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Optimising the implementation of the 2nd RBMP in the Malta River Basin District

LIFE 16 IPE MT 008

Action A.6:

Consultancy on Contaminants of Emerging Concern: Identification & Shortlisting

Report drawn up by

and

ERA Tender Ref: GF/Admin/39/18

Consultancy on Contaminants of Emerging Concern: Identification & Shortlisting

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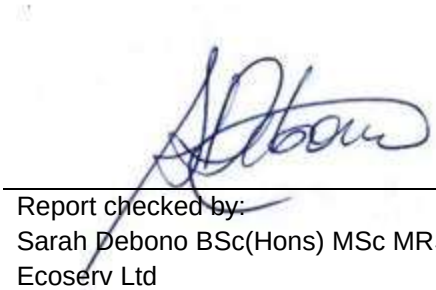

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Introduction

1. The Water Framework Directive (WFD) requires that good chemical status of surface waters and groundwaters is achieved by all member states of the European Union, providing a list of priority substances that are to be monitored and managed, and Environmental Quality Standards that are to be attained. These contaminants are listed in the relevant EU legislation, in particular the EU Water Framework Directive (2000/60/EC) and the Groundwater Directive (2006/118/EC).

2. The European Commission has also established a watch list of substances that is to be evaluated and monitored, to address the risks posed by chemicals arising from various anthropogenic activities. The WFD, through the Directive on Environmental Quality Standards (Directive 2008/105/EC), also requires consideration of 'Contaminants of Emerging Concern', a term used to describe compounds previously not considered or known to be significant with respect to the environmental health of the various water bodies.

3. The Environment and Resources Authority (ERA) has commissioned[1] Ecoserv Ltd., in collaboration with @econsulting, to develop a Monitoring Strategy for Contaminants of Emerging Concern (CEC) In four (4) Water Categories. This study is part of a project funded by the LIFE Programme under the Project Policy Area LIFE Integrated Project Environment contributing to the achievement of the objectives of the Water Framework Directive. The Project's reference and title are LIFE 16 IPE MT 008: *Optimising the implementation of the 2nd RBMP in the Malta River Basin District*, specifically *Action A.6 - Development of a monitoring strategy for contaminants of emerging concern.*

[1] Through award of tender GF/Admin/39/18.

4. This report is one of the deliverables highlighted within the tender dossier within article 24:

   'A report including the selected list of contaminants of emerging concern for each of the four (4) water categories and justifications for the selection of the final list on the basis of their use characteristics and risks to human health and the environment (to be delivered by month 6 and formally approved by ERA).'

5. This report is intended to satisfy tender requirements by:

   - Providing an outline of datasets collected through research and stakeholder consultation;
   - Selecting potential contaminants through review of potential sources that may affect the four water categories being studied; and
   - Shortlisting potential contaminants of emerging concern as per methodologies described in the approved workplan (attached as Annex 1)

Report Scope and Objective

6. Many emerging contaminants are unregulated, and in various cases unrecognized. Chemical substances that have the potential to be pollutants are generally identified via their CAS number, maintained in a registry by the American Chemical Society. The scale of the Registry, and consequently of potential CECs is illustrated by the following statement:

   '*CAS REGISTRY® contains more than 158 million unique organic and inorganic chemical substances, such as alloys, coordination compounds, minerals, mixtures, polymers and salts, and more than 68 million biosequences - more than any other database of its kind*.'[2]

   The European Chemicals Agency (ECHA) manages a parallel registration of chemicals throughout the European Union, via the European Classification and Labelling Inventory and Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH).

7. Identification and prioritisation of CECs depends upon an understanding of the sources of the contaminants, and the pathways through which the contaminants are introduced into the various environmental media that are the receptors for such pollution, and may act as pollution sinks. This report reviews the various potential sources of anthropogenically induced CECs, '*including* inter alia *industrial, pharmaceuticals, pesticides and personal care products*' as stipulated within the Terms of Reference. The processes through which such CECs may eventually reach receptor water bodies is also evaluated through review of available data sources, including water quality monitoring results that provide some insight into the type and scale of pollution pathways.

8. Data collection was an essential component of this study, given the need to ensure that the pollutants considered are relevant to the local context. The following section describes the stakeholder consultation undertaken with various agencies holding relevant datasets, or that offered insight into the use of substances that may eventually qualify as CECs. The process of data collection and resulting information are also described.

[2] From: https://www.cas.org/support/documentation/chemical-substances

9. Consideration of the pollution sources and potential pathways allowed the identification of candidate CECs, as well as their prioritisation as candidates for monitoring, based on the methodology described in Dulio *et al.* (2013). The latter defines a methodology where substances are assigned into action categories as defined within the same paper, followed by ranking of the substances within each action category, to generate a final shortlist for review. Deviations from this methodology that were found to be necessary are described and justified. This process made reference to data held in the NORMAN network, or data in the literature where appropriate.

Data Collection

10. Data collection was an essential component of this study, given the need to ensure that the pollutants considered are relevant to the local context. Stakeholder consultation was undertaken with various agencies holding relevant datasets, or that offered insight into the use of substances that may eventually qualify as CECs. The main entities involved in the importation, regulation or monitoring of substances that may contain contaminants of emerging concern are:

    - **National Statistics Office (NSO)**: importation data, list of chemical and products imported into Malta via the Customs Department.
    - **Malta Competition and Consumer Affairs Authority**: the competent authority responsible for the REACH directive (on chemicals), cosmetics, pesticides and fertilizers.
    - **Water Services Corporation**: holds data on drinking water quality, data on sewerage (treatment and chemical composition).
    - **Energy and Water Agency**: holds data on priority pollutants in groundwater bodies.
    - **Pesticides Control Board**: holds data on pesticides.
    - **Agriculture Department**: holds data on agricultural practices in Malta.
    - **Veterinary Regulation Directorate**: holds data on chemical and pharmaceutical use in animal husbandry.
    - **Department of Environmental Health**: data on communicable diseases resulting from vectors of disease that are water-borne.
    - **Medicines Authority**: data on pharmaceuticals used in Malta.
    - **Central Procurement Unit, Mater Dei** – data on procurement of medicines in Malta by Government
    - **National Antibiotic Committee**: holds data on antibiotic use in Malta.
    - **Environment and Resources Authority**: holds data on wastes and environmental permits.
    - **Ministry for Transport, Infrastructure and Capital Projects**: holds data on urban runoff collected through the National Flood Relief Project.

The collaboration and insights provided by the above are gratefully acknowledged.

11. As datasets held by the various agencies are collected for specific regulatory purposes that differ from the scope of this exercise, various gaps were encountered with respect to data required for evaluation. Such gaps were addressed through literature review, and expert knowledge on the use of various substances within the local context.

Pollution Pathways to Receptor Water Bodies

13. A review of anthropogenic sources of pollution affecting water bodies necessitates a review of the materials and activities that may give rise to these sources. A high-level strategic but systematic review of such materials or activities has been undertaken as part of this exercise, to evaluate the potential sources of contaminants. This was done through review of data held by the National Office on Statistics with respect to importation of materials, given that there are no other sources of primary production in Malta (e.g. through mining) that would constitute a contamination source. The spatial distribution of use of such potential contaminants was also considered.

14. The water bodies present in the Maltese islands are documented in detail within the *2nd Water Catchment Management Plan for the Malta Water Catchment District 2015 – 2021* (2015) ERA & SEWCU. This study also documents possible pollution pathways from potential sources of pollution to receptor bodies that are likely in the local context. The findings of this study were reviewed to identify aspects of the receptor water bodies or the pollution pathways which were relevant to the identification, behaviour and detection of CECs.

15. Existing monitoring data collected for regulatory purposes, or that is available in the literature regarding water quality highlight existing pollution pathways that may be followed by CECs, and the significance of such pathways was reviewed by assessing monitoring data on water quality held by the following agencies:

    - Environment and Resources Authority
    - Environment & Health department
    - Malta Resources Authority

    This data includes data collected through monitoring exercises, as well as relevant data collected through permitting, and/or other projects (where this was available). The above exercise was used to identify potential pollution pathways that would affect water bodies, and provide a context for the evaluation of the levels of risk posed by contaminants to the various water resources.

Water bodies potentially affected by CECs

16. Water bodies are described in detail within '*The 2nd Water Catchment Management Plan for the Malta Water Catchment District (2015 – 2021)*'. It is not the purpose of this report to replicate these findings; however, the following is a list of water bodies that have been considered as the receptors of the CECs which require investigation:

- **surface waters** as defined in the Water Framework Directive, including the coastal, transitional and inland surface waters. All surface water bodies have been listed and characterized as per Water Framework Directive Article 5 Summary Reports for Surface Waters, which lists the various bodies and describes them in terms of geographic location and size. Data on catchment is also provided, together with a list of risks and pressures that affect these water bodies;
- **rainwater runoff** which in the local context consists of rainfall that is not absorbed by soils, but that is collected on the surface of saturated or impermeable areas, and eventually joins a flow of water that may or may not be channelled into a storm water collection system;
- **groundwater** as analysed in detail in the 2nd Water Catchment Management Plan for the Malta Water Catchment District 2015 – 2021, which describes the three main typologies of groundwater bodies found within the Maltese context:

  i. Sea-level groundwater bodies developed in the Lower Coralline Limestone formation and take the form of freshwater lenses floating over seawater and referred locally as mean-sea-level aquifers (MSLAs). These are ubiquitous and occur extensively at sea level in Malta, Gozo and Comino.
  ii. Unconfined (phreatic) perched groundwater bodies sustained in the Upper Coralline Limestone formation perched over the Blue Clay formation. Perched aquifers are completely absent in central and eastern Malta where the UCL and the clay aquitard have been completely eroded. These aquifers occur in western Malta and in Gozo, on the sea-level aquifers.
  iii. Coastal groundwater bodies occurring in depressed valley areas within the Upper Coralline Limestone formation where the clay lies below sea level and freshwater is laterally bounded at its contact with seawater. These small aquifer systems occur at Pwales, Mellieha and Marfa.

- **new water** i.e. reclaimed water, a recent innovation managed by the Water Services Corporation, where wastewater collected through the urban wastewater sewerage system is treated to secondary treatment standards as required by the Urban Waste Water Treatment Directive; instead of being discharged to sea, the waters are further treated using ultrafiltration, reverse osmosis and advanced oxidation processes to produce a high quality reclaimed water suitable for agriculture and managed aquifer recharge.

Pollution Pathways

17. There are a variety of potential pathways that CECs may follow to reach the receptor bodies described in the previous section. The generation of CECs requires anthropogenic materials to be exposed to the physical or chemical processes leading to the migration of materials to the receptor environmental media, and eventually interact with natural chemical cycles that underpin ecosystems generally.

18. In the local context, it is useful to consider the spatial distribution of their uses, to have a clearer indication as to which CECs would result in the different receptor water bodies. Uses of different materials would generally have a different spatial distribution. Generally, materials used in rural areas would tend to be related to agriculture and animal husbandry, while urban uses would involve materials that are utilised in residential and industrial contexts. Chemical uses that are specific to road networks are limited, but the range of chemicals that are associated with transportation is very wide, including the materials used in construction, maintenance and operation of roads and vehicles.

19. The potential pathways from pollution source to the environmental media are illustrated in figure 1. The latter lists the various main categories of uses, and the manner in which potential pollutants can reach the various environmental media that can then act as pollution sinks. The main mechanisms would include:

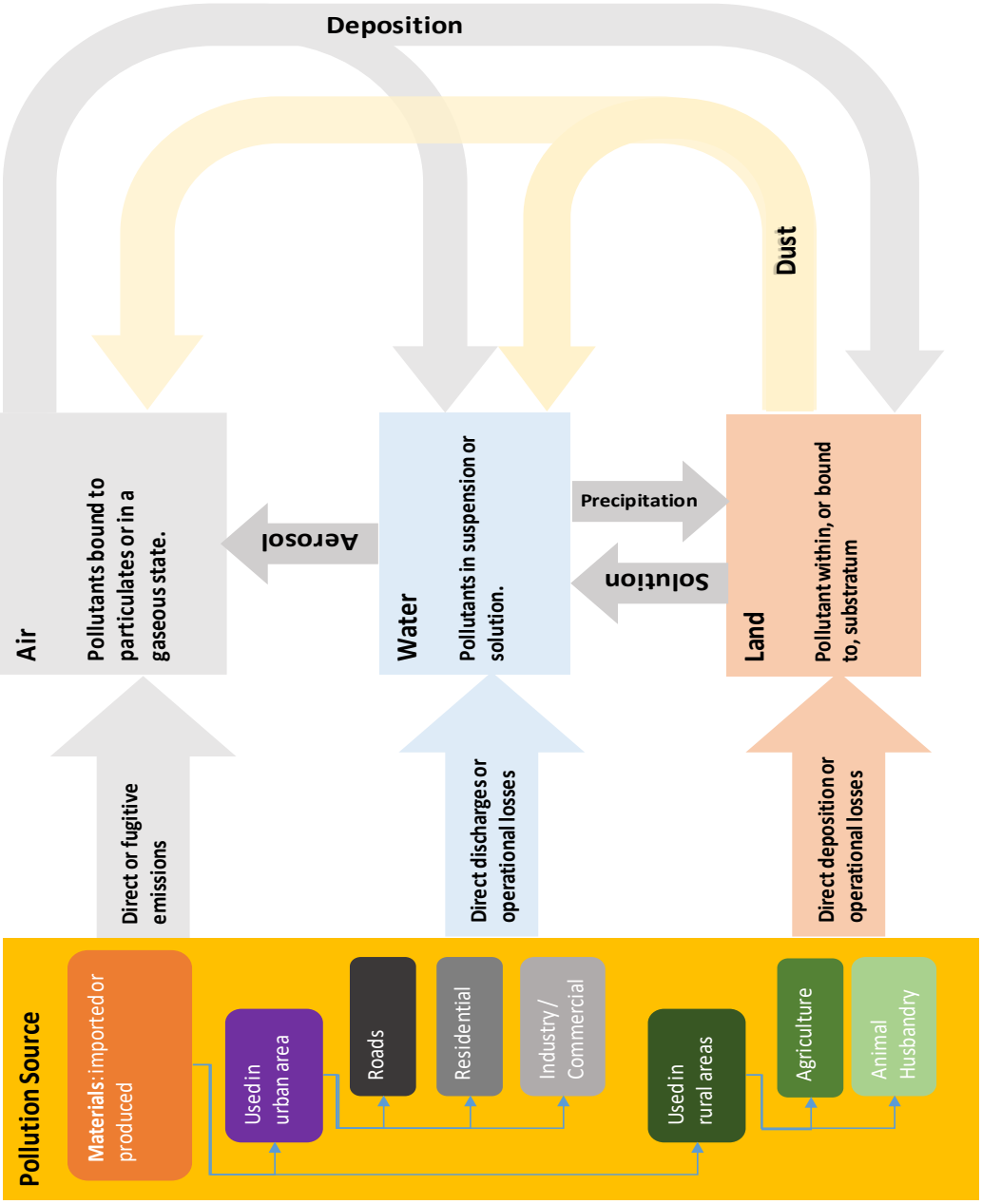
    - Direct discharges or spills of liquids into or onto an environmental medium, from where they can be dispersed through physical or chemical means;
    - Direct deposition of solid materials into an environmental medium, from which chemical substances can be released through physical or chemical processes, including fragmentation through abrasion or weathering, leaching of chemicals, release of degradation products, etc.; and
    - Direct or fugitive emissions of materials from processes that can then deposit or dissolve within an environmental medium.

    Figure 1 does not include maritime uses of materials that can result in the generation of CECs through the mechanisms described above.

Figure 1.
Pollution pathways from sources originating from different uses, to the various environmental media.

Arrows indicate pathways from use to water body via director fugitive emissions, which then move between the various environmental media through physical and chemical processes.

Only main processes and land based use of materials are illustrated.



20. The spatial distribution of use of materials in the Maltese islands is complicated by the density of different uses, which is a direct reflection of the high population density - 1,505 persons per square kilometre, within an area of 316 square kilometres (NSO 2019). Images providing a high-level overview of such complexity are provided in images 1a and 1b overleaf.

21. A review of land uses is facilitated through reference to the CORINE Land Cover inventory as managed by the European Environmental Agency (EEA). Image 1b highlights the distribution of uses in the Maltese islands. Most development tends to be concentrated around the port areas: Valletta on the north-eastern coast, and Marsaxlokk on the south-eastern coast. These form a large conurbation around the Valletta ports which extends southwards to the airport, and form the largest part of the developed areas in the Maltese islands.

22. The natural and agricultural areas tend to be concentrated in the north-western and south-eastern pasts of Malta, and throughout the island of Gozo. Agricultural areas dominate these landscapes, and the natural areas tend to be interspersed within this context, in extremely close proximity to agricultural uses and practices. The main water bodies associated with such areas would be watercourses, the underlying groundwater bodies, and the marine surface waters which are the ultimate receptors of runoff.

23. The residential areas on the island are either located within the main conurbation around the Grand Harbour, or constitute satellite developments of varying sizes dispersed throughout the agricultural and natural areas. Increasing population density has historically driven development towards the formation of residential units which maximise utilisation of residential space, leaving little scope for outdoor areas. Such areas are consequently dominated by outdoor surfaces that are coated with hard surfaces, which direct water flow towards limited storage facilities. Ultimately, road culverts are the principal receptors of storm waters.

24. Industrial areas (highlighted in shades of purple) are scattered in discrete land parcels, which can be correlated with either port related activities, energy generation, or industrial parks managed either by private entities or by Malta Industrial Parks. Some of the industrial areas on the south-western coastline are related to the limestone quarrying industry, which is the only primary production on the islands involving mineral extraction. Similarly, industrial areas tend to include substantial areas having impervious surfaces that constitute water harvesting facilities, with connections to sewerage networks for collection of discharge waters. Storm waters are collected by culverts in some areas, but contribute to catchment areas in others.

Image 1a: satellite image of the Maltese islands (Google Maps, 2015 image) where extent of developed areas is immediately visible.

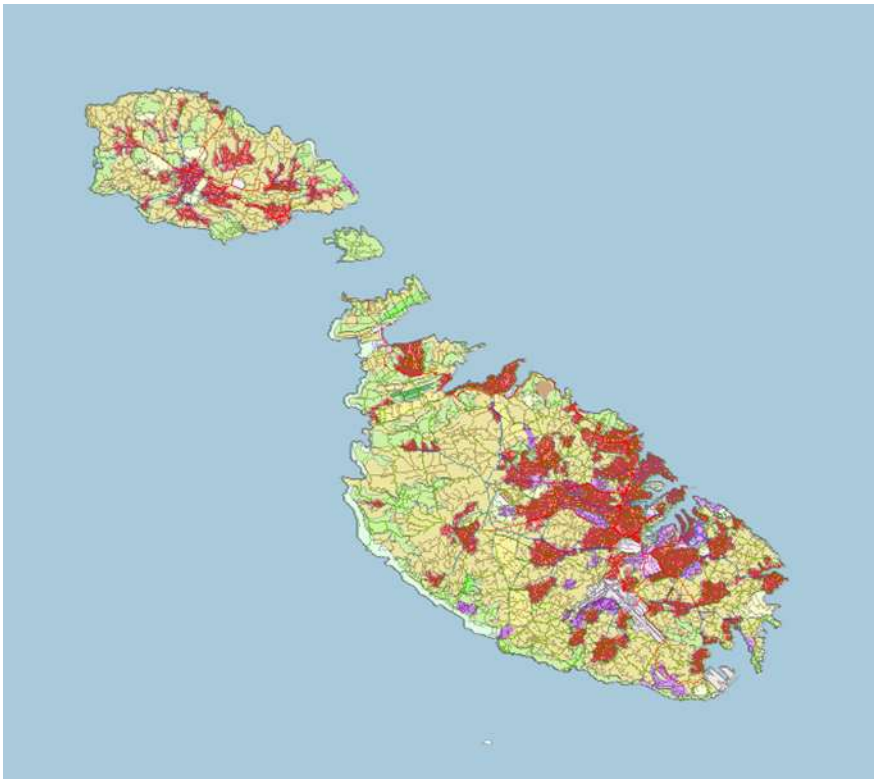


Image 1b: Corine Land Cover (CLC) data as per Planning Authority Geoserver (2019). At this scale, CLC classification may be summarised as follows: urban development consisting of residential and road networks correlate to the red areas, predominantly industrial or commercial sites are highlighted in purple; yellow and green areas are agricultural and natural areas respectively.

25. The above description of industrial and residential areas is not absolute at the local levels, where individual (or limited clusters) of residential or industrial units are located within areas not necessarily designated for such use. However, it is generally the case that the circumstances of such sites tend to be specific, and the effect of the latter on water bodies would need to be evaluated on a case by case basis.

26. Road networks are spatial elements typically associated with urban areas; however, these frequently transect rural areas, and run along surface water bodies (both freshwater and marine). Such areas dedicated to land transport tend to be monopolised by traffic, and the impact of these areas on water bodies would be expected to originate from vehicles, either from operational leakages of fluids (e.g. fuels, lubricants), mechanical erosion of specific components (e.g. brake linings, tyres) or leaching of substances from the vehicles or their emissions generally.

27. Sewerage networks are managed by the Water Services Corporation, which is responsible for their maintenance, upgrading and general management. Sewerage networks are organised in agglomerations; although these are primarily associated with urban areas and uses, these also transect rural areas.

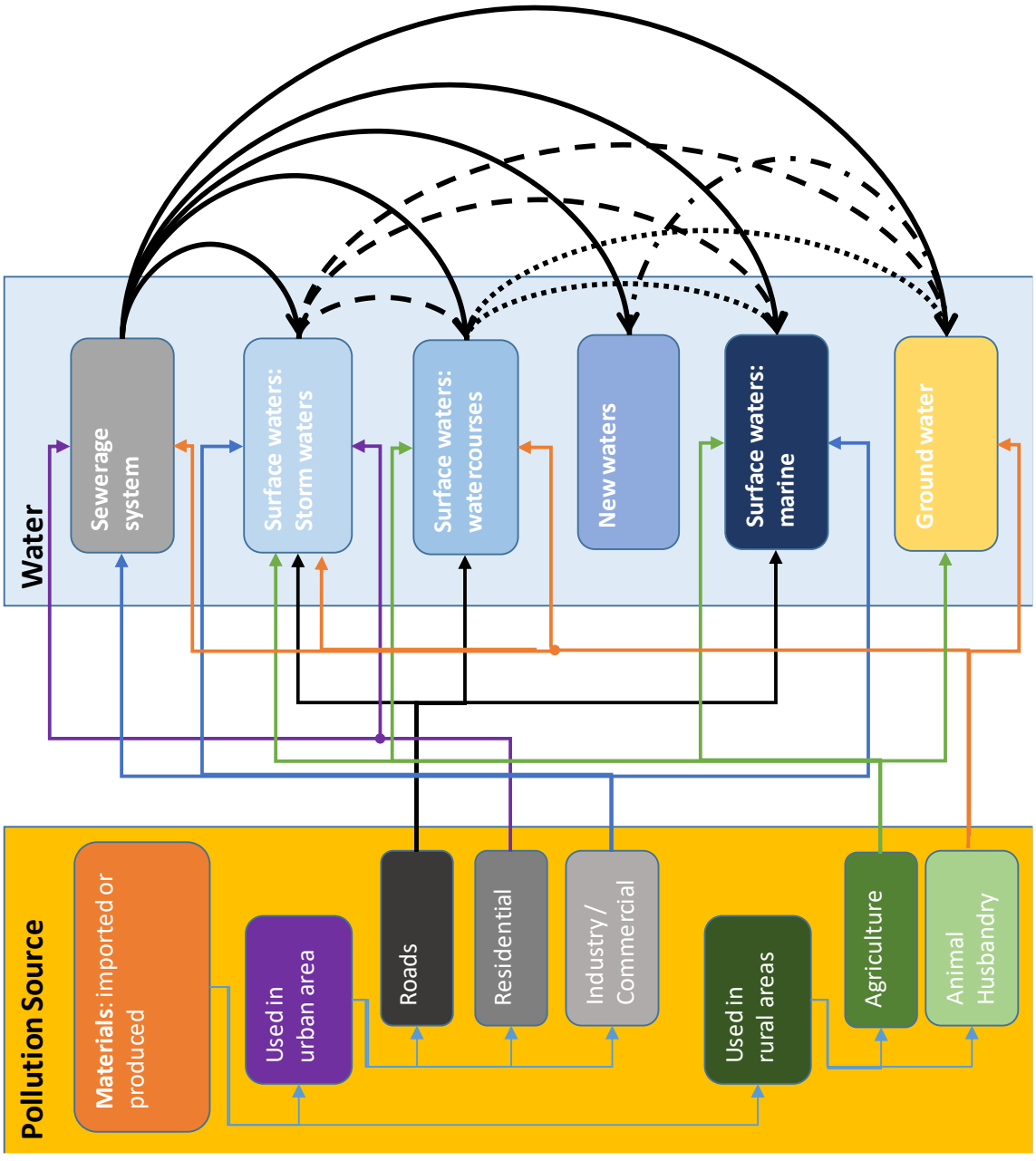
28. The spatial distribution of road culverts and storm water drainage systems also transect rural areas, with the difference that there is no systematic organisation of these systems, as these tend to either follow road developments, or drain areas prone to flooding. An exception is the National Flood Relief Project managed by the Ministry for Transport, Infrastructure and Capital Projects. This project was designed to alleviate flash flooding in urban areas within defined rain catchment areas, though the construction of a network of culverts, oil and grit interceptors, and underground tunnels leading to coastal discharge points.

29. The discharge paths from different uses (and associated pollution sources) to different water bodies are illustrated in Figure 2 overleaf. Movement of pollutants between different water bodies is also indicated. The density of linkages between sources and different waters indicates the complexity of water movements, and highlights the potential mobility of pollutants generally.

Figure 2.
Pollution pathways from sources originating from different uses, through different water bodies.

Straight arrows indicate pathways from use to water body via direct discharge. Colour coding of straight arrows: roads in black, residential in purple, commerical and industrial in blue, agriculture in green and animal husbandry in orange.

Curved arrows (solid) indicate pathways from the sewerage system to the various water bodies due to overflow or leakage; curved arrows (dashes indicate direct linkages between other water bodies).



30. Linkages between water bodies can be summarised as follows:

- **Sewerage systems** generally receive waters from residential or industrial units through a fixed connection point, though irregular connections from storm waters or agricultural units are encountered from time to time. Such irregularities lead to overflows from the sewerage systems, where surface waters are then contaminated. The degree of leakages from the sewerage networks cannot be determined with accuracy at this point, with the result that such leakages may potentially percolate to storm waters, surface waters or to groundwaters.
- **Groundwater** is replenished through percolation from rainfall; movement of CECs can follow either percolation through absorption of water by the limestone pores, or may follow discontinuities in the stone matrix. Such discontinuities may be natural geological formations (typically fault lines), or man-made structures such as boreholes. The main source of pollution affecting groundwaters is agriculture, where nitrate pollution has clearly documented the pollution pathway from source to receptor sink. Direct linkages from stormwaters and watercourses may also be supplemented through any contaminants in new water, via direct replenishment or infiltration of irrigation waters.
- **Storm waters** are generated through rain episodes where rainfall exceeds the ability of the substratum of a given area to absorb the rainfall. Urban areas having high proportions of hard surfaces tend to generate higher volumes of such waters, which are eventually channelled to either storm water channels, watercourses or to the sea. Such movement of waters also transports materials originating from agricultural practices in rural areas.
- **New waters** are produced by polishing water following urban waste water treatment; the latter is a recent innovation managed by the Water Services Corporation, where water collected through the urban wastewaters collection system, and treated using reverse osmosis. Given the source of these waters, the potential pollution in these waters is expected to be that originating from sewerage.
- **Watercourses** in the Maltese islands are seasonal, in that the flow of waters is generally interrupted during the dry summer period due to lack of rainfall. Sources of pollution would be expected to be via percolation from agricultural activities, or through storm waters arising from road surfaces and urban areas. Such transport is expected to be most significant in the initial rainfall after the summer, where the transported sediments would include the pollutants accumulated during the dry season.
- **Marine waters** are the final receptor water bodies, where pollution is received from either direct discharge, watercourses, storm waters or sewage overflows.

31. The mobility of CECs is expected to vary according to their physical and chemical properties, which determine the manner in which pollutants are transferred between environmental media and the various water bodies. The efficiency of the transport mechanisms in the local context is best understood by evaluating the transport mechanisms of known pollutants.

32. Although the above sections focus on the list of water bodies specified previously, transitional waters are relevant to this exercise. The behaviour of CECs is expected to be influenced by the nature of the interface between fresh and sea waters. In transitional waters, the main factor of significance is expected to be that of dilution, where CECs in the freshwater medium will be dispersed in seawater. The chemical behaviour of the different CECs will vary at this point, but monitoring results from coastal waters (see following sections) highlight that substances persist within the aqueous medium at detectable limits despite dilution. Some degree of partitioning of certain pollutants to sediments is also likely in all water bodies, but this aspect is beyond the scope of this study.

Known Pollution Pathways - Groundwater

33. Existing monitoring data collected for regulatory purposes, or that is available in the literature regarding water quality, highlight existing pollution pathways that may be followed by CECs; the significance of such pathways was reviewed by assessing monitoring data on water quality held by the following agencies:

    - Environment and Resources Authority
    - Environmental Health Directorate
    - Water Services Corporation
    - Malta Resources Authority

    This data included data collected through monitoring exercises, as well as some available data collected through permitting, and/or other projects.

34. The most recent data on groundwater monitoring was that carried out as part of a surveillance monitoring exercise carried out in 2016, arising from the requirements of the Water Framework Directive. Findings of note were:

    - Chloride and sodium levels typically associated with saline intrusions or discharges of brine reverse osmosis plants;
    - Nitrate pollution typically associated with agricultural fertilisers;
    - Frequent occurrences of orthophosphates, boron, and zinc, and occasional detection of other metals; and
    - Occasional detection of various trihalomethanes, flame retardants, plasticisers, pesticides and pharmaceuticals.

35. Barring the nitrates and saline intrusion, substances detected were usually at low concentrations. However, it is important to note that at the source of the contamination, such substances were probably at higher concentrations, and were diluted by unknown and variable orders of magnitude before accumulating in the groundwater.

36. Detected levels of pollution in groundwater did not follow any particular pattern. Although some boreholes included levels of more than one pollutant, no clear patterns of pollution emerged. This indicates that it is likely that different areas were subjected to different sources of pollution, and the levels of pollution detected were the result of different sources of pollution, being introduced into the water body at different times, and displaying different behaviours according to the different properties of the pollutant and the water body itself.

37. The difficulties in interpreting the data collected on contaminants in groundwater is illustrated by evaluation of some parameters:

- The presence of faecal coliforms and streptococci in a number of samples is indicative of a pollution pathway from the sewage network to groundwater in the affected areas.
- The presence of Acesulpham k (a widely used artificial sweetener) in most samples is harder to interpret. The predicted biodegradable half-life[3] of 4.29 days indicates that sustained levels of this substance requires regular replenishment, e.g. from a sewage leak, where this substance is expected in substantial amounts given that it is excreted directly by the kidneys[4]. It is not presently possible to explain why this substance was found in greater frequency than the bacterial indicators for sewage.
- The limited presence of caffeine is interesting to compare with that of Acesulpham k, as this substance tends to be metabolised[5] by the liver within a few hours of ingestion, reducing scope for presence of the substance in urine, possibly explaining the limited number of samples where this substance was detected.

38. Other substances can be interpreted in a different manner: boron and its compounds (particularly borax) could also originate from sewage, given use in in the manufacture of personal care products. However, another potential source might be the various fertilisers that include this substance (and its esters) as part of its formulation, or seawater intrusion. A similar case can be made for selenium. A summary of the substances detected and some observations on their frequency of detection and potential sources are provided in Annex 04.

[3] See Norman network database.
[4] European Commission Health & Consumer Protection Directorate-General (March 2000) *Opinion Re-evaluation of acesulfame K with reference to the previous SCF opinion of 1991*. https://ec.europa.eu/food/sites/food/files/safety/docs/sci-com_scf_out52_en.pdf
[5] See https://www.pharmgkb.org/chemical/PA448710#biotransformation

39. The presence of perfluoroalkyl substances (PFASs) in groundwaters from 10 boreholes has been studied by Sammut *et al.* (2019)[6], where all groundwater samples were contaminated with at least one PFAS, PFOA being found in all samples. The concentrations of PFASs detected in groundwater were below the parameters set by the Directive 98/83/EC. Sammut *et al.* (2019) observed that 'there appears to be a general trend of increasing PFAS concentration in samples of groundwater depending on four factors:

> *(1) how far from an urban area and whether it is downstream from this urban area: the closer to the urban, area the higher the PFAS concentration.*
> *(2) road run-off: the heavier the vehicular traffic in the area the higher the PFAS concentration.*
> *(3) past or current use of AFFF and.*
> *(4) the presence of any landfills in the surrounding area.*'

40. The effect of perchlorates on groundwater in Malta has been studied by Pace & Vella (2019)[7], who found that 44% of 36 groundwater samples contained perchlorate, as did 62% of water runoff samples. This effectively documented the pollution pathways originating from the deposition of dust containing perchlorate, and eventually migrating to water runoff and groundwater.

[6] Sammut G., Sinagra E., Sapiano M., Helmus R., & de Voogt,P., (2019) *Perfluoroalkyl substances in the Maltese environment – (II) sediments, soils and groundwater.* Science of The Total Environment Volume 682, 10 September 2019, Pages 180-189.
[7] Pace C. & Vella A. (2019) *Contamination of water resources of a small island state by fireworks-derived perchlorate: A case study from Malta.* Environmental Pollution 250 (2019) 475-481

Known Pollution Pathways – Inland Surface Waters

41. Data on the extent of contamination on inland surface waters may be gained from Ecoserv (2012), where inland surface and transitional waters across the islands were surveyed to evaluate the presence of priority substances and other specified pollutants. Further information may be gained from the baseline surveys for physico-chemical parameters in inland surface waters as documented by AIS Environmental (2014).

42. AIS (2014) included analysis of the following parameters: nitrates, nitrites, total Nitrogen, orthophosphates, total phosphorus, and ammonium. It is interesting to note that these studies highlighted the influence of agriculture on the various inland surface water bodies. This finding on fertiliser contamination is consistent with those of the studies on groundwater quality reviewed previously, providing some insight into the nature of the pollution pathways from arable agriculture to the receptor water bodies.

43. Other contaminants were detected in the survey conducted by Ecoserv (2012), where the plasticiser di(2-ethylhexyl) phthalate (DEHP), occurred in all the 60 samples monitored reflecting the ubiquitous nature of contamination from plastic origin. Other contaminants of note recorded in a limited number of samples included:

    - Fluoranthene, a PAH commonly encountered as a combustion product, and also from coal tar products;
    - dichloromethane (an industrial solvent); and
    - mercury.

44. The Ecoserv (2012) survey found that nickel and lead occurred in 88% and 43% of the samples respectively, and were correlated with industrial activity in the former case, and in the latter with vegetation cover and possible leaching from lead shot. The behaviour of metals in the local context, particularly in terms of partitioning between different environmental media, requires further study. Lead in particular is frequently assumed to be inert given the general alkaline nature of Maltese soils; however, the observed presence of this substance in the water column may well be a result of the complex chemistry demonstrated by this substance as documented in the SCHER (2011) EQS dossier[8], where other parameters such as water hardness and dissolved organic content was found to play a significant role, and where bioavailability to different species was found to be more complex than envisaged previously.

[8] *EQS dossier prepared by the Sub-Group on Review of the Priority Substances List (under Working Group E of the Common Implementation Strategy for the Water Framework Directive (2011)* Lead and its compounds.

45. Both groundwater and inland surface water monitoring highlight the probability of pollution pathways involving the sewage network. The 2nd Water Catchment Management Plan notes the following:

'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, 2009 and 2011. Such data indicates detectable concentration of contaminants listed in the Priority Substances Directive including the synthetic diuron and chlorpyrifos in 2008. Nickel and lead were the main Annex I non-synthetic contaminants detected in waste streams.'

The presence of lead and nickel provides further insight into the complexities involved in evaluating the potential origin of CECs, and the various potential pollution pathways followed. In particular, the presence of the pesticides diuron and chlorpyrifos in both the wastewaters and groundwater are clear indicators of the intensity of use, as well as an indicator of improper disposal of pesticides or tank washings into the sewer network.

46. Runoff or storm waters generated via precipitation are expected to contribute significantly to movement of CECs. Data available on pollutants in storm waters are those of SCE (2018), who evaluated the water quality of storm waters captured by the National Flood Relief Project Infrastructure, which captured waters arising from urban areas. Their findings indicated that:

- Most metals, such as chromium, manganese, copper, lead and nickel were partitioned in the sediment fraction, where these occurred in appreciable amounts;
- Water quality was affected mainly by PAHs, and DEHP, and
- Other substances tested for were absent, including:
    a. the solvent Hexachlorobutadiene
    b. the fungicides Quinoxyfen and Hexachlorobenzene (the latter being banned), the miticide Dicofol and the insecticides Hexachlorocyclohexane, Heptachlor & Endosulfan (not permitted for local use), and the herbicide Trifluralin
    c. Pentachlorobenzene (banned)
    d. Nonylphenol,
    e. Sum of Polybrominated diphenyl ethers (PBDE)
    f. Chloroalkanes (C10-13)
    g. Perfluorooctane sulfonic acid (PFOS)
    h. Hexabromocyclododecane (HBCDD)
    i. TBTs

Known Pollution Pathways – Marine Surface Waters

47. A detailed baseline survey of marine water quality was carried out by Ambiente sc & CIBM (2013), who were responsible for preparing the following document: *Development of Environmental Monitoring Strategy and Environmental Monitoring Baseline Surveys*. This study evaluated variations in water quality during different seasons, describing the seasonal fluctuations of nitrogen and phosphorus nutrients. Spatial variation in levels of detected nutrients was also discussed, where diffuse terrestrial sources of pollution – particularly agriculture – were considered as sources.

48. The study also considered the influence of geological and anthropogenic inputs on concentrations of trace metals, particularly with respect to the elevated levels of lead, mercury, cadmium and nickel detected. Atmospheric deposition, sewage overflows and point sources such as power generation were all considered, and thought to contribute to the elevated levels detected.

49. The evaluation of organic pollutants only detected a range of PAHs and dichloromethane, with the latter only recorded once. The PAHs detected were considered to have originated from combustion sources, though the pollution pathways involved could not be documented.

50. The relationship between point sources on the coast and marine water quality is illustrated by observations are made within the assessment of the effect of the Maghtab landfill on the marine environment (Axiak V., 2004). This study highlighted the effect of the lack of containment at the Maghtab landfill on marine sediments in terms of heavy metals such as lead, chromium and manganese (amongst others). There was also comparison with data collected from coastal areas exposed to traffic, where lead, copper and chromium were also observed to have increased. Hydrocarbon contamination was also correlated with land based and maritime traffic.

51. Further insight into pollution pathways in harbour areas may be gained from Huntingford & Turner (2011), who studied trace metals in harbour and slipway sediments from the Grand harbour, Marsamxett Harbour, and Marsaxlokk. The linkage between boating and shipping activities and maintenance and levels of various metals was described, particularly levels of copper from anti-fouling paints, nickel (and copper) from grit-blasting slag, lead from paints, and zinc from paints, sacrificial anodes and galvanised materials. The greatest risk to the marine benthic environment was considered to be lead.

52. The pollution pathways between land and sea are also clearly documented in the various bathing water quality studies carried out by the Environmental Health Directorate, which are expressly designed to detect pollution from sewage overflows, and which document levels of pollution that have been detected from time to time.

53. The presence of CECs in Maltese waters has been studied as part of the ERA study *Chemical monitoring of Watch List substances in the Maltese Islands*, which screened various CECs[9] at a point at the northernmost end of Gozo, and another outside the Ta'Barkat Urban Waste Water Treatment Plant. The only CEC detected was Imidacloprid (a neonicotinoid) at the northernmost end of the island of Gozo, a result which was surprising given that the nature of the monitoring site in terms of depth and exposure to the currents, as well as the distance from potential sources of the substance.

[9] Other contaminants are included in this monitoring exercise which include erythromycin, the five neonicotinoids, oxadiazon and tri-allate ,17-Alpha-ethinylestradiol (EE2), 17-Beta-estradiol (E2), Estrone (E1), Diclofenac, 2,6-Ditert-butyl-4-Methylphenol, 2-Ethylhexyl 4-methoxycinnamate, Clarithromycin, Azithromycin & Methiocarb

Relative Risks of Pollution Sources

54. CECs of anthropogenic origin are expected to originate from the wide variety of materials used by human activities. Given that Malta has no primary resources associated with the potential for contamination, such materials would arrive on the Malta islands through importation via port facilities, and be distributed across the islands for use under different scenarios, each of which would have different relative risks.

55. The different scenarios of use of chemicals that may qualify as CECs is highlighted in figures 1 and 2 displayed previously. Each pattern of use present different risks to the various water bodies, where such difference is related to:

- the type of chemical that is used;
- the potential for chemicals to move from a contained use to a receptor water body; and
- spatial and temporal variations in chemical use and resultant risk.

It should be noted that the major uses listed are those that are representative of large scale uses. Other specific uses, such as pollutants that may emerge from a specialised industrial use, or demolition/construction of particular buildings or installations, are not captured by this exercise, as these would present specific scenarios that would require assessment in their own right.

56. High level risk assessments for the various bodies are presented in Annex 3. These assessments are necessarily high level, as quantification of material flows is not possible at this point in time, and neither is the potential for quantifying degree of exposure. Scoring of risk as low or high provides an indication as to the types of chemicals that would be expected to be considered as CECs, where a high risk is indicative of the probability of candidate CECs being encountered in water bodies. A medium score has been allocated where the linkage in the pollution pathway is indirect, and the presence of a CEC is expected to be low (if only through dilution).

57. These risk assessments highlight that the risks to the water bodies may be summarised as follows:

- The highest level of risk is associated with **storm waters**, given the potential to receive CECs from all potential sources considered.
- **Groundwaters** have a similar level of risk, given the potential for such waters to receive storm waters contaminated by CECs, as well as from leaks from the sewage networks, and substances used agriculture.
- A similar level of risk is associated with **watercourses**, given the potential for such waters to receive storm waters contaminated by CECs, the extent to which this happens depending on the catchment areas of the different watercourses.
- Pollution pathways to **sewerage** would mainly be from discharges from the residential and commercial/industrial sources, as well as from animal husbandry.
- Risks to **new waters** tend to mirror those for sewer waters, given the direct linkage. The dilution factor is here expected to reduce the risks somewhat, but this is expected to vary according to the different catchment of the sewerage network branches from different sources (agglomerations).
- Risks to **marine waters** and **transitional waters** from land-based sources of CECs would tend to mirror those of storm waters, given that a significant proportion of these waters eventually reach the sea. These risks do not include risks arising from specific coastal maritime activities, mainly those that are port related, sewage overflows, or from maritime traffic. Compared to other water bodies, risks here are considered to be less given that pollutants arriving here from all other sources are expected to be rapidly diluted.

All water bodies are exposed to emissions from traffic, either from deposition of emitted dusts resulting from fuel combustion or abrasion of parts (particularly tyres or brakes), operational leakages (particularly from lubricants) and longer-term leaching of metals and carbon-based synthetic materials that constitute the vehicles themselves.

58. These risk assessments also highlight that the potential sources of CECs would mainly be:

- Contaminants pertaining to **agriculture** and **animal husbandry** – besides the typical pollutants such as pesticides and fertilizers, there is the need to consider other potential sources such as veterinary medicines, hormones and their metabolites, as well as residues or transformation products of man-made chemicals used in agriculture, ranging from plastics to disinfection products. Biological contaminants, such as bacteria and viruses, should also be considered.
- Contaminants originating from sewage discharges from **residences** and **industry**; these would include:
    - industrial type chemicals, either used directly in the local industrial context, or derived from manufactured products in general use;
    - chemicals from residential type discharges:
        - pertaining to **pharmaceuticals** and their metabolites that have the potential to contaminate water bodies;
        - pertaining to **personal care products** i.e. chemicals involved in the formulation of such products, including substances such as parabens, synthetic preservatives, phthalates, surfactants and fragrances. Microplastics is another area where further consideration is required; or
        - **household chemicals** i.e. chemicals included in cleaning agents, detergents, etc.
- Contaminants arising from **traffic**, which would constitute fuels, and the chemical substances used in the manufacture of vehicles.

59. It is expected that such risk assessments would be progressively updated as further information becomes available, particularly from the monitoring programmes resulting from this study. The design of the monitoring programmes is also expected to be informed by this risk assessment process.

Pollution Sources

Imported Substances

60. CECs of anthropogenic origin are expected to originate from the wide variety of materials used by human activities. Given that Malta has no primary resources associated with the potential for contamination, such materials would arrive on the Malta islands through importation via port facilities. Data on such port activities is retained by the Customs Department, and eventually processed and published by the National Statistics Office.

61. Data on importation of materials is organised using the EU Combined Nomenclature system, whereby different materials and items (essentially tradeable commodities) are given an 8-digit code, which are organised into 98 different chapters, the latter having a 2-digit code. A list of chapter codes is provided as Annex 02.

62. A scan of the codes immediately highlights that the range of materials imported cannot be immediately correlated with substances that may be considered as CECs, but are typically items whose components are made up of various substances having different chemical properties, each of which may have the potential of being considered as a CEC. In their review of the NORMAN network's achievements over ten years documenting emerging pollutants, Dulio *et al.*, (2018) comment that '*more than 100 million chemical substances are currently registered in the Chemical Abstracts Service (CAS) and about 4000 new ones are registered every day. According to the number of registered and pre-registered substances in REACH, 30,000–50,000 industrial chemicals are found in daily-use products and they are potentially ultimately released into the environment*.'

63. Some insight into the scale of materials and the potential for contamination is indicated through statistics on material flows carried out within the Maltese islands during 2018:

- circa 19 million tons imported into Malta;
- circa 12 million tons exported from Malta;
- circa 3 million tons of organic materials used as lubricants, mineral fuels, etc. (the balance between imports and exports of these substances);
- circa 0.3 million tons of material being deposited as waste within landfills or incinerated during 2018; and
- an unspecified but clearly voluminous balance of material that is retained for use as raw material, equipment or consumables on roads, or within residences or industrial sites.

The above snapshot of materials in 2018 highlight the scope for materials to fall into the role of CEC through the pathways described below, either through direct discharge in some form or other, or through leaching through contact with water.

64. The use of data on importation of materials is limited by the ability to determine the type and quality of use, as well as the extent of potential exposure of the material that would lead to contamination via the pollution pathways described previously. Annex 02 include3s a complete list of Common Nomenclature codes used by the National Statistics Office to classify imported materials. Comments against each code highlights the potential of the code to generate CECs.

65. A review of the various CECs allows the codes to be classified in the following generic categories:

- Codes including chemicals that may behave as CECs;
- Codes which may be considered to be very low priority as these constitute foodstuffs and natural products;
- Materials of natural origins having been exposed to chemical treatment e.g. leather products, etc.;
- Raw materials and items manufactured out of specific raw materials e.g. iron and iron products, etc;
- Manufactured items made out of various composite materials, e.g. machinery.

Most codes did not allow insight into the specific nature of the materials, particularly with respect to the chemical composition of composite materials or manufactured articles, the chemical treatments to which they were exposed, or the trace compounds present within the materials included within individual codes.

66. Table 1 lists those CN codes having the highest risk of being associated with the generation of CECs. The aggregation of data on chemicals in importation statistics limits the chemicals that can be readily identified as candidate CECs at this stage. This highlights the need for selection of CECs to be an iterative process, to be continuously updated to take into consideration other sources of information throughout the implementation of the monitoring programme. The consideration of socio-economic factors is considered to be particularly significant in this process.

Table 1: potential for CECs within different CN code categories. (Base year 2018)

2-Digit CN	Commodity description	Description and potential for CECs
25	Salt/sulphur/earths/plastering materials and cement	Mainly materials associated with the construction industry, where the main materials imported constitute cement and various building materials. No specific chemical can be identified as a CEC, though the risk of trace elements persists.
26	Ores, slag and ash	Main import is 'Slag, ash and residues containing mainly copper' @ just over 300 tons. Other slags and ores at about 10% of this value. Use is likely to be associated with a specific industrial use, and potential as CECs is indeterminate, and probably site specific.
27	Mineral fuels, oils and products	Imported and exported in significant volumes, with significant local consumption of fuel and lubricants.
28	Inorganic chemicals and compounds	Various chemicals, with only sodium hydrogen carbonate and unspecified polyphosphates being imported at an order of magnitude of over 1000 tonnes. Chemicals imported at a magnitude of between 100 to 1000 tonnes are: • Hypochlorites, chlorites and hypobromites (excl. calcium hypochlorites) • Hydrogen chloride "hydrochloric acid" • Calcium carbonate • Phosphates of calcium (excl. calcium hydrogenorthophosphate "dicalcium phosphate") • Calcium carbonate • Sodium hydroxide "caustic soda" solid • Nitrate of potassium • Hydrogen peroxide, whether or not solidified with urea Chemicals imported at a magnitude of between 10 to 100 tonnes have a similar chemical nature i.e. mainly assorted salts, acids or alkali. The chemicals described above are captured by existing monitoring regimes, particularly those that evaluate metals. Other compounds are imported in the kilogram range, e.g. oxides of antimony, titanium, etc.; potential as CECs is indeterminate, and probably site specific.

2-Digit CN	Commodity description	Description and potential for CECs
29	Organic chemicals	Various chemicals, with only unspecified acyclic ether and their derivatives and citric acid being imported at an order of magnitude of over 1000 tonnes. Chemicals imported at a magnitude of between 100 to 1000 tonnes are various, though most compounds are group in families. However, the following chemicals can be flagged as potential CECs, probably having some role in the industrial sector: • Methylene chloride (129 tons) • Aniline (100 tons) Chemicals imported at a magnitude of between 10 to 100 tonnes tend to be groupings of chemicals in the same family; their potential as CECs is probably site specific. The above chemicals do not include the more significant organic chemicals that form part of formulations or composite materials, and have significant potential as CECs.
30	Pharmaceutical products	See section below on Pharmaceuticals.
31	Fertilisers	Nitrogen, phosphorus and potassium rich salts; see section on agricultural chemicals below.
32	Tanning/dyeing extracts and paints	Chemical nature not specified, though over 300 tons of paint containing titanium dioxide imported; substantial use of unspecified synthetic polymers noted.
33	Essential oils and toilet preparations	Over 5000 tons of unspecified formulations of unknown chemical composition imported in 2018.
34	Soap, etc, lubricants, waxes, dental preparations	Over 19,000 tons of unspecified formulations of unknown chemical composition imported in 2018. These formulations have uses as cleaning, polishing and lubricating agents.
35	Albuminoidal substances	Unspecified glues and food products.
36	Explosives/pyrotechnic	Circa 19 tons of unspecified formulations of unknown chemical composition imported in 2018.
37	Photographic/cinema	Unspecified formulations
38	Miscellaneous chemical products	Unspecified formulations for use in different industries, e.g. concrete additives, dyeing agents, biodiesel, pesticides etc..

67. When considering the above list of imported material, and the risks posed via the pollution pathways reviewed previously, the following categories were selected for further study:

- Pharmaceuticals for human use;
- Pharmaceutical used for veterinary purposes;
- Agricultural Chemicals: Pesticides and Fertilisers;
- Household and Personal care Products; and
- Chemicals used in Industry.

Pharmaceuticals (Human Use)

68. Data on the potential for pharmaceuticals/nutraceuticals to contaminate water bodies is limited. However, of particular interest is that the following substances have been detected in the groundwater monitoring carried out to date:

- Acesulfam k: detected in 24 out of 33 boreholes tested
- Carbamazepine: detected in 8 out of 33 boreholes tested
- Sulfamethoxazole, Sucralose, and Caffeine were detected sporadically
- codeine and venlafaxine were not detected in any boreholes.

It is pertinent to note that:

- Acesulpham k and sucralose are sweeteners,
- Carbamazepine is an anticonvulsant,
- Sulfamethoxazole is an antibiotic,
- Codeine is an opiate painkiller; and
- Venlafaxine is an antidepressant

The nature of these compounds suggests that the pollution pathway for the transport of such materials was most likely through disposal and/or excretion into the sewers, and afterwards through leaks in the network.

69. The variability in concentrations and geographic range may have a number of explanations. Extent of use, dilution, and the degree to which the pharmaceutical/nutraceutical is metabolised prior to discharge is a significant consideration. A clear indicator is the sweetener acesulpham k, which is widespread in various formulations (in food products, pharmaceutical formulations, etc.), and is largely unmetabolized prior to excretion[10].

[10] https://pubchem.ncbi.nlm.nih.gov/compound/36573

70. Both Carbamazepine and Sulfamethoxazole were detected to a limited extent; it is interesting to note that while Carbamazepine is largely metabolised[11], a relatively larger amount (circa 20%) of active Sulfamethoxazole[12] is excreted after being metabolised. The detection of Carbamazepine across a wider area (circa 25% of boreholes surveyed as compared with circa 10% for Sulfamethoxazole) is consistent with data collected from the Central Procurement Unit at Mater Dei, in that the use of Carbamazepine is higher by orders of magnitude.

71. Consultation with the Medicines Authority highlighted the point that procurement by Government constituted approximately half of the pharmaceutical consumption in Malta, and this was the most accurate indication of the consumption of pharmaceutical products in Malta that was available. Assessment was undertaken using data on the use of pharmaceuticals as provided by the Central Procurement Unit at Mater Dei, which provided a list of the most common pharmaceuticals procured.

72. The dataset on the greatest volume of pharmaceuticals consumed in Malta (as provided by the Central Procurement Unit) was ranked in order of mass of pharmaceutical compounds consumed, where the mass was the product of the typical dose of active ingredient multiplied by the number of doses issued. Given that the list of pharmaceutical products is particularly long, and that substances consumed in low frequencies and/or doses were likely to be lost via dilution, priority for shortlisting was given to those substances which were more concentrated than the substances encountered in the monitoring surveys conducted to date.

73. Consultation was also held with the National Antibiotics Committee, given the particular concerns posed by antibiotic use generally. Data available on consumption patterns was that published within the European Centre for Disease Prevention and Control reports (see ECDC, 2018 for typical data), which indicates that antibiotic, antivirals and antimycotic consumption tended to be higher than the EU average, and indicating high tourist volumes as a potential cause. However, data on specific products was not available.

74. The results attained by the above assessment is generally consistent with the observations made by the Medicines Authority regarding the use of typical pharmaceuticals used, e.g. contraceptives, anti-inflammatories, and diabetes treatments. Given that **Ibuprofen** was raised as a very typical example, this was added to the long list of substances.

[11] https://www.drugbank.ca/drugs/DB00564
[12] https://pubchem.ncbi.nlm.nih.gov/compound/5329

75. The Medicines Authority also highlighted high-risk pharmaceuticals such as radioisotopes, cytotoxins and cytostatics (such as **Methotrexate, Tamoxifen**), **platinum**-based anti-cancer treatment pharmaceuticals, etc.

Veterinary Pharmaceuticals

76. The use of veterinary pharmaceuticals is documented by the Veterinary and Phytosanitary Regulation Division (VPRD), which collects data on the use of antibiotics in the animal husbandry sector. The data is presented in the following table, where the different antibiotics are listed in order of the magnitude of uses, for the main species of livestock.

Table 2: veterinary pharmaceuticals used within different animal husbandry sectors, organised in descending order by mass consumed. Colour coding is used to highlight those substances that are not species specific, and are used in three or more species.

Species	Rabbits	Ovine and Caprine	Swine	Bovine	Poultry
Ranking*					
1	Oxytetracycline (Rabbits)	Dihydrostreptomycin (Ovine and Caprine)	Oxytetracycline (Swine)	Dihydrostreptomycin (Bovine)	Amoxicillin (Poultry)
2	Bacitracin Zinc (Rabbits)	Prociane penicillin (Ovine + Caprine)	Tiamulin (Swine)	Oxytetracycline (Bovine)	Tylosin (Poultry)
3	Enrofloxacin (Rabbits)	Benzylpenicillin (Ovine + Caprine)	Zinc Oxide (Swine)	Benzylpenicillin (Bovine)	Sulfonamide (Poultry)
4	Tiamulin (Rabbits)	Neomycin (Ovine and Caprine)	*Colistin (Swine)	Doxycyline (Bovine)	Enrofloxacillin (Poultry -
5	Valnemulina (Rabbits)		Benzylpenicillin (Swine)	Amoxicillin (Bovine)	
6	Dihydrostreptomycin (Rabbits)		Spectinomycin (Swine)	Cloxacillin (Bovine)	
7			Amoxicillin (Swine)	Florfenicol (Bovine)	
8			Doxycyline (Swine)	Lincomycin (Bovine)	
9				Enrofloxacin (Bovine)	

77. Discussions with the VPRD highlighted the intensive use of cleaning agents within the animal husbandry sector, given the need to minimise the probability of disease outbreak in livestock. There is no systematic data collected on such substances, though it is understood that such use is likely to be intensive. Data on active ingredients used locally in such formulations (**Benzenesulfonic acid**, **P-Chloro-M-Cresol** & **2-Butoxyethanol**) were identified through examination of Substance Data Sheets of disinfectants commonly used, and added to the list.

78. The use of hormone treatments was also discussed, though data on nature and quantities used was not available. However, the use of such materials is limited to poultry and swine treatment, in microgram doses. As with pharmaceuticals for human use, queries were raised regarding the disposal of waste pharmaceuticals, and potential volumes of pharmaceuticals used for other domestic animals, where no statistics are available regarding the types and volumes of products used.

79. Also considered is the insecticide Fipronil, which is used in the poultry industry.

80. Discussions with the Agriculture Department highlighted that that they do not maintain records regarding use of pesticides and fertilisers. However, it was noted that tomatoes, viticulture and potatoes are the crops where intensity of production was highest, so products associated with the cultivation of these materials were prioritised.

81. Fertilisers were assessed through evaluation of products available on the market, to determine the typical constituents that form part of the formulations:

- Nitrogen, phosphorus and potassium in various formulations
- Various trace elements, including molybdenum, boron, manganese, copper and zinc
- Ammonium salts, including nitrates
- EDTA, EDDHSA, EDDHA used as a common chelating agent
- Esterified boron

The chelating agents were noted for addition to the long list of potential CECs. However, it should be noted that the sampling carried out was not comprehensive, and that other relevant ingredients may be identified through a systematic survey.

82. Of note is Regulation (EU) 2019/1009 of the European Parliament and of the Council of 5 June 2019 *laying down rules on the making available on the market of EU fertilising products and amending Regulations (EC) No 1069/2009 and (EC) No 1107/2009 and repealing Regulation (EC) No 2003/2003.* This regulation documents the problem posed by cadmium in fertilisers derived from mineral phosphates, and include provisions for the limitation of the use of such fertilisers by individual Member States, should this be found to be necessary.

83. Pesticides are regulated through the provisions of Legal Notice 284 of 2011, *Plant Protection Products (Implementation) Regulations*, issued under the Pesticides' Control Act (Cap. 430) with the provisions of Regulation (EC) 1107/2009. These regulations involve the maintenance of a list of Plant Protection Products, together with their relevant details, that are authorised for use in the Maltese island.

84. No systematic data was available regarding the extent and intensity of use of pesticides and herbicides. Priority for evaluation was given through assessment of products available on the market, to determine the typical constituents that form part of the formulations. Note was also taken of other organic constituents of the pesticides that may constitute CECs.

85. Reference to available data on pesticides detected highlighted the detection of Imidacloprid in marine waters in a single sample (ERA). This particular substance merits separate consideration, given that it was observed that this active ingredient is found in a wide variety of substances, including those used domestically (for pets). Consequently, the pollution pathway may differ from the rest of the pesticides considered, where the application is typically in a rural context via application to crops.

86. Also detected in the 2016 groundwater surveillance monitoring were the following:

- Diuron occasionally detected
- Chlorpyrifos occasionally detected
- Aldrin occasionally detected
- Dieldrin occasionally detected
- N,N- Diethyl-meta-toluamide Detected once at Tal-Palma
- Glyphosate Detected once at Qammieh
- alpha-Hexachlorocyclohexane (HCH / Lindane) occasionally detected
- gamma-Hexachlorocyclohexane (HCH / Lindane) occasionally detected
- Chlorothalonil µg/L occasionally detected

It was noted that the above range of substances were generally congruent with those carried out in the sampling of products available on the market. However, variation in detection is to be expected given that the use of these substances tends to be seasonal, following which degradation of the chemical products is to be expected, albeit at varying rates (depending on chemical properties, and conditions prevalent within the receptor water body).

Household Chemicals and Personal Care Products

87. As noted in the section of imported materials, household cleaning products and personal care products are imported and consumed in significant quantities. NSO data indicate that over 5000 tons of essential oils and toilet preparations, and over 19,000 tons of soap, etc, lubricants, waxes, dental preparations, were imported during 2018. No data is available regarding the nature, extent and manner of their use; however, it is plausible that a substantial portion of them were utilised in household, commercial and industrial contexts, and that these were eventually discharged as wastewaters.

88. NSO data did not provide sufficient granularity to allow identification of the main chemical constituents – this was not the original scope of this data collection exercise. However, the volume and implied range of materials imported indicates that the chemical constituents of these materials are likely to be very similar to those utilised outside Malta, given that these are produced by companies have a wide European (if not global) market share.

89. Identification of potential CECs in household and personal care products was carried out using data held by the International Chemical Secretariat[13], a non-profit organisation based in Sweden. A useful tool developed by this organisation is the SIN (Substitute It Now) list, which has been developed to help industry find safer substitutes to chemicals whose properties raise health or environmental concerns.

90. A range of chemicals widely used in the production of household chemicals, personal care, and food contact materials were selected, by shortlisting those materials having production volumes in excess of 1000 tons annually, and which are consequently found in trace quantities across a wide range of products. It is considered likely that a proportion of these materials have been imported as part of the products described previously, and will exhibit behaviour similar to that of DEHP (a common plasticiser), which was encountered in stormwaters and inland surface waters.

[13] https://chemsec.org/

91. The following substances were identified as being the most common chemicals utilised in personal care products, household chemicals and furniture generally:

- Styrene
- Resorcinol
- Triphenyl phosphate
- Benzophenone
- Galaxolide
- Butylated Hydroxytoluene
- 4-(1,1,3,3-tetramethylbutyl)phenol
- Tonalide
- 2-(2H-benzotriazol-2-yl)-4-(1,1,3,3-tetramethylbutyl)phenol (UV-329)
- Formaldehyde
- Octamethylcyclotetrasiloxane (D4)
- Aniline
- Chlorinated paraffins (CPs)
- Carbon disulphide
- Bisphenol A
- diethyl phthalate (DEP)
- 1,2-dichlorobenzene
- 4-Tert-Butylphenol

92. Also selected for evaluation were the following:

- Nonylphenol: a common detergent metabolite
- Sodium Lauryl Sulphate: a common surfactant
- Para-hydroxybenzoate: a paraben commonly used in personal care products
- DEHP Bis(2-ethylhexyl) phthalate[14]

[14] Di(2-ethylhexyl)phthalate is listed in Directive 2013/39/EU, and hence may not need to be considered as CEC. However, it is being included as a candidate compound to be considered for the monitoring programme to be derived, given that local data on this substance is limited. Furthermore, given that this compound is commonly encountered, data on this substance may provide to be a useful benchmark against which other compounds can be compared.

Chemicals Used in Industry

93. As noted in the section of imported materials, a range of organic and inorganic compounds are imported and processed in significant quantities. However, NSO data did not provide sufficient granularity to allow identification of the main chemical constituents, as this was not the original scope of the original data collection exercise. The only chemicals that could be identified that are used in significant amounts are **methylene chloride** (129 tons) and **aniline** (100 tons).

94. No data is available regarding the nature, extent and manner of use of imported chemicals; however, it is plausible that some portion of these materials may have persisted within the wastewaters that were eventually discharged. It is also highly likely that discharges of chemicals (leaked or leached) resulted from other composite or manufactured items, whether machinery, plastic items, packaging, etc.

95. However, the volume and range of materials imported indicates that the chemical constituents of these materials are likely to be very similar to those utilised outside Malta, given that these are produced by companies have a wide European (if not global) market share. Identification of potential CECs in industrial use was carried out using data held by the International Chemical Secretariat[15], a non-profit organisation based in Sweden. A useful tool developed by this organisation is the SIN (Substitute It Now) list, which has been developed to help industry find safer substitutes to chemicals whose properties raise health or environmental concerns.

96. A range of chemicals widely used in the production of industrial materials were selected, by shortlisting those materials having production volumes in excess of 1000 tons annually, and which are consequently found in trace quantities across a wide range of products. It is considered likely that a proportion of these materials have been imported as part of the products described previously, and will exhibit behaviour similar to that of DEHP (a common plasticiser), which was encountered in stormwaters and inland surface waters. It is interesting to note that methylene chloride and aniline noted in statistics on imported materials were included in this list.

[15] https://chemsec.org/

97. Online data on industrial facilities regulated under the Integrated Pollution Prevention and Control (IPPC) regime were examined to determine whether these could be used to identify potential CECs. However, given that this provided data on only three pharmaceutical enterprises, such data was not considered to be representative of the risk posed by substances used in local industry. Furthermore, it was noted that such facilities tended to be those having increased regulatory scrutiny, and improved levels of chemical containment, reducing the potential for generation of CECs. Finally, the data provided online tended to be aggregated and generalised, not allowing for the meaningful identification of substances generally.

98. The following chemicals were added to the list on the basis of knowledge of their use in the local context:

- Titanium dioxide an imported item also used an additive in some pesticides
- 1,2-benzisotiazol-3(2H)-one, a solvent used in pesticides and industry
- Swimming pool treatment chemicals[16]: cyanuric acid, Bromochlorodim-ethylhydantoin, and Biguanide (the latter includes a wide range of potential formulations, and cannot be evaluated further without further examination).
- Solvents used in industry and noted as pesticide propellants: Benzisothiazolone
- Cyclohexanone, N-methyl-2-pyrolidone & propan-1,2-diol

[16] As permitted by Subsidiary Legislation 465.02 Swimming Pools Regulations

Shortlisting of candidate CECs

99. Consideration of the pollution sources and potential pathways allowed the identification of candidate CECs as described in the previous section on pollution sources. These substances were assigned into action categories following the methodology described in Dulio et al. (2013). This methodology is described as follows:

'Unlike other prioritisation methods, which aim simply to rank all candidate substances against one single prioritisation objective, the NORMAN method combines the ranking process with a prior allocation of the substances into action categories, which allows substances to be managed on the basis of the level of available information, thereby avoiding the exclusion of substances for which there are limited data.

The overall prioritisation procedure is carried out in two successive stages. In the first stage, the NORMAN prioritisation methodology uses a decision tree that classifies chemicals into six categories, based on identified ("categories" of) knowledge gaps and actions to be taken by the research community and public authorities to fill them. The second stage entails the prioritisation of the substances within each (action) category, on the basis of the criteria / indicators identified for each category.

The overall process is an iterative process that involves a periodic revision of the priority substances in each category whenever e.g. new information / more reliable data are generated or feedback from applied reduction measures is available.'

100. The scope of the exercise is to establish a list of CECs for the different water bodies present in Malta; caution is required when applying this methodology, to ensure relevance to the local situation. The data collection exercise raised the concern that data on local chemical consumption is limited, as is actual data on CECs in the Maltese context. The selection of CECs for further study and prioritisation was based on the documented use of these substances, and failing which, the probability of their occurrence based on the available data.

101. The limited baseline data available indicates that shortlists for monitoring need to focus on priorities for regular monitoring (Category 1 substances – see below for further definition). The second stage prioritisation described above is given in the following sections, but should only be considered as a preliminary exercise, where consideration of local socio-economic considerations (e.g. local priorities or usage patterns) should take precedence when formulating the actual monitoring programme.

102. The iterative nature of investigations into occurrence of CECs is critical to understanding of CEC behaviour in the local context. In this regard, a reliable baseline study is required to define basic patterns of occurrence and insight into the pollution pathways. The results of the baseline studies would then direct further monitoring effort considering (at minimum) the following criteria:

- spatial extent of CECs detected;
- temporal variations of the quantities of CECs detected;
- origins and pollution pathways of CECs; and
- review of the list of CECs to eliminate candidates not detected, and identify other plausible CECs.

Although the risks posed by CECs have importance, more attention is required at this point to actually understand the range of potential CECs, the pollution pathways followed, and the extent to which dilution will determine whether a potential CEC is actually detectable or otherwise.

103. Review of the available data on water quality pollution highlighted the need to gain further understanding as to how pollutant loads behave in the local context, in terms of their dispersion through the water bodies, particularly since there is the probability that CECs discharged may be rapidly diluted to the point where their concentration would be below the limits of quantification. A typical example are the data collected on Acesulpham K and Carbamazepine from groundwater; a meaningful monitoring programme on emerging CECs will need to address the following issues:

- Whether these substances are detected in other water bodies;
- The extent to which CECs move between water bodies (e.g. from wastewaters to groundwater) as may be implied by different concentration loads; and
- Whether similar CECs (in terms of chemical properties and/or origins) display the same behaviours when discharged at equivalent rates.

The above points will receive further consideration during the finalisation of the preliminary and final lists of CECs, as well as the formulation of the monitoring programme.

104. Furthermore, CECs may only be of significance in a localised area (e.g. particular catchment areas), or may not be as easily dispersed given their specific chemical behaviour (e.g. tendency to partition into another environmental medium, or rate of degradability). Similarly, this issue will be considered further during the formulation of the monitoring programme required by the next phase of the study.

Process of Prioritisation

105. The process of assignment into action categories as per Dulio et al. (2013) referred to previously involves the assessment of potential CECs listed during the data collection exercise against a number of criteria, and assignment into the following action categories that define the actions required with respect to the different candidate CECs:

Cat.	Action category	Current situation
1	Integration in routine monitoring and derivation of legally binding EQS	Sufficient evidence of exposure and adverse effects at environmental concentration
2	Screening studies for information about current exposure	Hazard assessment is based on experimental data BUT few monitoring data
3	Rigorous hazard assessment	Evidence of exposure BUT hazard assessment is based on predicted toxicity (P-PNEC)
4	Improvement of analytical methods required	Hazard assessment is based on experimental data BUT analytical capabilities not yet satisfactory
5	Screening studies AND rigorous hazard assessment	No or few monitoring data AND hazard assessment is based on predicted toxicity (P-PNEC)
6	Monitoring efforts for these compounds could be reduced	Toxicity data are sufficient for the derivation of an EQS and there is evidence that the exposure does not pose a hazard to ecosystems

Category 1 compounds are those most significant with respect to the formulation of a monitoring programme aimed at detecting CECs and devising remedial measures for pollution detected. Other categories address issues related to availability of ecotoxicological data in other member states, the need for further hazards assessments or testing methodologies.

106. The classification on action categories is based primarily:

- on the extent to which candidate CECs are monitored in different countries, and
- then on the degree to which such monitoring is deemed to be sufficient, and quantifiable in a relevant matrix.

Dulio et al. (2013) provides detailed instructions in the form of a decision tree as to the classification process, making reference to the need to evaluate whether there is sufficient data to determine whether testing regimes for CECs are available, or whether there is sufficient ecotoxicological data on substances.

107. Reference to monitoring data from other countries was made via reference to the NORMAN website[17], where NORMAN is a '*network of reference laboratories, research centres and related organisations for monitoring of emerging environmental substances*.' This website includes factsheets for different substances summarising the data on the different substances identified in the previous section of this study; the EMPODAT[18] database also includes monitoring datasets for the different substances. This data was used as a base reference for the assignment of the substances in different action categories.

108. Further prioritisation was carried out using the methodology described in Dulio *et al.* (2013), where the substances assigned into action categories are ranked to generate a final shortlist. The scoring system is defined in Dulio et al. (2013), but in brief consists of a summation of the following:

i. **Exposure**: where standard scores are assigned according to the following parameters:
   - frequency of detectable observation in different countries, sites and concentrations[19];
   - observation in groundwater; and
   - annual usage volumes and patterns[20].

ii. **Hazard**: where standard scores are assigned according to:
   - data on Persistence, Bioavailability and Toxicity according to data collected from the NORMAN database;
   - potential for long-range air transport[21]; and
   - Data on CMR & ED (see further below) or other known effect of CECs[22].

iii. **Risk**: which considered standard scores based on spatial frequency of exceedances and extent of exceedance of the lowest PNEC value[23].

[17] https://www.norman-network.com/
[18] https://www.norman-network.com/nds/empodat/
[19] Freshwater data was used in lieu of marine data when the latter was absent, given that the linkage between these two sources is considered to be strong in the local context (see risk assessments).
[20] To improve relevance, local usage patterns and volumes were derived on the basis of expert opinion or the data collected.
[21] To improve relevance, local usage patterns and volumes were used to assign a score. However, this score does not assess the potential for transport of CECs int the aqueous medium.
[22] The extent to which other known effects (e.g. on hatching, etc.) could be evaluated was typically limited.
[23] This information was derived from the NORMAN database when this was available, though the relevance of this data to the local context required careful consideration, and differences in data availability may skew results. However, given that such scores were typically low, this is not considered to be particularly significant with respect to the final findings. In any case, formulation of the monitoring programmes should include weighting derived from local socio-economic parameters and concerns.

109. The data used for scoring were those provided within the NORMAN databases referenced previously. Deviations from this methodology are described in the following sections describing the findings on different groups of CECs (or in the footnotes associated with the previous paragraphs). The different CECs (grouped in terms of origin) were kept separate, as their relevance with respect to different water bodies varies.

110. The prioritisation of candidate CECs involved assessment of the substances with respect to their characteristics in terms of their risk to human health and the environment. In this regard, the Excel sheet attached to this report details the scoring of the different substances with respect to the substance properties in terms of being carcinogenic, mutagenic or toxic for reproduction (CMR), or endocrine disruptors (ED); in this case, reference data used was that presented by the European Chemical agency (ECHA) on their website[24].

    It was noted that the prioritisation exercise tended to dilute the significance of the scores associated with CMR and ED properties; consequently, the monitoring programme shall ensure inclusion of the higher risk substances within the monitoring, on the basis of their socio-economic significance, and the probability of their occurrence in the local context. Notes on this issue are also included in the following sections on the shortlisting of substances.

111. It should be noted that further research in the literature is expected to refine further aspects of scoring of particular parameters (e.g. non-standard end-points), resulting in changes in action category and scoring value. As noted by Dulio et al. (2013), scoring '*is an iterative process that involves a periodic revision of the priority substances in each category whenever e.g. new information / more reliable data are generated or feedback from applied reduction measures is available.*'

112. Reference data on marine datasets was limited for a number of substances, data on occurrence of pollutants in rivers, lakes and other surface waters in Europe were considered instead. PNEC values for marine waters were used instead of freshwater ones, given that these tended generally to be ten times less in value; this was deemed to be the most appropriate approach when considering the potential effect of potential CECs on marine water bodies, particularly when considering the effect of transfers of terrestrial discharges and runoff into the marine waters, as documented in the section on pollution pathways leading to the marine environment.

[24] https://echa.europa.eu/home

Pharmaceuticals (Human Use)

113. The preliminary list of Pharmaceuticals considered includes the following substances as being those most widely consumed within Malta, as indicated by data collected by the Central Procurement Unit:

Table 3: candidate CECs selected on the basis of mass consumed in the local context.

Pharmaceutical	Mass active ingredient consumed
METFORMIN HYDROCHLORIDE	over 1000kg
PARACETAMOL	over 1000kg
ACETYLSALICYLIC ACID	over 100kg
GLICLAZIDE	over 100kg
MESALAZINE	over 100kg
VALSARTAN	over 100kg
VALPROATE SODIUM [EPILIM]	over 100kg
RANITIDINE	over 100kg
SULFASALAZINE	over 100kg
VALSARTAN	over 100kg
SIMVASTATIN	over 100kg
DIPYRIDAMOLE	over 100kg
OMEPRAZOLE	over 100kg
ATENOLOL	over 100kg
MESALAZINE	over 100kg
LEVETIRACETAM	over 50kg
ALLOPURINOL	over 50kg
CARBAMAZEPINE [TEGRETOL]	over 50kg
VENLAFAXINE	over 50kg
BEZAFIBRATE	over 50kg
ATORVASTATIN	over 50kg
FENOFIBRATE	over 50kg
VILDAGLIPTIN	over 50kg

It should be noted that the above values are only indicative of total consumption, as this reflects procurement by government agencies, and not by private entities.

114. Other pharmaceuticals added to the list were:

- Ibuprofen – not included in the list of most pharmaceuticals consumed, but a common antibiotic highlighted in discussions with stakeholders;
- Tamoxifen – a cancer treatment highlighted by stakeholders, where less than 5kg of active ingredient were consumed; and
- Methotrexate - a cancer treatment highlighted by stakeholders, where less than 1kg of active ingredient was consumed;
- Sulfamethoxazole – an antibiotic not included in the list of most pharmaceuticals consumed, on which no consumption data is available, but which was detected sporadically in groundwater as detailed previously;
- The hormones Progesterone, Estrone & diethylstilbestrol which are understood to be the active ingredients of various contraceptives.

115. The classification of **pharmaceuticals** selected previously into action categories is provided in Annex 5. It should be noted that the following substances were categorised as Action Category 1: Priority Regular Monitoring.

- Atenolol
- Bezafibrate
- Carbamazepine [Tegretol]
- Fenofibrate
- Ibuprofen
- Metformin Hydrochloride
- Ranitidine
- Simvastatin
- Sulfamethoxazole
- Valsartan
- Venlafaxine
- Estrone

It is pertinent to note that Tamoxifen and Methotrexate were not included in this action category given the limited extent of monitoring carried out in other countries and sites, and that there were no records of these substances being detected above the Limits of Quantification (LOQ).

116. All of the Priority 1 CECs listed for inclusion in the monitoring programme have been detected in their own right by monitoring programmes in other Member States. As yet, the priority list being generated for pharmaceuticals makes no reference to metabolites. As discussed previously with respect to Carbamazepine and Sulfamethoxazole (in the context of pollutants detected in groundwater), the various resultant metabolites of all Priority 1 CECs may potentially be included in the monitoring programme. However, it would be more productive to establish a wider range of CECs resulting from pharmaceutical consumption to establish a baseline, prior to evaluating whether more attention is required with respect to other pharmaceuticals discharged at lesser concentrations), as well as considering their eventual metabolites. As an interim measure, it may be useful to include some metabolites of Carbamazepine, given its extent of use and confirmed detection in the local context[25]. A useful selection would be 2-hydroxycarbamazepine, which has been studied to some extent in other countries.

117. Pharmaceuticals in other action categories have the potential to escalate to Priority 1 on further in-depth research, as indicated in the iterative approach required by Dulio et al. (2013). However, given that data on CECs in the local context with respect to Priority 1 pharmaceuticals is sparse, emphasis should be given to establishing a baseline to establish the direction required for further study.

118. This category of candidate CECs is expected to pose most risk to wastewaters, given that these are the direct receptors once these CECs have been eliminated from the human body. However, it is also expected that these will have a further effect on storm waters, inland surface waters, ground water and marine waters as per the pollution pathways described previously. Comparison between pollution loads noted between different water bodies are expected to provide useful insights in terms of the pollution pathways followed.

[25] Data on https://www.pharmgkb.org/, a website dedicated to pharmacogenomics knowledge resources, states that Carbamazepine metabolizes into the following:

- 2-hydroxycarbamazepine
- 2-hydroxyiminostilbene
- 3-hydroxycarbamazepine
- 3-hydroxycarbamazepine free radical
- carbamazepine 10,11-epoxide
- carbamazepine 2,3-epoxide
- carbamazepine catechol
- carbamazepine epoxide glucuronide
- carbamazepine glucuronide
- carbamazepine iminoquinone
- carbamazepine o-quinone
- dihydroxycarbazepine

119. Caution is required when interpreting data on the effects of CECs of pharmaceutical origins on human health and the environment. Generally, such compounds are selected on the basis of their effect on human physiology; the eventual effects of such pollutants in water bodies is less predictable, though it is arguable that such effects (whether the intended target of the pharmaceutical or its associated side-effects) would still persist. The potential range of possible outcomes and actual level of risk can be better evaluated once the concentrations of such CECs are understood.

120. CMR substances evaluated are Tamoxifen and Methotrexate, as are the various hormones listed previously. The latter, however, are not included as endocrine disruptors in the references quoted previously. This illustrates the level of caution required in interpreting scorings and references generally, as such hormones are expected to indeed have some level of endocrine effect on the wide range of potential receptors having different degrees of sensitivity. In this regard, socio-economic considerations shall be applied to give further weighting to such factors during the formulation of the monitoring strategy. This scenario also applies to the various substances investigated that were not formally listed as CMR or ED substances, but where descriptions of individual pharmaceuticals included caveats regarding potential risks.

121. Given that there may be practical restrictions in the extent to which monitoring of numerous substances can be carried out, prioritisation of the above is also provided in Annex 5, using the prioritisation methodology described previously. However, the monitoring programme that will be prepared will reconsider this prioritisation in terms of the monitoring strategy to be adopted, and apply further socio-economic considerations to refine the prioritisation.

Veterinary Pharmaceuticals

122. The preliminary list of Pharmaceuticals considered includes the following substances as being those most widely consumed within Malta, as indicated by data collected from the VPRD. Given that the range of veterinary pharmaceuticals is limited to 18 substances, all were evaluated as CECs and prioritised as per the methodologies described earlier.

123. Also assessed were the following chemicals, known to be active ingredients within disinfectants used within the animal husbandry industry:

- Benzenesulfonic acid
- P- Chloro-M-Cresol
- 2-Butoxyethanol

The insecticide fipronil was also considered here, given that it has the potential to follow the same pollution pathway from point of use to receptor water body.

124. The classification of veterinary pharmaceuticals and related chemicals into action categories is provided in Annex 6. It should be noted that the following substances were categorised as Action Category 1: Priority Regular Monitoring.

- Amoxicillin
- Enrofloxacin
- Lincomycin
- Tiamulin
- Tylosin
- Fipronil

Assumptions made for human pharmaceutical use also apply here, and extended with respect to extent of use given the lack of data available on local use.

125. Pharmaceuticals in other action categories have the potential to escalate to Priority 1 on further in-depth research, as indicated in the iterative approach required by Dulio et al. (2013). However, given that data on CECs in the local context with respect to Priority 1 pharmaceuticals is sparse, emphasis should be given to establishing a baseline to establish the direction required for further study.

126. This category of candidate CECs is expected to pose most risk to groundwaters and inland surface waters (and eventually coastal waters), given that these are the direct receptors once these CECs have been eliminated by the livestock, and processed within the cesspits. The main risk is expected to be posed by overflows and infrastructural leakages. However, given that connections of livestock farms to the sewerage system is not unknown, some effect on wastewater is expected. In this regard, comparison between pollution loads noted between different water bodies are expected to provide useful insights in terms of the pollution pathways followed.

127. Caution is required when interpreting data on the effects of CECs of veterinary pharmaceutical origins on human health and the environment. Generally, such compounds are selected on the basis of their effect on animal physiology; the eventual effects of such pollutants in water bodies is less predictable, though it is arguable that such effects (whether the intended target of the pharmaceutical, or its associated side-effects) would still persist. The plausible range of possible outcomes can be better evaluated once the concentrations of such CECs is understood.

128. While the various substances investigated were not formally listed as CMR substances, a wide range of pharmaceuticals included caveats regarding potential risks, illustrating the level of caution required in interpreting scorings and references generally. In this regard, socio-economic considerations shall be applied to give further weighting to such factors during the formulation of the monitoring strategy.

Agricultural Chemicals: Pesticides and Fertilisers

129. The preliminary list of pesticides focussed upon those where there were indications of frequent use in the local context as discussed previously. Also included were other pesticides previously encountered during monitoring in the local context. Also assessed were the following chemicals, known to be common ingredients within the pesticide formulations, as identified through examination of the pesticide Safety Data sheets:

    - 1,2,4-trimethyl benzene
    - Benzisothiazolone
    - cyclohexanone
    - **N-methyl-2-pyrolidone**
    - propan-1,2-diol

    It is interesting to note that of the substances listed above, only the highlighted substance has a formal CMR rating.

130. The classification of pesticides and related chemicals into action categories is provided in Annex 7. It should be noted that the following substances were categorised as Action Category 1: Priority Regular Monitoring.

    - Azoxystrobin
    - Chlorpyrifos-methyl
    - Deltamethrin
    - Dimethomorph
    - Glyphosate
    - Metabromuron
    - Metazachlor
    - Propamocarb
    - Fipronil
    - Imidacloprid
    - EDTA

    Assumptions made for human pharmaceutical use also apply here, and extended with respect to extent of use given the lack of data available on local use. Furthermore, it is observed that various compounds are under study, and include caveats regarding the potential effects on human health and the environment. In this regard, scorings related to such substances should be interpreted with caution.

131. Pesticides in other action categories have the potential to escalate to Priority 1 on further in-depth research, as indicated in the iterative approach required by Dulio et al. (2013). However, given that data on pesticide CECs in the local context is limited, emphasis should be given to establishing a baseline to establish the direction required for further study. Further attention is required with respect to consumption volumes and patterns of use at the local level, to ensure that monitoring effort is relevant to local requirements.

132. This category of candidate CECs is expected to pose most risk to groundwaters and inland surface waters (and eventually coastal waters), given that these are the direct receptors once these CECs have been deposited on the target crops and the ground.

Household Chemicals and Personal Care Products

133. The preliminary list of household chemicals and personal care products focussed upon those chemicals having a wide global application, and that would consequently be encountered with significant frequency in the local context. The classification of household chemicals and personal care products into action categories is provided in Annex 8. It should be noted that the following substances were categorised as Action Category 1: Priority Regular Monitoring.

- Styrene
- Triphenyl phosphate
- Galaxolide
- Tonalide
- Aniline
- Bisphenol A
- diethyl phthalate (DEP)
- Para-hydroxybenzoate

134. CECs in other action categories have the potential to escalate to Priority 1 on further in-depth research, as indicated in the iterative approach required by Dulio et al. (2013). However, given that data on CECs originating from personal care products and household chemicals is relatively limited in the local context, emphasis should be given to establishing a baseline to establish the direction required for further study. Further attention is required with respect to consumption volumes and patterns of use at the local level, to ensure that monitoring effort is relevant to local requirements.

135. The prioritisation sheet highlights various compounds investigated where the scoring with respect to CMR and ED indicates that these are suspected of having such properties, or are under investigation. Bisphenol A is highlighted as clearly having ED properties; it is likely that further study will allow further insight as to the extent to which suspected CMR and ED compounds have an actual effect. In this regard, given the paucity of local data on occurrence of such CECs, most emphasis should be given to establishing a clear baseline.

136. This category of candidate CECs is expected to pose most risk to wastewaters, groundwaters and inland surface waters (and eventually coastal waters), given that these are the direct receptors once these CECs have been discharged into the sewer, or rendered prone to leaching via exposure to the elements.

Chemicals used in Industry

137. The preliminary list of industrial chemicals and personal care products focussed upon those chemicals having a wide global application, and that would consequently be encountered with significant frequency in the local context. It is pertinent to note that there was some overlap with chemicals highlighted in the survey of importation data (methylene chloride and aniline), confirming that this list of chemicals has local relevance in terms of direct use of chemicals.

138. It was also noted that this list included the CECs identified as being significant constituents within personal care products, furniture and household chemicals. This serves to underscore the degree to which industrial production forms the basis of consumption of products generally, and the degree to which high-volume production of synthetic chemicals is integrated into industrial supply chains. Although industrial high-volume production of synthetics is not carried out in Malta, the risk of leachability of such materials from the product matrix remains, and is highlighted by the review of monitoring data available, where DEHP was detected from surface water bodies, as well as the various flame retardants, plasticisers and additives that were occasionally detected in groundwater as highlighted in Annex 4.

139. Also assessed were Bromochlorodim-ethylhydantoin and cyanuric acid, given their widespread use in swimming pools, and their potential for diffusion into water bodies following discharge from backwash of swimming pool filters. Substances detected during groundwater monitoring were also added so as to determine any trends associated with their presence or absence in further rounds of monitoring.

140. The classification of industrial chemicals into action categories is provided in Annex 9. It should be noted that the following substances were categorised as Action Category 1: Priority Regular Monitoring.

- tert-butyl methyl ether; MTBE
- N-butylbenzenesulphonamide
- DEHP
- tris-(2-Butoxyethyl)phosphate
- tris-(2-Chloroisopropyl)phospate
- Triisobutylphosphate
- Methylbenzotriazole
- Benzotriazole

141. CECs in other action categories have the potential to escalate to Priority 1 on further in-depth research, as indicated in the iterative approach required by Dulio et al. (2013). However, given that data on CECs originating from personal care products and household chemicals is relatively limited in the local context, emphasis should be given to establishing a baseline to establish the direction required for further study. Further attention is required with respect to consumption volumes and patterns of use at the local level, to ensure that monitoring effort is relevant to local requirements.

142. The prioritisation sheet highlights various compounds investigated where the scoring with respect to CMR and ED indicates that these are suspected of having such properties, or are under investigation. Phenol and tris-(2-Chloroisopropyl)phosphate are highlighted as clearly having CMR properties, while various other compounds have suspected ED and CMR properties. It is likely that further studies on the latter will allow further insight as to the extent to which suspected CMR and ED compounds have an actual effect. In this regard, given the paucity of local data on occurrence of such CECs in water bodies, most emphasis should be given to establishing a clear baseline.

143. This category of candidate CECs is expected to pose most risk to wastewaters, groundwaters and inland surface waters (and eventually coastal waters), given that these are the direct receptors once these CECs have been discharged into the sewer, or rendered prone to leaching via exposure to the elements.

Metals

144. The review of potential pollutants highlighted the following metals as meriting further investigation given their potential as CECs:

- Lead Pb as a contaminant frequently encountered in different media;
- Cadmium Cd as a potential CEC associated with certain fertilisers;
- Platinum, forming part of a range of cancer treating drugs;
- Titanium, antimony and arsenic, a wide variety of compounds being noted as being used in chemical formulations and industrial products generally, and that may be lost to the environment through a variety of pathways.

Lead and Cadmium are listed in Directive 2013/39/EC and hence may not need to be considered as CECs, further consideration is recommended with respect to the speciation of these species, given their regular presence in historic monitoring data, and the lack of clarity regarding the origin of these metals and their mobilisation int the water column. However, it is recognised that such speciation is technically challenging, and will require further consideration during the formulation of the monitoring programme. Furthermore, the full mapping of the mobilisation pathways through the various environmental media will require investigative approaches that are beyond the scope of this study.

145. Although various elements and compounds of the above are listed in the NORMAN databases, it has not been possible to trace their specific use during the data collection exercise e.g. wood or electronics treated with Arsenic trioxide do not have identifiers allowing their clear identification (let alone quantification). Consequently, the above will be examined in more detail during the formulation of the monitoring programme, where consultation will be held with laboratories to determine the feasibility of speciating the metals detected in the eventual monitoring programme.

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Annex 01: Workplan

ERA Tender Ref: GF/Admin/39/18

Consultancy on Contaminants of Emerging Concern:
Work Plan

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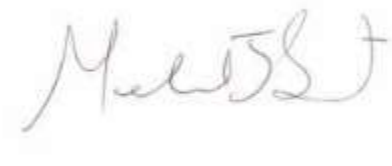

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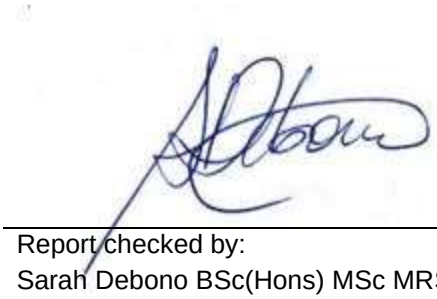

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Introduction

146. The term ‘emerging contaminants’ is generally used to refer to compounds previously not considered or known to be significant with respect to the environmental health of the various environmental media. The WFD (Water Framework Directive) requires that good chemical status of surface waterbodies is achieved by all member states of the European Union, providing a list of priority substances that are to be monitored and managed, and Environmental Quality Standards that are to be attained. In this regard, the European Commission is establishing a watch list of substances that is to be evaluated and monitored, to address the risks posed by chemicals arising from various anthropogenic activities.

147. The Environment and Resources Authority (ERA) has commissioned Ecoserv Ltd., in collaboration with @econsulting, through award of tender GF/Admin/39/18, to develop a Monitoring Strategy for Contaminants of Emerging Concern (CEC) In four (4) Water Categories. This study is part of a project funded by the LIFE Programme under the Project Policy Area LIFE Integrated Project Environment contributing to the achievement of the objectives of the Water Framework Directive. The Project’s reference and title are LIFE 16 IPE MT 008: *Optimising the implementation of the 2nd RBMP in the Malta River Basin District*, specifically *Action A.6 - Development of a monitoring strategy for contaminants of emerging concern.*

148. This report is one of the deliverables highlighted within the tender dossier within article 24:

    ‘A work plan outlining the approach to be adopted by the contractors to identify the indicator parameters (or contaminants of emerging concern) including stakeholders to be involved, data sources and methodologies to be employed in gathering the required data and information (to be delivered by Month 1 from the signature of the contract and formally approved by ERA).’

    This report is intended to satisfy tender requirements by:

    - Providing an outline of methodology to be employed;
    - List stakeholders to be involved; and
    - List data to be collected as required background material and project context.

149. Many emerging contaminants are unregulated, and in various cases unrecognized. Detection of such substances depends upon an understanding of the sources of the contaminants and the pathways through which the contaminants are introduced into the various environmental media.

150. It is understood that these terms of reference are to consider the following (amongst others):

    a. **contaminants pertaining to agriculture** – besides the typical pollutants such as pesticides and fertilizers, there is the need to consider other potential sources such as natural toxins, veterinary medicines, hormones and their metabolites, as well as residues or transformation products of man-made chemicals used in agriculture, ranging from plastics to disinfection products. Biological contaminants, such as bacteria and viruses, should also be considered.
    b. **contaminants pertaining to industry** – these include the wide range of chemicals used by industry as raw materials, together with the wastes and fugitive emissions that may eventually contaminate water bodies. An understanding of how local industries manage on-site waters and potential contamination pathways is key.
    c. **contaminants pertaining to medicine** – these include the wide range of substances emerging mainly from the pharmaceutical industry, as well as the biological materials (such as bacteria and viruses) that have the potential to contaminate water bodies.
    d. **contaminants pertaining to personal care products** – these are chemicals involved in the formulation of such products, including substances such as parabens, synthetic preservatives, phthalates, surfactants and fragrances. Microplastics is another area where further consideration is required.

151. It is also understood that, as highlighted in the Terms of Reference, the emerging contaminants shall be evaluated in the following categories of water bodies:

- **surface waters** as defined in the Water Framework Directive, and include the coastal, transitional and inland surface waters. Surface waters are analysed in detail in the 2nd Water Catchment Management Plan for the Malta Water Catchment District 2015 – 2021. All surface water bodies have been listed and characterized as per Water Framework Directive Article 5 Summary Reports for Surface Waters, which lists the various bodies and describes them in terms of geographic location and size. Data on catchment is also provided, together with a list of risks and pressures that affect these water bodies;
- **rainwater runoff** which in the local context consists of rainfall that is not absorbed by soils, but that is collected on the surface of saturated or impermeable areas, and eventually joins a flow of water that may or may not be channelled into a storm water collection system;
- **groundwater** as analysed in detail in the 2nd Water Catchment Management Plan for the Malta Water Catchment District 2015 – 2021, which describes the three main typologies of groundwater bodies found within the Maltese context:

  iv. Sea-level groundwater bodies developed in the Lower Coralline Limestone formation and take the form of freshwater lenses floating over seawater and referred locally as mean-sea-level aquifers (MSLAs). These are ubiquitous and occur extensively at sea level in Malta, Gozo and Comino.
  v. Unconfined (phreatic) perched groundwater bodies sustained in the Upper Coralline Limestone formation perched over the Blue Clay formation. The perched aquifers overlie, in western Malta and in Gozo, the sea-level aquifers. Perched aquifers are completely absent in central and eastern Malta where the UCL and the clay aquitard have been completely eroded.
  vi. Coastal groundwater bodies occurring in depressed valley areas within the Upper Coralline Limestone formation where the clay lies below sea level and freshwater is laterally bounded at its contact with seawater. These small aquifer systems occur at Pwales, Mellieha and Marfa.

- **new water** i.e. polished water following urban waste water treatment; the latter is a recent innovation managed by the Water Services Corporation, where water collected through the urban wastewaters collection system, and treated using reverse osmosis to be brought to a standard where it can be put to alternative use, mainly in the agricultural context or aquifer recharge.

152. The above is only a cursory overview that would need to be amplified further. Other sources that require consideration are – amongst others – urban infrastructure (including the road network), domestic water mis/management, and waste treatment. It is also critical to consider different scenarios which may result in generation or mobilization of contaminants of emerging concern:

- Chemicals for which analytical methods are available, where reference values are available, but have not necessarily been studied locally;
- Chemicals used historically, but are only now being recognized as contaminants of emerging concern;
- Chemicals that are regularly used in industry, but where risks of pollution have not been systematically mapped, or are still in the process of being recognized;
- Chemicals that have a seasonal use;
- Whether chemicals are persistent, or have different rates of degradation, of whether the degradation products pose a risk in their own right.

The overview of selected sectors above already highlights that the contaminants of concern that are shortlisted for monitoring will need to be classified according to:

- Individual chemicals e.g. specific pesticides or pharmaceuticals
- Chemical family or group e.g. parabens, phthalates, etc.
- Origin or taxonomic affinity in the case of contaminants of biological origin

Each of the sectors highlighted above is associated with various processes that tend to be sector specific (e.g. processes related to animal husbandry in agriculture; processes related to handling of chemicals in industry). High level mapping of material flows will be carried out to establish the potential linkages between the various sectors, and sector specific processes, to define linkages between sources of potential pollutants (and where possible, potential by-products) and the receptor water bodies.

Methodology

153. **Outline of the methodology to be employed**: the identification of contaminants of emerging concern shall follow the process highlighted in the NORMAN prioritisation framework for emerging substances, as highlighted in Dulio V, von der Ohe PC (2013) *NORMAN prioritisation framework for emerging substances.* NORMAN Association, Verneuil-en-Halatte. ISBN 978-2-9545254-0-2 17. The first step required involves the definition of an initial list of candidate substances as indicated below.

154. Deriving an initial list for candidate substances for prioritisation shall include:

A. A top down approach where data mining in the literature is carried out to identify specific contaminants that have been highlighted elsewhere, and that should be considered in the local context. In this regard, reference shall be made to various databases, the scientific literature, and in particular the data held by the NORMAN network, which is active in the field of exchange of information on emerging environmental substances of concern.
B. Consideration of data collected from relevant stakeholders.
C. A review of high-level material flows of materials currently present and handled within Malta, to identify plausible sources of contamination, and assess the possibility of their role with respect to emission or leaching of contaminants of emerging concern.

This combined approach is considered essential given that datasets are incomplete, the number of potential substances too large for systematic examination in certain circumstances (e.g. pharmaceuticals and the resultant metabolites), and others (such as flame retardants) emanate from a range of products (such as furniture, electronics) are not included in any systematic database.

155. Further prioritisation will follow the methodology described in Dulio *et al.* (2013), where the substances are assigned into action categories as defined within the same paper, followed by ranking of the substances within each action category, to generate a final shortlist for review. Should any deviations from this methodology be found to be necessary, these will be described and justified as appropriate. However, the overall criteria for selection will consider:

- Known presence or absence of potential CECs in the Maltese context (i.e. through production and/or use, and usage patterns), based on data collected, and expert judgement in the absence of data; and
- The environmental and health hazard risks posed by the various substances, in relation to the indicated, expected or potential abundance of the substance occurrence, making reference to data emanating from the requirements of Regulation (EC) No 1272/2008 on the classification, labelling and packaging of substances and mixtures (CLP Regulation).

Knowledge of by-products of parent compounds must be based on data held in the NORMAN network. Alternatively, data in the literature (i.e. case histories with comparable scenarios) will be used where available.

156. Environmental and health risk assessment will require assessment of CEC candidates to their status as actual or potential substances of very high concern (SVHCs):

- Substances meeting the criteria for classification as carcinogenic, mutagenic or toxic for reproduction (CMR) category 1A or 1B in accordance with the CLP Regulation.
- Substances which are persistent, bioaccumulative and toxic (PBT) or very persistent and very bioaccumulative (vPvB) according to REACH Annex XIII.
- Substances on a case-by-case basis, that cause an equivalent level of concern as CMR or PBT/vPvB substances.

Assessment will also require an evaluation of the known behaviour of the various substances in the natural environment, to determine the extent of significance of the presence of that substance, and to facilitate their ranking and prioritisation.

157. In parallel, monitoring data and other available literature regarding water quality will then be reviewed to provide a context to the list generated above, to highlight existing pollution pathways that may be followed by the CECs that are identified in the above exercise. This data would include those datasets and reports held by the following:

- Environment and Resources Authority
- Water Services Corporation
- Malta Resources Authority

This data should include data collected through monitoring exercises, as well as relevant data collected through permitting, and/or other projects.

158. The above exercise will be used to identify potential pollution pathways that would affect water bodies, and evaluate the levels of risk posed by contaminants to the various water resources. This would in turn generate a shortlist of chemical parameters for each water body, that would consist of the most likely CECs that should be investigated with priority.

Stakeholders & Timeline

159. **Stakeholders:** The main entities involved in the importation, regulation or monitoring of substances that may contain contaminants of emerging concern are:

- **Customs Department**: importation data, list of chemical and products imported into Malta
- **Malta Competition and Consumer Affairs Authority**: the competent authority responsible for the REACH directive (on chemicals), cosmetics, pesticides and fertilizers
- **Water Services Corporation**: holds data on drinking water quality, data on sewerage (treatment and chemical composition)
- **Energy and Water Agency**: holds data on priority pollutants in groundwater bodies
- **Pesticides Control Board**: holds data on pesticide use
- **Agriculture Department**: holds data on fertilizer use
- **Veterinary Regulation Directorate**: holds data on chemical and pharmaceutical use in animal husbandry
- **Department of Environmental Health**: data on communicable diseases resulting from vectors of disease that are water-borne
- **Medicines Authority**: data on pharmaceuticals used in Malta
- **National Antibiotic Committee**: holds data on antibiotic use in Malta
- **Environment and Resources Authority**: holds data on wastes and environmental permits
- **Ministry for Transport, Infrastructure and Capital Projects**: holds data on urban runoff.

The above all contribute data to the National Statistics Office.

160. The above exercise is projected to follow the timeline indicated below:

Item	Description	Month (from signing contract*)										
		1	2	3	4	5	6	7	8	9	10	11
1	Finalization of workplan – submission to ERA (Result 1a)**											
2	Desk study on contaminants of emerging concern											
3	Collection of data from authorities											
4	Consultation meetings with authorities to discuss data gaps and identify concerns											
5	Risk assessment											
6	Shortlisting of selected chemicals of concern											
7	Report on shortlisted chemicals – submission to ERA (Result 1b)											
8	Collection of data on required laboratory & sampling techniques, and consideration of feasibility											
9	Report on the proposed monitoring strategy and programme for the contaminants of emerging concern – submission to ERA (Result 2)											
10	Finalisation of Report / clarification of any outstanding comments.											

* Contract signed in May 2019
**Workplan approved 30th July 2019

Annex 02: Common Nomenclature (CN) chapter codes

2-Digit CN	Commodity description	Risk with respect to CECs
01	Live animals	See section on Veterinary Pharmaceuticals
02	Meat and edible offal	Low risk
03	Fish and crustaceans, etc.	Low risk
04	Dairy produce; birds' eggs	Low risk
05	Products of animal origin	Low risk
06	Live trees and plants	Low risk
07	Edible vegetables	Low risk
08	Edible fruit and nuts	Low risk
09	Coffee, tea, mate and spices	Low risk
10	Cereals	Low risk
11	Milling industry products	Low risk
12	Oil seeds, oleag. fruits	Low risk
13	Lac; gums, resins etc.	Low risk
14	Vegetable plaiting products	Low risk
15	Animal/vegetable fats/oil	Low risk
16	Preparations of meat/fish	Low risk
17	Sugars and sugar confectionary	Low risk
18	Cocoa and cocoa preparations	Low risk
19	Preparations of cereals	Low risk
20	Preparations of vegetables, fruit and nuts	Low risk
21	Miscellaneous edible preparations	Low risk
22	Beverages, spirits and vinegar	Low risk
23	Food residues and waste	Low risk
24	Tobacco and manufactured tobacco substitutes	Low risk
25	Salt/sulphur/earths/plastering materials and cement	Potential CECs?
26	Ores, slag and ash	Potential CECs?
27	Mineral fuels, oils and products	Potential CECs?

28	Inorganic chemicals and compounds	Potential CECs?
29	Organic chemicals	Potential CECs?
30	Pharmaceutical products	Potential CECs?
31	Fertilisers	Potential CECs?
32	Tanning/dyeing extracts and paints	Potential CECs?
33	Essential oils and toilet preparations	Potential CECs?
34	Soap, etc, lubricants, waxes, dental preparations	Potential CECs?
35	Albuminoidal substances	Potential CECs?
36	Explosives/pyrotechnic	Potential CECs?
37	Photographic/cinema	Potential CECs?
38	Miscellaneous chemical products	Potential CECs?
39	Plastics and articles of plastics	Potential CECs?
40	Rubber and articles of rubber	Potential CECs?
41	Raw hides and skins (excluding fur skins) and leather	Natural products – chemically treated?
42	Articles of leather; saddlery	Natural products – chemically treated?
43	Fur skins and artificial fur; manufactures thereof	Natural products – chemically treated?
44	Wood and articles of wood; wood charcoal	Natural products – chemically treated?
45	Cork and articles of cork	Natural products – chemically treated?
46	Manufactures of straw, etc.	Natural products – chemically treated?
47	Pulp of wood, etc.; paper waste	Natural products – chemically treated?
48	Paper and paperboard articles	Natural products – chemically treated?
49	Printed books, newspapers	Natural products – chemically treated?
50	Silk	Natural products – chemically treated?
51	Woven fabric of wool/fine animal hair	Natural products – chemically treated?
52	Cotton	Natural products – chemically treated?
53	Other vegetable textile fibres	Natural products – chemically treated?
54	Man-made filaments	Chemical synthetics
55	Man-made staple fibres	Chemical synthetics
56	Wadding, felt and nonwovens	Chemical synthetics
57	Carpets and other textile floor coverings	Chemical synthetics
58	Special woven fabrics	Chemical synthetics

59	Impregnated/coated/laminated textile fabrics	Chemical synthetics
60	Knitted/crocheted fabrics	Chemical synthetics
61	Knitted clothing	Chemical synthetics
62	Woven clothing	Chemical synthetics
63	Made up textile articles	Chemical synthetics
64	Footwear, gaiters etc.and parts	Chemical synthetics
65	Headgear and parts thereof	Chemical synthetics
66	Umbrellas, sun umbrellas and parts	Chemical synthetics
67	Prepared feathers/down articles	Chemical synthetics
68	Articles of stone/plaster/cement etc.	Chemical synthetics
69	Ceramic products	Chemical synthetics
70	Glass and glassware	Chemical synthetics
71	Pearls, precious stones/metals and imitation jewellery	Chemical synthetics
72	Iron and steel	Chemical synthetics
73	Articles of iron or steel	Raw materials and related items
74	Copper and articles thereof	Raw materials and related items
75	Nickel and articles thereof	Raw materials and related items
76	Aluminium and articles thereof	Raw materials and related items
78	Lead and articles thereof	Raw materials and related items
79	Zinc and articles thereof	Raw materials and related items
80	Tin and articles thereof	Raw materials and related items
81	Other base metals/cermets and articles thereof	Raw materials and related items
82	Tools, implements/cutlery etc.,parts	Manufactured composite items
83	Miscellaneous articles of base metal	Manufactured composite items
84	Machinery and mechanical appliances	Manufactured composite items
85	Electrical machinery etc.	Manufactured composite items
86	Railway locomotives,etc., parts	Manufactured composite items
87	Vehicles (excluding trains) and parts thereof	Manufactured composite items
88	Aircraft/spacecraft and parts thereof	Manufactured composite items
89	Ships, boats and floating structures	Manufactured composite items
90	Optical/photographic/cinematographic instruments	Manufactured composite items
91	Clocks and watches/parts	Manufactured composite items
92	Musical instruments and parts thereof	Manufactured composite items
93	Arms and ammunition and parts thereof	Manufactured composite items
94	Furniture; bedding, etc.	Manufactured composite items
95	Toys, games and sports requisites	Manufactured composite items

96	Miscellaneous manufactured articles	Manufactured composite items
97	Works of art, collector's pieces and antiques	Manufactured composite items
98	Complete industrial plant	Manufactured composite items
99	Special classifications	Personal items, ship & aircraft stores, items for offshore installations or low value items.

Annex 03: Risks posed by CECs to the various water bodies.

Table 1: Assessment of risks posed by CECs from various sources to waters in the sewerage network, taking into account pollution pathway, and the spatial and temporal extent of such risk.

Sewers	Pathway	Linkage	Spatial & Temporal Extent of Expected Risk	Risk posed by CECs	Category of CECs expected	Risk Evaluation
URBAN						
Roads	No	Linkage would be irregular	Specific to site, and subject to enforcement where detected	Low	None in substantial volumes	While the risks posed here cannot be discounted, these are expected to be specific to the site where such irregular connections are detected.
Residential	Yes	Direct	Generally across the island, consistent flow	High	Household chemicals, personal care products, pharmaceuticals	Volumes of household chemicals and personal care products used is appreciable. Main route for pharmaceutical contamination.
Industry/Commercial	Yes	Direct	In industrial areas, consistent flow	High	Wide range of chemicals used in industry	High volume and variety of chemicals used. However, risks here is dependent on the extent to which the use of chemicals is contained and consistent with regulatory requirements.
RURAL						
Agriculture	No	No formal linkage	Specific to site, and subject to enforcement where detected	Low	None in substantial volumes	While the risks posed here cannot be discounted, these are expected to be specific to the site where such irregular discharges are detected.
Animal Husbandry	Yes	Intermittent, depending on farm	Typically in rural areas	High	Cleaning agents, pharmaceutical products	The types of connections between farms and sewerage systems is currently under review. However, these connections - direct or indirect - have been active for an appreciable period, and are in the process of being phased out.

Table 2: Assessment of risks posed by CECs from various sources to storm waters, taking into account pollution pathway, and the spatial and temporal extent of such risk.

Storm Waters	Pathway	Linkage	Spatial & Temporal Extent of Expected Risk	Risk posed by CECs	Category of CECs expected	Risk Evaluation
URBAN						
Roads	Yes	Direct	Across road network, rainy season, particularly first flush	High	Substances used in vehicle construction, operation and maintenance	The risk here is deemed high given the signficant local traffic volumes and extensive road network.
Residential	Yes	Direct	Mainly in residential areas	High	Household chemicals	Volumes of household chemicals and used is appreciable. This is a risk when such chemicals are used in outdoor areas where containment is not available e.g. floor and vehicle washings.
Industry/Commercial	Yes	Direct	In industrial areas, consistent flow	High	Chemicals used in industry	High volume and variety of chemicals used. However, risks here is dependent on the extent to which the use of chemicals is contained and consistent with regulatory requirements.
RURAL						
Agriculture	Yes	Direct	Agricultural areas, rainy season	High	Fertilisers, pesticides	These are mainly expected to be signficant during the first rains, or where application coincides with application.
Animal Husbandry	Yes	Intermittent, depending on farm	Site specific, typically in rural areas	High	Cleaning agents, pharmaceutical products	The types of connections between farms and sewerage systems is currently under review. However, these connections -direct or indirect - have been active for an appreciable period, and are in the process of being phased out.

Table 3: Assessment of risks posed by CECs from various sources to watercourses, taking into account pollution pathway, and the spatial and temporal extent of such risk.

Water courses	Pathway	Linkage	Spatial & Temporal Extent of Expected Risk	Risk posed by CECs	Category of CECs expected	Risk Evaluation
URBAN						
Roads	Yes	Via storm waters	Dependent on extent of catchment area	High	Substances used in vehicle construction, operation and maintenance	The risk here is deemed high given the signficant local traffic volumes and extensive road network.
Residential	Yes	Via storm waters	Dependent on extent of catchment area	High	Household chemicals	Volumes of household chemicals and used is appreciable. This is a risk when such chemicals are used in outdoor areas where containment is not available e.g. floor and vehicle washings.
Industry/Commercial	Yes	Via storm waters	Dependent on extent of catchment area	High	Chemicals used in industry	High volume and variety of chemicals used. However, risks here is dependent on the extent to which the use of chemicals is contained and consistent with regulatory requirements.
RURAL						
Agriculture	Yes	Via storm waters, percolation	Agricultural areas, rainy season	High	Fertilisers, pesticides	These are mainly expected to be signficant during the first rains, or where application coincides with application.
Animal Husbandry	Yes	Via storm waters	Site specific, typically in rural areas	High	Cleaning agents, pharmaceutical products	The types of connections between farms and sewerage systems is currently under review. However, these connections -direct or indirect - have been active for an appreciable period, and are in the process of being phased out.

Table 4: Assessment of risks posed by CECs from various sources to new waters, taking into account pollution pathway, and the spatial and temporal extent of such risk.

New Waters	Pathway	Linkage	Spatial & Temporal Extent of Expected Risk	Risk posed by CECs	Category of CECs expected	Risk Evaluation
URBAN						
Roads	No	None	None	Low		
Residential	Yes	Indirect via sewerage	At point of production of new water, consistent	High	Household chemicals, personal care products, pharmaceuticals	Volumes of household chemicals and personal care products used is appreciable. Main route for pharmaceutical contamination.
Industry/Commercial	Yes	Indirect via sewerage	At point of production of new water, consistent	High	Chemicals used in industry	High volume and variety of chemicals used. However, risks here is dependent on the extent to which the use of chemicals is contained and consistent with regulatory requirements.
RURAL						
Agriculture	No	None	None	Low	None	
Animal Husbandry	Yes	Intermittent, depending on farm	Typically in rural areas	High	Cleaning agents, pharmaceutical products	

Table 5: Assessment of risks posed by CECs from various land based sources sources to marine waters, taking into account pollution pathway, and the spatial and temporal extent of such risk.

Marine Waters	Pathway	Linkage	Spatial & Temporal Extent of Expected Risk	Risk posed by CECs	Category of CECs expected	Risk Evaluation
URBAN						
Roads	Yes	Via storm waters	Dependent on extent of catchment area	High	Substances used in vehicle construction, operation and maintenance	The risk here is deemed high given the signficant local traffic volumes and extensive road network.
Residential	Yes	Via storm waters	Dependent on extent of catchment area	High	Household chemicals	Volumes of household chemicals and used is appreciable. This is a risk when such chemicals are used in outdoor areas where containment is not available e.g. floor and vehicle washings.
Industry/Commercial	Yes	Via storm waters	Dependent on extent of catchment area	High	Chemicals used in industry	High volume and variety of chemicals used. However, risks here is dependent on the extent to which the use of chemicals is contained and consistent with regulatory requirements.
RURAL						
Agriculture	Yes	Via storm waters	Agricultural areas, rainy season	High	Fertilisers, pesticides	These are mainly expected to be signficant during the first rains, or where application coincides with application.
Animal Husbandry	Yes	Via storm waters	Site specific, typically in rural areas	High	Cleaning agents, pharmaceutical products	The types of connections between farms and sewerage systems is currently under review. However, these connections -direct or indirect - have been active for an appreciable period, and are in the process of being phased out.

Table 6: Assessment of risks posed by CECs from various sources to ground water, taking into account pollution pathway, and the spatial and temporal extent of such risk.

Ground Water	Pathway	Linkage	Spatial & Temporal Extent of Expected Risk	Risk posed by CECs	Category of CECs expected	Risk Evaluation
URBAN						
Roads	Yes	Via storm waters that are not contained and percolate to ground water	Dependent on extent of catchment area	High	Substances used in vehicle construction, operation and maintenance	The risk here is deemed high given the signficant local traffic volumes and extensive road network.
Residential	Yes	Via storm waters that are not contained and percolate to ground water; via sewage leaks	Dependent on extent of catchment area	High	Household chemicals	Volumes of household chemicals and used is appreciable. This is a risk when such chemicals are used in outdoor areas where containment is not available e.g. floor and vehicle washings.
Industry/Commercial	Yes	Via storm waters that are not contained and percolate to ground water; via sewage leaks	Dependent on extent of catchment area	High	Chemicals used in industry	High volume and variety of chemicals used. However, risks here is dependent on the extent to which the use of chemicals is contained and consistent with regulatory requirements.
RURAL						
Agriculture	Yes	Direct percolation to ground water, via storm waters	Agricultural areas, rainy season	High	Fertilisers, pesticides	These are mainly expected to be signficant during the first rains, or where application coincides with application.
Animal Husbandry	Yes	Direct percolation to ground water, via storm waters	Site specific, typically in rural areas	High	Cleaning agents, pharmaceutical products	This is expected to vary depending on the degree of containment found on farms, both on external areas and the integrity of cesspit systems.

Annex 04: Summary of Substances detected in groundwater during the 2016 Surveillance Monitoring

Groundwater Chemical Parameters studied	Observations
ELEMENTS & SALTS	
Calcium mg/L Ca	Of geological origin
Magnesium mg/L Mg	Of geological origin
Chlorides mg/L	Elevated levels at various sampling points highlighting saline intrusion, or reception of briny discharge.
Nitrates mg/L	Elevated levels at various points; likely receptors of agricultural irrigation enriched with nitrate fertilisers.
Hydrogen Sulphide µg/L	Detected at various points; potentially due to decomposition of sulphates through reduction, or contamination by sewage.
Potassium mg/L	Elevated levels at various points generally correlated with nitrates; likely receptors of agricultural irrigation enriched with NPK fertilisers.
Sodium mg/L	Elevated levels at various sampling points highlighting saline intrusion, or reception of briny discharge; generally correlated with chlorides.
Ammonia mg/L	Typically below detection limits in most samples, detected only towards the north of Malta
Fluorides mg/L	Detected at various points, generally at a concentration having an order of magnitude consistent with that of drinking water.
Iron mg/L	Detected at limited concentration at various localities.
Silica mg/L	Detected at limited concentration at various localities.
Nitrites mg/L	Generally below detection limits; detected at very low concentration at few localities.
Total Phosphorus mg/L	Detected at various points generally correlated with nitrates and orthophosphates; likely receptors of agricultural irrigation enriched with NPK fertilisers, sewage, or naturally occurring.
Orthophosphates mg/L	Detected at various points; likely receptors of agricultural irrigation enriched with NPK fertilisers, sewage, or naturally occurring.

Sulphates mg/L	Detected at various points across the island at various concentrations; sulphate formation generally part of the natural sulphur cycle, though input from anthropogenic sources is possible, particularly from copper sulphate-based pesticide treatments ('Bordeaux mix').
Boron mg/L	Elevated levels detected; possible uses various including fertilisers, personal care products.
Copper µg/L	Below detection limit
Zinc µg/L	Detected at different concentrations in different areas; possibly due to slow erosion of sacrificial anodes and galvanised metal.
Arsenic µg/L	Occasionally detected
Lead µg/L	Detected at Naxxar
Aluminium µg/L	Detected at Ghajn Tuffieha, Wied Busbies
Chromium µg/L	Occasionally detected
Manganese µg/L	Occasionally detected
Nickel µg/L	Occasionally detected
Selenium µg/L	Occasionally detected
Cadmium µg/L	Consistently below detection limits
Antimony µg/L	Occasionally detected
Mercury µg/L	Detected at Tal Balal
TOTAL COLIFORMS	
E.coli	Occasionally detected
FAECAL STREPTOCOCCI	Occasionally detected
TOTAL BACTERIAL COUNT	Occasionally detected
TOTAL BACTERIAL COUNT	Occasionally detected
PESTICIDES & HERBICIDES	
Isoproturon ng/l	Not detected
Diuron ng/l	Occasionally detected
Heptachlor ng/l	Not detected
Chlorpyrifos ng/l	Occasionally detected
Heptachlor epoxide B ng/l	Not detected
Aldrin ng/l	Occasionally detected
Isodrin ng/l	Not detected
Dieldrin ng/l	Occasionally detected
Endrin ng/l	Not detected
Bentazone ng/l	Not detected
N,N- Diethyl-meta-toluamide ng/l	Detected once at Tal-Palma
MCPA ng/l	Not detected

Glyphosate ng/l	Detected once at Qammieh
AMPA ng/l	Not detected
Tecnazene µg/L	below detection limit
Hexachlorobenzene µg/L	below detection limit
Trifluralin µg/L	below detection limit
alpha-Hexachlorocyclohexane (HCH / Lindane) µg/L	occasionally detected
Quintozene (PCNB) µg/L	below detection limit
Triallate µg/L	below detection limit
gamma-Hexachlorocyclohexane (HCH / Lindane) µg/L	occasionally detected
Heptachlor µg/L	below detection limit
Aldrin µg/L	below detection limit
Chlorothalonil µg/L	occasionally detected
beta-Hexachlorocyclohexane (HCH / Lindane) µg/L	below detection limit
Telodrin µg/L	below detection limit
Isodrin µg/L	below detection limit
Heptachlor epoxide µg/L	below detection limit
Triadimefon µg/L	below detection limit
Pendimethalin µg/L	below detection limit
o,p-DDE µg/L	below detection limit
Endosulphan I µg/L	below detection limit
Trans-chlordane µg/L	below detection limit
cis-Chlordane µg/L	below detection limit
p,p-DDE µg/L	below detection limit
Dieldrin µg/L	below detection limit
o,p-TDE (DDD) µg/L	below detection limit
Endrin µg/L	below detection limit
o,p-DDT µg/L	below detection limit
p,p-TDE (DDD) µg/L	below detection limit
Ethion µg/L	below detection limit
Endosulphan II µg/L	below detection limit
p,p-DDT µg/L	below detection limit
o,p-Methoxychlor µg/L	below detection limit
p,p-Methoxychlor µg/L	below detection limit
Endosulphan sulphate µg/L	below detection limit
Permethrin I µg/L	below detection limit
Permethrin II µg/L	below detection limit

PAHs	
Napthalene ng/l	Regularly detected
Acenaphtene ng/l	Regularly detected
Fluorene ng/l	Regularly detected
Acenaphtylene ng/l	Regularly detected
Phenantrene ng/l	Regularly detected
Anthracene ng/l	Regularly detected
Fluoranthene ng/l	Regularly detected
Pyrene ng/l	Regularly detected
Benzo(a)anthracene ng/l	Regularly detected
Chrysene ng/l	Regularly detected
Benzo(b)fluoranthene ng/l	Regularly detected
Benzo(k)fluoranthene ng/l	Regularly detected
Benzo(a)pyrene ng/l	Regularly detected
Indeno (1,2,3-cd) pyrene ng/l	Regularly detected
Benzo(g,h,i)perylene ng/l	Regularly detected
Dibenzo(a,h)anthracene ng/l	Regularly detected
Sum of PAHs ng/l	Regularly detected
THMs (trihalomethanes)	
1,2- dichloroethane ng/l	Not detected
Benzene ng/l	Occasionally detected
Trichloroethylene ng/l	Occasionally detected
Tetrachloroethylene ng/l	Occasionally detected
Trichloromethane ng/l	Occasionally detected
Bromodichloromethane ng/l	Not detected
Dibromochloromethane ng/l	Occasionally detected
Tribromomethane ng/l	Occasionally detected
Total THMs ng/l	Occasionally detected
PHARMACEUTICALS /NUTRACUETICALS	
Venlafaxine ng/l	Not detected
Codeine ng/l	Not detected
Sulfamethoxazole ng/l	Occasionally detected
Carbamezapine ng/l	Occasionally detected
Acesulfam k ng/l	Occasionally detected
Sucralose ng/l	Occasionally detected
Caffeine ng/l	Occasionally detected

FLAME RETARTDANTS, PLASTICISERS, ADDITIVES	
tris-(2-Butoxyethyl)phosphate ng/l	Occasionally detected
tris-(2-Chloroisopropyl)phospate ng/l	Occasionally detected
Triphenylphosphate ng/l	Occasionally detected
Triisobutylphosphate ng/l	Occasionally detected
Phenol ng/l	Occasionally detected
Methylbenzotriazole ng/l	Occasionally detected
Benzotriazole ng/l	Occasionally detected

Annex 05: Pharmaceuticals

Name	Countries monitored	Number of sites monitored	Monitoring results greater than LOQ	Recent data (last 6 years)	LOQmax< PNEC (existing data in EMPODAT)	Action Category
Acetylsalicylic Acid	4	188	11	yes	n/a	Cat 3: action ecotox
Allopurinol	2	3	0	yes	n/a	Cat 4: Action analytical
Atenolol	16	659	1894	yes	yes	Cat 1: Priority Regular monitoring
Atorvastatin	2	33	0	yes	yes	Cat 2: Watch list
Bezafibrate	19	738	1360	yes	yes	Cat 1: Priority Regular monitoring
Carbamazepine [Tegretol]	20	1930	207507	yes	yes	Cat 1: Priority Regular monitoring
Dipyridamole	2	33	0	yes	n/a	Cat 4: Action analytical
Fenofibrate	14	7050	140	yes	Yes	Cat 1: Priority Regular monitoring
Gliclazide	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
Ibuprofen	21	2659	4940	yes	n/a	Cat 1: Priority Regular monitoring
Levetiracetam	2	33	0	yes	n/a	Cat 4: Action analytical
Mesalazine - 5-amino salicyclic acid	2	33	0	yes	n/a	Cat 4: Action analytical
Metformin Hydrochloride	15	605	2310	yes	yes	Cat 1: Priority Regular monitoring
Methotrexate	2	33	0	yes	n/a	Cat 4: Action analytical
Omeprazole	3	189	0	yes	n/a	Cat 4: Action analytical

Paracetamol	9	200	995	yes	n/a	Cat 3: action ecotox
Ranitidine	14	314	77	yes	yes	Cat 1: Priority Regular monitoring
Simvastatin	5	230	26	yes	yes	Cat 1: Priority Regular monitoring
Sulfamethoxazole	19	1774	3936	yes	yes	Cat 1: Priority Regular monitoring
Sulfasalazine	2	33	0	yes	n/a	Cat 4: Action analytical
Tamoxifen	9	55	0	yes	n/a	Cat 2: Watch list
Valproate Sodium [Eplim]	11	45	12	yes	yes	Cat 2: Watch list
Valsartan	14	249	473	yes	yes	Cat 1: Priority Regular monitoring
Venlafaxine	14	208	256	yes	yes	Cat 1: Priority Regular monitoring
Vildagliptin	2	33	0	yes	n/a	Cat 4: Action analytical
Progesterone	8	55	0	yes	n/a	Cat 4: Action analytical
Estrone	16	1136	261	yes	yes	Cat 1: Priority Regular monitoring
Estradiol - local occurrence insuficiently speciated						
diethylstilbestrol	2	610	6	yes	yes	Cat 2: Watch list

Annex 06: Veterinary Pharmaceuticals

Name	Origin	Countries monitored	Sites analysed	Results greater than LOQ	Recent data (last 6 years)	LOQmax < PNEC (existing data in EMPODAT)	Action Category
Lincomycin	Vet. Pharmaceutical	14	232	21	yes	yes	Cat 1: Priority Regular Monitoring
Amoxicillin	Vet. Pharmaceutical	14	307	68	yes	yes	Cat 1: Priority Regular Monitoring
Enrofloxacin	Vet. Pharmaceutical	16	285	31	yes	yes	Cat 1: Priority Regular Monitoring
Fipronil	Pesticide	15	1756	574	yes	yes	Cat 1: Priority Regular Monitoring
P- Chloro-M-Cresol	Vet. Disnfectant	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
Cloxacillin	Vet. Pharmaceutical	1	156	0	No	n/a	Cat 4: Action analytical
2-Butoxyethanol	Vet. Disnfectant/surfactant	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
Dihydrostreptomycin	Vet. Pharmaceutical	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
Doxycyline	Vet. Pharmaceutical	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
Oxytetracycline	Vet. Pharmaceutical	2	179	0	yes	n/a	Cat 2: Watch list

Tiamulin	Vet. Pharmaceutical	12	62	87	yes	yes	Cat 1: Priority Regular Monitoring
Tylosin	Vet. Pharmaceutical	14	224	8	yes	yes	Cat 1: Priority Regular Monitoring
Valnemulina	Vet. Pharmaceutical	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
Florfenicol	Vet. Pharmaceutical	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
Procaine penicillin	Vet. Pharmaceutical	2	33	0	yes	n/a	Cat 4: Action analytical
Spectinomycin	Vet. Pharmaceutical	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
Benzenesulfonic acid	Vet. Disnfectant	6	22	0	yes	n/a	Cat 2: Watch list
Bacitracin Zinc	Vet. Pharmaceutical	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
Neomycin	Vet. Pharmaceutical	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
Colistin	Vet. Pharmaceutical	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
Benzylpenicillin - insufficient detail on speciation	Vet. Pharmaceutical						
Sulfonamide - insufficient detail on speciation	Vet. Pharmaceutical						

Annex 07: Agricultural Chemicals, Pesticides & Fertilisers

Name	Origin	Countries monitored	Sites analysed	Results greater than LOQ	Recent data (last 6 years)	LOQmax< PNEC (existing data in EMPODAT)	Action Category
1,2,4-trimethyl benzene	pesticide propellant, solvent	1	30	10	yes	yes	Cat 2: Watchlist
Benzisothiazolone	pesticide propellant, solvent	5	22	0	yes	n/a	Cat 2: Watchlist
cyclohexanone	pesticide propellant, solvent	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
N-methyl-2-pyrolidone	pesticide propellant, solvent	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
propan-1,2-diol	pesticide propellant, solvent	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
EDDHA common chelating agent	Fertiliser	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
EDTA common chelating agent	Fertiliser	5	1238	6939	yes	yes	Cat 1: Priority Regular monitoring

Name	Countries monitored	Sites analysed	Results greater than LOQ	Recent data (last 6 years)	LOQmax< PNEC (existing data in EMPODAT)	Action Category
Metazachlor	15	5763	31782	yes	yes	Cat 1: Priority Regular Monitoring
Glyphosate	12	1790	4032	yes	yes	Cat 1: Priority Regular Monitoring
N-methyl-2-pyrolidone	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
1,2,4-trimethyl benzene	1	30	10	yes	yes	Cat 2: Watchlist
Benzisothiazolone	5	22	0	yes	n/a	Cat 2: Watchlist
cyclohexanone	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
propan-1,2-diol	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
Imidacloprid	17	4880	10300	yes	yes	Cat 1: Priority Regular Monitoring
Azoxystrobin	15	3042	3874	yes	yes	Cat 1: Priority Regular Monitoring
Chlorantraniliprole	2	33	n/a	yes	n/a	Cat 4: Action analytical
Cyazofamid	2	33	n/a	yes	n/a	Cat 4: Action analytical
Bifenazate	2	33	n/a	yes	n/a	Cat 4: Action analytical
Cymoxanil	2	33	n/a	yes	n/a	Cat 4: Action analytical
Chlorpyrifos-methyl	7	4058	196	yes	yes	Cat 1: Priority Regular Monitoring
2-(2-ethoxyethoxy)ethanol	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
Fipronil	15	1756	574	yes	yes	Cat 1: Priority Regular Monitoring
Deltamethrin	4	4409	528	yes	yes	Cat 1: Priority Regular Monitoring
Propamocarb	12	44748	1808	yes	yes	Cat 1: Priority Regular Monitoring

Dimethomorph	6	30558	2098	yes	yes	Cat 1: Priority Regular Monitoring
Metabromuron	10	101	40	yes	yes	Cat 1: Priority Regular Monitoring
Chlorothalonil	3	4353	511	yes	yes	Cat 2: Watch list
Diuron	18	258,485	19976	yes	yes	Cat 1: Priority Regular Monitoring
Dieldrin	4	66	3	yes	yes	Cat 2: Watch list
Meptyldinocap	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
Oxyfluorfen	2	33	n/a	yes	n/a	Cat 4: Action analytical
Aldrin	4	66	0	yes	yes	Cat 2: Watch list
Myclobutanil	2	33	n/a	yes	n/a	Cat 4: Action analytical
Pyrimethanil	2	33	n/a	yes	n/a	Cat 4: Action analytical
Valifenalate	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
Pyraclostrobin	2	33	n/a	yes	n/a	Cat 4: Action analytical
alpha-Hexachlorocyclohexane (HCH / Lindane)	3	108	0	yes	yes	Cat 2: Watch list
gamma-Hexachlorocyclohexane (HCH / Lindane)	5	126	0	yes	yes	Cat 2: Watch list
Boscalid	8	54	0	yes	n/a	Cat 4: Action analytical
Flonicamid	2	33	n/a	yes	n/a	Cat 4: Action analytical
Pyridate	2	33	n/a	yes	n/a	Cat 4: Action analytical
Diquat	1	33	0	yes	n/a	Cat 4: Action analytical
Flazasulfuron	2	33	n/a	yes	n/a	Cat 4: Action analytical
Methoxyfenozide	2	33	n/a	yes	n/a	Cat 4: Action analytical
N,N- Diethyl-meta-toluamide (DEET) - insufficient data in Norman database						

Annex 08: Household Chemicals and Personal Care Products

Name	Origin	Countries monitored	Sites analysed	Results greater than LOQ	Recent data (last 6 years)	LOQmax< PNEC (existing data in EMPODAT)	Action Category
Styrene	Highly reactive compounds	6	1429	248	yes	yes	Cat 1: Priority Regular monitoring
Resorcinol	Other Aromatics	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
Triphenyl phosphate	Organophosphors	9	777	1436	yes	yes	Cat 1: Priority Regular monitoring
Benzophenone	Highly reactive compounds	12	78	16	yes	yes	Cat 2: Watchlist
Galaxolide	Heterocyclic compounds	4	350	21325	yes	yes	Cat 1: Priority Regular monitoring
Butylated Hydroxytoluene	Alkylphenols	3	34	102	yes	yes	Cat 2: Watchlist
4-(1,1,3,3-tetramethylbutyl)phenol	Alkylphenols	4	89	156	yes	yes	Cat 2: Watchlist
Tonalide	Other Aromatics	4	879	725	yes	yes	Cat 1: Priority Regular monitoring
2-(2H-benzotriazol-2-yl)-4-(1,1,3,3-tetramethylbutyl)phenol (UV-329)	Alkylphenols, Benzotriazols	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
Formaldehyde	Highly reactive	2	1151	541	yes	yes	Cat 2: Watchlist

	compounds						
Octamethylcyclotetrasiloxane (D4)	Organosilicones	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
Aniline	Aromatic amines	4	390	431	yes	yes	Cat 1: Priority Regular monitoring
Chlorinated paraffins (CPs)	(Poly)halogenated alkanes	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
Carbon disulphide	Others	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
Bisphenol A	Bisphenols	15	2429	13056	yes	yes	Cat 1: Priority Regular monitoring
diethyl phthalate (DEP)	Phthalates	14	1131	1373	yes	yes	Cat 1: Priority Regular monitoring
1,2-dichlorobenzene	(Poly)halogenated aromatics	2	47	0	n/a	n/a	Cat 4: Action analytical
4-Tert-Butylphenol	Alkylphenols	2	1483	272	Yes	yes	Cat 2: Watchlist
Nonylphenol	Detergent metabolites						
Sodium Lauryl Sulfate	Surfactants	1	12	115	Yes	yes	Cat 2: Watchlist
Para-hydroxybenzoate	paraben - Personal Care Products	6	155	503	Yes	yes	Cat 1: Priority Regular monitoring

Annex 09: Chemicals used in Industry

Name	Origin	Countries monitored	Sites analysed	Results greater than LOQ	Recent data (last 6 years)	LOQmax< PNEC (existing data in EMPODAT)	Action Category
Melamine	Aromatic amines	2	33	1	yes	yes	Cat 2: Watchlist
1,4-dioxane	Others	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
tert-butyl methyl ether; MTBE; 2-methoxy-2-methylpropane	fuel additive, solvent	4	1237	8129	yes	yes	Cat 1: Priority Regular monitoring
N-butylbenzenesulphonamide	Others	10	256	160	yes	yes	Cat 1: Priority Regular monitoring
Carbon tetrachloride (CTC)	(Poly)halogenated alkanes	14	3819	1306	yes	yes	Cat 1: Priority Regular monitoring
Chloroform	(Poly)halogenated alkanes	2	47	165	yes	yes	Cat 2: Watchlist
benzenamine, N-phenyl-, reaction products with 2,4,4-trimethylpentene (BPTMP) - insufficient detail on speciation	Aromatic amines						
2-(2H-benzotriazol-2-yl)-4,6-bis(1-methyl-1-phenylethyl)phenol (UV-234)	Alkylphenols, Benzotriazols	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
TFA (Trifluoracetat)	Fluorinated compounds	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical

Biguanide - insufficient detail on speciation	SUBSIDIARY LEGISLATION 465.02 SWIMMING POOLS REGULATIONS						
Bromochlorodim-ethylhydantoin	SUBSIDIARY LEGISLATION 465.02 SWIMMING POOLS REGULATIONS	n/a	n/a	n/a	n/a	n/a	Cat 4: Action analytical
cyanuric acid	SUBSIDIARY LEGISLATION 465.02 SWIMMING POOLS REGULATIONS	2	33	1	yes	yes	Cat 2: Watchlist
DEHP	from monitoring results	12	134	173	yes	yes	Cat 1: Priority Regular monitoring
tris-(2-Butoxyethyl)phosphate	from monitoring results	10	751	629	yes	yes	Cat 1: Priority Regular monitoring
tris-(2-Chloroisopropyl)phosphate	from monitoring results	10	864	855	yes	yes	Cat 1: Priority Regular monitoring
Triisobutylphosphate	from monitoring results	9	936	15481	yes	yes	Cat 1: Priority Regular monitoring
Phenol	from monitoring results	n/a	n/a	n/a	n/a	yes	Cat 4: Action analytical
Methylbenzotriazole	from monitoring results	11	115	505	yes	yes	Cat 1: Priority Regular monitoring
Benzotriazole	from monitoring results	12	230	1356	yes	yes	Cat 1: Priority Regular monitoring