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Diep River Pollution Overview Report

28 October 2020

Overview Summary

- The Diep River and Milnerton Lagoon system is a **natural heritage** on the community's doorstep that is rapidly being **lost to uncontrolled sewage pollution**.
- After many years of **concern for the environemt**, the residents, rate payers and voters have **implemented their own sampling**, paid for by voluntary civil contributions under the guidance and support of OUTA - Organisation Undoing Tax Abuse.
- These results are being accumulated for purposes of scientific analyses to **find solutions and confirm pollution sources**.

- Although the data accumulated will be augmented, there are already **very clear and serious trends** that should be noted:

1. Although up stream informal settlements have been blamed, and do contribute, the impact is **insignificant** compared to the contaminated water being discharged in the **Pots Dam and Theo Marais areas**.

2. **5 different discharges** have been identified along riverbanks around the **Pots Dam Wastewater Treatment Plant** with E. Coli levels **averaging 119 000 cfu/100ml** and going **as high as 1.1M cfu /100ml**.

3. The **Theo Marais Storm Water** channel is another source of contamination. It is fortunately normally at a relatively lower level of contamination, but peaks whenever there are operation issues with the adjacent **Koeberg Pump Station**. These spills dump raw sewage into the river causing untold damage with E. coli counts as high as 6M cfu/ml. These slugs of raw sewage **can easily trigger an environmental disaster** as has been experienced on numerous occasions in the lagoon.

- While there may be **other contributing pollution streams**, this **cannot absolve or diminish** the **impact** that these sources have on the system.
- **This consistent change in contamination levels as the flow moves down past Pots dam and Theo Marais is the focus of this document and shows a clear and logical trend.**

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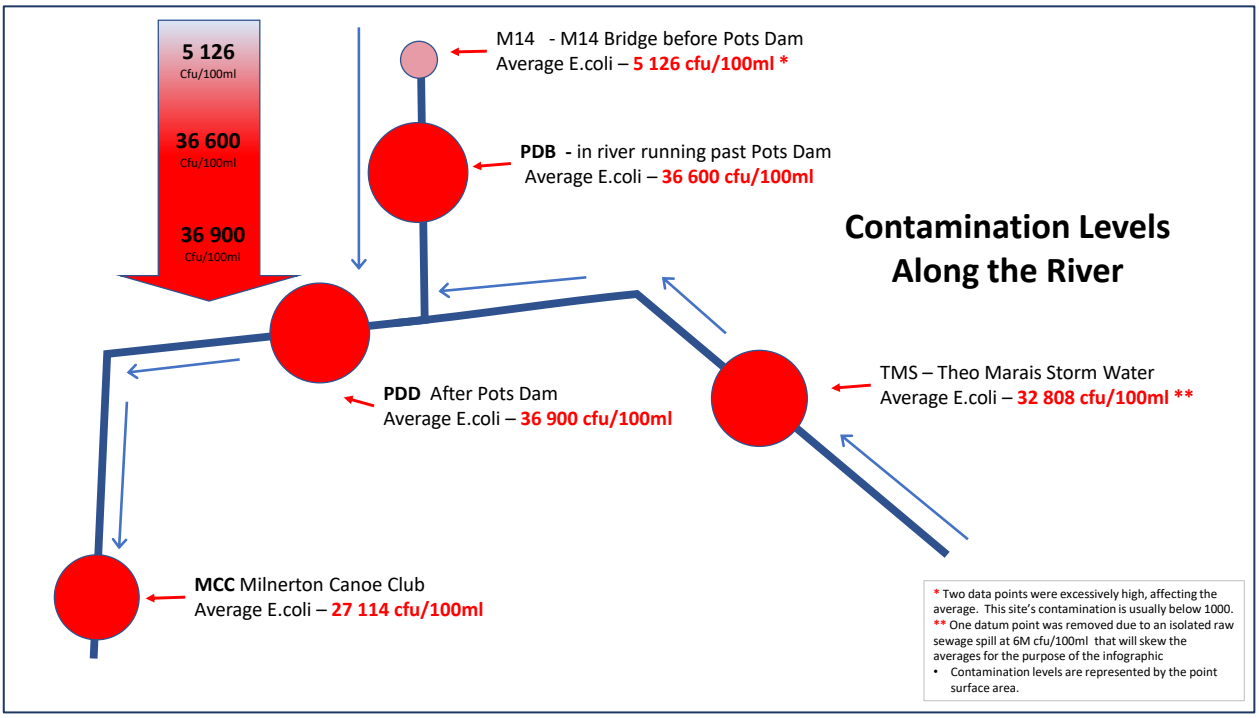
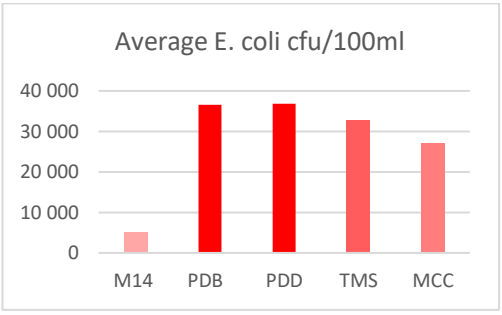


How much is too much E. coli?

- It must be noted that for simplicity, Makoya Amanzi has **focussed on E. coli** for the **obvious health risk** posed to humans.
- E. coli is also a very **good indicator** of the level faecal matter in the water. We do not need science to confirm that **faecal matter (sewage) will cause great harm to an aquatic environment.**
- However, the ecological and environmental processes are actually quite complex and are more related to the **high nutrient value of untreated sewage** (nitrogen and phosphorous compounds). This causes a phenomenon known as **eutrophication** that ultimately depletes the water of its oxygen, **killing off** many of the **aerobic organisms** (from fish to bacteria).
- **A more detailed description of this process will be available at the end of this document, however for now, we will limit the reader data to E. coli.**
- We quote limits from the "**SOUTH AFRICAN WATER QUALITY GUIDELINES VOLUME 2 RECREATIONAL USE**" as published by **Department of Water Affairs and Forestry - Second Edition 1996**.

- **It is clear that the pollution in the Diep River is so extreme that the scale of the figures prevents any comparison to safe recreational use – sailing, swimming fishing.**



Recreational Use

Risk Level	cfu/100ml
Low Risk Target	0 - 130
Slight Risk	130 - 200
Some Risk	200 - 400
High Risk	>400

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Document Objectives

- This document is an **introduction** to the pollution in the lower reaches of the Diep River compiled from water sampling and observations made by civil society as supported by OUTA and their contractors.

- **The document is targeted at anyone who has a vested interest in this urban natural heritage or a or a civil investment in these communities:**
  1. Residents
  2. Rate payers
  3. Businesses
  4. NGOs and Institutions
  5. Government
  6. Elected Officials and Voters
  7. Civil Organisations and Political Parties
- This representation of the data is looking purely at **logical trends in the numbers** as well as **individual documented observations** that strongly indicate the health of the system and the potential sources of pollution.
- It also gives some basic background to the approaches that OUTA and the communities have taken and some of the scientific principles behind pollution.

Monitoring Approach

- As the river became more and more polluted, and there was a reported **lack of accountability from authorities**, OUTA offered to assist the residents and rate payers of the surrounding communities.
- Before any remediation strategy can be formulated, **the levels of pollution and sources need to be measured and identified** as accurately as possible. A **sampling program** was initiated.
- In order to create useable data, very **strict sampling procedures** need to be followed. While these procedures are available on request, the following are critical components:

1. **Consistency –** Procedures force consistency which allows the data from one sample to be compared with other sites, or over time.
2. **Record Keeping –** Strong record keeping of sampling, sampling handling and submission ensure the data is able to stand critique and be of value in the future.

3. **Contamination Prevention –** The accuracy of the sampling is dependant on strict procedures to prevent contamination of the sample.
4. **Health and Safety –** strict procedures ensure the best measures to protect the sampler from the contaminated source.

- **Repetition** – This type of environmental sampling is generally a **grab sample** – that means a sample of the flow is taken at the exact time of the sampling (**at the minute**). Therefore, the results from one sample do not necessarily represent the norm by themselves and a single sample could be deemed as an anomaly to the normal conditions. For this reason, **multiple samples are taken over a period of time** to look for means or trends in the data. To date, **102** separate samples have been taken at **10** different sample locations over a period of **8 months**.
- **Parameter Selection** – The selection of parameters is important, and OUTA looked at the following criteria:

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1. **Direct Health and Safety** of humans and wildlife using or living in the environment. These are parameters that measure pollutants that are chronically toxic or pathogenic (or indicate similar chemicals or biology in the water) – EG E. coli
2. **Indirect Health and Safety** – There are parameters that measure chemicals that contribute to the decline in the environmental health of the system – predominantly **nutrient compounds** that cause **eutrophication**, and ultimately make the environment toxic and uninhabitable for most macro life forms, as well as many microorganisms – EG, Nitrates, Ammonia and Phosphorous
3. **Compliance** – The parameters selected were the same as those stipulated in the local municipal sewage work's Water Use Licence limits. Some of these parameters are not necessarily directly harmful to the environment (unless excessively high) but can indicate operative issues from a plant that effect discharge.

Sampling Points

- The popular hypotheses vary, but most are that the Diep River pollution is mainly originating from one or more of the following sources:
  1. **Informal settlements upstream** where population density and growth has put the general municipal services under pressure.
  2. **Pots Dam Sewage Treatment Plant** that is licenced to discharge treated sewage within certain prescribed limits.
  3. **Theo Marais Storm Water Channel** – that should only convey storm water from an industrial area but was rumoured (and has been proven) to contain substantial faecal matter.
  4. There are also reports of **various other storm water inlets** throughout the system that are visually contaminated.

- In order to monitor these potential sources, the sampling points were set up along the river. The 5 main sampling points were:

1. After the Informal Settlement Area and Before Pots Dam Sewage Treatment Plant

The logic in this site was to see what type of an impact the informal settlements upstream had, and then as a measure of contamination before the river passes the sewage treatment plant. For this site we selected where the river flows under the **M14 Bridge** and is the highest and starting point in the river flow.

2. Sewage Treatment Discharge

We wanted to measure the direct discharge from Pots Dam Sewage Treatment Plant into the river. Selecting this site was challenging as we found **5 visible discharges** into the river with variable flows depending on the day. In order to accurately measure this, we walked the perimeter of the plant along the river and measured wherever we found substantial flow.

3. After Pots Dam Wastewater Treatment Plant

This site would show the **change in the contamination** of water as it passes the sewage treatment plant. Initially we selected a site just after what we presumed was the official Pots Dam discharge, but after finding various other discharges we had to move it down. We settled on a point just after where the river and the Theo Marais Channel meet. This means that we always have to take the contamination levels of Theo Marais storm water into account.

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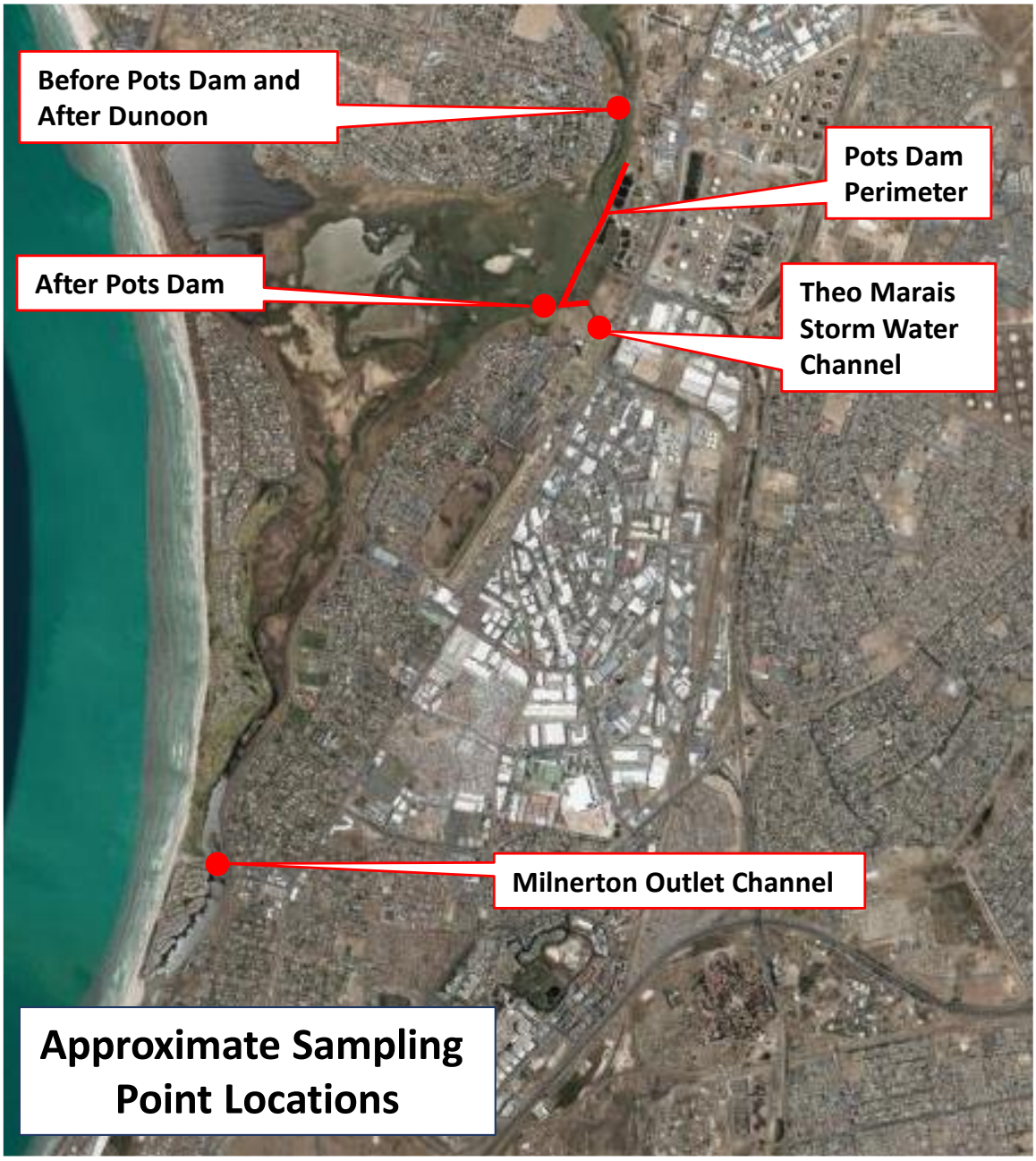
4. Theo Marais Channel

Apart from being a known pollution site, we had to sample this flow so that we could measure its impact against the impact of the sewage treatment plant. We selected the weir **adjacent to the Koeberg Road Pump Station** that is a likely source of most of the contamination.

5. Milnerton Outlet Channel

This site represents the culmination of sewage contamination, as well as the dilution from clean storm water, and whatever natural treatment the ecology of the system has. The **Milnerton Canoe Club** was selected as the sampling point. This was the last sample in the river flow.



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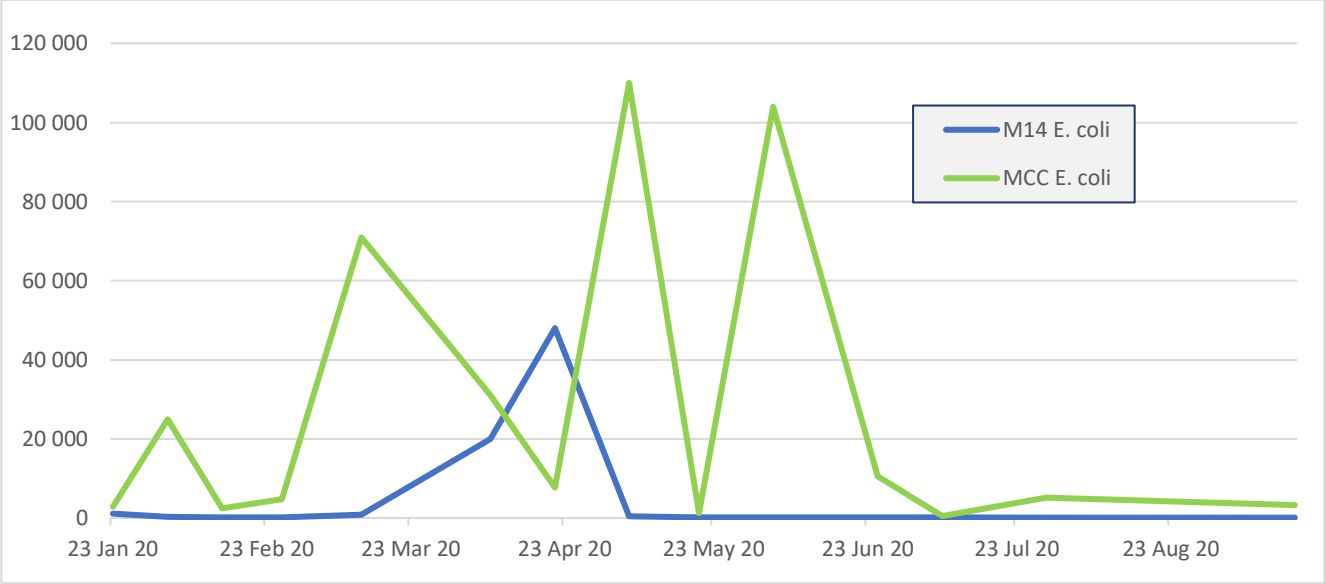
Observations

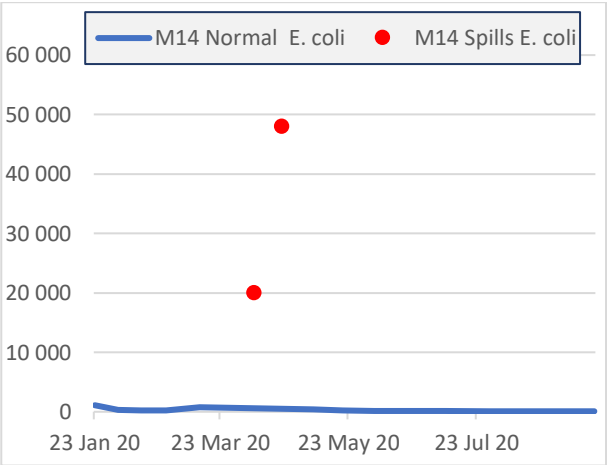
- The observations are focused on looking at **logical trends** over the 8 months of monitoring between the different sites, as well as specific areas of concern where the sampling indicated a **high probability of contamination sources**.
- Please note that although various parameters were tested for and the results are freely available for scrutiny or scientific analyses, **this report will focus on the E. coli**. E coli is not only an indicator of potential pathogenic organisms in the water but is also an excellent indicator for sewage contamination.

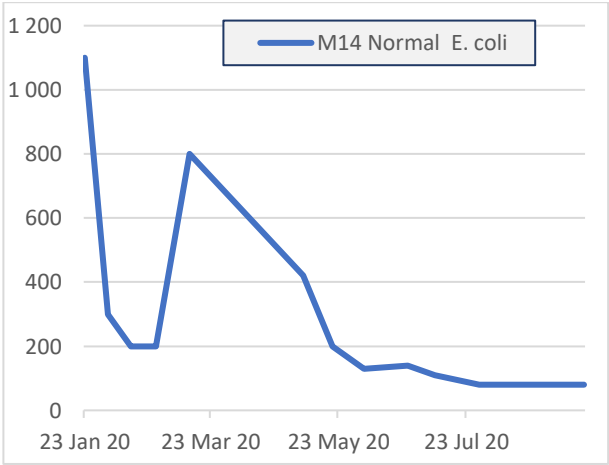
1. Before Sewage (M14)

- We found this point to show some signs of sewage contamination.
- However, apart from two exceptional days, the contamination was **significantly lower than the Milnerton Lagoon Outlet (MCC)**.
- **This indicates that although informal settlements and stressed sewer reticulation up stream do have an impact on the river, it is by far the lowest, or has been significantly diluted from other sources.**



- Excluding the two days that were probably caused by isolated spills, the average E. coli levels upstream from Pots Dam are at 1000 or below cfu/100ml.





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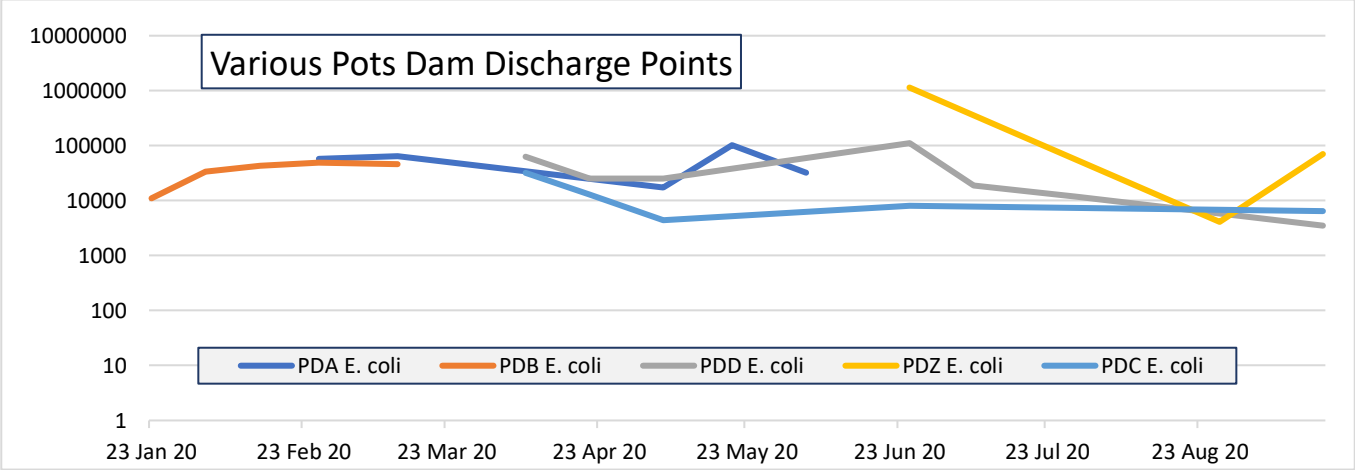
2. Sewage Treatment Discharge

- Pots Dam Sewage Treatment Plant was challenging to measure as there were various discharges observed.
- Some look like formal discharges, but others are literally running out of the plant pond banks or through old culverts from the ponds.
- Pots dam have only reported one official discharge.






- The concern is that these multiple discharges are not being measured, and that although the **results in the official discharge may be fair**, the **alternative discharges have been found to be excessively high in E. coli.**
- Please note:
  - Due to excessive results (site PDZ at 1 140 000 cfu/100ml) the points can only be compared in a logarithmic scale.
  - Note that there are comprehensive details of all of these sampling points with GPS locations, photographic and documented records that are available on request but are too numerous for this report.



- Although City representatives have said that these are storm water outlets, their **flows have not been associated with any significant precipitation** and are all located around the perimeter of treatment plant on the pond banks.
- Furthermore, one flow (point PDC) looks very much like **treated effluent**, and the other (Point PDZ) looks like a **sewage treatment sludge rich effluent.**
- **By applying the most logical assessment, it is highly <u>likely</u> that the Pots Dam discharge is one of (if not the biggest) contamination sources to the river.**

3. After Pots Dam and Theo Marais Strom Water Channel

- These two points will be **covered simultaneously** as the Theo Marais Channel does **impact** on the measurability of the pollution contamination change from before to after the pots Dam Sewage Treatment Plant.

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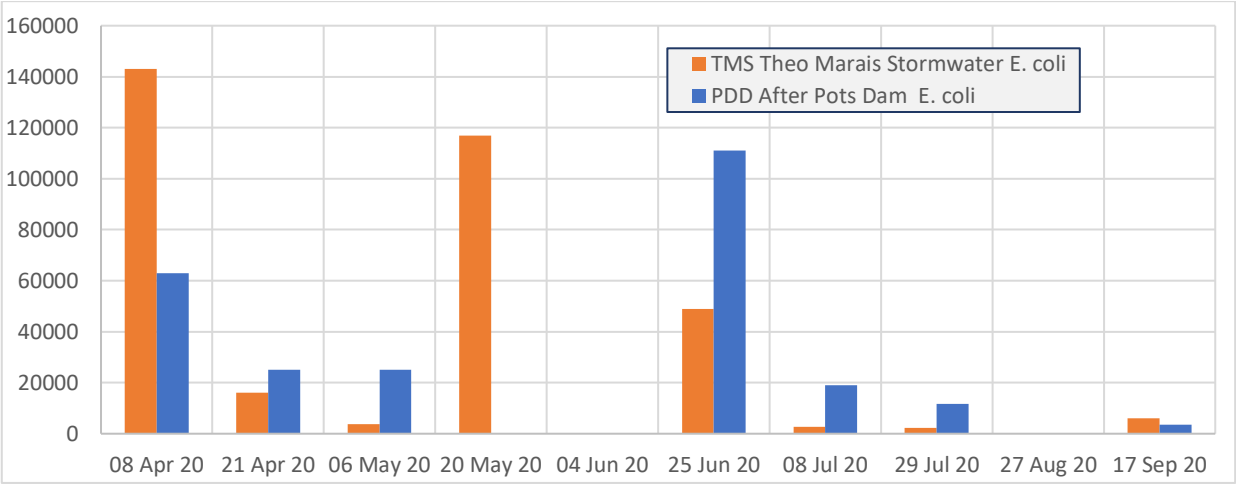
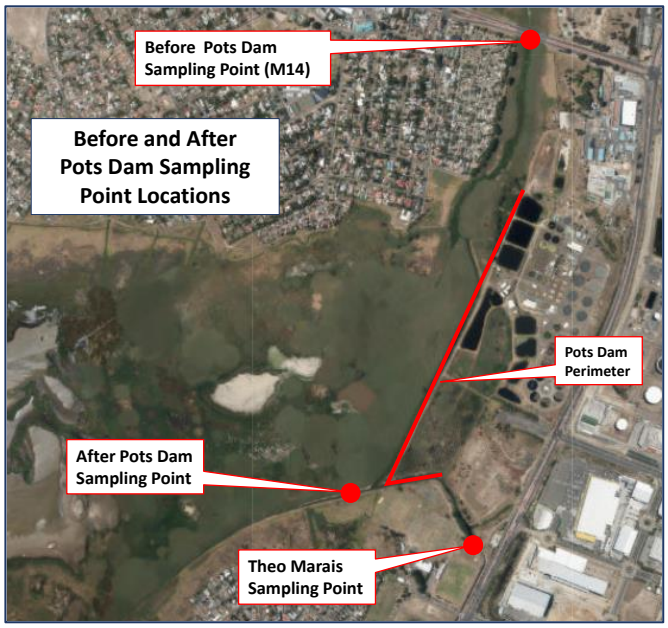
- The Theo Marais Storm Water Channel has traditionally been blamed for a lot of the contamination due to an **aged infrastructure up stream** under pressure from **high population density growth**.



- This is certainly probable, and adding to this, Makoya Amanzi has experienced massively contaminated water when the **Koeberg Sewage Pump Station fails** and spills over to the channel.
- However, there are **many days of sampling where the Theo Marais Channel contamination levels are relatively low**, but the contamination downstream is still very high.
- This inconsistency could be indicative of Theo Marais contamination being more directly **related to operational failures than a lack of capacity.**



- **Bearing in mind the contributing factors from the Theo Marais Storm Water Channel, there is still significant data to indicate that there is a notable increase in the E. coli as the river flows past the Pots Dam Sewage Treatment Plant.**
- **While more sampling in this area would be useful, the current data should be enough to register huge concern with the authorities responsible for both the Koeberg Pump Station and the Pots Dam Wastewater Treatment Plant.**



Submitted by: Craig Greggor **Date:** 18 October 2020

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Notes on Eutrophication to follow:

Notes on Eutrophication

- As discussed in the Diep River Pollution Overview Report, **E. coli is a good indicator** of environmental pollution as it is associated with faecal/sewage contamination.
- High E. coli levels are dangerous for humans using water for drinking, washing or recreation. However, even though they possess some risks to aquatic animals, the **nutrients in sewage are of more danger to the aquatic environmental and ecology**, causing eutrophication.
- Eutrophication is a very complex process in the details, but **the mechanism is relatively simple** and for purposes of this document, the following explanation should suffice.

Eutrophication (from Greek eutrophos, "well-nourished") – Wikipedia

Sources of Eutrophication

- As per the translation of the origin of the word indicates, Eutrophication is **excessive growth** of organisms (mainly plants) due to an **oversupply of Nutrients**. These nutrient sources are nitrogen, phosphorous and carbon based, and can come from a variety of sources:
  - Animal waste – roosting birds, hippos, fish etc
  - Urban organic waste (food waste).
  - Garden, turf, or agricultural fertiliser runoff.

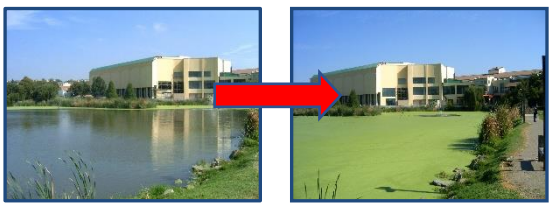
- However, in a high-density urban environment, **the most probable source is sewage**. This can be in the form of raw sewage, or partially treated wastewater from a sewage treatment facility.

- The primary and critical function of a sewage treatment plant is **to remove excess nutrients** in the form of:
  - **Sewage Sludge** – which is generally carted off for disposal at a land fill site (which will not be permitted in Cape Town by 2027) or recycled to reclaim the nutrient value for agriculture – composting.
  - **Gasses** into The Atmosphere – Carbon Dioxide and Nitrogen Gas – this also is a form of recycling as plants reuse these gases in their metabolism.

The Mechanism and Negative Impact of Eutrophication

- This is a very **natural process** and is happening all of the time, even in healthy systems.
- Unless you are very observant you would not even notice it. Sometimes it just produces a little **odour** (anaerobic gasses) or a **change in the colour of the water**. However, where there is large scale pollution, the effects are **catastrophic**.
- Any defined environment has a limited amount of space and **can only sustain a certain number of organisms** (both plant and animal).

- When excessive nutrient is added, plants, which are **more efficient at digesting raw nutrients**, start to **outcompete the other organisms**. Specifically, smaller plants like single celled algae are able to rapidly increase their number under ideal conditions and with lots of nutrient.



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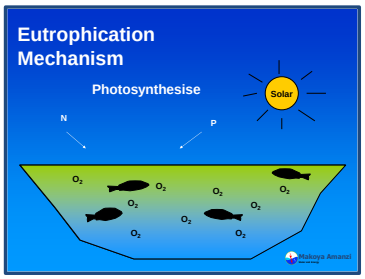
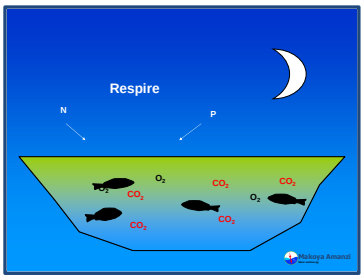
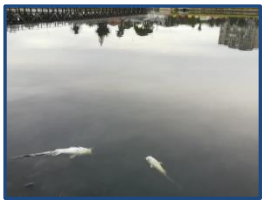
- This creates an **imbalance between the Fauna and Flora**.
- Plants **consume carbon dioxide and discharge oxygen** into the water during the day as a by product of photosynthesis.
- However, at night they **respire** (like we do) and **consume oxygen** – hence we are advised not to leave plants in hospital rooms overnight.



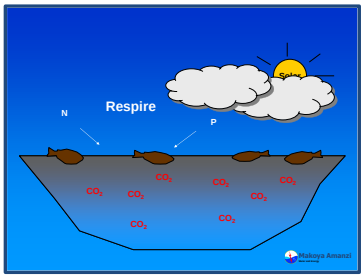


- These two physiological processes start to create **massive oxygen imbalanced**. A lot of oxygen is consumed out of the water during the night, and then returned during the day.

- Eventually, with enough plants, this hits a critical point where the **aerobic organisms** (oxygen dependant – mainly animals) **cannot survive** the low oxygen levels at night.
- The result is a **mass die off** of the aquatic animals – generally we would only see the larger species like fish that float to the surface, but **any animal or plant dependant on dissolved oxygen in the water is at risk**.



- This can be further **compounded on overcast or rainy days** when there is not enough light for the plants to photosynthesise and replenish the oxygen.



- At this stage, the **whole ecological system starts to crash**, including the aquatic plants that also need the oxygen at night – it is noteworthy that plants like reeds and hyacinth do very well in eutrophic water as they can utilise the nutrient, but still breath out of water.

- In **summer rainfall areas**, the effect is worse with frequent hot days followed by overcast or rainy days (Bruma Lake, Zoo Lake and Hartbeespoort Dam in Gauteng and the North West). However rainy days in late November and December are not unheard of in the Cape, which will more than likely cause some notable eutrophication in the Diep River.

- It is worth noting that the **terrible odours** associated with sewage spills are more from the anaerobic gasses produced by the eutrophication effect, and not the actual faecal matter that might be visible.

- **Communities living along or visiting the Diep river are all too familiar with eutrophication, and in spring and summer, the high solar radiation really gets the system going.**

Submitted by: Craig Greggor **Date:** 28 October 2020