

D.1.1.3 Bordeaux Test Site Report

CONFIDENTIAL



Rev.	Amendments	Issue	Validation	Date Approval
1	Initial Release	F. Vince	M. Kiersnowski	Dec 25

1. Tables, references and acronyms

1.1 Table of Contents

1. Tables, references and acronyms.....	2
2. Introduction.....	5
3. Regulatory framework.....	22
4. Maritime coordination.....	25
5. Electrical coordination	31
6. Information system	35
7. Environmental impact monitoring	35
8. Insurance and certification	36
9. Appendices.....	37

1.2 Table of figures

Figure 1 : Location of the SEENEOH test site in the Gironde estuary.....	6
Figure 2: Perimeter of the SEENEOH test site in Bordeaux.....	7
Figure 3 : Aerial photo of the test site and slots	7
Figure 4 : SEENEOH site locations, with platforms and connections	8
Figure 5: "Bare" pitches of the SEENEOH site, with connection	8
Figure 6: Current status of the SEENEOH website (November 2025)	9
Figure 7: High-resolution bathymetric data (Source EDL).....	10
Figure 8: Multibeam echosounder bathymetric data, February 2019 (Ref..20).....	11
Figure 9: Depth at each berth.....	12
Figure 10: Bathymetry profile and depth at Bilbao (Ref. zero hydro)	13
Figure 11: and depth at the different positions of Bilbao (Ref. zero hydro).....	13
Figure 13: Evolution of the surface salinity according to the tide in July 2005 (as modified in Sottolichio et al., 2011, Observations of suspended sediment dynamics in a highly turbid macrotidal estuary, derived from continuous monitoring. Journal of Coastal Rese	15
Figure 14: Floating debris on the Garonne river, Bordeaux	16

Figure 15: Variation of the turbidity profile at Bordeaux on a tidal cycle	17
Figure 16: Position of the TMZ in winter (left) and in summer (right) (source: D. Doxaran)	17
Figure 17: Tidal range propagation (Modified from Salomon et al. 1980).....	18
Figure 18: Tidal range in Bordeaux (Source: Port of Bordeaux)	19
Figure 19: Water levels at the different slots. Source: SHOM	19
Figure 34: Starboard side marker	26
Figure 35: Principle of connection to the SEENEOH network	31
Figure 36 : Simplified single-line diagram of the SEENEOH onshore substation	32

1.3 Table of tables

Table 1: Delineation of the zone in the UTM Zone 30N reference system (WGS84).....	5
Table 5: Phases, Main Deliverables and Roles related to the hosting of a demonstrator on SEENEOH	22
Table 6: Electrical and optical tests	34
Table 7: Phases, Main Deliverables and Roles related to the hosting of a demonstrator on SEENEOH	37

1.4 References

- [1] Agreement for the Temporary Occupation of the Natural River Public Domain, 01/10/2015, amended by amendment on 03/10/2022 (extension) and 04/04/2024 (change of beneficiary)
- [2] Declaration of the Water Law, registered at the Single Window of Water Police under n° 33-2012-00083, on March 6, 2012
- [3] Ministerial decision to create maritime signalling for the marking of a tidal turbine site near the Pont de Pierre in Bordeaux, 08/06/2016
- [4] BI1-ENV-RP-001_Rapport METOC_SEENEOH
- [5] [Decree No. 86-606 of 14 March 1986 on nautical commissions](#)
- [6] Maritime Coordination Plan – SEENEOH
- [7] Maritime Intervention Plan – SEENEOH
- [8] Electrical coordination plan – SEENEOH

1.5 Acronyms

COT	Temporary Occupancy Agreement
BT	Low Voltage (U<1kV)
CARD-I	Feed-in Distribution Network Access Contract
CNL	Local Nautical Commission
DPM	Maritime Public Domain
DPFn	Natural River Public Domain
EMR	Marine Renewable Energies
FO	Fiber Optics
GPMB	Grand Port Maritime de Bordeaux
HAZID	HAZard Identification
LAT	Lowest Astronomical Tide
MWS	Marine Warranty Surveyor
PDL	Delivery Station
PIM	Maritime Response Plan
QHSE	Quality, Health, Safety, Environment
ROV	Remotely Operated Vehicle
SCADA	Supervisory Control and Data Acquisition
SEENEOH	National Estuarine Experimental Site for the Testing and Optimization of Tidal Turbines

2. Introduction

2.1 Background

The SEENEOH experimental site is intended to test tidal turbines that can be connected to the electricity distribution network. The SEENEOH website is also intended for research and development activities on system equipment, its environmental impact and its in-service monitoring.

In addition to the collaboration agreement signed between the OPEN-C Foundation ("OPEN-C") and the entity in charge of the on-site demonstrator ("the Company"), this document specifies the framework and requirements of the local authorities and OPEN-C relating to the hosting, on the SEENEOH site, of a demonstrator developed by the Company. He describes:

- The site and its infrastructure;
- The regulatory framework and the process for hosting demonstrators on site;
- Characterization of the site's environmental conditions;
- The regulatory framework and the Parties' commitments in terms of environmental monitoring;
- The maritime safety rules to be respected on the site;
- The constraints associated with the electrical connection to the Public Distribution Network (PDN);
- Obligations in terms of data sharing/communication via OPEN-C's SCADA system;
- The conditions of insurance and certification.

2.2 Presentation and occupancy of the test site

The SEENEOH tidal energy site is located in the Nouvelle-Aquitaine region, in the Gironde department, on the Garonne in Bordeaux. The SEENEOH test site, represented Figure 1 and Figure 2 includes:

An area in the city centre of Bordeaux on the river part of the Gironde Estuary. The test site benefits from authorisations [1] and [2]. The geographical coordinates of this 7-hectare experimental area are defined in the Temporary Occupation Agreement (TOC) [1] and specified in the Table 1. The depth of the site is between 2m and 17m LAT. The area is signalled on site by 2 green channel buoys. The area is delimited by its four georeferenced corners:

Table 1: Delineation of the zone in the UTM Zone 30N reference system (WGS84)

	Latitude	Longitude
North	44.839409	-0.565261
East	44.836511	-0.566777
South	44.835653	-0.561753

West	44.838480	-0.563155
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A dedicated electricity network, connected to the public electricity distribution network in 400Vac (compound three-phase voltage) at a frequency of 50Hz and whose power must not exceed 250kVA.

A secure computer network consisting of an operational center on land, located in the converter station, currently equipped with a 100Mb/s internet connection, and hosting the site's digital infrastructure.



Figure 1 : Location of the SEENEOH test site in the Gironde estuary

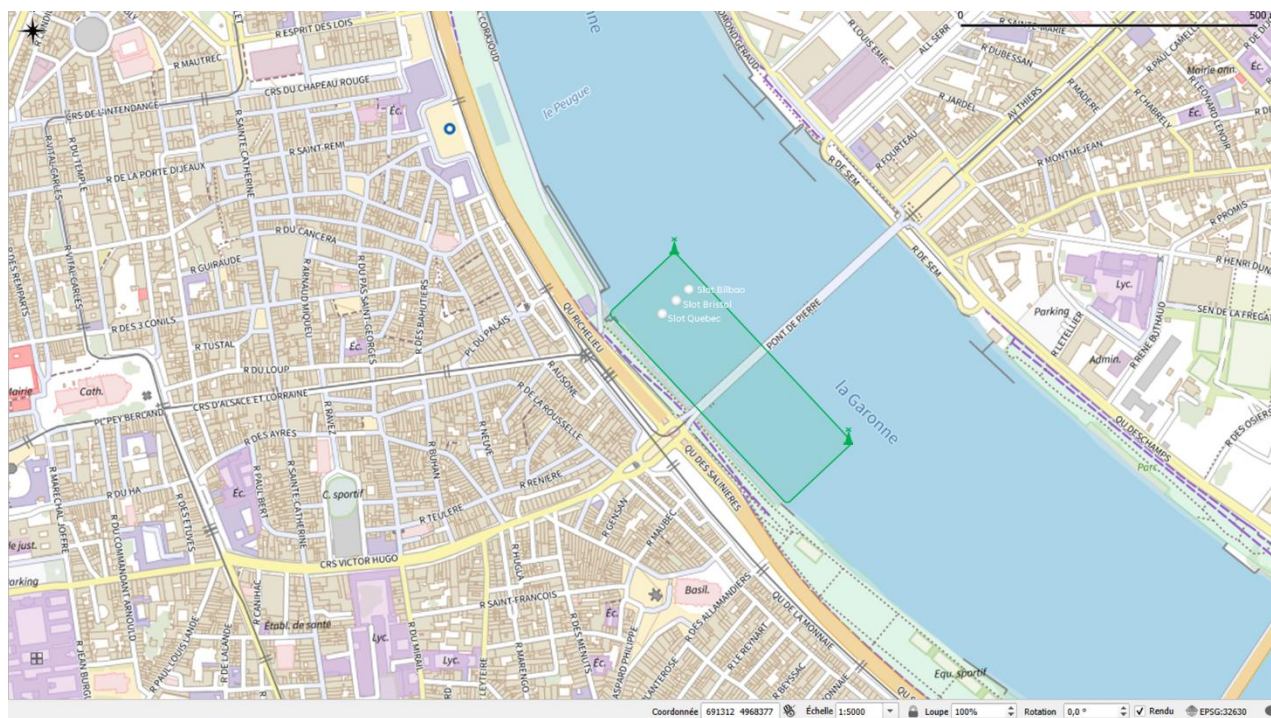


Figure 2: Perimeter of the SEENEOH test site in Bordeaux



Figure 3 : Aerial photo of the test site and slots

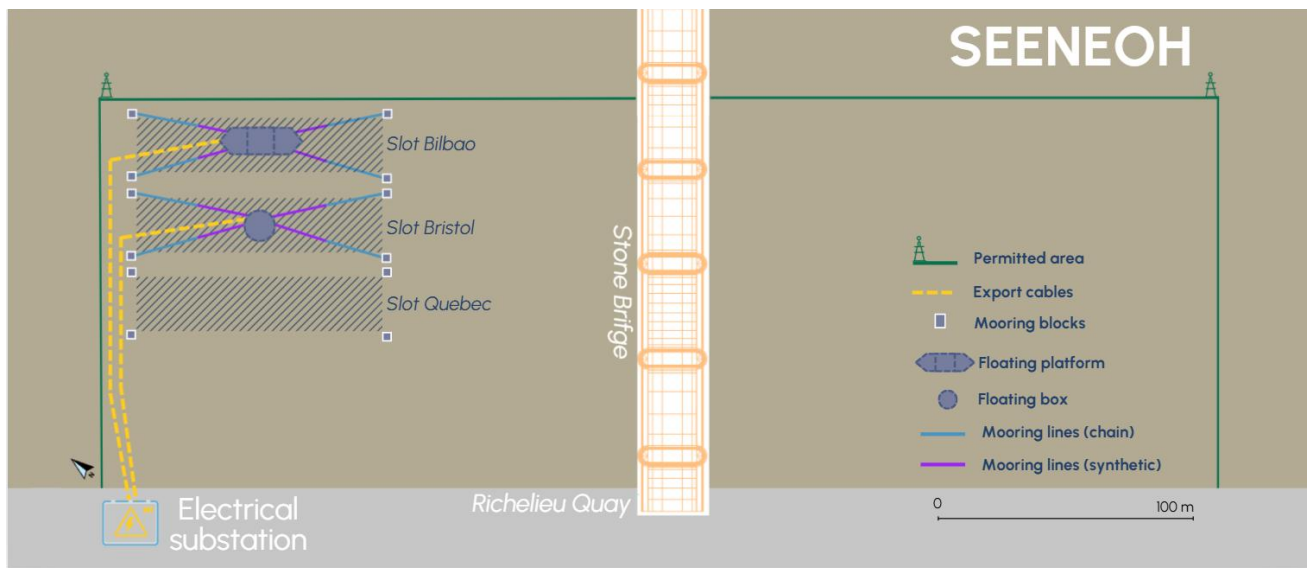


Figure 4 : SEENEOH site locations, with platforms and connections

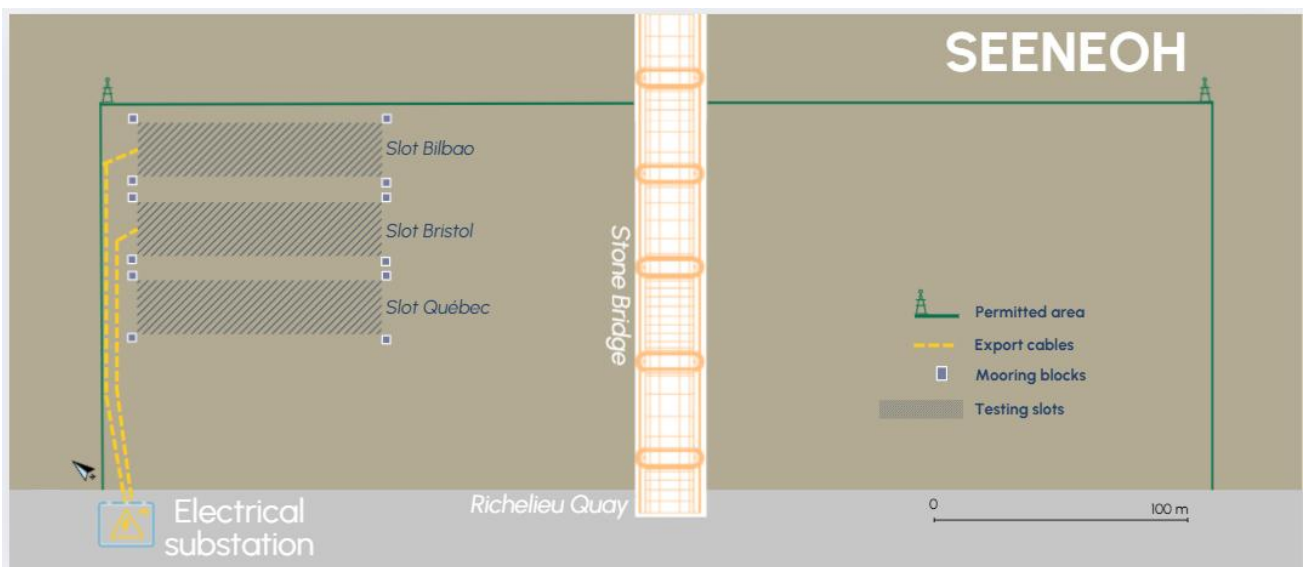


Figure 5: "Bare" pitches of the SEENEOH site, with connection

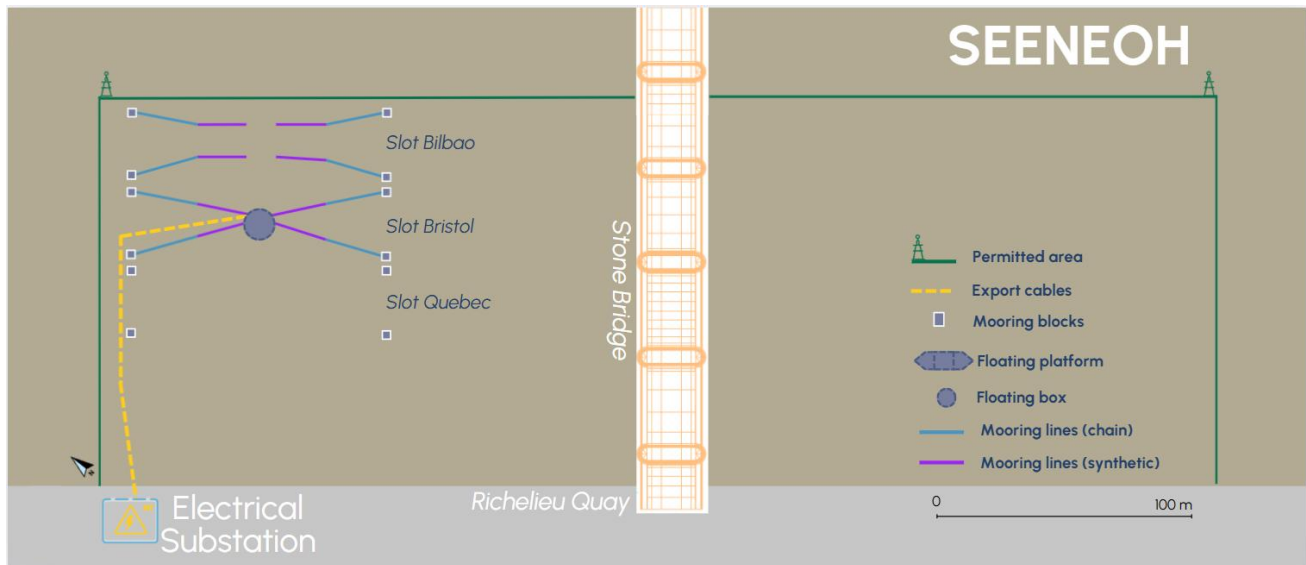


Figure 6: Current status of the SEENEHOH website (November 2025)

In the event that several demonstrators are present on the test site, OPEN-C, as manager of the test site, ensures coordination between projects, in order to ensure that the interests and confidentiality due to each project are respected.

2.3 Characterization of the site's environmental conditions

The METOC Seeneoh [4] describes the environmental conditions of the site. This document should serve as a basis for the design of the various components of the demonstrator, in particular for the design of subsea elements and associated accessories (cables, anchors, submerged systems, etc.), for the determination of the behaviour of floating systems, and for the determination of systems subjected to hydrodynamic forces.

Some relevant features of the METOC Seeneoh [4] are described below.

2.3.1 Bathymetry

Given the hydrodynamic regime of the area, scouring areas are created downstream and upstream of the bridge, with depths up to 17 meters (Ref. Zero Hydro 2003).

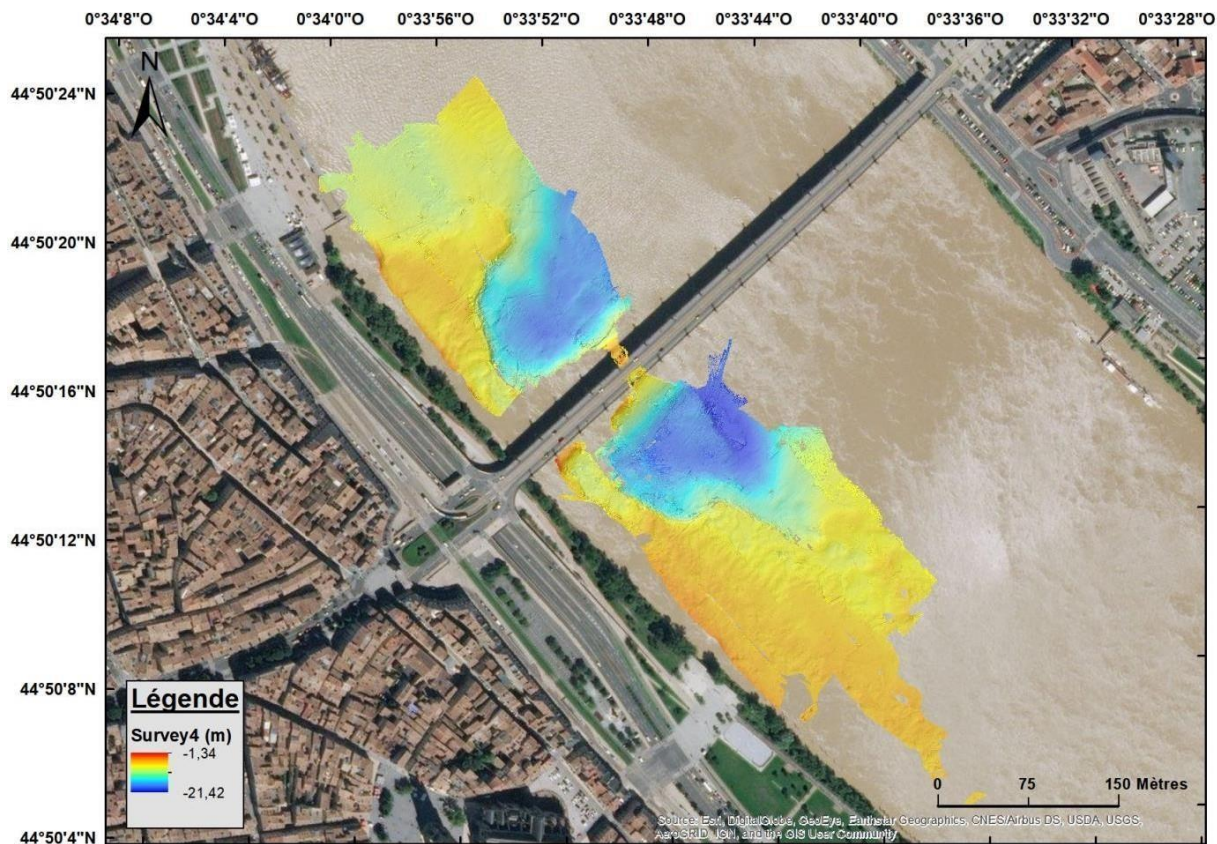


Figure 7: High-resolution bathymetric data (Source EDL)

At the position of the berths, the depth ranges between 2,5- and 7-meters depth (Ref. zero hydro).

Regular bathymetric surveys are carried out on the test site for environmental monitoring purpose. The bathymetric data corresponding to the latest survey (February 2019, Ref. 19) are detailed below. The berth locations are represented by the 3 dotted circles.

The bathymetric survey and equipment used are complying with the IHO Standards for Hydrographic Surveying (S44, 5th edition) Order 1A standard.

Horizontal datum: referenced in the WGS84 geodetic system (World Geodetic System 1984). Grid coordinates is processed using the projection Universal Transverse Mercator (UTM) Zone 30 projection.

Vertical datum: a terrestrial datum is based on the French General Levelling NGF - IGN69. The referential zero hydro 2003 corresponds to low water level. It is located 1.81 m below the zero NGF or -1.81 m NGF IGN69. We use the zero hydro 2003 as vertical referential for reading the depth as nautical chart would do.

NGF and Zero Hydro

The “Nivellement Général Français” is an altimetric landmarks network spread over the French continental metropolitan territory as well as Corsica, and for which the IGN (Institut Géographique National) is currently in charge. This network is currently the official levelling network in metropolitan France. NGF-IGN69 has the Marseille tide gauge as "level zero". It is positive towards zenith.

The “zero hydrographic 2003” is the hydrographic datum, or chart datum, represents the reference level from which depth soundings on nautical charts are counted positively towards nadir. Also called zero low water, it is chosen in France as the level of the lowest astronomical water. This is a theoretical level below which the water level only falls very exceptionally.

The latest bathymetric data of the test site has been acquired in February 2019. The figure below displays the isobaths every meter. The berth locations are represented by the 3 dotted circles.

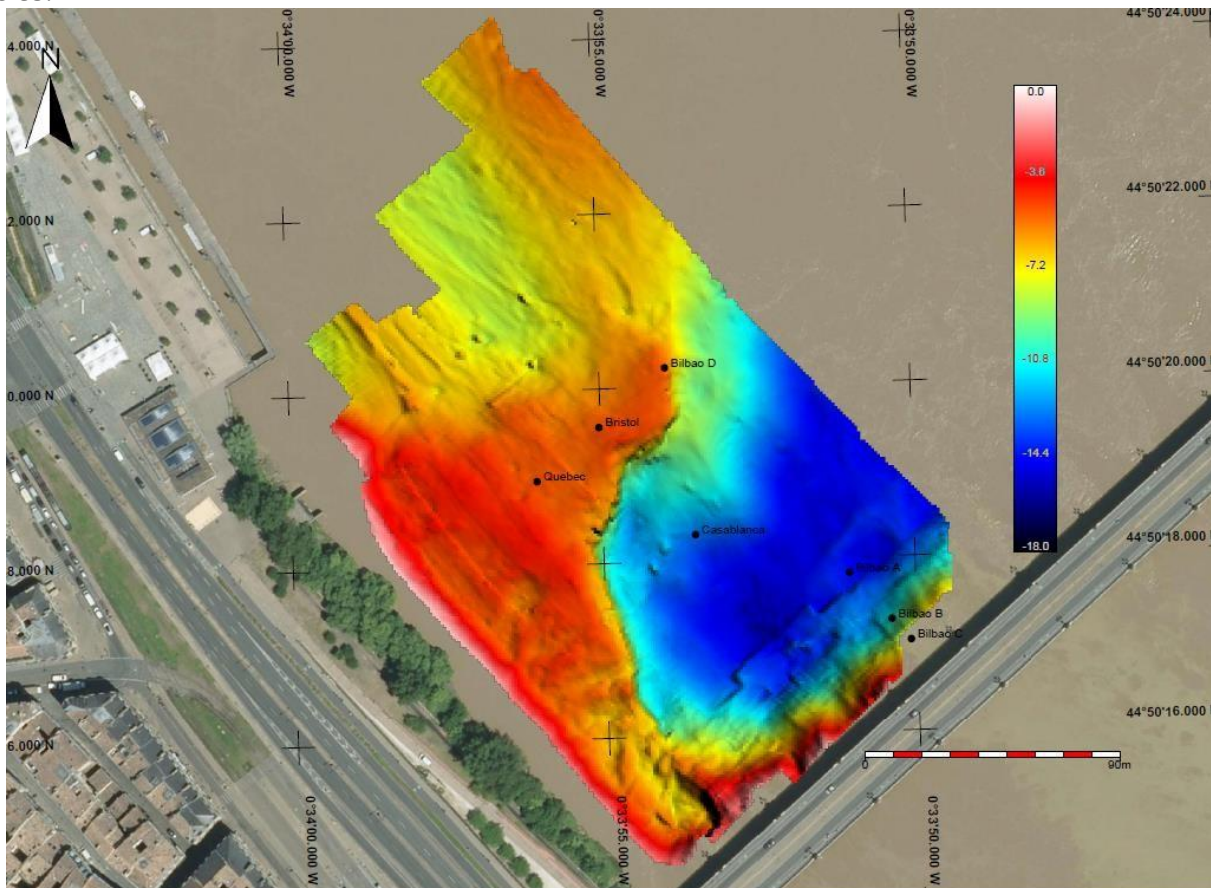


Figure 8: Multibeam echosounder bathymetric data, February 2019 (Ref..20)

The depth of each individual berth is reported below:

Berth	Latitude WGS84	Longitude WGS84	Depth m (Zero Hydro)	Depth m (Zero NGF)
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Bilbao	44°50.337'N	0°33.899'W	4.83	-6.64
Bristol	44°50.326'N	0°33.917'W	4.95	-6.76

Figure 9: Depth at each berth

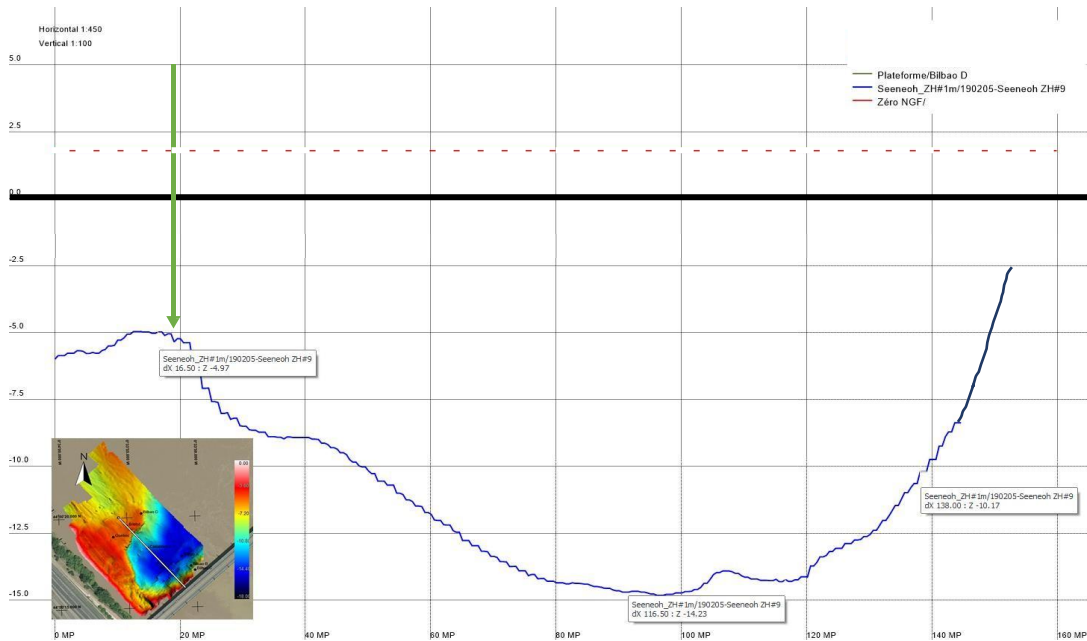


Figure 10: Bathymetry profile and depth at Bilbao (Ref. zero hydro)

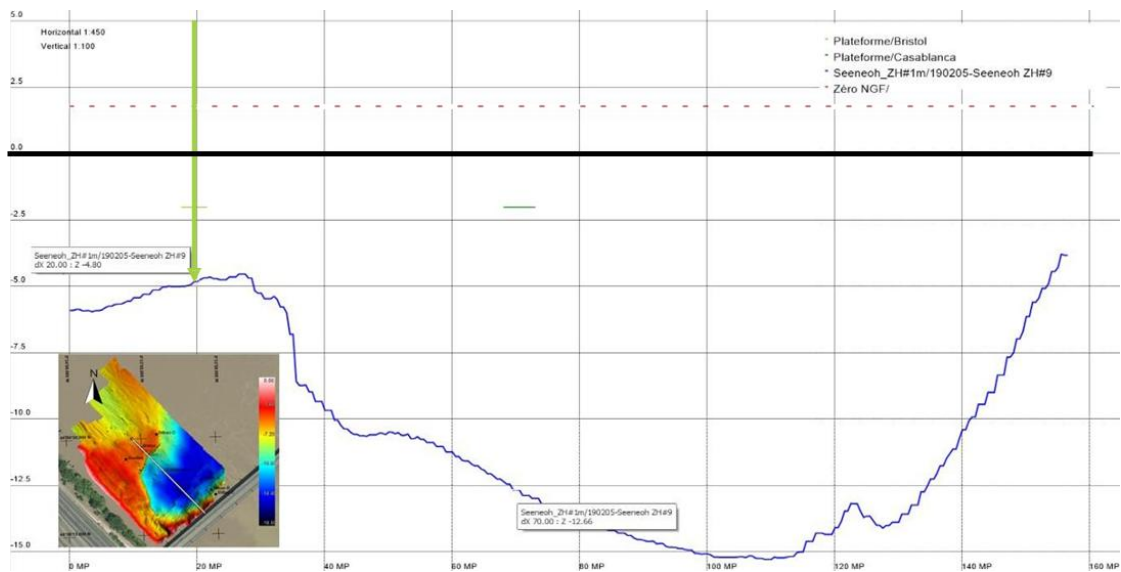


Figure 11: and depth at the different positions of Bilbao (Ref. zero hydro)

2.3.2 Nature of the seabed

The sedimentary facies encountered at the test site are not characteristic of a natural deposition area. Indeed, the presence of the bridge has modified local hydrodynamics. Thus, in the vicinity of the bridge, fine sediments (clays/vases) tend to be expelled. Coarser sediments (sands/gravels) are then deposited.

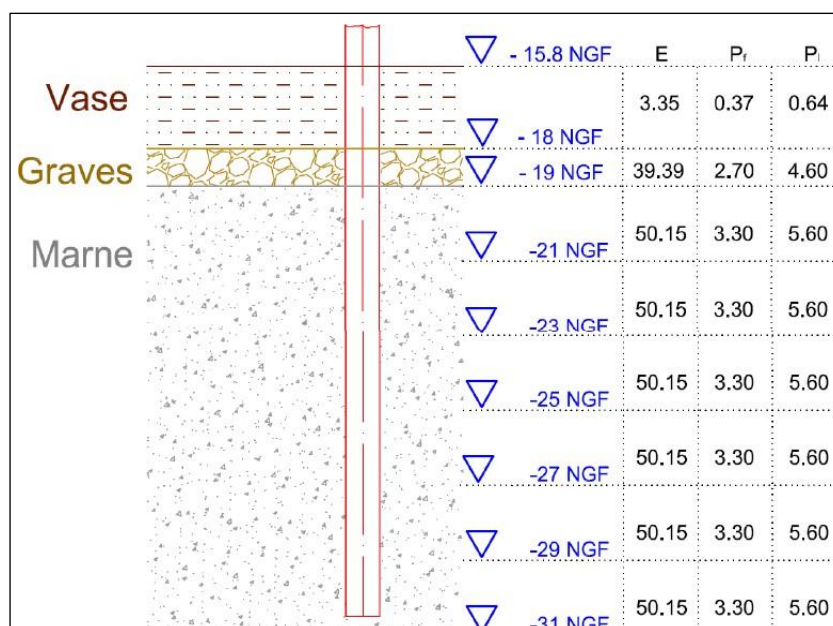


Figure 8: Geological cross-section from a campaign of 1981 at piers 4,5,6 of the Pont de Pierre. E: Pressure in MPa, P_f: Pressure of the fluid MPa, P_i: Ultimate pressure in MPa (Source: BRGM)

The geological surveys were carried out in 1981 survey at piers 4, 5 and 6 of the bridge. In this reference, it is specified:

- the roof of the marly substratum which deepens from the left bank (-15 NGF) to pile n°9 (-22 NGF),
- the sand and gravel horizon underlying the mud has a thickness of less than 1 m on the left bank and reaches 11 m on the right bank.

A dual-frequency survey (15 and 33 kHz) identified the thickness of the soft mud layer. This was characterized on the test site area and indicates a thickness of about 20 cm in the shallow areas (Ref. 14).

2.3.3 Salinity

The intrusion of more saline oceanic waters results in variations of the semi-diurnal salinity in Bordeaux area, ranging between 1 and 4 PSU during spring tides. Generally, the salinity reaches its highest level at the end of the flow tide and its lowest level at the end of the ebb tide.

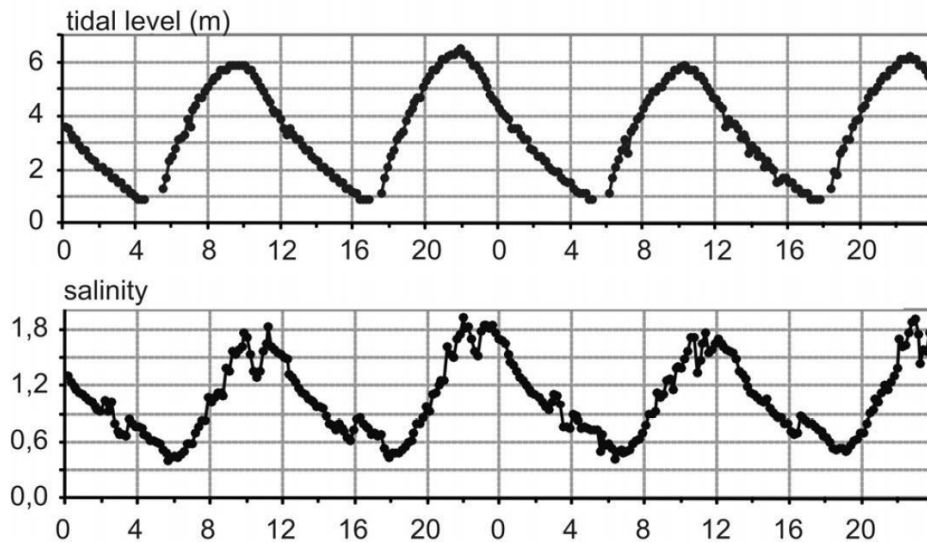


Figure 12: Evolution of the surface salinity according to the tide in July 2005 (as modified in Sottolichio et al., 2011, *Observations of suspended sediment dynamics in a highly turbid macrotidal estuary, derived from continuous monitoring. Journal of Coastal Rese*

2.3.4 Debris

The Garonne is a river having floating debris, which in most cases consist of branches and tree trunks. These debris transported during flood periods can reach multi-metres dimensions. They occur in Bordeaux mainly after rainy events and after high-water levels during spring tide. An additional factor to consider is the snowmelt in the Pyrenees Mountains (Spring).

SENEOH takes the benefit of the bidirectional currents that create a tidal bidirectional current allowing a “self-cleaning” of debris trapped into the equipment and mooring lines. However, maintenance operations are sometimes required.

This challenge must be carefully addressed by the User which must consider robust design and device protection together with additional financial support in case damages occur.



Figure 13: Floating debris on the Garonne river, Bordeaux

2.3.5 Turbidity maximum zone (TMZ)

The Gironde estuary is one of the most turbid estuary in Europe. The important concentration of suspended particles matter (SPM) gives its striking brown colour. On the surface, SPM frequently exceed a concentration of 0.4 g/l. This concentration increases with depth to reach values of about 100 g/l near the bottom. The Turbidity Maximum Zone (TMZ) is an area where SPM is highly concentrated. Its formation is facilitated by the combination of fresh waters loaded with SPM and nutrients in solution and marine saline waters. The position of this zone of maximum turbidity migrates according to hydrodynamic conditions depending on different time scale.

The mineralogical composition of SPM includes on average 65% micas and clays and 20% sand, the rest being feldspar, calcite and other minerals (Etcheber, 1978). Since 1978, numerous *in situ* measurements have been carried out in the estuary so that this phenomenon is quite well understood and monitored.

Sediment dynamics in the estuary evolve according to 3 different time scales:

- The tidal scale, i.e. the tidal cycle,
- The seasonal scale, mainly driven by freshwater river discharge,
- The multi-year scale influenced by global climate variations.

During dry and low-water periods occurring in summer/fall, the TMZ rises towards the upstream part of the estuary and towards the river parts. During flood periods, the TMZ moves downstream and can be partially expelled to the ocean. The concentrations of SPM or sediment found within the TMZ are 100 to 500 times higher than those found in the clear rivers or at sea. The deposited part is called fluid mud, and its thickness is maximum during periods of neap tide, because the residual currents are less intense, favouring the deposition phases.

At slack water, sediment deposition occurs on the riverbed and banks. In the channel fluid mud can form elongated patches, with concentrations up to 300 g/L (Allen, 1971).

The test site area is subject to the seasonal variation of the position of the TMZ. This characteristic should be considered with regards to abrasion problems occurring and therefore the choice of materials used for prototypes.

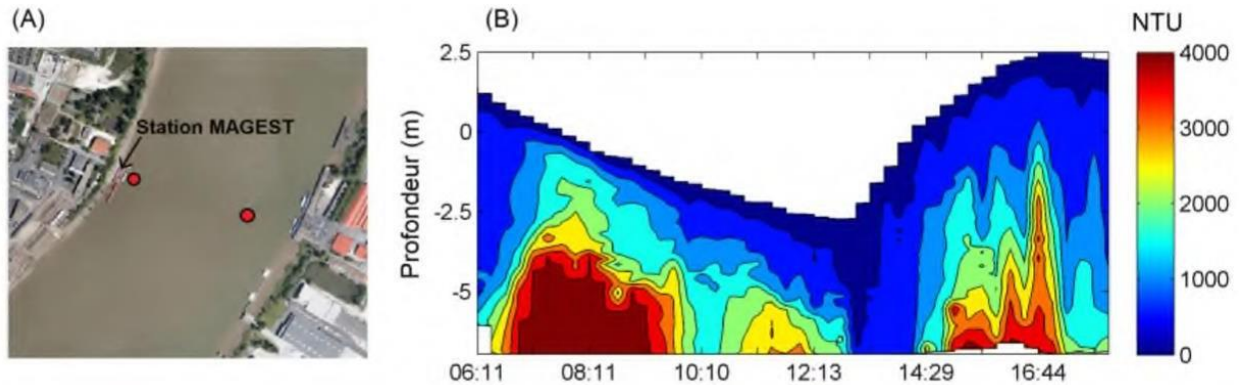


Figure 14: Variation of the turbidity profile at Bordeaux on a tidal cycle

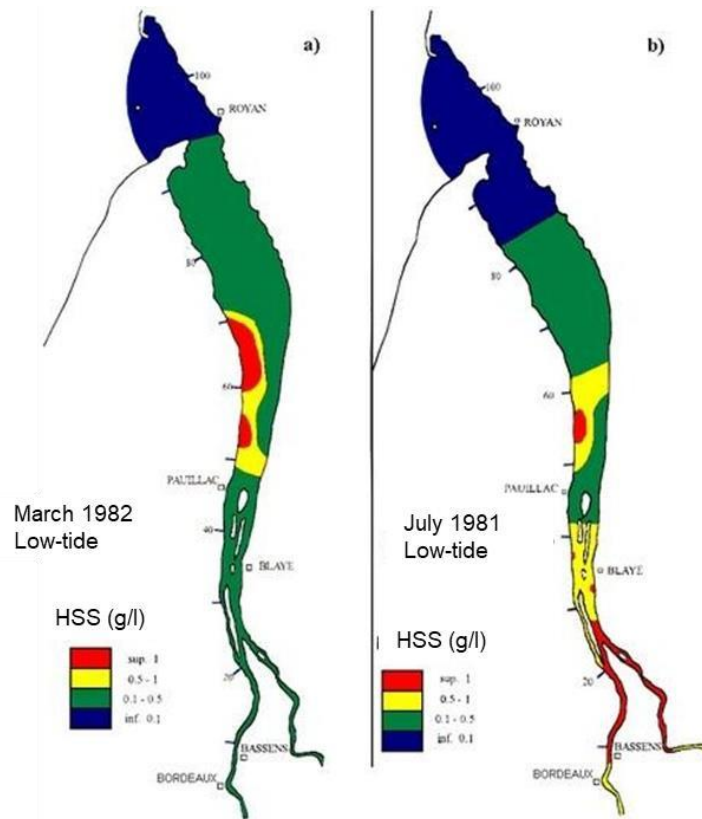


Figure 15: Position of the TMZ in winter (left) and in summer (right) (source: D. Doxaran)

2.4 Hydrodynamics

The hydrodynamic regime of the Garonne at the SEENEOH test site is driven by the tide and also the river flow.

2.4.1 Tidal range

The Gironde is a macrotidal estuary with a tidal range between 2 and 6 m. During spring tides, Bordeaux tide gauge, located close to the test site, record tidal ranges of up to 5.8 m. This range increases upstream due to the narrowing of the river width and the shallowing depth: the estuary is hypersynchronous.

The Gironde Estuary is subject to the semi-diurnal tides of the Bay of Biscay over a period of 12h24min. When the tide enters into the estuary, three phenomena occur:

- | Friction on the bottom, which results in a slowing of the tide as it travels upstream from the estuary;
- | The narrowing of the upstream flow sections that causes the tide to be amplified;
- | Reflection on the banks.

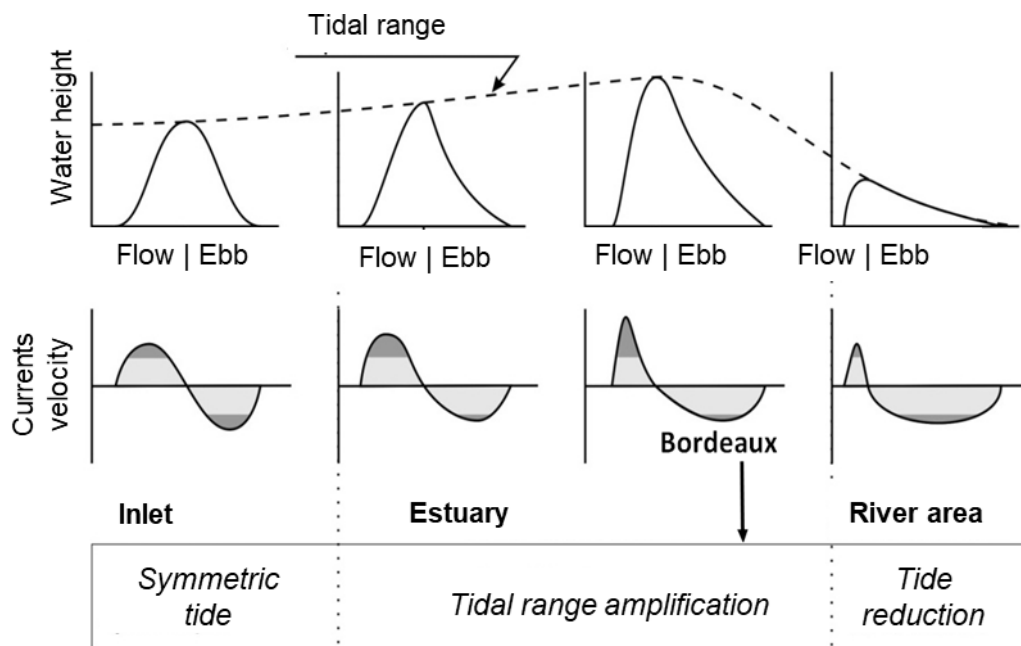


Figure 16: Tidal range propagation (Modified from Salomon et al. 1980)

The flow passage being narrower, the tidal range is amplified and the current intensified, which results in an asymmetry: the flow is shorter. As they are faster, the flow tides are more intense than ebb tides.

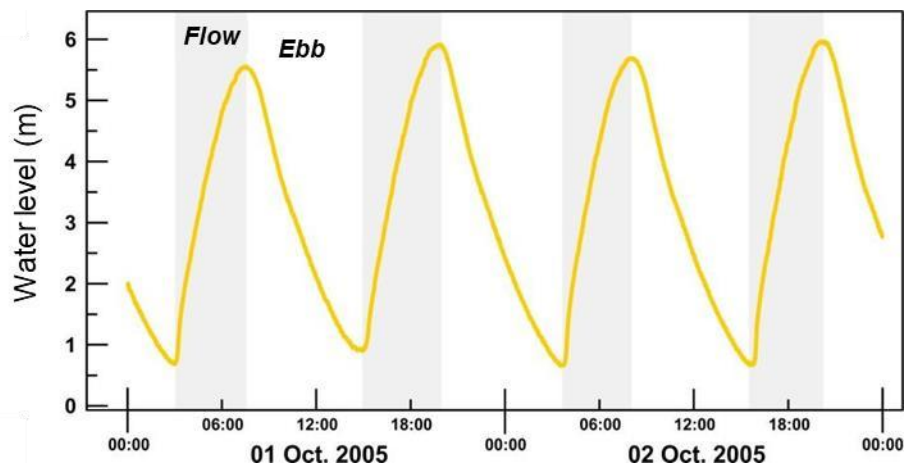


Figure 17: Tidal range in Bordeaux (Source: Port of Bordeaux)

Typical water levels of each slots are given below. The three levels of high tide (PHMA, PMVE and PMME) respectively correspond to coefficients of 120, 95 and 45. The levels for the port of Bordeaux come from Total Tide software of the UKHO which uses data from SHOM.

Typical tidal levels		Port of Bordeaux	Bristol	Bilbao
		(m Zero hydro)	(depth m)	(depth m)
100-years rating		7.05	12	11.88
Level of highest astronomical tide	PHMA	6.2	11.15	11.03
Level of medium high tide at spring tide	PMVE	5.3	10.25	10.13
Level of medium high tide at neap tide	PMME	4.2	9.15	9.03
Medium level of sea	NMM	2.45	7.4	7.28
Level of medium low tide at neap tide	BMME	0.4	5.35	5.23
Level of medium low tide at spring tide	BMVE	0	4.95	4.83
Level of the lowest astronomical tide	PBMA	- 0.2	4.75	4.63

Figure 18: Water levels at the different slots. Source: SHOM

2.4.2 River discharge

The Garonne River originates in Spain, in the Val d'Aran. Its French part begins at Pont-du-Roi and leaves the Pyrenees downstream of Saint-Gaudens. It then joins a main river at the confluence of the Ariège, crosses the city of Toulouse, receives the Tarn and the Lot, before reaching Bordeaux. The Garonne drains, with its different tributaries, a catchment area of 55,000 km². Its length of 580 km makes it the 3rd longest French river, behind the Loire and the Seine. The Garonne's feeding regime is both snowy (fed by snowmelt) between Spain and Toulouse, and rainy (fed by both rainwater and snowmelt) downstream of Toulouse.

2.5 Currents

The sections below will be progressively completed as more data is available.

CEREMA has contributed to the description of the environmental features for the SEENEOH test site. CEREMA has exploited a 3D numerical model to estimate the variability of the resources with 2015-2024 period. The model has been forced with a daily time series of the flowrate. Results will be incorporated in a next version of this document.

2.6 Climate

The climate of the Gironde Estuary is oceanic. In autumn and winter, rainfall is high. Winters are relatively mild. In summer, there is a lot of sunshine, allowing high summer temperatures to be reached. The general characteristics of temperature, wind and precipitation in the project area are indicated below (Source Météo France, Mérignac station).

2.6.1 Temperatures

The average winter temperatures (January) vary from 5 to 7°C. Frost occurs on average about two weeks a year. The hottest months are July and August, with average temperatures of 21°C and regular exceedances of the 30°C.

2.6.2 Rainfalls

The average cumulative annual total rainfall is relatively high (1,000mm/year) with peaks generally occurring in late autumn (rainfall above 100 mm in November and December). The driest months are statistically July (54.5 mm) and August (59.5 mm). The distribution of precipitation during the year is quite irregular. The annual number of days of precipitation (rainfall greater than 1 mm) is low (around 128 days). Less than 3 days of snow are recorded per year on average (1985 - 2000).

2.6.3 Wind

The predominant winds in both duration and speed come from the western sector. Thus, for the sector between the azimuths 240° and 300°, the occurrence of winds with speeds greater

than 2 m/s is equal to 25%. For speeds strictly above 8 m/s, this frequency is 1.7%. Inland winds generally blow from the Northeast (14.6%) and Southeast (12.8%) sectors.

The maximum wind speed recorded in Bordeaux during the storm of December 27, 1999, during which the highest water levels observed since the beginning of the twentieth century occurred at tide gauge stations between Le Verdon and Bordeaux, is 145 km/h, for an average hourly speed of 90 km/h.

2.6.4 Sea conditions

The swell that develops in the Bay of Biscay does not enter into the estuary; it breaks on the sandbanks of the inlet. There is no influence of swell on the test site area.

The characteristics of waves depend on wind speed and direction (occurrence of waves from 3 to 4 m/s wind speed), the duration of exposure and the extent of the water affected. During the storm of December 27, 1999, the very strong winds that blew over the estuary caused significant turbulence in the water body and waves of up to 1 metre in height were recorded over the test site area.

This phenomenon remains exceptional and the meteorological and geographical characteristics make the test site a particularly sheltered area. As a result, maintenance phases and scientific field surveys are not often disrupted. However, they can be occasionally delayed because of debris or heavy fog. Some operations may need to be carried out preferably during slack tide.

3. Regulatory framework

3.1 Permits

The SEENEOH sea trial site is the subject of a Temporary Occupation Agreement for the Natural River Public Domain (COT) [1] and a Declaration under the Environmental Code. These administrative authorisations set out the conditions for the use of the test site:

- The prototypes and demonstrators tested: tidal turbine technologies;
- The geographical boundaries (area of 0.6km² mapped via its four georeferenced corners);
- Up to 3 tidal turbines connected simultaneously;
- The reciprocal exchange of environmental scientific data;
- The fee related to the occupation of the sites;
- The restoration of the premises to their original state at the end of the experiment.

The COT defines the responsibility of the test site manager with regard to the prototypes/demonstrators and the rules of operation of the site. The process for onboarding new systems is described in the 3.2 below.

3.2 Reception procedure for the installation of a demonstrator

The Table 2 presents the hosting of a demonstrator on the test site as well as the main deliverables associated with them.

Appendix 1 presents the terms and conditions of access to the SEENEOH site for major operations (installation, maintenance, dismantling, etc.) related to the hosting of a demonstrator on site. The conditions of access to the site and the demonstrator during the operation phase are described in the Maritime Coordination Plan [6].

The Demonstrator Dossier and the Works Documentation are the two key documents for authorizing the project. They are to be provided by the Company wishing to deploy a demonstrator on the SEENEOH test site. They are intended for OPEN-C, and may, if necessary, be shared with the services of the Port of Bordeaux and the members of the Local Nautical Commission (CNL), in cases where it is necessary to convene it.

The expected contents of the folders are described in the following sections. Templates prepared by OPEN-C will be provided to the Company.

Table 2: Phases, Main Deliverables and Roles related to the hosting of a demonstrator on SEENEOH

Phases	Deliverable	Company	OPEN-C
Contracting	Confidentiality agreement	A	R
	Reservation Agreement	A	R
	Cooperation agreement <i>t0-9 months</i>	A	R
Preparation of the welcome	Demonstrator Dossier <i>t0-6 months</i>	R*	A
	Installation Procedure + HAZID <i>t0-4 months</i>	R	A
	Works Documentation <i>t0-3 months</i>	R*	A
	Dismantling deposit payment <i>t0-3 months</i>	R	A
	Risk analysis (HAZID) operation <i>t0-3 months</i>	R	A
	Maritime Response Plan (MIP) installation and operation, <i>t0-2 months</i>	R*	A
	Holding of a Local Nautical Commission (CNL), at the discretion of the State Services <i>t0-2 months</i>	C	C
Installation = t0	Installation Report	R	A
	Commissioning tests	R	A
Operation	Maritime Intervention Plan (PIM)	R*	A
	Environmental Monitoring Reports	C	R
Dismantling	Works Documentation	C*	R
	Dismantling procedure	R	A
	Decommissioning Report	R	A
	Waiver of the dismantling bond	R	C

*based on a report template provided by the Foundation

RACI Matrix Legend:

- R: Responsible - Responsibility for writing the document / carrying out the activity
- A: Accountable – Approval, Validation
- C: Consulted – Advice, contribution, review, expertise or opinion
- I: Informed – Information

3.2.1 Demonstrator Dossier

The Demonstrator Dossier is a document presenting the project and includes at least the following elements:

- General description of the project, the test program and its objectives;
- Planning with the main milestones for the installation, operation and dismantling of the demonstrator;
- Description of the system as a whole and its specificities, allowing a simple and concise understanding of how the system works, is anchored to the bottom and connected to the SEENEOH electricity network. The technical descriptions must in particular make it possible to ensure that there are no significant impacts on the environment;
- Description of the methods envisaged for the operations (installation, commissioning, operation and maintenance);
- Environmental monitoring program;
- Preliminary risk analysis (HAZID) to identify risks concerning people, the environment, maritime activities. The measures taken to mitigate these risks must be described in the file;
- Insurance plan;
- Description of the methods envisaged for decommissioning, including an assessment of its cost.

This file is expected **about six months before the actual start of the installation work**. Any significant change in the reception project may result in the update of the Demonstrator Dossier.

3.2.2 Works Documentation

The Works Documentation is a document presenting the marine installation operations, specific O&M or dismantling. It can be used in whole or in part as a support for a possible CNL and it includes at least the following elements:

- General description of the operation, including its timeline and operational limitations;
- List of subcontractors;
- Characteristics of the components handled on site (specifications, plans, certificates, test reports);
- Description of the nautical means used;
- Operating procedures for the various elements making up the demonstrator;

- Signposting (if relevant);
- Description of the commissioning procedure (if relevant);
- QHSE plan;
- Risk analyses;
- Risk prevention plan;
- Insurance.

3.2.3 Local Nautical Commission

A Local Nautical Commission (CNL) could be convened, at the request of the State services, if a specific regulation (restriction of certain uses outside the already regulated area, towing, etc.) were to be taken by the maritime prefect in view of the planned work. In this case, the CNL is responsible for issuing an opinion to inform the decision of the maritime prefect concerning the navigation rules during the operation.

The terms and conditions related to the CNL are framed by legislation [5]. The Works Documentation may be sent (in whole or in part) to the members of the CNL.

3.2.4 Decommissioning bond

The complete dismantling of the demonstrator/prototype elements and the restoration of the area are one of the obligations of the SEENEOH site with regard to its authorisations. The Company will have to provide a guarantee to the OPEN-C Foundation equal to the cost of the dismantling, as presented in the Demonstrator Dossier. The demonstrator/prototype can only be installed on the SEENEOH site once the deposit has actually been paid (t0 - 3 months).

4. Maritime coordination

4.1 Site marking and markup



Figure 19:
Starboard side
marker

In accordance with the ministerial decision of 8 June 2016 [3], two starboard side buoys illuminating green at the two-flashed rhythm (6s) for a range of 3 M are installed downstream and upstream of the area. These buoys are referenced on the nautical documentation.

The perimeter of the test site is prohibited to the navigation, berthing and anchoring of any vessel, except for operational vessels in the SEENEOH zone.

The signalling of demonstrators hosted on the test site is not subject to any special requirements.

4.1.1 Floating platform

In the case of a floating structure, each anchor line will be marked by a signal buoy.

4.1.2 Submerged platform

In the case of a submerged structure design in operation, it must integrate a lifting device out of the water at a minimum of 2 points, materialized with buoys. Otherwise, the user must provide proof of at least equivalent technical provisions.

4.2 Maritime Coordination Plan

The Maritime Coordination Plan (MCP) [6] defines the rules for the coordination of maritime activities and the modalities of access to the SEENEOH test site, thus ensuring a high level of maritime safety. It determines a common reference framework for the various companies working on the test site, on behalf of the site manager or the entities hosted for tests. It is also intended for all parties potentially concerned by the risks associated with the activities taking place within its perimeter and its immediate surroundings.

More specifically, the maritime coordination plan includes the following sections:

- Presentation and occupation of the test site: organization, occupation of the DPFn, equipment on site, contacts of the entities, etc. ;
- General conditions of access to the test site: general safety rules, navigation safety zones, general terms and conditions of access to the site;
- Special conditions of access for site visits;
- Special conditions of access to the emerged parts of the demonstrators;
- Special conditions of marine operations in the test site;
- Installation or dismantling operations;

- Conduct of search and rescue operations.

In order to prepare for the reception of the demonstrator, the PCM will be provided by OPEN-C to the Company, in a version reflecting the current state of the Site before the arrival of the new demonstrator. It will then be updated during the project in order to integrate the demonstrator project.

4.3 Risk analyses

In order to guarantee the safety of the equipment present on the test site when a demonstrator is hosted, the Company is asked to conduct several risk analyses:

Preliminary risk analysis, such as HAZard IDentification (HAZID), covering all phases of the project's life. This risk analysis will be integrated into the Demonstrator Dossier (section 4.3).

Risk analysis of the demonstrator installation procedure. This risk analysis is usually carried out by the maritime operator in charge of the installation, with the participation of OPEN-C and, if applicable, the Marine Warranty Surveyor (MWS). This risk analysis makes it possible to consolidate the installation procedure, as well as the Maritime Intervention Plan (PIM) installation if necessary (section 4.4).

Risk analysis, HAZID type, dedicated to the operation phase, and based on the detailed design of the demonstrator. This risk analysis makes it possible to consolidate the operational PIM (section 4.4), as well as the safety signal exchange table (section 6.4).

Risk analysis of the demonstrator dismantling procedure, paid for by the maritime operator in charge of the dismantling, with the participation of OPEN-C and, if applicable, the MWS.

In the event of significant operation and maintenance activity of the demonstrator during the operation phase, OPEN-C reserves the right to ask the Company for a review of the operating procedures and additional risk analyses to guarantee the safety of the equipment and demonstrators present on the test site.

The conduct of these risk analyses is strongly recommended in the form of meetings/workshops involving the project stakeholders (Company, Organisation, installer, MWS, operator, etc.).

4.4 Maritime Response Plan

The Maritime Response Plan (MIP) [7] defines the organization set up by OPEN-C to respond to emergency situations that may arise in and around the SEENEHO test site. It determines a common reference framework for the various entities involved in the Site and concerned by the risks related to the activities taking place on the Site.

A PIM specific to each demonstrator is established and implemented by the Company in coherence with the PIM of the Site [7], and for each phase of the life of its test project: Installation / Operation / Heavy maintenance / Dismantling.

The work of drafting the PIM by the Company, and the exchanges with OPEN-C, must be anticipated several months in advance, with a view to a validation and signature of the PIM two weeks before the installation of the demonstrator on the test site.

The expected content of the PIM is as follows:

- Emergency numbers to reach the operator 24 hours a day, 7 days a week (document header)
- Context of the MIP and project description
- Risk analysis and risk control measures
- Operator's Emergency Management System
- Annexes: risk analyses, list and characteristics of personal and collective protective equipment, means available to the operator to contribute to the management of emergency situations, emergency notification diagram, etc.

4.5 Towing

The regulatory framework concerning the towing of a demonstrator on the SEENEHO test site, located on the natural river public domain (DPFn), is mainly governed by the provisions of the Transport Code and the Special Police Regulations (RPP) for inland navigation in force on the Garonne.

Towing operations must comply with:

Depending on the areas of competence, the requirements of the Inter-Prefectural Decree on special regulations for the navigation police in the maritime waters of the Gironde, Garonne and Dordogne estuaries, December 2015¹ (applicable in the river-sea zone, bounded upstream, by the Pont de Pierre, and downstream, by the transversal limit of the sea) and the requirements of the Voies Navigables de France (VNF) under the terms of Order No. 2014276-0004 of 3 October 2014² (applicable in inland waters: area bounded upstream, by the departmental moth with the Lot-et-Garonne, and downstream, by the Pont de Pierre in Bordeaux)

The safety rules for river manoeuvres (Decree of 21 December 2007 on the safety of inland waterway vessels and the operation of boats);

¹ [Special police regulations - Navigation and river safety - Transport - Navigation and river safety - Road safety - State actions - State services in Gironde](#)

² [The Special Police Regulations \(RPP\) of the South-West - VNF](#)

The special conditions set by the Harbour Master's Office of the Port of Bordeaux and the Prefecture.

Where towing involves transit through tidally influenced estuarine areas, the technical recommendations from IMO A.765 and MSC/Circ.884 may be considered as good practice, even if they are not mandatory.

4.6 Presence of Foundation staff onshore or onboard the demonstrator

When a demonstrator is hosted on site, the presence of representatives of OPEN-C on the vessels and the demonstrator may be required at several key moments:

- Before installation: visit of the demonstrator on land (e.g. assembly site, dockside, etc.).
- During the installation: presence of one or more representatives of OPEN-C on board the vessels used for the installation.
- Operation:
 - Occasional presence of representatives of OPEN-C on board the demonstrator and the associated vessels to access it (environmental monitoring, network and electrical infrastructure, R&D projects, etc.). The number of people, equipment, actions on board, and duration of intervention will be adapted to each demonstrator and specified later, and will comply with the operator's rules.
 - In the event of significant marine operations related to the demonstrator during the operating phase (e.g. heavy maintenance), OPEN-C reserves the right to request the Company's presence on board the vessels to guarantee the safety of the equipment and demonstrators present on the test site.
- During the dismantling: presence of one or more representatives of OPEN-C on board the vessels used for the dismantling.

4.7 Operation Report

The Foundation wishes to have precise knowledge of the XYZ position of all the structures and equipment implemented by the Company in the context of the installation of the demonstrator (foundations, anchors, anchor lines, cables, connectors, demonstrator, etc.) or operations on it.

It will be up to the Company to implement all means (ROV, USBL sonar, video, metrological means, etc.) to allow a precise re-gluing of the position of the equipment after each intervention (*As Aid*) and at the end of the operation (*As Built*).

The company will also transmit the *As Built specifications* of the installed equipment performing the bottom-to-surface connection (cable and anchorage).

An installation report including these elements will be drawn up by the Company and sent to OPEN-C within one month of installation.

For any significant transaction, an operating report will also be drawn up by the Company and sent to OPEN-C.

A dismantling report will also be requested post-operation to ensure that operations are running smoothly and that all the system and associated equipment are removed.

5. Electrical coordination

5.1 Presentation of electrical infrastructures

The SEENEOH electricity network consists of:

- An onshore substation, or "Delivery Substation" (PDL), connected to the Enedis public distribution network. The injection into the Enedis public distribution network is done in 400Vac (compound three-phase voltage) at a frequency of 50Hz and the power must not exceed 100kVA. The delivery station is located near the test site, at the mouth of the Peugue in Bordeaux (33000);
- A 212m semi-static submarine cable, or "export cable", with an electrical power of 100 kV AC and 150 A, equipped with 12 Optical Fibers [FO];



Figure 20: Principle of connection to the SEENEOH network

5.2 Single line diagram of the delivery station

The onshore substation is the physical and legal interface between the SEENEOH electricity network (private domain) and the ENEDIS electricity network (public domain). It ensures a role of protection and management of electrical parameters and energy flows between the offshore grid and the distribution network. The simplified single-line diagram of the SEENEOH substation is presented below.

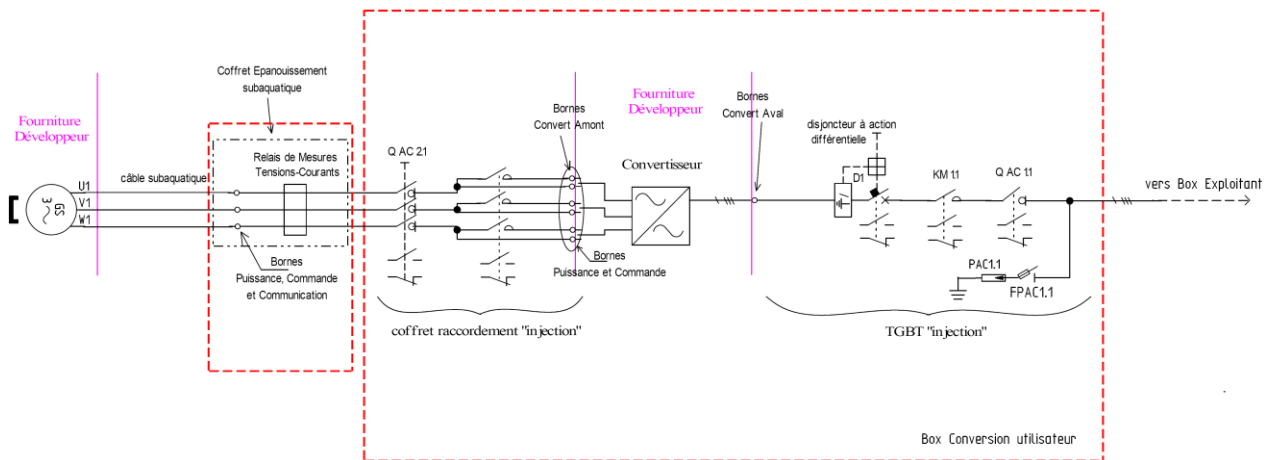


Figure 21 : Simplified single-line diagram of the SEENEOH onshore substation

5.3 Electrical coordination plan

The electrical coordination plan or PCE [8] specifies the contractual rules to ensure a high level of electrical safety at the SEENEOH test site. The electrical coordination plan covers the following topics:

- Presentation of SEENEOH's electrical infrastructure;
- Electrical operating rules and limits of the SEENEOH network;
- Identification of electrical operations managers within the meaning of the NF C18-510 standard;
- Exchange of electrical and safety operating data;
- Procedures for submarine cable lockout/lockout operations.

In order to prepare for the reception of the demonstrator, the electrical coordination plan for the SEENEOH site will be provided by OPEN-C to the Company, in a version reflecting the current state of the site before the arrival of the new demonstrator. It will then be updated during the project to integrate the future demonstrator or annually to report on developments.

5.4 Electrical Studies

The Foundation, and its possible electricity operations manager, operates the SEENEOH electricity network. As a result, it is the sole interlocutor of ENEDIS and undertakes to do what is necessary to update the agreements and/or contracts (connection agreement, CARD-I, operating agreement, etc.) according to the needs of hosting the demonstrators and the evolution of the test site.

The connection of a new demonstrator requires OPEN-C to carry out, at a minimum, the following studies:

- A connection study, allowing the SEENEOH network to be modelled with the new demonstrator
- A declaration to ENEDIS of the electrical characteristics of the new demonstrator and the expected state of the SEENEOH network (resumption of the study, disruptive customer sheets, etc.). In the case of a resumption of the study, it consists of the declaration of a new demonstrator and the verification of compatibility with the ENEDIS network. It leads to the updating of the connection agreement, the CARD-I and the operating agreement.
- An update of the selectivity study of the SEENEOH network, allowing the definition and adjustment of the protection equipment of the SEENEOH network and demonstrators (calculation of short-circuit currents, decoupling protections, etc.).
- A reactive power regulation study, in order to ensure compliance with the requirements of the public distribution network (ENEDIS) in terms of injected/absorbed reactive power, or to provide for the implementation of the necessary regulation or compensation means if necessary.
- A study of the voltage plan, making it possible to verify that the HVA voltages of the demonstrators are in accordance with the operating ranges of the equipment and to determine any adjustments to be made.

The Company undertakes to provide OPEN-C with the data from the demonstrator necessary for the proper performance of these studies, in particular the data requested in the collection sheets that will be used for the resumption of the study carried out by ENEDIS, if applicable.

The Foundation undertakes to provide the Company with the network data necessary for the sizing of the demonstrator, according to the needs expressed by the Company. In particular, the sizing studies carried out by the Company may include:

- A selectivity study on the demonstrator side, allowing the definition and adjustment of protective equipment respecting the principles of selectivity (calculation of short-circuit currents, decoupling protections, etc.) at the prototype level, and the results of which will feed into the selectivity study at the SEENEOH level;
- A pre-harmonic study (optional), prior to the resumption of the study carried out by ENEDIS, to anticipate the analysis of the harmonics generated by the installation (consumption or production), to verify compliance with the thresholds (regulatory limits, energy code) and to propose means of action if necessary (anti-harmonic filter, converter regulation, etc.).

5.5 Electrical and optical testing

The commissioning of the SEENEOH subsea electrical network, after connection work, cable handling or major HV electrical work, is subject to the performance of electrical and optical tests in accordance with a protocol validated between the Company and OPEN-C, in the presence of the Company and OPEN-C, demonstrating the electrical integrity of the work. Performing electrical and optical tests before, during, and after offshore operations is

therefore essential to ensure the integrity of the network, or to be able to take corrective actions quickly in the event of a fault.

The tests recommended by OPEN-C are listed in the Table 3, and follow the standards and recommendations in force (e.g. IEC 63026:2019).

Table 3: Electrical and optical tests

Type of test	Checks carried out	Description
Electric	Breakdown tests or Insulation stiffness test at 2U0	The insulation stiffness test according to IEC 60502-2:2014 (Clause 20.3.1-c) or IEC 63026:2019 (Clause 13.3) is performed by the use of TBF (Very Low Frequency) sinusoidal voltage sources to verify the implementation of the cable and its accessories (also known as breakdown tests). For installations that have already been in operation, lower voltages and/or shorter durations (2 U0) are permitted.
Optics	OTDR / 1550nm Reflectometry Measurement	Measurement by reflectometry makes it possible to characterize the different fiber sections and all the events present on the optical link.

The Company will be required to provide the following:

- The results of the FAT following the exit of its dynamic cable from the factory in order to attest to the integrity of the cable to be installed;
- The anticipated test plan for the offshore operations of installation, connection or maintenance of the Company's dynamic cable, including at least the tests of the Table 3;
- The results of these tests in the form of a report including the results and calibration certificates of the equipment. Especially for optical tests, the results will be presented in the form of a table, indicating for each fiber: its length (km), the measured attenuation (dB), and the deviation from the attenuation at the initial state. The report will also specify the parameters of the test: wavelength (nm), refractive index, pulse (μ s) and duration (s). The source files of the OTDRs as well as the files in .pdf format will be provided to OPEN-C.

The realization of electrical and/or optical qualification tests (tan delta, resistance, capacitance, etc.) and intermediate tests to validate the critical phases of operation is strongly recommended by OPEN-C.

As part of these tests, OPEN-C undertakes to:

- Provide the results of electrical and optical tests of the SEENEOH network previously carried out by OPEN-C and corresponding to the initial state before the works;
- Take the necessary steps to consign the SEENEOH subsea network and provide a certificate of consignment to allow the work and associated tests to be carried out;
- Provide access to the onshore substation in order to be able to connect the necessary test equipment;
- At the end of the installation of the demonstrator, OPEN-C will be able to carry out a power-up test for 24 hours with the system's nominal operating voltage.

6. Information system

The sections below will be progressively completed in line with the evolution of the site architecture.

6.1 Optical network

TBD

6.2 Communication

TBD

6.3 SCADA System

TBD

6.4 Data exchange

TBD

7. Environmental impact monitoring

7.1 Environmental monitoring

The analysis of the project's environmental impacts revealed that the development of the test site had no significant impact on its environment. However, environmental monitoring can be set up by opportunity or on request when a prototype is deployed.

This monitoring could include the following compartments:

- Evaluation of ichthyo-compatibility;
- Study of bathymetry and underwater imaging;
- Study of underwater acoustics;
- Studies of environmental parameters (physico-chemical, meteorological, hydrodynamic).

8. Insurance and certification

8.1 Insurance

8.1.1 OPEN-C and Company Insurance

The responsibilities and commitments relating to the insurance coverage of the Company and OPEN-C are set out in the collaboration agreement signed between the Company and OPEN-C.

The Company's insurance certificates required by the agreement are provided to OPEN-C prior to the installation of the demonstrator on site. In the event of a substantial update of the insurance contracts, the Company must communicate the updated insurance certificates to OPEN-C.

8.1.2 Subcontracting companies

A copy of the insurance certificate of the companies acting as subcontractors of the Company may be requested by OPEN-C. These certificates will be required in particular for subcontractors involved in the execution of offshore works.

8.1.3 Marine Warranty Surveyor

The intervention of a Marine Warranty Surveyor (MWS) may be required by the Company's insurance, as is commonly the practice in order to reduce the risks inherent in marine operations. In this case, the name of the company, and the point of contact within the company chosen to perform these MWS services will be transmitted to OPEN-C.

The Foundation also strongly recommends the intervention of an MWS to ensure that the subcontracted activities are carried out according to standards and good practices.

8.2 Certification

The Company undertakes to have the design of the demonstrator reviewed by a third party, such as a certification office. A copy of the certificate issued by the third party must be provided to OPEN-C prior to the deployment of the demonstrator on the SEENEOH site.

The certificate provided will be at least of the "Approval in Principle" or "Statement of Feasibility" type. The review may initially be limited to the methodological basis of the project ("design basis"), without independent calculations by the third party.

The purpose of this review is to ensure that the design of the demonstrator is carried out in accordance with the norms and standards in force and in a manner that minimizes risks. It will cover at least the following elements (if applicable to the demonstrator):

- General arrangement drawings
- Hydrodynamics
- Stability
- Anchoring
- Structure, corrosion
- Electricity (single-line, load balance)
- Mechanical resistance of the dynamic cable
- List of systems and equipment on board
- Ballast

Beyond this approval in principle, it is recommended that the Company obtain a certificate for the detailed design review and manufacturing monitoring of the demonstrator before its installation on the test site. Where applicable, the Company will provide OPEN-C with the third party's certificates/attestations. In the absence of these certificates/attestations, the specific documents and methodologies that demonstrate the integrity of the demonstrator for the duration of the tests will be included in the Works Documentation detailed in section **Erreur ! Source du renvoi introuvable..**

8.3 Extension of the trials

In the event of an extension of the Lifetime Extension beyond the initial Design Life, the Company shall provide OPEN-C with third-party certifications; or the specific documents and methodologies that demonstrate the total integrity of the demonstrator (float, turbine, anchor, dynamic cable, ...) for the new test duration. The Foundation will carry out a technical review with a view to validating this request for an extension of the trials.

9. Appendices

9.1 Appendix 1: Terms and conditions of access to the SEENEOH site for demonstrators

Table 4: Phases, Main Deliverables and Roles related to the hosting of a demonstrator on SEENEOH

Phases	Deliverable	Company	OPEN-C
Contracting	Confidentiality agreement	A	R
	Reservation Agreement	A	R

	Cooperation agreement <i>t0-9 months</i>	A	R
Preparation of the welcome	Demonstrator Dossier <i>t0-6 months</i>	R*	A
	Installation Procedure + HAZID <i>t0-4 months</i>	R	A
	Works Documentation <i>t0-3 months</i>	R*	A
	Dismantling deposit payment <i>t0-3 months</i>	R	A
	Risk analysis (HAZID) operation <i>t0-3 months</i>	R	A
	Maritime Response Plan (MIP) installation and operation, <i>t0-2 months</i>	R*	A
	Holding of a Local Nautical Commission (CNL), at the discretion of the State Services <i>t0-2 months</i>	C	C
Installation = t0	Installation Report	R	A
	Commissioning tests	R	A
Operation	Maritime Intervention Plan (PIM)	R*	A
	Environmental Monitoring Reports	C	R
Dismantling	Works Documentation	C*	R
	Dismantling procedure	R	A
	Decommissioning Report	R	A
	Waiver of the dismantling bond	R	C

*based on a report template provided by OPEN-C

RACI Matrix Legend:

- R: Responsible - Responsibility for writing the document / carrying out the activity
- A: Accountable – Approval, Validation
- C: Consulted – Advice, contribution, review, expertise or opinion
- I: Informed – Information