Contamination by Hazardous Substances

1.1 Introduction

The Marine Strategy Framework Directive (hereinafter referred to as 'MSFD') calls for the development of marine strategies to protect and preserve the marine environment and to prevent and reduce inputs into the marine environment, with a view to phasing out pollution. This report analyses pressures and impacts resulting from contamination of marine waters by hazardous substances with a view to define current status of marine waters in terms of contaminants, in line with the requirements of Article 8 of the MSFD.

'Hazardous substances' are defined as chemical elements and compounds or groups of substances that are toxic, persistent and liable to bio-accumulate[1], and other substances or groups of substances which give rise to an equivalent level of concern[2].

In line with Annex III of the MSFD, hazardous substances can be broadly classified into two principal groups: synthetic substances and non-synthetic substances. Synthetic substances refer to man-made compounds such as pesticides, pharmaceuticals and anti-fouling agents, whereas non-synthetic substances include naturally occurring substances such as trace metals, aliphatic and aromatic hydrocarbons, as well as by-products of combustion activities.

1.2 Legislative Framework

1.2.1 Dangerous Substances Directive (76/464/EEC) and Water Framework Directive (2000/60/EC)

At the European Union level, the Dangerous Substances Directive 76/464/EEC[3] first established a series of quality standards aimed at protecting human health and the environment from discharges of chemicals of concern into the aquatic environment. In the year 2000, the Water Framework Directive (hereinafter referred to as 'WFD') established a framework for European wide action for the protection, improvement and prevention of further deterioration of the water quality across Europe. The WFD is in the process of fully repealing the Dangerous Substances Directive by 2013.

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1 Bioaccumulation refers to the accumulation of substances in an organism

2 Piha H. 2010. Marine Strategy Framework Directive Task Group 8 Report Contaminants and Pollution effects; 171pp. Available online at: http://www.ices.dk/projects/MSFD/TG8%20Report_Final_vII.pdf (Accessed on 13th September 2012).

3 Directive 76/464/EEC has been codified to Directive 2006/11/EC.

The WFD establishes, *inter alia*, requirements for good surface water chemical status. Chemical status is defined in terms of compliance with environmental quality standards (EQS) established for chemical substances at European level.

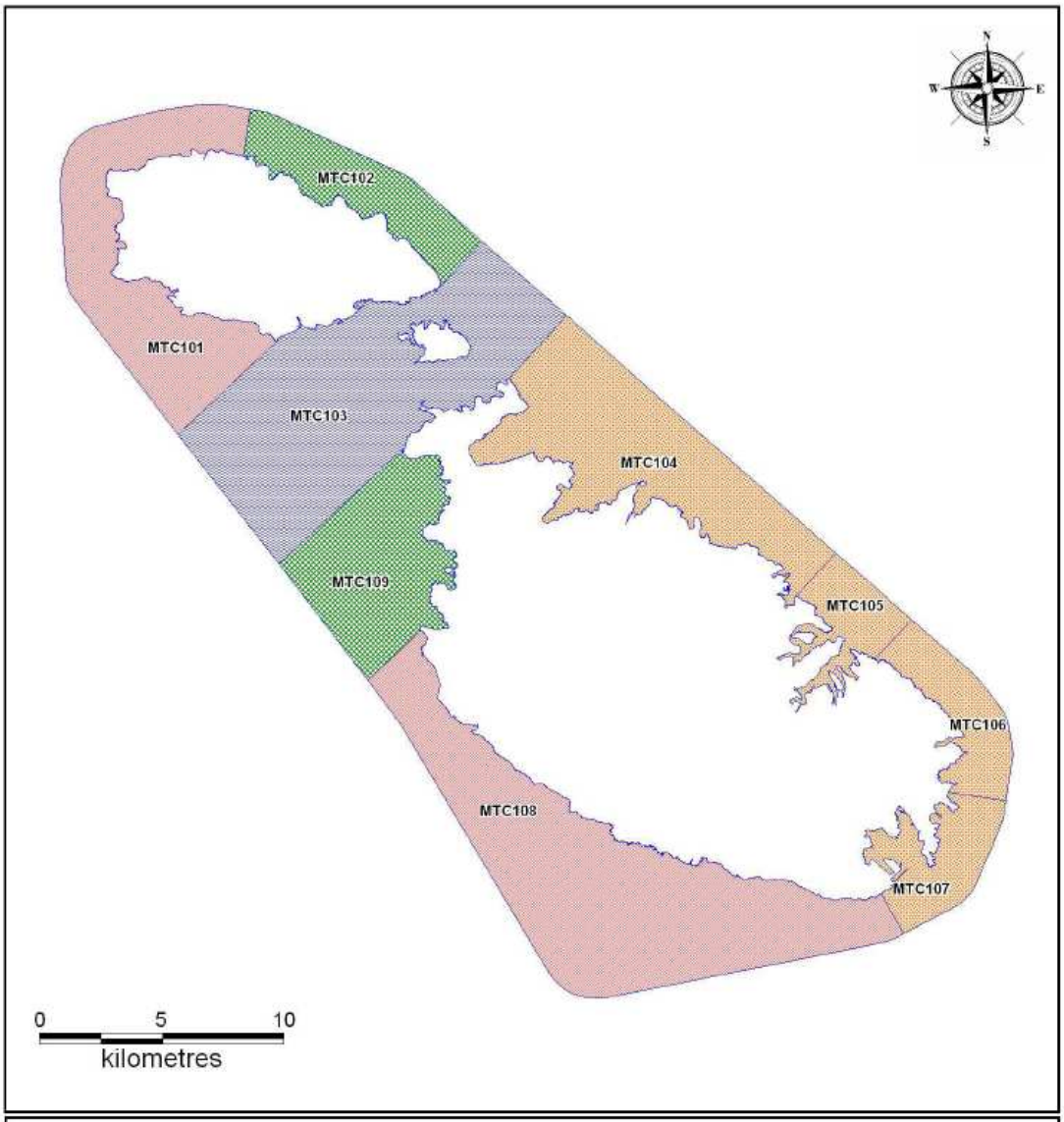
For the purposes of the WFD, the coastal waters around the Maltese Islands have been divided into nine distinct water bodies, the boundaries of which were determined on the basis of the predominant physical and ecological characteristics, as well as on the nature and magnitude of pressures on the coastal water environment (Figure 1). The nine water bodies include seven natural coastal water bodies and two heavily modified water bodies which have undergone significant physical changes. The two heavily modified water bodies are the harbours of Marsamxett and the Grand Harbour (MTC 105) and Marsaxlokk harbour (MTC 107).

Malta's Water Catchment Management Plan[4] identifies a series of measures aimed at achieving the goals of the WFD for the identified water bodies. Measures which are deemed relevant to contamination by hazardous substances include those targeted at:

- the management of pesticide use on agricultural land;
- aquaculture operations;
- the development of pollution abatement programmes and tools to link environmental quality standards to emission limits for marine discharges;
- regulatory frameworks for industrial operations, including discharges;
- dumping operations at the spoil ground and
- dredging and disposal of dredged material.

[4] http://www.mepa.org.mt/topic-wcmp

Figure 1: Coastal Water bodies designated pursuant to the requirements of the EU Water Framework Directive



COASTAL WATER BODIES
(as in 2009)

Key

Typology

- Type I - Deep, very exposed
- Type II - Exposed, intermediate
- Type III - Exposed, intermediate to deep
- Type IV - Exposed, intermediate to deep waters with channel mix

INDICATIVE ONLY - Not to be used for direct interpretation.

1.2.2 Priority Substances Directive (2008/105/EC)

The Priority Substances Directive is a daughter directive to the WFD, which includes Environmental Quality Standards (EQS) for a list of priority substances and other pollutants present in the aquatic environment.

Good water chemical status is defined in terms of levels of chemical pollution in the aquatic environment which do not present any hazards or risks to human health, aquatic biota and ecosystem functioning. An Environmental Quality Standard (hereinafter referred to as 'EQS') is a concentration limit for a specific chemical in water, sediment or biota which should not be exceeded in order to achieve 'good water chemical status'.

The water environment can be affected by chemical pollution both in the short and long term and therefore data on both acute and chronic effects of contaminants is used as the basis for establishing EQS concentrations. By targeting priority substances, Directive 2008/105/EC focuses on individual pollutants that present significant risk to or via the water environment. Thirty three chemicals have been categorised as priority substances within this list; where thirteen chemicals have been identified as priority hazardous substances due to their persistence, bioaccumulation and toxicity properties in the water environment.

Article 3 of the Priority Substances Directive requires EU member states to apply the EQS to the water medium, as well as to arrange for the long-term trend analysis of concentrations of those priority substances that tend to accumulate in sediments and/or biota.

1.2.3 Industrial Emissions Directive

The Industrial Emissions Directive (hereinafter referred to as 'IED') came into force in January 2011. The IED is a result of extensive discussions among Member States, the European Commission and the European Parliament. Its purpose is to incorporate the obligations of the following seven Directives into one:

- Integrated Pollution Prevention & Control (IPPC) Directive;
- Large Combustion Plants Directive;
- Waste Incineration Directive;
- Volatile Organic Compound (VOC) Solvents Directive; and
- Three Directives regarding Titanium Dioxide.

The IED was transposed into national legislation through Legal Notices 9 to 14 (inclusive) of 2013. The provisions regarding Integrated Pollution Prevention and Control (IPPC) within the IED will apply to the industrial installations listed in Schedule 1 of Legal Notice 10 of 2013. The Directive sets out general principles for IPPC sites including the requirements that all the appropriate preventive measures are taken against pollution, particularly through application of best available techniques (BAT). The general principles also require specific consideration of waste management and accident prevention.

The Directive requires the establishment of Emission Limit Values (hereinafter referred to as 'ELVs') for polluting substances that are likely to be emitted in significant quantities. The ELVs must be based on best available techniques, and the Competent Authority, through IPPC permits, is required to set ELVs which do not exceed the emission levels associated with BAT. There is the possibility to set higher ELVs should assessment of the individual industrial installation show that the achievement of these ELV would lead to disproportionately higher costs compared to the environmental benefits due to the technical characteristics of the particular installation, its geographic location, or the local environmental conditions.

1.2.4 Sewer Discharge Control Regulations

The sewer discharge control regulations (Legal Notice 139 of 2002, as amended by Legal Notice 378 of 2005) are of relevance to the MSFD in terms of 'input of contaminants' particularly from the industrial sector, which may in turn influence the quality of wastewaters discharged from urban waste water treatment plants.

These regulations establish the need of a 'public sewer discharge permit' for the discharge of effluents into the public sewerage system. They prohibit the discharge of effluents in the public sewerage system containing substances listed in Schedule A of the regulations in concentrations significantly higher than those existing upstream of the discharge point in the receiving sewer. These substances include organohalogen compounds, organophosphorous compounds, organotin compounds, mercury and its compounds, cadmium and its compounds, persistent mineral oils and petroleum hydrocarbons, radioactive substances and persistent synthetic substances which may float, remain in suspension or sink and which may interfere with any use of the waters. The regulations provide 'guideline maximum discharge concentration values' for specific substances.

1.2.5 Regulation (EC) No 1907/2006 REACH

REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) is a European Regulation on chemicals and their safe use. REACH aims to improve the protection of human health and the environment from chemical risks. Its authorisation system ensures that substances of very high concern are well controlled and progressively substituted by safer substances or technologies.

1.2.6 Regulation (EC) No 1881/2006 on Contaminants in Foodstuffs

The presence of contaminants in fish and other seafood for human consumption is regulated by the European Regulation (EC) No 1881/2006 and its amendments, which sets maximum regulatory levels for certain contaminants in foodstuffs, in order to ensure protection of public health. Regulatory levels have been laid down for the heavy metals lead, cadmium and mercury, for polycyclic aromatic hydrocarbons, dioxins and polychlorinated biphenyls.

1.2.7 Barcelona Convention and the LBS Protocol

The Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention) was adopted in 1976 and came into force in 1978. The principal aim of the Barcelona Convention and its protocols is to reduce pollution in the Mediterranean Sea and protect and improve the marine environment in the area, thereby contributing to its sustainable development.

The Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities (LBS Protocol) was amended in 1996 and entered into force in June 2008. The Protocol identifies a list of substances of which control should be sought through action plans, programmes and measures. The list of substances includes organohalogen compounds, organophosphorus compounds, organotin compounds, polyaromatic hydrocarbons, heavy metals, lubricating oils, radioactive substances, biocides, pathogenic microorganisms, crude oil, petroleum hydrocarbons, cyanides and fluorides.

The Programme for the Assessment and Control of Marine Pollution in the Mediterranean region (MEDPOL) is the environmental assessment component of the Mediterranean Action Plan (MAP) of the Barcelona Convention. MEDPOL monitoring activities have reached Phase IV with periodical assessments of the state of the environment in hot spots and coastal areas, for the determination of temporal trends of selected contaminants and for the assessment of the effectiveness of actions and policy

measures to enhance the control of pollution by means of compliance to national and international regulatory limits.

1.2.8 Mediterranean Hazardous Waste Protocol

The Hazardous Waste Protocol calls for Contracting Parties to the Barcelona Convention to take all appropriate measures to prevent, abate and eliminate pollution of the Mediterranean region, which can be caused by transboundary movements and disposal of hazardous waste. The latter is defined as waste belonging to any category in Annex I to the Protocol and other substances which are otherwise considered to be hazardous by the domestic legislation of the State of export or possess any characteristic listed in Annex III to the Protocol.

Contracting Parties should reduce to a minimum the transboundary movement of hazardous wastes and if possible eliminate such movement. Parties thus have the right to ban the import of hazardous waste. However when transboundary movement needs to be resorted to, it should be subject to a written notification from the State of Export and written consent of the State of Import and of Transit. The movement itself should be consistent with international safety standards, in particular the procedures and standards set by the Basel Convention, and the hazardous waste should be disposed of in an approved site or facility.

1.2.9 Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from ships and aircraft (Dumping Protocol)

The Dumping Protocol within the framework of the Barcelona Convention, prohibits the dumping of waste or other matter listed in Annex I to the protocol into the Mediterranean Sea. These substances include organohalogen compounds, organosilicon compounds, mercury and its compounds, cadmium and it compounds, persistent plastic, crude oil and hydrocarbons, radioactive waste.

The dumping of other wastes listed in Annex II to the protocol requires a special permit from the competent national authorities. Such substances include heavy metals other than mercury and cadmium, cyanides, and pesticides not covered by Annex I.

1.2.10 The International Convention for the Prevention of Pollution from ships (MARPOL)

The International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention calling for the prevention of pollution of the marine environment by ships from operational or accidental causes.

Annexes to this Convention which are deemed relevant to this report include the following:

- Annex I - Regulations for the Prevention of Pollution by Oil (entered into force 2 October 1983)
- Annex II - Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk (entered into force 2 October 1983)
- Annex III - Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form (entered into force 1 July 1992)

1.2.11 Directive 2000/59/EC on port reception facilities (Legal Notice 278 of 2004)

The Port Reception Facilities Regulations target the reduction of discharges of ship-generated waste and cargo residues into the sea. Within this context, the port or terminal operator shall ensure that adequate authorised port reception facilities are available to meet the needs of ships normally using the port or terminal in question. The regulations also call for the preparation of a waste management plan with respect to the provision and use of port reception facilities.

1.3 Input of Contaminants to the Marine Environment

1.3.1 Importation Data for Hazardous Substances

Importation data for hazardous substances can be useful to indicate the use of certain chemical substances over the years within the national territory, hence to provide an indication of the risks for such substances to reach the marine environment. Importation quantities however do not necessarily represent loads of substances of potential releases to the environment.

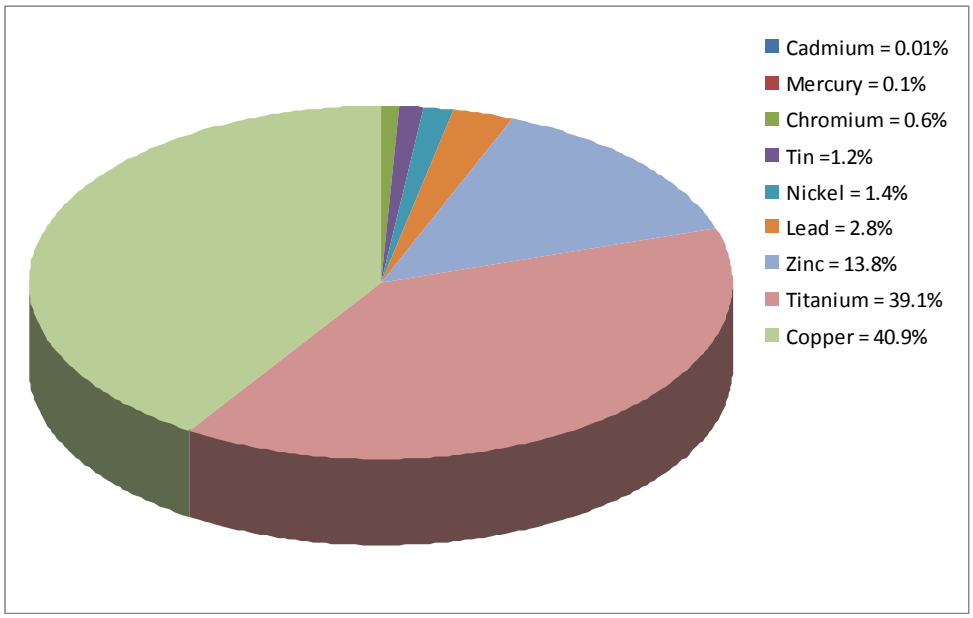
In 2010, the Malta Environment and Planning Authority (MEPA) has reviewed the importation statistics data for the period 2004 to 2009 for chemical substances included in the Priority Substances Directive, as well as chemical substances of potential national

concern to the marine environment. The importation quantities were made available by the National Statistics Office.

The available data confirms importation of substances including benzene, dichloromethane, naphthalene, tetrachloromethane, trichloromethane and the plasticizer Di(2-ethylhexyl-phthalate) (DEHP), which substances are mainly used for industrial purposes. The synthetic plant protection products Chlorpyrifos, Diuron and Trifluralin were also recorded in the importation statistics.

Total metals importation data for the period 2004-2009 is presented as percentage contribution in Figure 2. Cadmium, mercury and chromium contributed to less than 1% of the total importation of metals within this period, with cadmium imports amounting to less than one tonne. Comparable quantities have been imported for tin, nickel and lead, followed by higher quantities of zinc. Titanium and copper contribute to more than 80% of the total imported metal quantities over the period 2004-2009.

Figure 2: Metals Importation Data for 2004-2009



1.3.2 Point and Diffuse Sources of Contaminants

Input of chemical contaminants to the marine environment can result from both point and diffuse sources of emissions. A point source is defined as a single localised point of discharge of wastewater containing one or more pollutant(s)[5]. Diffuse sources are defined as smaller or scattered sources from which pollutants may be released to land, air or water[6].

A pioneer study on land-based sources of contaminants in the marine environment was carried out by Axiak & Delia in 2000[7]. This study involved considerable field monitoring of effluent discharges to sea from local industrial operators and provided an initial but comprehensive indication of the sources of land-based discharges to coastal waters.

Within the framework of the Strategic Action Plan Programme (SAP) adopted by the Contracting Parties to the Barcelona Convention, Malta has prepared a National Baseline Budget (NBB)[8] for emissions/releases of the SAP targeted pollutants from land-based sources. The National Baseline Budget (NBB), which was strongly based on the initial study carried out by Axiak and Delia (2000), and the National Diagnostic Analysis (NDA)[9] formed the basis for the development of a National Action Plan for Malta for the reduction and elimination of land-based pollution[10]. This National Action Plan (NAP) provides an initial indication of Environmental Quality Standards and Emission Limit Values for Direct Marine Discharges with respect to the following substances:

- Heavy metals: Mercury, Cadmium and Lead
- Selected organohalogens
- Petroleum hydrocarbons
- Pesticides (to note that use of the pesticides under consideration by the NAP is banned from Malta)

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5 European Commission. 2012. Common Implementation Strategy for the Water Framework Directive (2000/60/EC) Guidance Document No. 28. Technical Guidance for Preparation of an Inventory of Emissions, Discharges and Losses of Priority Substances and Priority Hazardous Substances; 69pp. Available online at: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/guidance_document_2/_EN_1.0_&a=d (Accessed on 13th September 2012).

6 Regulation (EC) No 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/699/EEC and 96/61/EC. OJ L33, 4.2.2006, p.1-17

7 Axiak & Delia. 2000. Assessing the Impact of Compliance with CD 76/464/EEC and other related Water Quality Directives with Reference to Marine Discharges in Malta. Commissioned Report for the Ministry for the Environment; 250 pp.

8 Axiak, V. 2003. Baseline Budget of Emissions/Releases for SAP targeted pollutants for Malta. As submitted to the United Nations Environment Programme, coordinating unit for the Mediterranean Action Plan through the Environment Protection Directorate of the Malta Environment and Planning Authority. http://www.mepa.org.mt/file.aspx?f=3523

9 Axiak, V. 2004. National Diagnostic Analysis for Malta. As submitted to the United Nations Environment Programme, Coordinating Unit for the Mediterranean Action Plan through the Environment Protection Directorate of the Malta Environment and Planning Authority. http://www.mepa.org.mt/file.aspx?f=3524

10 National Action Plan for the Protection of the Marine Environment from Land-based activities – Malta – 2005 http://www.mepa.org.mt/file.aspx?f=3526

The baseline budget was subsequently updated in 2008[11] with a view to update the estimates of the National Baseline budgets for land-based sources of pollution and detect any possible positive or negative trend of the inputs of pollutants into the marine environment.

The Water Catchment Management Plan (WCMP) for the Maltese Islands (MEPA, 2011[12]), prepared in accordance with the requirements of the Water Framework Directive, provides the most recent qualitative overview of point sources of hazardous contaminants reaching the Maltese coastal environment.

The following sections of this report describe the input of hazardous substances into coastal waters from point and diffuse sources, based on the data available to date. As described above, the currently available data pertains to land-based sources of pollution.

1.3.3 Point Land-based Sources of contaminants: Sectors

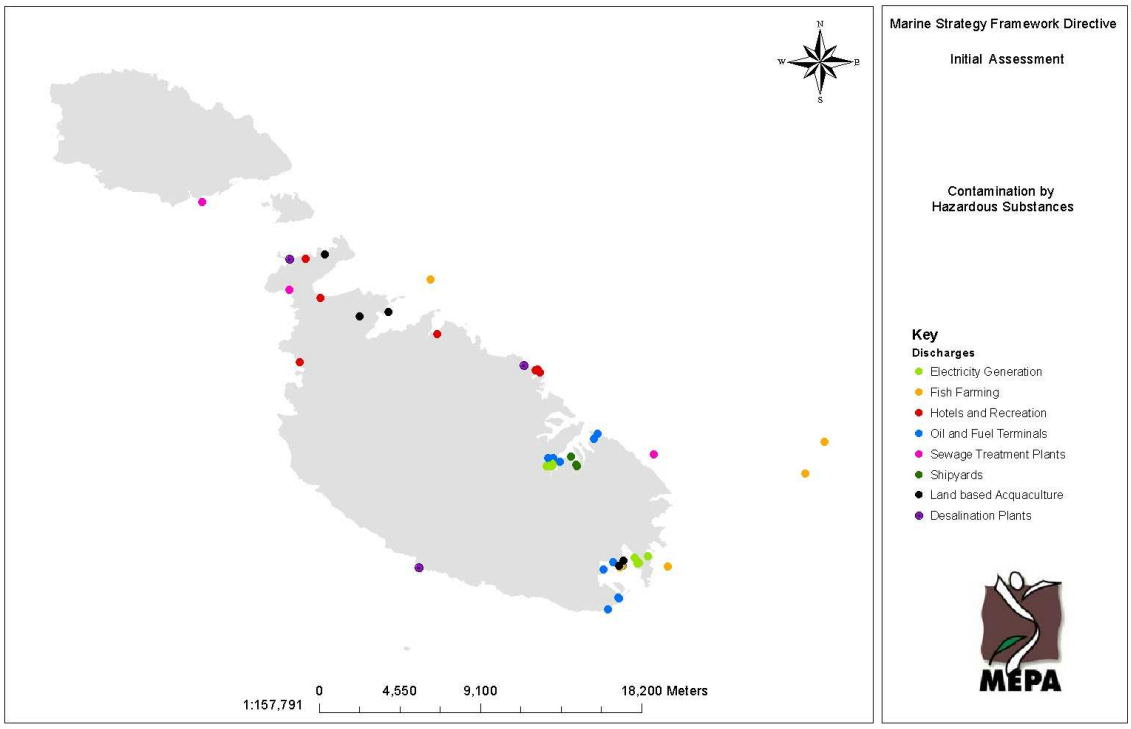
The main sectors associated with marine discharges are described below on the basis of the information provided in the Water Catchment Management Plan and information on substances provided by the National Diagnostic Analysis (2005) as well as other available data.

The location of point marine discharges in Malta is indicated in Figure 3. This spatial information was mainly collated as part of MEPA's environmental permitting process in collaboration with the operators. Within this context, it should be noted that MEPA's environmental permitting system has only recently started being implemented, therefore other marine discharges which are not currently permitted would be present throughout the Maltese Islands.

[11] Axiak, 2009. Baseline Budget of Emissions/Releases for SAP targeted pollutants for Malta, 2008. As submitted to the United Nations Environment Programme, Coordinating Unit for the Mediterranean Action Plan. Environment Protection Directorate, Malta Environment and Planning Authority; 20pp.

[12] http://www.mepa.org.mt/topic-wcmp

Figure 3: Location of discharges per sector



Urban Wastewater Outfalls

Historically, discharges of untreated municipal and industrial wastewaters into coastal waters were the most prominent form of pollution. The National Baseline Budget (2008)[13] confirms that the majority of wastewaters reaching the marine environment from land-based operations were being discharged from untreated sewage outfalls[14]. The data on input loads provided by the National Baseline Budget however should be interpreted within the context whereby only a small fraction of sewage was being treated at that time.

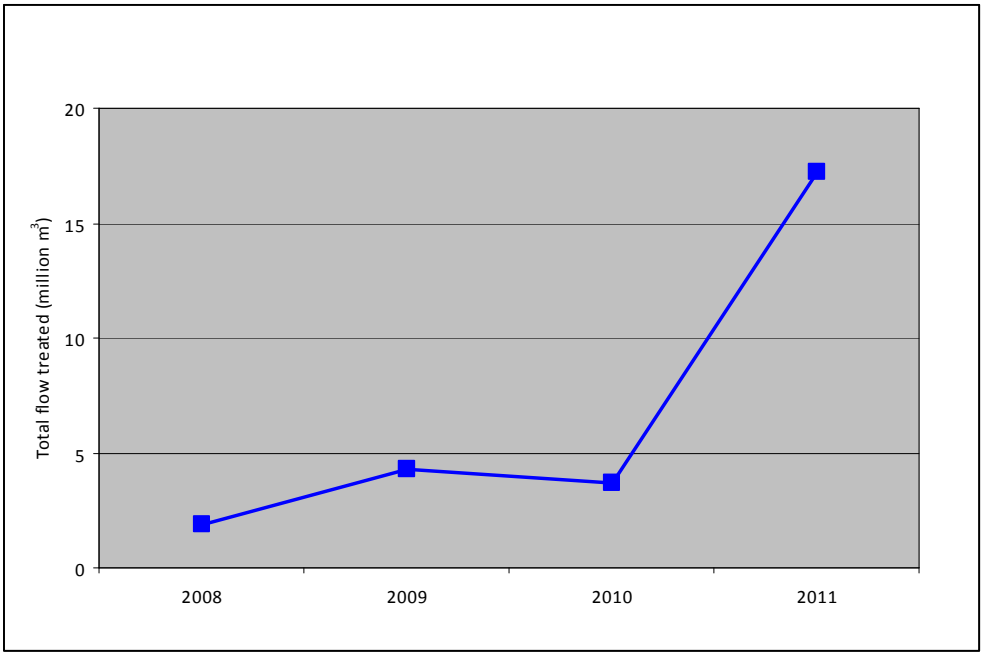
Of particular significance in recent years was the effluent of untreated sewage at Wied Għammieq within WFD water body MTC 106, Northeastern coast of mainland Malta. Untreated sewage used to be released into the sea via a submarine pipe running perpendicular to the coast. However, when the submarine outfall was not operating, sewage used to be discharged directly at shore.

Discharge of untreated sewage in Malta has been completely replaced by effluents treated to the secondary level. Sewage treatment plants at Ras il-Ħobż in Gozo and Iċ-Ċumnija in Malta have been discharging treated effluents from January 2008 and March 2009 respectively. The sewage treatment plant at Ta' Barkat (Northeastern coast of mainland Malta) has replaced the untreated sewage outfall at Wied Għammieq and became operational in June 2011. Figure 4 provides an indication of the amount of wastewaters treated in the period 2008-2011.

[13] Axiak, 2009. Baseline Budget of Emissions/Releases for SAP targeted pollutants for Malta, 2008. As submitted to the United Nations Environment Programme, Coordinating Unit for the Mediterranean Action Plan. Environment Protection Directorate, Malta Environment and Planning Authority; 20pp.

[14] Axiak, 2009. Baseline Budget of Emissions/Releases for SAP targeted pollutants for Malta, 2008. As submitted to the United Nations Environment Programme, Coordinating Unit for the Mediterranean Action Plan. Environment Protection Directorate, Malta Environment and Planning Authority; 20pp.

Figure 4: Volume of treated wastewaters in the period 2008-2011 (data provided by the Water Services Corporation)



The sewerage system in Malta collects both domestic and industrial wastes, the latter regulated by Legal Notice 139 of 2002[15], as amended by Legal Notice 378 of 2005. Therefore hazardous substances generated by industries could end up in the marine environment through the sewerage network.

With the exception of data reported for the purposes of the Urban Waste Water Treatment Directive, data with respect to loads of contaminants in treated effluents is limited. On the other hand, data on the composition of wastewater at key nodes on the wastewater collection and transmission network leading to the three sewage treatment plants currently in operation is available for the period 2008-2011 (Water Services Corporation, personal communication). Such data indicates detectable concentration of contaminants listed in the Priority Substances Directive including the synthetic Diuron and Chlorpyrifos in 2008 and tetrachloroethylene which was only recorded in 2011. Nickel and lead were the main Annex I non-synthetic contaminants detected in wastestreams.

The Malta Resources Authority has, earlier on this year, undertaken a series of analysis on the product waters from WasteWater Treatment Plants, as part of an EU funded project (Manuel Sapiano, personal communication). Negative results for all parameters

[15] Sewer Discharge Control Regulations

analysed[16] were obtained for samples from the Malta North and Gozo Treatment Plants. In the case of the Malta South Treatment Plant, the only positive results were for Alkylbenzene (2.8ug/l[17]) and Dibromochloromethane (0.2ug/l[18]) in two samples out of eight samples. The latter compound is mainly a by-product of chlorination undertaken at the plant and therefore should not be considered as an indicator of anthropogenic pollution.

Although sewage effluents can reach the marine environment through sewage overflows (in emergency situations, particularly heavy rainfalls), such overflows are rigorously controlled by Malta's Water Services Corporation and the influx of raw sewage into the marine environment from sewage overflows is deemed to be localised and of short duration. Therefore risk of contamination from sewage overflows will not be considered further in this report.

Industrial Point Source Discharges

Most industries in Malta are located inland and are either connected to the municipal sewerage system or employ specific waste management practices to regulate discharges generated on site. The majority of the installations with direct discharges to the marine environment are located in harbour areas (coastal water bodies MTC105, MTC107). Such installations include oil storage and treatment facilities (oil and fuel supply terminals), as well as the power stations of Marsa (MTC 105) and Delimara (MTC 107). According to the National Diagnostic Analysis (2004)[19], cooling waters of power stations may contain traces of organotins, tetrachloroethylene, petroleum hydrocarbons and biocides. Reported emissions to water from the Marsa[20] and Delimara[21] Power Stations were respectively found to be in compliance with the contaminants discharge limits established in the operation permit of the installation.

Oil and fuel terminals are considered to be a potential source of chronic oil pollution. Wastewaters from such terminals are generally associated with dewatering of fuels during storage or from oil-water separation of ballast waters, or rainwater runoff. The

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[16] The parameters analysed were: Carbamezepine, Aceteminophen, Diazepam, Diclofenac, Dilantin, Fluoxetine, Gemfibrozil, Hydrocondone, Ibrupofen, Iopromide, Meprobamate, Naproxen, Pentoxifylline, Mefanamic Acid, Dibutylphthalte, Glycol Ether, Alkyl Benzene, Dibromochloromethane, PFOA, PFOS, BisphenolA, Caffeine, Galoxolide, Oxybenzone, TCEP, DEET, Androstenedione, Estradiol, Estriol, Estrone, Ethinylestradiol, Progesterone, Testosterone, Tripethoprim, Trioclosan, Sulfamedthoxazole and Erythromycin.

[17] values quoted are the maximum values encountered

[18] values quoted are the maximum values encountered

[19] Axiak, V. 2004. National Diagnostic Analysis for Malta. As submitted to the United Nations Environment Programme, Coordinating Unit for the Mediterranean Action Plan through the Environment Protection Directorate of the Malta Environment and Planning Authority. http://www.mepa.org.mt/file.aspx?f=3524

[20] Annual Environment Report 2011, Marsa Power Station; pp 47. Available online: https://www.mepa.org.mt/ippc-applications-installations-mps (Accessed on 22nd October 2012).

[21] Annual Environment Report 2011, Delimara Power Station; pp 29. Available online: https://www.mepa.org.mt/ippc-applications-installations-dps (Accessed on 22nd October 2012).

majority of the oil and fuel terminals are also located within harbour areas as indicated in Figure 5. The nature of the activities taking place at these terminals presents a risk of contamination of the marine waters, particularly by polycyclic aromatic hydrocarbons (PAHs), and traces of heavy metals[22]. Minor to moderate oil spills have been reported in inshore waters, resulting mostly from fuel terminals in the Grand Harbour area.

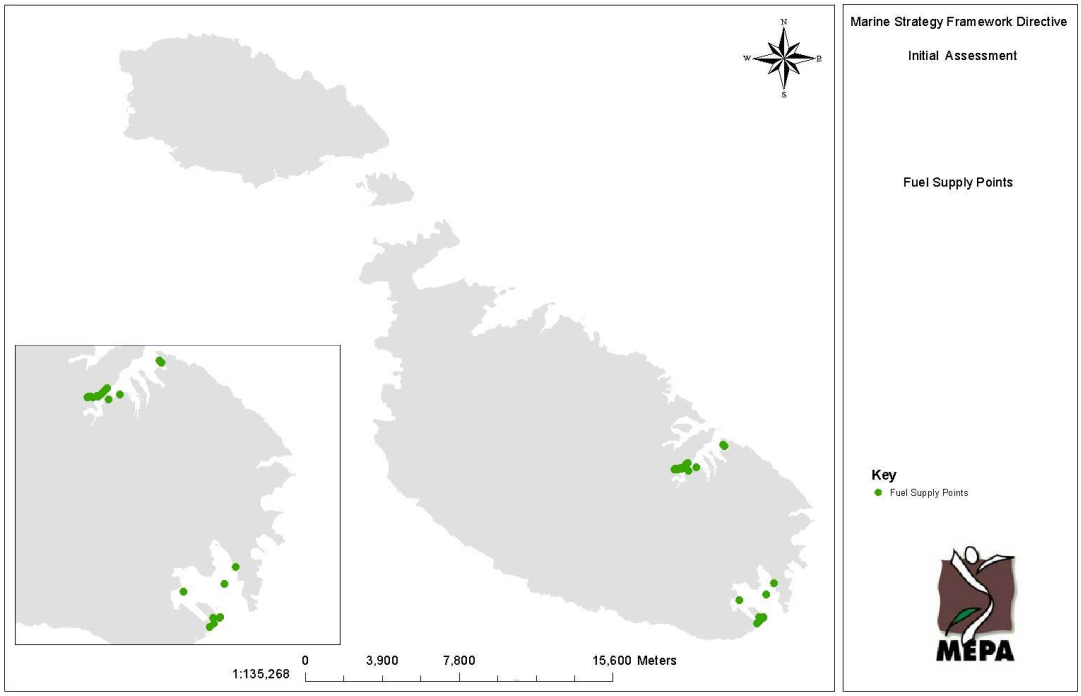
Shipyards located in the Grand Harbour area also constitute a source of contaminants in the marine environment. Until recently, the most important shipyard in Malta was the Malta Shipyards which was one of the largest ship repairing yards in the Mediterranean. Waste streams were mostly discharged directly to sea and were associated with organotins, hexachlorobutadiene, trichloromethane, dichloroethane, trichloroethylene, tetrachloroethylene, carbon tetrachloride, possible traces of polychlorinated biphenyls together with petroleum hydrocarbons and a range of heavy metals[23].

Activity at the Malta Shipyards was reduced significantly during the last decade. However they have been recently privatised and work is expected to increase in the future.

[22] Axiak, V. 2004. National Diagnostic Analysis for Malta. As submitted to the United Nations Environment Programme, Coordinating Unit for the Mediterranean Action Plan through the Environment Protection Directorate of the Malta Environment and Planning Authority. http://www.mepa.org.mt/file.aspx?f=3524

[23] Axiak, V. 2004. National Diagnostic Analysis for Malta. As submitted to the United Nations Environment Programme, Coordinating Unit for the Mediterranean Action Plan through the Environment Protection Directorate of the Malta Environment and Planning Authority. http://www.mepa.org.mt/file.aspx?f=3524

Figure 5: Location fuel supply points associated with the oil and fuel terminals in the Harbour areas



Waste Disposal: Landfills and Disposal at Sea

Until recently, mixed solid municipal waste was collected at three unmanaged land-based landfills at Magħtab, Qortin and Wied Fulija (Figure 6). These landfills could represent sources of contaminants through leaching in adjacent coastal water bodies MTC 104, MTC 102 and MTC 108 respectively. The NDA (2005)[24] suggests that the major impact exerted on the marine environment by the Magħtab landfill was that of contamination by heavy metals. However, Scott Wilson (2004)[25] concluded that overall these landfills did not pose a significant risk of contamination to the landfills' nearby water environment.

At present, municipal solid waste disposal is carried out at non-hazardous engineered waste facilities regulated through the Integrated Pollution Prevention and Control (IPPC) Regulations 2002, as amended and the Waste Management (Landfill) Regulations 2002. As part of the permitting process of Ta' Żwejra and Għallis Non-Hazardous Landfills, four

[24] Axiak, V. 2004. National Diagnostic Analysis for Malta. As submitted to the United Nations Environment Programme, Coordinating Unit for the Mediterranean Action Plan through the Environment Protection Directorate of the Malta Environment and Planning Authority. http://www.mepa.org.mt/file.aspx?f=3524

[25] Scott Wilson. 2004. Development of Rehabilitation Strategies, Magħtab, Qortin and Wied Fulija Landfills, Summary Report. Malta: WasteServ Malta Ltd.

coastal monitoring stations have been designated for monitoring of contaminants in water and sediments in adjacent water body MTC 104.

Results[26] from the alleged impacted coastal monitoring points, close to the landfills' sites, at the water surface and bottom, during the years 2010 and 2011, have indicated concentrations in water well below Environmental Quality Standards as defined in the Priority Substances Directive for cadmium, lead, nickel and mercury in coastal waters. Chemical analysis of sediments from same sampling points and period, indicated concentrations of mercury, cadmium, lead, nickel, arsenic, chromium, copper and zinc below Environmental Quality Standards as proposed by Axiak (2003)[27] for non-industrial sites. Therefore the site in question does not seem to be affected by the Ta' Żwejra and Għallis Non-Hazardous Landfills.

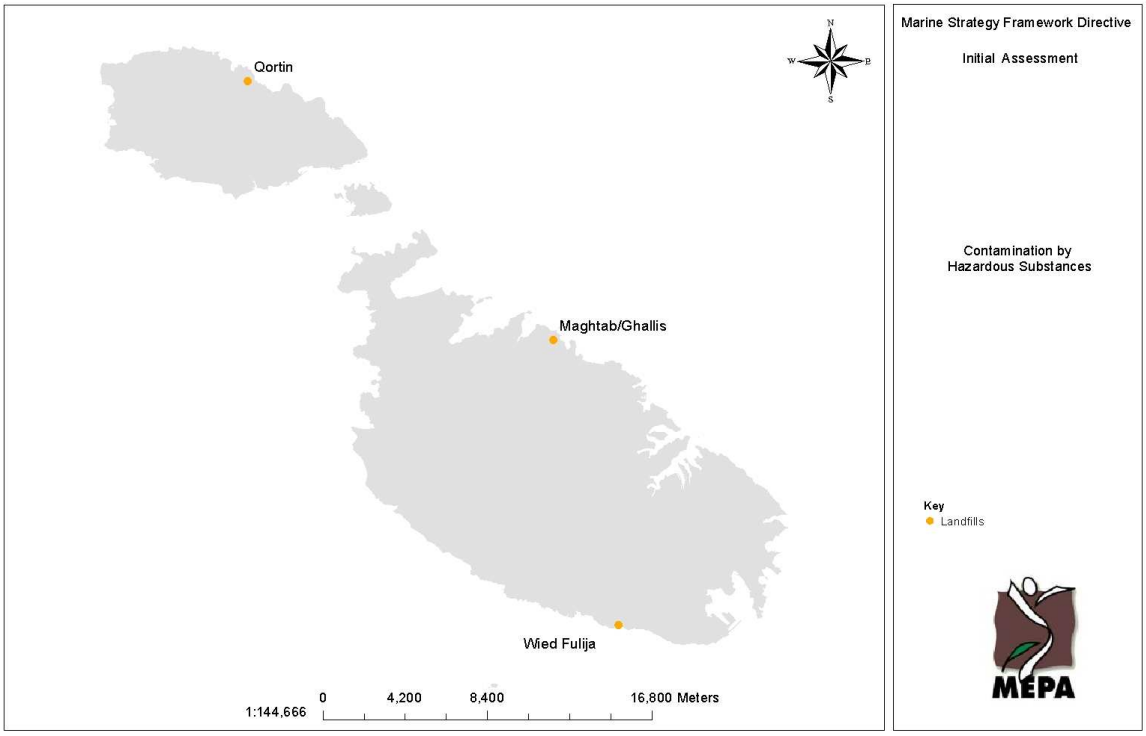
Dumping of inert material at sea takes place at a designated national spoil ground off the Northeastern coast of Malta, consisting of a circular area with a radius of about 350m[28]. The potential impact of the national spoil ground is to date unknown.

[26] Annual Environment Report 2011, Ghallis Non-Hazardous Waste Landfill; pp 47. Available online: https://www.mepa.org.mt/ippc-applications-installations-ghallisnh

[27] Axiak, V. 2003. Proposal for a National Marine Pollution Strategy to Control Direct Discharges into the Marine Environment. Final document submitted for consideration by the Environment Protection Directorate of the Malta Environment and Planning Authority; 96 pp. Available online at: http://www.mepa.org.mt/topics-water-monitoring

[28] Designated by Legal Notice 128 of 1997, as amended.

Figure 6: Location of previously unmanaged landfills



Fish Farming

Marine-based fish farming is a source of contamination in the marine environment particularly through excess food and fish wastes, potential use of pharmaceuticals and packaging processes. During the past decade, there was an increasing shift towards tuna penning, accompanied by a drive to relocate such practices to offshore areas. A site designated for such purpose is located to the Southeast of mainland Malta. At the moment, the drive of the fish farming sector is towards research into culturing alternative species, particularly the amberjack[29].

The NBB (2008) indicates that most of the wastewaters associated with tuna penning operations arise from ship-based sources where tuna processing and packaging takes place. Such wastewaters would be rich in organic contaminants and nutrients. Land-based aquaculture installations are on the other hand associated with wastewater effluents arising from net cleaning, defrosting and frozen bait, fish processing and packaging. However the significance of marine contamination from such discharges is considered low.

Other Point Source Discharges

Discharges from municipal desalination plants and cumulative discharges from tourist resorts are also considered to be sources of hazardous substances, albeit of a localised nature and hence of low significance. There are three main desalination plants in Malta, operating at Lapsi (MTC 108), Cirkewwa (MTC 103) and Pembroke (MTC 104).

Brine wastewaters, as well as membrane wash waters produced during back-flushing of the membranes are discharged directly into the sea. The main chemicals of concern which have been detected in desalination discharges are boron, and to a lesser extent, arsenic and nitrates[30]. It is more likely that such chemicals or potential marine contaminants are originally found in the feed waters and are being concentrated in the discharged brine stream (Axiak and Delia, 2000)[31].

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[29] http://www.mrra.gov.mt/page.aspx?id=80

[30] NBB (2003) indicates that the amount of quantitative data available with respect to discharges from desalination plants is insufficient to be able to make a thorough assessment and the data provided by the NBB needs further verification.

[31] Axiak & Delia. 2000. Assessing the Impact of Compliance with CD 76/464/EEC and other related Water Quality Directives with Reference to Marine Discharges in Malta. Commissioned Report for the Ministry for the Environment; 250 pp.

1.3.4 Point Land-based Sources: Input Loads

The National Baseline Budget 2003 and 2008 provide estimates of input loads for contaminants in discharges for the following sectors:

- Marine discharges from Public sewers
- Electricity production
- Oil and fuel terminals
- Freshwater production (desalination)
- Shipyards
- Fish farming

These reports were based on archived data in relation to the major point discharges into the marine environment, estimated flow rates and volumes of discharged wastewaters, as well as preliminary chemical profiles. While such data was considered to be reliably sourced, it was very limited and incomplete, and the authors deemed such data insufficient to ensure an accurate estimate of annual baseline budgets of marine pollutants. The loads quoted in this report on the basis of the NBB should thus take full consideration of such limitations. With regards to methodology used by the reports, an 'end of pipe' approach was applied rather than 'load oriented' approach, through determination of concentrations of the pollutant in the wastewaters released.

It should be noted that some of the marine discharges reported in one or both reports were discontinued in recent years, specifically 3 sewage outfalls: Ħal Far industrial estate and Anchor Bay outfalls on mainland Malta and San Blas outfall in Gozo[32]. Another outfall at Wied il-Mielaħ was decommissioned in June 2011 (Water Services Corporation, personal communication). Furthermore, data on input loads from public sewers reflects a scenario whereby only a small fraction of sewage was being treated at the time. Nowadays all municipal wastewaters are treated at three sewage treatment plants, two on mainland Malta and one on Gozo.

National baseline budgets estimated by the NBB (2008) for substances listed in Annex I of the Priority Substances Directive are provided in Table 1. Data is only available for 16 synthetic substances out of 33 listed in the Priority Substances Directive; and for 4 non-synthetic substances (namely cadmium, lead, mercury and nickel) out of 9 listed in the Priority Substances Directive. Table 2 provides an indication of baseline budgets for substances not listed in the Priority Substances Directive. For the purposes of the MSFD, the substances are classified as 'synthetic' and 'non-synthetic' in both tables.

[32] Axiak, 2009. Baseline Budget of Emissions/Releases for SAP targeted pollutants for Malta, 2008. As submitted to the United Nations Environment Programme, Coordinating Unit for the Mediterranean Action Plan. Environment Protection Directorate, Malta Environment and Planning Authority; 20pp.

Figure 7 provides an indication of the contribution of each sector under consideration for the synthetic and non-synthetic substances listed in Annex I of the Priority Substances Directive for which data is available. Public sewers (at the time representing untreated sewage) constituted the main contributing sector for Annex I synthetic substances (namely tetrachloroethylene and trichloromethane), while fish farming, desalination[33], energy generation and public sewers collectively contribute to discharge of non-synthetics (namely metals).

Trends in point source discharges of substances into the marine environment can only be based on the two sets of data for 2003 and 2008. As indicated in Figure 8, for substances listed in Annex I of the Priority Substances Directive, and

Figure 9 for all substances for which data is available, there seems to be a significant decrease in emissions of Annex I non-synthetic substances (cadmium, lead, mercury and nickel) especially from public sewers. No changes in discharges of non-synthetics are evident when comparing the 2003 with the 2008 budgets.

[33] NBB (2003) indicates that the amount of quantitative data available with respect to discharges from desalination plants is insufficient to be able to make a thorough assessment and the resultant computed BB needs further verification.

Table 1: Total National Baseline Budgets of synthetic and non-synthetic substances as reported in the National Baseline Budget (2008)[34].

Substances	Total National Baseline Budget (kg/year)	Sectors contributing to emissions (ranked according to contribution)
Synthetic		
Alachlor		
Atrazine		
Brominated diphenylether		
Carbon tetrachloride	0	Not applicable
C10-13 Chloroalkanes		
Chlorfenvinphos		
Chlorpyrifos		
Aldrin	0	Not applicable
Dieldrin	0	Not applicable
Endrin	0	Not applicable
Isodrin	0	Not applicable
DDT total	0	Not applicable
Para-para-DDT		
1,2-Dichloroethane	0	Not applicable
Dichloromethane		
Di(2-ethylhexyl)-phthalate (DEHP)		
Diuron		
Endosulfan		
Hexachloro-benzene	0	Not applicable
Hexachloro-butadiene	0	Not applicable
Hexachloro-cyclohexane	0	Not applicable
Isoproturon		
Nonylphenol		
Octylphenol		
Pentachloro-benzene		
Pentachloro-phenol	0	Not applicable
Simazine		
Tetrachloro-ethylene	2097	Public sewers; Other industry; Freshwater production; Oil and Fuel terminals; Shipyards
Trichloro-ethylene	0	Not applicable
Tributyltin compounds	10	Public sewers; Energy generation; Fishfarming; Shipyards
Trichloro-benzenes	0	Not applicable
Trichloro-methane	36	Freshwater Production; Public sewers; Fish farming; Oil and Fuel Terminals; Shipyards
Trifluralin		
Non-Synthetic		
Anthracene		

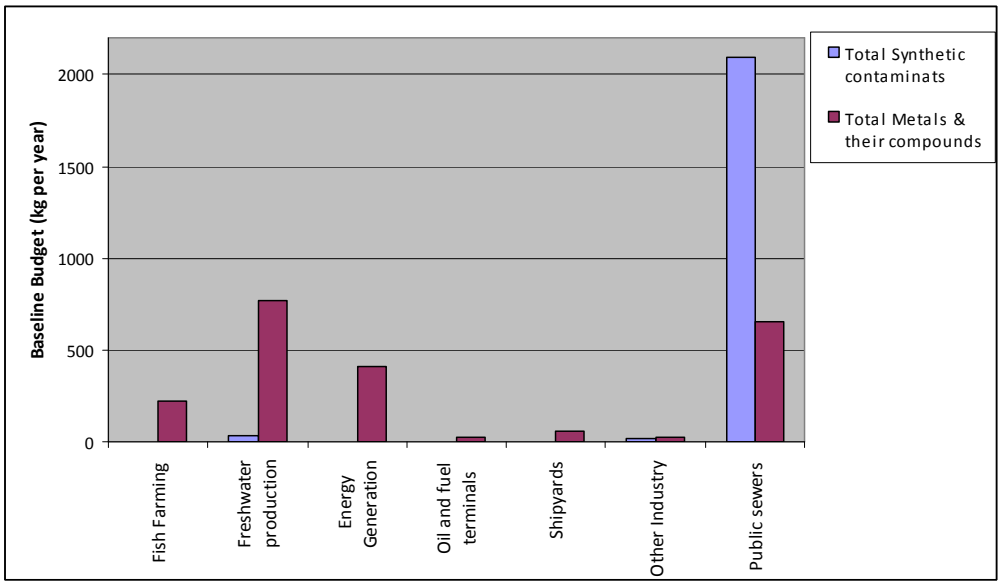
[34] For completeness purposes, this table is including all substances listed in the EQS Directive, for which data may not be available at this stage.

Benzene		
Cadmium and its compounds	184	Energy Generation, Shipyards, Public Sewers
Fluoranthene		
Lead and its compounds	667	Public Sewers, Energy Generation; Shipyards; Other Industry; Oil and Fuel terminals; Freshwater production; Fishfarming.
Mercury and its compounds	200	Public Sewers
Napthalene		
Nickel and its compounds	1099	Freshwater production; Fishfarming; Public sewers; Energy Generation; Shipyards; Oil and Fuel Terminals
Polyaromatic hydrocarbons		

Table 2: Total National Baseline Budgets of synthetic and non-synthetic substances as reported in the National Baseline Budget (2008) for substances not listed in EQS Directive.

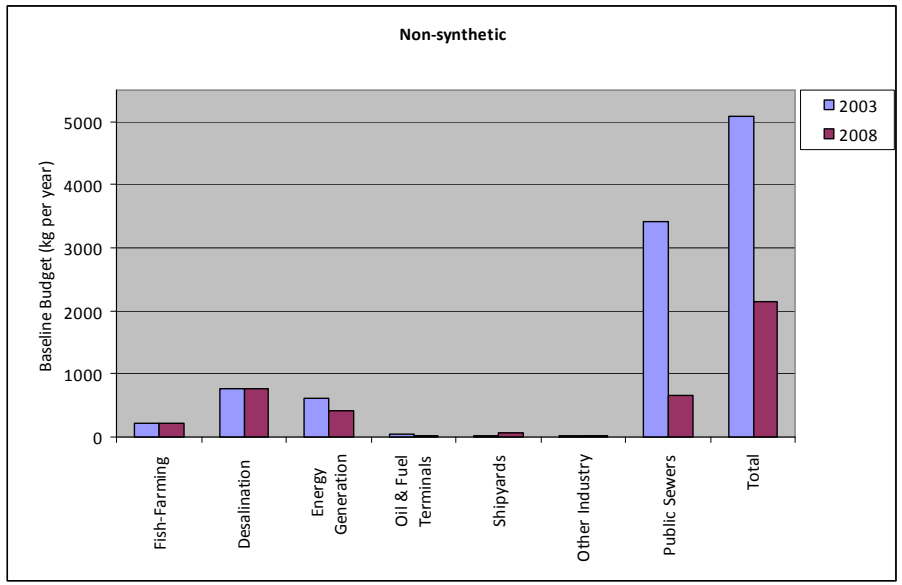
Substances	Total National Baseline Budget (kg/year)	Sectors contributing to emissions (ranked according to contribution)
Synthetic		
Polychlorinated biphenyls (PCBs)	0.02	Oil and Fuel Terminals
Parathion	0	Not applicable
Malathion	0	Not applicable
Cypermethrine	0	Not applicable
Dichlorvos	0	Not applicable
Non-Synthetic		
Arsenic	547	Public sewers; Freshwater production; Other Industry; Energy Generation; Fishfarming; Oil and Fuel Terminals
Chromium	217	Public sewers; Shipyards; Freshwater Production; Other Industry; Energy Generation; Oil and Fuel Terminals
Copper	1 730	Public sewers; Shipyards; Freshwater Production; Energy Generation; Oil and Fuel Terminals; Other Industry
Manganese	0	Not applicable
Selenium	646	Public sewers; Freshwater Production;
Zinc	23 196	Public sewers; Freshwater Production; Fish farming; Energy Generation; Shipyards; Other Industry; Energy Generation; Oil and fuel terminals.
Antimony	0	Not applicable
Barium	474	Public sewers
Beryllium	0	Not applicable
Boron	72 628	Public sewers; Freshwater Production; Fish farming; Other industry; Energy Generation; Oil and fuel terminals.
Tin	596	Public sewers; Other Industry; Shipyards
Petroleum hydrocarbons	53 336	Public sewers; Energy Generation; Oil and Fuel Terminals; Fish farming; Other Industry; Shipyards
Total Oil	441 665	Public sewers; Other Industry; Energy Generation; Oil and Fuel Terminals; Shipyards;
Cyanides	626	Public sewers; Other Industry
Fluorides	7 684	Public sewers; Fish farming; Energy Generation; Other Industry; Oil and Fuel Terminals; Shipyards.

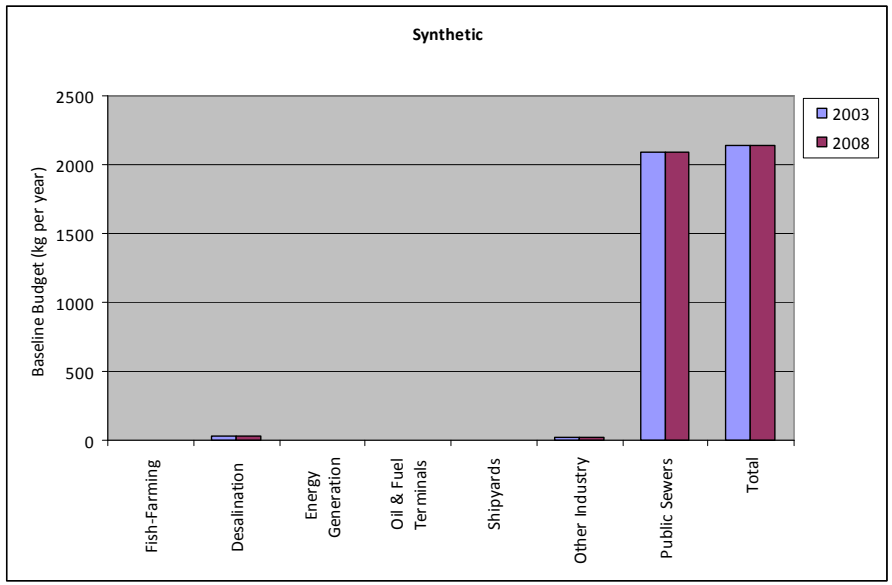
Figure 7: National baseline budgets for total synthetic contaminants and non-synthetic contaminants or metals (cadmium, lead, mercury and nickel) listed in Annex I of the Priority Substances Directive for each sector under consideration based on the National Baseline Budget (2008)[35].



[35] 'Other Industry' includes a pig farm, food processing company and the location of the Malta Film Facilities.

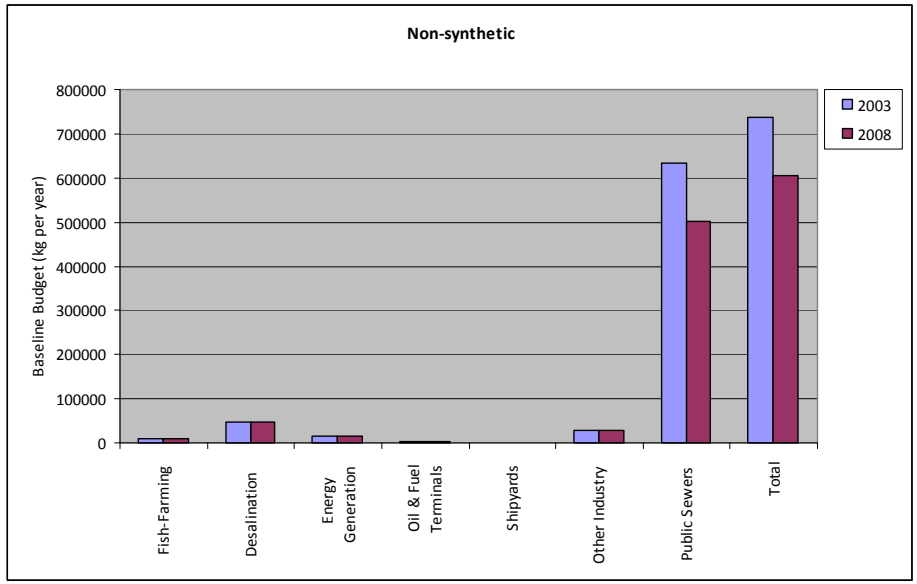
Figure 8: National baseline budgets for non-synthetic and synthetic substances listed in the Priority Substances Directive, per sector under consideration and totals, for the years 2003 and 2008 (data extracted from the National Baseline Budget 2008)[36].

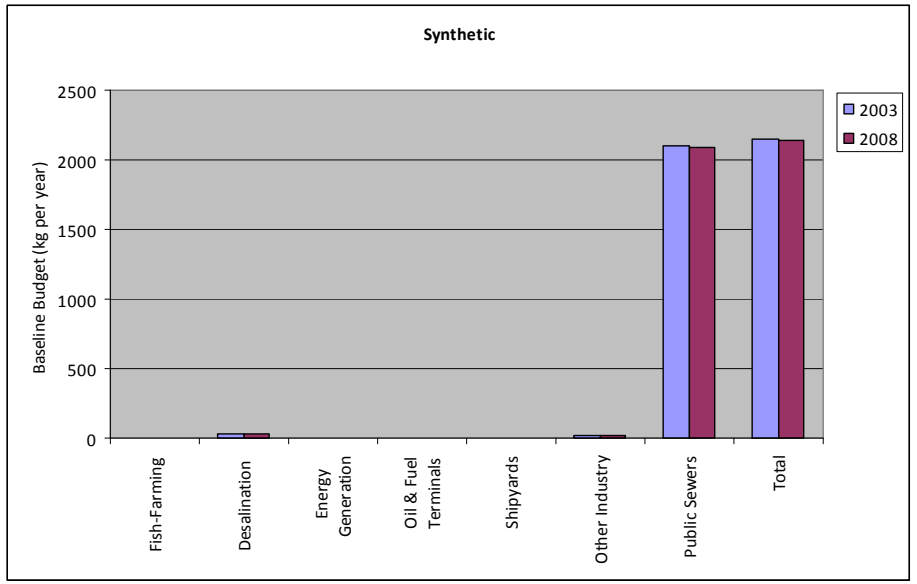




[36] As per Table 1 of this report, not all substances listed in the Priority Substances Directive are covered by the National Baseline Budget 2008.

Figure 9: National baseline budgets for non-synthetic and synthetic substances included in Table 1 and Table 2 of this document, per sector, and totals, for the years 2003 and 2008 (data extracted from the National Baseline Budget 2008).





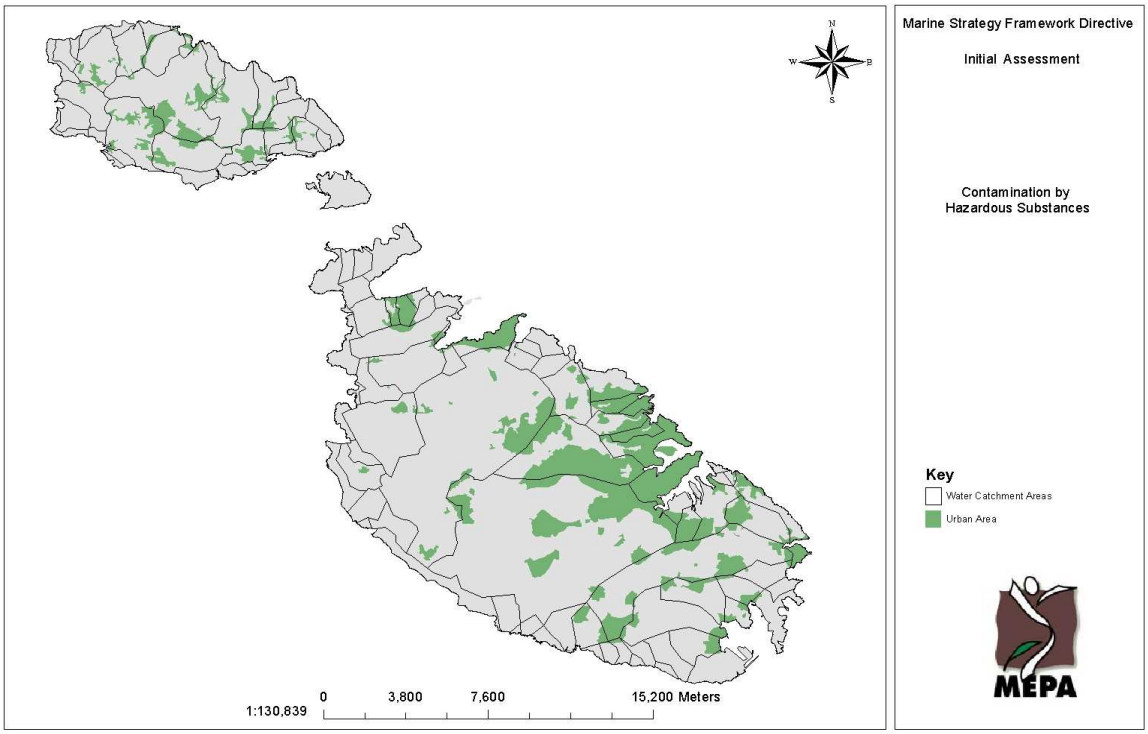
1.3.5 Diffuse Land-based Sources

Contaminants from diffuse land-based sources may ultimately end up into coastal waters through surface water run-off transporting such contaminants from water catchments into the marine environment. Such sources encompass a wide spectrum of activities including industrial and agricultural activities. Figure 10 provides an indication of the water catchment areas within which contaminants from both predominantly urban and predominantly agricultural/rural land can end up in the marine environment through surface run-off.

Storm water runoff within urban catchments is generally associated with the transport of debris, litter traces of oil and sewage as well as particulate matter, (such as soot from vehicular and industrial activities) to the water environment. Agriculture, through an excessive use of fertilisers and pesticides, and animal husbandry activities from the mismanagement of wastes, may also lead to the dispersion of fertilisers, pesticides and nutrients into the marine environment through water run-off (reference is made to the MSFD Initial Assessment report on 'Nutrient Enrichment'). Pesticides pertaining to the group of 'Persistent Organic Pollutants' (POPs), namely aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex and toxaphene, were banned as from 1998. However there is no information on the possible existence of stockpiles of obsolete or banned pesticides in Malta[37]. On the other hand, concentrations of some of these pesticides (aldrin, DDT, dieldrin, endrin, hexachlorobenzene) in previous sewage outfalls were below detection limits.

[37] Axiak, V. 2004. National Diagnostic Analysis for Malta. As submitted to the United Nations Environment Programme, Coordinating Unit for the Mediterranean Action Plan through the Environment Protection Directorate of the Malta Environment and Planning Authority. http://www.mepa.org.mt/file.aspx?f=3524

Figure 10: Delineation of water catchment areas on the Maltese Islands superimposed on predominantly urban areas and predominantly rural areas, including agricultural areas.



1.3.6 Sea-based Sources

Maritime activities contribute to chronic and/or accidental release of contaminants into inshore and offshore maritime zones. Such activities include intense maritime traffic, harbour activities and yacht marinas, bunkering activities as well as intense leisure boating activities especially in summer. These activities in general lead to the diffuse release of hazardous substances such as tar, fuels, lubricating oils and biocides from the use of anti-fouling paints.

The National Diagnostic Analysis identifies various risks of oil pollution in the marine environment associated with the maritime transport sector, including:

- major or moderate accidents involving maritime traffic, including bunkering[38];
- illegal discharges of ballast waters by maritime traffic;
- operational and minor losses of fuel and diesel oils from small water craft

Nevertheless, to date, data on input loads from such activities is not available.

Dredging activities at sea may also lead to the potential release of historic contaminants and accumulated nutrients present in sediments. Such activities are mainly undertaken in inshore waters for the purposes of the maritime transport sector and are thus mainly restricted to harbour areas. Once again, no data is available with respect to type and amount of contaminants released into the marine environment through such activities.

1.3.7 Atmospheric Inputs

Inputs of contaminants into the marine environment can also result from atmospheric deposition. Such sources of contamination could occur through long-range atmospheric transport and deposition, as well as from land-based sources emitting to air. Parties to the Convention on Long-range Transboundary Air Pollution (CLRTAP) shall endeavour to limit and, as far as possible, gradually reduce and prevent air pollution including long-range transboundary air pollution[39].

In accordance with CLRTAP and the European NEC Directive[40] obligations, a national inventory of emissions to air is compiled annually. These emissions are worked out by multiplying emission factors and activity statistics for each respective sector; partly also through the use of mathematical models. The national air inventory report for Malta (IIR) published in March 2012[41] includes emissions reporting up to 2010. The IIR

[38] Oil spills are analysed in a separate paper report for the purposes of the MSFD Initial Assessment.

[39] http://www.unece.org/env/lrtap/

[40] Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants. OJ L309, 27.11.2001, p22-30

[41] MEPA. 2012. Informative Inventory Report for Malta, March 2012.

includes a key category analysis, representing the most significant sources of emissions to air. Hazardous substances which feature in the key category analysis are presented in Table 3 below.

Benzo(a)pyrene emissions to air resulted from road transport and other sources of fuel combustion. Emissions of chromium, lead, zinc and copper emissions to air have been reported solely from road transport tyre and brake wear. 5.32 tonnes of nickel emissions to air have been estimated to occur from public electricity production. Arsenic and cadmium have been reported to occur from road transport tyre and brake wear and public electricity production. Lastly, 0.1 tonnes of mercury have been estimated to be released to air from public electricity production and to a lesser extent from electrical and scientific equipment utilising mercury.

The degree of atmospheric deposition of such substances in the marine environment has not been assessed to date. At this stage, this data is being included in this report with a view to provide an indication of the type and levels of contaminants emitted to air, hence an indication of the potential for such contaminants to end up in the marine environment through deposition.

Table 3: Estimated Emissions to Air (Kg) from Key Category Sources in 2010

Substance	Estimated Emissions to Air (Kg)
Benzo(a)pyrene	16
Cadmium	40
Mercury	104
Arsenic	120
Chromium	1220
Lead	3260
Nickel	5320
Zinc	8400
Copper	26700

1.4 Concentration of Contaminants in Water, Sediments and Biota

Data on the concentration of contaminants in Malta and sediments is available for specific pollutants. However monitoring for contaminants in the marine environment was intermittent, with sampling stations and parameters varying throughout the past years. This rendered comparison of data and determination of trends difficult. A review of monitoring works undertaken in inshore waters (Ecoserv, 2009[42]) highlights the uneven geographical extent of available data, where except for some heavy metals, not much is known about the levels of priority substances in water and other chemicals included in the European water legislation.

This report provides a description of the data available, with focus on the most recent monitoring results of the current WFD monitoring regime.

1.4.1 Presence of Contaminants in Water

The first set of data pertaining to contaminants in the water column spans the period 2003 – 2007[43]. The location of the sampling stations used throughout this period are shown in Figure 11, while the pollutants targeted for each year are indicated in Table 4.

Concentrations of all synthetic substances assessed during 2005-2007 were below detection limits. With respect to non-synthetics, the presence of heavy metals mercury and chromium was detected in most stations sampled in 2004. Detectable levels of Cadmium are also recorded in the same year in Marsaxlokk, Marsascala and Birżebbuġa. Cadmium, lead and mercury were also recorded in Marsaxlokk and/or Birżebbuġa in 2003. This report will not delve into the actual concentrations of such heavy metals, in view of the different analytical techniques which could have been employed throughout this period, however these results seem to be indicative of the presence of heavy metals in the water column, particularly in the harbour areas represented by Marsaxlokk and Birżebbuġa.

[42] Ecoserv, 2009. Proposal for a design of monitoring (Physico-Chemical quality elements and attributes, and priority substances) of Maltese coastal water bodies as per requirements of the Water Framework Directive. Report commissioned for the Malta Environment and Planning Authority; 82pp.

[43] http://cdr.eionet.europa.eu/mt/eea/me1

Figure 11: Location of sampling stations for contaminants in the water column for analysis carried out in 2003 – 2007.

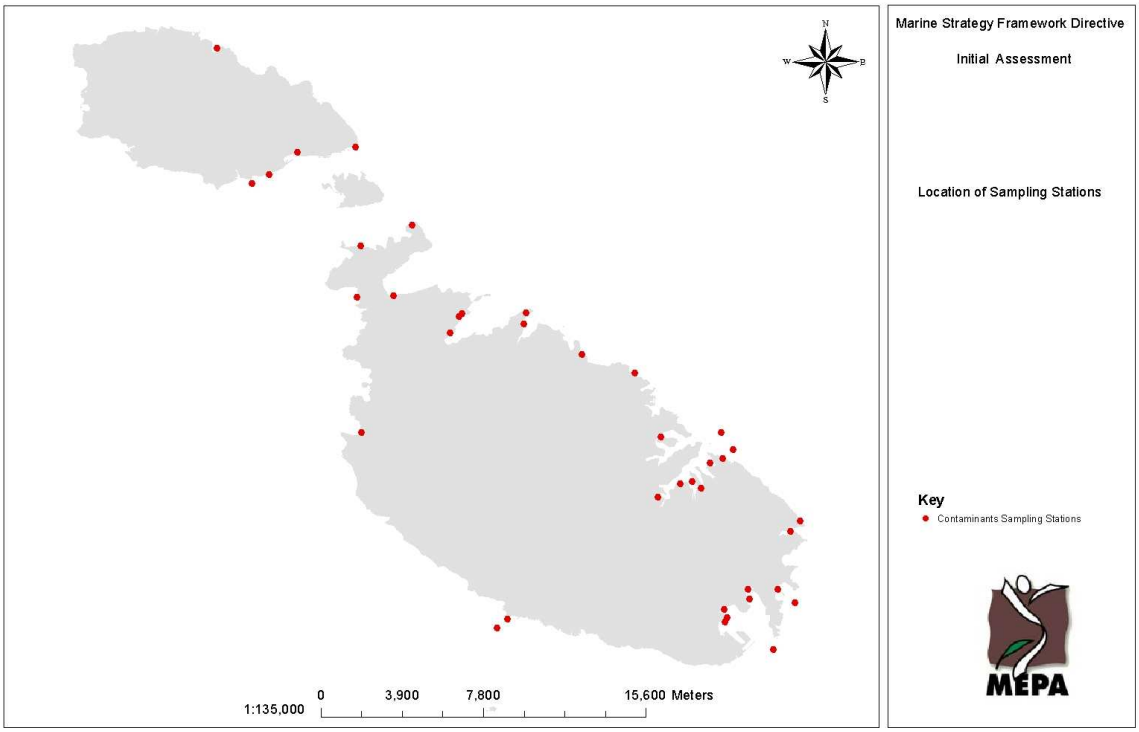


Table 4: Contaminants of which concentrations in the water column were measured in stations indicated in Figure 11 in the period 2003 – 2007[44].

	2003	2004	2005	2006	2007
Synthetics					
1,1,1, Trichloroethane			x	X	
1,1,2-Trichloroethane			x	X	
1,1,2,2,-Tetrachloroethane			x	X	
1,1-Dichloroethane			x	X	
1,1-Dichloroethylene			x	X	
1,2,3,-Trichloropropane			x	X	
1,2-Dibromomethane			x	X	
1,2-Dichloroethane			x	X	x
1,2-Dichloropropane			x	X	
Alachlor					x
Aldrin			x	x	x
Atrazine					x
Bromodichloromethane			x	x	
C10-C13 chloroalkanes					x
Carbon tetrachloride			x	x	x
Chlorfenvinphos					x

[44] Shading indicates substances listed in the Priority Substances Directive.

Chloromethane			x	x	
Chlorpyrifos					x
DDT			x	x	x
Di-(2-ethylhexyl)phthalate					x
Dibromochloromethane			x	x	
Dichloromethane			x	x	x
Dieldrin			x	x	x
Diuron					x
Endosulfan					x
Endrin			x	x	x
Hexachlorobenzene			x	x	x
Hexachlorobutadiene			x	x	x
Hexachlorocyclohexane			x	x	x
Isodrin			x	x	x
Isoproturon					x
Nonylphenol					x
Octylphenol					x
Pentabromodiphenylether					x
Pentachlorobenzene					x
Pentachlorophenol			x	x	x
Polychlorinated biphenyls (PCB)			x	x	
Simazine					x
Tetrachloroethylene			x	x	x
Tribromomethane			x	x	
Tributyltin			x	x	x
Trichlorobenzene			x	x	x
Trichloroethylene			x	x	x
Trichloromethane			x	x	x
Trifluralin					x
Vinyl chloride			x	x	
Non-synthetics					
Anthracene					x
Arsenic	x	x			
Benzene			x	x	x
Boron			x	x	
Cadmium	x	x	x	x	x
Chromium	x	x			
Copper			x	x	
Dimethylbenzene			x	x	
Ethylbenzene			x	x	
Fluoranthene					x
Lead	x	x			x
Mercury	x	x	x	x	x
Methylbenzene			x	x	
Nickel			x	x	x
Petroleum Hydrocarbons			x	x	x
Polyaromatic hydrocarbons					x
Styrene			x	x	
Zinc			x	x	

Additional water monitoring data for the year 2003 was collected from ten stations along the Northeastern coast of mainland Malta and Gozo. For all additional stations the measured levels of arsenic (detection limit 0.2µg/L), cadmium (detection limit 0.1µg/L), chromium (detection limit 0.5µg/L), cyanides (detection limit 0.03µg/L), lead (detection limit 1µg/L) and mercury (detection limit 0.08µg/L) were found to be almost all below or very close to the detection limits of the analytical instrumentation employed.

The most recent measurements of concentration of contaminants in the water column were made within the framework of the EU Water Framework Directive. The substances monitored in the water column for the purposes of the WFD are listed below:

Synthetics
Alachlor
Atrazine
Brominated diphenylether
Carbon tetrachloride
C10-13 Chloroalkanes
Chlorfenvinphos
Chlorpyrifos
Aldrin
Dieldrin
Endrin
Isodrin

DDT total
1,2-Dichloroethane
Dichloromethane
Di(2-ethylhexyl)-phthalate (DEHP)
Diuron
Endosulfan
Hexachloro-benzene
Hexachloro-butadiene
Hexachloro-cyclohexane
Isoproturon
Nonylphenol

4-para-Nonylphenols
Octylphenol
Pentachloro-benzene
Pentachloro-phenol
Simazine
Tetrachloro-ethylene
Trichloro-ethylene
Tributyltin compounds
Trichloro-benzenes
Trichloro-methane
Trifluralin

Non-Synthetics
Anthracene
Benzene
Cadmium

Fluoranthene
Lead
Mercury
Naphthalene

Nickel
Polyaromatic hydrocarbons

The results of the first monitoring year indicate exceedances for non-synthetics mercury, lead, nickel and Polycyclic Aromatic Hydrocarbons (PAHs) in the water column. No exceedances for synthetic compounds were recorded.

Monitoring stations, including sites with recorded exceedances are indicated in Figure 12. The results as shown in this map should be interpreted with caution since any exceedances are one-off exceedances recorded during the period June – November 2012 (including replicate sampling) rather than annual averages as stipulated by the Priority Substances Directive. Such exceedances do not necessarily represent a pollution problem in Malta, and long-term data is necessary for an adequate assessment of background concentrations and interpretation of the status of the water column in Malta in terms of contaminants.

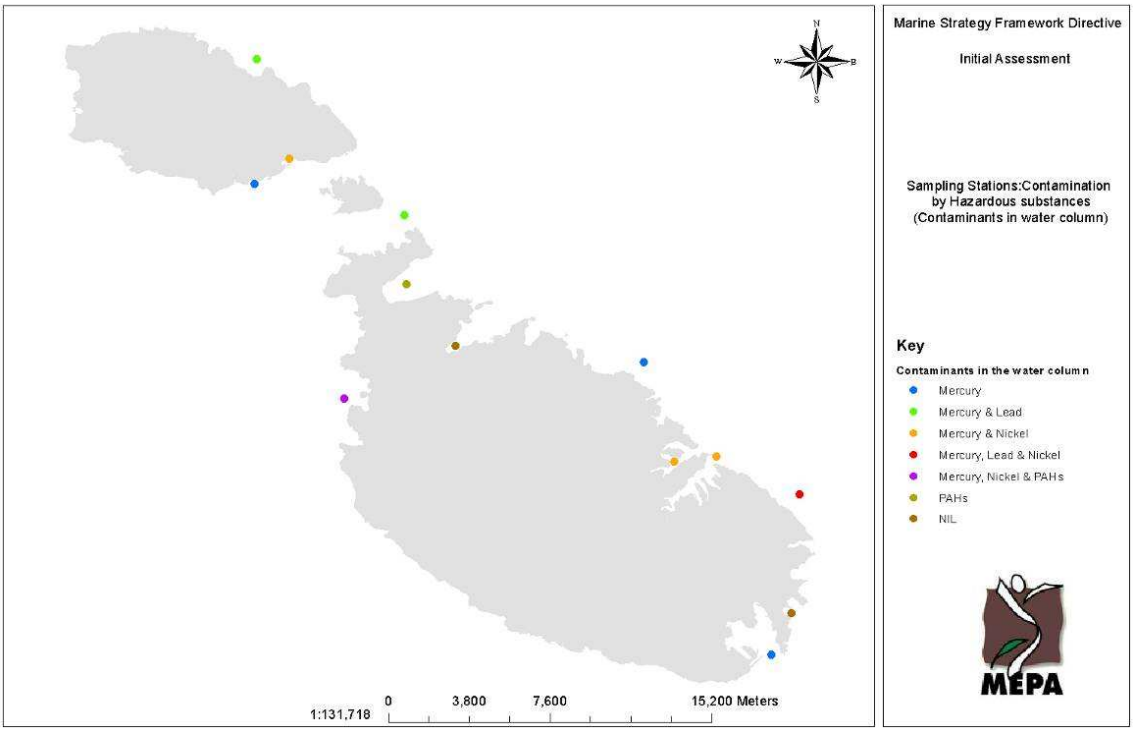
Exceedances for lead, nickel and PAHs are one-offs[45] and should not be used to determine status in terms of contaminants in the water column. On the other hand, these results may preliminary imply that mercury is the most common metal in the water column, since exceedances have been recorded from most sampling stations. The overall mercury concentrations are relatively low with mean concentrations, taking into consideration all sampling data (including replicates), is 0.15µg/L. It should also be borne in mind that mercury is a naturally occuring element found throughout the world at natural background concentrations. Anthropogenic activities have increased the mobilisation of the element into the global environment; particularly coal burning and to a lesser extent the use of other fossil fuels, which is one of the most significant anthropogenic sources of mercury emissions[46]. As indicated in previous sections, the sewerage system is the major source of mercury in Malta from land-based sources (refer to Table 1 above).

While interpretation of the results in the absence of long-term monitoring is not advisable, the reported exceedances for mercury, lead and nickel, seem to corroborate with past data (specifically that collected in 2004) indicating presence of detectable concentrations of mercury and lead in the water column.

[45] Exceedances reported for Lead include a mean of 8.35µg/L from replicate samples and 12µg/L in a different station (not confirmed by replicate sample); Exceedances for Nickel include means of 28µg/L, 26.5µg/L, 26µg/L, 25.5µg/L and 22µg/L in replicate samples from five stations; Exceedances of PAHs are due to one-off exceedances of Benzo(b)fluoranthene (mean of 0.0275µg/L – mean of replicate sample in same station) and Benzo(b)fluoranthene (mean of 0.0068µg/L – mean of replicate sample in same station) and total PAHs at 0.4µg/L (latter concentration not confirmed by replicate sample).

[46] UNEP, 2013. Global Mercury Assessment 2013: Sources, Emissions, Releases and Environmental Transport. UNEP Chemicals Branch, Geneva, Switzerland.

Figure 12: WFD monitoring sampling stations, including stations for which exceedances of Mercury, Lead, Nickel and PAHs concentrations in water column were reported in 2012.



1.4.2 Presence of Contaminants in Sediments

Marine sediments can act as temporary or permanent reservoirs of contaminants in the water environment, particularly in fine grained sediments. Availability of data on contaminants in sediments in marine waters is as follows:

- Petroleum hydrocarbons (2000-2002),
- Lead, Copper, Zinc, Cadmium (2001-2002)
- Chromium, Copper , Lead (2003)
- Chromium, Copper, Nickel, Zinc (2005-2006)
- Monitoring of priority substances and other substances of national concern as part of the WFD monitoring regime (2012)

To date, there is no legally-binding EQS for pollutants in local sediments for Malta. In the absence of such EQS, the proposed EQS for the presence of heavy metals in local marine sediments from non-industrial areas as put forward in Axiak (2003)[47,48] and MEPA

[47] Axiak, V. 2003. Proposal for a National Marine Pollution Strategy to Control Direct Discharges into the Marine Environment. Final document submitted for consideration by the Environment Protection Directorate of the Malta Environment and Planning Authority; 96 pp. Available online at: http://www.mepa.org.mt/topics-water-monitoring (Accessed on 20th October 2012).

(2005)[49,50] will be adopted when assessing monitoring data on heavy metals in local sediments for the purposes of this initial assessment. These relevant EQS are included in Table 5. No Environmental Quality Standards are available as yet for synthetic substances, that can be used for assessment purposes in local marine waters.

Table 5: Environmental Quality Standards adopted for heavy metals for the purposes of the MSFD initial assessment.

Heavy Metal	Environmental Quality Standard (mg/Kg DW)
Cadmium	0.6
Lead	30
Copper	16
Zinc	120
Nickel	16
Chromium (Cr)	15

1.4.2.1 Petroleum Hydrocarbons in Sediments (2000-2002)

According to Axiak and Sammut (2002)[51], sediments are generally considered to be the most reliable environmental medium for assessing trends and levels of pollution from petroleum hydrocarbons (PHC) and oils in coastal waters.

Axiak (1997)[52] reports on studies undertaken in the period 1987 to 1993 and indicates that the levels of petroleum hydrocarbons (PHC) in superficial sediments from several coastal sites within Marsamxett and the Grand Harbour were showing an upward trend. PHC concentrations of 43 – 48 µg Chrysene Equivalents (CE) per gram dry weight (DW) sediments were reported through such studies. Axiak (1997)[53] pointed out that even though coastal waters had not yet been exposed to any massive oil pollution incident,

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[48] Axiak (2003) proposes indicative Environmental Quality Standards (EQS) for sediments from industrial and non-industrial areas for Malta.

[49] MEPA, 2005. National Action Plan for the Protection of the Marine Environment from Land Based Activities. Malta. November 2005; Environment Protection Directorate of the Malta Environment and Planning Authority; 84pp. Available online at: http://www.mepa.org.mt/topics-water-monitoring (Accessed on 20th October 2012).

[50] The National Action Plan for the Protection of the Marine Environment from Land Based Activities (MEPA, 2005) proposes Environmental Quality Standards (EQS) for Mercury, Cadmium and Lead in sediments from industrial and non-industrial areas.

[51] Axiak, V. & Sammut, A. 2002. The Coast and Freshwater Resources. In: State of the Environment Report for Malta, 2002. Ministry for Home Affairs and the Environment; 70 pp.

[52] Axiak, V. (1997). Evaluation of Environmental Impact of Yacht Marina Development in Malta. *Xjenza*, *2*(1), 15-20.

[53] Axiak, V. (1997). Evaluation of Environmental Impact of Yacht Marina Development in Malta. *Xjenza*, *2*(1), 15-20.

chronic low-level pollution by oil and petroleum hydrocarbons from boats and yachts might be gaining significance.

Axiak, 2003[54] reports on monitoring in superficial sediments of inshore coastal waters around Malta with a view to identify possible trends in levels of pollution by petroluem hydrocarbons. Monitoring took place in summer 2000, 2001 and winter 2001, 2002. This study included 44 monitoring stations from relatively clean and pristine inshore areas, as well as from harbour areas. A sufficiently large volume of data was produced which allowed the establishment of background levels of hydrocarbons.

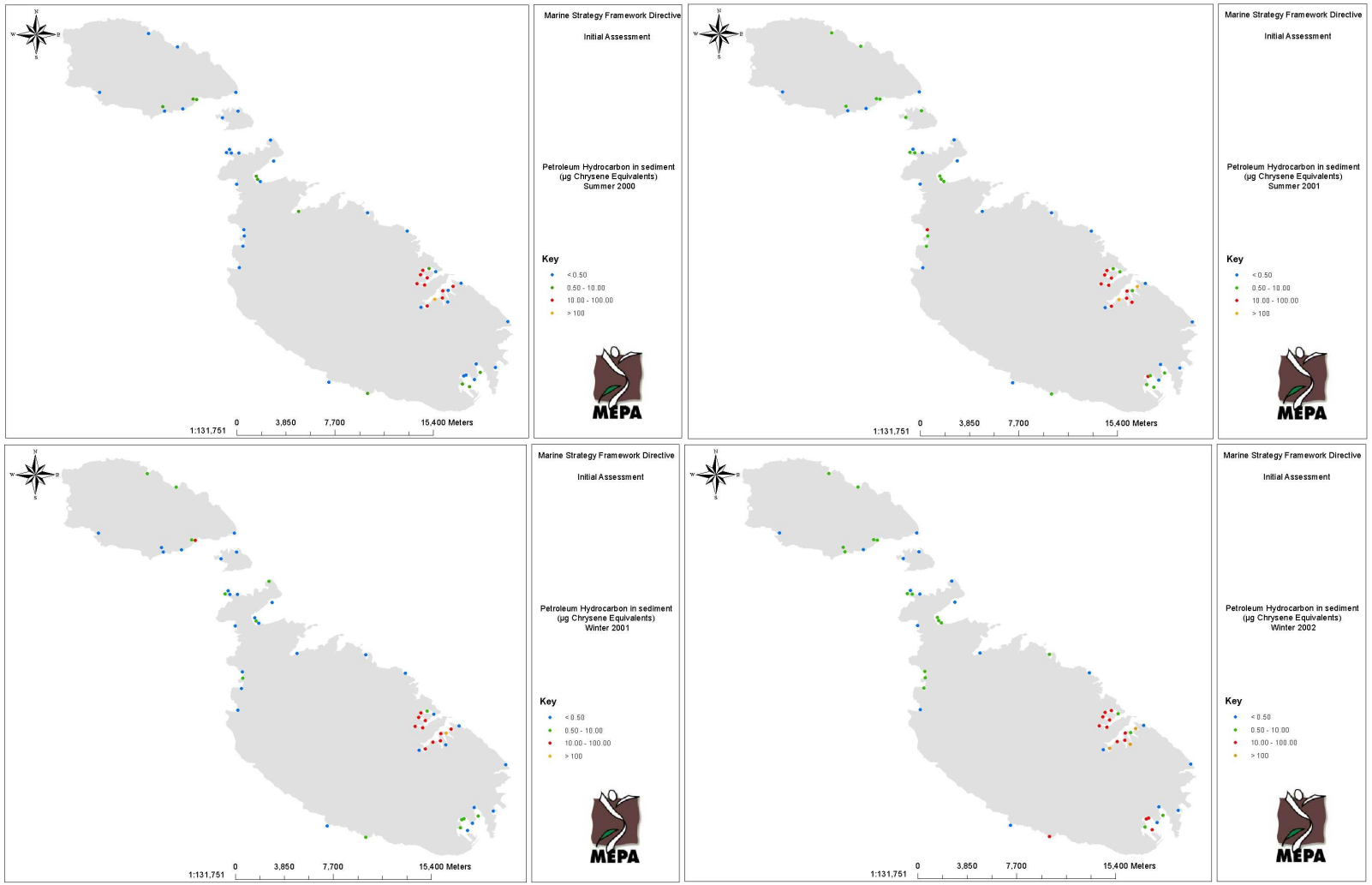
The study showed that the monitoring stations may be classified in three separate categories, as follows:

- Reference areas, exhibiting baseline hydrocarbon levels of up to 0.5µg CE/g DW of sediment;
- Areas exposed to low levels of oil pollution, exhibiting up to 10µg CE/g DW of sediment;
- Areas exposed to high oil pollution exhibiting more than 10µg CE/g DW of sediment.

As indicated in Figure 13, stations within the Grand Harbour and Marsamxett always exhibited values greater than 10 µg CE/g DW, with the Grand Harbour showing the highest recorded levels exceeding 500 µg CE/g DW in summer 2001. When compared to 1987-1993 data, the present study has shown that in general, for most stations being monitored, there has not been any dramatic increase in the levels of oil pollution.

[54] Axiak, V. 2003. Monitoring Pollution by Petroleum Hydrocarbons in Inshore Coastal Areas Around Malta. Report submitted to the Pollution Control Coordinating Unit, Environment Protection Directorate, Malta Environment and Planning Authority.

Figure 13: Concentration ranges for Petroleum Hydrocarbons in summer 2000, summer 2001, winter 2001 and winter 2002[55]



[55] Seasonal variations could be attributed to a number of factors including changes in physical factors (currents, temperature) but also changes in degree of human activities.

1.4.2.2 Heavy Metals in Sediments

The 2001-2002 data on exceedances of lead, copper, zinc and cadmium in sediments, the 2003 data for chromium, copper and lead; and the 2005-2006 data for chromium, copper, nickel and zinc are indicated in Figure 14 - Figure 16. Harbour areas, specifically Marsamxett and Grand Harbour and the Freeport area in Marsaxlokk show consistent exceedances in metal concentrations in sediments throughout the years, with the exception of concentrations of chromium and nickel in 2006, for which no exceedances were recorded for all sampling stations. Although this data should once again be interpreted with caution in view of the potential variations in the methodologies used, it indicates that harbour areas are particularly susceptible to input of contaminants.

Figure 14: Exceedances of lead, copper, zinc and cadmium concentrations in sediments based on data collected in 2001-2002.

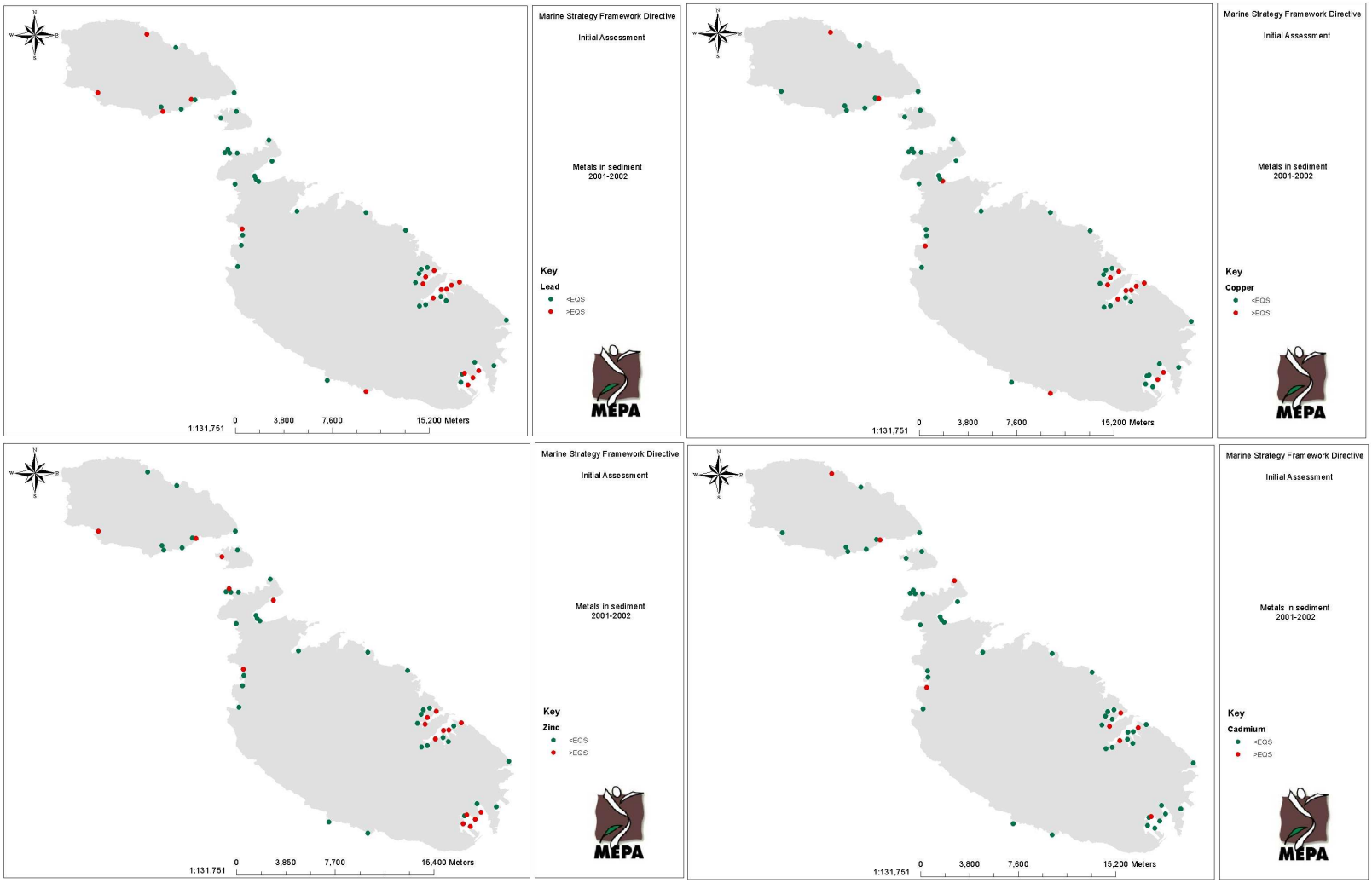


Figure 15: Exceedances of lead, copper and chromium concentrations in sediments based on data collected in 2003

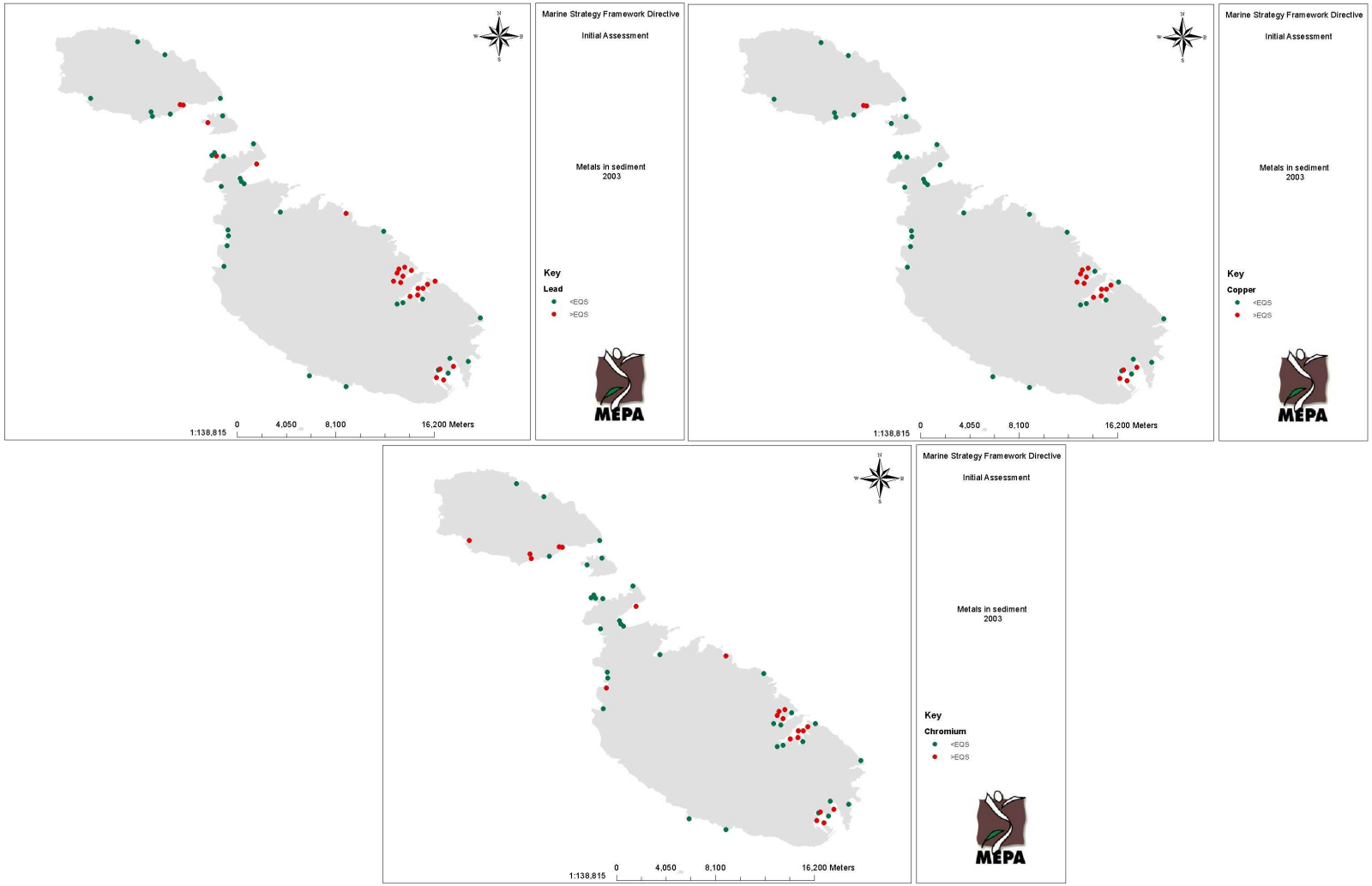


Figure 16: Exceedances of copper, chromium, nickel and zinc concentrations in sediments based on data collected in 2005

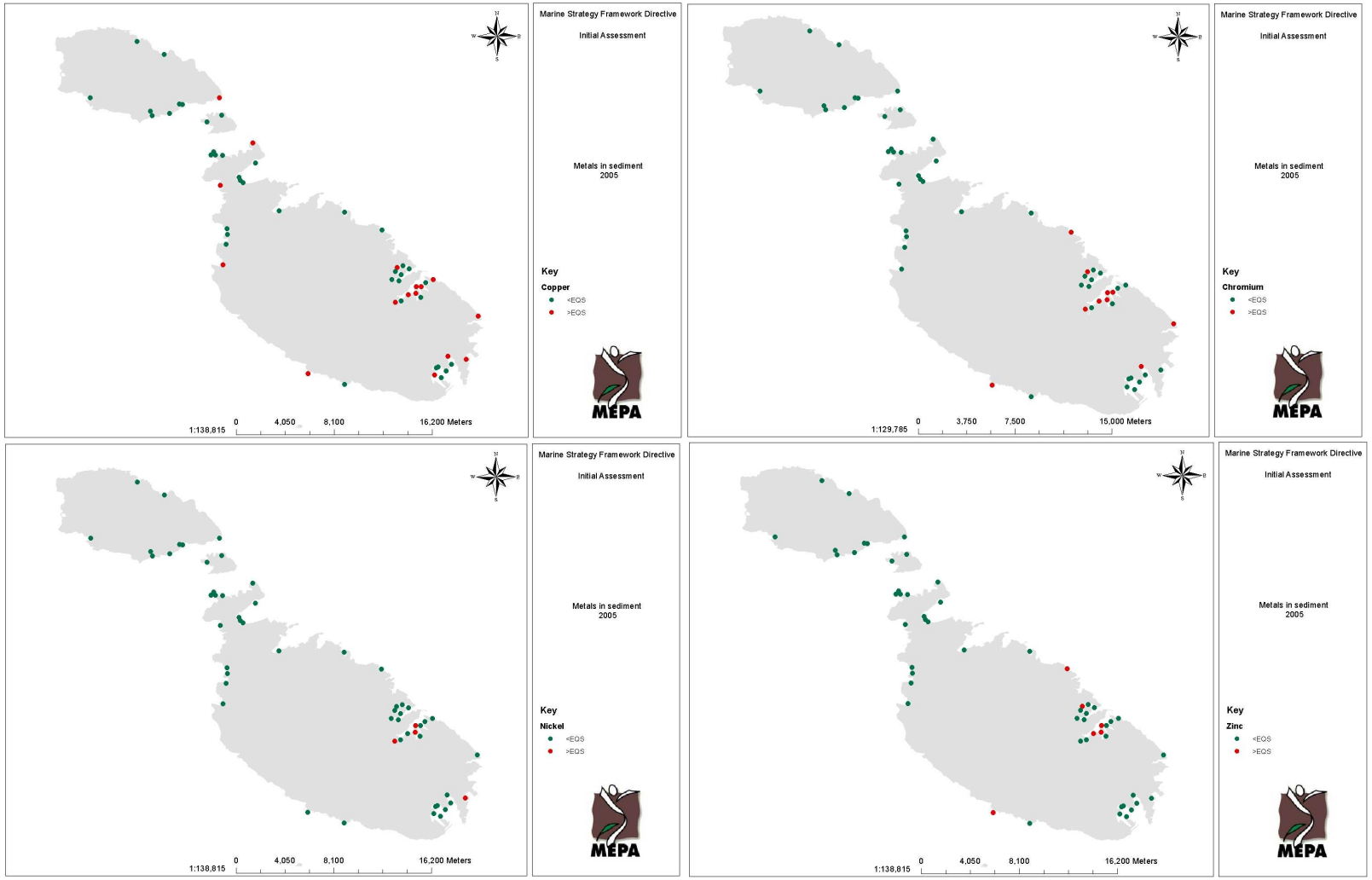
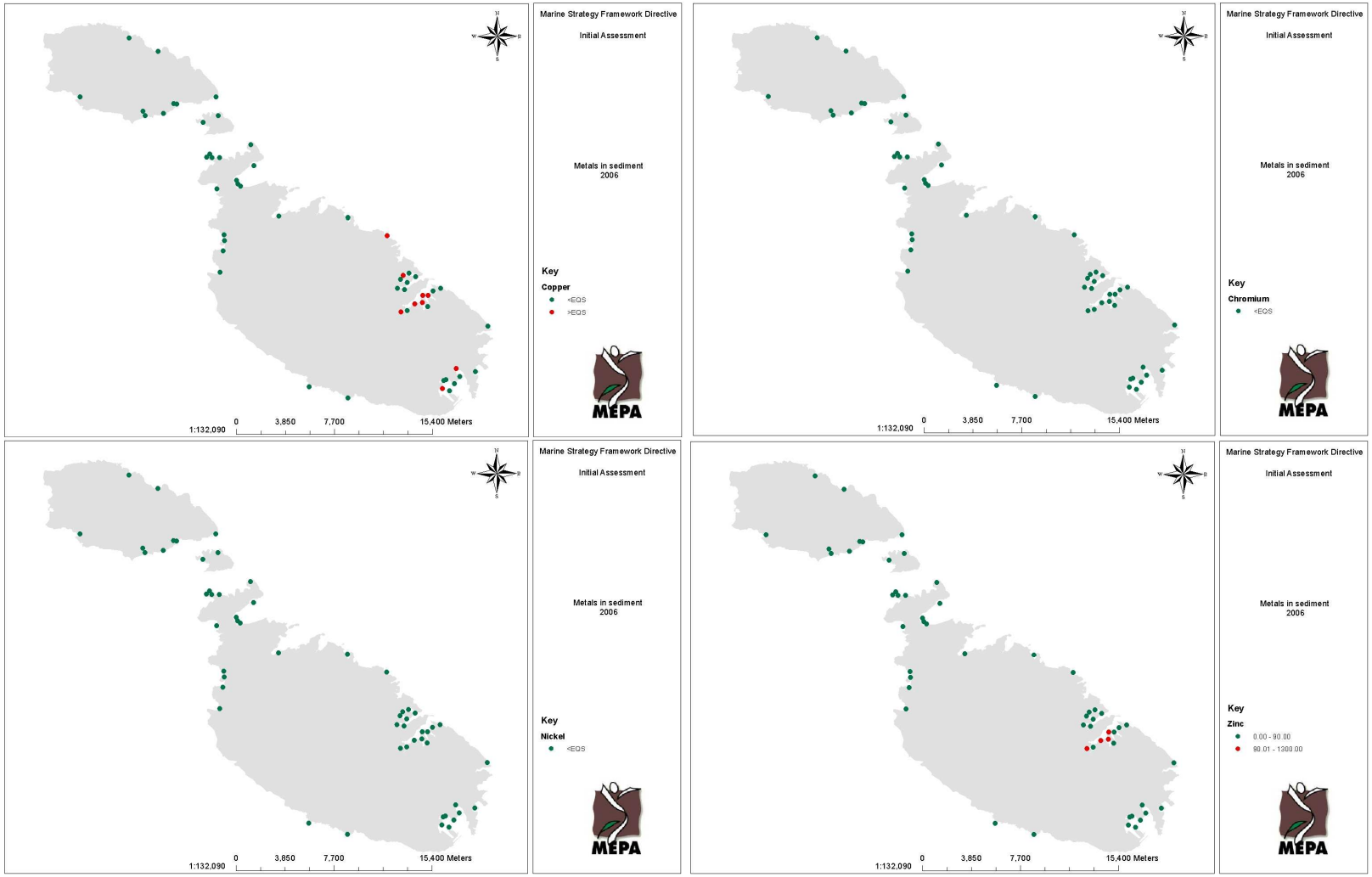


Figure 17: Exceedances of copper, chromium, nickel and zinc concentrations in sediments based on data collected in 2006



A more recent publication by Huntingford and Turner (2011)[56] investigated the presence of trace metal contaminants in superficial muddy deposits at Marsamxett and Grand Harbour (MTC 105) and from within Marsaxlokk harbour (MTC 107). Ghajn Tuffieha Bay (MTC 109) was used as a control sampling point, considering its relatively remote distance from the major anthropogenic inputs.

The concentrations of metal contaminants were found to be significantly low at the control location, when compared to the other sampled locations. These authors evaluated the overall environmental quality of the studied sediments from the Maltese harbours by comparing the measured mean concentrations with sediment quality guidelines as suggested in Long *et al.* (1995)[57]. At all locations, the measured concentrations of arsenic, copper, nickel, lead and zinc were found to exceed the respective Effects Range Low (ERL) concentrations, while cadmium was only found to exceed its ERL from the slipways at Marsaxlokk. The authors argue that the sources of such contaminants may most likely have been uses in paint pigments, anti-foulants, grid blasting and other ship maintenance activities, which are concentrated within the harbour areas.

It was observed that the measured levels of quasi-total tin in this reported study, generally exceeded by several orders of magnitude the TBT concentrations as previously reported by Axiak *et al.* (2000)[58] in sediments of the Grand Harbour and Marsamxett. However, given that different sampling and analytical techniques were used in these reported studies, limited comparisons can be done. It could however be suggested that the presence of tin in harbour sediments may be due to persistent sources, yet whose specific origin remains undefined.

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[56] Huntingford, E. J., & Turner, A. (2011). Trace metals in harbour and slipway sediments from the island of Malta, central Mediterranean. *Marine pollution bulletin*, *62*(7), 1557-1561.

[57] Long, E. R., MacDonald, D. D., Smith, S. L., & Calder, F. D. (1995). Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. *Environmental Management*, *19*(1), 81-97.

[58] Axiak, V., Vella, A. J., Agius, D., Bonnici, P., Cassar, G., Cassone, & Sammut, M. (2000). Evaluation of environmental levels and biological impact of TBT in Malta (central Mediterranean). *Science of the total environment*, *258*(1), 89-97.

1.4.2.3 Priority Substances and other substances in sediment monitored as part of the EU Water Framework Directive Monitoring Regime

Priority substances and other substances monitored in sediments as part of the WFD monitoring regime are listed hereunder:

Synthetics
Malathion
DDT
Diuron
Endosulfan

Endrin
Hexachloro-benzene
Hexachloro-butadiene
Hexachloro-cyclohexane
Pentachloro-benzene

Brominated diphenylether
C10-13 Chloroalkanes
Di(2-ethylhexyl)-phthalate (DEHP)
Tributyltin compounds

Non-Synthetics
Cadmium
Nickel
Lead
Mercury
Copper
Chromium

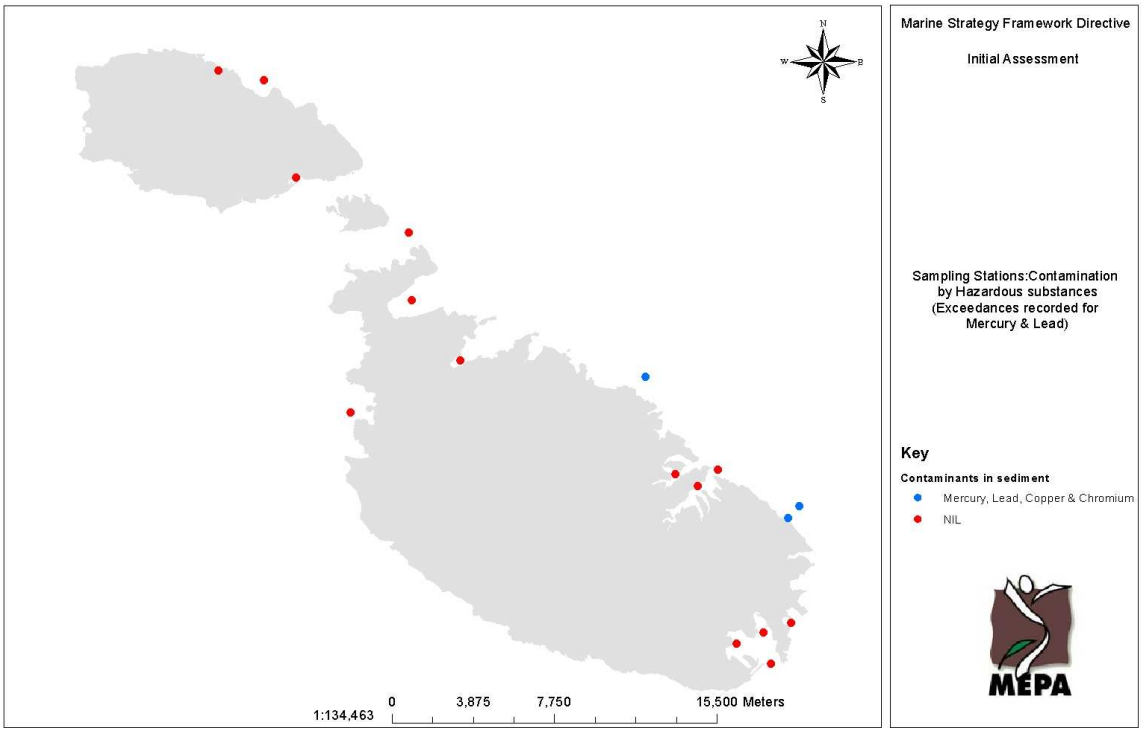
Cobalt
Manganese
Zinc
Barium
Beryllium
Boron
Fluorides

Hydrocarbons Total
Petroleum hydrocarbon
Fluoranthene
Naphthalene
Anthracene

The results of the first monitoring year (2012) are indicative of exceedances to the EQSs (as listed in Table 5) for Mercury, Lead, Copper and Chromium in stations shown in Figure 18. Such exceedances were only recorded in three stations (17.6% of the total stations sampled) . Exceedances of metals in sediments in two of the sampling stations (Northeastern coast of Malta) can be attributed to the fact that this area was until 2011 subject to untreated sewage effluent. Exceedances in the third station however cannot be explained in terms of the activities taking place in this area. This data, does not seem to corroborate the exceedances recorded for metals in sediments in the period 2001-2006, since no exceedances were recorded in stations within the harbour and Freeport areas.

While it is acknowleged that Environmental Quality Standards for synthetic substances are not yet available for Malta, most synthetic substances were below detection limits. Detectable concentrations were only recorded for Di(2-ethylhexyl)-phthalate (DEHP) with concentration ranging from 0.013-0.28 mg/Kg and tributyltin with concentrations ranging 0.13 – 1mg/Kg. Locations of these detectable concentrations are indicated in Figure 19. While acknowledging that these concentrations are not necessarily exceedances, tributyltin compounds, which are mostly associated with the use of anti-founlant paints, are, as expected restricted to harbour areas. The plasticizer DEHP commonly used in the manufacture of certain plastics, on the other hand is quite widespread in sediments.

Figure 18: WFD sampling stations, including stations for which exceedances of Mercury, Lead, Copper and Chromium concentrations in sediments were reported[59]. EQS used are those proposed in Axiak (2003)[60,61] and MEPA (2005)[62,63].



59 CIBM & Ambiente SC 2012. Development of Environmental Monitoring Strategy and Environmental Monitoring Baseline Surveys – Water Lot 3 – Surveys of Coastal Water – November 2012; ERDF156 - Developing national environmental monitoring infrastructure and capacity

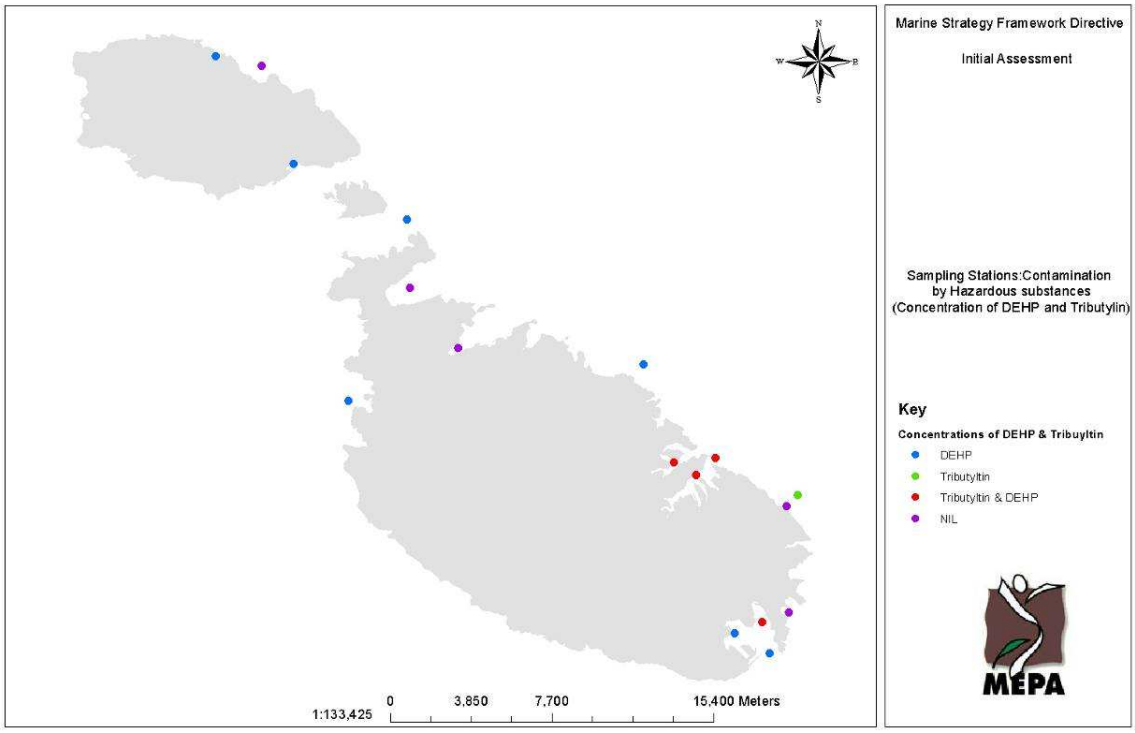
60 Axiak, V. 2003. Proposal for a National Marine Pollution Strategy to Control Direct Discharges into the Marine Environment. Final document submitted for consideration by the Environment Protection Directorate of the Malta Environment and Planning Authority; 96 pp. Available online at: http://www.mepa.org.mt/topics-water-monitoring (Accessed on 20th October 2012).

61 Axiak, 2003 proposes indicative Environmental Quality Standards (EQS) for sediments from industrial and non-industrial areas for Malta were set.

62 MEPA, 2005. National Action Plan for the Protection of the Marine Environment from Land Based Activities. Malta. November 2005; Environment Protection Directorate of the Malta Environment and Planning Authority; 84pp. Available online at: http://www.mepa.org.mt/topics-water-monitoring (Accessed on 20th October 2012).

63 The National Action Plan for the Protection of the Marine Environment from Land Based Activities (MEPA, 2005) proposes Environmental Quality Standards (EQS) for Mercury, Cadmium and Lead in sediments from industrial and non-industrial areas.

Figure 19: WFD sampling stations for which detectable concentrations of Di(2-ethylhexyl)-phthalate (DEHP) and Tributyltin compounds were recorded[64].



1.4.3 Presence of Contaminants in Biota

1.4.3.1 Bioindicators of Pollution in Coastal Waters

A bioindicator is an organism, or part of an organism or a community of organisms, that contains information on the quality of the environment. During the past two decades, a number of biomonitoring exercises have been performed, in order to assess the presence of contaminants in the local coastal environment, using marine snails, limpets, chitons and fish.

Axiak *et al.* (1999)[65] reports unpublished research work undertaken by the Department of Biology of the University of Malta on the use of the clam *Venus verrucosa*, the limpet *Patella rustica* and the marine snail *Hexaplex trunculus* as bioindicators of heavy metal pollution. In general it was concluded that the selection of local biota studied at the time, accumulated metals in the same range as that of a spectrum of invertebrates from

[64] CIBM & Ambiente SC 2012. Development of Environmental Monitoring Strategy and Environmental Monitoring Baseline Surveys – Water Lot 3 – Surveys of Coastal Water – November 2012; ERDF156 - Developing national environmental monitoring infrastructure and capacity

polluted locations in the Mediterranean. Fish, including the red mullet, were reported to accumulate lower concentrations of heavy metals in their tissues as compared to marine molluscs.

Further unpublished research work undertaken by the University of Malta during 1999 to 2001 was presented in Axiak and Sammut (2002)[66], with investigations involving chemical analysis for heavy metals in the biota tissue of the limpet *Patella rustica*, the chiton *Lepidochitona corrugata* and the fish *Mullus surmuletus*, as well as the use of Metallothionein (MT) induction in such organisms, as a biomarker protein measurement in response to pollution by heavy metals. The authors acknowledge that the information available was not sufficient to identify any long-term trends in time. Such studies however confirmed the general findings of Axiak *et al.* (1999), where some sites were identifed as persistently exposed to heavy metal pollution: sewage outfalls, unmanaged solid waste landfills, fuel terminals, marinas and harbours.

More recently, unpublished research work at the University of Malta[67] assessed the use of the seagrass *Posidonia oceanica*, the edible sea urchin *Paracentrotus lividus* and the benthic fish *Mugil cephalus* as bioindicators of heavy metal pollution within coastal waters. All three studies measured the levels of cadmium, lead, copper and zinc in the tissue of such biota. The study on *P.oceanica* provided new data on the levels of coastal heavy metal pollution in relation to local aquatic flora. Results from the studies on *P.oceanica* and *P.lividus* were compared with regional data available on metal content in biota. It was concluded that the measured levels of lead were comparable to levels in other Mediterranean regions that are considered to be hotspots for this pollutant.

Through the WFD monitoring programme, levels of mercury (non-synthetic) and hexachlorobenzene and hexachlorobutadiene (synthetics) were assessed in *Posidonia oceanica*. Concentrations of hexachlorobenzene and heaxchlorobutadiene were in all cases below detection limits, while concentrations of mercury were in the range of 0.0025-0.017 mg per kg, wet weight). Figure 20 indicates the concentration ranges of mercury in *Posidonia oceanica*. There are no evident spatial patterns with respect to concentrations of mercury in *Posidonia oceanica*, and further trend data would be necessary in order to be able to derive any conclusions.

On the other hand, this data seems to imply that higher concentrations are within enclosed bays which are presumably subject to significant boating activities, areas which are currently subject to discharge of treated sewage effluents and harbour areas (such as Freeport area). However this inference would need to be confirmed.

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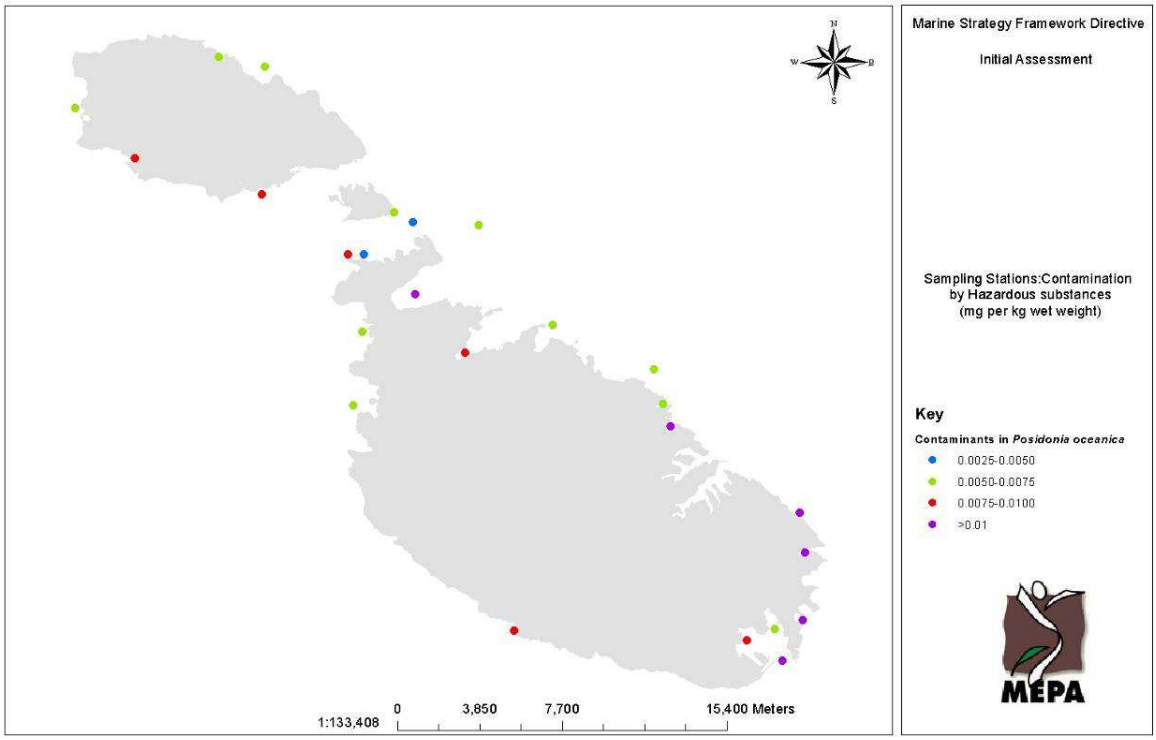
[65] Axiak, V., Gauci, V., Mallia, A., Mallia, E., Schembri, P.J. & Vella, A.J. 1999. State of the Environment Report for Malta 1998, Submitted to the Environment Protection Department Through The Malta Council for Science and Technology; 427pp. Available online at: http://www.mepa.org.mt/soer1998 (Accessed on 20th October 2012).

[66] Axiak, V. & Sammut, A. 2002. The Coast and Freshwater Resources. In: State of the Environment Report for Malta, 2002. Ministry for Home Affairs and the Environment; 70 pp.

[67] Dandria, D. 2010. Biology Symposium, Biology Abstracts, University of Malta.

Figure 20: Concentration Ranges of Mercury in *Posidonia oceanica*[68]



[68] CIBM & Ambiente SC 2012. Development of Environmental Monitoring Strategy and Environmental Monitoring Baseline Surveys – Water Lot 3 – Surveys of Coastal Water – November 2012; ERDF156 - Developing national environmental monitoring infrastructure and capacity

1.4.3.2 Active Mussel Watch Project

The Active Mussel Watch project[69] was undertaken in 2006-2007. This project aimed at the assessment of levels of contaminants in biota through the deployment of mussel cages in proximity of the marine protected area of Ġnejna (Rdum Majjiesa to Ras ir-Raħeb MPA), the (then) sewage outfalls at iċ-Ċumnija (MTC 109) and Xgħajra (MTC 106). The project reported high levels of mercury, lead and copper in mussels at Xgħajra. Sediment analysis confirmed the mussel watch results, with the area of Xgħajra presenting the highest values of trace metals of an anthropogenic origin.

[69] Available online at: http://www.ciesm.org/online/archives/abstracts/pdf/39/PG_0798.pdf (Accessed on 20th October 2012).

1.4.3.3 Contamination in Fish and Seafood for human consumption

In Malta, the Department of Environmental Health undertakes chemical monitoring in fish and other seafood destined for human consumption, in accordance with Commissions Regulation 1881/2006 on contaminants in foodstuffs, as amended by Regulation 420/2011. As part of this sampling programme, fish and other seafood caught from Malta is sampled at the retail market. Retail samples of the following fish and seafood were monitored in the period 2010-2012:

- Amberjack
- Bogue
- Bronze Bream
- Comber
- Dogfish
- Dolphin fish
- Forkbeard
- Fresh and frozen swordfish
- Fresh Tuna
- Grouper
- Hake
- Pandora
- Pilot fish
- Red Mullet
- Scorpion fish
- Sea Bass
- Sea Bream
- Spearfish
- White Bream

Measured levels of lead and cadmium in such biota were at levels below the maximum permissible limits in the European food contaminants legislation for fish and cephalopods. However, there were a few occasions where mercury exceeded the permissible levels stipulated by EC 1881/06 (1mg/kg wet weight) in muscle meat of sampled fresh dogfish, chilled tuna and fresh and frozen swordfish. The reported levels of exceedance ranged from 1.5 to a maximum of 2.4 mg/Kg wet weight of mercury. Notifications submitted by Maltese authorities can be accessed through the European Rapid Alert System for Food and Feed (RASFF) portal database[70].

In 2007 and 2008, the Fisheries Department investigated the presence of heavy metals (lead, cadmium, mercury, arsenic), polyaromatic hydrocarbons, organochlorine compounds and medicinal active compounds in fish muscle from farmed and wild fish. Such studies reported negligible concentrations of these substances in fish muscle.

1.5 Contaminant-specific Biological Effects

Knowledge on the effects of contaminants on biota or ecosystems is very limited for Malta. Research efforts to date have focused on the effects of tributyltin on marine gastropods as explained hereunder.

[70] Available online at: http://ec.europa.eu/food/food/rapidalert/rasff_portal_database_en.htm (Accessed on 21st October 2012).

The biocide tributyltin (TBT), which has been used in the past as a very popular marine antifouling agent to prevent fouling organisms from settling on seafaring vessels. This is associated with the occurence of 'imposex', that is the imposition of male sexual characteristics on female marine gastropods.

Axiak (1997)[71] reports on an extensive chemical monitoring programme for butyltins in the water column and in superficial sediments from local marinas and in their vicinity during the period summer 1993 to spring 1994. Levels in the water column at 1m depth ranged from 0.007 to 0.041 µg tin/L in Marsamxett harbour and from 0.008 to 0.12 µg tin/L in the Grand Harbour. The chemical analysis in sediments from Marsamxett and the Grand Harbour indicated lowest levels of 0.018 µg tin/g DW of sediment as measured from both harbours and highest levels of 0.41 µg tin/g DW of sediment from Marsamxett and 0.21 µg tin/g DW of sediment from the Grand Harbour. The same study reports on the occurence of imposex in marine gastropods, where this effect may be quantified in terms of a Relative Penis Size Index (RPS). The data on RPS indices from the various populations of this species along the Maltese coastline is indicative of higher indices in the harbour areas and other sites subject to boating activities. Axiak and Sammut (2002)[72] reports on further work undertaken in the early 2000, indicating a severe condition of imposex in *H. trunculus* from all sites along the Maltese coastline which were exposed to boating and/or shipping activities.

Imposex was later studied again by the University of Malta in different locations around the Maltese Islands during the period July 2005 - February 2006[73] and during July 2009 – March 2010[74]. Both studies confirmed that imposex was ubiquitous in all analysed populations of *H. trunculus*, with all the populations and females studied showing varying signs of imposex. Essentially the observed differences may mostly be attributed to differences in the degree of boating activity which varied among the sites.

On a positive note, the most recent investigation of 2009-2010 has recorded some female individuals which were unaffected by imposex and these were collected from sites within the Marine Protected Area between Rdum Majjiesa to Ras ir-Raħeb as well as from other sites along the Maltese coastline. The same study also observed a decline in the intensity of imposex which has reached lower levels than those recorded in 1996.

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71 Axiak, V. 1997. Evaluation of Environmental Impact of Yacht Marina Development in Malta. *Xjenza*, *2*(1), 15-20.

72 Axiak, V. & Sammut, A. 2002. The Coast and Freshwater Resources. In: State of the Environment Report for Malta, 2002. Ministry for Home Affairs and the Environment; 70 pp

73 Dandria, D. 2006. Biology Symposium, Biology Abstracts, University of Malta.

74 Dandria, D. 2010. Biology Symposium, Biology Abstracts, University of Malta.

1.6 Assessment of Status

1.6.1 MSFD criteria and indicators

The MSFD criteria and indicators used for the purposes of assessment of status on the basis of the contamination by hazardous substances pertain to Descriptors 8 and 9, reproduced hereunder:

Criterion 8.1: Concentration of contaminants

- Concentration of contaminants measured in the relevant matrix (such as biota, sediment and water) in a way that ensures comparability with the assessments under Directive 2000/60/EC (indicator 8.1.1)

Criterion 8.2: Effects of contaminants

- Levels of pollution effects on the ecosystem components concerned, having regard to the selected biological processes and taxonomic groups where a cause/effect relationship has been established and needs to be monitored (Indicator 8.2.1)

Criterion 9.1 - Levels, number and frequency of contaminants

- Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels (Indicator 9.1.1)
- Frequency of regulatory levels being exceeded (Indicator 9.1.2)

Based on the data available described in this report, it was only possible to attempt assessment of status on the basis of the concentration of contaminants in the different matrices, hence through the application of Indicator 8.1.1. Knowledge of the effects of contaminants on the ecosystem components is not adequate enough to be able to determine status in terms of MSFD criterion 8.2.

In accordance with the Commission Decision 2010/477/EU, relevant provisions of the WFD in territorial and/or coastal waters have to be taken into consideration for the purposes of MSFD Descriptor 8. Within this context and in line with the recommendations provided in the Commission Decision, assessment of status will focus on the substances regulated in the Priority Substances Directive and other substances which may present risks in the marine environment and which are currently being monitored as part of the WFD monitoring regime.

Assessment of status for MSFD purposes builds on the determination of chemical status in terms of the criteria stipulated by the WFD, listed in Table 6, taking into consideration the fact that the Commission Decision 2010/477/EU states that '*progress towards GES will depend on whether pollution is progressively being phased out, i.e. the presence of*

contaminants in the marine environment and their biological effects are kept within acceptable limits, so as to ensure that there are no significant impacts on or risk to the marine environment'.

Consideration was also given to the WFD criteria for biological quality elements for heavily modified water bodies.

Table 6: WFD criteria for 'High', 'Good' and 'Moderate' status based on synthetic and non-synthetic pollutants in coastal waters

	High	Good	Moderate
Specific Synthetic pollutants	Concentrations close to zero or at least below the limits of detection of the most advanced analytical techniques in general use	Concentrations less than Environmental Quality Standards	Conditions consistent with the achievement of the values specified above for the biological quality elements
Specific non-synthetic pollutants	Concentrations remain within the range normally associated with undisturbed conditions (background levels)	Concentrations less than Environmental Quality Standards	Conditions consistent with the achievement of the values specified above for the biological quality elements.

1.6.2 Assessment Areas

In the light of the requirements of the EU Water Framework Directive with respect to contaminants, coupled to the fact that major sources of contaminants in Malta (based on available data to date) are land-based, the assessment area for the purposes of the MSFD Initial Assessment is equivalent to the WFD coastal water bodies as indicated in Figure 1 of this report.

It is acknowledged that this assessment area might not be adequate enough for assessing status of contaminants originating from sea-based sources of pollution or atmospheric deposition. However, data on input of contaminants from such sources is currently too limited to allow assessment of status in this regard.

1.6.3 Status in terms of synthetics

Water column

The available data to date implies that synthetics were generally below detection limits in the water column. While acknowledging that long-term trend data is very limited for synthetic compounds, the results of the WFD baseline survey, point towards a good status for these substances in the water column, also in line with the WFD criteria listed in Table 6.

Sediments

Environmental Quality Standards for synthetics in sediments have not been established as yet. Nevertheless, the only substances which were detected through the EU Water Framework Directive's baseline survey were tributyltin compounds (restricted to harbour areas) and Di(2-ethylhexyl)-phthalate (DEHP), which was recorded within sediments throughout coastal waters. Given the low numbers of synthetic contaminants which were detected in sediments, as well as the localised presence of tributyltin compounds, the status in terms of synthetic contaminants in sediments can be considered to be 'good', although such status is not being based on the WFD criteria for classification of status and is thus of low confidence.

Biota

Scientific research with respect to contaminants in biota throughout the past years focused on metals rather than on synthetic contaminants. The most recent WFD baseline survey however assessed the concentrations of hexachlorobenzene and hexachlorobutadiene in *Posidonia oceanica*. The results of this baseline survey indicate that these synthetic compounds were always below detection limits in this seagrass.

Such results point towards a 'good status' for synthetics in biota. Nevertheless, further data, particularly long-term data, would be required to re-affirm such status.

1.6.4 Status in terms of non-synthetics

Water column

With the exception of the latest baseline survey carried out as part of the WFD monitoring regime, most of the data available to date with respect to non-synthetic contaminants pertains to metals and petroleum hydrocarbons. For the purposes of this MSFD Initial Assessment, assessment of status will be focusing on those metals which

are listed in the Priority Substances Directive, namely cadmium, lead, mercury and nickel.

Past data on the metals mentioned above is indicative of the presence (not necessarily exceedances) of cadmium, lead and mercury, particularly in the water column in areas subject to harbour activities. The most recent assessment as part of the WFD monitoring regime corroborates this data, since exceedances to the annual average EQSs established by the Priority Substances Directive were reported for lead, nickel and mercury in the water column during the period June-November 2012. Exceedances[75] for lead and nickel were one-offs, while exceedances for mercury were more common across the sampling stations throughout this period. The baseline survey also reported exceedances in PAHs on three occasions. No other exceedances were reported for other non-synthetic substances.

While it is acknowledged that this scenario does not point towards a good status for non-synthetics in the water column of coastal waters, the assessment of status in the absence of long-term data is not desirable. Classification of the water column of Malta as 'moderate' or 'poor' status might not reflect the actual status due to the highly dynamic nature of the water column, hence the need for long-term data, as well as the lack of knowledge on background concentrations of these contaminants, precluding the possibility to define 'undisturbed conditions'. For this reason, the status of the water column in coastal waters in terms of non-synthetics is not being determined at this stage, and will be assessed once trend data is available.

Sediments

Environmental Quality Standards for non-synthetic contaminants in sediments have not yet been established for Malta and assessment of status in this regard is being based on proposed EQSs for metals only (refer to above text). Past data from surveys carried out in 2001-2006 are indicative of exceedances to the proposed EQSs for lead, cadmium and nickel particularly in harbour areas (mercury was not assessed during this period).

However this scenario is not corroborated by the most recent WFD baseline surveys. Through such surveys, exceedances were reported for mercury and lead in three stations located outside harbour areas. Exceedances in two of these stations can be explained in terms of the past exposure of the area in question to the discharge of untreated sewage which discharge has ceased since 2011, while no realistic explanation can be currently put forward with respect to the exceedances in the third station.

[75] It should be noted that reference to exceedances here is not equivalent to 'annual averages'.

Once again, on the basis of the WFD criteria for classification of status, this scenario does not point towards a 'good status' in terms of metal contaminants in sediments in coastal waters. However difficulties encountered in comparing data generated by recent assessments with past data highlight the need to base definition of status on long-term data, which is currently not available. For this reason, the status of non-synthetic contaminants in sediments of coastal waters is not being determined at this stage, and will be assessed once trend data is available and background levels are determined.

Biota

While scientific research on the levels of metals in biota has been carried out throughout the past years, data generated through such research cannot be applied for the determination of status for the purposes of the MSFD Initial Assessment.

The recent baseline survey carried out as part of the WFD monitoring regime, has resulted in detectable levels of mercury in *Posidonia oceanica*. Nevertheless, in the absence of knowledge on background levels and particularly in the absence of long-term data, it is difficult to assign a status for non-synthetics in biota.

1.6.5 Status in terms of contaminants in fish and seafood.

Based on the current data, exceedances to the permissible levels of contaminants stipulated by EC regulation 1881/06 in fish and seafood were reported solely for mercury. Such exceedances are also considered to be infrequent.

However, this data is not deemed sufficient to define status in terms of contaminants in fish and seafood. The data generated through the current monitoring regime in terms of EC regulation 1881/06 might not reflect the overall picture of contaminants in seafood and the extent to which the current monitoring practices would lend themselves to address MSFD requirements will be assessed through the development of the MSFD monitoring programme.

1.7 Data Gaps

The major data gaps identified throughout this report are related to the following:

- information on input loads of contaminants as listed in the Priority Substances Directive from all sources of pollution, particularly diffuse land-based sources, sea-based sources of pollution as well as atmospheric deposition.
- trend data on contaminant concentrations in the different media in Malta; and
- effects of contaminants on marine habitats and biota, which data gap can be appropriately addressed through specific research activity.