



lwandle
MARINE ENVIRONMENTAL SERVICES

MARINE DISCHARGE MONITORING

Specialist Review of Marine Surveys 2015/2016

PREPARED FOR:



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REPORT REF: LT-570-WS1 CoCT Discharges Peer Review V 1.0

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1 INTRODUCTION

The City of Cape Town (CoCT) appointed the CSIR to conduct a scientific assessment of the impact of effluent discharges through the Green Point, Camps Bay and Hout Bay outfalls on the receiving environment. Through a measurement programme the assessment evaluated effects on receiving water quality, sediment properties and levels of contaminants in seafood organisms (mussels and crayfish (kreef)) collected from sites adjacent to the outfalls. The CSIR study was designed to assist CoCT's application for Coastal Waters Discharge Permits (CWDPs) for the outfalls, inform the city on outfall performance and identifying needs, if any, for management interventions to improve performances, define ongoing monitoring strategies and, importantly, as a vehicle to inform Cape Town's residents on the outfalls and their respective performance.

As part of this process CoCT required that the CSIR assessment be subjected to a specialist peer review to help ensure that the assessment was scientifically sound. Following a competitive tendering process CoCT appointed Lwandle Technologies (Pty) Ltd (Lwandle) to carry out the required review which was conducted by Dr Robin Carter with assistance from Kate Dodds (Lwandle staff member).

2 TERMS OF REFERENCE, REVIEW MATERIALS & REVIEW STRUCTURE

2.1 TERMS OF REFERENCE

The specified terms of reference for the review required that the following be provided:

- o An overall review of the methods and approach employed in the CSIR assessment;
- o A review of the analyses, results and findings provided in the draft report;
- o A review of the conclusions and recommendations provided in the assessment; and
- o A clear determination of any flaws, inaccuracies, gaps and/or incorrect analysis in the report.

2.2 REVIEW MATERIALS

The review materials provided to Lwandle for the review was the draft report itself entitled: CSIR (2017) Cape Town Outfalls Monitoring Programme: Surveys made in 2015/2016. CSIR Report CSIR/NRE/ECOS/IR/2017/00XX/B. The report comprised 10 volumes including a Technical Report, eight volumes of figures and tables, and appendices.

CoCT also provided access to data files not included in the report.

2.3 REVIEW STRUCTURE

The review presented below addresses the set terms of reference in the following sections:

- o An overview of the report and adopted approach;
- o Detailed reviews of each of the survey report chapters;
- o Summary comments on possible flaws, gaps and assumptions in the report; and
- o A review of the overall conclusions reached.

3 REVIEW

3.1 OVERVIEW OF THE REPORT AND ADOPTED APPROACH

Consistent with the title of the focus of the report is on the impacts of discharges through three outfalls operated by CoCT on the Cape Peninsula at Green Point, Camps Bay and Hout Bay.

In Chapter 1 the CSIR provides informative detail on the nature of the effluents that are discharged along with their respective known and possible unknown sources and histories of the discharge structures leading up to their current configurations. This is followed by summarised information on the pre-discharge treatment of effluents at each of the respective outfalls. The main characteristics of the receiving environments are then adequately described, including the beneficial uses of these environments. In view of understanding the complexities of discharged effluent behaviour the most important component of this chapter is section 1.4 that provides a succinct overview of outfall design to optimise effluent dilution along with factors affecting the dilution and dispersion of discharged effluent in the receiving environment. This includes the important concept of the zone of initial dilution and dilution factors within this. We comment on this further in the detailed chapter reviews below.

The balance of the report follows the logical sequence of providing and discussing measurements used for effluent characterisation and effluent dilution in Chapter 2, measurements of whole effluent toxicity in Chapter 3 and measurements of water quality in the receiving environment along with seawater toxicity tests in Chapter 4. Chapter 5 addresses distributions of contaminants in seabed sediments and possibly associated toxicity effects, with human health risks possibly generated through effluent discharges being dealt with in Chapter 6. Chapter 7 summarises the overall conclusions and recommendations arising from the assessment.

The general approach adopted in the CSIR report is to present location specific empirical data and information focused on the topics being addressed and then invoke other survey and/or monitoring and/or research to provide further context(s) to their findings. This follows the general principle of employing multiple lines of evidence for determining risks and possible impacts from outfalls. The CSIR needs to be credited for this.

The field surveys conducted by CSIR followed standard practices and were methodologically robust. The effluent and receiving environment variables analysed for were comprehensive and included ‘emerging contaminants¹ of concern’, such as pharmaceutical products. It must be noted, however, that effluent itself is generally a complex mixture of compounds and obtaining a full listing and analyses of these is impractical. The analytical methods used are those generally applied in South Africa and have been shown to be robust. A caveat here is that these are not fully referenced in the text nor are the accreditation, e.g. SANAS, details provided for the laboratories that conducted the analyses. The level of interrogation that the data were subject to was intense and followed methods and approaches employed by CSIR in other survey work on outfalls and sediment property distributions in South Africa.

As pointed out above the use of multiple lines of evidence is a strength of the adopted approach and, in all but one case, ensured that the conclusions reached can be considered to be robust. The exception is human health risk assessment presented in Chapter 6. For reasons outlined in section 3.2.6 below we recommend that CSIR revise this chapter to ensure that it is robust to criticism². A further issue meriting attention by the authors are their remarks on effluent treatment alternatives in Chapter 7 of the report. We recommend that these be removed.

In summary the approach adopted by the CSIR for the 2015/2016 survey and analyses of the results was scientifically well founded and, in our view, would suit the purpose of presenting information on the marine outfalls to the public and forming a critical part of the CoCT’s CWDP application process once issues noted in the individual chapter reviews set out below have been addressed.

3.2 CHAPTER REVIEWS

3.2.1 Chapter 1: General Introduction

3.2.1.1 General Comments

The descriptive section provides adequate overview detail the three marine outfalls (Green Point, Camps Bay and Hout Bay) operated by CoCT, the effluents discharged, the receiving environment and beneficial uses, outfall design and effluent dispersion and dilution in the receiving environment. This is introductory material to more detailed descriptions and discussions in the later chapters. A central issue brought forward, however, is the assumption on initial dilutions used for determining probable compliance/non-compliance with water quality guidelines in the receiving environment. This deserves more evidence based evaluation than that given and should be elaborated in terms of current measurement data (suggested references in 3.2.1.2) as these influence choices on applied effluent dilution rates and their consequences.

¹ We use this term as pollution effects are not yet identified here

² We advise this as human health and marine outfalls are individually emotive issues and combined can generate adverse comment. Therefore survey results and linked conclusions need to be well founded.

3.2.1.2 Specific Comments/Queries

- o Page 1/paragraph 2: The authors should state that discharge of both domestic and industrial discharges to sea is an accepted practice in RSA within set conditions; i.e. marine discharges are not unique to Cape Town.
- o/paragraph 4: Generalise the statement about wastewater management to other coastal cities to emphasise that Cape Town is not unique here.
- o Page 2/paragraph 1: Restrict the effluent dilution statement to fresh water as, e.g., brine discharges from desalination plants may not achieve similar dilutions.
- o Page 3/paragraph 2: If known specify maceration levels in terms of particle size (mm).
- o Page 5/paragraph 3: Include current measurements from e.g. Nelson and Polito (1987) and others (e.g. Brown and Hutchings 1987) for the Cape Peninsula area.
- o Page 7/paragraph 3: The statement '.... expected to exceed 520,....' needs expansion – on what was this expectation based?
- o/paragraph 3: Please clarify statement on bacterial dilutions of '<1600 for 1% of the time and <31 for 90% of the time'. This only makes sense, to us at least, if the <1600 is actually >1600.
- o/paragraph 4: Clarify whether the 5 minute pump cycle still applies or was only operated during the initial phases of the discharge operation.
- o/paragraph 5: Specify whether the 8000, 6890 and 4043 dilutions were at some point distant from the discharge or at the boundary of the zone of initial dilution (ZID). If latter, is there an explanation why they are an order of magnitude than the other cited observations/ estimations.
- o Page 8/paragraph 1: The assumed 200x dilutions at the ZID boundary is applied throughout the assessment. It needs justification, or the prevalence of conditions under which it may apply need to be estimated, given the current data in Nelson and Polito (1987) and other sources for the Cape Peninsula area.

3.2.2 Chapter 2: Effluent Characterisation

3.2.2.1 General Comments

Knowing what is being discharged governs risk assessments for discharges as well as design of monitoring procedures in the receiving environment. The characterisation of the effluent includes the 'standard' variables but is considerably strengthened through estimates of so-called emerging contaminants of concern, notably cosmetics and pharmaceuticals. Also, the assessment shows that there are differences in effluent composition between the three outfalls, linking these to differing characteristics of their respective catchments. Comment is provided on compliance/non-compliance with the permit conditions. However, it is not stated whether the permit conditions are based on absolute limits or whether compliance should be on aggregated data at the 95th or

99th percentile to make allowances for short term 'spikes' in concentrations that may occur. This does not detract from the general conclusions on compliance though.

The CSIR also assess whether the discharged effluent would be compliant with emerging policy on coastal water discharge permits (Anchor 2016). Special Limits are employed for this based on the discharges being in or near semi-enclosed bays. Our understanding of this is that these limits apply if discharges are actually in such bays which are defined as being enclosed bodies of water with length axes within the bay being greater than the distance between the bay entrance headlands. None of the three discharges discussed are in such bays and consequently the general as opposed to special limits would apply.

Section 2.3.2 provides estimates of effluent constituent concentrations within the receiving water body at the ZID boundary. This section repeats some of the discussion given in Chapter 1 on initial dilution and defaults to the 200x for effluent discharged at greater than 20 m depth under calm conditions given in DWAF (2004). As noted before this may be overly conservative.

3.2.2.2 Specific Comments/Queries

- o Page 9/paragraph 5: Specify who conducted the effluent sample analyses and accreditation.
- o Page 10/paragraph 3: References to or details of the analytical techniques should be included in an appendix to the report.
- o/paragraph 9: It would be helpful to include known ranges for Kjeldahl nitrogen as this also relates to statements on limits being 'illogical'.
- o Page 12/paragraph 3: Disposal of unused medicine into the sewerage system is identified as a probable pathway for pharmaceuticals into effluents. This may occur but, if from storage areas such as commercial entities, this would probably occur in batch mode whilst the data indicate a more continuous source and thus possibly household sources. Source identification is not trivial as it informs intervention measures.
- o Page 13/paragraph 3: Clarify statement on <1600 colony forming units for 1% of the time (as above).
- o/paragraph 3: Specify whether the Botes and Kapp (1995) dilution estimates were at the ZID boundary or some point(s) further afield.
- o Page 15/paragraph 2: Refer to BCLME guidelines (CSIR 2006) as justification/support for employing the 80th percentile of the background concentration as a guideline.
- o Page 16/paragraph 2 (and elsewhere): The 'opinions of the scientists preparing the report' is advanced as justification in a number of instances in the assessment. The opinions are probably well informed but may be problematic to the wider readership. We recommend that this be avoided as far as possible.
- o Page 17/paragraph 1: The statement on implications of organic discharges on oxygen depletion is true but, due to naturally high turbulence in most open coastal areas in South Africa, should be rare here. We suggest that caveats be added to this statement.

- o/paragraph 3 (and elsewhere): If invoking 'other investigators' sources should be provided.
- o Page 18/paragraph 3: Oxygen debt may be generated in the far field below target values.
- o Page 19/paragraph 5: Section starts with a defensive statement, consider changing.
- o Page 20/paragraph 5: This section is duplicated in Chapter 4.

3.2.3 Chapter 3: Effluent Toxicity

3.2.3.1 General Comments

This section assesses the important, and vexed, issue of whole effluent toxicity. It is vexed as, if toxicity is demonstrated, determining the primary driver of this in the effluent itself, be it a single constituent or combinations of these, is extremely difficult. Nonetheless, given that the time varying toxicity levels in the effluent are adequately defined, the tests provide robust determinations of required effluent dilutions to avoid short term acute toxicity effects in the receiving environment. The CSIR employed acceptable tests (sea urchin fertilisation rates) that have an appreciable provenance for this application with their laboratories (probably) being the sole provider for such in South Africa. The main caveat to the results presented, however, and noted by the report authors, is the small sample size for each of the three outfalls tested. Therefore the obtained results in terms of minimal acceptable dilutions should be viewed as being indicative rather than definitive.

3.2.3.2 Specific Comments/Queries

- o Page 22/paragraph 7: Define 'Top' in the regression model.
- o Page 23/paragraph 3: The extrapolation to 25% of the time is, as acknowledged in the following text, unsafe due to low sample numbers. Given the sensitivity of effluent discharges amongst the general public the authors should consider rewording this.
- o/paragraph 5: Chapter 3 should be Chapter 4.

3.2.4 Chapter 4: Water Quality

3.2.4.1 General Comments

This section investigates the distributions of microbiological indicators of faecal pollution in the receiving environment in the vicinity of the three outfalls and adjacent shoreline waters and toxicity levels. It employs established methods for sampling and sample processing and places the obtained microbiological results in the context of a nine year long time series of shoreline microbiological status measurements conducted by CoCT.

The section is comprehensive and reaches robust conclusions on the distributions and implications thereof for the microbiological faecal indicators and seawater toxicity levels around

the outfalls. The authors note that there were limitations in the seawater quality coverage in that variables other than microbes were not included leaving possible perturbations to, e.g., inorganic nutrient distributions untested. They rightly recommend that future monitoring surveys be expanded to include such variables.

3.2.4.2 Specific Comments/Queries

- o Page 25/paragraph 3: The reasoning for water sample spacing around each of the outfalls should be provided.
- o/paragraph 5: References to the employed methods should be provided.
- o Page 26/paragraph 1: There is a seal colony near the entrance to Hout Bay and seals are ubiquitous in the nearshore areas throughout the year.
- o/paragraph 1: Another potential vector for transporting faecal bacteria to the shoreline is via foams. These are typically enriched with organic material due to microbubble scavenging through the upper water column during foam formation. Foams are generally associated with high waves when wave driven turbulence may be expected to normally dilute discharge effluents and lessen potential for onshore transport. Note that this may also be a mechanism to transfer microbes onto and into beach sands.
- o/paragraph 2: The authors should provide error estimates for the measurements made.
- o/paragraph 4: Provide the human health risk thresholds for context.
- o Page 27/paragraph 3 (and elsewhere): Provide references for comparative/contextual information.
- o/paragraph 6: Measurement data are snapshots in time and there does not need to be continuity between measurement sites as advection and eddy formations may not lead to linear, or other continuous, dilution between source and sink. The authors themselves suggest a similar explanation for microbial count distributions around the diffusers. Therefore the invoked example of a 'reverse' gradient itself does not provide convincing support for stormwater sources.
- o Page 28/paragraph 2 (and elsewhere): In their report CSIR extrapolate distributions from time base or spatially limited data and then 'retract' them because of the limitations. We suggest that explicit caveats are included such that such statements are not taken out of context.
- o Page 30/paragraph 4: Survival rates of faecal indicator bacteria in sunlight and seawater are discussed (with references) and are indicated to be relatively short. This is contradicted to an extent on page 31, paragraph 2, the authors need to reconcile this.
- o Page 33/paragraph 6: Define 'vulnerable segments'.
- o/paragraph 7: This paragraph is discursive and, in our opinion, misplaced in a scientific document (see comments on Chapter 7).
- o Page 35/paragraph 3: The single biggest source of inorganic nutrients to the southern Benguela inner continental shelf is upwelling. To place risks of eutrophication from nutrient rich discharges into context supplies from the two sources need to be compared. Note that

a commonly held misconception, for the southern Benguela system at least, is that land derived nutrients promote the formation and development of harmful algal blooms (HABs). These occur in the survey area and links need to be evaluated.

3.2.5 Chapter 5: Sediment Quality

3.2.5.1 General Comments

The report presents results on sediment particle size (explanatory variable), sediment total organic content, metal concentrations and organic compound distributions in the vicinity of the three effluent outfalls. Sediments in the surveyed areas do exhibit levels of contamination for all three categories but distinguishing between sources (outfalls vs stormwater discharges/port and harbour operations) was not clearly achieved. Given the history of commercial and industrial development and rapid urbanisation in and around Cape Town it is to be expected that contamination would occur and that multiple sources would be responsible for this.

The CSIR employed comparisons against sediment quality guidelines for the 2015/2016 survey as well as a number of previous surveys to examine whether the contaminated sediments represented toxicity risks to sediment dwelling fauna. For this they employed calculated enrichment factors against baseline relationships as well as established sediment quality guidelines for non-metallic compounds. Although the overall conclusions reached are supported by the data two issues merit attention by the authors:

- o Metal baseline – the basis of using a baseline constructed from measurements in a putatively effluent discharge affected area to detect perturbations due to the discharges needs explanation; and
- o At best, it seems that each of the historic surveys along with the current survey can be treated as being internally consistent but with possibly systematic differences between them. This also applies to comparatively ‘modern’ surveys conducted by the same agency (CSIR 2003 & current work, CSIR 1980 and 1982.). It can be argued that analytical efficiencies should be similar between such survey pairs but probably different across the surveys even due to extraction methods alone. So, for example Figure 5.44 indicates that (iron) normalised nickel in 1982 was higher than that measured in 1980 and that copper measured in 1993 was higher than that measured in 2015/2016 (Figure 5.45). CSIR circa 1980 extractions were done by the ‘hot plate’ + aqua regia method whereas in the 1990’s they changed to microwave assisted digestion. In the latter case then the copper enriched particles have either been resuspended and advected out of the system, the copper has solubilised (unlikely) or the copper signal has been diluted by uncontaminated sediments moving into or through the area which may also be unlikely given what is known about sediment dynamics in the study area. This begs the question as to which values are actually correct which is most important when comparing contaminant concentrations with ‘guideline’ values to determine whether

there are pollution risks, and whether contaminant levels, and pollution risks, are decreasing/increasing with time. Typically we assume that the latest versions are closest to the truth, which needs some justification, but systematic variations somehow need to be resolved to understand the time varying issue and to be able to detect whether management intervention, if employed, are working.

Similar to using multiple approaches to demonstrate contamination CSIR also employ multiple metrics to demonstrate toxicity risk of the contaminants in the sediments. The use of such, especially when derived from independent data sets, lends credence to their overall conclusions regarding sediment toxicity.

3.2.5.2 Specific Comments/Queries

- o Page 38/paragraph 3: Stainless steel spatula and homogeniser bowls were used for sediment sample aliquots destined for metal analysis. This is counter to current guides on sample processing (e.g. Simpson and Batley 2016). The authors need to explain possible errors (if they exist).
- o Page 40/paragraph 3: High wave energy levels apply to all of the Peninsula coast line; Dungeons is a wave focus site. So, most sediments in the region will probably be coarse.
- o Page 45/paragraph 5: An offshore deposition area where contaminants may be accumulating is invoked without evidence that this may occur. It probably does but other allocthonous fine sediment would also deposit there possibly obscuring evidence of incorporation of contaminated particles from the Cape Town area. Therefore, without a clear effluent signal/indicator measuring such areas may not be beneficial (apart from improving knowledge on such areas).
- o Page 46/paragraph 1 (and elsewhere): Varying methods of dealing with variable concentrations below method detection levels are employed throughout the report (but are the same within sections). This may be justified but is confusing. The authors should provide precedence or justifications for the options adopted in each case.
- o Page 50/paragraph 4: It is conjecture that sediment within 250m of the Green Point outfall would have been found to be contaminated in the 2015/2016 survey.
- o Page 53/paragraph 5: Invoking the precautionary principle as done here is an incorrect application. It would be better to state that 'on a conservative and precautionary basis'....However, the assumption is then contradicted to an extent by identifying other contaminant sources. This section needs clarification.
- o Page 55/paragraph 55 (and further): We support the use of the Long et al (1995) derived guidelines as they are based on community responses and not single species toxicity responses. The latter can lead to a biased data set as they are focused on species able to survive being held in culture and may be more hardy than other members of the community. The main issue with the ERL/ERM approach for specific constituents is that it is not totally certain which constituents within a mix of them is actually responsible for the

observed responses. This notwithstanding, the approach is generally accepted and is most reliable for predicting the absence of toxicity as opposed to toxicity itself.

- o Page 59/paragraph 2: This is another discourse – we recommend that it be excised from the report.

3.2.6 Chapter 6: Human Health Risks

3.2.6.1 General Comments

This section evaluates potential health risks for consumers of mussels and rock lobster taken from the shallow subtidal areas in the larger survey area. This is based on measurements of contaminants within the flesh of the target organisms and translating this into non-carcinogenic and carcinogenic risks for consumers, based on current international practice. Apart from the direct measurements on flesh contents local data/information for this study is not available. Therefore the authors rely extensively on extrapolations from other studies, mainly conducted in the USA, and assumptions. Due to the dearth of local information these are difficult to verify leading to questionable reliability of the conclusions reached. This to the extent that the authors, through an evaluation of the uncertainties in the analyses, conclude that the health risks have probably been overestimated and are unreliable.

Given this conclusion, with which we fully agree, we recommend that the chapter be revised and restricted to what can be safely concluded from the available data and epidemiological information applicable to the Atlantic seaboard of the Peninsula. It must be noted that the conjunction of effluent discharges and human health risks, even if these are vanishingly small, can be a very emotive issue and therefore needs a lot of care in presentation.

In view of the above we do not provide detailed comment on the contents of the chapter.

3.2.7 Chapter 7: Conclusions

Each of Chapters 2-6 contain sections summarising the main conclusions for the topics being addressed. Chapter 7 presents the main conclusion of which there are five (drawn from the report text):

1. Most chemicals and compounds in the effluents discharged through the three outfalls are likely to be diluted to concentrations protective of marine fauna and flora shortly after discharge (i.e. within a small distance of points of effluent discharge). This does not appear to be the case for ammonia and total suspended solids, which require much greater dilution to meet water quality targets than other constituents and under calm conditions are unlikely to be effectively diluted in the receiving environments such that water quality targets are met at the margin of the zone of initial dilution.
2. Toxicity testing of seawater samples collected at the surface in the greater vicinity of the outfalls revealed a single incidence of very low magnitude toxicity, even though some seawater samples were collected in the effluent plume at the sea surface. This supports

the notion that most contaminants in the effluents are likely to be sufficiently diluted shortly after discharge to limit the incidence of acute toxicity.

3. No significant acute toxic risk associated with chemical concentrations in sediment in the Table Bay, Camps Bay and Hout Bay areas was identified. Thus, despite the over 100 year history of the discharge of partially treated wastewater into the marine receiving environment off Cape Town there has been no significant accumulation of effluent derived contaminants in the sediment with time.
4. Mussels and rock lobsters collected from the shoreline and nearshore along the Atlantic seaboard of the Cape Peninsula were not found to be accumulating contaminants derived from effluent in their tissue, at least not to concentrations that could be discriminated from concentrations in mussels and rock lobsters collected at 'clean' sites.
5. The measurement of faecal indicator bacteria in surface seawater samples provided clear evidence of effluent reaching the surface in some surveys, but no clear evidence the bacteria (and thus presumably other effluent constituents) were reaching the shoreline. There is indirect evidence from faecal indicator bacteria counts in seawater samples collected at many sites along the Cape Town shoreline over an extended period that effluent is possibly, even if infrequently, reaching the shoreline. The uncertainty stems from the fact that stormwater runoff may be a significant source of faecal indicator bacteria to the shoreline, as is the case in most urban areas. These uncertainties make it difficult to estimate the risk posed by effluent discharge to the health of recreational users of nearshore and shoreline waters and represents perhaps the most important uncertainty that should be addressed through further research and monitoring.

Each of these conclusions is well supported by data and analyses presented in the report.

In the conclusions chapter the report authors provide further insights into general risks of effluent discharges into the marine environment and offer opinions and discussion on alternatives facing Cape Town. In our view these are outside of the requirements of the survey which was to provide evidence based assessments of the environmental risks and impacts of the current practice of effluent discharge through the Green Point, Camps Bay and Hout Bay outfalls and should be excised from the chapter.

3.2.8 References

The reference list is comprehensive but incomplete – i.e. references are cited in the report but not listed, and there are references listed but do not appear in the report. We provide lists of these below but these may be incomplete. This needs to be rectified by the authors.

The following authors were cited but not put in the final reference list;

Bergmann 2011
Birdlife International 2016a&b
Branch & Steffani 2004
Bustamante and Branch 1996

CSIR 1982, 1986, 1992, 1995, 2013 and unpublished data report
DEA 2011
Fick et al 2011
Knutzen and Green 2001
Lee et al 2013
Long et al 2006
Lu et al 2011
Ma et al 2017
Martindale 2011
Mead et al 2011
Pacific Shellfish Institute 2008
PRDW 2014
Robinson et al 2005
Roesijadi and Robinson 1994
Steering Committee 1985
Tom and Botes undated document
USEPA 1989,2012,2015
Van Leperen 1970

The following references are not cited in the text;

APHA (American Public Health Association)
Barnes (CSIRO 2003)
Bartlett 1980, 1985 (CSIR reports?)
Betancourt WQ and Rose JB 2004
Beverdort et al 2006
Bloom 1992
Carter and Steffani 2003
Chapman et al 2002
Clark et al 2015 (Anchor)
Crawford 1998 (IUCN report?)
Green and Knutzen 2003
Herberer 2002
Jiang et al 2001, 2004,2 014
Kolpin et al 2000
Long et al 2000
Monteiro P.M.S 1994
Prochazka 2001
Wille et al 2010

4 EVALUATION AND RECOMMENDATIONS

4.1 EVALUATION

The CSIR (2017) report on the 2015/2016 survey of Cape Town's marine outfalls operated by CoCT is a comprehensive assessment of the state of the receiving environment into which the outfalls

discharge. The report is well laid out and is logically structured. In their analyses and assessments of the environmental risks linkable to the discharges CSIR employs the 2015/2016 set of measurements backed up by monitoring data collected in the region by their own agency as well as other entities such as CoCT. This is commendable as it provides temporal and spatial context to the current (2015/2016) measurement data allowing confident conclusions to be drawn on the effects of the discharges from multiple lines of evidence.

As in any survey there are some gaps and unconstrained uncertainties which are acknowledged in the report and, where such gaps/uncertainties do or may influence conclusions, recommendations on actions that can be taken to improve survey results and their interpretation are made. Examples include:

- o Conduct simulation modelling on effluent behaviour for each of the three discharges to determine dispersion patterns and provide robust estimates of near- and far-field dilution factors, particularly at the zone of initial dilution boundary;
- o Validate/ground truth model outcomes with dye dispersion tests;
- o Use such data to design robust water quality monitoring grids for each of the discharges;
- o When conducting water quality monitoring ensure that an effluent tracer is present to aid interpretation of water quality results (an option here is to add a dye such as Rhodamine-B into the discharge at the time of survey which may allow estimates of effluent dilution matched to water quality variable distributions);
- o Resolve the complex issues underlying the assumptions made in the human health section of the assessment such that a robust evaluation can be made. This specifically relates to partition between total arsenic and inorganic arsenic concentrations and carcinogenic risks linked to seafood consumption.

We support these recommendations in general (see below).

4.2 RECOMMENDATIONS

Marine discharges are complex and receiving environments into which effluent is discharged are also inherently complex of which that in which the three City of Cape Town outfalls are situated is a prime example. Therefore monitoring programmes require very careful planning and execution to provide useful and reliable information to the management entities. This is especially the case with the current CWDPs as these are issued for generally five year periods and are subject to review, and possible withdrawal, based on proven outfall performance. Consequently, we recommend that, in agreement with the CSIR (above) and in alignment with DEA CWDP application requirements, CoCT commission 3D hydrodynamic numerical modelling to provide a prediction base on discharge plume behaviours under the variety of oceanographic conditions that characterise the respective receiving environments. The results from these should then be used as bases for the design of robust water quality monitoring programmes for the outfalls. As part of this quantitative information on effluent flows and constituents should be collected

allowing short term (e.g. diurnal) and longer term variability to be determined for input to the models. This will allow outfall specific models to be constructed and overcome issues that can arise when generic stable effluent flows and constituent concentrations/levels are used in models to predict distributions.

In addition to the above priority attention should be focused on the human health aspects linked to consumption of seafood collected from the respective discharge receiving water bodies to either confirm that risks are in fact low or to indicate whether and when seafood advisories may be necessary. Undoubtedly there will be claims made that the effluents discharged into the area are impairing human health and CoCT needs objective evidence that this is or is not the case.

5 REFERENCES

Brown, P.C., and L. Hutchings 1987. The development and decline of phytoplankton blooms in the southern Benguela upwelling system. 1. Drogue movements, hydrography and bloom development. *South African Journal of Marine Science*, **5**: 357-391.

Nelson, G., and A. Polito 1987. Information on currents in the Cape Peninsula area, South Africa. *South African Journal of Marine Science*, **5**: 287-304.

Simpson S and G Batley 2016. Sediment quality assessment: A practical guide. 2nd Edition. CSIRO Publishing, Australia. 346pp.

