Monitoring Factsheet: Hydrographical Changes

October 2015

1. Subject: Hydrographical Changes

Hydrographical conditions of the marine environment are characterized by the physical parameters of seawater including temperature, salinity, depth, currents, waves, turbulence and turbidity. These conditions can change as a result of large-scale human activities such as coastal defence works and structures in coastal or open sea which can permanently influence the hydrographical regime of currents, waves and sediments[1]. Such changes can in turn induce further changes to sediment transportation, seabed structure, salinity and temperature which might lead to effects on marine ecosystems as a result of changes to their immediate dynamic environment or through food chain effects[2]. Changes in currents and salinity can also influence the spreading pattern of larvae and breeding and spawning areas[3].

There is no common definition for 'permanent alterations' of hydrographical conditions, although OSPAR (2012)[4] indicates that the potential for recovery and the timescales involved need to be factored in when differentiating between permanent and temporary changes. Current advice for the EU Marine Strategy Framework Directive recommends that construction projects lasting more than ten years should be considered permanent[5].

[1] OSPAR Commission 2012. MSFD Advice document on Good environmental status - Descriptor 7: Hydrographical conditions. A living document - Version 17 January 2012

[2] OSPAR Commission 2012. MSFD Advice document on Good environmental status - Descriptor 7: Hydrographical conditions. A living document - Version 17 January 2012

[3] OSPAR Commission 2012. MSFD Advice document on Good environmental status - Descriptor 7: Hydrographical conditions. A living document - Version 17 January 2012

[4] OSPAR Commission 2012. MSFD Advice document on Good environmental status - Descriptor 7: Hydrographical conditions. A living document - Version 17 January 2012

[5] UNEP/MAP 2014. Draft Monitoring and Assessment Methodological Guidance, 4th meeting of the EcAp Coordination Group UNEP(DEPI)/MED WG.401/3

2. Monitoring Requirements

2.1. Marine Strategy Framework Directive - MSFD (2008/56/EC)

2.1.1. Annex III characteristics/pressures/impacts

The MSFD calls for an assessment of the environmental status based on a list of characteristics listed in Table 1 of Annex III to the Directive, and pressures and impacts listed in Table 2 of the same Annex.

This monitoring factsheet will enable assessment of the following:

Table 1:

- Physical and chemical features including:
  - topography and bathymetry of the seabed;
  - annual and seasonal temperature regime,
  - current velocity;
  - spatial and temporal distribution of salinity;
  - spatial and temporal distribution of nutrients and oxygen;
  - pH.

Table 2:

- Interference with hydrological processes
  - significant changes in thermal regime (e.g. by outfalls from power stations);
  - significant changes in salinity regime (e.g. by constructions impeding water movements, water abstraction).

2.1.2. Annex I Good Environmental Status Descriptors

MSFD Annex I descriptors of Good Environmental Status and the associated criteria and indicators established by MSFD Commission Decision 2010/477/EU of relevance to the achievement of GES in terms of hydrographical conditions and which will be directly or indirectly addressed by this monitoring factsheet are listed hereunder:

Descriptor 1: *Biological Diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions*

- 1.6 Habitat Condition
  - Physical, hydrological and chemical conditions (1.6.3)

Descriptor 7: *Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.*

- 7.1 Spatial characterisation of permanent alterations
  - Extent of area affected by permanent alterations (7.1.1)

- 7.2. Impact of permanent hydrographical changes
  - Spatial extent of habitats affected by the permanent alteration (7.2.1)
  - Changes in habitats, in particular the functions provided (e.g. spawning, breeding and feeding areas and migration routes of fish, birds and mammals), due to altered hydrographical conditions (7.2.2).

2.2. EU Water Framework Directive – WFD (2000/60/EC)

The WFD calls for the protection of all water resources, including coastal waters. The main objective of the WFD for coastal water bodies is the achievement, by 2015, of 'good ecological status' up to one nautical mile from the coast; 'good chemical status' for territorial waters and 'good ecological potential'[6] for heavily modified water bodies.

'Good ecological status' is defined by quality elements, including hydromorphological elements supporting the biological elements. This means assessing the effects of pressures and impacts on two main hydromorphological quality elements: Morphological conditions and Tidal Regime[7]. The list below provides the key features as proposed by the WFD of each hydromorphological quality element in coastal waters. Member States are required to select those parameters indicative of the quality element considered to be most relevant to the purpose of the monitoring station.

1. Morphological conditions, consisting of:
   - depth variation (topography of the water body);
   - structure and substrate of the coastal bed (these may include grain size, substrate type coverage and presence of sedimentological structures such as ripples, sand reefs etc; oxygenation conditions in sediment, bioturbation)
   - structure of the intertidal zone[8] (which may include rock type and exposure to waves; distribution of biological communities and features of erosion or deposition)

2. Tidal regime
   - direction of dominant currents (speed and direction)
   - wave exposure (water mass movements including wave, wind, fetch-index, frequency of storm surges)

[6] 'Good Ecological Potential' is less stringent objective than good ecological status, making allowances for ecological impacts resulting from alterations to the physical environment that are necessary to either support a specific use, or must be maintained in order to avoid effects on the wider environment.

[7] Tidal regime in the Mediterranean to be interpreted as the regime of currents and waves rather than the role of tides since there is a negligible tidal range in the Mediterranean

[8] The 'intertidal zone' would reflect the 'mediolittoral zone' in the Mediterranean region.

Hydromorphological alterations can lead to a water body to be designated as a heavily modified water body if the water body shows substantial changes in character which are extensive, and the modifications are neither temporary nor intermittent and in general alter both hydrological and morphological characteristics. A heavily modified water body refers to a body of surface water that as a result of physical alteration by human activity is substantially changed in character; and cannot therefore meet 'good ecological status'. Thus any water body deemed to be heavily altered from anthropogenic hydromorphological modifications has to meet 'good ecological potential' rather than good ecological status. The implications of any modification on the biota of the respective heavily modified water bodies need to be defined too.

For the purposes of the WFD, the coastal waters around the Maltese Islands have been divided into 9 distinct water bodies, two of which are designated as heavily modified water bodies. Such bodies constitute the harbour areas (Il-Port il-Kbir and Il-Port ta' Marsamxett; Il-Port ta' Marsaxlokk) which are substantially changed in character as a result of physical alterations by human activity.

2.3. Barcelona Convention and the Ecosystem Approach (EcAp)

The principal aim of the Barcelona Convention and its protocols is to reduce pollution in the Mediterranean Sea and to protect and improve the marine environment in the area, thereby contributing to its sustainable development. The Barcelona Convention/MAP are working towards an Integrated Monitoring Programme and an Integrated Policy of Assessments to be established by 2015. The Integrated Monitoring Programme should be able to provide all the data needed to assess whether 'Good Environmental Status' defined through the EcAp process[9] has been achieved or maintained.

One common indicator in relation to hydrographical conditions is currently being proposed under the EcAp process: "*Extent of area affected by permanent alterations*". However, it is being pointed out that there is no common interpretation of 'permanent alteration of hydrographical conditions'[10]. By definition the term 'hydrography' is meant to include depth, tidal current and wave characteristics of marine waters, including the topography and morphology of the seabed.

At the time of compiling this document, the physical characteristics to be monitored are considered to be:

- Bathymetric data
- Seafloor topography

[9] Ecosystem-based approach undertaken as part of the Barcelona Convention.

[10] UNEP/MAP 2014.Working document on Common Indicators for the Mediterranean. Integrated Correspondence Groups of GES and Targets Meeting, Athens (Greece), 17-19 February 2014 , UNEP(DEPI)/MED WG.390/3

- Current velocity
- Wave exposure
- Turbulence
- Turbidity

The knowledge of parameter related local dominant time-scales of natural variability are a pre-condition for an authoritative assessment of change in the hydrographical background conditions[11].

[11] UNEP/MAP 2014. Draft Monitoring and Assessment Methodological Guidance, 4th meeting of the EcAp Coordination Group UNEP(DEPI)/MED WG.401/3

3. Targets

This section includes targets set by policies in relation to hydrographical changes.

Implementation of this monitoring factsheet would facilitate the achievement of targets adopted by Malta as part of the first reporting cycle of the EU Marine Strategy Framework Directive. Monitoring as stipulated by this monitoring factsheet however may also apply in assessing progress towards targets articulated through other processes.

Policy	Status to be achieved	Targets
Marine Strategy Framework Directive	Good Environmental Status: *Significant adverse effects of permanent alterations of hydrographical conditions on key marine habitats and species are, in so far as practicable prevented or minimised to the extent possible.*	Changes in hydrographical conditions from large-scale development proposals are adequately assessed through existing permitting and licensing procedures in line with the parameters stipulated by the Marine Strategy Framework Directive
Water Framework Directive	In the case of **natural water bodies**, in order for high status to be achieved, the WFD requires that there are no more than very minor human alterations to the hydromorphological quality elements. This means that the direction and speed of the dominant currents, depth variation, substrate and structure of the coastal bed etc. correspond totally or nearly totally to undisturbed conditions. For good status the required values for the hydromorphological quality elements must be such as to support the required biological quality element values associated with a good classification.	
	In the case of **heavily modified waters**, maximum ecological potential is allowed when the hydromorphological conditions are consistent with the only impacts on the coastal water body resulting in its designation as heaviliy modified, once all mitigation measures have been taken to ensure the best approximation to an ecological continuum. For good ecological potential status the required values for the hydromorphological quality elements must be such as to support the slight changes detected in the biological quality element values associated with a good status classification.	

Barcelona Convention: ECAP Process	Operational Objective: Impacts to the marine and coastal ecosystem induced by climate variability and/or climate change are minimized Indicators*:* - Large scale changes in circulation patterns, temperature, pH, and salinity distribution - Long term changes in sea level Good Environmental Status defined as: Ecosystems are resilient enough to adapt to climate change.	Anthropogenic impacts which may alter ecosystems' adaptive capacity are reduced.
	Operational Objective: Alterations due to permanent constructions on the coast and watersheds, marine installations and seafloor anchored structures are minimized Indicators*:* - Impact on the circulation caused by the presence of structures *Common Indicator[12]:* *Location and extent of the habitats impacted directly by hydrographical alterations* Good Environmental Status defined as: - With new structures in place, near shore wave- and current patterns maintain as natural as possible. - Negative impacts due to new structure are minimal with no influence on the larger scale coastal and marine system	- Marine and shore based new structures planned, constructed and operated in a way to maintain the natural wave and current pattern as much as possible - Planning of new structures takes into account all possible mitigation measures in order to minimize the impact on coastal and marine ecosystem and its services integrity and cultural/historic assets. Where possible, promote ecosystem health**.**
	Operational Objective: Impacts of alterations due to changes in freshwater flow from watersheds, seawater inundation and coastal freatic intrusion, brine input from desalination plants and seawater intake and outlet are minimized	Site specific tolerable limits of key species in immediate proximity of seawater intake and outlet structures are considered while planning, constructing and operating such infrastructure

[12] UNEP/MAP 2014.Working document on Common Indicators for the Mediterranean. Integrated Correspondence Groups of GES and Targets Meeting, Athens (Greece), 17-19 February 2014 , UNEP(DEPI)/MED WG.390/3

	Indicators*:* - Changes in key species distribution due to the effects of seawater intake and outlet Good Environmental Status defined as: Water circulation in coastal and marine habitats, and changes in the levels of salinity and temperature are within thresholds, to maintain natural/ecological processes	

4. Competent Authorities

Policy	Competent Authority
MSFD	Office of the Prime Minister (delegation of technical implementation to the Malta Environment and Planning Authority)
WFD	Malta Environment and Planning Authority
Barcelona Convention	Malta Environment and Planning Authority

5. Spatial Extent of monitoring requirements

Policy	Extent of marine waters
MSFD	Extent of waters to be monitored depends on relevance and established GES and targets.
WFD	1 nautical mile
Barcelona Convention	Regional

6. Monitoring Approach

This monitoring factsheet includes five monitoring subprogrammes listed hereunder:

Monitoring sub-programme	Title	Monitoring Purpose
1	Water Column – Hydrological Characteristics	State
2	Water Column – Nutrient Levels	Pressure
3	Water Column – Physical and Chemical Characteristics	State
4	Physical Characteristics of the seabed and coastline	State
5	Activities with potential effect on hydrographical conditions	Activities

The monitoring sub-programmes described in this monitoring factsheet cover the 'core parameters' for hydrographical data and physical characteristics for the purpose of providing background information against which changes in hydrographical conditions can be assessed. The monitoring parameters do not constitute direct indicators, but their monitoring is required for the purpose of assessing changes in hydrographical conditions and/or extent of areas affected by permanent alterations as required by policy indicators.

The monitoring sub-programmes do not cover ecological data needed to assess changes in benthic biota, habitat types and functions resulting from hydrological alterations. The background data for this aspect will be generated through monitoring of biological elements (refer to monitoring factsheets on 'seabed habitats', 'water column habitats', 'marine reptiles & marine mammals').

Assessment of changes in hydrographical conditions and ecological parameters will be associated with new development on the basis of a risk-based approach and needs to be dealt with on a case-by-case basis through existing permitting and licensing systems. Monitoring parameters for this purpose cannot be specified at this stage to ensure flexibility.

7. Assessment of status

Assessment of status in terms of hydrographical conditions is linked to the assessment of status of biological elements, including benthic habitats, water column habitats and species groups. Optimum hydrographical conditions for marine ecosystems are poorly known at this stage, however linking the hydrographical data

with the status of biological elements would enable determination of whether the hydrographical conditions as measured through implementation of this monitoring factsheet are able to support and maintain the biological communities at a good status or otherwise.

Within this context, good status of biological elements would generally represent adequate or unaltered hydrographical conditions, hence good status also in terms of hydrographical conditions. On the other hand, non-good status of biological elements does not necessarily reflect inadequate or modified hydromorphological conditions unless links with other known pressures are excluded, in which case further investigations to identify links between biological elements and hydrographical conditions would be necessary (refer to Section 18).

Implementation of this monitoring factsheet will also generate the background information against which changes in hydrographical conditions can be assessed. Within this context, the data will be used, on a case-by-case basis in:

- Determining or forecasting the extent of area affected by permanent alterations as a result of new development/intervention at sea;
- assisting the determination of the extent of habitats affected by permanent alterations and determination of changes to biological elements.

8. Monitoring sub-programme 1: *Water Column – Hydrological Characteristics*

8.1. Monitoring Parameters

Table 1: Hydrographical parameters to be monitored

Parameter	WFD	MSFD	EcAp
Current velocity	✓	✓	✓
Wave exposure	✓	✓	✓

8.2. Monitoring methodologies

Monitoring procedures to be applied for measuring hydrographical parameters are only outlined for *in situ* monitoring. Details in relation to modeling are pending the identification of appropriate models and the setting up of mechanisms to enable application of such models (refer to Section 18).

8.2.1. Spot measurements

- Depth profiles of current direction and velocity are recorded through the use of current meters - Acoustic Doppler Current Profiler (ADCP);
- The ADCP is deployed from vessels at monitoring stations for spot measurements of current profiles.

8.2.2. Fixed Stations: Continuous current profiling and wave measurements – to be resorted to subject to availability of funds

- Automated wave buoy/s[13] are deployed at strategic location/s to measure wave height and direction, meteo conditions and physico-chemical parameters[14] in the surface and water column on a continuous basis.
- Fixed moorings[15] equipped with Acoustic Doppler Current Profiler (ADCP) are set at strategic location/s to provide continuous measurements of surface and subsurface currents.

[13] Drago, A., Cordina, G., Borg, S., Deidun, A.; Delitala, A. & the Marine Group of Experts (2009), *The support of Operational Oceanography for a more effective maritime sector in the Maltese Islands,* Report for the NET.MARI.MED (Network for supporting Marine Affairs in the Mediterranean) Archimed Interreg project.

[14] Physico-chemical parameters monitored depend on acquired equipment.

[15] Drago, A., Cordina, G., Borg, S., Deidun, A.; Delitala, A. & the Marine Group of Experts (2009), *The support of Operational Oceanography for a more effective maritime sector in the Maltese Islands,* Report for the NET.MARI.MED (Network for supporting Marine Affairs in the Mediterranean) Archimed Interreg project.

8.3. Monitoring area

Monitoring stations listed in this section shall be updated after the first monitoring year in parallel to revision of related monitoring factsheets.

8.3.1. Spot measurements

Monitoring stations for spot measurements of current direction and velocity include inshore and offshore stations.

Inshore monitoring stations reflect those to be used for monitoring of nutrients as per Section 9.3. These stations will also be used for the purpose of spot measurements of hydrographical parameters.

Offshore monitoring stations are listed in Table 2 and shown in Figure 1.

Table 2: Offshore monitoring stations

Offshore Monitoring stations	**Coordinates (Full UTM ED50)**	
	Longitude	**Longitude**
Malta North	378799.33 4	4028101.37
Malta East	530961.17 3	3976110.62
Malta South	473775.46 3	3904926.63
Malta West	375854.66 3	3951016.29

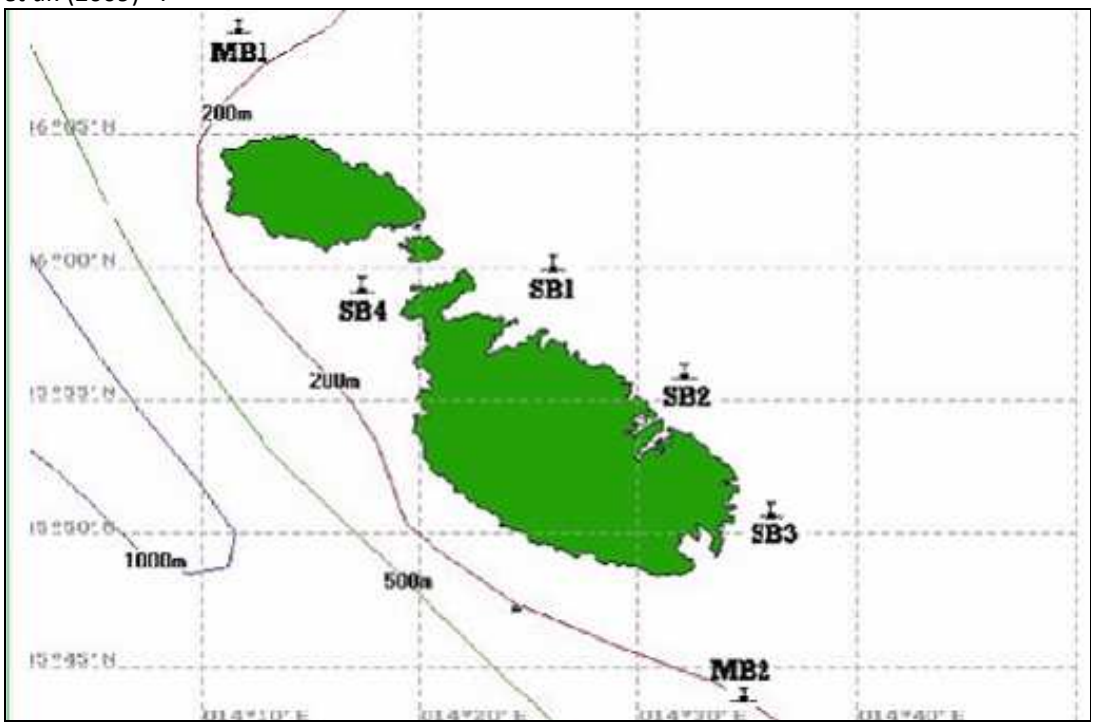
Figure 1: Offshore Monitoring Stations

8.3.2. Fixed Stations: Continuous current profiling and wave measurements

The location of automated wave buoys and fixed moorings will be determined on the basis of the station positions as proposed by Drago *et al*. (2009) and extracted in Figure 2.

Deployment of a minimum number of one automated buoy and one fixed station shall be sought, although this is subject to availability of funds.

Figure 2: Proposed location of automated buoys and secondary buoys as proposed by Drago *et al*. (2009)[16].



[16] Drago, A., Cordina, G., Borg, S., Deidun, A.; Delitala, A. & the Marine Group of Experts (2009), *The support of Operational Oceanography for a more effective maritime sector in the Maltese Islands,* Report for the NET.MARI.MED (Network for supporting Marine Affairs in the Mediterranean) Archimed Interreg project.

8.4. Monitoring frequency

Monitoring frequency for the first monitoring year is indicated hereunder. The monitoring frequency is subject to revision following the initial monitoring episodes.

Characteristics	Parameters	Monitoring Stations	Monitoring Frequency (first monitoring year)
Hydrographical parameters	Currents (spot measurements)	Inshore stations	Monthly
		Nearshore stations	Monthly (first monitoring year)
		6 nautical miles & bunkering areas	6-monthly
		Offshore	6-monthly
	Currents at fixed stations[17]		Continually
	Wave exposure[18]		Continually

[17] If resorted to

[18] If resorted to

9. Monitoring sub-programme 2: *Water Column – Nutrient Levels*

9.1. Monitoring Parameters

Table 3: List of nutrients to be monitored in water

Parameter	Unit	WFD	MSFD	MEDPOL[19]
Dissolved Nitrates (NO_3-N)	NO_3-N µmol/L, µg/L	×	×	×
Dissolved Nitrites (NO_2-N)	NO_2-N µmol/L, µg/L	×	×	×
Ammonium ions (NH_4-N)	NH_4-N µmol/L, µg/L	×	×	×
Dissolved Phosphates (PO_4-P)	PO_4-P µmol/L, µg/L	×	×	×
Silicate (SiO_2)	SiO_2 µmol/L		×	×
Total Nitrogen	N µmol/L, µg/L	×	×	×
Total Phosphorous	P µmol/L, µg/L	×	×	×

9.2. Monitoring methodologies

- Water sampling will take place at monitoring stations at surface and at one sub-surface depth (between 1m and 5m from surface). Samples are collected using Van-Dorn vertical all-plastic sampler or Niskin bottles and appropriately preserved and stored in agreement with the accredited laboratory performing the chemical analyses.

- Limits of Detection and/or Limits of Quantification to be applied for nutrient analysis are listed in Table 4.

Table 4: Limits of Detection and Limits of Quantification to be used in sample analysis

Parameter	Limit of Detection		Limit of Quantification	
	µmol	µg	µmol	µg
Dissolved nitrates	0.01µmol-N/L	0.14µg N/L	0.03µmol-N/L	0.46µg N/L
Dissolved nitrites	0.01µmol-N/L	0.14µg N/L	0.05µmol-N/L	0.7µg N/L
Ammonium ions	0.01µmol-N/L	0.14µg N/L	0.03µmol-N/L	0.46µg N/L
Dissolved phosphates	0.005µmol-P/L	0.15µg P/L	0.01µmol-P/L	0.31µg P/L
Total Nitrogen	0.1µmol-N/L	1.4µg N/L	0.17µmol-N/L	2.4µg N/L
Total Phosphorous	0.01µmol-P/L	0.3µg P/L	0.02µmol-P/L	0.62µg P/L
Dissolved silicates	0.01µmol-Si/L	0.28µg Si/L	0.02µmol-Si/L	0.56µg Si/L

[19] The list of parameters is in line with the 'Eutrophication Monitoring Strategy for MED POL' UNEP(DEPI)/MED WG.321/Inf.5 listing the mandatory parameters to be monitored by each country, which parameters support the adoption of the TRIX index.

9.3. Monitoring area

Monitoring stations listed in this section shall be updated after the first monitoring year in parallel to revision of related monitoring factsheets.

9.3.1. Monitoring Stations: inshore

Inshore stations are listed in Table 5.

Table 5: Inshore Monitoring Stations

Mon. Site Ref. Code	Monitoring Network	Coordinates (Full UTM ED50)	
		Longitude	Latitude
Operational Monitoring Stations			
CP04-1[20]	Operational	453769,71	3977836,62
CP04-2	Operational	449013,07	3979914,24
CP05	Operational - Harbour	457169,68	3973252,05
CP06-1[21]	Operational	461078,41	3971492,15
CP06-2	Operational	460522,84	3970960,01
CP07	Operational - Harbour	459771,77	3964111,98
Surveillance Monitoring Stations			
CS01[22]	Surveillance	425781,39	3992303,97
CS02[23]	Sur + Reference Site	435571,14	3992063,13
CS03[24]	Sur + Reference Site	442502,54	3984741,51
CS08[25]	Surveillance	453654,59	3962794,34
CS09[26]	Sur + Protected area	439697,26	3976129,46
National Monitoring Stations of relevance to 'Eutrophication'			
CN01-1	Protected Area	426700,89	3990134,58
CN02-1	Op – Diffuse sources	433397,15	3992518,78
CN03-1	Op – Sewage Outfall	435420,03	3986084,12
CN03-2	Op - Harbour	437057,14	3987236,76
CN03-3	Op-Harbour	440130,02	3983083,45
CN03-6	Op-Minor Sewage Outfall	441540,34	3985079,15
CN04-1[27]	Op - diffuse sources	442596,44	3981355,59
CN04-3[28]	Op - bunkering site	445500,41	3984462,78
CN04-5	Nitrates Directive	454162,08	3976206,21
CN04-6	Nitrates Directive	454528,54	3975162,74
CN05-1	Op - Harbour	455167,45	3973034,62
CN06-1	Op - diffuse sources	460815,92	3969206,43
CN07-1	Op - Thermal effluent	460712,08	3966044,50
CN07-3	Op – Harbour	458110,28	3965070,20

[20] Station located beyond 500m therefore can be considered to be nearshore.
[21] Station located beyond 500m therefore can be considered to be nearshore.
[22] Station located beyond 500m therefore can be considered to be nearshore.
[23] Station located beyond 500m therefore can be considered to be nearshore.
[24] Station located beyond 500m therefore can be considered to be nearshore.
[25] Station located beyond 500m therefore can be considered to be nearshore.
[26] Station located beyond 500m therefore can be considered to be nearshore.
[27] Station located beyond 500m therefore can be considered to be nearshore.
[28] Nutrients were not assessed within this station during the first WFD monitoring surveys. Station retained for monitoring to be representative of bunkering sites. Station located beyond 500m therefore can be considered to be nearshore.

Mon. Site Ref. Code	Monitoring Network	Coordinates (Full UTM ED50)	
		Longitude	Latitude
CN08-1	Op – Desalination Plant	447163,40	3965389,58
CN09-1	Op – Sewage Outfall	440099,89	3979621,63

9.3.2. Monitoring stations: nearshore (500m-1500m)

Sampling of nutrients from additional nearshore stations shall be carried out for one monitoring year to enable WFD intercalibration of chlorophyll-a. Additional inshore stations to be sampled at a distance of >500m - <1500m perpendicular are listed in Table 6.

Table 6: Additional nearshore stations

Mon. Site Ref. Code	Monitoring Network	Coordinates (Full UTM ED50)	
		Longitude	Latitude
CP04-2	Operational	449013,07	3979914,24
CP05	Operational - Harbour	457169,68	3973252,05
CP06-2	Operational	460522,84	3970960,01
CP07	Operational - Harbour	459771,77	3964111,98
CN01-1	Protected Area	426700,89	3990134,58
CN03-1	Op – Sewage Outfall	435420,03	3986084,12
CN03-6	Op-Minor Sewage Outfall	441540,34	3985079,15
CN09-1	Op – Sewage Outfall	440099,89	3979621,63

9.3.3. Monitoring stations: territorial waters

Nine of the inshore stations will be sampled at a distance of 6 nautical miles from the baselines where the breadth of the territorial waters is measured with a view to provide data between the 1nm and the 12nm extent of Malta's territorial waters. These stations are listed in Table 7 together with additional stations in bunkering areas. Dissolved Nitrates (NO_3-N) will be monitored at these stations.

Table 7: Monitoring Stations to **be sampled at a distance of 6 nautical miles from the baselines where the breadth of the territorial waters is measured and additional monitoring stations in bunkering areas, for monitoring of dissolved nitrates**[29]

Mon. Site Ref. Code	Monitoring Network	Coordinates (Full UTM ED50)	
		Longitude	Latitude
CS01	Surveillance	425781,39	3992303,97
CS02	Sur + Reference Site	435571,14	3992063,13
CS03	Sur + Reference Site	442502,54	3984741,51
CP04-1	Operational	453769,71	3977836,62
CP05	Operational - Harbour	457169,68	3973252,05

[29] Bunkering Area 1 is covered by monitoring station CN04-3 hence not included in this table

Mon. Site Ref. Code	Monitoring Network	Coordinates (Full UTM ED50)	
		Longitude	Latitude
CP06-1	Operational	461078,41	3971492,15
CP07	Operational - Harbour	459771,77	3964111,98
CS08	Surveillance	453654,59	3962794,34
CS09	Sur + Protected area	439697,26	3976129,46
Bunkering Area 2		463215,69	3970468,46
Bunkering Area 3		480042,40	3971974,31
Bunkering Area 4		463310,71	3964577,20
Bunkering Area 6		439080,51	3978830,25
Waiting Area		470247,20	3967047,73

9.4. Monitoring frequency

Monitoring frequency for the first monitoring year is indicated hereunder. The monitoring frequency is subject to revision following the initial monitoring episodes.

Parameters	Monitoring Stations	Monitoring Frequency (first monitoring year)
Nutrient levels	Inshore Monitoring stations and additional nearshore monitoring stations	3-monthly[30]
	Additional nearshore monitoring stations	3-monthly (first monitoring year)
Nitrates only	Stations at 6 nautical miles; bunkering areas	6-monthly

[30] Except for monitoring station CN05-1 for which monthly sampling will be sought.

10. Monitoring sub-programme 3: *Water Column – Physical and Chemical Characteristics*

10.1. Monitoring Parameters

Table 8: List of physical and chemical parameters to be monitored in water

Parameter	Unit	WFD	MSFD	MEDPOL[31]
Temperature	°C	×	×	×
Salinity	psu	×	×	×
pH		×	×	×
Water Transparency	Secchi depths, NTU	×	×	×
Dissolved Oxygen	% saturation	×	×	×

10.2. Monitoring Methodologies

- Multiparametric probes are used for *in situ* measurements of physical parameters as follows:
  - Salinity
  - Temperature
  - Turbidity (through Transmissometer or Optical Black-Scatter System[32])
  - Dissolved Oxygen
  - pH
- Depth profiles of these parameters are recorded.
- Measurement of physical parameters are undertaken under the same meteo-marine conditions throughout the monitoring years
- Measurements of salinity and pH are repeated in the laboratory.

10.3. Monitoring area

Monitoring stations, including inshore stations and offshore stations, are listed in Sections 8.3.1 and 9.3. These stations are subject to revision following the initial monitoring episodes as per previous sections.

[31] The list of parameters is in line with the 'Eutrophication Monitoring Strategy for MED POL' UNEP(DEPI)/MED WG.321/Inf.5 listing the mandatory parameters to be monitored by each country, which parameters support the adoption of the TRIX index.

[32] The OBS is the preferred instrument in areas where the total suspended material concentration in the water column exceeds ~200 ppm, whereas a transmissometer usually is the more effective instrument in locations with low total suspended material concentration

10.4. Monitoring frequency

Monitoring frequency for the first monitoring year is indicated hereunder. The monitoring frequency is subject to revision following the initial monitoring episodes.

Characteristics	Parameters	Monitoring Stations	Monitoring Frequency (first monitoring year)
Physico-chemical parameters	Salinity; Temperature; Oxygen; Turbidity; pH;	Inshore stations	Monthly
		Additional nearshore stations	Monthly (first monitoring year)
		6 nautical miles & bunkering areas	6-monthly
		Offshore	6-monthly

11. Monitoring sub-programme 4: *Physical Characteristics of the seabed and coastline*

11.1. Monitoring Parameters

Table 9: List of parameters related to seabed morphology

Parameter	WFD	MSFD	EcAp
Seabed topography and bathymetry	✓	✓	✓
Substrate Composition	✓	✓	

11.2. Monitoring Methodologies

11.2.1. Seabed topography and bathymetry

- Seabed topography and bathymetry up to the 1 nautical mile boundary from the baselines where the breadth of the territorial waters is measured were mapped by means of side-scan sonar in 2012[33]. Within this context, further assessment/monitoring of seabed topography and bathymetry are not deemed necessary in the short term with the exception of specific localities which may be subject to regular changes in topography and bathymetry.
- In the longer-term, the topography and bathymetry of the marine waters within the 1 nautical mile boundary would need to be re-assessed by means of echosoundings [side-scan sonars (SSS) or multibeam echo-sounders (MBES)[34]] in selected localities known to have been subject to bathymetry/morphological changes post-2012. Such monitoring is not being considered at this stage however.

11.2.2. Substrate Composition

- Substrate composition has been partly assessed by ground truthing of side-scan sonar plots in 2012[35]. Seabed substrate types also constitute one of the deliverables of the Geology lot of the EMODnet Project.
- Additional assessments of substrate composition will be undertaken as deemed necessary following an analysis of the information compiled by ERDF 156[36] and EMODnet Geology and cannot be elaborated at the time of compiling this document. Should any monitoring procedures be deemed

[33] ERDF 156 - Development of Environmental Monitoring Strategy and Environmental Monitoring Baseline Surveys (Lot 2) Contracts Ref. No – CT3024/2011 Activities 1 – 4

[34] A major advantage of MBES over SSS is that MBES generate quantitative bathymetric data that are much more amenable to classification and image processing, but the narrow beam width (ideal for quantitative analysis) makes them less useful for detection of small objects (<1 m)

[35] ERDF 156 - Development of Environmental Monitoring Strategy and Environmental Monitoring Baseline Surveys (Lot 2) Contracts Ref. No – CT3024/2011 Activities 1 – 4

[36] ERDF 156 - Development of Environmental Monitoring Strategy and Environmental Monitoring Baseline Surveys (Lot 2) Contracts Ref. No – CT3024/2011 Activities 1 – 4

necessary in the longer term, substrate composition should be classified in line with the classification system as adopted for the purpose of EMODnet Geology.

11.3. Monitoring area

11.3.1. Seabed topography and bathymetry

- Assessment of seabed topography and bathymetry will be restricted to 1 nautical mile and the spoil ground located beyond this boundary, off the Northeastern coast of mainland Malta.
- Areas/localities to be subject to assessment of seabed topography and bathymetry within the 1 nautical mile shall be determined following an assessment of potential changes in these aspects within specific localities through time.
- Monitoring beyond the 1 nautical mile boundary will take place on the basis of a risk-based approach on a case-by-case basis.

11.3.2. Substrate Composition

- Any additional monitoring of substrate composition as deemed necessary will be restricted to the 1 nautical mile boundary.
- Location of additional grab samples, if deemed necessary for the purpose of ground truthing or further assessment of substrate composition, will be determined following an analysis of the SSS plots[37] and the outcome of the EMODnet project which is using existing data published and unpublished to provide a seabed substrate GIS layer.
- Monitoring beyond the 1 nautical mile boundary, if any, will take place on the basis of a risk-based approach on a case-by-case basis.

11.4. Monitoring frequency

Characteristics		Monitoring Frequency (first monitoring year)
Physical Characteristics of the seabed	Seabed topography and bathymetry	Monitoring frequency depends on necessity to monitor potential alterations to seabed topography, bathymetry and substrate types
	Seabed substrate composition	

[37] Data from the side scan sonar surveys was not available at the time of compiling this document.

12. Monitoring sub-programme 5: *Activities with potential effect on hydrographical conditions*

Anthropogenic activities which can lead to permanent alterations of hydrographical conditions shall be mapped by collating information that is available through existing processes/mechanisms as indicated in Table 10.

The processes/mechanisms listed in Table 10 would call for monitoring associated with 'new development' for the determination of the extent of changes in hydrographical conditions resulting from human activities. Such monitoring, details of which is to be determined on a case-by-case basis, should concentrate on modelling changes in hydrographical parameters using appropriately calibrated models, validated with *in situ* datasets[38]. Such models would shed light on the potential effects on marine ecosystems. Field measurements[39] in this regard will only be necessary in areas where the changes are large enough to have significant effects on the marine ecosystem, at which point ground truthing will be considered appropriate[40]. In such a situation ongoing monitoring of changes in benthic fauna could be used to indicate any effects of permanent hydrographical alterations in line with MSFD indicators established for Descriptor 7.

Table 10: Information on anthropogenic activities with potential for permanent alterations of hydrographical conditions.

Type of Activity	Legislation/Mechanism
Development at sea	The Environment and Development Planning Act regulating development and use of land and sea; Environmental Assessment procedures.
Coastal Defence and engineering Works	The Environment and Development Planning Act regulating development and use of land and sea;
Discharge of cooling waters and brine	The Environment and Development Planning Act regulating development and use of land and sea; Environmental Permitting and Licensing systems

[38] OSPAR Commission 2012. MSFD Advice document on Good environmental status - Descriptor 7: Hydrographical conditions. A living document - Version 17 January 2012

[39] Bottom shear stress can be an indicator of sediment mobilisation and transport. Although not specifically required by the policies under consideration, it is a good indicator for the purpose of assessing alterations to hydrographical conditions.

[40] OSPAR Commission 2012. MSFD Advice document on Good environmental status - Descriptor 7: Hydrographical conditions. A living document - Version 17 January 2012

13. Supporting Parameters

Information to be recorded in the field includes:

- date and time,
- sampling depth and
- meteo-marine conditions, mainly rainfall, wind speed, wind direction.

Satellite data on sea surface temperatures and chlorophyll concentrations can also used to support the implementation of this monitoring factsheet. Drago *et al.* (2009)[41] indicate that such satellite data is already supported by the local Meteorological Office.

14. Links to monitoring processes

Monitoring in terms of this factsheet is linked with monitoring for other marine elements as follows:

- Monitoring of hydrographical conditions and seabed characteristics provides supporting parameters to monitoring of:
  - Benthic habitats
  - Water column habitats
  - Marine reptiles and marine mammals
  - Contaminants
  - Eutrophication
- Monitoring of physico-chemical parameters is shared with monitoring for eutrophication and water column habitats both in terms of parameters and monitoring stations.

15. Quality Assurance & Quality Control

Monitoring for hydrographical monitoring will be carried out in line with the following standards/guidelines as relevant:

- EN ISO 5667-3: 2012 including guideline procedures for sampling programmes and techniques, preservation and handling of different types of water and sediments, bio-testing of samples and other general techniques.
- HELCOM COMBINE Programme. Manual for marine monitoring. Annex B-8 Technical note on the determination of hydrographic parameters. Helsinki Commission, Baltic Marine Environment Protection Commission.

[41] Drago, A., Cordina, G., Borg, S., Deidun, A.; Delitala, A. & the Marine Group of Experts (2009), *The support of Operational Oceanography for a more effective maritime sector in the Maltese Islands,* Report for the NET.MARI.MED (Network for supporting Marine Affairs in the Mediterranean) Archimed Interreg project.

- HELCOM COMBINE Programme. Manual for marine monitoring. Annex C-2. Hydrographic and hydrochemical variables. Helsinki Commission, Baltic Marine Environment Protection Commission.
- UNEP/MAP/MED POL, 2005. Sampling and Analysis Techniques for the Eutrophication Monitoring Strategy of MED POL. MAP Technical Reports Series No. 163. UNEP/MAP, Athens, 2005.
- UNESCO, 1988. The acquisition, calibration, and analysis of CTD data. A report of SCOR Working Group 51. UNESCO Technical Papers in Marine Science, 54, 94pp.
- UNESCO, 1991. Processing of Oceanographic station data. JPOTS editorial panel.

16. Data collection, storage and dissemination

All data should be collected and stored in accordance with the INSPIRE Technical Specifications listed in this section and/or any other relevant INSPIRE standard as identified through the Marine Pilot Project[42]. Processed data to be uploaded in a geoportal.

- D2.8.II/III.7 Data Specification on Environmental Monitoring Facilities – Technical Guidelines[43]
- Data Specification on Oceanographic geographical features – Technical Guidelines

17. Responsible organisations

Monitoring sub-programme	Responsible Authorities
Water Column – Hydrological Characteristics Currents	Malta Environment and Planning Authority
Water Column – Nutrient Levels	
Water Column – Physical and Chemical Characteristics	
Physical Characteristics of the seabed and coastline	
Activities with potential effect on hydrographical conditions	

[42] https://circabc.europa.eu/w/browse/bc33dff1-0f8c-467a-8382-7724c5f79d45
[43] http://inspire.ec.europa.eu/index.cfm/pageid/2

18. Gaps and Research Needs

Gaps	Plans to address gaps
The monitoring factsheet does not cover hydrodynamic modelling and numerical modelling. More specifically, this monitoring factsheet is not covering certain aspects such as mixing characteristics and residence time which should be assessed through modelling.	- Identification of appropriate models suitable for monitoring hydrographical conditions, including assessment of specific parameters such as mixing characteristics and residence time. - Type and sources of input data to be identified. - Application of appropriate modelling to be undertaken including training of personnel. - Modelling to be also used for the determination of extent of areas affected by marine discharges. This process requires liaison with research institutions and research projects, in order to maximize the use of research products and activities
Links between hydrographical conditions and biological elements are poorly known.	Research efforts to be undertaken in relation to the requirements of selected habitat types and/or species in terms of hydrographical conditions, with a view to better define links between hydrographical data and ecological status.

19. Main Sources

- AAE Consortium (ADI Associates Ltd, Ecoserv Ltd and E Cubed Consultants). 2014. Long Term Monitoring Strategy for the Marine Environment of the Maltese Islands under the Marine Strategy Framework Directive. Service Contract for the development of a long-term monitoring strategy for the marine environment, a social and economic analysis of the use of marine waters and costs of degradation, and baseline sediment survey in inland waters (MEPA tender ref: CT3048/2012). ERDF156 - Developing national environmental monitoring infrastructure and capacity. Malta, unpublished report, 252 pp.

- AAE Consortium (ADI Associates Ltd, Ecoserv Ltd and E Cubed Consultants). 2014. Long Term Monitoring Programme for the Marine Environment of the Maltese Islands under the Marine Strategy Framework Directive. Service Contract for the development of a long-term monitoring strategy for the marine environment, a social and economic analysis of the use of marine waters and costs of degradation, and baseline sediment survey in inland waters (MEPA tender ref: CT3048/2012). ERDF156 - Developing national environmental monitoring infrastructure and capacity. Malta, unpublished report, 346 pp.

- Drago, A., Cordina, G., Borg, S., Deidun, A.; Delitala, A. & the Marine Group of Experts (2009), The support of Operational Oceanography for a more effective maritime sector in the Maltese Islands, Report for the NET.MARI.MED (Network for supporting Marine Affairs in the Mediterranean) Archimed Interreg project.

- OSPAR Commission 2012. MSFD Advice document on Good environmental status - Descriptor 7: Hydrographical conditions. A living document - Version 17 January 2012