the water intake channels of the open cooling system / the FRRS and, therefore, no significant effects would occur.
Discharges from the sewage treatment plant + discharges from construction site + dredging of excavations for	**Effects on water quality** A modelling has been carried out to determine the amount of sediments that will be disturbed and discharged by the dredgers during the construction works related to the installation of the cooling water intake and discharge system, and the fish recovery and return system. The modelling was based on the

Marine infrastructure components	Environmental interactions
cooling water channels/pipelines	assumption of the open excavation method, which is the worst-case scenario when it comes to mobilising sediments. The modelling shows that the magnitude of impacts is negligible because the modelled average concentrations of suspended sediments would be exceeded for a period of 30 days, mainly within the boundaries of the area covered by the water-law permit. In the case of the acute exposure guidelines, the overrun would also largely concern the area covered by the water-law permit. The overrun would occur partly in the body of coastal waters and partly at sea. In both cases, the area of the overrun is less than 0.1% of the area of the coastal water body concerned. The magnitude of this effect is therefore negligible because, despite high significance of the receptor, the water bodies to which the WFD and MSFD apply would be able to absorb this short-term impact of negligible magnitude. The assessment of the effects of the discharges of process effluents and municipal wastewater generated by the Project has shown that adequate ELV and EQS values can be achieved for all chemical substances present in process effluent discharges and, therefore, provided that appropriate treatment is applied, changes in the quality of the surrounding water caused by the discharges would be insignificant. In addition, discharges from the municipal wastewater treatment plant (associated infrastructure/investment) during operation will result in negligible impact on the marine environment. This is due to the fact that the assessment of these potential impacts was based, where appropriate and available, on EQS and other environmental standards, after which it has been concluded that the effects throughout the life cycle of the Project would be insignificant and the quality of waters in bathing areas would in each case remain “Excellent”. As regards the additional quantities of nutrients, the influx of these nutrients from the effluents is very small in relation to their current amount on the scale of the body of water. The increased inflow of nutrients from this source is likely to be at least partially offset by the reduction in the volume of discharges of untreated municipal wastewater and by the relocation of a number of workers from other areas from which effluents are eventually discharged into the Baltic Sea anyway. In general, the impacts of the Project will therefore be very small in relation to the reduction of the total amount of nutrients that can result from the implementation of the measures planned under the Water Management Plan. Therefore, this will not affect the possibility of improving the state in the future. It is therefore very unlikely that there would be any intra-Project impacts on the quality of seawaters resulting from discharges from the sewage treatment plant (associated infrastructure/investment), discharges from the construction site and from the dredging of excavations for the cooling water channels/pipelines and, therefore, no significant effects would occur.
Operational phase	
The presence of the MOLF + cooling water inlet and outlet structures + sewage treatment plant outlet structures	**Effects on coastal processes and hydromorphology** As stated above, the inlet and outlet structures of the cooling water system, and the outlet structures of the sewage treatment plant are too small to be considered using the modelled grid and, therefore, the scenario effectively takes into account only the effects of the presence of the MOLF structure. The results of the 3D modelling and subsequent assessment have shown that all the potential effects would be within the range of the natural variability and that no significant effects would occur. It is therefore very unlikely that there would be any intra-Project effects resulting from the presence of the MOLF and the outlet structures of the sewage treatment plant and, therefore, no significant effects would occur.
The discharge of process effluents + municipal wastewater treatment plant (associated infrastructure/investment)	**Effects on water quality** The assessment of the effects of the discharges of process wastewater and municipal wastewater generated by the Project has shown that adequate ELV and EQS values can be achieved for all chemical substances present in process effluent discharges and, therefore, provided that appropriate treatment is applied, changes in the quality of the surrounding water caused by the discharges would be insignificant. In addition, discharges from the municipal wastewater treatment plant (associated infrastructure/investment) during operation will result in negligible impact on the marine environment. This is due to the fact that the assessment of these potential impacts was based, where appropriate and available, on EQS and other environmental standards, after which it has been concluded that the effects throughout the life cycle of the Project would be insignificant and the quality of waters in bathing areas would in each case remain “Excellent”.

Marine infrastructure components	Environmental interactions
	As regards the additional quantities of nutrients, the influx of these nutrients from the effluents is very small in relation to their current amount on the scale of the body of water. The increased inflow of nutrients from this source is likely to be at least partially offset by the reduction in the volume of discharges of untreated municipal wastewater and by the relocation of a number of workers from other areas from which effluents are eventually discharged into the Baltic Sea anyway. In general, the impacts of the Project will therefore be very small in relation to the reduction of the total amount of nutrients that can result from the implementation of the measures planned under the Water Management Plan. Therefore, this will not affect the possibility of improving the state in the future. It is therefore very unlikely that there would be any intra-Project effects caused by the process effluent discharges and discharges from the sewage treatment plant and, therefore, no significant effects would occur.

Source: [456]

IV.19.4.1.3 Impacts of the associated infrastructure/investment projects – detailed analyses

Detailed descriptions of the impacts discussed in the previous chapter, resulting from the Project's links with the associated infrastructure/investment projects, have been presented in chapter [Chapter IV.19.4.1.3] of the EIA Report. The following chapters [Chapter 19.4.1.4] and [Chapter 19.3.1.5], also presented in the EIA Report, analyse possible effects that these impacts may have in relation to the requirements of the Water Framework Directive and the requirements of the Water Framework Directive on the Maritime Strategy.

Only a summary of them and the most important conclusions are presented below:

Effect of the associated infrastructure/investment projects on compliance with the Water Framework Directive

As a result of the implementation of the infrastructure associated with the Project, no adverse effects are expected on the current ecological or chemical status of the water body, as defined by the WFD, or on the achievement of the good environmental status in the future, as provided for in the Water Management Plan. The WFD assessment for the associated infrastructure for all the stages has shown that **there will be no significant adverse impact**s on the elements of biological, hydromorphological and/or physicochemical quality that could jeopardise the current WFD status of the water bodies in which the works are to be carried out. In addition, the activities related to the construction and operation of the Project will not affect the implementation of the proposed measures to improve the status specified for the body of coastal waters in the current River Basin Management Plan for the Second Cycle (2016-21) [417] or in the draft Water Management Plan for the Third Cycle (2022-27) [352] for the Vistula river basin area. There will also be no risk to sites designated for their ecological importance or to the designated bathing sites in close proximity.

Effect of the associated infrastructure/investments on compliance with the Marine Strategy Framework Directive

The assessment of the extent to which the implementation of the associated infrastructure in question (i.e. the MOLF, the service road and the sewage treatment plant at the construction stage) complies with the requirements of the MSFD for the relevant marine water bodies within areas 27 and 62. The assessment is based on the eleven descriptors used in the MSFD to determine the overall ecological status of a body of water. These descriptors are defined for Polish waters in the table above [Table IV.8.3- 33], and in detail in chapter [Chapter IV.8.3] of the EIA Report, and the summary of the current initial environmental status of the relevant water bodies is presented in chapter [Chapter IV.8.3] of the EIA Report.

The results of this assessment are summarised in table [Table IV.8.3-1-4] in appendix [Appendix IV.8.3-1] to chapter [Chapter IV.8.3] of the EIA Report for each of these descriptors, taking into account whether the implementation of the associated infrastructure/investments is likely to undermine the good environmental status already achieved or to prevent the achievement of the good environmental status where it has not yet been achieved. The results have been compiled based on the impact assessment process described above and they cover all three phases of the Project.

IV.19.4.2 Variant 2 — Żarnowiec site

IV.19.4.2.1 Impacts external to the Project

Establishment of the zone of impact

In order to take into account the assessment of effects cumulated with those of other projects, plans and programmes, an appropriate maximum geographic area has been designated around the main Project site and around the locations of the associated infrastructure/investments where there is a possibility of affecting the marine environment. This area has been designated as the zone of impact. The offshore projects, such as the locations of projects related to offshore wind farms and issued permits for the laying and maintaining of cables or pipelines, covered by the analysis have been presented in the chapter concerning the cumulative assessment methodology, where the process of establishing the zone of cumulative impacts in the offshore area has been described.

Analysis of projects, plans and programmes

Taking into account the GDOŚ Decision and using specific maps to consider the spatial relation with the Project at the Żarnowiec site, each of the other projects has been considered in terms of whether it could cause impacts likely to cumulate with the effects of the Project. The result of this process is presented in table [Table IV.19-52] in the EIA Report. Where justified, this analysis takes into account the worst-case scenario.

Assessment of cumulative effects

Based on the analysis presented in table [Table IV.19-52] from the EIA Report, all the identified projects have been excluded from the further assessment of Project's cumulative impacts. This is due to the fact that even if such works were carried out in parallel to the Project, it is very unlikely that the zones of impact for sediment plumes from dredging works and underwater noise would coincide.

IV.19.4.2.2 Impacts internal to the Project

The existing environment components likely to be affected by the Project at the development and construction stages and at the operational phase are discussed in detail in [Chapter IV.8.3]. This chapter presents interactions that can occur between the potential effects caused by the individual marine infrastructure components. The marine environment is characterised by the fact that impacts between all the marine infrastructure components are potentially possible and/or can occur to some extent for most activities.

The key interactions have been identified for the development and construction stages, and for the operational phase of the Project, with the worst-case scenario also being taken into account here. They are as follows:

Development works

- Effects on coastal processes and hydromorphology resulting from the construction of the MOLF structure and the discharge point of the sewage treatment plant (STW) for the construction stage (associated infrastructure/investment).

Construction

- Effects on coastal processes and hydromorphology resulting from the presence of the MOLF structures and the cofferdam for the common trench for the intake and discharge pipelines and the FRRS's duct.
- Effects on coastal processes and hydromorphology resulting from the presence of the MOLF structures and from the dredging of the common trench for the intake and discharge pipelines and the FRRS's duct.

- Effects on water quality resulting from the discharges from the STW for the construction stage (associated infrastructure/investment), discharges from the construction site and from the dredging of the common trench for the intake and discharge pipelines and the FRRS's channel.

Operation

- Effects on coastal processes and hydromorphology resulting from the presence of the MOLF, of the cooling water intake and discharge points structures, and the discharge structure from the municipal wastewater treatment plant* (STW) (associated infrastructure/investment).
- Effects of the impacts of the discharges of cooling water, process effluents and effluents from the municipal wastewater treatment plant (STW)* (associated infrastructure/investment) on water quality.

(* It is assumed that the sewage treatment plant for the construction stage will remain in use and will be used for municipal purposes at the operational phase.)

The identified key environmental impacts are discussed in more detail in table [Table IV.19-53].

Table IV.19-53: The summary of the intra-Project effects

Marine infrastructure components	Environmental interactions
Development stage	
The construction of the MOLF + the STW's discharge point	**Effects on coastal processes and hydromorphology** Although the MOLF is not a permanent structure, there is a possibility that foundation piles that protrude above the seabed throughout the depth of the water column can affect hydrodynamics in their immediate vicinity by, for example, washing out the seabed around the pile base or blocking/disturbing the existing sediment movement scheme in the coastal zone. Potential changes in seabed bathymetry due to the presence of the permanent MOLF structure have been modelled using the numerical hydrodynamic model (Delft-3D). The modelling has taken into account the likely effects of the offshore infrastructure on coastal processes and bathymetry. Although this modelling scenario applies to the start of the operation, the structures of the discharge point of the sewage treatment plant (STW) are too small to be considered using the modelled grid and, therefore, the scenario effectively takes into account only the effects of the presence of the MOLF structure. The modelling shows that the impacts of the mere presence of the MOLF structure on the seabed morphology after 12 months leads to the deposition of a very small amount of material both up and down the drift from the structure. The modelling of the baseline state suggests, however, that the scale of erosion and deposition of surface sediments caused by the presence of these structures is generally within the limits of the natural scale of variation for comparable periods. In a longer term, even taking into account climate change, a balance is expected to be achieved between the slight accumulation trend associated with the presence of the MOLF structures and the erosion trends resulting from storms, as well as the local washout around the structure. It is anticipated that the construction of the treated sewage discharge point will involve the use of trenching and pipe pulling. The need to use a linear cofferdam is unlikely. The works are expected to take less than a month and will be carried out in summer, when sediment transport rates in the coastal zone are the lowest. In view of the very small area and short duration of these works compared to the installation of the infrastructure necessary for cooling water systems, where it has been assessed that any potential effects would be **within the range of the natural variability** and that **no significant effects** would occur resulting from the installation of the point of discharge of treated effluents – the effects can be considered **negligible** and **insignificant**. It is therefore very unlikely that there would be any intra-Project effects resulting from the presence of the MOLF and from the construction of the sewage treatment works (STW) discharge point and, therefore, **no significant effects** would occur. The only interactions with the marine environment at the development stage will be related to the associated infrastructure/investments, while there will be no intra-Project effects generated by the Project.
Construction stage	
The MOLF + the cofferdam used for the construction of the	**Effects on coastal processes and hydromorphology**

Marine infrastructure components	Environmental interactions
cooling system’s intake and discharge pipelines and the FRRS’s channel	At the construction stage of the Project in the marine environment there will be a number of temporary infrastructure components, mainly sheet piles for the construction of the cooling water pipelines and the FRRS’s channel. Each of these, alone or in combination with other aspects, could potentially change the initial conditions. In order to predict how the infrastructure associated with the Project can change the existing hydrological regimes in the area, a number of scenarios have been modelled in detail. The modelling covers the first 8 months of the construction, when the cofferdam used for the construction of cooling system’s intake and discharge pipelines, the FRRS’s channel, and the MOLF would already be in place. The modelling results determine the effects of the construction on erosion/deposition at the end of each main stage (i.e. at the end of the presence of a dike for the construction of the intake/discharge/FRRS, at the end of the presence of the cofferdam for the construction of the discharge point, after four months of natural regeneration), with the MOLF structure permanently present throughout the periods of natural regeneration. These scenarios present the intra-Project impacts assessment in an effective manner. The assessment concludes that the impact magnitude is negligible due to the small area of the seabed affected by the morphological changes and the scale of these changes compared to the levels of the natural variability recorded in the marine survey area off of the Project site. The assessment also shows that most of the effects originate in connection with the construction of the cofferdam, while the effects of the MOLF structure are minimal and **negligible**. It is therefore very unlikely that there would be any intra-Project effects resulting from the presence of the MOLF and the cofferdam required for the construction of the cooling water intake and discharge points and the FRRS and, therefore, **no significant effects would occur**.
The MOLF + the trench dredging for the construction of the intake and discharge pipelines of the cooling system and the FRRS	**Effects on coastal processes and hydromorphology** In addition to the presence of offshore structures, sediments would be mobilised during the dredging in the case of the submerged channel option, when it would precipitate from the suspension and would settle again on the seabed around the work areas. However, the assessment suggests that the sediment layer on the seabed would be negligible outside the immediate work areas. It is therefore unlikely that the deposition of sediments mobilised as a result of the dredging works will affect the characteristics of the seabed in this area or the fauna associated with it (more information on the effects on the marine ecology). The assessment also shows that most of the effects are due to the dredging and that the effect of the MOLF on morphological aspects is minimal and **negligible**. It is therefore very unlikely that there would be any intra-Project effects affecting coastal processes and hydromorphology resulting from the presence of the MOLF and dredging works for the construction of the cooling water intake and discharge points, and the FRRS and, therefore, **no significant effects would occur**.
The discharges from the sewage treatment plant (STW) + the discharges from the location + the dredging of the trench for the cooling system’s intake/discharge structure, and the FRRS	**Effects on water quality** In order to determine the amount of sediments that will be disturbed and dumped by the dredgers during the construction works related to the installation of the cooling system intake/discharge structure and the FRRS, a modelling process has been carried out. The modelling has been based on the assumption of the open excavation option, which is the worst-case scenario when it comes to the disruption of sediments. The modelling shows that the impact magnitude is **negligible** because the relevant EQS values for suspended sediment concentrations would be exceeded largely within the boundaries of the Project Area. The overrun would occur partly in the body of coastal waters and partly at sea. In both cases, the area of the overrun is less than 0.1% of the area of the coastal water body concerned. The magnitude of this effect is therefore **negligible** because, despite high significance of the receptor, the water bodies to which the WFD and MSFD apply would be able to absorb this short-term impact of **negligible** magnitude. In addition, discharges from the STW for the construction stage (associated infrastructure/investment) during the construction will have negligible impact on the marine environment. This is due to the fact that the assessment of these potential impacts was based, where appropriate and available, on EQS and other environmental standards, after which it has been concluded that the effects throughout the life cycle of the Project would be **insignificant** and the quality of waters in bathing areas would in each case remain “Excellent”. As regards the additional quantities of nutrients, the influx of these nutrients from the effluents is very small in relation to their current amount on the scale of the water body. The increased inflow of nutrients from this source is likely to be at least partially offset by the reduction in the volume of discharges of untreated municipal wastewater and by the relocation of a number of workers from other areas from which effluents

Marine infrastructure components	Environmental interactions
	are eventually discharged into the Baltic Sea anyway. In general, the impacts of the Project will therefore be very small in relation to the reduction in the total amount of nutrients that may result from the implementation of the measures planned under the Water Management Plan. Therefore, this will not affect the possibility of improving the state in the future. It is therefore very unlikely that there would be any intra-Project impacts on the quality of seawater resulting from the discharges from the sewage treatment plant (associated infrastructure/investment), discharges from the site and from the dredging of the trenches for the cooling water channels/pipelines and, therefore, **no significant effects would occur**.
Operational phase	
The presence of the MOLF + cooling water intake and discharge point structures + the discharge point of the municipal sewage treatment plant (STW)	**Effects on coastal processes and hydromorphology** As stated above, the structures of the cooling water intake and discharge points and of the STW discharge point for the construction stage (assuming that the associated infrastructure/investment will be preserved for use by the commune at the operational phase) are too small to be considered using the modelled grid and, therefore, the scenario effectively takes into account only the effects of the presence of the MOLF structure. The results of the modelling and subsequent assessments have shown that all the potential effects would be **within the range of the natural variability** and that **no significant effects** would occur. Thus, given the very small size of the discharge structure and the distance from the MOLF, it is very unlikely that there would be any intra-Project effects resulting from the presence of the MOLF and the outlet chambers of the sewage treatment plant (STW) and, therefore, **no significant effects would occur**.
The discharges of process effluents + the discharges from the STW	**Effects on water quality** The assessment of the effects of the discharges of process wastewater and municipal wastewater generated by the Project has shown that adequate ELV and EQS values can be achieved for all chemical substances present in process effluent discharges and, therefore, provided that appropriate treatment is applied, changes in the quality of the surrounding water caused by the discharges would be **insignificant**. In addition, discharges from the STW for the construction stage (assuming that this associated infrastructure/investment will be preserved and used as the municipal wastewater treatment plant at the operational phase) will have negligible effects on the marine environment. This is due to the fact that the assessment of these potential impacts has been based on a worst-case scenario for discharges that would occur during the construction stage and, where justified and possible, on the EQS and other environmental standards, after which it has been concluded that the effects throughout the life cycle of the Project would be negligible and the quality of water in bathing areas would in any case remain “excellent”. As regards the additional quantities of nutrients, the influx of these nutrients from the effluents is very small in relation to their current amount on the scale of the water body. The increased inflow of nutrients from this source is likely to be at least partially offset by the reduction in the volume of discharges of untreated municipal wastewater and by the relocation of a number of workers from other areas from which effluents are eventually discharged into the Baltic Sea anyway. In general, the impacts of the Project will therefore be very small in relation to the reduction in the total amount of nutrients that may result from the implementation of the measures planned under the River Basin Management Plan. Therefore, this will not affect the possibility of improving the state in the future. It is therefore very unlikely that there would be any intra-Project effects caused by the process effluent discharges and discharges from the sewage treatment plant and, therefore, **no significant effects would occur**.

Source: [456]

IV.19.4.2.3 Impacts of the associated infrastructure/investments – detailed analyses

Detailed descriptions of the impacts resulting from the Project’s links with the associated infrastructure/investments have been presented in chapter [Chapter IV.19.4.2.3] of the EIA Report. The following chapters [Chapter 19.4.2.4] and [Chapter 19.4.2.5], also presented in the EIA Report, analyse possible effects that these impacts may have in relation to the requirements of the Water Framework Directive and the requirements of the Water Framework Directive on the Maritime Strategy.

Only a summary of them and the most important conclusions are presented below:

Effect of the associated infrastructure/investments on compliance with the Water Framework Directive

The following are the results of the analysis of compliance of the implementation of the associated infrastructure with the requirements of the WFD, carried out in order to ensure that the current status of the relevant body of coastal waters is not disturbed and to ensure that the good quality status will be maintained in the future.

The summary of the conclusions of the assessment in relation to ecological status has been presented in table [Table IV.8.3-4-7] in appendix [Appendix IV.8.3-4] to the EIA Report.

With regard to the chemical status, the assessment and compliance with the EQS and other limit values set out in the legislation has shown that there are no significant chemical effects and, as a result, the construction of associated infrastructure will have no effects on the future condition.

In addition, the sewage treatment plant will be handed over to local authorities after the completion of the construction stage and will be used during the operational phase of the Project for the purpose of collecting municipal wastewater from nearby villages. This solution is in line with one of the key objectives of the draft of the second update of the Vistula river basin management plans (IIaPGW) [13]: *"the implementation of the National Municipal Wastewater Treatment Programme (KPOSK) in areas adjacent to coastal water bodies".*

As shown in table [Table IV.8.3-4-7] in appendix [AppendixIV.8.3-4] to the EIA Report as a general conclusion, no adverse effects are expected on the current ecological or chemical status of the body of coastal waters, as defined by the WFD or on the achievement of the good environmental status in the future, as provided for in the River Basin Management Plan, as a result of the implementation of investment projects associated with the Project. The WFD assessment for the associated infrastructure/investments at all the stages has shown that there will be no significant adverse effects on elements of biological, hydromorphological and/or physicochemical quality that could jeopardise the current WFD status for the coastal water bodies in which the works are to be carried out. In addition, the activities related to the construction and operation of the Project will not impact the implementation of the proposed measures to improve the status specified for the body of coastal waters in the current River Basin Management Plan for the Second Cycle (2016-21) [19] or in the draft Water Management Plan for the Third Cycle (2022-27) [13] for the Vistula river basin area. There will also be no risk to sites designated for their ecological importance or to the designated bathing sites in close proximity. Appendix D: The Water Framework Directive Compliance Assessment provides further details on compliance with the WFD.

Effect of the associated infrastructure/investments on compliance with the Marine Strategy Framework Directive

The following are the results of the analysis of the compliance of the implementation of the associated infrastructure with the requirements of the MSFD for the relevant marine water bodies within areas 27 and 62. The assessment is based on the eleven parameters used in the MSFD to determine the overall ecological status of a water body. These parameters are specified for Polish waters in chapter [Chapter IV.8.3] of the EIA Report. The chapter also summarises the current baseline status of the environment for each of these parameters.

The results of the assessment of each of these parameters are presented in table [Table IV.8.3-4-8] in appendix [Appendix IV.8.3-4] to the EIA Report, taking into account whether the implementation of the associated infrastructure/investments is likely to undermine the good environmental status (GES) already achieved or prevent the achievement of the good environmental status (GES) where it has not yet been achieved. The results have been compiled based on the impact assessment described above and cover all the stages of the Project.

Based on the findings presented in table [Table IV.8.3-4-8] in appendix [AppendixIV.8.3-4] to the EIA Report, it has been concluded that the construction of the associated infrastructure/investments related to the Project will not result in adverse impacts on the ability of any of the water bodies to achieve or maintain the good environmental status (GES) according to the MSFD.

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Appendix IV.17-1
MATCH model results

Extract from the Appendices to Volume IV of the EIA Report

Language version: EN

July, 2022

świadomie o atomie
energia jądrowa w Polsce

Polskie Elektrownie Jądrowe sp. z o.o.

Table IV.17-1- 1 maximum dose rate values with the given date of release start and geographical coordinates of the middle of calculation loop

Target location	Source of emissions	Release start	MV – Maximum dose value [mSv/h]	Longitude MV	Latitude MV
Bialystok	Lubiatowo	26-Jan-2008 12:30:00	1.31056E-06	22.451	53.192
Bialystok	Żarnowiec	26-Jan-2008 15:30:00	1.60405E-06	22.821	53.023
Bydgoszcz	Lubiatowo	15-Aug-2008 12:30:00	7.45000E-06	17.826	53.229
Bydgoszcz	Żarnowiec	15-Aug-2008 18:30:00	6.99000E-06	18.033	53.215
Częstochowa	Lubiatowo	18-May-2010 03:30:00	2.59876E-06	18.981	50.874
Częstochowa	Żarnowiec	18-May-2010 00:30:00	2.29915E-06	19.176	50.857
Dolnośląskie	Lubiatowo	14-Oct-2009 12:30:00	1.27566E-06	16.907	51.531
Dolnośląskie	Żarnowiec	13-Oct-2009 09:30:00	1.78401E-06	17.326	51.629
Gdańsk	Lubiatowo	08-Feb-2011 00:30:00	2.33086E-05	18.500	54.441
Gdańsk	Żarnowiec	01-Feb-2007 00:30:00	2.84000E-05	18.500	54.441
Gdynia	Lubiatowo	28-Nov-2011 00:30:00	4.3300E-05	18.530	54.560
Gdynia	Żarnowiec	01-Feb-2007 00:30:00	6.35000E-05	18.314	54.580
Katowice	Lubiatowo	18-May-2010 00:30:00	1.99402E-06	19.044	50.238
Katowice	Żarnowiec	18-May-2010 00:30:00	1.89959E-06	19.044	50.238
Kielce	Lubiatowo	09-Apr-2011 03:30:00	1.16156E-06	20.794	50.958
Kielce	Żarnowiec	09-Apr-2011 06:30:00	1.56E-06	20.794	50.958
Kraków	Lubiatowo	18-May-2010 00:30:00	1.58853E-06	19.783	50.045
Kraków	Żarnowiec	18-May-2010 00:30:00	1.54196E-06	19.783	50.045
Kujawsko-pomorskie	Lubiatowo	09-Apr-2011 06:30:00	8.45409E-05	18.158	53.836
Kujawsko-pomorskie	Żarnowiec	15-Aug-2008 00:30:00	1.1200E-05	19.178	53.632
Lubelskie	Lubiatowo	08-Apr-2011 12:30:00	9.27E-07	21.765	50.855
Lubelskie	Żarnowiec	08-Apr-2011 12:30:00	1.57E-06	21.765	50.855
Lublin	Lubiatowo	08-Apr-2011 18:30:00	5.61E-07	22.455	51.157
Lublin	Żarnowiec	08-Apr-2011 18:30:00	7.46E-07	22.455	51.157
Lubuskie	Lubiatowo	05-Aug-2006 06:30:00	8.55896E-06	14.857	52.895
Lubuskie	Żarnowiec	05-Aug-2006 06:30:00	8.05523E-06	14.842	52.770
Łódź	Lubiatowo	09-Apr-2011 06:30:00	2.66434E-06	19.339	51.600
Łódź	Żarnowiec	17-Mar.2009 18:30:00	6.3500E-06	19.594	51.830
Łódzkie	Lubiatowo	09-Apr-2011 06:30:00	1.37867E-05	18.370	51.805

Target location	Source of emissions	Release start	MV – Maximum dose value [mSv/h]	Longitude MV	Latitude MV
Łódzkie	Żarnowiec	09-Apr-2011 06:30:00	1.26212E-05	19.076	52.253
Małopolskie	Lubiatowo	17-March-2009 21:30:00	7.43769E-07	20.090	50.521
Małopolskie	Żarnowiec	17-March-2009 18:30:00	6.65035E-07	19.897	50.540
Mazowieckie	Lubiatowo	08-Apr-2011 12:30:00	4.89309E-06	19.448	52.979
Mazowieckie	Żarnowiec	08-Apr-2011 12:30:00	1.0283E-05	19.712	53.209
Opolskie	Lubiatowo	14-Oct-2009 06:30:00	1.20435E-06	17.437	51.118
Opolskie	Żarnowiec	14-Oct-2009 06:30:00	1.14179E-06	18.027	51.076
Podkarpackie	Lubiatowo	01-Feb-2007 00:30:00	4.89424E-07	21.732	50.732
Podkarpackie	Żarnowiec	17-March-2009 18:30:00	6.04207E-07	21.732	50.732
Podlaskie	Lubiatowo	26-Jan-2008 12:30:00	3.92343E-06	22.852	53.783
Podlaskie	Żarnowiec	26-Jan-2008 12:30:00	3.71068E-06	22.812	53.661
Poznań	Lubiatowo	13-Oct-2009 09:30:00	3.92358E-06	16.850	52.414
Poznań	Żarnowiec	14-Oct-2009 18:30:00	2.46511E-06	17.074	52.525
Radom	Lubiatowo	31-Jan-2007 21:30:00	1.48174E-06	21.315	51.411
Radom	Żarnowiec	08-Apr-2011 18:30:00	1.8345E-06	21.086	51.308
Rzeszów	Lubiatowo	01-Feb-2007 00:30:00	3.76159E-07	21.979	50.196
Rzeszów	Żarnowiec	01-Feb-2007 00:30:00	4.25931E-07	22.205	50.297
Śląskie	Lubiatowo	17-March-2009 18:30:00	2.46319E-06	19.426	51.088
Śląskie	Żarnowiec	17-March-2009 18:30:00	1.45184E-06	19.033	51.122
Świętokrzyskie	Lubiatowo	17-Mar-2009 18:30:00	1.22E-06	20.298	51.386
Świętokrzyskie	Żarnowiec	01-Feb-2007 00:30:00	1.03713E-06	21.640	51.123
Szczecin	Lubiatowo	30-May-2009 00:30:00	5.19504E-06	14.694	53.278
Szczecin	Żarnowiec	27-May-2014 12:30:00	6.90989E-06	14.723	53.527
Toruń	Lubiatowo	09-Apr-2011 00:30:00	1.92834E-05	18.421	53.061
Toruń	Żarnowiec	17-March-2009 12:30:00	1.92242E-05	18.832	53.029
Warmińsko-mazurskie	Lubiatowo	28-Nov-2011 00:30:00	1.640E-05	19.806	54.464
Warmińsko-mazurskie	Żarnowiec	13-Jan-2007 12:30:00	1.620E-05	19.351	54.375
Warsaw	Żarnowiec	08-Apr-2011 15:30:00	1.8092E-06	20.884	52.089
Wielkopolskie	Lubiatowo	14-Oct-2009 06:30:00	7.22823E-06	17.041	53.533
Wielkopolskie	Żarnowiec	14-Oct-2009 12:30:00	6.21838E-06	17.458	53.506

Target location	Source of emissions	Release start	MV – Maximum dose value [mSv/h]	Longitude MV	Latitude MV
Wrocław	Lubiatowo	14-Oct-2009 21:30:00	5.66634E-07	17.240	51.132
Wrocław	Żarnowiec	14-Oct-2009 18:30:00	1.12E-06	17.239	51.131
Zachodnio-pomorskie	Lubiatowo	22-March-2007 00:30:00	1.13451E-04	16.770	54.429
Zachodnio-pomorskie	Żarnowiec	22-March-2007 00:30:00	1.29279E-04	16.748	54.304
Warsaw	Lubiatowo	31-Jan-2007 21:30:00	1.22521E-06	20.917	52.212

Source: [1]

Tabela IV.17-1- 2 Wartości maksymalne dawek od narażenia zewnętrznego z podaną datą uwolnienia oraz ze współrzędnymi geograficznymi środka oczka obliczeniowego

Target location	Source of emissions	Release start	MV – Maximum dose value [mSv]	Longitue MV	Latitude MV
Bialystok	Lubiatowo	26-Jan-2008 12:30:00	8.0000E-06	23.350	53.344
Bialystok	Żarnowiec	26-Jan-2008 15:30:00	7.6000E-06	23.350	53.344
Bydgoszcz	Lubiatowo	09-Apr-2011 06:30:00	1.4690E-04	18.009	53.091
Bydgoszcz	Żarnowiec	17-March-2009 18:30:00	2.1800E-05	18.033	53.215
Częstochowa	Lubiatowo	18-May-2010 03:30:00	1.0200E-05	19.176	50.857
Częstochowa	Żarnowiec	18-May-2010 00:30:00	9.6000E-06	19.176	50.857
Dolnośląskie	Lubiatowo	14-Oct-2009 12:30:00	7.2000E-06	17.503	51.491
Dolnośląskie	Żarnowiec	13-Oct-2009 09:30:00	1.0200E-05	17.326	51.629
Gdańsk	Lubiatowo	08-Feb-2011 00:30:00	2.0200E-04	18.527	54.564
Gdańsk	Żarnowiec	06-Dec-2013 12:30:00	4.310E-04	18.500	54.441
Gdynia	Lubiatowo	27-Nov-2011 18:30:00	2.97E-04	18.527	54.564
Gdynia	Żarnowiec	17-March-2005 12:30:00	6.870E-04	18.314	54.580
Katowice	Lubiatowo	18-May-2010 00:30:00	1.2800E-05	19.018	50.114
Katowice	Żarnowiec	18-May-2010 00:30:00	1.1700E-05	19.044	50.238
Kielce	Lubiatowo	09-Apr-2011 03:30:00	6.8000E-06	20.599	50.978
Kielce	Żarnowiec	09-Apr-2011 06:30:00	8.0000E-06	20.599	50.978
Kraków	Lubiatowo	18-May-2010 00:30:00	7.8000E-06	19.812	50.169
Kraków	Żarnowiec	18-May-2010 00:30:00	7.7000E-06	19.812	50.169
Kujawsko- pomorskie	Lubiatowo	09-Apr-2011 06:30:00	3.2680E-04	18.158	53.836
Kujawsko-pomorskie	Żarnowiec	01-Feb-2007 00:30:00	6.1100E-05	18.551	53.681
Lubelskie	Lubiatowo	08-Apr-2011 12:30:00	6.87E-06	22.317	52.063
Lubelskie	Żarnowiec	08-Apr-2011 12:30:00	9.39E-06	22.516	52.041

Target location	Source of emissions	Release start	MV – Maximum dose value [mSv]	Longitue MV	Latitude MV
Lublin	Lubiatowo	17-March-2009 12:30:00	4.4000E-06	22.455	51.158
Lublin	Żarnowiec	17-March-2009 15:30:00	5.1000E-06	22.455	51.158
Lubuskie	Lubiatowo	05-Aug-2006 06:30:00	3.3200E-05	16.165	51.952
Lubuskie	Żarnowiec	05-Aug-2006 06:30:00	2.5300E-05	16.366	51.940
Łódź	Lubiatowo	09-Apr-2011 06:30:00	2.1000E-05	19.537	51.583
Łódź	Żarnowiec	09-Apr-2011 06:30:00	2.5100E-05	19.509	51.459
Łódzkie	Lubiatowo	09-Apr-2011 06:30:00	4.3900E-05	18.345	51.681
Łódzkie	Żarnowiec	09-Apr-2011 06:30:00	4.5300E-05	18.570	51.790
Małopolskie	Lubiatowo	17-March-2009 21:30:00	6.0000E-06	19.897	50.540
Małopolskie	Żarnowiec	17-March-2009 18:30:00	5.6000E-06	20.090	50.521
Mazowieckie	Lubiatowo	08-Apr-2011 12:30:00	2.5200E-05	19.448	52.979
Mazowieckie	Żarnowiec	08-Apr-2011 12:30:00	3.8400E-05	19.448	52.979
Opolskie	Lubiatowo	14-Oct-2009 06:30:00	5.8000E-06	17.656	51.229
Opolskie	Żarnowiec	14-Oct-2009 06:30:00	6.6000E-06	18.027	51.076
Podkarpackie	Lubiatowo	01-Feb-2007 00:30:00	5.3000E-06	21.732	50.732
Podkarpackie	Żarnowiec	17-March-2009 18:30:00	5.4000E-06	21.732	50.732
Podlaskie	Lubiatowo	26-Jan-2008 12:30:00	1.2900E-05	22.398	53.707
Podlaskie	Żarnowiec	26-Jan-2008 12:30:00	1.5400E-05	22.398	53.707
Poznań	Lubiatowo	13-Oct-2009 09:30:00	3.5000E-05	16.871	52.538
Poznań	Żarnowiec	14-Oct-2009 18:30:00	9.8000E-06	16.871	52.538
Radom	Lubiatowo	31-Jan-2007 21:30:00	9.8000E-06	21.315	51.411
Radom	Żarnowiec	08-Apr-2011 18:30:00	1.0100E-05	21.118	51.432
Rzeszów	Lubiatowo	01-Feb-2007 00:30:00	4.5000E-06	22.014	50.319
Rzeszów	Żarnowiec	01-Feb-2007 00:30:00	4.5000E-06	22.205	50.297
Śląskie	Lubiatowo	17-March-2009 18:30:00	1.2800E-05	19.426	51.088
Śląskie	Żarnowiec	17-March-2009 18:30:00	6.7000E-06	19.760	50.805
Swiętokrzyskie	Lubiatowo	01-Feb-2007 00:30:00	7.0000E-06	21.640	51.123
Świętokrzyskie	Żarnowiec	17-Mar-2009 18:30:00	1.01E-05	19.789	50.929
Szczecin	Lubiatowo	30-May-2009 00:30:00	4.4800E-05	14.723	53.527
Szczecin	Żarnowiec	27-May-2014 12:30:00	6.6400E-05	14.514	53.536

Target location	Source of emissions	Release start	MV – Maximum dose value [mSv]	Longitue MV	Latitude MV
Toruń	Lubiatowo	09-Apr-2011 00:30:00	9.4400E-05	18.421	53.061
Toruń	Żarnowiec	17-March-2009 12:30:00	8.2400E-05	18.832	53.029
Warmińsko-mazurskie	Lubiatowo	13-Jan-2007 06:30:00	1.0000E-04	19.563	54.358
Warmińsko-mazurskie	Żarnowiec	13-Jan-2007 12:30:00	1.1350E-04	19.563	54.358
Warsaw	Lubiatowo	31-Jan-2007 21:30:00	1.1400E-05	20.884	52.089
Warsaw	Żarnowiec	08-Apr-2011 15:30:00	1.0100E-05	20.884	52.089
Wielkopolskie	Lubiatowo	14-Oct-2009 06:30:00	1.2860E-04	17.041	53.533
Wielkopolskie	Żarnowiec	14-Oct-2009 12:30:00	5.6500E-05	17.250	53.520
Wrocław	Lubiatowo	14-Oct-2009 21:30:00	2.6000E-06	17.043	51.145
Wrocław	Żarnowiec	23-Jun-2009 06:30:00	4.1000E-06	16.846	51.158
Zachodniopomorskie	Lubiatowo	22-March-2007 00:30:00	7.8000E-04	16.791	54.553
Zachodniopomorskie	Żarnowiec	22-March-2007 00:30:00	7.5290E-04	16.791	54.553

Source: [1]

Appendix IV.17-2

MATCH model results

Extract from the Appendices to Volume IV of the EIA Report

Language version: EN

July, 2022

świadomie o atomie
energia jądrowa w Polsce

Polskie Elektrownie Jądrowe sp. z o.o.

Table IV.17-2- 1 Effective doses for adults from all exposure pathways in the event of a severe accident representative for emergency planning in a nuclear power plant located in Variant 1 – Lubiatowo – Kopalino site (L–K) or in Variant 2 – Żarnowiec site (Ż)

Receptor	Source	Longitude	Latitude	Effective dose mSv					
				2-day	7-day	14-day	30-day	annual	lifetime
Bialystok	L-K	23.350	53.344	8.26E-05	1.51E-04	2.34E-04	3.66E-04	1.38E-03	6.80E-03
Bialystok	Ż	23.104	53.245	5.53E-05	9.66E-05	1.46E-04	2.25E-04	7.94E-04	3.58E-03
Bydgoszcz	L-K	18.009	53.091	4.70E-03	9.74E-03	1.54E-02	2.25E-02	4.97E-02	1.09E-01
Bydgoszcz	Ż	18.240	53.200	7.69E-03	1.59E-02	2.51E-02	3.60E-02	7.20E-02	1.20E-01
Częstochowa	L-K	19.149	50.733	1.42E-04	2.62E-04	4.06E-04	6.28E-04	2.67E-03	1.15E-02
Częstochowa	Ż	19.149	50.733	1.49E-04	2.71E-04	4.17E-04	6.38E-04	2.58E-03	1.16E-02
Dolnośląskie	L-K	17.525	51.615	8.35E-04	1.90E-03	2.96E-03	3.47E-03	4.81E-03	1.10E-02
Dolnośląskie	Ż	17.525	51.615	1.94E-03	4.46E-03	6.99E-03	8.39E-03	1.17E-02	2.64E-02
Gdańsk	L-K	18.500	54.441	9.96E-04	1.22E-03	1.59E-03	2.24E-03	7.41E-03	2.42E-02
Gdańsk	Ż	18.500	54.440	1.02E-02	1.61E-02	2.32E-02	3.46E-02	1.13E-01	4.32E-01
Gdynia	L-K	18.527	54.565	4.31E-03	5.33E-03	6.56E-03	8.54E-03	2.54E-02	7.19E-02
Gdynia	Ż	18.310	54.580	2.06E-02	3.11E-02	4.37E-02	6.41E-02	2.06E-01	7.41E-01
Katowice	L-K	19.044	50.238	8.28E-05	1.52E-04	2.35E-04	3.64E-04	1.49E-03	6.03E-03
Katowice	Ż	18.826	50.130	3.74E-04	8.42E-04	1.31E-03	1.53E-03	2.13E-03	4.65E-03
Kielce	L-K	20.794	50.958	4.49E-05	5.39E-05	6.52E-05	8.54E-05	2.91E-04	7.19E-04
Kielce	Ż	20.599	50.978	4.59E-05	5.60E-05	6.87E-05	9.08E-05	3.23E-04	7.87E-04
Kraków	L-K	19.946	49.903	6.36E-05	1.15E-04	1.76E-04	2.74E-04	1.18E-03	5.05E-03
Kraków	Ż	19.783	50.045	7.79E-05	1.41E-04	2.16E-04	3.31E-04	1.38E-03	6.35E-03
Kujawsko-pomorskie	L-K	17.924	53.726	2.11E-03	2.55E-03	3.15E-03	4.76E-03	1.62E-02	6.81E-02
Kujawsko-pomorskie	Ż	18.832	53.029	7.19E-03	1.49E-02	2.37E-02	3.48E-02	8.06E-02	2.00E-01
Łódź	L-K	19.594	51.830	1.20E-04	1.41E-04	1.67E-04	2.11E-04	6.52E-04	1.51E-03
Łódź	Ż	19.367	51.724	1.57E-04	1.81E-04	2.11E-04	2.67E-04	8.87E-04	2.11E-03
Łódzkie	L-K	19.710	52.325	2.76E-04	4.53E-04	6.67E-04	1.01E-03	3.45E-03	1.38E-02
Łódzkie	Ż	20.422	51.881	2.36E-04	3.86E-04	5.68E-04	8.59E-04	3.11E-03	1.29E-02
Lubelskie	L-K	23.350	51.432	8.73E-05	9.54E-05	1.44E-04	4.19E-04	1.39E-03	4.43E-03
Lubelskie	Ż	23.193	51.579	1.24E-04	1.37E-04	2.02E-04	5.61E-04	1.84E-03	5.68E-03
Lublin	L-K	22.687	51.258	2.19E-05	2.39E-05	3.67E-05	1.10E-04	3.43E-04	9.33E-04
Lublin	Ż	22.687	51.258	3.46E-05	3.69E-05	5.74E-05	1.80E-04	6.42E-04	2.02E-03
Lubuskie	L-K	14.595	52.405	3.70E-03	7.89E-03	1.26E-02	1.85E-02	5.33E-02	9.81E-02
Lubuskie	Ż	15.063	52.886	4.66E-03	9.77E-03	1.55E-02	2.26E-02	6.23E-02	1.09E-01
Małopolskie	L-K	19.676	50.434	1.66E-04	3.05E-04	4.73E-04	7.42E-04	3.44E-03	1.50E-02
Małopolskie	Ż	20.061	50.398	1.05E-04	1.93E-04	3.00E-04	4.72E-04	2.18E-03	1.03E-02
Mazowieckie	L-K	20.535	53.135	5.52E-04	6.07E-04	8.59E-04	2.20E-03	6.77E-03	1.94E-02
Mazowieckie	Ż	20.361	53.278	7.48E-04	8.17E-04	1.21E-03	3.39E-03	1.04E-02	2.97E-02
Opolskie	L-K	17.830	51.090	3.73E-04	8.62E-04	1.35E-03	1.59E-03	2.27E-03	5.40E-03

Receptor	Source	Longitude	Latitude	Effective dose mSv					
				2-day	7-day	14-day	30-day	annual	lifetime
Opolskie	Ż	18.515	50.534	3.82E-04	8.74E-04	1.36E-03	1.61E-03	2.32E-03	5.51E-03
Podkarpackie	L-K	21.400	49.500	1.82E-05	2.13E-05	2.54E-05	3.39E-05	1.29E-04	6.10E-04
Podkarpackie	Ż	21.243	49.644	9.35E-05	1.74E-04	2.71E-04	4.26E-04	1.97E-03	9.54E-03
Podlaskie	L-K	23.390	53.466	1.04E-04	1.91E-04	2.97E-04	4.68E-04	1.79E-03	8.37E-03
Podlaskie	Ż	23.185	53.491	1.22E-04	2.20E-04	3.39E-04	5.30E-04	1.99E-03	9.13E-03
Poznań	L-K	17.032	52.277	2.57E-03	5.41E-03	8.24E-03	9.68E-03	1.27E-02	2.55E-02
Poznań	Ż	16.829	52.289	2.40E-03	5.46E-03	8.48E-03	9.90E-03	1.36E-02	2.98E-02
Radom	L-K	21.118	51.432	1.92E-05	2.33E-05	2.84E-05	3.64E-05	1.21E-04	2.89E-04
Radom	Ż	21.315	51.411	5.88E-05	6.90E-05	8.78E-05	1.50E-04	4.78E-04	1.25E-03
Rzeszów	L-K	21.788	50.218	3.44E-05	6.24E-05	9.63E-05	1.51E-04	6.59E-04	2.68E-03
Rzeszów	Ż	22.014	50.319	3.54E-05	5.99E-05	8.94E-05	1.36E-04	5.68E-04	2.43E-03
Śląskie	L-K	19.704	50.558	1.65E-04	2.97E-04	4.55E-04	7.08E-04	3.26E-03	1.48E-02
Śląskie	Ż	19.316	50.593	1.04E-04	1.83E-04	2.78E-04	4.28E-04	1.94E-03	8.34E-03
Świętokrzyskie	L-K	19.704	50.558	1.63E-04	2.93E-04	4.50E-04	7.00E-04	3.26E-03	1.48E-02
Świętokrzyskie	Ż	19.897	50.540	1.04E-04	1.83E-04	2.78E-04	4.28E-04	1.94E-03	8.34E-03
Szczecin	L-K	14.723	53.527	8.04E-04	1.44E-03	2.21E-03	3.43E-03	1.25E-02	5.41E-02
Szczecin	Ż	14.723	53.527	8.24E-04	1.50E-03	2.31E-03	3.60E-03	1.30E-02	5.53E-02
Toruń	L-K	18.832	53.029	4.18E-04	6.63E-04	9.58E-04	1.43E-03	4.86E-03	1.91E-02
Toruń	Ż	18.832	53.029	6.08E-04	7.60E-04	9.42E-04	1.23E-03	4.22E-03	1.11E-02
Warmińsko-mazurskie	L-K	20.410	54.285	9.24E-04	1.56E-03	2.33E-03	3.49E-03	1.16E-02	4.60E-02
Warmińsko-mazurskie	Ż	19.474	53.987	1.95E-03	3.42E-03	5.21E-03	8.07E-03	2.76E-02	1.23E-01
Warsaw	L-K	20.884	52.089	1.34E-04	2.39E-04	3.65E-04	5.60E-04	2.00E-03	9.28E-03
Warsaw	Ż	20.884	52.089	9.23E-05	1.06E-04	1.52E-04	3.75E-04	1.27E-03	3.63E-03
Wielkopolskie	L-K	17.041	53.533	9.32E-03	2.04E-02	3.13E-02	3.65E-02	5.20E-02	1.11E-01
Wielkopolskie	Ż	17.458	53.506	9.79E-03	2.22E-02	3.43E-02	3.98E-02	5.37E-02	1.11E-01
Wrocław	L-K	17.022	51.021	1.37E-04	3.09E-04	4.80E-04	5.61E-04	7.86E-04	1.79E-03
Wrocław	Ż	17.043	51.145	2.10E-04	5.04E-04	7.98E-04	9.48E-04	1.39E-03	3.34E-03
Zachodniopomorskie	L-K	16.961	54.292	5.19E-03	9.25E-03	1.41E-02	2.18E-02	8.76E-02	3.24E-01
Zachodniopomorskie	Ż	16.770	54.429	7.61E-03	1.22E-02	1.77E-02	2.65E-02	8.94E-02	3.59E-01

Source: [1]

Table IV.17-2- 2 Effective doses for children from all exposure pathways in the event of a severe accident representative for emergency planning in a nuclear power plant located in Variant 1 – Lubiatowo – Kopalino site (L–K) or in Variant 2 – Żarnowiec site (Ż)

Receptor	Source	Longitude	Latitude	Effective dose mSv					
				2-day	7-day	14-day	30-day	annual	Lifetime
Bialystok	L-K	23.350	53.344	1.98E-04	3.58E-04	5.45E-04	8.12E-04	2.27E-03	8.47E-03
Bialystok	Ż	23.104	53.245	1.31E-04	2.34E-04	3.53E-04	5.22E-04	1.35E-03	4.54E-03
Bydgoszcz	L-K	18.009	53.091	1.92E-02	3.67E-02	5.57E-02	7.49E-02	1.12E-01	1.79E-01
Bydgoszcz	Ż	18.240	53.200	3.79E-02	7.01E-02	1.05E-01	1.37E-01	1.86E-01	2.39E-01
Częstochowa	L-K	19.149	50.733	3.64E-04	6.52E-04	9.84E-04	1.43E-03	4.49E-03	1.47E-02
Częstochowa	Ż	19.149	50.733	3.95E-04	6.91E-04	1.03E-03	1.48E-03	4.37E-03	1.48E-02
Dolnośląskie	L-K	17.525	51.615	5.00E-03	9.55E-03	1.40E-02	1.57E-02	1.74E-02	2.45E-02
Dolnośląskie	Ż	17.525	51.615	1.03E-02	2.02E-02	2.99E-02	3.43E-02	3.83E-02	5.52E-02
Gdańsk	L-K	18.470	54.320	1.06E-03	1.76E-03	2.59E-03	3.81E-03	1.08E-02	2.90E-02
Gdańsk	Ż	18.500	54.44	1.75E-02	3.05E-02	4.58E-02	6.78E-02	1.77E-01	5.35E-01
Gdynia	L-K	18.528	54.565	3.66E-03	5.49E-03	7.66E-03	1.08E-02	3.20E-02	8.13E-02
Gdynia	Ż	18.310	54.580	3.08E-02	5.28E-02	7.88E-02	1.17E-01	3.09E-01	9.06E-01
Katowice	L-K	19.044	50.238	2.07E-04	3.72E-04	5.64E-04	8.29E-04	2.52E-03	7.69E-03
Katowice	Ż	18.826	50.130	2.25E-03	4.28E-03	6.26E-03	7.00E-03	7.79E-03	1.07E-02
Kielce	L-K	20.794	50.958	3.08E-05	4.23E-05	5.72E-05	8.58E-05	3.35E-04	7.53E-04
Kielce	Ż	20.599	50.978	3.47E-05	4.78E-05	6.46E-05	9.63E-05	3.81E-04	8.31E-04
Kraków	L-K	20.195	50.132	1.21E-04	2.33E-04	3.52E-04	4.69E-04	7.44E-04	1.10E-03
Kraków	Ż	20.195	50.132	1.27E-04	2.42E-04	3.65E-04	4.84E-04	7.48E-04	1.08E-03
Kujawsko-pomorskie	L-K	17.924	53.726	2.64E-03	4.75E-03	7.21E-03	1.07E-02	2.69E-02	8.49E-02
Kujawsko-pomorskie	Ż	18.832	53.029	2.66E-02	5.20E-02	7.98E-02	1.09E-01	1.74E-01	3.10E-01
Łódź	L-K	19.594	51.830	7.90E-05	1.06E-04	1.40E-04	2.03E-04	7.28E-04	1.56E-03
Łódź	Ż	19.367	51.724	9.83E-05	1.31E-04	1.74E-04	2.54E-04	9.93E-04	2.19E-03
Łódzkie	L-K	19.710	52.325	4.95E-04	8.77E-04	1.33E-03	1.97E-03	5.39E-03	1.72E-02
Łódzkie	Ż	20.422	51.881	4.30E-04	7.65E-04	1.16E-03	1.72E-03	4.87E-03	1.60E-02
Lubelskie	L-K	23.350	51.432	2.03E-04	1.93E-04	2.94E-04	1.02E-03	2.59E-03	6.05E-03
Lubelskie	Ż	23.193	51.579	3.10E-04	2.96E-04	4.43E-04	1.51E-03	3.64E-03	8.05E-03
Lublin	L-K	22.687	51.258	6.88E-05	6.24E-05	9.36E-05	3.40E-04	7.63E-04	1.45E-03
Lublin	Ż	22.687	51.258	9.98E-05	8.99E-05	1.36E-04	5.06E-04	1.27E-03	2.86E-03
Lubuskie	L-K	14.595	52.405	1.54E-02	3.00E-02	4.59E-02	6.22E-02	1.02E-01	1.52E-01
Lubuskie	Ż	15.063	52.886	1.97E-02	3.78E-02	5.74E-02	7.72E-02	1.24E-01	1.76E-01
Małopolskie	L-K	19.676	50.434	3.87E-04	7.04E-04	1.07E-03	1.60E-03	5.58E-03	1.88E-02
Małopolskie	Ż	20.061	50.398	2.38E-04	4.30E-04	6.55E-04	9.76E-04	3.46E-03	1.28E-02
Mazowieckie	L-K	20.535	53.135	1.19E-03	1.14E-03	1.69E-03	5.65E-03	1.30E-02	2.72E-02
Mazowieckie	Ż	20.361	53.278	1.80E-03	1.72E-03	2.57E-03	8.77E-03	2.03E-02	4.21E-02

Receptor	Source	Longitude	Latitude	Effective dose mSv					
				2-day	7-day	14-day	30-day	annual	Lifetime
Opolskie	L-K	17.830	51.090	2.04E-03	3.99E-03	5.90E-03	6.67E-03	7.51E-03	1.11E-02
Opolskie	Ż	18.515	50.534	2.19E-03	4.20E-03	6.18E-03	6.96E-03	7.84E-03	1.15E-02
Podkarpackie	L-K	21.400	49.500	1.77E-05	3.17E-05	4.81E-05	7.14E-05	2.05E-04	7.48E-04
Podkarpackie	Ż	21.243	49.644	2.17E-04	3.93E-04	5.98E-04	8.89E-04	3.16E-03	1.19E-02
Podlaskie	L-K	23.390	53.466	2.42E-04	4.37E-04	6.67E-04	1.00E-03	2.88E-03	1.03E-02
Podlaskie	Ż	23.185	53.491	2.72E-04	4.93E-04	7.53E-04	1.13E-03	3.24E-03	1.14E-02
Poznań	L-K	17.032	52.277	1.64E-02	2.99E-02	4.31E-02	4.83E-02	5.21E-02	6.67E-02
Poznań	Ż	16.829	52.289	1.33E-02	2.53E-02	3.70E-02	4.15E-02	4.61E-02	6.47E-02
Radom	L-K	21.118	51.432	1.36E-05	1.92E-05	2.58E-05	3.63E-05	1.40E-04	3.02E-04
Radom	Ż	21.315	51.411	6.84E-05	7.70E-05	1.09E-04	2.69E-04	7.38E-04	1.56E-03
Rzeszów	L-K	21.788	50.218	7.83E-05	1.42E-04	2.18E-04	3.26E-04	1.08E-03	3.38E-03
Rzeszów	Ż	22.014	50.319	6.83E-05	1.20E-04	1.81E-04	2.69E-04	8.93E-04	3.02E-03
Śląskie	L-K	19.704	50.558	3.66E-04	6.60E-04	1.00E-03	1.49E-03	5.22E-03	1.85E-02
Śląskie	Ż	19.316	50.593	2.30E-04	4.07E-04	6.12E-04	8.99E-04	3.09E-03	1.04E-02
Świętokrzyskie	L-K	19.704	50.558	3.62E-04	6.52E-04	9.90E-04	1.46E-03	5.22E-03	1.85E-02
Świętokrzyskie	Ż	19.897	50.540	2.30E-04	4.07E-04	6.12E-04	8.99E-04	3.09E-03	1.04E-02
Szczecin	L-K	14.723	53.527	1.91E-03	3.44E-03	5.22E-03	7.77E-03	2.10E-02	6.84E-02
Szczecin	Ż	14.723	53.527	2.01E-03	3.63E-03	5.52E-03	8.23E-03	2.19E-02	7.01E-02
Toruń	L-K	18.832	53.029	7.23E-04	1.27E-03	1.90E-03	2.81E-03	7.61E-03	2.36E-02
Toruń	Ż	18.832	53.029	4.78E-04	6.80E-04	9.21E-04	1.29E-03	4.94E-03	1.17E-02
Warmińsko-mazurskie	L-K	20.440	54.410	1.89E-03	3.35E-03	5.05E-03	7.50E-03	1.94E-02	5.90E-02
Warmińsko-mazurskie	Ż	19.474	53.987	4.28E-03	7.67E-03	1.16E-02	1.74E-02	4.54E-02	1.54E-01
Warsaw	L-K	20.884	52.089	3.21E-04	5.73E-04	8.66E-04	1.28E-03	3.37E-03	1.17E-02
Warsaw	Ż	20.884	52.089	2.24E-04	2.18E-04	3.22E-04	1.05E-03	2.45E-03	5.03E-03
Wielkopolskie	L-K	17.041	53.533	4.97E-02	9.42E-02	1.37E-01	1.54E-01	1.73E-01	2.39E-01
Wielkopolskie	Ż	17.458	53.506	5.42E-02	1.03E-01	1.51E-01	1.68E-01	1.86E-01	2.52E-01
Wrocław	L-K	17.022	51.021	7.88E-04	1.49E-03	2.18E-03	2.44E-03	2.72E-03	3.86E-03
Wrocław	Ż	17.043	51.145	1.03E-03	2.09E-03	3.12E-03	3.56E-03	4.11E-03	6.34E-03
Zachodniopomorskie	L-K	16.961	54.292	1.22E-02	2.18E-02	3.29E-02	4.85E-02	1.50E-01	4.20E-01
Zachodniopomorskie	Ż	16.770	54.429	1.37E-02	2.40E-02	3.60E-02	5.32E-02	1.41E-01	4.46E-01

Source: [1]

Table IV.17-2- 3 Thyroid absorbed doses for adults in the event of a severe accident representative of emergency planning at the Lubiatowo-Kopalino (L-K) or Żarnowiec (Ż) nuclear power plant sites

Receptor	Source	Longitude	Latitude	Thyroid absorbed dose mGy:					
				2-day	7-day	14-day	30-day	annual	lifetime
Bialystok	L-K	23.35	53.344	9.25E-05	1.69E-04	2.62E-04	4.10E-04	1.55E-03	7.62E-03
Bialystok	Ż	23.104	53.245	6.19E-05	1.08E-04	1.64E-04	2.52E-04	8.89E-04	4.01E-03
Bydgoszcz	L-K	18.009	53.091	5.26E-03	1.09E-02	1.72E-02	2.52E-02	5.57E-02	1.22E-01
Bydgoszcz	Ż	18.24	53.2	8.61E-03	1.78E-02	2.81E-02	4.03E-02	8.06E-02	1.34E-01
Częstochowa	L-K	19.149	50.733	1.59E-04	2.93E-04	4.55E-04	7.03E-04	2.99E-03	1.29E-02
Częstochowa	Ż	19.149	50.733	1.67E-04	3.04E-04	4.67E-04	7.15E-04	2.89E-03	1.30E-02
Dolnośląskie	L-K	17.525	51.615	9.35E-04	2.13E-03	3.32E-03	3.89E-03	5.39E-03	1.23E-02
Dolnośląskie	Ż	17.525	51.615	2.17E-03	5.00E-03	7.83E-03	9.40E-03	1.31E-02	2.96E-02
Gdańsk	L-K	18.5	54.441	1.12E-03	1.37E-03	1.78E-03	2.51E-03	8.30E-03	2.71E-02
Gdańsk	Ż	18.5	54.44	1.14E-02	1.80E-02	2.60E-02	3.88E-02	1.27E-01	4.84E-01
Gdynia	L-K	18.527	54.565	4.83E-03	5.97E-03	7.35E-03	9.56E-03	2.84E-02	8.05E-02
Gdynia	Ż	18.31	54.58	2.31E-02	3.48E-02	4.89E-02	7.18E-02	2.31E-01	8.30E-01
Katowice	L-K	19.044	50.238	9.27E-05	1.70E-04	2.63E-04	4.08E-04	1.67E-03	6.75E-03
Katowice	Ż	18.826	50.13	4.19E-04	9.43E-04	1.47E-03	1.71E-03	2.39E-03	5.21E-03
Kielce	L-K	20.794	50.958	5.03E-05	6.04E-05	7.30E-05	9.56E-05	3.26E-04	8.05E-04
Kielce	Ż	20.599	50.978	5.14E-05	6.27E-05	7.69E-05	1.02E-04	3.62E-04	8.81E-04
Kraków	L-K	19.946	49.903	7.12E-05	1.29E-04	1.97E-04	3.07E-04	1.32E-03	5.66E-03
Kraków	Ż	19.783	50.045	8.72E-05	1.58E-04	2.42E-04	3.71E-04	1.55E-03	7.11E-03
Kujawsko-pomorskie	L-K	17.924	53.726	2.36E-03	2.86E-03	3.53E-03	5.33E-03	1.81E-02	7.63E-02
Kujawsko-pomorskie	Ż	18.832	53.029	8.05E-03	1.67E-02	2.65E-02	3.90E-02	9.03E-02	2.24E-01
Łódź	L-K	19.594	51.83	1.34E-04	1.58E-04	1.87E-04	2.36E-04	7.30E-04	1.69E-03
Łódź	Ż	19.367	51.724	1.76E-04	2.03E-04	2.36E-04	2.99E-04	9.93E-04	2.36E-03
Łódzkie	L-K	19.71	52.325	3.09E-04	5.07E-04	7.47E-04	1.13E-03	3.86E-03	1.55E-02
Łódzkie	Ż	20.422	51.881	2.64E-04	4.32E-04	6.36E-04	9.62E-04	3.48E-03	1.44E-02
Lubelskie	L-K	23.35	51.432	9.78E-05	1.07E-04	1.61E-04	4.69E-04	1.56E-03	4.96E-03
Lubelskie	Ż	23.193	51.579	1.39E-04	1.53E-04	2.26E-04	6.28E-04	2.06E-03	6.36E-03
Lublin	L-K	22.687	51.258	2.45E-05	2.68E-05	4.11E-05	1.23E-04	3.84E-04	1.04E-03
Lublin	Ż	22.687	51.258	3.88E-05	4.13E-05	6.43E-05	2.02E-04	7.19E-04	2.26E-03
Lubuskie	L-K	14.595	52.405	4.14E-03	8.84E-03	1.41E-02	2.07E-02	5.97E-02	1.10E-01
Lubuskie	Ż	15.063	52.886	5.22E-03	1.09E-02	1.74E-02	2.53E-02	6.98E-02	1.22E-01
Małopolskie	L-K	19.676	50.434	1.86E-04	3.42E-04	5.30E-04	8.31E-04	3.85E-03	1.68E-02
Małopolskie	Ż	20.061	50.398	1.18E-04	2.16E-04	3.36E-04	5.29E-04	2.44E-03	1.15E-02
Mazowieckie	L-K	20.535	53.135	6.18E-04	6.80E-04	9.62E-04	2.46E-03	7.58E-03	2.17E-02

Receptor	Source	Longitude	Latitude	Thyroid absorbed dose mGy:					
				2-day	7-day	14-day	30-day	annual	lifetime
Mazowieckie	Ż	20.361	53.278	8.38E-04	9.15E-04	1.36E-03	3.80E-03	1.16E-02	3.33E-02
Opolskie	L-K	17.83	51.09	4.18E-04	9.65E-04	1.51E-03	1.78E-03	2.54E-03	6.05E-03
Opolskie	Ż	18.515	50.534	4.28E-04	9.79E-04	1.52E-03	1.80E-03	2.60E-03	6.17E-03
Podkarpackie	L-K	21.4	49.5	2.04E-05	2.39E-05	2.84E-05	3.80E-05	1.44E-04	6.83E-04
Podkarpackie	Ż	21.243	49.644	1.05E-04	1.95E-04	3.04E-04	4.77E-04	2.21E-03	1.07E-02
Podlaskie	L-K	23.39	53.466	1.16E-04	2.14E-04	3.33E-04	5.24E-04	2.00E-03	9.37E-03
Podlaskie	Ż	23.185	53.491	1.37E-04	2.46E-04	3.80E-04	5.94E-04	2.23E-03	1.02E-02
Poznań	L-K	17.032	52.277	2.88E-03	6.06E-03	9.23E-03	1.08E-02	1.42E-02	2.86E-02
Poznań	Ż	16.829	52.289	2.69E-03	6.12E-03	9.50E-03	1.11E-02	1.52E-02	3.34E-02
Radom	L-K	21.118	51.432	2.15E-05	2.61E-05	3.18E-05	4.08E-05	1.36E-04	3.24E-04
Radom	Ż	21.315	51.411	6.59E-05	7.73E-05	9.83E-05	1.68E-04	5.35E-04	1.40E-03
Rzeszów	L-K	21.788	50.218	3.85E-05	6.99E-05	1.08E-04	1.69E-04	7.38E-04	3.00E-03
Rzeszów	Ż	22.014	50.319	3.96E-05	6.71E-05	1.00E-04	1.52E-04	6.36E-04	2.72E-03
Śląskie	L-K	19.704	50.558	1.85E-04	3.33E-04	5.10E-04	7.93E-04	3.65E-03	1.66E-02
Śląskie	Ż	19.316	50.593	1.16E-04	2.05E-04	3.11E-04	4.79E-04	2.17E-03	9.34E-03
Świętokrzyskie	L-K	19.704	50.558	1.83E-04	3.28E-04	5.04E-04	7.84E-04	3.65E-03	1.66E-02
Świętokrzyskie	Ż	19.897	50.54	1.16E-04	2.05E-04	3.11E-04	4.79E-04	2.17E-03	9.34E-03
Szczecin	L-K	14.723	53.527	9.00E-04	1.61E-03	2.48E-03	3.84E-03	1.40E-02	6.06E-02
Szczecin	Ż	14.723	53.527	9.23E-04	1.68E-03	2.59E-03	4.03E-03	1.46E-02	6.19E-02
Toruń	L-K	18.832	53.029	4.68E-04	7.43E-04	1.07E-03	1.60E-03	5.44E-03	2.14E-02
Toruń	Ż	18.832	53.029	6.81E-04	8.51E-04	1.06E-03	1.38E-03	4.73E-03	1.24E-02
Warmińsko-mazurskie	L-K	20.41	54.285	1.03E-03	1.75E-03	2.61E-03	3.91E-03	1.30E-02	5.15E-02
Warmińsko-mazurskie	Ż	19.474	53.987	2.18E-03	3.83E-03	5.84E-03	9.04E-03	3.09E-02	1.38E-01
Warsaw	L-K	20.884	52.089	1.50E-04	2.68E-04	4.09E-04	6.27E-04	2.24E-03	1.04E-02
Warsaw	Ż	20.884	52.089	1.03E-04	1.19E-04	1.70E-04	4.20E-04	1.42E-03	4.07E-03
Wielkopolskie	L-K	17.041	53.533	1.04E-02	2.28E-02	3.51E-02	4.09E-02	5.82E-02	1.24E-01
Wielkopolskie	Ż	17.458	53.506	1.10E-02	2.49E-02	3.84E-02	4.46E-02	6.01E-02	1.24E-01
Wrocław	L-K	17.022	51.021	1.53E-04	3.46E-04	5.38E-04	6.28E-04	8.80E-04	2.00E-03
Wrocław	Ż	17.043	51.145		5.64E-04	8.94E-04	1.06E-03	1.56E-03	3.74E-03
Zachodniopomorskie	L-K	16.961	54.292	5.81E-03	1.04E-02	1.58E-02	2.44E-02	9.81E-02	3.63E-01
Zachodniopomorskie	Ż	16.77	54.429	8.52E-03	1.37E-02	1.98E-02	2.97E-02	1.00E-01	4.02E-01

Source: [1]

Table IV.17-2- 4 Thyroid absorbed doses for children in the event of a severe accident representative for emergency planning ina nuclear power plant located in Variant 1 – Lubiatowo – Kopalino site (L–K) or in Variant 2 – Żarnowiec site (Ż)

Receptor	Source	Longitude	Latitude	Thyroid absorbed dose mGy:					
				2-day	7-day	14-day	30-day	annual	lifetime
Bialystok	L-K	23.35	53.344	2.40E-04	4.33E-04	6.59E-04	9.83E-04	2.75E-03	1.02E-02
Bialystok	Ż	23.104	53.245	1.59E-04	2.83E-04	4.27E-04	6.32E-04	1.63E-03	5.49E-03
Bydgoszcz	L-K	18.009	53.091	2.32E-02	4.44E-02	6.74E-02	9.06E-02	1.36E-01	2.17E-01
Bydgoszcz	Ż	18.24	53.2	4.59E-02	8.48E-02	1.27E-01	1.66E-01	2.25E-01	2.89E-01
Częstochowa	L-K	19.149	50.733	4.40E-04	7.89E-04	1.19E-03	1.73E-03	5.43E-03	1.78E-02
Częstochowa	Ż	19.149	50.733	4.78E-04	8.36E-04	1.25E-03	1.79E-03	5.29E-03	1.79E-02
Dolnośląskie	L-K	17.525	51.615	6.05E-03	1.16E-02	1.69E-02	1.90E-02	2.11E-02	2.96E-02
Dolnośląskie	Ż	17.525	51.615	1.25E-02	2.44E-02	3.62E-02	4.15E-02	4.63E-02	6.68E-02
Gdańsk	L-K	18.47	54.32	1.28E-03	2.13E-03	3.13E-03	4.61E-03	1.31E-02	3.51E-02
Gdańsk	Ż	18.5	54.44	2.12E-02	3.69E-02	5.54E-02	8.20E-02	2.14E-01	6.47E-01
Gdynia	L-K	18.528	54.565	4.43E-03	6.64E-03	9.27E-03	1.31E-02	3.87E-02	9.84E-02
Gdynia	Ż	18.31	54.58	3.73E-02	6.39E-02	9.53E-02	1.42E-01	3.74E-01	1.10E+00
Katowice	L-K	19.044	50.238	2.50E-04	4.50E-04	6.82E-04	1.00E-03	3.05E-03	9.30E-03
Katowice	Ż	18.826	50.13	2.72E-03	5.18E-03	7.57E-03	8.47E-03	9.43E-03	1.29E-02
Kielce	L-K	20.794	50.958	3.73E-05	5.12E-05	6.92E-05	1.04E-04	4.05E-04	9.11E-04
Kielce	Ż	20.599	50.978	4.20E-05	5.78E-05	7.82E-05	1.17E-04	4.61E-04	1.01E-03
Kraków	L-K	20.195	50.132	1.46E-04	2.82E-04	4.26E-04	5.67E-04	9.00E-04	1.33E-03
Kraków	Ż	20.195	50.132	1.54E-04	2.93E-04	4.42E-04	5.86E-04	9.05E-04	1.31E-03
Kujawsko-pomorskie	L-K	17.924	53.726	3.19E-03	5.75E-03	8.72E-03	1.29E-02	3.25E-02	1.03E-01
Kujawsko-pomorskie	Ż	18.832	53.029	3.22E-02	6.29E-02	9.66E-02	1.32E-01	2.11E-01	3.75E-01
Łódź	L-K	19.594	51.83	9.56E-05	1.28E-04	1.69E-04	2.46E-04	8.81E-04	1.89E-03
Łódź	Ż	19.367	51.724	1.19E-04	1.59E-04	2.11E-04	3.07E-04	1.20E-03	2.65E-03
Łódzkie	L-K	19.71	52.325	5.99E-04	1.06E-03	1.61E-03	2.38E-03	6.52E-03	2.08E-02
Łódzkie	Ż	20.422	51.881	5.20E-04	9.26E-04	1.40E-03	2.08E-03	5.89E-03	1.94E-02
Lubelskie	L-K	23.35	51.432	2.46E-04	2.34E-04	3.56E-04	1.23E-03	3.13E-03	7.32E-03
Lubelskie	Ż	23.193	51.579	3.75E-04	3.58E-04	5.36E-04	1.83E-03	4.40E-03	9.74E-03
Lublin	L-K	22.687	51.258	8.32E-05	7.55E-05	1.13E-04	4.11E-04	9.23E-04	1.75E-03
Lublin	Ż	22.687	51.258	1.21E-04	1.09E-04	1.65E-04	6.12E-04	1.54E-03	3.46E-03
Lubuskie	L-K	14.595	52.405	1.86E-02	3.63E-02	5.55E-02	7.53E-02	1.23E-01	1.84E-01
Lubuskie	Ż	15.063	52.886	2.38E-02	4.57E-02	6.95E-02	9.34E-02	1.50E-01	2.13E-01
Małopolskie	L-K	19.676	50.434	4.68E-04	8.52E-04	1.29E-03	1.94E-03	6.75E-03	2.27E-02
Małopolskie	Ż	20.061	50.398	2.88E-04	5.20E-04	7.93E-04	1.18E-03	4.19E-03	1.55E-02
Mazowieckie	L-K	20.535	53.135	1.44E-03	1.38E-03	2.04E-03	6.84E-03	1.57E-02	3.29E-02

Receptor	Source	Longitude	Latitude	Thyroid absorbed dose mGy:					
				2-day	7-day	14-day	30-day	annual	lifetime
Mazowieckie	Ż	20.361	53.278	2.18E-03	2.08E-03	3.11E-03	1.06E-02	2.46E-02	5.09E-02
Opolskie	L-K	17.83	51.09	2.47E-03	4.83E-03	7.14E-03	8.07E-03	9.09E-03	1.34E-02
Opolskie	Ż	18.515	50.534	2.65E-03	5.08E-03	7.48E-03	8.42E-03	9.49E-03	1.39E-02
Podkarpackie	L-K	21.4	49.5	2.14E-05	3.84E-05	5.82E-05	8.64E-05	2.48E-04	9.05E-04
Podkarpackie	Ż	21.243	49.644	2.63E-04	4.76E-04	7.24E-04	1.08E-03	3.82E-03	1.44E-02
Podlaskie	L-K	23.39	53.466	2.93E-04	5.29E-04	8.07E-04	1.21E-03	3.48E-03	1.25E-02
Podlaskie	Ż	23.185	53.491	3.29E-04	5.97E-04	9.11E-04	1.37E-03	3.92E-03	1.38E-02
Poznań	L-K	17.032	52.277	1.98E-02	3.62E-02	5.22E-02	5.84E-02	6.30E-02	8.07E-02
Poznań	Ż	16.829	52.289	1.61E-02	3.06E-02	4.48E-02	5.02E-02	5.58E-02	7.83E-02
Radom	L-K	21.118	51.432	1.65E-05	2.32E-05	3.12E-05	4.39E-05	1.69E-04	3.65E-04
Radom	Ż	21.315	51.411	8.28E-05	9.32E-05	1.32E-04	3.25E-04	8.93E-04	1.89E-03
Rzeszów	L-K	21.788	50.218	9.47E-05	1.72E-04	2.64E-04	3.94E-04	1.31E-03	4.09E-03
Rzeszów	Ż	22.014	50.319	8.26E-05	1.45E-04	2.19E-04	3.25E-04	1.08E-03	3.65E-03
Śląskie	L-K	19.704	50.558	4.43E-04	7.99E-04	1.21E-03	1.80E-03	6.32E-03	2.24E-02
Śląskie	Ż	19.316	50.593	2.78E-04	4.92E-04	7.41E-04	1.09E-03	3.74E-03	1.26E-02
Świętokrzyskie	L-K	19.704	50.558	4.38E-04	7.89E-04	1.20E-03	1.77E-03	6.32E-03	2.24E-02
Świętokrzyskie	Ż	19.897	50.54	2.78E-04	4.92E-04	7.41E-04	1.09E-03	3.74E-03	1.26E-02
Szczecin	L-K	14.723	53.527	2.31E-03	4.16E-03	6.32E-03	9.40E-03	2.54E-02	8.28E-02
Szczecin	Ż	14.723	53.527	2.43E-03	4.39E-03	6.68E-03	9.96E-03	2.65E-02	8.48E-02
Toruń	L-K	18.832	53.029	8.75E-04	1.54E-03	2.30E-03	3.40E-03	9.21E-03	2.86E-02
Toruń	Ż	18.832	53.029	5.78E-04	8.23E-04	1.11E-03	1.56E-03	5.98E-03	1.42E-02
Warmińsko-mazurskie	L-K	20.44	54.41	2.29E-03	4.05E-03	6.11E-03	9.08E-03	2.35E-02	7.14E-02
Warmińsko-mazurskie	Ż	19.474	53.987	5.18E-03	9.28E-03	1.40E-02	2.11E-02	5.49E-02	1.86E-01
Warsaw	L-K	20.884	52.089	3.88E-04	6.93E-04	1.05E-03	1.55E-03	4.08E-03	1.42E-02
Warsaw	Ż	20.884	52.089	2.71E-04	2.64E-04	3.90E-04	1.27E-03	2.96E-03	6.09E-03
Wielkopolskie	L-K	17.041	53.533	6.01E-02	1.14E-01	1.66E-01	1.86E-01	2.09E-01	2.89E-01
Wielkopolskie	Ż	17.458	53.506	6.56E-02	1.25E-01	1.83E-01	2.03E-01	2.25E-01	3.05E-01
Wrocław	L-K	17.022	51.021	9.53E-04	1.80E-03	2.64E-03	2.95E-03	3.29E-03	4.67E-03
Wrocław	Ż	17.043	51.145	1.25E-03	2.53E-03	3.78E-03	4.31E-03	4.97E-03	7.67E-03
Zachodniopomorskie	L-K	16.961	54.292	1.48E-02	2.64E-02	3.98E-02	5.87E-02	1.82E-01	5.08E-01
Zachodniopomorskie	Ż	16.77	54.429	1.66E-02	2.90E-02	4.36E-02	6.44E-02	1.71E-01	5.40E-01

Source: [1]

Reference materials

References

1. Modelling of contamination and calculation of dose rates beyond 30 km from the NPP for accidents representative of emergency planning. Document code: BLS_ADR_ADR01_RY_05003_04_PL.

List of Tables