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Impact of Slow-Release Fertilizer and Struvite in Enhancement of Biodegradation in Filter Drains to Prevent Groundwater Pollution

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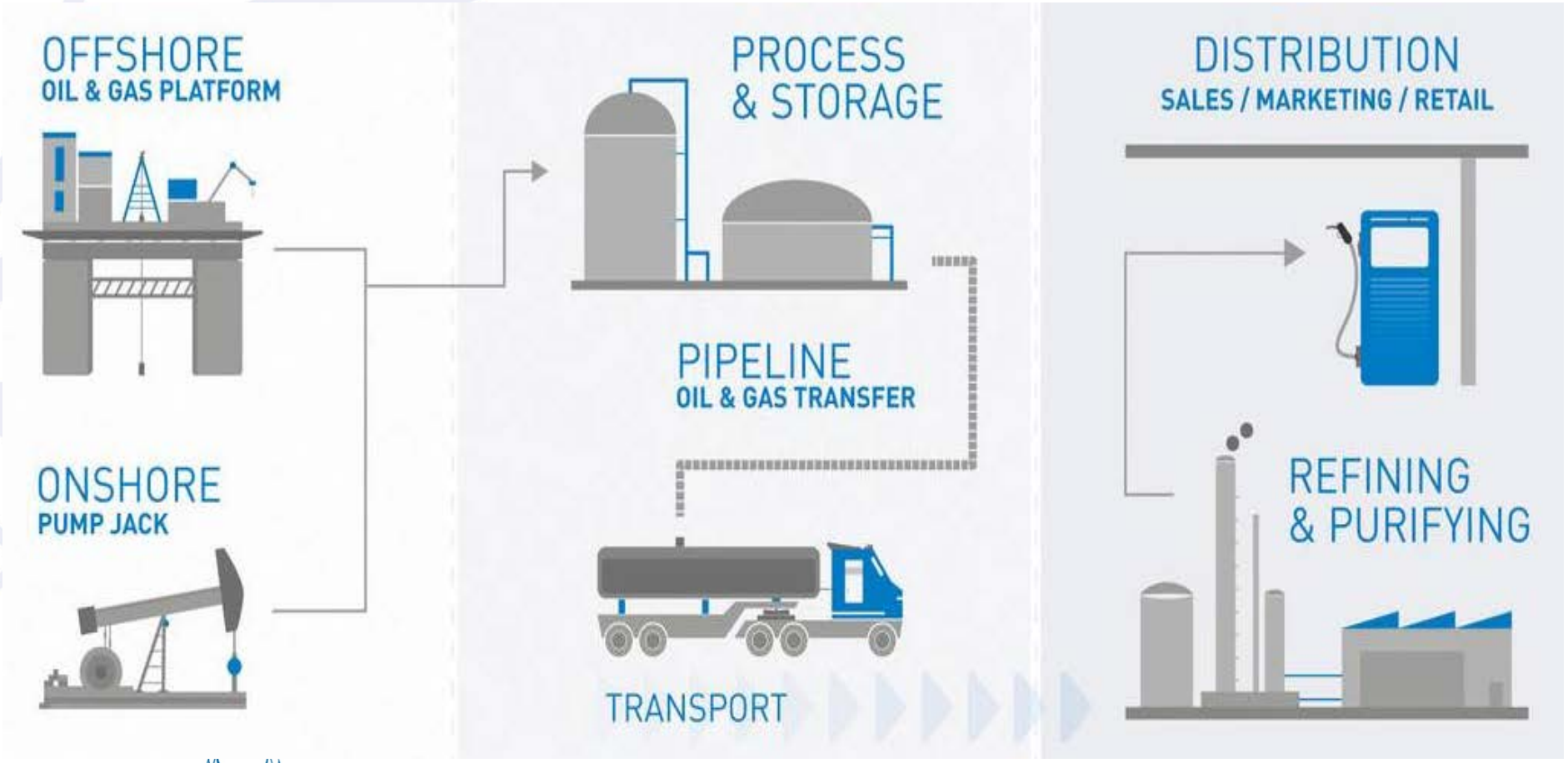
Introduction



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Upstream Process problems - Fire

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Upstream Process problems - Oil spill

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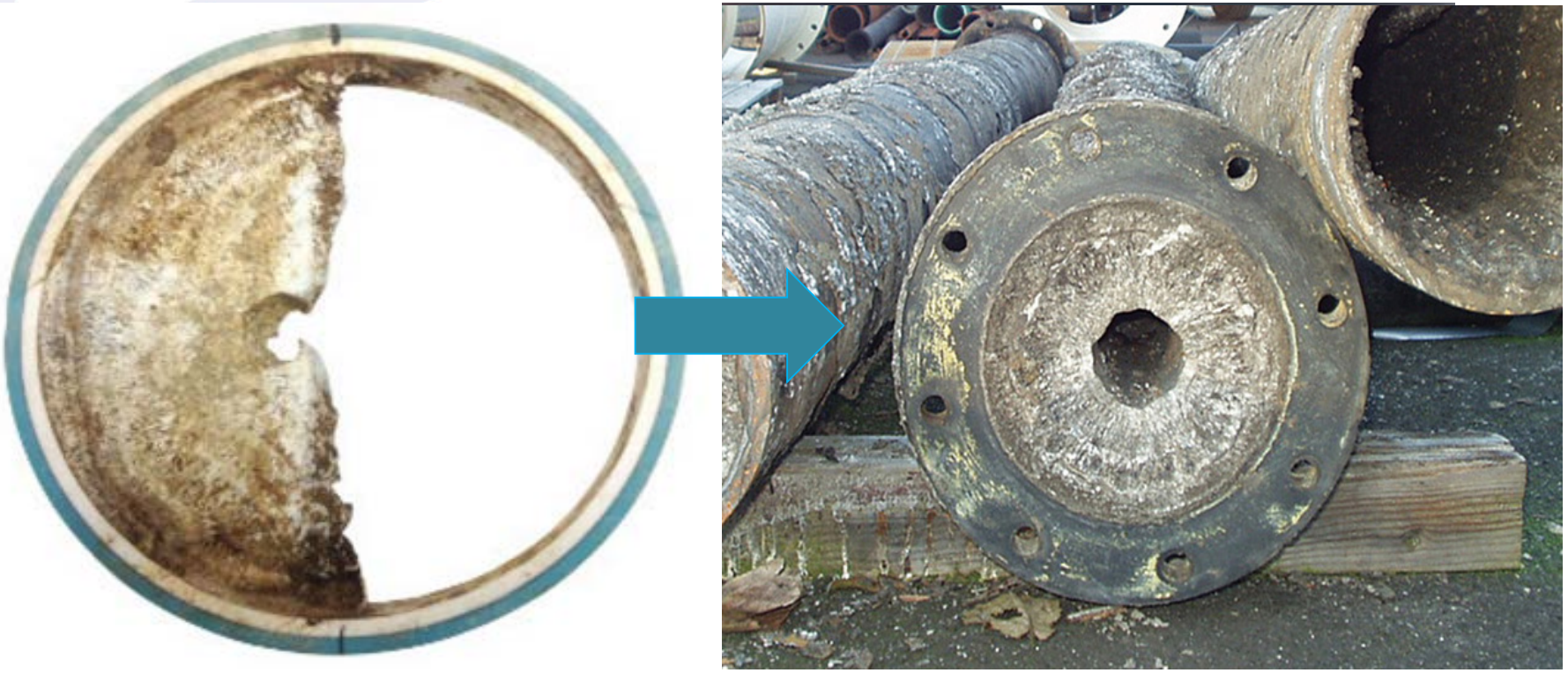

Upstream Process problems -Waste (Cuttings and Struvite)

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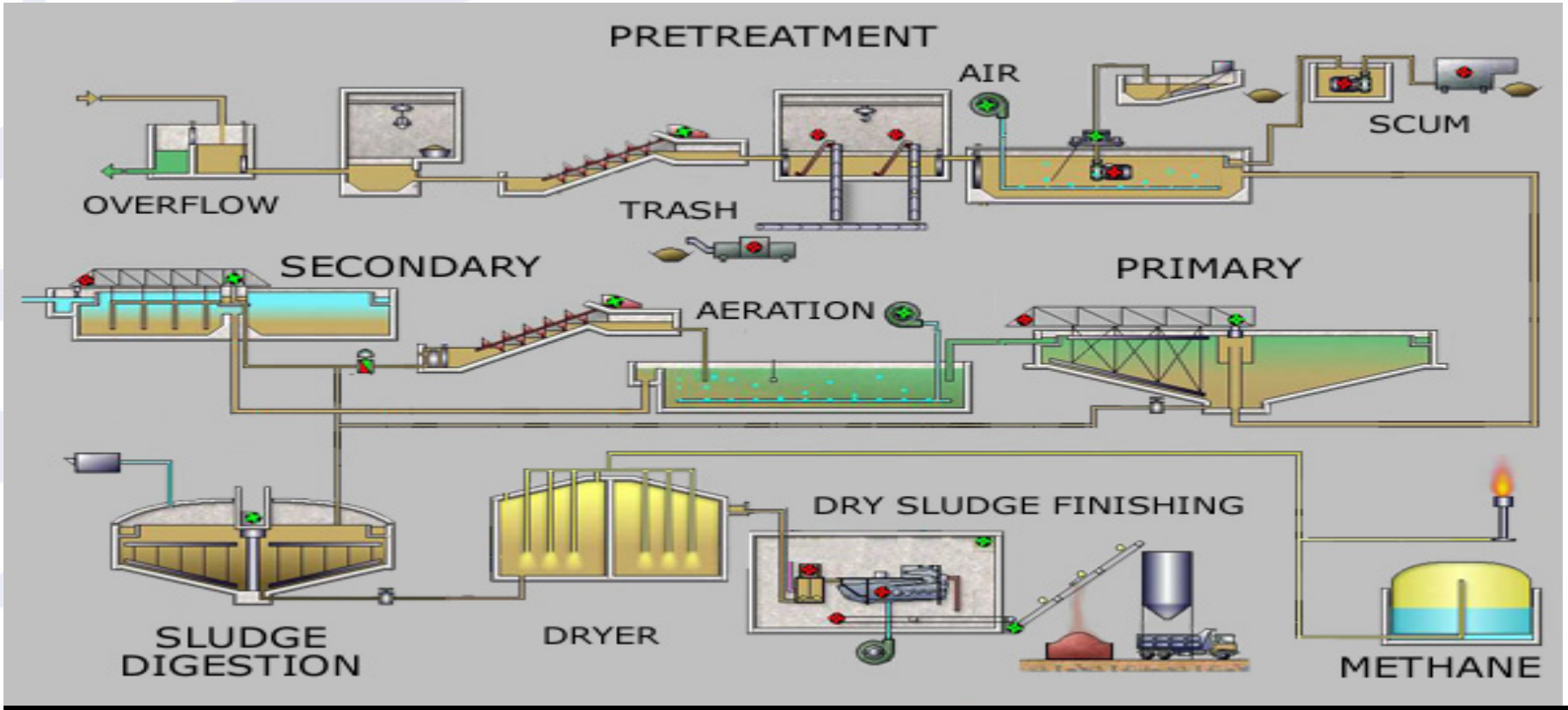

Wastewater treatment companies- Waste (Struvite)

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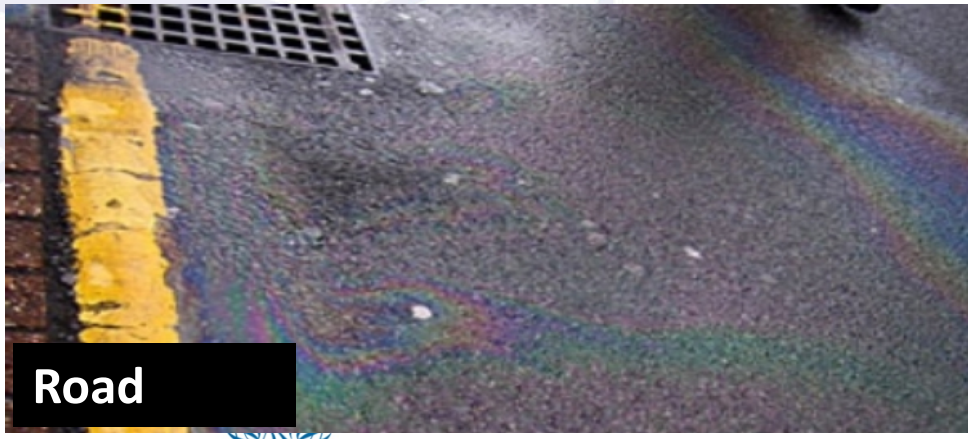

Downstream Problems e.g.

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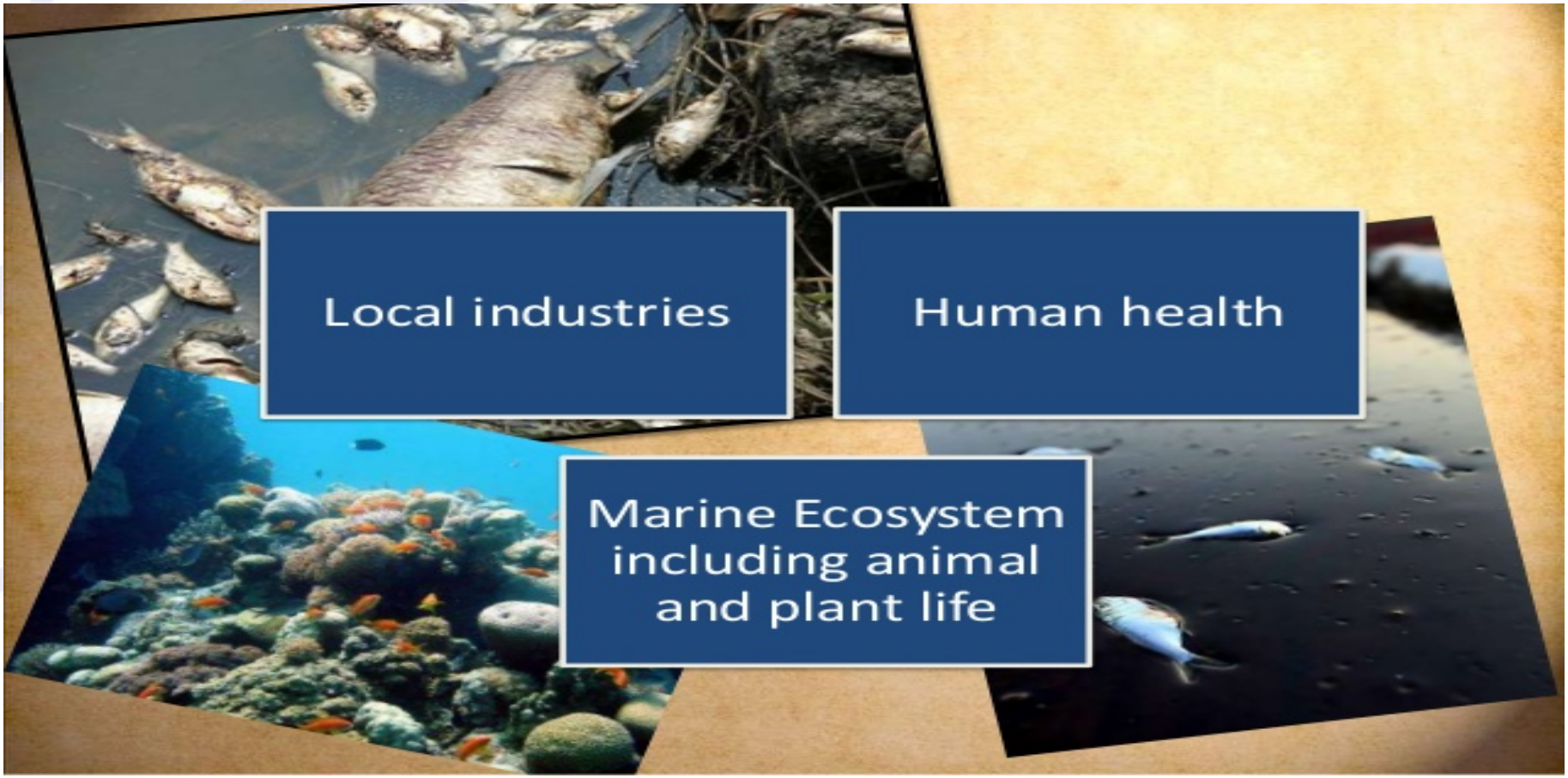

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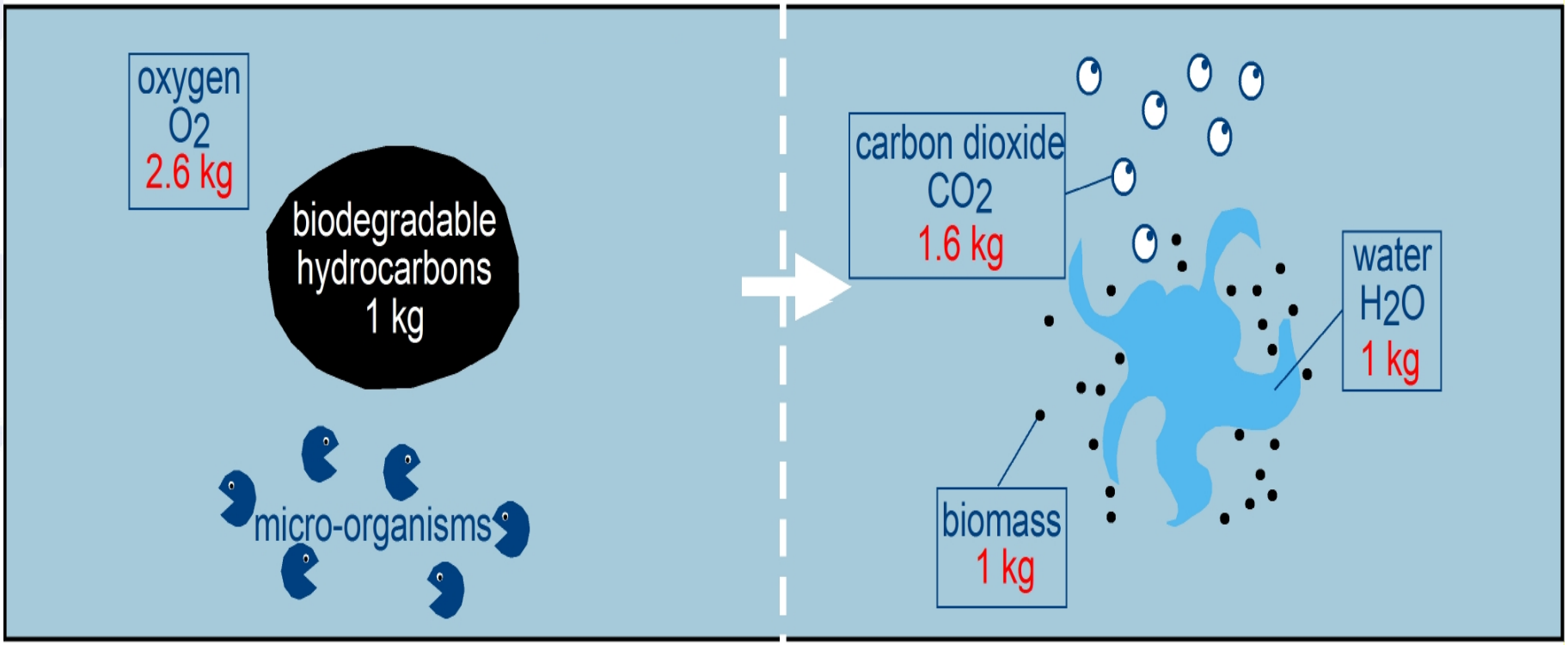
Natural aerobic biodegradation of hydrocarbons considered the best



Schematic of natural aerobic biodegradation of hydrocarbons.

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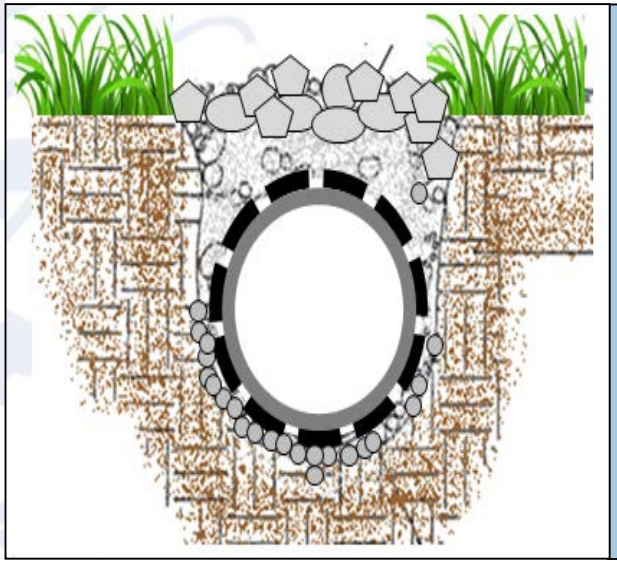
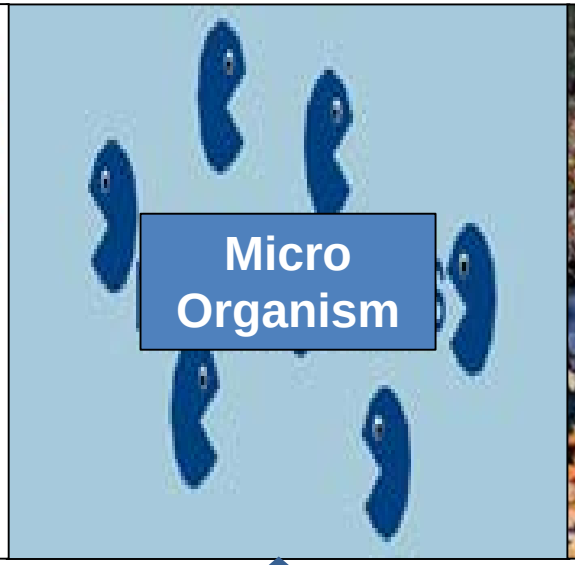
In Situ	Bio	Remediation





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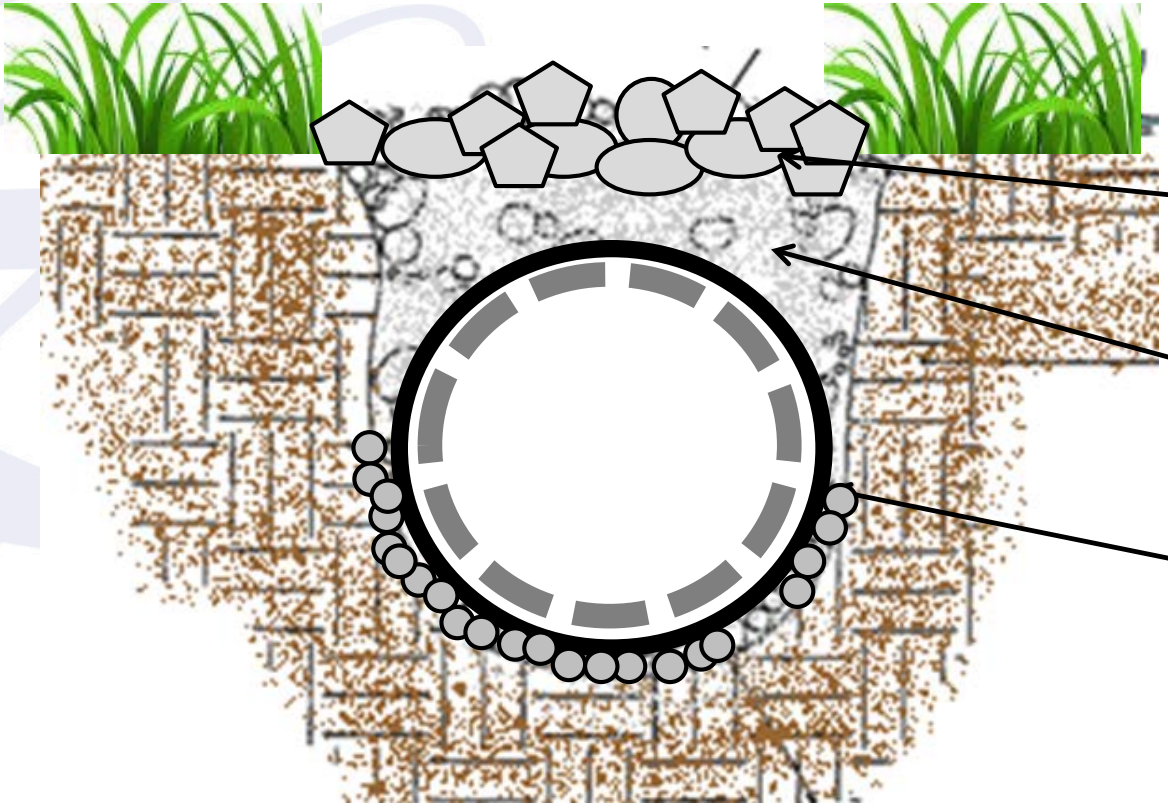
French Drain



Control runoff from road and car park surfaces

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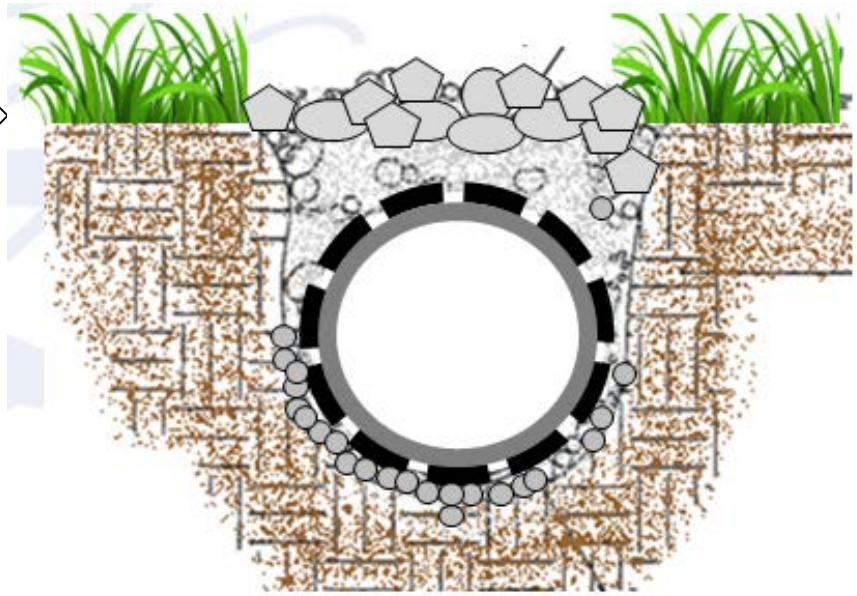
The idea



- Struvite has emerged as a sustainable source of nutrient.
- The active ingredient in struvite, phosphorus is one of the limiting factors in biodegradation process.
- Struvite have the potential application in biodegradation reliant systems such as SUDS devices.

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Aim

Filter drain designs for overflow runoff in high intensity rainfall and oil spillage incidents on the roads in addition to leakages from vehicles

The aim was to investigate the performance of slow-release fertilizer and Struvite in enhancement of biodegradation of hydrocarbon in filter (French drains) drains

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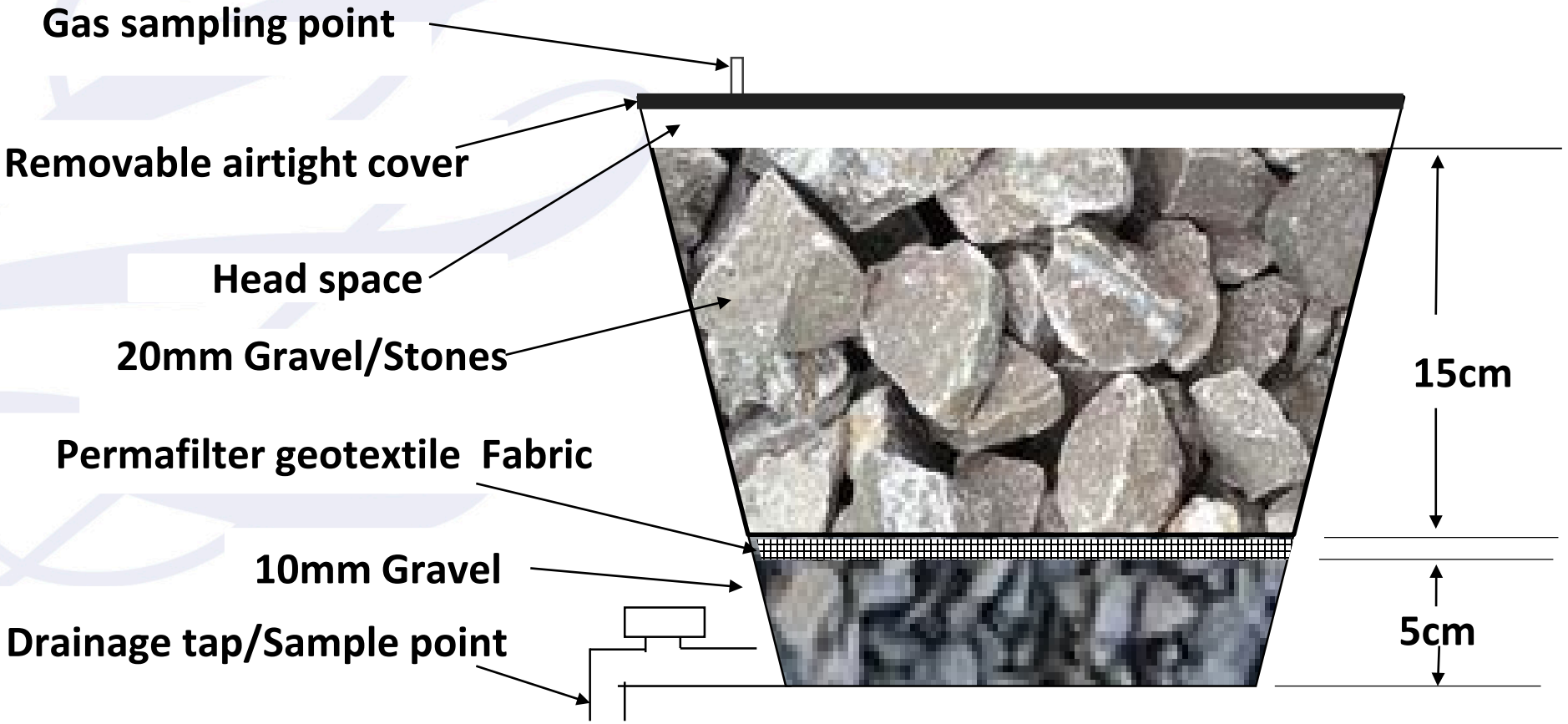
Material and Methods



Schematic of Test Models Used

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Material and Methods

Rig Set Up With The Various Treatments Applied.

No of replicates	 3	 3	 3
Additions	Water + Diesel	Water + Diesel + Slow-Release Fertilizer	Water + Diesel + Struvite
	Control Experiment	Slow-Release Fertilizer (Osmocote) Experiment	Struvite Experiment

- Equivalent of 13mm of rain applied weekly.
- Oil (Diesel) loading was simulated at the rate of 178mg/m2/Week.
- Nutrients (Struvite and Slow-Release Fertilizer) applied at one - off at the rate of 17g/$m^{2.}$
- 1.55g of Characterized Coventry street dust was added to replicate a real life scenario.
- Experiment was carried out in a temperature controlled environment (20^{O}C)

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Experimental Study

The impact of Slow-Release Fertilizer and Struvite on biofilm formation and biodegradation of hydrocarbon was studied through microbial analysis and activity through:

- CO_2 evolution,
- Electrical Conductivity,
- pH,
- TPH, and
- Heavy metals.

Elemental analysis, SAR were used to investigate water quality of effluent of filter drains during experimental study

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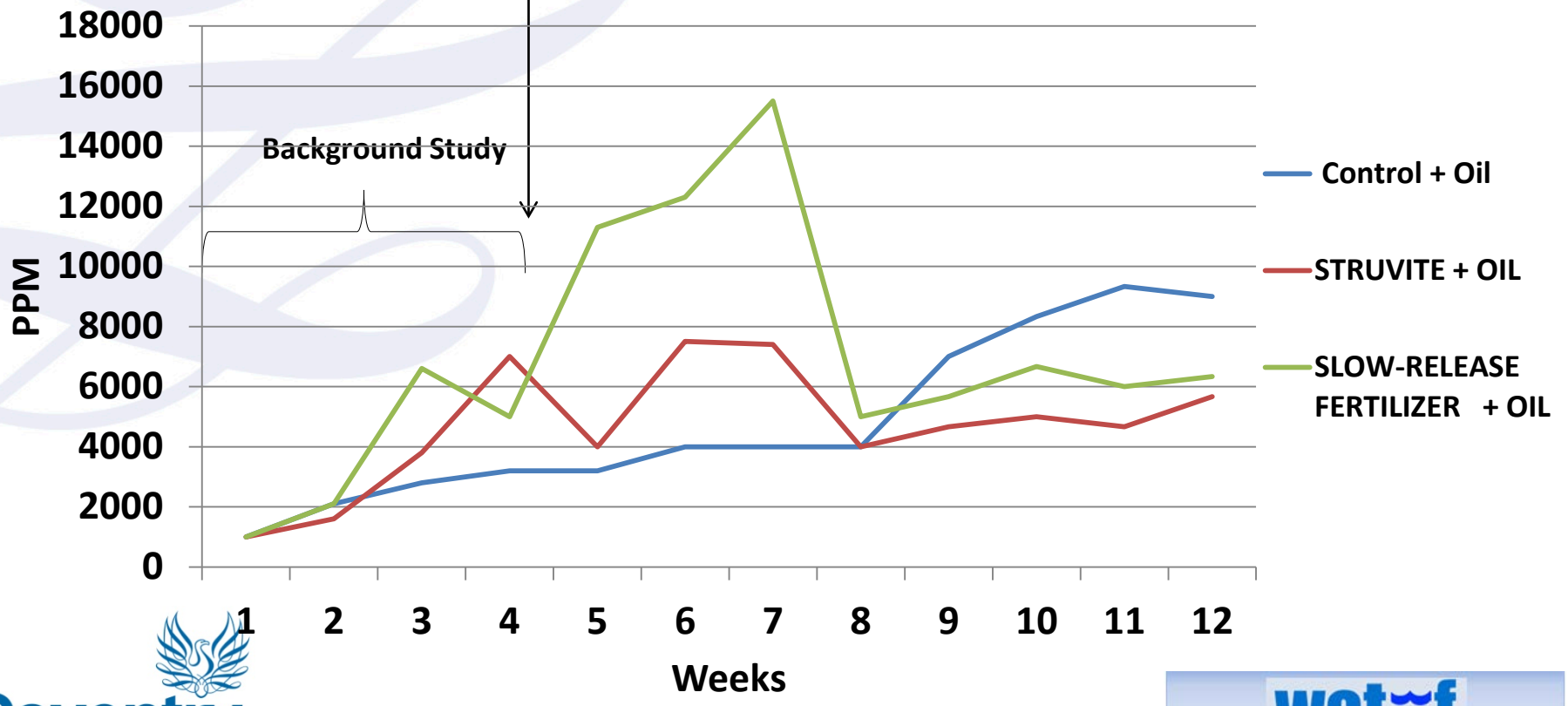
Carbon Dioxide Evolution Results

Start of Contaminant addition
(Diesel oil and Street dust Weekly),
Struvite and Slow-Release Fertilizer (one off)

	N (mg/l)	P (mg/l)	K (mg/l)
Struvite	6%	29%	0%
Slow-Release Fertilizer	10%	4.8%	14.9%



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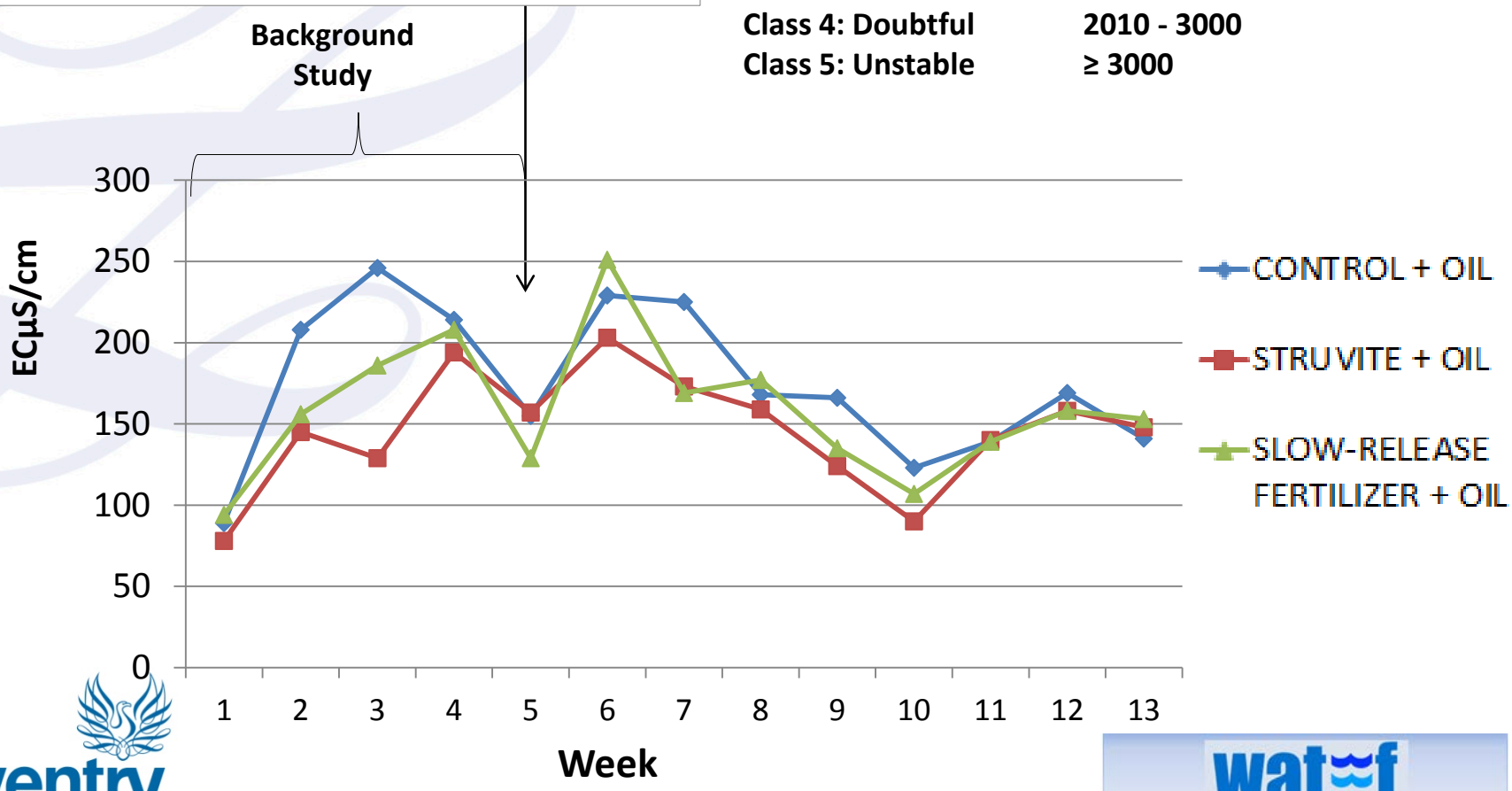
Electrical Conductivity Results

Start of Contaminant addition
(Diesel oil and Street dust Weekly),
Struvite and Slow-Release Fertilizer (one off)

Classes of Irrigation water Electrical Conductivity (µS/cm)

Class 1: Excellent	**≤ 250**
Class 2: Good	**250 – 750**
Class 3: Permissible	**760 – 2000**
Class 4: Doubtful	**2010 - 3000**
Class 5: Unstable	**≥ 3000**



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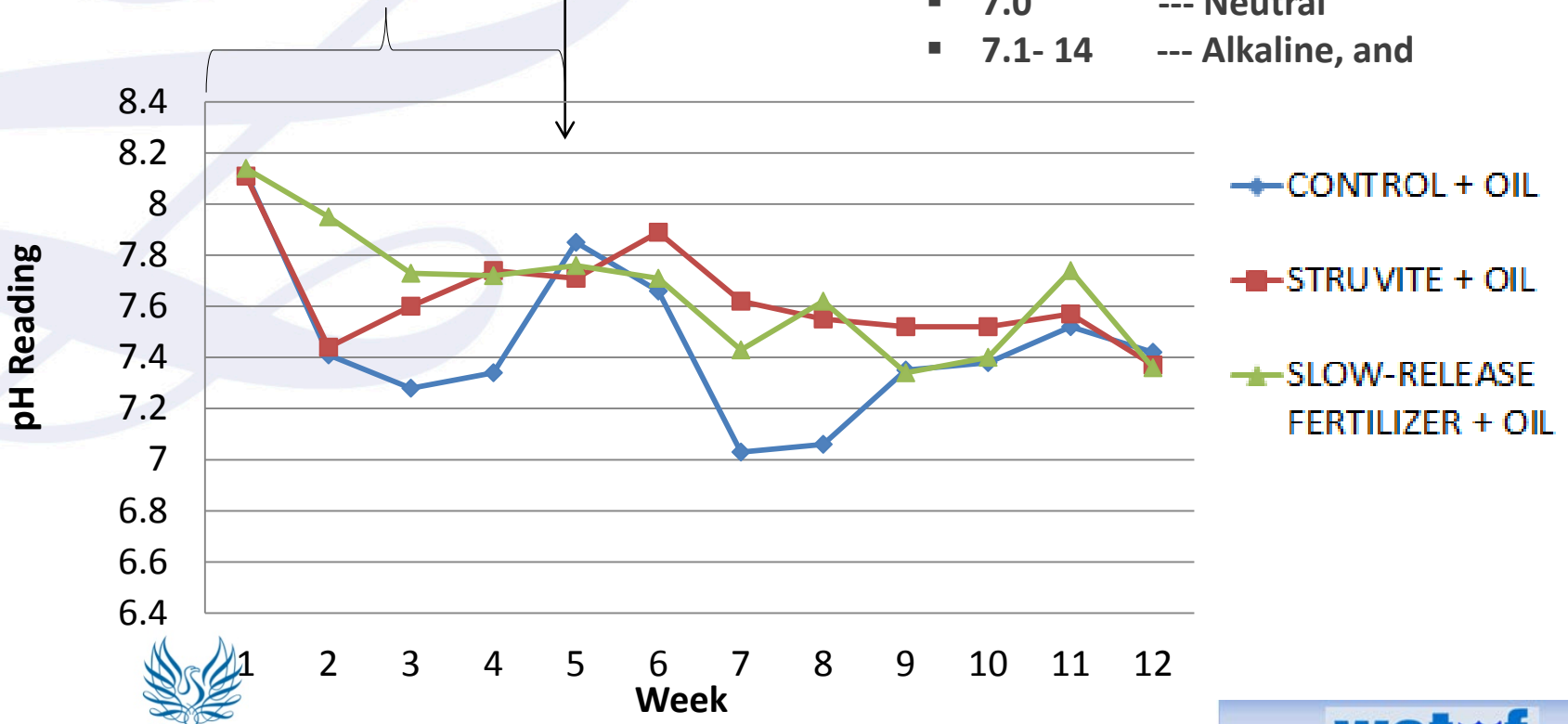
pH Results

Start of Contaminant addition
(Diesel oil and Street dust Weekly),
Struvite and Slow-Release Fertilizer (one off)

Physiochemical parameters used to determine the existence of essential nutrients in a given sample

- **0 - 6.9 --- Acidic**
- **7.0 --- Neutral**
- **7.1- 14 --- Alkaline, and**



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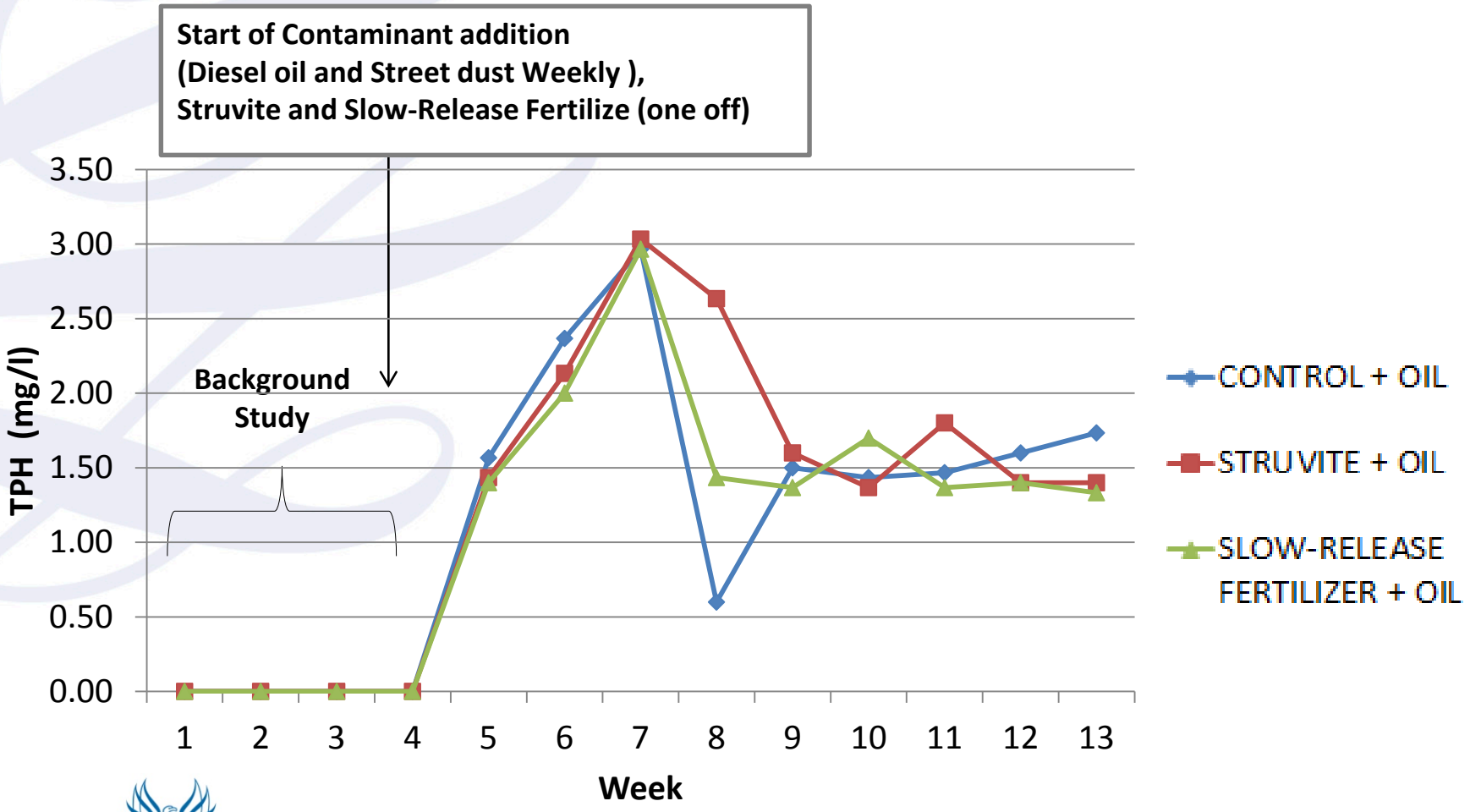
Total Petroleum Hydrocarbon (TPH) Results



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Heavy Metal (Ave. Conc.) (mg/L)

Rigs	Al	Ca	Cd	Cu	Fe	K	Mg	Na	Pb	S	Zn
Street dust + Diesel + Water only	0.01	14.80	BLD	0.02	0.01	1.29	4.12	22.6	BLD	13.32	0.02
Street dust + Diesel + Water + Osmocote	0.02	14.88	BLD	0.02	0.01	2.74	3.56	22.34	BLD	8.38	0.02
Street dust + Diesel + Water + Struvite	BLD	14.20	BLD	0.02	0.01	1.08	3.69	22.08	BLD	8.14	0.04
Limits	0.2	-	0.003	2	0.5 – 50	-	0.2	200	0.01	-	3

- BLD = Below the Limits of Detection
- Limits = WHO's Guidelines for Drinking-water Quality, set up in Geneva

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Conclusions

- **Nutrient (Struvite and Slow-Release Fertilizer) application increased microbial activities with high nutrient rich environment showing best potential for rapid degradation of pollutants in systems such as filter drains.**

- **This shows the need for incorporation of permafilter geotextile and nutrients in filter drains to improve pollutant removal of such systems**

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Conclusions

- **Such improvement offers the potential for reuse of highway runoff treated in filter for:**
  - ✓ **landscape irrigation.**

- **This study shows the potential for utilization of Struvite in SUDS devices for enhancement of biodegradation and improvement of efficiency of such systems.**

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Thank you

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