MONITORING POLLUTION BY PETROLEUM HYDROCARBONS IN INSHORE COASTAL AREAS AROUND MALTA.

Submitted by

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to the

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1. Introduction

The Pollution Control Coordinating Unit of the Environment Protection Directorate (Malta Environment and Planning Authority) had commissioned the present author to undertake a monitoring programme with the following objectives:

- To identify trends in levels of pollution by petroleum hydrocarbons a in a inshore coastal waters around Malta which are more likely to be exposed to risks of contamination. These sites (including, the main harbours) have been monitored in 1989 and more recently in 1993.

- To establish baseline data on the levels of such pollution in other areas which have not to be monitored as yet.

- To provide the necessary information on the basis of which as assessment of the degree of environmental damage resulting from future incidents of oil spillage, may be made.

For the purpose of this monitoring programme, superficial sediments rather than the water column were used as the environmental phase to be monitored. This is because it is well known that monitoring of petroleum hydrocarbons (PHC) in the water phase often yield unreliable results due to the heterogeneous distribution of this class of compounds in water as well as the rapid temporal fluctuations which may occur at the same site. On the other hand, superficial sediments are generally considered to be a most reliable environmental phase to monitor this form of pollution over time, since they are well known to act as sinks for this class of marine contaminants as well as of other pollutants. However, superficial sediments are also a significantly dynamic phase, due to natural forces, such as natural deposition or loss of sediments, biological perturbation, as well as dredging and other anthropogenic activities. All these factors will need to be taken into consideration when assessing spatial and temporal trends in the levels of PHC in sediments.

In comparing reported levels of oil in the environment, it is important to note that different analytical methods often do not yield comparable quantitative data. In the present monitoring programme UV spectrofluorimetric analysis was used as the standard methodology. This methodology has been used for monitoring oil pollution in most Mediterranean states. Furthermore, it yields consistent and reliable data, and its minimum detection level is low (0.01 ug Chrysene Equivalents/ g Dry Weight).

On the other hand, this analytical methodology is sensitive to a narrow range of PHC aromatic components, and its level of discrimination between different classes of hydrocarbons (e.g. hydrocarbons of recent biogenic or petroleum origins) is low. This latter limitation may however be satisfactory controlled through proper chromatographic

clean-up of extracts. In any case in the present study, the wide geographical extent of monitoring stations (which included relatively clean and pristine inshore areas, as well as port areas) produced a sufficiently large volume of data which allowed for the establishment of background levels of hydrocarbons. Such background levels are most likely derived from recent biogenic sources, rather than from pollution by petroleum hydrocarbons. Concentrations which exceed such background levels are more likely to be of petroleum origin.

2. Monitoring Methodology

2.1 Sampling

Superficial sediments (top 3 to 5 cm) were collected by divers or by a grab sampler from 44 fixed monitoring stations. The location of such stations is shown in **Figure 1.** Sampling was carried out on a bi-annual basis, starting in Summer of 2000 and finishing in Winter 2002. Samples were stored at -22°C until analysed.

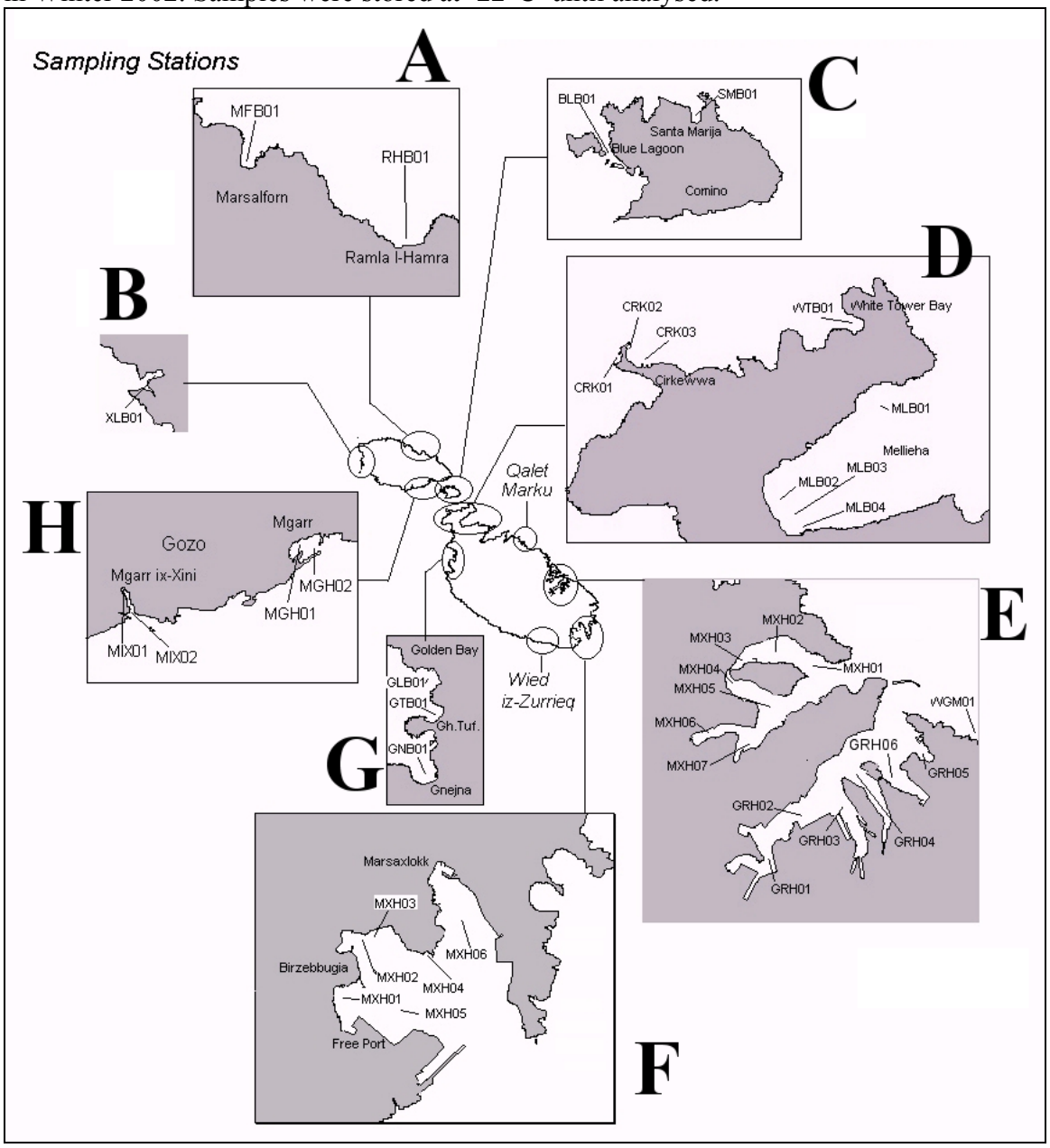

Figure 1: General overview of sampling stations

2.2 Extraction and Analysis

Prior to analysis, sediments were sieved through a 1mm mesh size. They were then refluxed in methanol and potassium hydroxide for 90 minutes. Hexane extraction of the methanol filtrate was then carried out, with the hexane extract being dried over anhydrous sodium sulphate, reduced in volume in a rotary evaporator and cleaned on 5% deactivated alumina. Elution of the clean-up column was carried out in three fractions: hexane, dichloromethane, and a mixture of both.

PHC were then quantified by measuring their fluorescence on a JASCO FP-750 spectrofluorimeter at 310 nm excitation and 360 nm emission wavelengths (band widths 10nm). Quantification was carried out against Chrysene standards, and levels of PHC expressed as ug Chrysene Equivalents per gramme dry weight of sediment. Reagent blank runs were periodically carried out.

3. Results

Table 1 shows the recorded levels of PHC for all stations monitored during the present programme. Levels are expressed as ug Chrysene Equivalents/g DW

When considering the frequency distribution for whole set of data produced, the data may be classified in the following defined ranges:

Baseline levels:	less than 0.5 ug CE/gDW
Trace Pollution:	0.6 to 4 ug CE/gDW
Moderate Pollution:	4.1 to 40 ug CE/gDW
Significant Pollution:	40.1 to 100 ug CE/gDW
High Pollution:	above 100 ug CE/gDW

The highest levels of PHC pollution in sediments were found in harbours and marinas, with Rinella (Grand Harbour) showing the highest recorded levels (exceeding 500 ugCE/gDW in summer 2001.

Table 1: Levels of hydrocarbons expressed as ug Chrysene Equivalents per gramme dry weight of sediments.

Locality	Site	Station Code	Summer 2000	Winter 2001	Summer 2001	Winter 2002
Gozo North	Ramla l-Hamra	**RHB01**	0.40	1.13	3.80	0.54
Gozo North	Marsalforn	**MFB01**	0.08	1.91	1.77	2.12
Gozo South	Xlendi	**XLB01**	1.43	1.48	2.41	8.80
Gozo South	Mgarr ix-Xini Inner	**MIX01**	2.07	0.02	3.30	1.65
Gozo South	Mgarr ix-Xini Outer	**MIX02**	0.08	0.32	0.49	1.22
Gozo South	Mgarr Harbour Inner	**MGH01**	1.82	2.83	2.22	8.95
Gozo South	Mgarr Harbour Outer	**MGH02**	0.56	14.99	2.91	2.40
Comino	Comino Blue Lagoon	**BLB01**	0.00	0.35	0.91	0
Comino	Comino Santa Maria	**SMB01**	0.10	0.33	0.53	0.36
Cirkewwa	Cirkewwa (Rosi Wreck)	**CRK01**	0.25	3.08	3.60	3.68
Cirkewwa	Cirkewwa Breakwater tip	**CRK02**	0.10	0.17	0.33	0.46
Cirkewwa	Cirkewwa near RO	**CRK03**	0.29	0.13	1.49	1.78
White Tower Bay	White Tower Bay	**WTB01**	0.00	0.77	0.06	0.48
Mellieha	Mellieha outer	**MLB01**	0.12	0.00	0.02	0.17
Mellieha	Mellieha inner (Ahrax side)	**MLB02**	0.54	0.28	1.03	0.71
Mellieha	Mellieha inner (mid)	**MLB03**	0.74	0.75	3.30	0.89
Mellieha	Mellieha inner (Tunny Net side)	**MLB04**	0.09	0.24	1.91	4.81
St. Paul's Bay	St. Paul's Bay (Xemxija) near Vecca	**SPB01**	1.07	0.10	na	na
Qalet Marku	Qalet Marku	**QAM01**	0.00	0.26	0.01	0.52
Golden Bay	Golden Bay	**GLB01**	0.06	0.26	14.62	2.10
Ghajn Tuffieha	Ghajn Tuffieha	**GTB01**	0.48	0.54	2.02	2.40
Gnejna	Gnejna	**GNB01**	0.27	0.39	1.82	2.45
Wied iz-Zurrieq	Wied iz-Zurrieq	**WZQ01**	1.13	0.73	1.28	32.97

Table 1: (continued)

Locality	Site	Station Code	Summer 2000	Winter 2001	Summer 2001	Winter 2002
Marsaxlokk Pretty Bay	Marsaxlokk ifo pitch Pretty Bay	**MXB01**	8.47	2.60	1.23	1.52
Marsaxlokk St. George	Marsaxlokk ifo St George's Bay	**MXB02**	0.16	2.03	11.33	11.96
Marsaxlokk	Marsaxlokk St. George's Bay Outer (near Qajjenza)	**MXB03**	0.00	5.35	2.87	26.56
Marsaxlokk	Fort St. Lucian	**MXB04**	0.17	na	na	na
Marsaxlokk	Marsaxlokk Freeport	**MXB05**	1.80	0.42	3.91	10.79
Marsaxlokk	Marsaxlokk ifo Power Station	**MXB06**	2.71	0.87	5.85	2.49
Wied Ghammieq	Wied Ghammieq	**WGH01**	0.71	1.69	13.40	24.20
Grand Harbour	Grand Harbour Marsa	**GRH01**	18.75	28.40	63.44	150.50
Grand Harbour	Grand Harbour ifo Menqa	**GRH02**	151.13	21.41	108.64	79.10
Grand Harbour	Grand Harbour French Creek	**GRH03**	34.35	27.33	60.81	69.61
Grand Harbour	Grand Harbour Dockyard Creek	**GRH04**	36.54	25.93	11.02	46.66
Grand Harbour	Grand Harbour near Dock 1	**DOCK1**	na	na	85.43	114.30
Grand Harbour	Grand Harbour Inner Rinella	**GRH05**	13.75	75.67	595.06	496.14
Grand Harbour	Grand Harbour Kalkara (opp Regatta Bar)	**GRH06**	na	188.45	2.80	2.39
Marsamxett	MXett Outer	**MXH01**	0.05	0.12	1.63	3.07
Marsamxett	MXett ifo Fortina	**MXH02**	2.55	3.21	5.51	11.70
Marsamxett	MXett Sliema Creek ifo Yacht Yard	**MXH03**	32.57	18.83	64.89	23.65
Marsamxett	MXett Lazzaretto Marina	**MXH04**	24.64	16.42	60.73	38.39
Marsamxett	MXett Msida marina	**MXH06**	18.96	23.01	73.46	95.69
Marsamxett	MXett ifo Maritime Squadron	**MXH07**	24.42	31.03	35.44	30.74
Marsamxett	Mxett Lazzaretto Outer/Ta Xbiex	**MXH05**	19.57	16.75	34.80	23.48

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