Understanding the contribution of irrigated agriculture to river nitrogen and phosphorous levels in the Middle Olifants

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Lefapha la Disaense tša Tlhago le Temo

Make today matter

Introduction

- Filamentous green algae obstruct operational equipment in irrigation schemes
- Influences operational efficiency of the irrigation systems & operation & maintenance costs of irrigation infrastructure
- Phosphorous is a major driver of eutrophication
- Common source of P pollution arises from agricultural runoff (fertilizers & manure)
- Irrigated agriculture accounts for approx. 60% of SA's water resources

Site description

The Middle Olifants catchment

- 4 main tributaries – Selons, Moses, Elands & Mohlapitse Rivers
- Mining activities
- Extensive irrigation – main economic activity

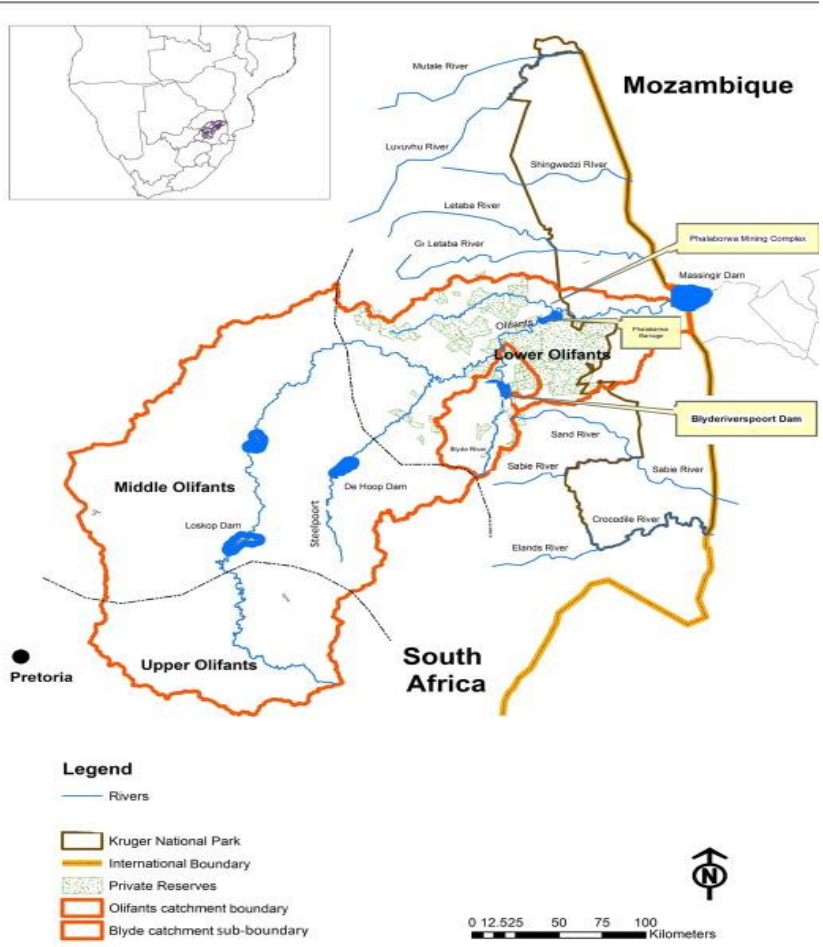

Figure 1: The Middle Olifants catchment within the Olifants River system

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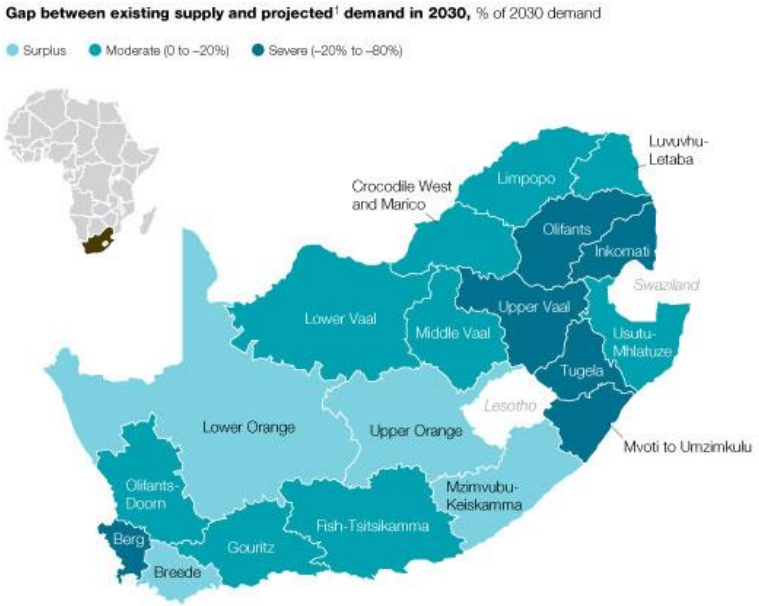
Site description

Agricultural activity in the Middle Olifants

- Catchment area = 22 500 km^2.
- Average rainfall = 500 $mm.a^{-1}$
- Growing competition between water users & overuse of water resources.
- Water requirements (395 $Mm^3.a^{-1}$) exceed availability (310 $Mm^3.a^{-1}$)
- Middle Olifants is 3rd most water-stressed basin in SA
- Large scale irrigation farmers grow high value crops (citrus and grapes) – large water footprint
- Dryland agriculture : approx. 114 000 ha
- Irrigated agriculture: approx. 50 000 ha



[1]Frozen irrigation levels and limited ability to increase rainfed land will drive an increase in virtual water trade between water-management areas and internationally with trading partners.

Source: Water Research Commission; South African Department of Water Affairs and Forestry (DWAF); Statistics South Africa; 2030 Water Resources Group

Agricultural activity in Middle Olifants

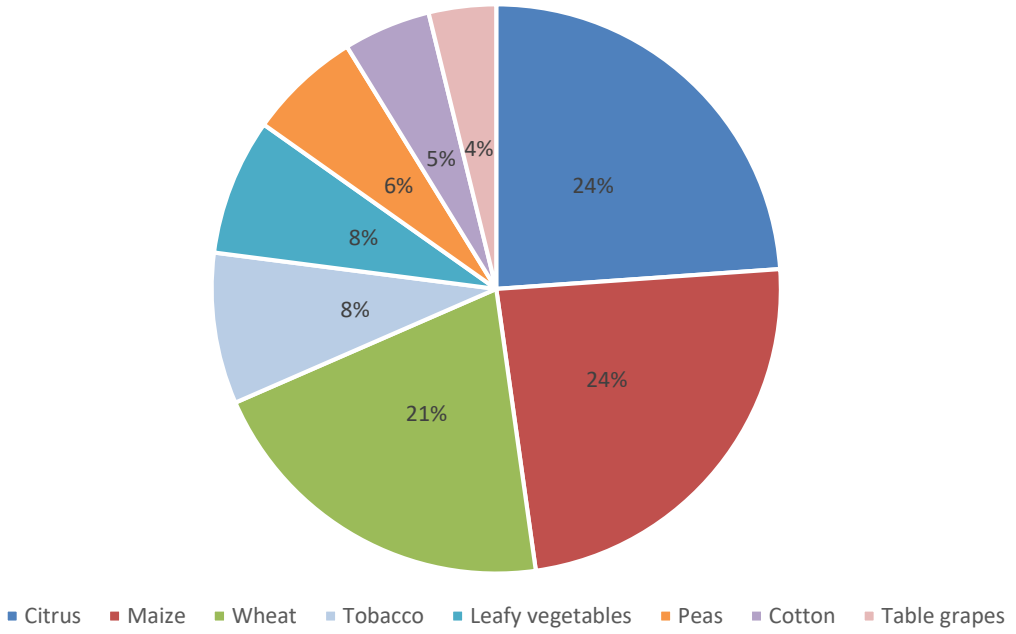


Figure 2: Irrigated crop profile for the Loskop area represented as a percentage of land covered

Agricultural activity in Middle Olifants

Table 1: Irrigation periods for crops (DWA 2013)

Crop	Irrigation season
Citrus	12 months (with peaks in September/October & December to February
Maize	August – February
Wheat (winter)	May – Early October
Tobacco	October – March
Peas	May – Early August
Cotton	October – April
Table grapes	12 months

Loskop Irrigation Scheme

- The Loskop irrigation scheme is the 2nd largest in SA
- Infrastructure: Loskop Dam, 7 balancing dams, 135 km main canal, 345 km service canals
- Water is managed via demand-based approach and delivered via 660 sluice gates
- Demand scheduling – 8 wards
- Scheme is currently fully allocated

Method

Sampling

- Sampling conducted over 20 months
- Points selected between Loskop Dam and Flag Boshielo Dam
- Drainage canals were added as sampling points after contact was established with LIB
- Drainage canals hold water coming directly out of farms

Method

Sampling points

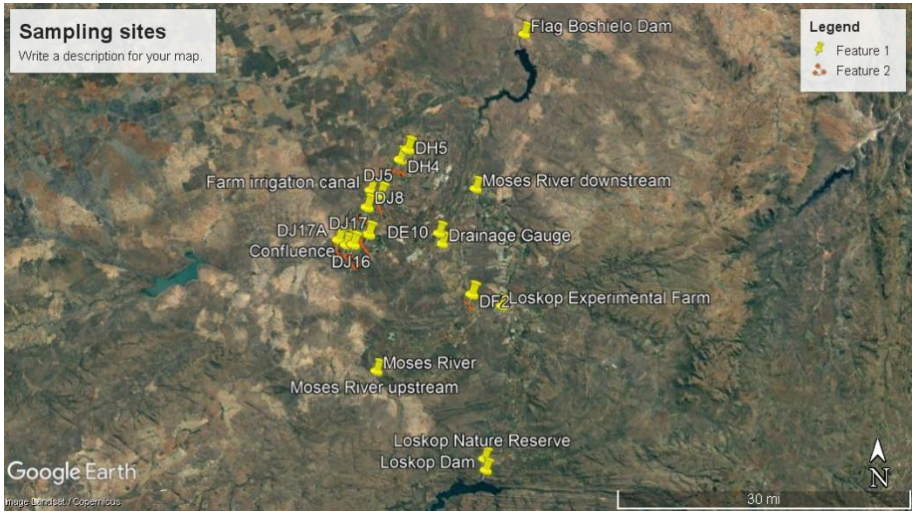


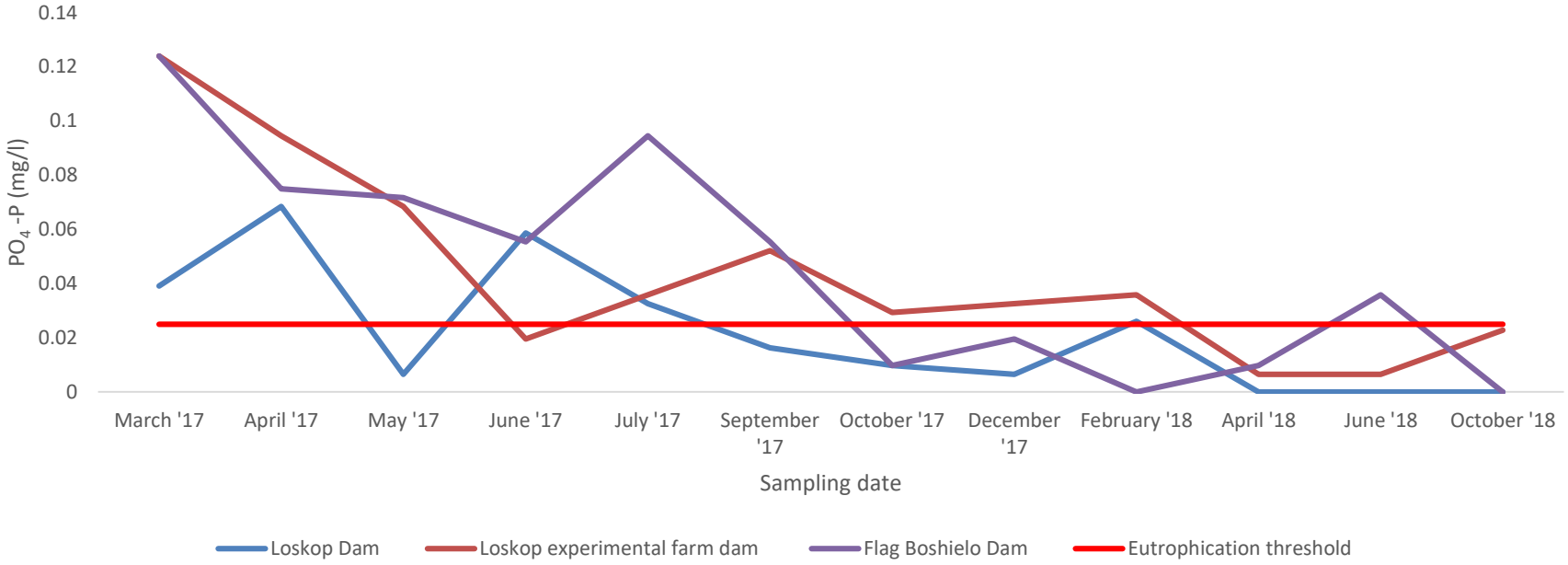
Figure 2: Sampling points between Loskop Dam and Flag Boshielo Dam

Method

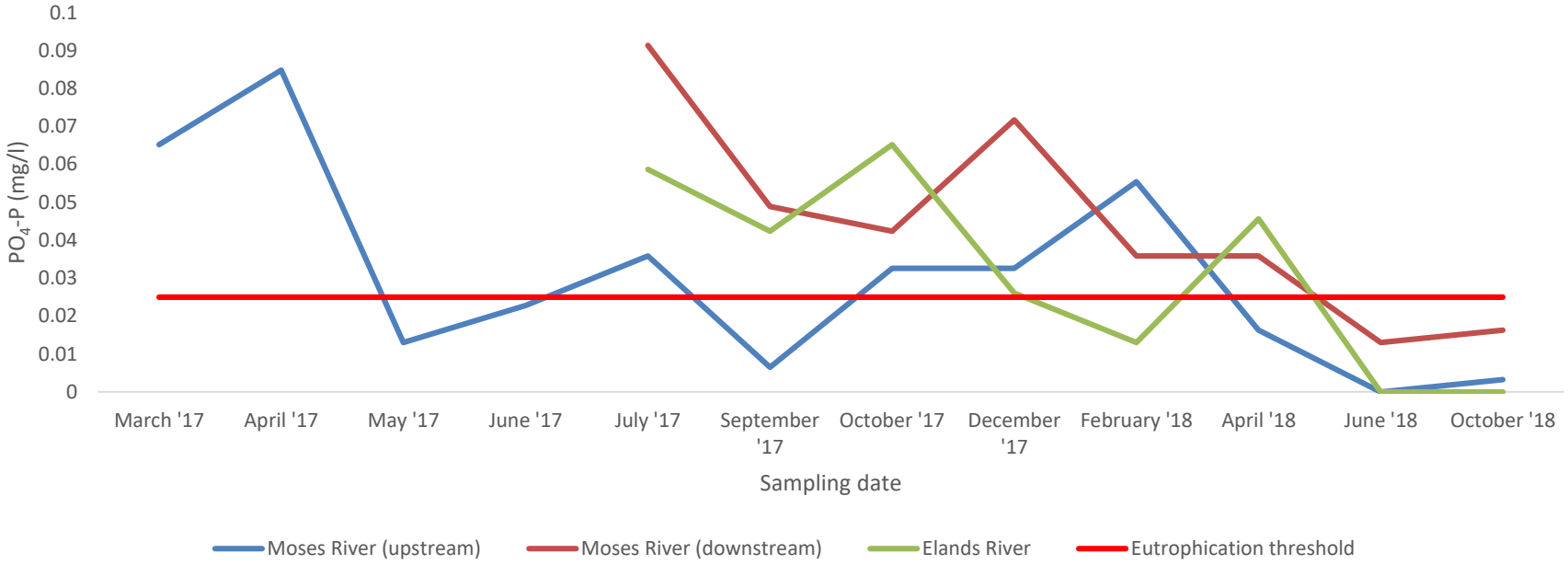
Water analysis

- Grab samples taken at each site - Tested for phosphates, nitrates, pH and EC
- Phosphate – Hanna phosphate low range photometer
- Nitrate – RQeasy nitrate test
- pH – Lab calibrated pH meter
- EC – Waterproof EC scan High meter
- Externally validates nutrient tests
- Comparison of measured results with DWS results

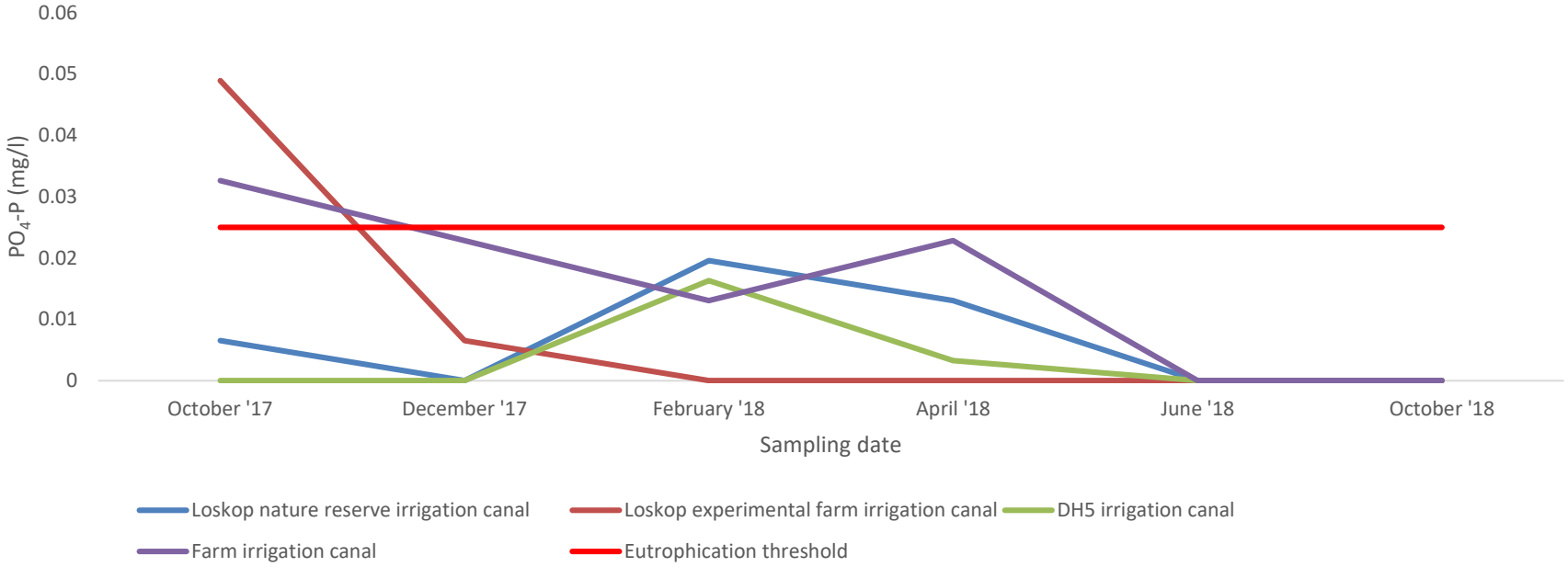
Results – Phosphates in dams



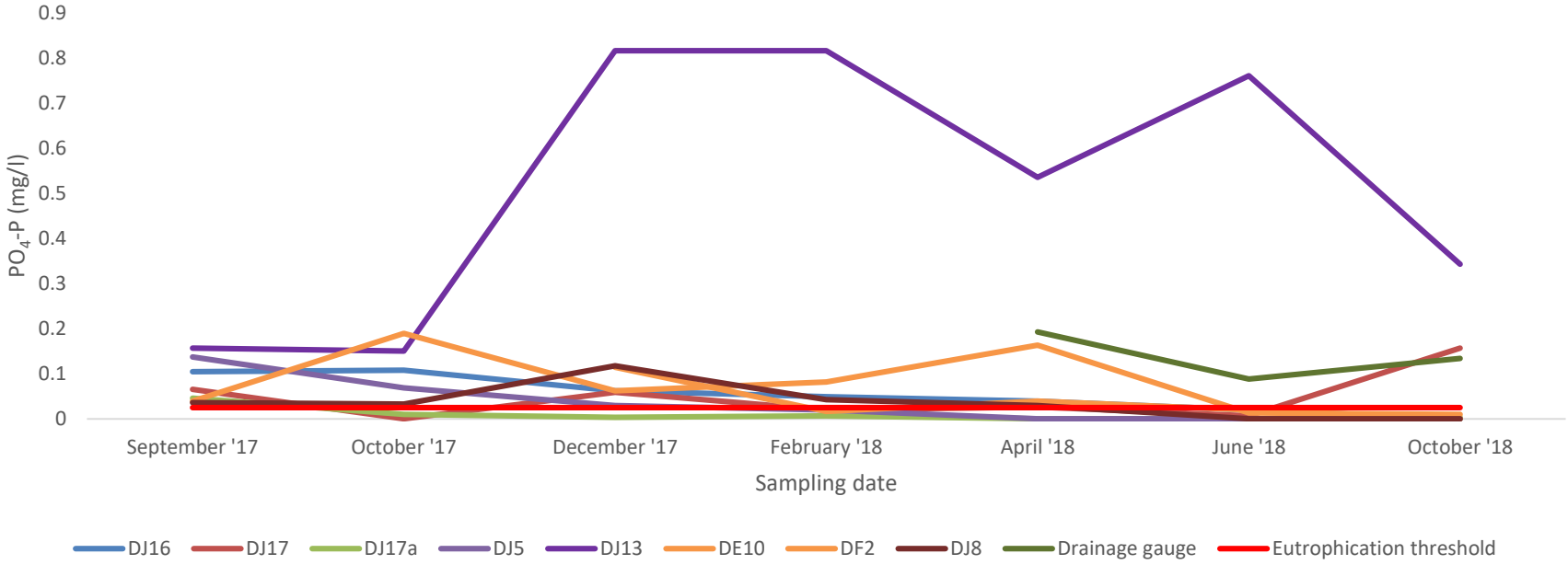
Results – Phosphate in rivers



Results – Phosphate in irrigation canals

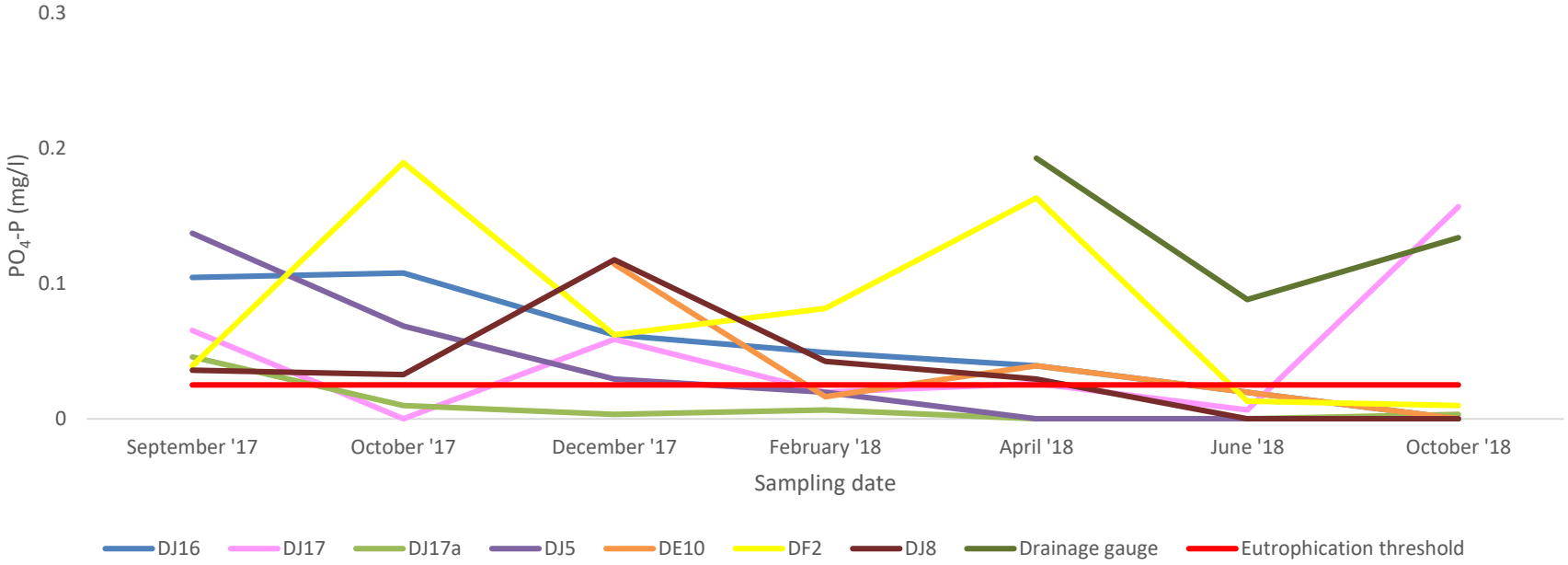


Results – Phosphate in drainage canals

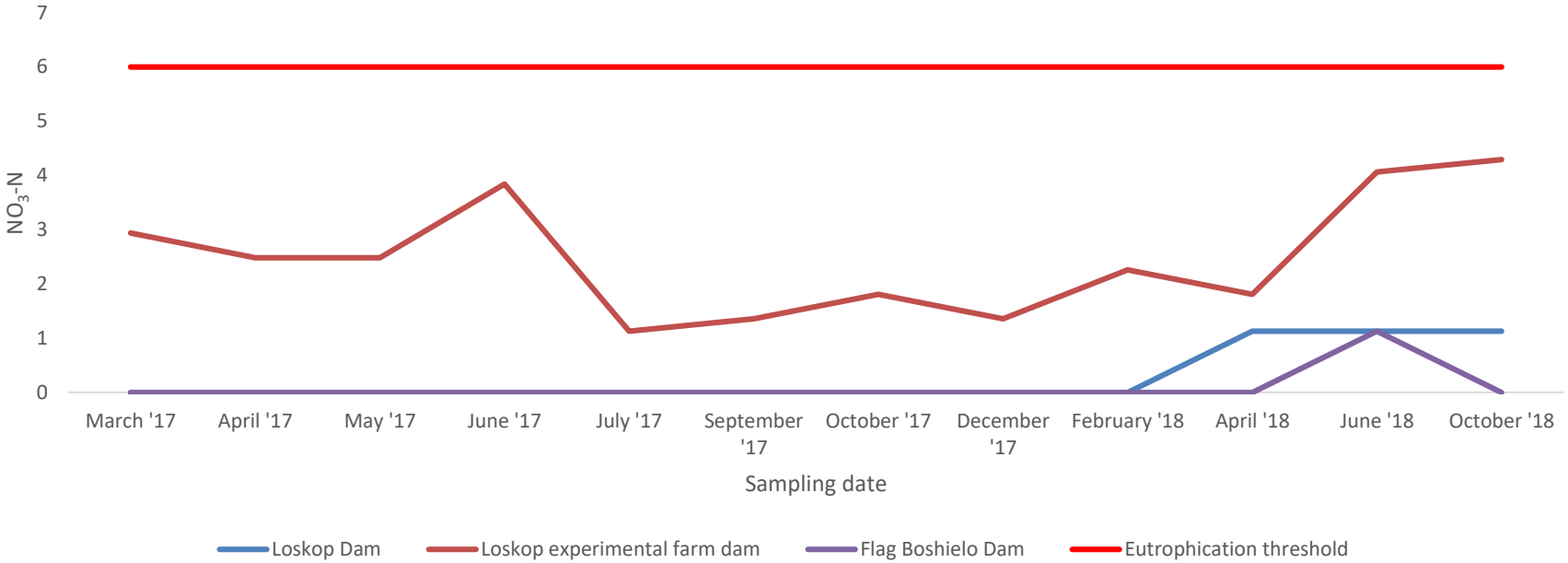


Results – Phosphate in drainage canals

Excluding DJ13



Results – Nitrate in dams



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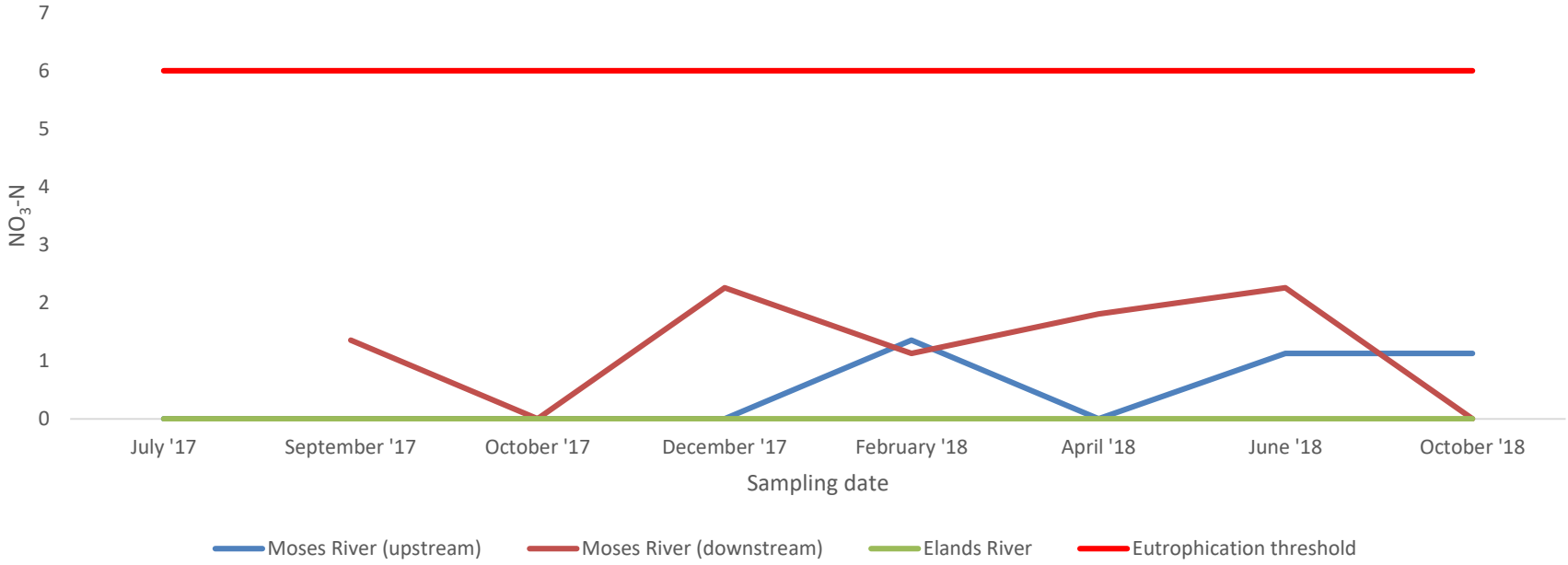
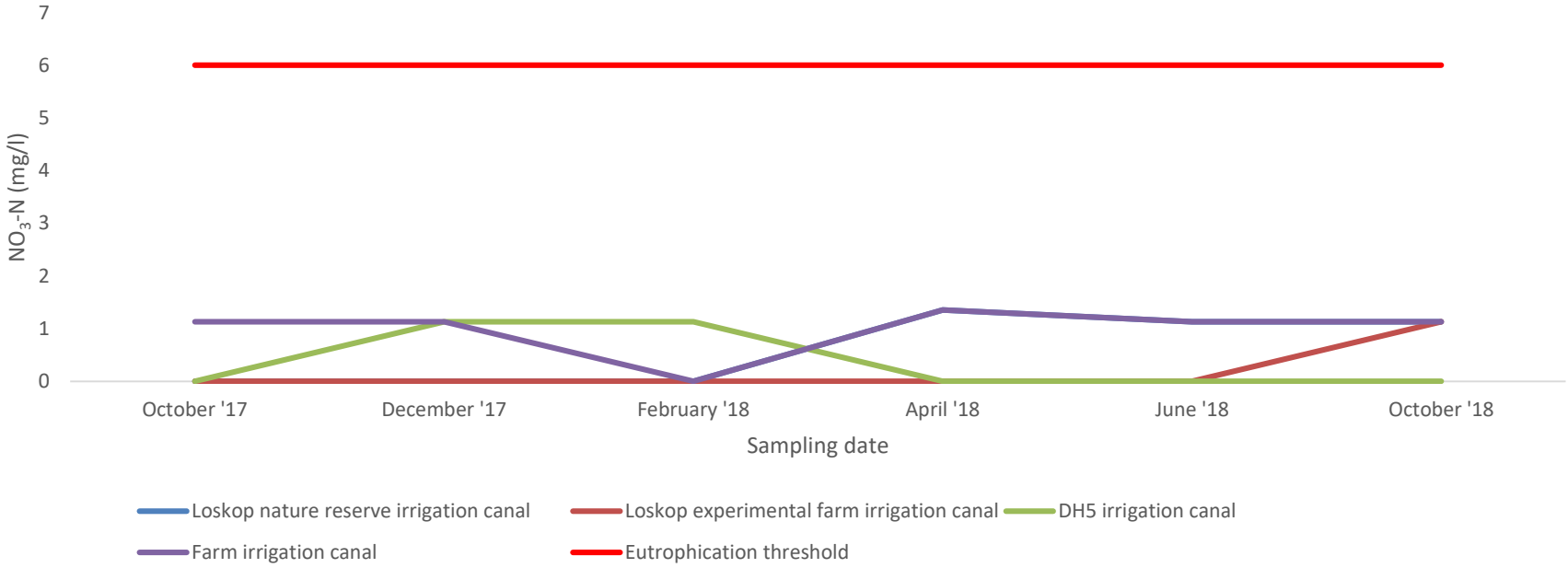


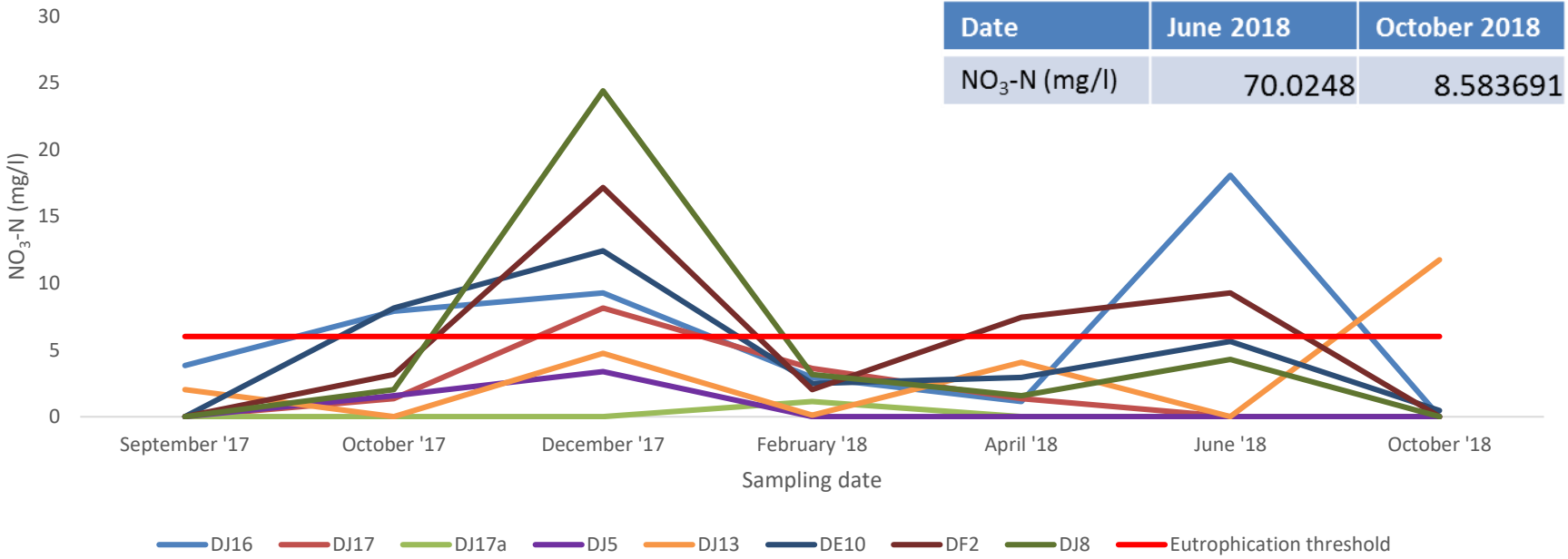
Results – Nitrate in irrigation canals



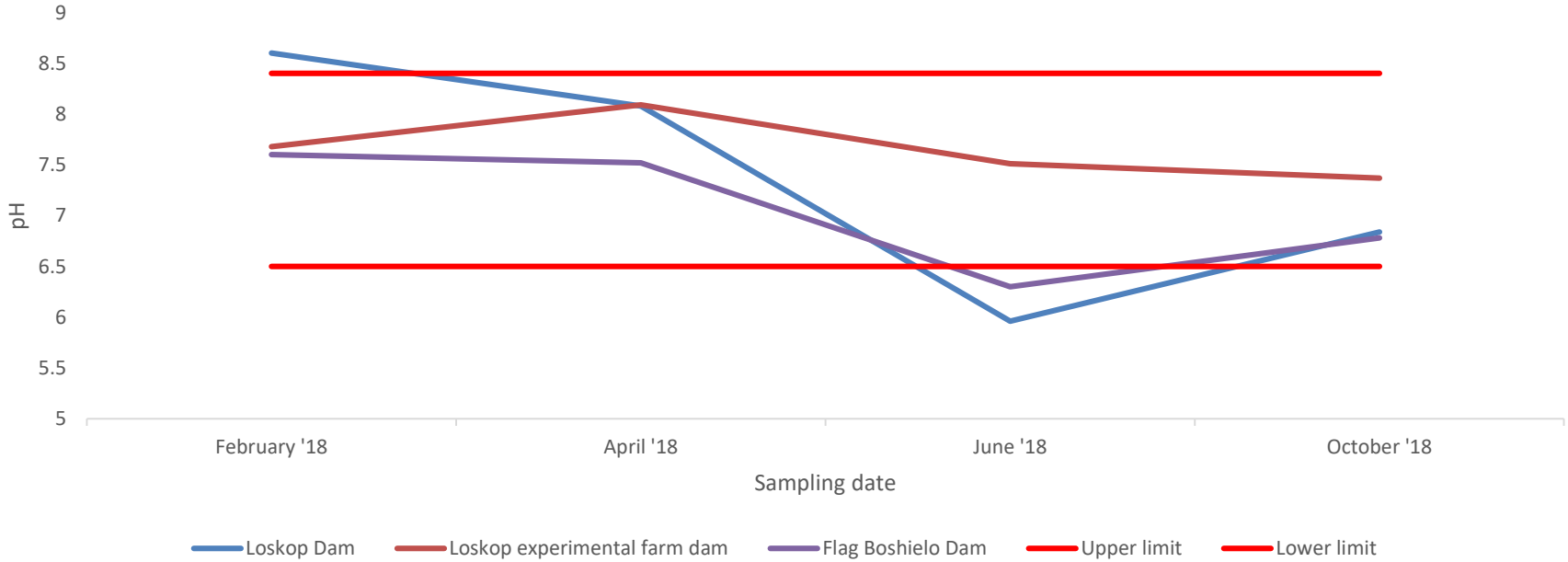
Results – Nitrate in drainage canals

Drainage gauge

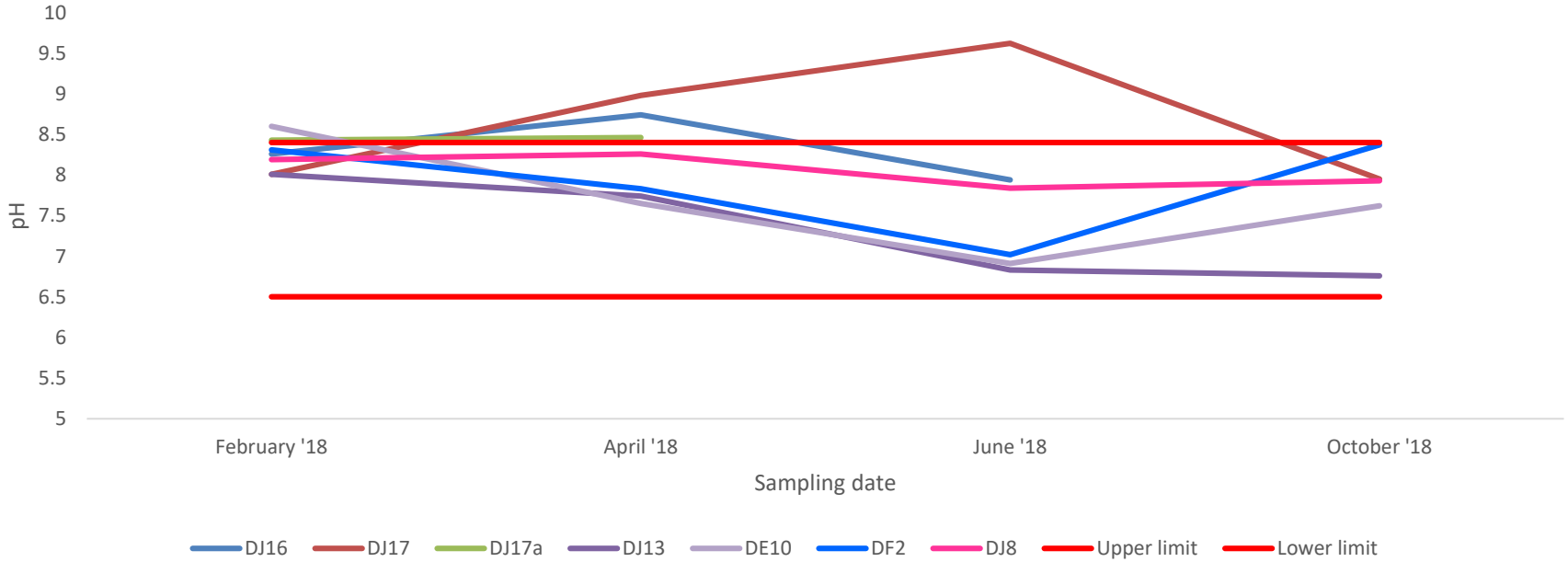
Date	June 2018	October 2018
NO_3-N (mg/l)	70.0248	8.583691



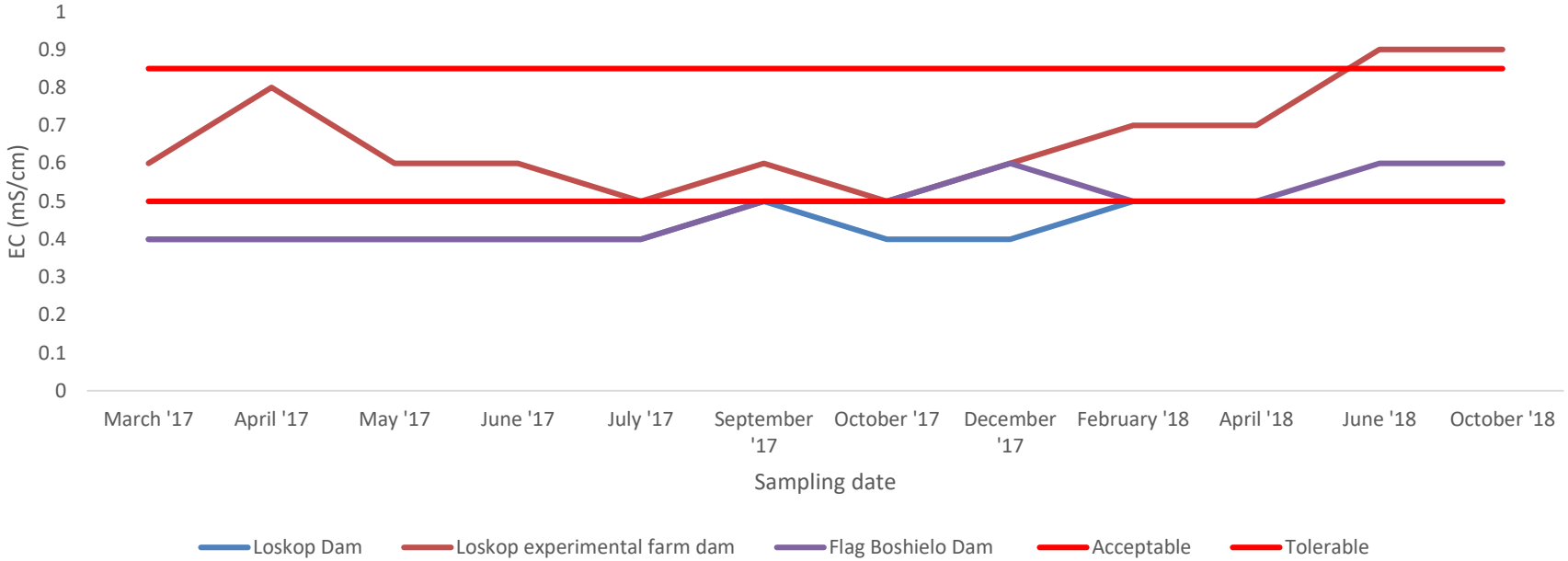
Results – pH in dams



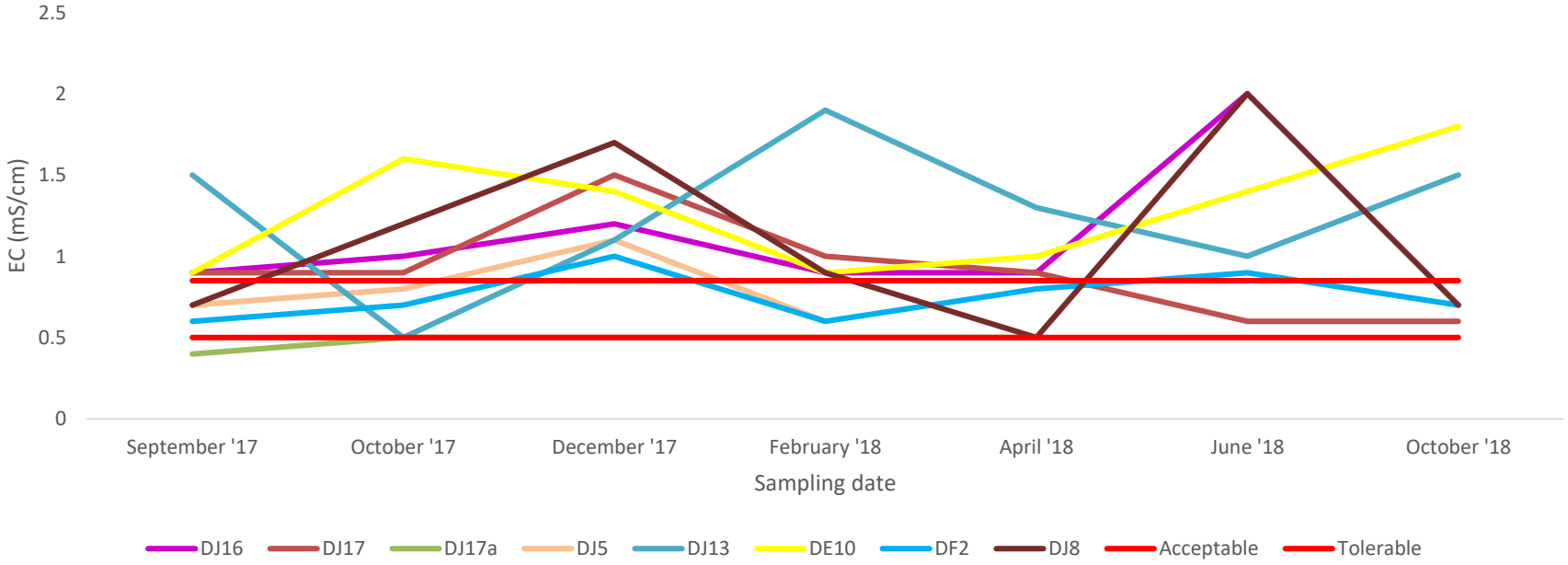
Results – pH in drainage canals



Results – EC in dams

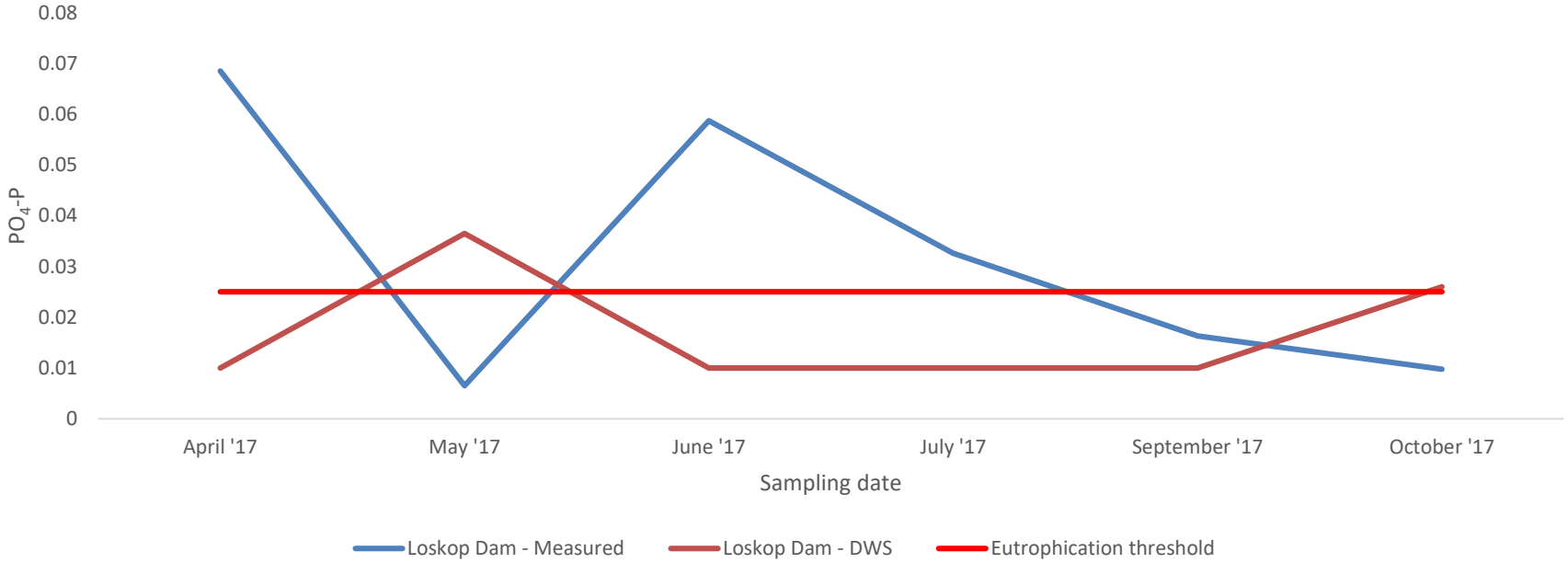


Results – EC in drainage canals



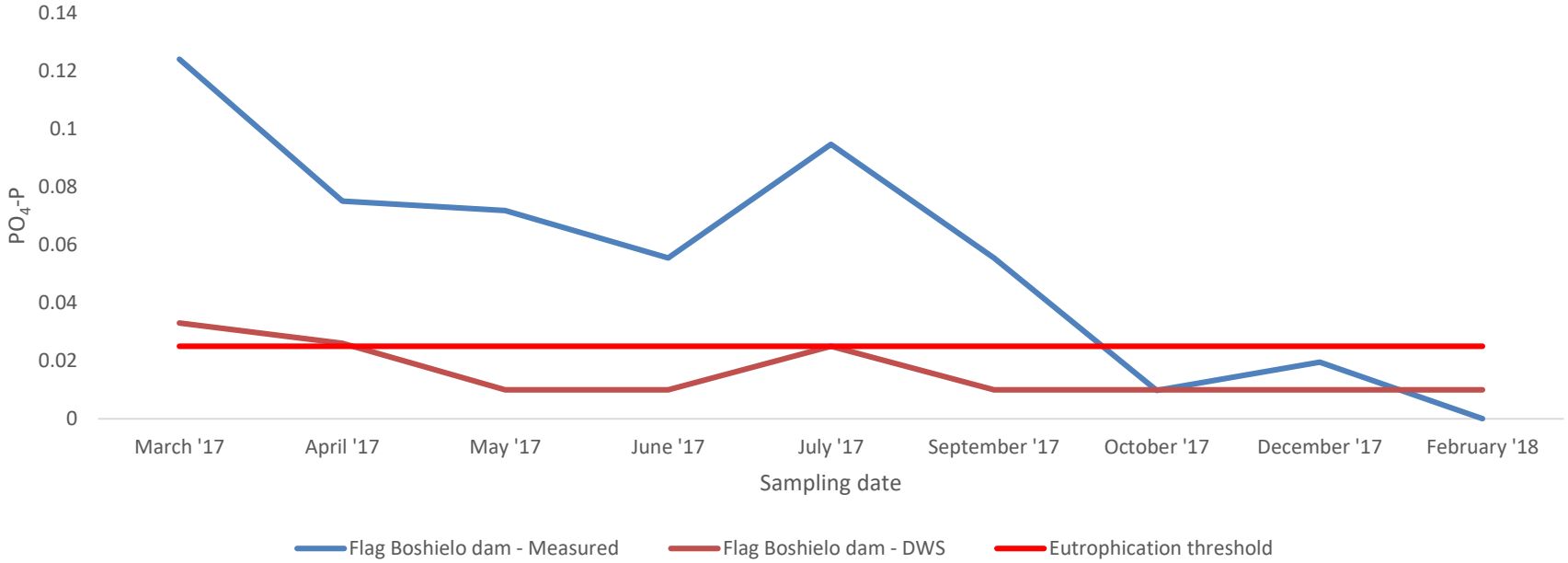
Results - Measured vs DWS comparison

Loskop Dam phosphate



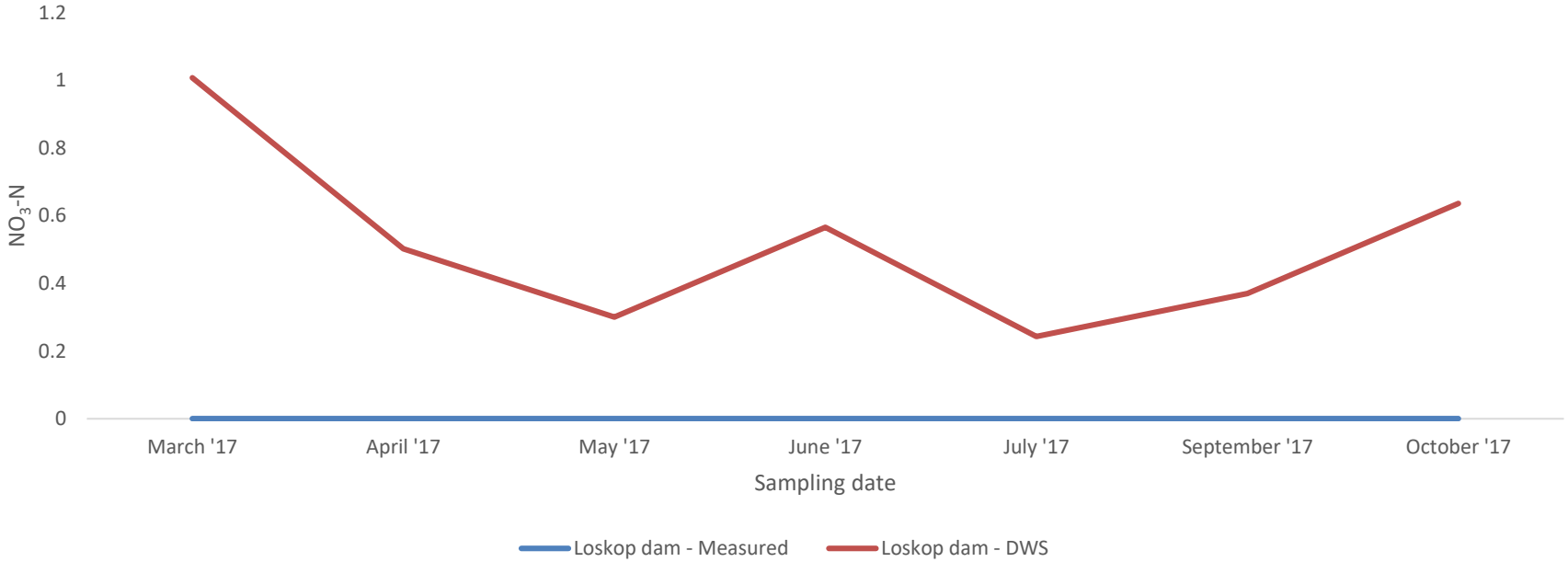
Results - Measured vs DWS comparison

Flag Boshielo Dam phosphate



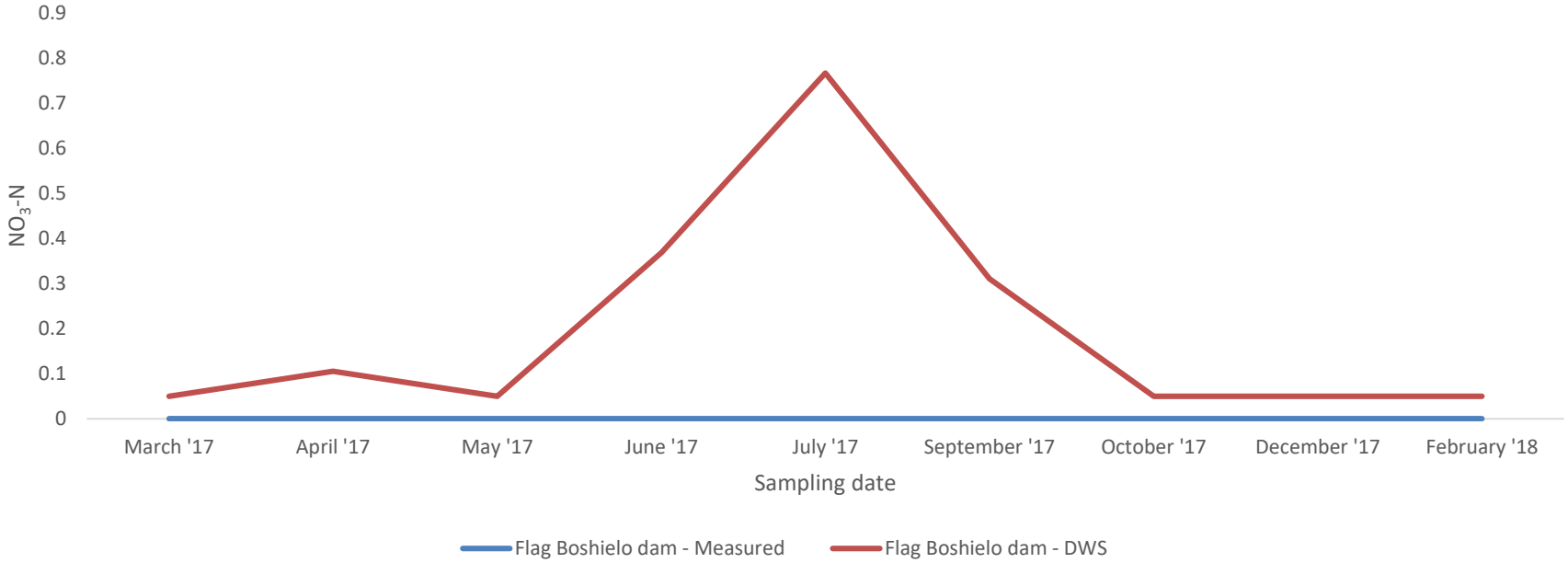
Results - Measured vs DWS comparison

Loskop Dam nitrate



Results - Measured vs DWS comparison

Flag Boshielo Dam nitrate



Results

Table 3: Comparison between measured and laboratory results

	NO_3-N				PO_4 - P		
	Lab 1	Lab 2	Measured		Lab 1	Lab 2	Measured
Sample	mg/l	mg/l	mg/l		mg/l	mg/l	mg/l
Drain Gauge	86.9	89	>56.47		0.127	0.2	0.192
DE 10	2.06	2.1	2.937		0.019	<0.1	0.039
DF 2	8.1	7.7	7.454		0.168	0.1	0.163
DJ13	4.92	3.4	4.066		0.98	1.1	0.535

Results

Google Earth Images of study area

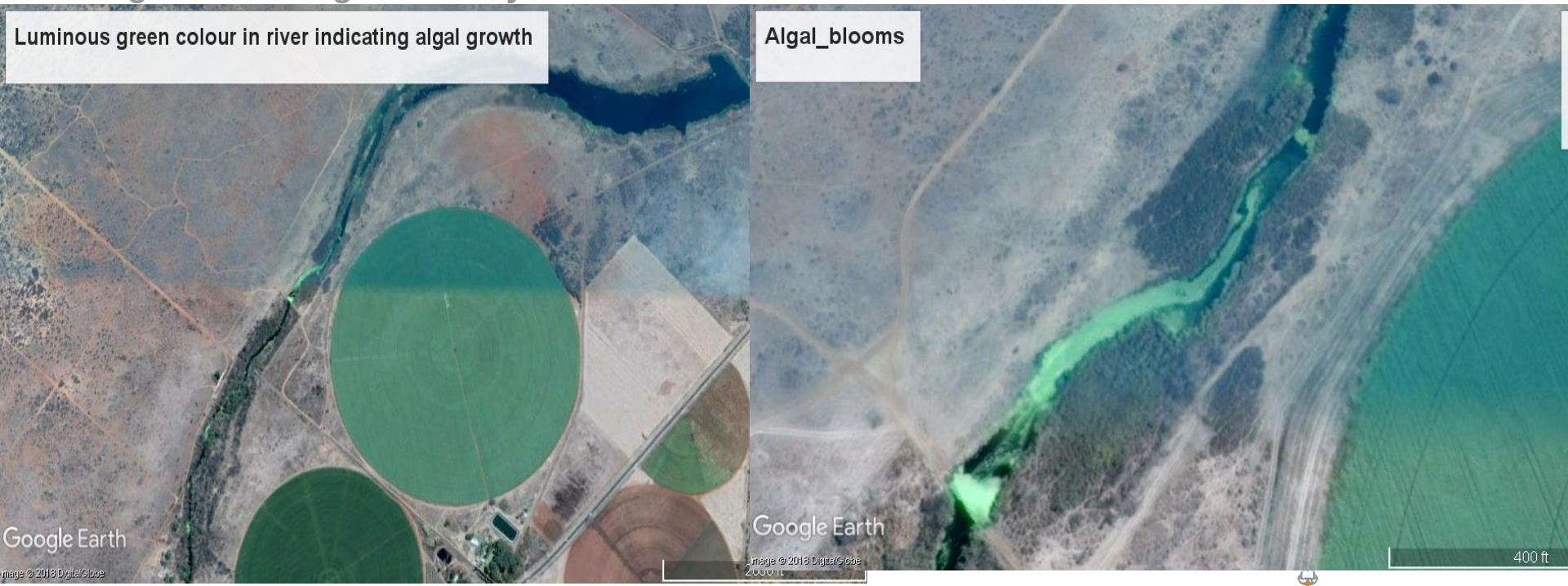


Figure 3: Luminous green colour in the Elands River indicative of algal blooms

Summary and conclusions

- Impact of activities upstream of Flag Boshielo impacts water quality
- Irrigation canals receiving water from Loskop Dam have PO_4-P and NO_3-N levels below ET and farmers should take into account existing P in irrigation water when designing a fertilizer programme
- PO_4-P in rivers is more concerning than NO_3-N
- Summer months tend to show higher nutrient concentrations than winter
- Our PO_4-P measured values were higher than DWS data - NO_3-N showed the opposite
- Gaps in water chemistry data problematic for monitoring in MO catchment
- DWS historical data is a major national asset, e.g. for SWAT modelling, but the perceived increasing infrequency of water quality sampling a concern
- Lab results correspond with observed data

Summary and conclusions

- P pollution appears to be a larger threat than N pollution in general
- Drainage canal data shows elevated amounts of P (and N seasonally) from agricultural losses – nutrients exported directly from drainage canals to freshwater resources
- Acknowledge that there are impacts from point sources (WWTW & mining)
- Although canals have low flow & this does not translate to load, its significance & contribution is worth noting.

Acknowledgements

- Water Research Commission (Project K5/ 2501, Quantifying and managing agricultural nitrogen and phosphorus pollution from field to catchment scale)
- Loskop Irrigation Board (Leon de Waal and Pieter Pretorius)
- Loskop Experimental Farm (Colleen)
- Department of Water and Sanitation

Thank You