THE ENVIRONMENTAL STATUS OF ST. AUBIN'S BAY, JERSEY ACCORDING TO THE REQUIREMENTS OF THE WATER FRAMEWORK DIRECTIVE

DATA MANAGEMENT AND ASSESSMENT FOR MONITORING PROGRAMMES

MONITORING PROGRAMME RESULTS AND STATUS ASSESSMENTS (2012-2015)

FINAL REPORT TO STATES OF JERSEY (ENVIRONMENTAL PROTECTION SECTION) FROM WCA ENVIRONMENT LIMITED

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EXECUTIVE SUMMARY

In 2012 the States of Jersey, Department of the Environment commissioned wca to develop a marine water quality monitoring and assessment programme to enable the States of Jersey to better understand the impact of pressures acting on the marine environment. Prior to 2012 only very limited data on the water quality of Jersey's coastal waters were available.

St Aubin's Bay was targeted for this assessment because it is considered to be the area of coastal water at highest risk from human pressures exerted on it. These pressures include:

- The majority of the Island's catchment run-off discharges into the bay (owing to the Island's topography). This is a significant pressure given the high intensity of agriculture and high population density of the Island;
- The Island's Sewage Treatment Works (STW) at Bellozanne discharges treated effluent into the bay;
- Heavy modification of the bay including the St Helier port, a waste reclamation site (La Collette) and various sea defences;
- Fisheries and aquaculture industries operating within the bay and offshore;
- The bay being a popular area for recreational activity.

Water quality monitoring is therefore required to assess the current and potential future impacts of these pressures on the bay, in particular to establish the current environmental status of the bay and to provide a baseline against which any changes in environmental quality can be assessed.

To this end The States of Jersey, Environmental Protection Section have undertaken a three-year monitoring programme in St. Aubin's Bay, with the aim of generating the chemical and ecological information that are required to assess the environmental status of the bay according to the requirements of the Water Framework Directive (WFD). The monitoring programme commenced in April 2012 and was completed in September 2015. The monitoring programme incorporated:

- Chemical/ physico-chemical monitoring to generate sufficient data on the concentrations of chemicals in the bay with which to estimate the chemical and ecological status, and
- A programme of ecological monitoring which comprised phytoplankton, macroalgae, seagrass, benthic invertebrate and imposex assessments.

This report presents the results of each element of the monitoring programme, corresponding estimates of the chemical or ecological status of the bay according to the monitoring results for each element, and the overall outcome of the assessment according to the requirements of the Water Framework Directive (WFD).

The table below summarises the chemical and ecological status for each pressure indicator, based on the results obtained in the St. Aubin's Bay monitoring programme.

Summary of Overall WFD Status Classifications for St. Aubin's Bay

Element	Metric	Status	Overall Status
Chemical Status	Priority Substances	Good	**Moderate**
Ecological Status	Physico-chemical Conditions	Moderate	
	Specific Pollutants	Good	
	Phytoplankton	High	
	Rocky Shore Macroalgae	Good	
	Opportunistic Macroalgae	Moderate	
	Seagrass	High	
	Benthic Invertebrates	Good	
	Imposex	Good	

The overall status of the bay is considered to be 'Moderate'. This is driven by the opportunistic macroalgal assessments and dissolved inorganic nitrogen concentrations, and suggests moderate impacts across the bay from nutrient enrichment.

Based on the outcomes of the monitoring programme, we make the following recommendations.

In order to assist in the classification process of Jersey's coastal waters, the coastline of Jersey has initially been divided into four waterbodies. St. Aubin's Bay sits within the Southern Coastline waterbody (Atkins 2014). This delineation is, however, preliminary and will need refinement to reflect the full array of characteristics, pressures, chemical inputs and expected quality of each coastal waterbody. Following this refinement, and based on the pressures identified for each waterbody, it may be necessary to revisit the environmental status assessment presented in this report, and to implement a similar programme of monitoring for other areas along the Jersey coastline.

The status assessment presented in this report focuses on one specific area of the Jersey coastline (St. Aubin's Bay and the immediate surrounding area), and the specific pressures and chemical inputs identified in this area (wca 2012). However, the Atkins study (Atkins 2014) on the challenges for the water environment of Jersey identified a wide range of pressures on the coastal environment of Jersey as a whole, including wastewater management, industry, fisheries and coastal aquaculture, road run-off, agriculture, tourism and recreation. While the WFD-based assessment reported here provides, as far as is currently possible, a holistic approach to evaluating the status of St. Aubin's Bay in response to such pressures, it is largely chemical focused, and only measures the concentrations, and long-term ecological effects, of chemicals entering the environment (from various sources). Other types of direct pressures from these sources (e.g. physical damage, overfishing, competition for space) are also likely to be important and should not be ignored when attempting to assess the overall condition of the coastal environment.

This status assessment is based on approximately three years of monitoring data, which is sufficient to derive an overall status for St. Aubin's Bay. However, the pressures acting on,

and conditions in, the bay are not static and will continue to change over time, particularly since modifications to the sewage treatment works discharging into the bay are planned (in a phased manner) in the future. For this reason, it is recommended that monitoring is continued for a number of the elements assessed here, to ensure that any deterioration or improvement is highlighted as early as possible. This monitoring should include, as a minimum:

- EU Priority Substances which could not be monitored in this monitoring programme owing to the lack of an appropriate analytical method. These substances include aclonifen, alachlor, bifenox, the cyclodiene pesticides and quinoxyfen, and these should be monitored on a monthly basis in any future chemical monitoring programme.

- Any new EU Priority Substances, as they are added Water Framework Directive requirements, should also be monitored on a monthly basis in any future chemical monitoring programme.

- EU Priority Substances for which the analytical method applied in this monitoring programme was insufficiently sensitive to reliably assess compliance with the relevant EQS value (e.g. octylphenol and TBT) should be monitored on a monthly basis in any future chemical monitoring programme, using a more sensitive analytical method.

In general, this future chemical monitoring (other than that required to monitor nutrients) should follow the WFD River Basin Management Plan (RBMP) cycle and be re-assessed every five years.

- The monthly monitoring of dissolved inorganic nitrogen and ammonia should be immediately continued at the central bay, offshore and Belcroute sites, and should focus on periods of low dilution.

- A continuation of the phytoplanktonic (monthly), macroalgal (annual), seagrass (annual) and benthic invertebrate (6-monthly) monitoring programmes is considered essential to highlight any trends in impacts from nutrient enrichment or chemical contamination. For the rocky shore macroalgal assessment a substitute site should be identified for Beach Rock as this site was deemed to not to meet the WFD criteria for rocky shore macroalgal assessments.

The monitoring should as far as is possible, and accounting for the recommendations above, be undertaken at the same sites as monitored in this programme to maintain consistency and allow a reliable demonstration of changes over time, with the exception of the port site. The port site is highly modified (relative to reference conditions) and subject to substantial and ongoing pressures from port, shipping and boating activity. Therefore, an assessment that seeks to evaluate the deviation of such a site from reference conditions will invariably demonstrate high impacts, and could bias the overall assessment of more subtle pressures in the same area.

Given that the driving pressures on St. Aubin's Bay appear to be related to eutrophication, it is important that all sources of nutrients to the bay are controlled if the overall status is to be improved. While the sewage works is likely to be a constant source of such nutrients to this particular area of Jersey's coastline, the intensive agriculture on the island will also contribute nutrients. Therefore it will be important to work with farmers to develop initiatives aimed at tackling agricultural pollution.

The current assessment did not consider invasive species, since at the commencement of the programme, no guidance had been published on how to assess invasive species for coastal environments under the WFD. Invasive marine species will, however, be relevant for Jersey's marine environment (as they are in the UK and mainland Europe), and it is therefore recommended that, going forward, a programme of monitoring be developed for coastal invasive species.

Finally, while the chemical status assessments presented here are based on EU-wide Environmental Quality Standards, the ecological assessments are based on reference conditions applied in southern England (UKTAG 2007, 2008a-b, 2009a-c, 2012), and the proximity of Jersey to the French coast may mean that the reference conditions applied to the nearest area of French coast may be more appropriate. It is therefore recommended that, if possible, the data collected as part of the monitoring programme reported be re-evaluated based on the relevant French reference conditions. Alternatively, given Jersey's small size and long coastline relative to its landmass, specific reference conditions for Jersey could be developed.

CONTENTS

TABLES

1 INTRODUCTION

In 2012 the States of Jersey, Department of the Environment commissioned wca to develop a marine water quality monitoring and assessment programme to enable the States of Jersey to better understand the impact of pressures acting on the marine environment. Prior to 2012 only very limited data on the water quality of Jersey's coastal waters was available.

St Aubin's Bay was targeted for this assessment because it is considered to be the area of coastal water at highest risk from human pressures exerted on it. These pressures include:

- The topography of the Island with the majority of the Island's catchment run-off discharging into the bay; this is a significant pressure given the high intensity of agriculture and high population density of the Island.
- The Island's Sewage Treatment Works (STW) at Bellozanne discharges treated effluent into the bay.
- Heavy modification of the bay including the St Helier port, a waste reclamation site (La Collette) and various sea defences.
- Fisheries and aquaculture industries operating within the bay and offshore.
- The bay being a popular area for recreational activity.

The Department of the Environment also commissioned the development of an Integrated Water Management Plan (IWMP) to safeguard all of Jersey's water environment (Atkins 2014), which includes the Island's coastal waters up to the 3 mile limit. The water quality assessment of St Aubin's Bay is integrally linked to this plan and will help shape future monitoring and implement protective measures for the bay.

The IWMP is applying existing environmental monitoring data to understand the current status of the water bodies, and follows an approach based on the European Commission's Water Framework Directive (WFD) (Section 1.1). Different types of environmental data (for example water quality, quantity and biological records such as invertebrate monitoring data) have been combined and compared against environmental standards to report status results in the categories of: 'High'; 'Good'; 'Moderate'; 'Poor' and 'Bad'. A further category of "not assessed" has been assigned where there is insufficient data to carry out a robust assessment. Any water body that is reported as having a status lower than 'Good' ('Moderate', 'Poor' or 'Bad') will be addressed through the IWMP. The monitoring undertaken in St. Aubin's Bay has also followed a WFD-based approach, and therefore is directly relevant to the IWMP.

The States of Jersey, Transport and Technical Services (TTS) operate the Bellozanne sewage treatments works (STW) which discharges treated effluent into St. Aubin's Bay.

Over the last five years the STW has been unable to meet the 10 mg L^{-1} total nutrient target stipulated by the discharge permit issued by the Department of the Environment (total nutrients ranged from 22 to 39 mg L^{-1} between 2009 and 2013) (Atkins 2014).

TTS are implementing a wastewater strategy which aims to improve the performance of the STW. This strategy sets out plans for £75m spend in the wastewater sector for an upgrade to sewage treatment works in St Aubin's Bay, commencing in 2019 (Atkins 2014). This includes the assurance by TTS that the construction will ensure the Island can conform to the standards required by the WFD, as well as the Urban Waste Water Treatment Directive.

In addition, a regulatory roadmap has been developed that provides clarification of relevant aspects of the build and commissioning of the new sewage treatment works and the monitoring and protection of the receiving environment (St Aubin's Bay). The road map will help both Environmental Protection (the regulator) and Transport and Technical Services (the permit holder) to work together to share and target resources and limit any delay in project completion.

Amongst the other elements (the STW design process, current effluent quality, the ongoing regulatory position regarding compliance with existing discharge permit conditions), the roadmap describes the details and principles of a phased approach to the future development of the STW, and outlines the definitions of 'no deterioration' and processes required to investigate this.

Phase 1 is the replacement of the current works with a conventional carbonaceous plant that does not include specific nutrient removal technology. Phase 2 are the addition of staged nutrient (nitrogen) removal technologies or any other treatment process in an area that has been identified and set aside for these purposes during Phase 1 and the Planning process. From a regulatory perspective, the need for Phase 2 is reliant on evidence that either links environmental deterioration of St Aubin's Bay to the existing performance of the works or that evidences that added treatment processes can lead to enhanced environmental conditions of the bay.

The deterioration of St Aubin's Bay (the receiving environment) will include:

- The overall classification of the Bay environment as evidenced by onward monitoring in accordance with the WFD;
- Any assessment criteria used in the overall classification in WFD status.

Water quality monitoring is therefore required to assess the current and potential future impact of the STW on the bay according to the requirements of the WFD, in particular to establish the current environmental status of the bay and to provide a baseline against which any changes in environmental quality can be assessed.

To this end The States of Jersey, Environmental Protection Section have undertaken a three-year monitoring programme in St. Aubin's Bay, with the aim of generating the chemical and ecological information that is required to assess the environmental status of the bay according to the requirements of the WFD. The monitoring programme commenced in April 2012 and was completed in September 2015. The monitoring programme incorporated:

- Chemical/ physico-chemical monitoring of the bay to generate sufficient chemical data with which to estimate the chemical and ecological status of the bay; and,

- A programme of ecological monitoring including phytoplankton, macroalgae, seagrass, benthic invertebrate and imposex assessments.

An initial, interim, status assessment was undertaken in 2013 (wca 2013) using the chemical and ecological monitoring data collected during the first year of the monitoring programme. The outcome of this assessment was that interim status of the bay was considered to be 'Moderate', which was based on moderate impacts measured in the bay in ecological indicators of nutrient enrichment.

The work to assess the baseline environmental status of St. Aubin's Bay has comprised a number of stages and this report represents the final report in a series, each related to different phases of the overall assessment.

This final report is focused on presenting the final outcomes of the three-year monitoring programme and therefore we have not provided all the detailed information in this report that is available in previous reports. The raw data from the full 3-year monitoring programme, the calculation of compliance statistics and Ecological Quality Ratios (EQRs), and the derivation of status assessments are provided in the Appendix as embedded Microsoft excel spreadsheets.

This report presents the results of each element of the monitoring programme, corresponding estimates of the chemical or ecological status of the bay according to the monitoring results for each element, and the overall outcome of the assessment according to the requirements of the WFD.

The remainder of Section 1 outlines the requirements of the WFD. Section 2 summarises the design of the St. Aubin's Bay monitoring programme and summarises the different chemical and ecological quality indicators, and Section 3 presents the chemical and ecological status assessment. In Section 4 we discuss the outcomes of the status assessments with respect to the primary chemical pressures on the bay, and the implications of these results for the Bellozanne sewage treatment works. Finally, Section 5 provides a series of recommendations based on the outcomes of the monitoring programme and status assessments.

1.1 The Water Framework Directive

The WFD is a holistic approach to managing the water environment in Europe and brings together objectives to protect the water environment from the effects of chemical pollution and broader ecological objectives, designed to protect the structure and function of aquatic ecosystems themselves.

Under the WFD, the overall environmental status of a waterbody (be it river, lake, estuary or coastal) is determined by the assessment of its ecological and chemical status. Ecological status refers to the quality of the structure and functioning of aquatic ecosystems while chemical status is based on the measured concentrations of specified substances in the waterbody.

This system of integrated chemical and ecological assessment provides a framework within which costs and benefits can be properly taken into account when setting environmental objectives, and proportionate and cost-effective combinations of measures to achieve the objectives (which consider a waterbody as a whole) can be designed and implemented.

Despite not being a member of the EU, small island jurisdictions, such as Jersey, may benefit from applying the WFD approach to environmental assessment since it provides an effective means of considering the combined effects of all identified chemical pressures on the island's waterbodies in an integrated manner while also delivering reliable information on which particular combinations of pressures may be driving potentially impoverished ecological status. It also allows for the effects of changes in the identified pressures on the local environment to be reliably measured against a baseline which considers each aquatic environment (freshwater or coastal) of the island as a whole. This means that limited resources can be focused on measures which are likely to result in the greatest benefit in terms of overall environmental improvement, rather than attempting to address individual chemical pollution issues (real or perceived) in isolation of considerations of the wider environmental impacts of combinations of different pressures.

The assessment of a waterbody is achieved by monitoring a series of chemical and ecological quality elements which generate results that can be compared with similar data for reference (uncontaminated) conditions. The degree of deviation from reference conditions for any particular quality element will define its status.

There are five classes for ecological status ('High', 'Good', 'Moderate', 'Poor' and 'Bad') and two classes for chemical status ('Good' and 'Less Than Good') and for both ecological and chemical status assessments, and overall surface water assessments, the status of a water body will be determined by the results for the quality element with the lowest class (Figure 1.1).

Estimates of the status of a waterbody will inevitably improve over time, as the amount of monitoring data, on which the status assessment is based, increases. As a result, the status of some water bodies may be re-classed as better, or worse, than originally estimated. Classification is therefore normally built up from the monitoring data over a number of stages, in which the data are collected using rolling programmes in which each site is monitored over

a number of years. This means that initial status assessments for a particular element may change as the monitoring dataset increases. In general, the status of a particular element can be estimated as soon as enough data have been generated to allow the relevant assessments to be undertaken, however, there is a difference between having enough data to mechanistically undertake the assessment and having a sufficiently representative dataset to be confident of the final status of an element. For this reason, assessments made before monitoring has been carried out over a sufficiently representative period can only be considered to represent the 'interim' status of a particular metric or waterbody.

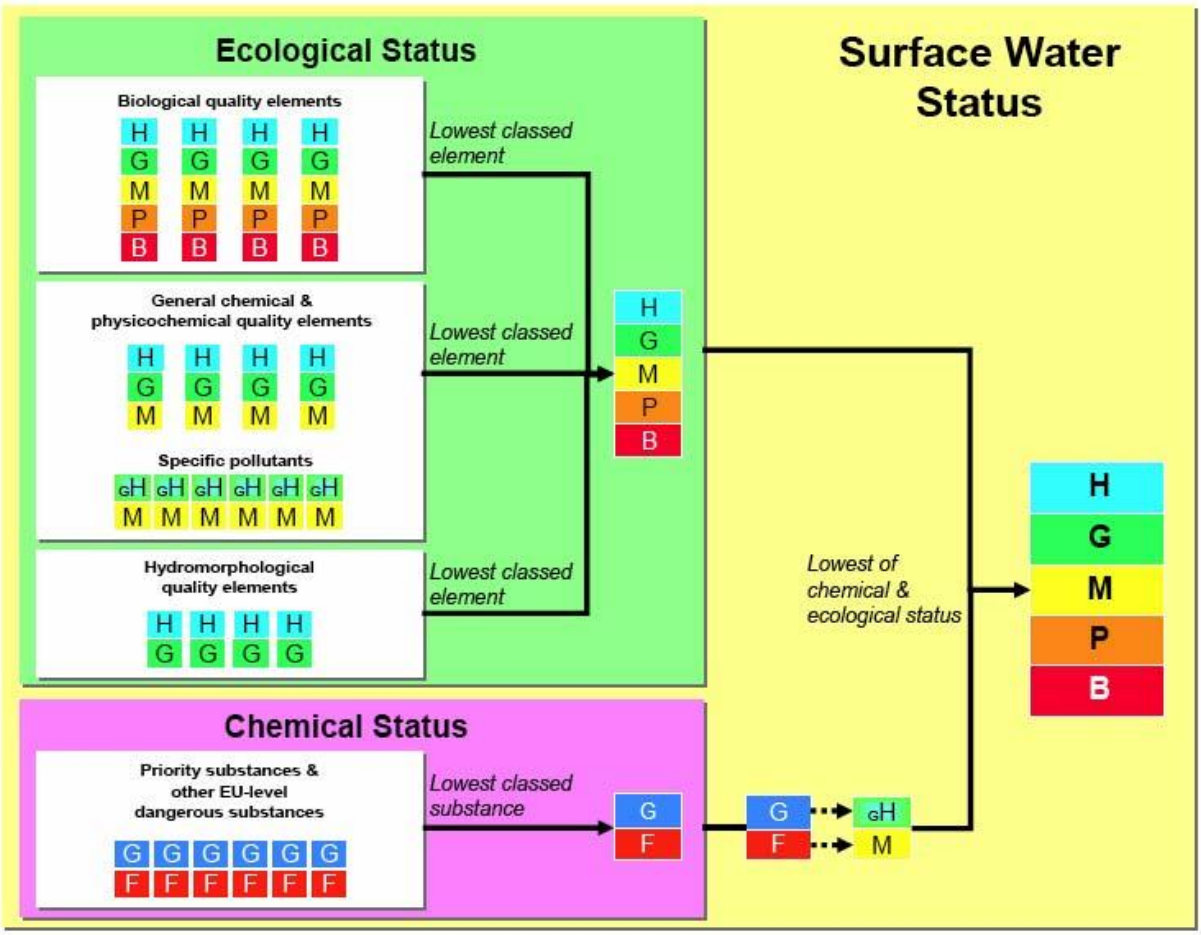

Figure 1.1 Surface Water Classification under the WFD (UKTAG, 2007/2008)

2 THE MONITORING PROGRAMME

2.1 Overview

The monitoring programme for St. Aubin's Bay applied the WFD chemical and ecological indicators for the WFD status assessment of coastal waters, since there is no river entering the bay (Jersey has no true rivers) and therefore the bay cannot be considered to be a transitional waterbody.

The monitoring programme was designed to assess the environmental status of St. Aubin's Bay according to the primary chemical pressures identified in a Scoping Study[1], and in particular to determine the chemical pressures inferred on the bay by the Bellozanne sewage treatment works effluent. Full details of the design of the chemical and ecological elements of the programme are provided in the Monitoring Programme Technical Specification[2].

In summary, three separate sampling sites were initially identified to represent St. Aubin's Bay as a whole. These three sites were selected on the basis of the likely primary sources of chemicals to the bay.

The main sites monitored were:

- Central Bay - corresponding to the main area receiving chemical inputs derived from the Bellozanne sewage treatment works effluent;
- The port area – corresponding to the area with current or historical chemical inputs from port, shipping and boating activities, and
- Off the La Collette reclamation site - corresponding to the area with the potential to receive current or historical chemical inputs from waste activities undertaken on the reclamation site, such as storage of incinerator ash, composting of green waste and aggregate recycling and the energy from waste plant.

A chemical screening programme comprised three samples of seawater, taken at monthly intervals from each of the three sites, and sediment (one occasion at each of the three sites), as well as the more intensive sampling of the Bellozanne sewage treatment works effluent (four weekly samples taken for one month, and then monthly samples for two further months). The substances monitored in the screening programme were all those EU Priority Substances or UK River Basin Specific Pollutants with the potential to be present, based on the sources of pollution identified in the Scoping Study[1]. The data obtained in the chemical screening programme was used to determine which substances were measured in the longer term chemical monitoring programme. In general, those substances detected (i.e. above their analytical limits of detection) in seawater sampled from each site were included in the long-term monitoring of seawater at each site. Substances detected in the treated sewage effluent

[1] Scoping Study to Define the Status of St. Aubin's Bay, Jersey According to the Requirements of the Water Framework Directive (wca, 2012)
[2] The Environmental Status of St. Aubin's Bay, Jersey, According to the Requirements of the Water Framework Directive –Monitoring Programme Technical Specification, Version 2 (wca 2012)

were also included in the long-term monitoring of seawater at the central bay site (where possible). Substances detected in sediment were monitored in biota in the long-term monitoring programme.

The longer term chemical monitoring programme comprised monthly samples of seawater taken from each site, so that for the substances selected following the screening programme a set of approximately 12 annual discrete measurements for each substance were achieved over an approximately three year period.

Biota (slipper limpets) were also collected on seven occasions (October 2012, January and April 2013 from the port site, June 2015 from Elizabeth Castle, January 2013 and June 2015 from the central bay site, and September 2015 from St. Aubin's Beach) in order to assess the status of substances with biota EQS.

Following completion of the first year of the monitoring programme (2012-2013)[3], two additional sites were added to the programme (a site outside of the main bay located at Hinget Reef buoy and a site at Belcroute) in order to provide some additional resolution for the results of the phytoplanktonic and physical-chemical ecological receptors. The seawater sampled at these two sites was analysed for phytoplanktonic and chlorophyll content, dissolved inorganic nitrogen, dissolved oxygen and salinity only. In addition, phytoplanktonic and chlorophyll monitoring was ceased at the port site, since it was considered that this site (being highly modified) was not representative of the ecological status of the bay as a whole.

The ecological monitoring programme comprised:

- Twelve annual seawater samples, taken at monthly intervals from each site, for the analysis of phytoplankton abundance, taxonomic diversity and chlorophyll-a content;
- Sediment samples that were taken on two occasions in 2012, 2014 and 2015, and once in 2013, for the assessment of benthic invertebrate communities;
- Dogwhelks sampled on two occasions (August and September 2012) for the assessment of imposex.
- The assessment of rocky shore macroalgae at three sites on a single annual occasion (2012, 2013, 2014 and 2015);
- The assessment of opportunistic macroalgae and seagrass, each on a single annual occasion across the entire parts of the bay supporting seaweed or seagrass beds.

The United Kingdom Technical Advisory Group on the WFD (UKTAG) best practice and guidance was applied in the monitoring and assessment of each of the specific ecological

[3] The Environmental Status of St. Aubin's Bay, Jersey According to the Requirements of the Water Framework Directive – Data Management and Assessment for Monitoring Programmes: Monitoring Programme Results and Status Assessments, (wca 2013)

elements employed in the ecological monitoring programme (UKTAG 2008a,b, 2009a,b,c, 2012). The ecological assessment methods employed are further detailed in the Scoping Report[4] and Technical Specification[5].

2.2 Chemical Monitoring

2.2.1 Chemical Screening

The overall objectives of the initial (screening) phase of the monitoring programme were to identify those EU Priority Substances and UK Specific Pollutants that were detectable in, or released to, the bay (i.e. their measured concentrations were greater than the limits of detection for each matrix in which their concentration was measured).

The results of the chemical screening assessment are presented in 'The Environmental Status of St. Aubin's Bay, Jersey According to the Requirements of the Water Framework Directive – Data Management and Assessment for Monitoring Programmes: Monitoring Programme Results and Status Assessments' (wca 2013).

2.2.2 Longer term Chemical Monitoring

The objectives of the longer term monitoring programme were to monitor the concentrations of the EU Priority Substances and UK Specific Pollutants over three years to allow the derivation of a reliable annual average concentration for each substance. This annual average concentration can then be compared with an Environmental Quality Standard (EQS) to determine the chemical (Priority Substances) or ecological (Specific Pollutants) status of the bay, according to compliance or failure with each substance-specific EQS.

For this element of the programme, chemical measurements were made in seawater and biota. Table 2.1 summarises the substances measured in the longer term chemical monitoring programme.

[4] Scoping Study to Define the Status of St. Aubin's Bay, Jersey According to the Requirements of the Water Framework Directive (wca, 2012)
[5] The Environmental Status of St. Aubin's Bay, Jersey According to the Requirements of the Water Framework Directive: Monitoring Programme Technical Specification, Version 2 (wca, 2012).

Table 2.1 Substances and Matrices Monitored in Longer term Monitoring Programme

Site/ Matrix	Substance
Central Bay/ Seawater	2,4 Dichlorophenol
	2,4 D
	Ammonia (unionised)
	DEHP
	Diuron
	Mecoprop
	Nonylphenol
	Octylphenol
	Zinc (Dissolved)
	Total Inorganic Nitrogen
	Arsenic (Dissolved)
	Lead (Dissolved)
Port/ Seawater	Ammonia (unionised)
	Arsenic (Dissolved)
	Copper (Dissolved)
	Lead (Dissolved)
	Nickel (Dissolved)
	Zinc (Dissolved)
	TBT
	Total Inorganic Nitrogen
La Collette/ Seawater	Arsenic (Dissolved)
	Ammonia (unionised)
	Copper (Dissolved)
	Lead (Dissolved)
	Nickel (Dissolved)
	Zinc (Dissolved)
	Cadmium (Dissolved)
	Naphthalene
	Total Inorganic Nitrogen
Biota	Benzo(a)pyrene
	Fluoranthene
	Mercury

In addition, the longer term chemical monitoring programme included measurements of salinity, and the concentrations of both dissolved oxygen and inorganic nitrogen in seawater. These physico-chemical parameters are required to support the ecological status assessment.

The full results of the three-year chemical monitoring programme are presented in the spreadsheet 'St. Aubin's Bay WFD Assessment – Chemical Monitoring' (Appendix).

2.3 Ecological Monitoring

The objectives of the ecological monitoring programme were to generate the necessary biological data required to assess the status of the various WFD ecological indicators. These indicators measure the ecological responses to pressures inferred on the coastal environment by toxic chemicals and nutrients. The monitoring data collected for each indicator is used to estimate the degree of ecological disturbance from a reference condition (which is considered to represent no disturbance) caused by inputs of toxic chemicals or nutrients to the bay. This degree of disturbance or Ecological Quality Ratio (EQR) is then used to determine the ecological status of the bay, according to each indicator of pressure.

The full results of the three-year ecological monitoring programme are presented in the spreadsheet 'St. Aubin's Bay WFD Assessment – Ecology' (Appendix).

2.3.1 Phytoplankton

The abundance of phytoplankton species, and the total chlorophyll-a concentration, was measured in discrete seawater samples taken from each site at monthly intervals over a three year period.

2.3.2 Macroalgae

Two different types of macroalgae (seaweed) monitoring were carried out in accordance with the WFD ecological assessment requirements for coastal waters. The first assessed the abundance of certain rocky shore indicator species, while the second assessed the extent and biomass of opportunistic macroalgal species.

The rocky shore assessment involved a single annual survey at three rocky sites bearing seaweed. Because rocky shore macroalgae can only be assessed at suitable rocky shore sites which actually support seaweed growth, it was not possible to undertake the rocky shore macroalgae assessments at the same sites as those used for the chemical and phytoplankton sampling. Three rocky shore sites were therefore selected to represent the bay – Beach Rock, Elizabeth Castle and St. Aubin's Fort. Beach Rock and Elizabeth Castle are close to the central bay and port monitoring sites, respectively. St.Aubin's Fort is situated on the west side of the bay and is not in the proximity of the other sampling sites.

The opportunistic macroalgae assessment also comprised a single annual survey with the entire intertidal habitat bearing macroalgae being assessed.

2.3.3 Seagrass

A seagrass assessment was also undertaken in accordance with the WFD ecological assessment requirements for coastal waters. The premise of the seagrass assessment is to estimate the loss (or increase) of seagrass beds over a defined time period.

A single annual survey was undertaken of each of the seagrass beds in St.Aubin's Bay which assessed the species present, coverage and total extent of the seagrass beds in each location.

2.3.4 Benthic Invertebrates

Benthic invertebrate surveys were undertaken over the period of the ecological monitoring programme (two occasions in 2012, 2014 and 2015, and once in 2013) in accordance with the WFD ecological monitoring requirements for coastal waters.

Benthic invertebrates were assessed at the central bay and port sites, but it was not possible to obtain sediment samples for benthic invertebrate analysis from the La Collette reclamation site. For this reason, benthic invertebrate assessments were additionally carried out at a further site, Elizabeth Castle, which is close to the port monitoring site (but outside of the port area).

2.3.5 Imposex in Dogwhelks

Imposex occurs in female dogwhelks when exposed to TBT, which is present in certain anti-foul paints used on boats and ships. Whilst the use of TBT in anti-foul paints has decreased markedly in recent years, largely as a result of an International Maritime Organisation (IMO) ban on their use, TBT is still found in coastal and estuarine waters and sediments in the UK, and UK dogwhelk populations continue to exhibit signs of exposure.

While TBT was not monitored in the St. Aubin's Bay sediment screening programme, it was measured in both the seawater and treated sewage effluent screening programmes, and was detected in a single seawater sample taken from the port site. This suggests that TBT is present in the sediments at the port site, probably as a result of historic rather than current contamination, and can be measured in relatively high concentrations in seawater at this site when the sediment is disturbed (e.g. in bad weather).

The detection of TBT in seawater in the screening programme meant that it was necessary to undertake a survey to assess the degree of imposex in dogwhelk populations in St. Aubin's Bay. Two separate dogwhelk surveys were undertaken (August and September 2012), and the results of both surveys were combined to assess the degree of imposex according to the requirements of the WFD ecological status assessment. The dogwhelks were obtained from a single site in the bay (close to Elizabeth Castle) where they were known to occur in sufficient numbers.

3 STATUS ASSESSMENTS

3.1 Chemical Status Assessment

The chemical status assessment is based on the measured concentrations of those EU Priority Substances monitored in the longer term chemical monitoring programme at each site.

For each substance measured at each site, an annual average concentration has been calculated as the mean substance concentration across all the monthly seawater samples taken in the chemical monitoring programme.

The limit of detection (LOD) is the analytical concentration value above which it can be affirmed that a sample concentration is different from a blank sample containing no determinand of interest. The limit of quantification (LOQ) is a stated multiple of the limit of detection at a concentration of the determinand that can reasonably be determined with an acceptable level of accuracy and precision.

The concentration of a substance that is reported as below the LOD or LOQ in a sample cannot be reliably quantified but may range from none (zero) up to the detection or quantification limit itself. Such so-called 'censored' analytical values present problems when attempting to calculate an average concentration for a substance.

The WFD QA/QC Directive (European Commission Directive 2009/90/EC) states that:

- 'where the amounts of physico-chemical or chemical measurands in a given sample are below the limit of quantification, the measurement results shall be set to half of the value of the limit of quantification concerned for the calculation of mean values', and

- 'where a calculated mean value of the measurement results is below the limits of quantification, the value shall be referred to as 'less than limit of quantification'.

The chemical monitoring data provided to wca for undertaking the chemical assessments contained a large amount of 'censored' data, and for some substances, the entire dataset comprised 'censored' values. This 'censored' data was a mixture of values reported as 'less than [LOD value]' and 'less than [LOQ value]. The LOD and LOQ values (for the same substance) also vary between samples and analytical occasions.

We have therefore taken a pragmatic approach to the calculation of annual average concentrations, whereby half the reported 'limit' (LOD or LOQ) has been used to calculate the annual average, in each case where a concentration has been reported as 'less than [LOD value]' or 'less than [LOQ value]'.

The above approach has been applied to all monitored substances for which the annual dataset contained a mixture of measured and 'censored' values. For monitored substances for which an entire annual dataset was comprised of 'censored' values, the annual average result has been reported as 'less than the LOD/LOQ'.

3.1.1 Seawater

Tables 3.1 to 3.3 show the chemical status assessments for seawater for the three sites within St. Aubin's Bay.

Table 3.1 Chemical Status Assessment for Seawater at the Central Bay Site

Substance	No. of Samples Taken	Units	EQS	No. of Individual Samples Failing EQS	Annual Average Concentration			Chemical Status
					Yr 1	Yr 2	Yr 3	
DEHP	35	μgL^{-1}	1.3	0	Less than LOD/LOQ			Good
Diuron	36	μgL^{-1}	0.2	0	Less than LOD/LOQ			Good
Lead (Dissolved)	36	μgL^{-1}	1.3	0	0.046	0.15	0.2	Good
Nonylphenol	36	μgL^{-1}	0.3	0	0.187	Less than LOD/LOQ		Good
Octylphenol	36	μgL^{-1}	0.01	0	Less than LOD/LOQ			Good

The overall chemical status of the central bay site with respect to the concentrations of EU Priority Substances in seawater is considered to be 'Good'.

No octylphenol was detected in any of the seawater samples from the central bay site, however, the reported LOD was greater than the EQS in all analysed samples. Therefore the applied LOD was insufficiently sensitive to assess the concentration of octylphenol against its EQS value and it is possible that the EQS was exceeded. Therefore, if a laboratory can be sourced that can offer a suitably sensitive analytical method for this substance we would recommend that any future chemical monitoring includes this substance to provide clarity on the compliance or non-compliance of environmental concentrations with the EQS value.

Table 3.2 Chemical Status Assessment for Seawater at the Port Site

Substance	No. of Samples Taken	Units	EQS	No. of Individual Samples Failing EQS	Annual Average Concentration			Chemical Status
					Yr 1	Yr 2	Yr 3	
Lead (Dissolved)	37	μgL^{-1}	1.3	0	0.1	0.1	0.2	Good
Nickel (Dissolved)	35	μgL^{-1}	8.6	0	0.18	0.31	0.43	Good
TBT	33	μgL^{-1}	0.0002	3	0.0003	Less than LOD/LOQ	0.00039	Good*

* See explanation below.

The overall chemical status of the port site with respect to the concentrations of EU Priority Substances in seawater is considered to be 'Good'.

TBT was detected in three seawater samples from the port site. While the apparent 'failure' of the EQS for this substance is partly an effect of half the limit of detection being greater than the EQS, the detections of TBT significantly exceeded the EQS value. Because of the

magnitude of these exceedances, the failure of the annual average concentration to meet the EQS value must be considered valid. However, where the annual average concentration of a substance exceeds the EQS, it is necessary to assess the confidence of this failure by evaluating the distribution of the individual measurements used to calculate the annual average (this allows account to be taken of potential errors and uncertainties in the sampling and analysis processes). Generally, a confidence of failure which is less than 95% (0.95) is considered uncertain, and would not result in improvement measures.

This confidence of the TBT failure for this assessment is 0.95 and 0.96 for the Year 1 and Year 3 annual assessments, respectively, and therefore this EQS failure would generally be considered to be certain. However, despite the high exceedences (n=3), we do not consider the annual average values to be reliable owing to the predominance of censored values in the dataset, and therefore we have not proposed a chemical status classification based on this apparent EQS failure. However, if a laboratory can be sourced that can offer a suitably sensitive analytical method for this substance we would recommend that any future chemical monitoring includes this substance to provide clarity on the compliance or non-compliance of environmental concentrations with the EQS value.

Table 3.3 Chemical Status Assessment for Seawater at the La Collette Site

Substance	No. of Samples Taken	Units	EQS	No. of Individual Samples Failing EQS	Annual Average Concentration			Chemical Status
					Yr 1	Yr 2	Yr 3	
Cadmium (Dissolved)	35	μgL^{-1}	0.2	0	0.023	0.015	0.022	Good
Lead (Dissolved)	36	μgL^{-1}	1.3	1	0.24	0.054	0.22	Good
Naphthalene	35	μgL^{-1}	2	0	0.011	Less than LOD/LOQ		Good
Nickel (Dissolved)	35	μgL^{-1}	8.6	0	0.6	0.32	0.41	Good

The overall interim chemical status of the La Collette reclamation site with respect to the concentrations of EU Priority Substances in seawater is considered to be 'Good'.

3.1.2 Biota

Since only a small number of separate samples of slipper limpets were taken across the whole of the bay within the biota monitoring programme (between five and seven, depending on the substance), the results from all the sites have been combined in order to allow the calculation of average values over the entire long-term monitoring programme. This does not represent an 'annual average' approach to assessment but does provide an indication of chemical status, compared to the relevant EQS value.

Table 3.4 shows the chemical status assessment for biota in St. Aubin's Bay.

Table 3.4 Chemical Status Assessment for Biota in St.Aubin's Bay

Substance	No. of Samples Taken	Units	EQS	No. of Individual Samples Failing EQS (%)	Average Concentration	Chemical Status Classification
Benzo(a) pyrene[1]	5	µg kg^{-1} wet weight	5	1	9.68	Less Than Good[2]
Fluoranthene	6	µg kg^{-1} wet weight	30	1	17.9	Good
Mercury	7	µg kg^{-1} wet weight	20	0	11.7	Good

[1] For the polyaromatic hydrocarbons (PAH), the biota EQS refers to the concentration of benzo(a)pyrene. Benzo(a)pyrene can be considered as a marker for the other PAHs, hence only benzo(a)pyrene needs to be compared with the biota EQS

[2] See explanation below

The overall chemical status of St. Aubin's Bay with respect to the concentrations of EU Priority Substances in biota is considered to be 'Less Than Good' and is driven entirely by the extremely high benzo(a)pyrene concentration detected in biota taken from St. Aubin's Beach in September 2015 (the final samples taken for the biota monitoring programme). A very high fluoranthene concentration was also detected in the same set of biota samples.

Since biota will accumulate contaminants to which they are exposed (via water, sediment or food) over time, the measurement of substance concentrations in biota on only one or two occasions per year is essentially equivalent to more frequent (e.g. monthly) water sampling over a similar period. Thus, the results of the biota monitoring programme suggest that failure of 'Good' status is limited to a discrete area of the bay (St. Aubin's Beach). Since the samples taken in September 2015 were the only samples taken from this location over the programme, it is not clear if such high concentrations are representative of biota concentrations in this area as a whole.

All of the other biota samples taken for the monitoring programme were obtained in open water, while the samples from St. Aubin's Beach were collected along the shoreline. In addition, it was reported that these slipper limpets had washed up on the beach and had never been previously observed in this location, so were unlikely to represent a resident population.

Given that the sample of slipper limpets taken from St. Aubin's Beach was anomalous in terms of the sampling strategy compared to all the other samples taken in the programme, and represented the only samples taken from the beach, it is proposed that these are excluded from the overall chemical status assessment for biota. The concentration of benzo(a)pyrene would then be below the limit of detection in all samples and the chemical status would be considered to be 'Good'.

3.2 Ecological Status

3.2.1 Physico-Chemical Indicators

The ecological status of the bay according to the physico-chemical parameters, dissolved oxygen and dissolved inorganic nitrogen has been assessed based on all measurements made across all five seawater sampling sites. The results of this assessment are shown in Table 3.5, below.

Table 3.5 Physico-Chemical Assessment for St. Aubin's Bay

Determinand	Units	No. of Samples	Result			Ecological Status
			Yr 1	Yr 2	Yr 3	
Dissolved Oxygen	mgL^{-1}	159	7.15[1]	7.94[1]	7.96[1]	High
Dissolved Inorganic Nitrogen	$\mu molL^{-1}$	97	No Result	20.37[2]	10.34[2]	Moderate

[1] 5th Percentile; All individual measurements normalised to a salinity of 35 ‰ based on measured salinity of each sample.

[2] Mean of all measurements from samples taken between Nov and Feb; 0.5 * LOD used to calculate mean where individual results < LOD.

The ecological status of coastal waterbodies is generally evaluated using the inorganic nitrogen concentrations measured in samples taken between November and February at a coastal salinity of 30-34.5 ‰. The salinity of the waters in St. Aubin's Bay is, however, consistently in excess of 34.5 ‰.

The relationship between salinity and dissolved inorganic nitrogen concentration was assessed, but there was not found to be significant linear relationship between these measurements (R^2=0.0005) for the coastal waters in St. Aubin's Bay. This may be owing to the high proportion of 'censored' values in the dataset and the high salinities of the waters in the bay.

In addition, the turbidity of the waters were determined qualitatively, rather than by measuring the concentration of suspended solids, which did not allow the measured inorganic nitrogen result to be compared with a turbidity-adjusted standard value.

Nevertheless, the coastal water standards have been applied (with no salinity adjustment and assuming 'clear' turbidity) and result in an ecological status of 'Moderate' for dissolved inorganic nitrogen (based on the Year 2 annual result).

3.2.2 Specific Pollutants

The Specific Pollutant ecological status assessment is based on the measured concentrations of those UK Specific Pollutants monitored in the longer term chemical monitoring programme at each site.

For each substance measured at each site, an annual average concentration has been calculated as the mean substance concentration across all the monthly seawater samples taken in the chemical monitoring programme.

The limit of detection (LOD) is the analytical concentration value above which it can be affirmed that a sample concentration is different from a blank sample containing no determinand of interest. The limit of quantification (LOQ) is a stated multiple of the limit of detection at a concentration of the determinand that can reasonably be determined with an acceptable level of accuracy and precision.

The concentration of a substance that is reported as below the LOD or LOQ in a sample cannot be reliably quantified but may range from none (zero) up to the detection or quantification limit itself. Such so-called 'censored' analytical values present problems when attempting to calculate an average concentration for a substance.

We have therefore also applied the pragmatic approach to the calculation of annual average concentrations for Specific Pollutants as described in Section 3.1 for Priority Substances.

Tables 3.6 to 3.8 show the ecological status assessments according to UK Specific Pollutants for seawater for the three sites within St. Aubin's Bay.

Table 3.6 Specific Pollutant Assessment for Seawater at the Central Bay Site

Substance	No. of Samples Taken	Units	EQS	No. of Individual Samples Failing EQS	Annual Average Concentration			Chemical Status
					Yr 1	Yr 2	Yr 3	
2,4 Dichlorophenol	36	μgL^{-1}	0.42	0	Less than LOD/LOQ			Good
2,4 D	36	μgL^{-1}	0.3	0	Less than LOD/LOQ			Good
Ammonia (unionized)	36	μgL^{-1}	21	8	14.3	66.1	42.5	Good
Arsenic (Dissolved)	36	μgL^{-1}	25	0	1.35	1.27	1.45	Good
Copper (Dissolved)	36	μgL^{-1}	3.76	0	0.18	0.67	0.72	Good
Mecoprop	36	μgL^{-1}	18	0	Less than LOD/LOQ			Good
Zinc (Dissolved)	36	μgL^{-1}	7.9	2	1.14	9.2	1.85	Good

The overall ecological status of the central bay site with respect to the concentrations of UK Specific Pollutants is considered to be 'Good'.

While the annual average concentration for unionized ammonia exceeded the EQS in both Year 2 and Year 3, this was based on some extremely high concentrations of unionized ammonia in a small number of isolated samples (maximum concentration of 663 μgL^{-1}). Since the majority of the samples taken complied with the EQS, the confidence of failure for both Year 2 and Year 3 was less than 0.95 (0.79 and 0.8, respectively) and therefore the exceedances are not considered reliable, and do not result in the overall chemical status of the bay being classed as 'Less than good'.

Similarly, the annual concentration for zinc also exceeded the EQS value in Year 2. This was again caused by two extreme exceedances in individual samples. The confidence of failure for Year 2 was less than 0.95 (0.6) and therefore the Year 2 EQS exceedance is not considered reliable.

Table 3.7 Specific Pollutant Assessment for Seawater at the Port Site

Substance	No. of Samples Taken	Units	EQS	No. of Individual Samples Failing EQS	Annual Average Concentration			Chemical Status
					Yr 1	Yr 2	Yr 3	
Ammonia (unionized)	36	μgL^{-1}	21	5	10.17	9.04	12.33	Good
Arsenic (Dissolved)	36	μgL^{-1}	25	0	1.43	1.35	1.29	Good
Copper (Dissolved)	37	μgL^{-1}	3.76	2	0.53	1.25	1.31	Good
Zinc (Dissolved)	37	μgL^{-1}	7.9	1	2.4	2.68	3.91	Good

The overall ecological status of the port site with respect to the concentrations of UK Specific Pollutants is considered to be 'Good'.

Table 3.8 Specific Pollutant Assessment for Seawater at the La Collette Site

Substance	No. of Samples Taken	Units	EQS	No. of Individual Samples Failing EQS	Annual Average Concentration			Chemical Status
					Yr 1	Yr 2	Yr 3	
Ammonia (unionized)	36	μgL^{-1}	21	4	9.42	10.06	9.88	Good
Arsenic (Dissolved)	36	μgL^{-1}	25	0	1.44	1.23	1.41	Good
Copper (Dissolved)	36	μgL^{-1}	3.76	3	1.04	1.38	1.02	Good
Zinc (Dissolved)	36	μgL^{-1}	7.9	4	6.14	1.88	3.34	Good

The overall ecological status of the La Collette reclamation site with respect to the concentrations of UK Specific Pollutants is considered to be 'Good'.

3.2.3 Phytoplankton

The ecological assessment according to phytoplankton is an indicator of nutrient pressures on a waterbody, and is based on three separate metrics.

The bloom frequency is a measure of the frequency of which the overall phytoplanktonic density exceeds certain threshold levels. A high frequency of phytoplanktonic blooming is an indicator of excess nutrients being available in the waterbody.

The seasonal succession of phytoplankton is based on the exceedance of specific temporal boundary values for the numbers of diatom and dinoflagellate cells.

The biomass is simply a measure of the total density of phytoplankton in a sample, based on the total concentration of chlorophyll-a.

3.2.3.1 Bloom Frequency

Table 3.9 shows the results of the bloom frequency assessment for St. Aubin's Bay as a whole.

Table 3.9 Bloom Frequency Assessment for St. Aubin's Bay

Metric	Measurement	Value
Chlorophyll Bloom Frequency	Proportion of samples with chlorophyll a > 10 µg/L	0
Individual Taxa Bloom Frequency	Proportion of samples with any single taxa > 250,000 cells per litre	0.103
Total Taxa Bloom Frequency	Proportion of samples with total phytoplankton > 1,000,000 cells per litre	0.0074
Phaeocystis Bloom Frequency	Proportion of samples with *Phaeocystis* > 1,000,000 cells per litre	0
Combined Bloom Frequency	Mean of individual metrics	0.03
Reference Value	10	
Ecological Quality Ratio (EQR)[1]	1.11	
Normalised EQR[2]	1	
Ecological Status	**High**	

During the first year of the monitoring programme (2012-13), none of the bloom frequency indicators were exceeded in any of the samples taken. Based on similar surveys undertaken in the UK, this outcome was considered as unusual, since such surveys in the UK generally indicate the exceedance of one or more of the bloom frequency indicator thresholds, even if the overall frequency is low (and therefore the status is 'Good' to 'High'). This could, therefore, be an indication of potential issues with the sampling or preservation of samples for phytoplankton analysis.

In an attempt to address these potential issues, improvements were made to the sample processing method for Year 2 and 3 of the programme. In addition, two additional sites were added to the phytoplankton monitoring programme, and the port site was dropped.

In Year 2 and 3 of the programme, the two taxa bloom frequency metric thresholds were exceeded in a very small number of samples, although this has had little effect on the overall status assessment.

Based on the assessment of these results, the ecological status of the bloom frequency metric is considered to be 'High'.

3.2.3.2 Seasonal Succession

Table 3.10 shows the seasonal succession assessments for the five seawater sampling sites in St. Aubin's Bay.

Table 3.10 Overall Seasonal Succession Assessment for St. Aubin's Bay

Site	Season Succession Indicator	Reference Value	Ecological Quality Ratio (EQR)	Normalised EQR	Ecological Status
Central Bay	29.7	80	0.37	0.45	Moderate
Port (Year 1 only)	41.7		0.52	0.65	Good
La Collette	39.8		0.47	0.61	Good
Offshore (Years 2-3 only)	30		0.38	0.49	Moderate
Belcroute (Years 2-3 only)	32		0.4	0.52	Moderate
Overall St. Aubin's Bay	**NA**	**NA**	**NA**	**0.54[4]**	**Moderate**

The lack of any dinoflagellates in many of the seawater samples is a cause for concern, and may suggest some continuing issues with sampling or the preservation of samples, despite the improvements made (as described in section 3.2.3.1).

Based on the assessment of these results, the ecological status of the seasonal succession metric is considered to be 'Moderate'.

3.2.3.3 Biomass

Table 3.11 shows the phytoplankton biomass assessment for the five seawater sampling sites in St. Aubin's Bay.

Table 3.11 Phytoplankton Biomass Assessment for St. Aubin's Bay

Site	No. of Samples	Chlorophyll-a (μgL^{-1}, 90th Percentile)	Reference Value	Ecological Quality Ratio (EQR)	Normalised EQR	Interim Ecological Status
Central Bay	39	1.95	6.67	3.4	1	High
Port (Year 1 only)	13	1.06		6.3	1	High
La Collette	39	1.93		3.5	1	High
Offshore (Years 2-3 only)	26	2.65		2.5	1	High
Belcroute (Years 2-3 only)	26	2.25		3	1	High
Overall St. Aubin's Bay	**NA**	**NA**	**NA**	**NA**	**1[4]**	**High**

As with the low numbers of phytoplankton cells indicated by the dinoflagellate element of the seasonal succession assessment, the chlorophyll-a concentrations of seawater samples (indicating total phytoplankton biomass) are much lower than would be expected based on the results of similar surveys undertaken in the UK. This may suggest an ongoing issue with the sampling of seawater samples, the filtration of samples to obtain chlorophyll-a samples or the storage of the chlorophyll-a samples following sample filtration.

Based on the assessment of these results, the ecological status of the phytoplankton biomass metric is considered to be 'High'.

3.2.3.4 Summary of Phytoplankton Assessments

Table 3.12 summarises the overall ecological status of the bay according to phytoplankton, based on the data obtained in the St. Aubin's Bay monitoring programme. The results are presented as overall interim status assessments for each metric (across all five sites) and for each site (across all three metrics).

Table 3.12 Overall Ecological Status of St. Aubin's Bay for Phytoplankton

Metric	Site	Normalised EQR	Mean EQR	Ecological Status
Biomass	Central Bay	1	1	High
	Port (Year 1 only)	1		
	La Collette	1		
	Offshore (Years 2-3 only)	1		
	Belcroute (Years 2-3 only)	1		
Bloom Frequency	Central Bay	1	1	High
	Port (Year 1 only)			
	La Collette			
	Offshore (Years 2-3 only)			
	Belcroute (Years 2-3 only)			
Seasonal Succession	Central Bay	0.45	0.54	Moderate
	Port (Year 1 only)	0.65		
	La Collette	0.61		
	Offshore (Years 2-3 only)	0.49		
	Belcroute (Years 2-3 only)	0.52		
Site	**Metric**	**Normalised EQR**	**Mean EQR**	**Ecological Status**
Central Bay	Biomass	1	0.82	High
	Bloom Frequency	1		
	Seasonal Succession	0.45		
Port (Year 1 only)	Biomass	1	0.88	High
	Bloom Frequency	1		
	Seasonal Succession	0.65		
La Collette	Biomass	1	0.87	High
	Bloom Frequency	1		
	Seasonal Succession	0.61		
Offshore (Years 2-3 only)	Biomass	1	0.83	High
	Bloom Frequency	1		
	Seasonal Succession	0.49		
Belcroute (Years 2-3 only)	Biomass	1	0.84	High
	Bloom Frequency	1		
	Seasonal Succession	0.52		
Overall Ecological Status for Phytoplankton	**NA**	**NA**	**0.85**	**High**

While the metric-specific assessment for seasonal succession indicates 'Moderate' ecological status, the other two metrics indicate 'High' ecological status. When the EQR results are

averaged across each site, the lack of response for the biomass and bloom frequency indicators balance the effects measured in the seasonal succession assessment, and the overall status for all three sites (and therefore the bay as a whole) is 'High'. This suggests minimal impacts by nutrient enrichment.

3.2.4 Macroalgae

The ecological assessment according to macroalgae is an indicator of nutrient pressures on a waterbody. The assessment is based on two separate indicators for which the ecological status is derived independently.

The rocky shore macroalgal assessment is a measure of the total number of seaweed species and the relative proportions of different groups of seaweed species at a site.

The opportunistic macroalgal assessment measures the extent of beds and biomass for opportunistic intertidal seaweed species.

3.2.4.1 Rocky Shore Macroalgae

Table 3.13 summarises the overall ecological status of the bay according to rocky shore macroalgae, based on the data obtained in the St. Aubin's Bay monitoring programme.

Table 3.13 Overall Ecological Status of St. Aubin's Bay for Rocky Shore Macroalgae

Year	Site	Normalised EQR	Mean EQR	Ecological Status
2012	St. Aubin's Fort	0.54	0.59	Moderate
	Elizabeth Castle	0.69		
	Beach Rock	0.54		
2013	St. Aubin's Fort	0.79	0.7	Good
	Elizabeth Castle	0.67		
	Beach Rock	0.65		
2014	St. Aubin's Fort	0.6	0.64	Good
	Elizabeth Castle	0.72		
	Beach Rock	0.58		
2015	St. Aubin's Fort	0.74	0.67	Good
	Elizabeth Castle	0.82		
	Beach Rock	0.45		
Overall Ecological Status for Rocky Shore Macroalgae			**0.65**	**Good**

The overall ecological status for the bay as a whole is 'Good' for rocky shore macroalgae.

The rocky shore macroalgal assessment is made up of five metrics – number of taxa, proportion of chlorophytes, proportion of rhodophytes, proportion of opportunistic species, and a final metric based on the ecological status group of species present.

Across the entire monitoring programme, the 'number of taxa' metric has consistently demonstrated the most impact, with 'Poor' (2013, 2014) to 'Moderate' (2012, 2015) status across all three monitored sites in St. Aubin's Bay. The 'opportunistic species' metric also demonstrated 'Moderate' status in the 2012, 2014 and 2015 surveys, but 'Good' status in 2013. The 'rhodophytes' metric also demonstrated 'Moderate' status in 2013, but 'Good' status in all the other individual annual surveys. Overall, the 'Good' to 'High' status of the other metrics generally balanced out any 'Poor' or 'Moderate' status assessments for individual metrics, resulting in an overall 'Good' status. In 2012, the overall status was 'Moderate' based on a mean EQR across sites and metrics of 0.59 however, this is only very slightly below the threshold for 'Good' status for rocky shore macroalgae (0.6).

The Beach Rock site has consistently demonstrated the lowest normalised rocky shore macroalgae EQR across all five metrics, relative to the other two sites, although in 2012 Beach Rock showed an identical EQR to St. Aubin's Fort (0.54, 'Moderate'), and in 2013 and 2014 the Beach Rock EQR was only slightly less than the Elizabeth Castle and St. Aubin's Fort site EQRs, respectively. In 2015, however, the Beach Rock showed an EQR that almost 50% lower than the other two sites.

In 2015, States of Jersey commissioned Lin Baldock to undertake an 'audit survey' of the rocky shore macroalgae at the three sites in St. Aubin's Bay used for monitoring of this element of the WFD ecological status assessment (Baldock 2015). Therefore, the assessment undertaken in 2015 is likely to be more accurate than previous annual assessments, since it was undertaken as an audit of the procedures and approaches applied, and was performed by a recognised expert in the field of macroalgal identification and the habitat and site characteristics required for seaweed growth. Owing to the variable quality status indicated by the metrics for the Beach Rock site, Lin Baldock recommended that the data from Beach Rock are not included in the overall status assessment for rocky shore macroalgae in St. Aubin's Bay, but that the site should be continued to be monitored as a reference location for changes in the macroalgal community in the central area of the bay (Baldock 2015).

The removal of the Beach Rock data from the dataset elevates the overall EQR (all sites, all years) slightly from 0.65 to 0.7, but does not affect the overall ecological status, which remains 'Good'.

3.2.4.2 Opportunistic Macroalgae

Table 3.14 shows the results of the ecological status assessment for opportunistic intertidal macroalgae.

Table 3.14 Opportunistic Macroalgae Assessment for St. Aubin's Bay

Year	Mean EQR[1]	Ecological Status
2012	0.54	Moderate
2013	0.55	Moderate
2014	0.45	Moderate
2015	0.38	Poor
Overall Ecological Status for Opportunistic Macroalgae	**0.48**	**Moderate**

The overall ecological status for the bay as a whole is 'Moderate' for opportunistic macroalgae.

The opportunistic macroalgal assessment is made up of five metrics – percentage cover of intertidal habitat, biomass cover of intertidal habitat, biomass of affected area, proportion of entrained algae, and either the total affected area in hectares or the percentage affected area (whichever has the lower EQR).

Across the entire monitoring programme, the 'entrained algae' metric has consistently demonstrated the most impact, with 'Bad' (2014) to 'Poor' (2012, 2013, 2015) status in St. Aubin's Bay. The 'biomass of affected area' metric also demonstrated 'Poor' status in the 2012, 2014 and 2015 surveys, but 'Good' status in 2013. The 'affected area' metrics demonstrated 'Moderate' status in 2012 and 2013, but deteriorated to 'Poor' status in the 2014 and 2015 surveys. The 'percentage cover of habitat' and 'biomass of habitat' metrics have consistently demonstrated higher EQR values than the other metrics ('Good' to 'High' for 2012-2014), but even these show only 'Moderate' status in the 2015 survey. Overall, the 'Moderate' to 'High' status of these two metrics generally balanced out any 'Poor' or 'Bad' status assessments for the other individual metrics, resulting in an overall 'Moderate' status.

3.2.5 Seagrass

The ecological assessment according to seagrass is an indicator of nutrient pressures on a coastal waterbody. Seagrass beds are particularly sensitive to the secondary pressures of nutrient enrichment and may decrease in size and diversity owing to encroachment by opportunistic macroalgae or shading by phytoplankton.

There are two distinct beds of seagrass in St. Aubin's Bay, one in the east and one in the west.

Table 3.15 shows the results of the ecological status assessment for seagrass in St. Aubin's Bay.

Table 3.15 Seagrass Assessment for St. Aubin's Bay

Year	Mean EQR[1]	Ecological Status
2012	1	High
2013	0.76	Good
2014	1	High
2015	0.67	Good
Overall Ecological Status for Opportunistic Macroalgae	**0.86**	**High**

[1] Mean across all metrics

Overall, the seagrass assessment suggests that there is minimal impact on seagrass beds caused by the secondary impacts of nutrients and that the ecological status according to seagrass is 'High'.

The seagrass assessment is made up of three metrics – taxonomic composition, shoot loss, and bed extent loss.

Between 2012 and 2014 (covering three annual surveys), all of these metrics returned results indicating 'High' ecological status, with the exception of the 2013 'shoot loss' assessment which indicated 'Moderate' status (and thus relegated the overall seagrass status for 2013 to 'Good', based on the average of the three metrics).

However, the results of the 2015 survey show 'Moderate' status for both the 'shoot loss' and 'bed extent' metrics. The 'taxonomic composition' metric remains at 'High' status because only one species of seagrass occurs in the St. Aubin's Bay area, and this means that the overall 2015 status is 'Good', based on all three metrics. While the 'shoot loss' metric was also of 'Moderate' status in 2013, and returned to 'High' status in 2014, demonstrating some fluctuation (die-off and re-growth) in the seagrass beds, the overall extent of the beds appears to have reduced considerably between 2014 and 2015.

There are, however, some differences in the way the extent of the seagrass beds was assessed in 2015. The bed perimeter data has been estimated from ground level photographs of the beds based on a 100 metre grid, rather than being measured from an aerial photograph. The 'non-aerial' photographic method of assessing bed extent is not designed to provide an accurate measurement, and therefore the 2015 bed extent data can only be considered to be an estimate.

Qualitative reports from the 2015 survey suggest that the seagrass beds have not expanded since 2014 and, based on the shoot loss data, it does appear that there has been some loss in the extent of the beds, but they may not have shrunken as much as the estimates suggest.

3.2.6 Benthic Invertebrates

The ecological status according to benthic invertebrates is generally an indicator of toxicity caused by chemical contamination.

Table 3.16 shows the results of the ecological status assessment according to IQI across all three sampling sites in the bay (summer and winter surveys).

Table 3.16 Benthic Invertebrate Assessment for St. Aubin's Bay

Month/ Year	Site	EQR	Ecological Status
May 2012	Mid-bay	0.96	High
	Elizabeth Castle	0.97	High
	Harbour	0.23	Bad
October 2012	Mid-bay	0.9	High
	Elizabeth Castle	1.01	High
	Harbour	0.37	Poor
2013	Mid-bay	0.75	High
	Elizabeth Castle	1.03	High
	Harbour	0.69	Good
May 2014	Mid-bay	0.76	High
	Elizabeth Castle	0.98	High
	Harbour	0.25	Poor
August 2014	Mid-bay	0.76	High
	Elizabeth Castle	0.96	High
	Harbour	0.37	Poor
May 2015	Mid-bay	0.59	Moderate
	Elizabeth Castle	1.07	High
	Harbour	0.52	Moderate
August 2015	Mid-bay	0.73	Good
	Elizabeth Castle	1.1	High
	Harbour	0.31	Poor
Overall Ecological Status for Benthic Invertebrates		**0.73**	**Good**

The overall ecological status of the bay according to IQI, based on this assessment, is 'Good'.

In general, the benthic invertebrate assessments carried out at the Mid-bay and Elizabeth Castle sites displayed 'Good' to 'High' status in all surveys, although the Mid-bay site did drop to 'Moderate' status in the May 2015 survey, before recovering to 'Good' in the August 2015 survey.

The Harbour site has, however, generally displayed 'Bad' to 'Poor' status across the monitoring programme, although did show 'Moderate' status in May 2015 and 'Good' status in 2013. Given that this site is situated within a highly developed and active harbour area, it is unsurprising that the benthic ecology is impoverished compared to reference (unimpacted) conditions, and this suggests that it is possibly not suitable for WFD ecology assessments.

The 'Good' to 'High' status of the other two sites does nevertheless balance the low status of the Harbour site, and hence the overall ecological status across all three sites remains 'Good'. This would be expected to be 'High' if an alternative 'natural' site were substituted for the Harbour.

3.2.7 Imposex

The ecological status assessment according to imposex is designed to evaluate the potential for sub-lethal toxic effect on common dogwhelk populations, caused by exposure to TBT.

As TBT was detected in seawater from the port site, an imposex assessment was necessary to complete the ecological status assessment of the bay.

Table 3.17 shows the results of the ecological status assessment for imposex, based on two surveys of imposex carried out in August and September 2012.

Table 3.17 Imposex Assessment for St. Aubin's Bay

Metric	Value
Number of females	51
Total VDS	32
VDSI	0.63
Ecological Quality Ratio*	0.895
Interim Ecological Status	**Good**

* (6-[VDSI])/6

This indicates that imposex effects on dogwhelk populations in St. Aubin's Bay are minimal and the overall ecological status according to imposex can be considered to be 'Good'.

3.3 Overall Status Assessment

As outlined in Section 1.1, the overall environmental classification of the status of a waterbody according to the requirements of the WFD is based on a worst-case assessment. That is the waterbody is assigned the lowest status achieved across all the sites generating monitoring data and all the different pressure indicators that have been assessed.

Table 3.18 summarises the chemical and ecological status for each pressure indicator, based on the results obtained in the St. Aubin's Bay monitoring programme.

Table 3.18 Summary of Overall WFD Status Classifications for St. Aubin's Bay

Element	Metric	Status	Overall Status
Chemical Status	Priority Substances	Good	**Moderate**
Ecological Status	Physico-chemical Conditions	Moderate	
	Specific Pollutants	Good	
	Phytoplankton	High	
	Rocky Shore Macroalgae	Good	
	Opportunistic Macroalgae	Moderate	
	Seagrass	High	
	Benthic Invertebrates	Good	
	Imposex	Good	

The overall ecological status of the bay is based on the average EQR values for each individual indicator across all of the sites and therefore the overall interim status of the bay is considered to be 'Moderate'. This is driven by the opportunistic macroalgal assessments and dissolved inorganic nitrogen concentration, and suggests moderate impacts across the bay from nutrient enrichment.

4 DISCUSSION

4.1 Chemical Contamination

Based on the entire chemical monitoring programme that has been carried out in this assessment in St. Aubin's Bay, the overall chemical status of the bay according to the requirements of the WFD has been determined to be 'Good' and there appear to be few concerns with regard to contamination by toxic substances. . In addition, those ecological indicators designed to assess impacts from toxic chemicals (benthic invertebrates and imposex) both indicated overall 'Good' ecological status.

However, some substances did exceed the relevant EQS in single samples, suggesting peaks in the relevant substance concentration. Such peaks may be caused by increased inputs, reduced dilution or adverse weather conditions (which may suspend contaminants bound to sediments) at the time of sampling.

At the central bay site unionized ammonia exceeded its EQS value (21 μgL^{-1}) in eight separate monthly spot samples (of 36). The annual average for ammonia also exceeded the EQS in years two and three of the monitoring programme (66.1 and 42.5 μgL^{-1}, respectively), although the confidence of these failures was less than 0.95, and therefore the exceedances are not considered reliable and indicate extremely high concentrations in single samples (maximum concentration of 663 μgL^{-1}, almost 32 times the EQS value).

The Bellozanne sewage treatment works is likely to be the source of the vast majority of ammonia entering the bay. The concentrations of unionised ammonia measured in spot samples of treated sewage effluent monitored during the screening programme ranged from 1,650 to 27,900 μgL^{-1} suggesting that, at least over the three month effluent screening programme (May to July 2012), the sewage treatment works was relatively ineffective at nitrifying the ammonia entering the works. Nevertheless, it is clear that for the majority of the time there is sufficient dilution in the bay to reduce these inputs to below the EQS value. The measurement of 663 μgL^{-1} in a seawater sample taken from the central bay therefore suggests an extremely high treated effluent concentration of ammonia or a low available dilution at the time of sampling. This may mean that the concentration of ammonia in the bay routinely exceeds the EQS value when dilution is low (i.e. at low tide). It is therefore recommended that monitoring of ammonia is continued at the central bay site, particularly at periods of low dilution. It is expected that Phase 1 of the replacement of the Sewage Treatment works will result in a significant reduction of ammonia input into the Bay as a result of changes in the treatment process.

Similarly, the annual concentration for zinc also exceeded the EQS value in Year 2. This was again caused by two extreme exceedances in individual samples. The confidence of failure for Year 2 was less than 0.95 (0.6) and therefore the Year 2 EQS exceedance is not considered reliable.

Mercury, fluoranthene and other PAHs were detected in biota (slipper limpets) sampled from the central bay site, and exceeded the relevant EQS value in a single sample for fluoranthene

and benzo(a)pyrenene. While the single exceedence for fluoranthene was not sufficient to cause the average value (6 samples) to exceed the biota EQS, the exceedence in a single sample for the benzo(a)pyrene was high enough to bring the average concentration to almost twice the EQS (5 samples).

The overall chemical status of St. Aubin's Bay with respect to the concentrations of EU Priority Substances in biota is therefore considered to be 'Less Than Good' and is driven entirely by extremely high PAH concentrations detected in biota taken from St. Aubin's Beach in September 2015 benzo(a)pyrene concentration in the final samples taken for the biota monitoring programme). The benzo(a)pyrene concentrations in all other samples were below the analytical limit of detection.

All of the other biota samples taken for the monitoring programme were obtained in open water, while the samples from St. Aubin's Beach were collected along the shoreline. In addition, it was reported that these slipper limpets had washed up on the beach and had never been previously observed in this location, so were unlikely to represent a resident population.

Given that the sample of slipper limpets taken from St. Aubin's Beach was anomalous in terms of the sampling strategy compared to all the other samples taken in the programme, and were the only samples taken from the beach, it is proposed that these are excluded from the overall chemical status assessment for biota. The concentration of benzo(a)pyrene would then be below the limit of detection in all samples and the chemical status would be considered to be 'Good'.

There remains to be much discussion at an EU level with regard to the optimal approaches to be applied in monitoring against biota EQS, however these results at least indicate that these two substances are present in the central bay.

The impact of chemical contamination is also indicated by the benthic invertebrate element of the ecological status assessment under the WFD. The benthic invertebrate assessments carried out at the Mid-bay site indicated a 'High' status according to this metric for 2012-2014, and a 'Moderate' to 'Good' status for 2015, suggesting minimal impact on invertebrate communities owing to contamination by toxic substances in this area of the bay. This supports the chemical status assessments and indicates that the periodical peaks of ammonia concentration measured in the central bay are likely to be of relatively short duration and do not infer significant long-term effects on invertebrate communities.

At the port site, ammonia, copper and zinc exceeded their EQS values in individual samples (five, two and one sample, respectively), but these exceedances were insufficient to result in EQS exceedances according to the annual average concentrations. TBT exceeded its EQS value in 3 of 33 individual samples and for the Year 1 and Year 3 annual average concentrations (2012-13 and 2014-15).

Despite only three exceedances of the TBT EQS being measured in the port area (of 33 samples taken), the degree of this exceedance combined with the use of half the limit of detection (which was greater than the EQS value) for the other samples results in a calculated

annual average concentrations of 0.0003 and 0.00039 μgL^{-1} respectively for the Year 1 and Year 3 assessment which exceeds the EQS value (0.0002 μgL^{-1}). However, this is not considered to be a reliable failure of the EQS because the reported results for the majority of samples comprised 'censored' values.

Despite the obvious presence of TBT in the port area, the ecological assessment designed to assess the potential effects of TBT on biota, the assessment of imposex in dogwhelks, did not indicate any significant effects. Dogwhelk surveys carried out in the bay in August and September 2012 indicated a relatively low incidence of imposex, and overall 'Good' interim ecological status based on the imposex metric. This suggests that TBT concentrations are probably localised to the port area and that the dogwhelk populations in the bay have largely recovered from any more extensive contamination that may have occurred in the past.

Benthic invertebrate sampling was also carried out in the port area in order to determine its ecological status with respect to impacts from chemical contamination. Conversely to the other two sites at which benthic invertebrate assessments were carried out, the assessments of invertebrates in the port area suggested that communities were severely impacted (compared to reference conditions) and the ecological status (for this site specifically) was determined to be 'Bad' to 'Moderate' for surveys carried out from 2012 to 2015. This is not an unexpected outcome for such a highly developed site, and it is unsurprising that the benthic ecology is impoverished compared to reference (unimpacted) conditions. This suggests that this site is possibly unrepresentative of WFD ecological impact assessments, beyond those inferred by the use of the site as an active harbour.

The benthic invertebrate assessments carried out at the Elizabeth Castle site indicated a 'High' interim status according to this metric across the entire monitoring programme (2012-2015), suggesting minimal impact on invertebrate communities caused by toxic substances in this area of the bay. Given the proximity of this site to the port, it seems that the impacts on invertebrate communities apparent in the port do not extend beyond the area of concentrated shipping activity.

The three main sites at which monitoring was undertaken were selected on the basis of the likely primary sources of chemicals entering the bay which included the activities at the port. While the port is a highly modified site, it is nevertheless situated in the bay, and therefore contaminants discharged into the port area are able to enter the wider bay. However, while the port area is therefore relevant to the overall WFD status of the bay, in retrospect, its selection as one of the three sites used to assess the interim WFD status of St. Aubin's Bay was probably not ideal owing to it being a highly modified area which is unrepresentative of the bay as a whole. While the outcomes of ecological assessment suggested 'Less than good' status in this specific area, the overall ecological status (according to benthic invertebrates) is based on the assessment across all the sites in the bay, and the high status of the other two sites means that, on average, the results obtained in the port have not caused the overall interim status to be significantly affected. It is recommended, however, that any future monitoring to assess the status of the bay according to WFD requirements, should not be undertaken in the port and that a new 'third' site be selected which is more representative of the bay as a whole. The assessments made in the port area could also be completely removed

from the overall interim status assessment for the bay, which would result in the improvement of some metrics (e.g. the benthic invertebrate metric for the bay as a whole would improve from 'Good' to 'High' interim status), but would not result in an improvement of the overall status of the bay (which would remain 'Moderate').

At the La Collette reclamation site, EQS failures were observed in individual samples for ammonia, copper and zinc (four, three and four individual samples, respectively), although concentrations never exceeded their respective EQS values based on annual average concentrations.

4.2 Eutrophication

In order to assess the potential for nutrient impacts in the bay, a series of eutrophication indicators were assessed as part of the ecological monitoring programme. These included the measurement of dissolved inorganic nitrogen concentrations, and phytoplankton abundance and taxonomic diversity, in seawater samples taken from the central bay, port and La Collette reclamation sites, as well as the assessment of both rocky shore and opportunistic intertidal macroalgae, and seagrass beds. The rocky shore macroalgal assessment was undertaken at different sites from those at which chemical and phytoplankton monitoring was carried out, since it was necessary to select suitable rocky shore sites supporting seaweed growth. The opportunistic macroalgae and seagrass assessments were undertaken on a bay-wide basis covering the entire areas at which intertidal macroalgae or seagrass beds were present.

Based on the three year ecological monitoring programme there appears to be clear evidence of some impact from nutrients. The overall ecological status of the bay according to those metrics designed to assess impacts from nutrients was assessed to be 'Moderate' compared to reference conditions, and this overall interim WFD status classification of the bay is driven by the 'Moderate' ecological status determined in the dissolved inorganic nitrogen and opportunistic macroalgal assessments.

Dissolved inorganic nitrogen (DIN) concentrations were measured in seawater samples years two and three of the monitoring programme. In year one of the programme, only Total Inorganic Nitrogen (TIN) was measured, and while this was used as a surrogate measurement of the inorganic nitrogen status of the bay in the interim ecological assessment (wca 2013), the two types of measurement cannot be accurately combined, and therefore the overall status assessment has been based on year two and three DIN measurements only.

The indicator itself is based on the mean DIN concentration (as μmol^{-1}) across all seawater samples taken between November and February, adjusted to a salinity of 32 ‰ (based on the measured linear relationship between salinity and DIN). In addition, the standard against which the final adjusted DIN value is assessed is different depending upon the degree of measured turbidity of the seawater.

In the St. Aubin's Bay assessment, the mean results for DIN in years two and three were 20.4 and 10.3 μmol^{-1}, respectively. The higher value indicates 'Moderate' interim ecological status for inorganic nitrogen, however, some assumptions have been made in deriving this status.

Firstly, the defined ecological assessment of coastal waters according to DIN is based on those waters having a salinity of 30 to 34.5 ‰. The salinity of the waters in St. Aubin's Bay is in the range 35 to 36 ‰ and therefore the ecological status assessments established for UK coastal waters do not apply. This increased salinity compared to UK coastal waters is likely due to the small size of the Jersey landmass, and the lack of any substantial freshwater entering the bay, which make the waters surrounding the island more akin to UK offshore waters (which are not subject to WFD assessments). Despite the high salinity of the seawater samples, a derivation of the linear relationship between measured DIN and measured salinity was attempted, however, this did not produce reliable results owing to the use of half the limit of detection for most individual values for DIN in the derivation.

Secondly, no reliable turbidity measurements (as mgL^{-1} suspended solids) were derived in the monitoring programme so it was not possible to assess the appropriate standard to apply based on turbidity. In the absence of this data, it was assumed that the waters in St. Aubin's Bay were 'clear' and the standard for 'clear' waters was applied.

Despite these assumptions made in deriving the ecological status assessment for inorganic nitrogen, it is considered that the status assessment for this physico-chemical metric is indicative of conditions in the bay. We would nevertheless recommend that monitoring of DIN is continued to assess the trends in the concentrations of inorganic nitrogen entering the bay, going forward.

Assessments made across all three phytoplankton metrics (bloom frequency, seasonal succession and phytoplankton biomass) for each site indicated 'High' ecological status for all three sites individually, and also for the bay as a whole, although the seasonal succession metric returned a 'Moderate' status (average across all sites). Overall, this suggests minimal impact from nutrient enrichment in the bay.

Based on the monitoring carried out in this survey, the overall ecological status for rocky shore macroalgae for St. Aubin's Bay was 'Good', despite the interim ecological status (wca 2012) suggesting 'Moderate' status. The 'Moderate' status outcome for the 2012 (interim) assessment was marginal (mean EQR value of 0.59 against a threshold of 0.6 for 'Good' status to be achieved), while all subsequent assessment returned indicated 'Good' status (EQR = 0.6-0.7), and the apparent slight impacts of nutrient enrichment observed in 2012 have not been confirmed by the continued monitoring of this metric (2013-2015).

The 2012 assessment of opportunistic intertidal species also indicated that the bay was at 'Moderate' interim status with respect to nutrient impacts, however, unlike the rocky shore macroalgal assessment, this has been confirmed by further monitoring, and indeed the status of this metric appears to have worsened over the monitoring programme. The 2013 and 2014 assessment also indicated 'Moderate' status according to this metric, while the 2015 assessment indicated 'Poor' status. The overall status for the opportunistic intertidal species is therefore considered to be 'Moderate'.

The assessment of seagrass did not indicate any impacts (overall 'High' ecological status), although the overall extent of the seagrass beds does appear to have reduced considerably between 2014 and 2015. There are, however, some differences in the way the extent of the

seagrass beds was assessed in 2015. Qualitative reports from the 2015 survey suggest that the seagrass beds have not expanded since 2014 and, based on the shoot loss data, it does appear that there has been some loss in the extent of the beds, but they may not have shrunken as much as the estimates suggest.

The 'Moderate' ecological status outcomes for the inorganic nitrogen and opportunistic macroalgal indicators drive the entire WFD status classification of the bay (based on the 'one-out all-out' principle) and therefore the status classification of the bay has been determined to be 'Moderate'. On this basis, and considering the outcomes of all the status assessments as a whole (both nutrients and chemical contamination), nutrients are likely to be the primary issue affecting the bay with respect to this WFD status assessment.

The 'Moderate' interim status of the driving nutrient indicators (macroalgae), the potentially contradictory phytoplankton assessment (i.e. if it is assumed that the results obtained for phytoplankton are reliable) and the lack of reliable effects on seagrass does, however, suggest a 'borderline' rather than critical nutrient issue or that impacts caused by nutrients are only beginning to be realised. Thus, a continuation of the nutrient monitoring programme is critical to both confirm these assessments and to highlight any trends in impacts.

4.3 Implications for the Bellozanne Sewage Treatment Works

While the Bellozanne treated sewage effluent certainly discharges some EU Priority Substances and UK River Basin Specific Pollutants to St. Aubin's Bay, most notably ammonia, this assessment clearly indicates that, for the most part, these are not discharged at high enough concentrations to exceed EQS values (based on annual average assessments) in the receiving environment. Nevertheless, some 'spikes' of high ammonia concentration do appear to occur and, under lower dilution conditions, these can periodically exceed the EQS value and could potentially excerpt a toxic effect on macroinvertebrate communities in the bay.

This study has also indicated that it is pressures from nutrient inputs that are driving the current ecological status of St. Aubin's Bay and that a reduction in nutrient inputs is likely, in the longer-term, to result in an improvement of the ecological (and therefore overall) status of the bay.

Given the 'borderline' impacts currently realised in the bay, a reduction in nutrient concentrations discharged into the bay by the treated sewage effluent is likely to contribute towards reducing nutrient concentrations in the bay and may provide the basis for a relatively rapid recovery of the indicators of nutrient enrichment currently driving the ecological assessment. A separate monitoring program of the inshore zone of the Bay will help quantify this.

The regulator has considered the 'end of pipe treatment' but considers that the control of nutrients at source through implementation of the Water Plan is a lower cost and more sustainable approach for the Island. Notwithstanding, Environmental Protection have conditioned the regulatory road map for the replacement works to provide a safeguard against any deterioration from the present status and an overall aspiration toward good status.

5 RECOMMENDATIONS

Based on the outcomes and conclusions made on the basis of the chemical and ecological status assessments for St. Aubin's Bay, we make the following recommendations.

In order to assist in the classification process of Jersey's coastal waters, the coastline of Jersey has initially been divided into four waterbodies. St. Aubin's Bay sits within the Southern Coastline waterbody (Atkins 2014). This delineation is, however, preliminary and will need refinement to reflect the full array of characteristics, pressures, chemical inputs and expected quality of each coastal waterbody. Following this refinement, and based on the pressures identified for each waterbody, it may be necessary to revisit the environmental status assessment presented in this report, and to implement a similar programme of monitoring for other areas along the Jersey coastline.

The status assessment presented in this report focuses on one specific area of the Jersey coastline (St. Aubin's Bay and the immediate surrounding area), and the specific pressures and chemical inputs identified in this area (wca 2012). However, the Atkins study (Atkins 2014) on the challenges for the water environment of Jersey identified a wide range of pressures on the coastal environment of Jersey as a whole, including wastewater management, industry, fisheries and coastal aquaculture, road run-off, agriculture, tourism and recreation. While the WFD-based assessment reported here provides, as far as is currently possible, a holistic approach to evaluating the status of St. Aubin's Bay in response to such pressures, it is largely chemical focused, and only measures the concentrations, and long-term ecological effects, of chemicals entering the environment (from various sources). Other types of direct pressures from these sources (e.g. physical damage, overfishing, competition for space) are also likely to be important and should not be ignored when attempting to assess the overall condition of the coastal environment.

This status assessment is based on approximately three years of monitoring data, which is sufficient to derive an overall status for St. Aubin's Bay. However, the pressures acting on, and conditions in, the bay are not static and will continue to change over time, particularly since modifications to the sewage treatment works discharging into the bay are planned (in a phased manner) in the future. For this reason, it is recommended that monitoring is continued for a number of the elements assessed here, to ensure that any deterioration or improvement is highlighted as early as possible. This monitoring should include, as a minimum:

- EU Priority Substances which could not be monitored in this monitoring programme owing to the lack of an appropriate analytical method. These substances include aclonifen, alachlor, bifenox, the cyclodiene pesticides and quinoxyfen, and these should be monitored on a monthly basis in any future chemical monitoring programme.

- Any new EU Priority Substances, as they are added Water Framework Directive requirements, should also be monitored on a monthly basis in any future chemical monitoring programme.

- EU Priority Substances for which the analytical method applied in this monitoring programme was insufficiently sensitive to reliably assess compliance with the relevant EQS value (e.g. octylphenol and TBT) should be monitored on a monthly basis in any future chemical monitoring programme, using a more sensitive analytical method.

In general, this future chemical monitoring (other than that required to monitor nutrients) should follow the WFD River Basin Management Plan (RBMP) cycle and be re-assessed every five years.

- The monthly monitoring of dissolved inorganic nitrogen and ammonia should be immediately continued at the central bay, offshore and Belcroute sites, and should focus on periods of low dilution.

- A continuation of the phytoplanktonic (monthly), macroalgal (annual), seagrass (annual) and benthic invertebrate (6-monthly) monitoring programmes is considered essential to highlight any trends in impacts from nutrient enrichment or chemical contamination. For the rocky shore macroalgal assessment a substitute site should be identified for Beach Rock as this site was deemed to not to meet the WFD criteria for rocky shore macroalgal assessments.

The monitoring should as far as is possible, and accounting for the recommendations above, be undertaken at the same sites as monitored in this programme to maintain consistency and allow a reliable demonstration of changes over time, with the exception of the port site. The port site is highly modified (relative to reference conditions) and subject to substantial and ongoing pressures from port, shipping and boating activity. Therefore, an assessment that seeks to evaluate the deviation of such a site from reference conditions will invariably demonstrate high impacts, and could bias the overall assessment of more subtle pressures in the same area.

Given that the driving pressures on St. Aubin's Bay appear to be related to eutrophication, it is important that all sources of nutrients to the bay are controlled if the overall status is to be improved. While the sewage works is likely to be a primary source of such nutrients to this particular area of Jersey's coastline, the intensive agriculture on the island will also contribute nutrients. Therefore it will be important to work with farmers to develop initiatives aimed at tackling agricultural pollution.

The current assessment did not consider invasive species, since at the commencement of the programme, no guidance had been published on how to assess invasive species for coastal environments under the WFD. Invasive marine species will, however, be relevant for Jersey's marine environment (as they are in the UK and mainland Europe), and it is therefore recommended that, going forward, a programme of monitoring be developed for coastal invasive species.

Finally, while the chemical status assessments presented here are based on EU-wide Environmental Quality Standards, the ecological assessments are based on reference conditions applied in southern England (UKTAG 2007, 2008a-b, 2009a-c, 2012), and the

proximity of Jersey to the French coast may mean that the reference conditions applied to the nearest area of French coast may be more appropriate. It is therefore recommended that, if possible, the data collected as part of the monitoring programme reported be re-evaluated based on the relevant French reference conditions. Alternatively, given Jersey's small size and long coastline relative to its landmass, specific reference conditions for Jersey could be developed.

6 ACKNOWLEDEMENTS

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8 APPENDIX

St Aubin's Bay WFD Assessment - Chemica

St. Aubin's Bay WFD Assessment - Ecology