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Produced Water Commitment Development and Challenges in PETRONAS

Presentation to Produced Water Workshop 2021
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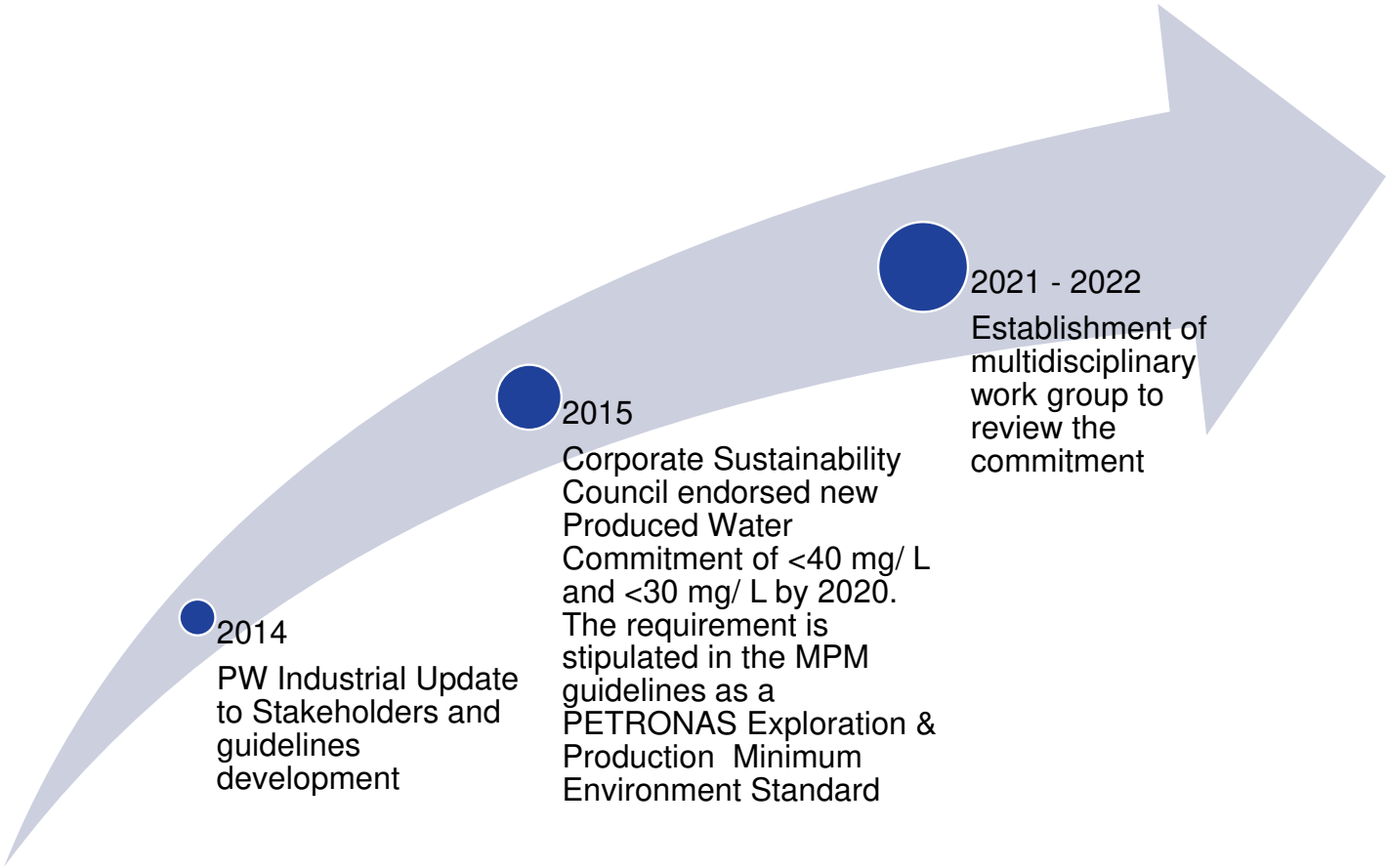
The journey of PETRONAS Produced Water Commitment started in 2014. As an organization, PETRONAS committed to safeguard the environment by limiting oil in water discharge to less than 40 mg/ L since 2015 and subsequently less than 30 mg/ L starting 2020.



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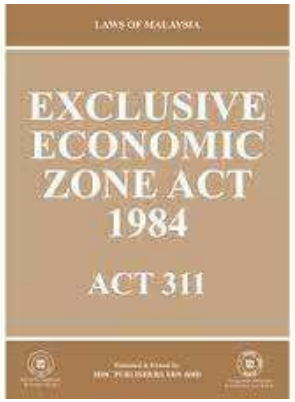
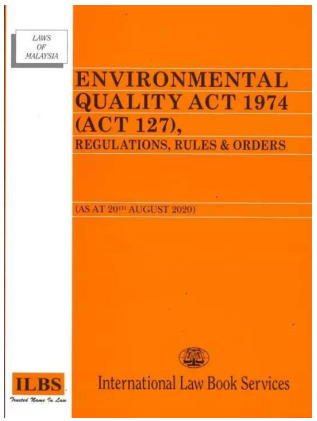
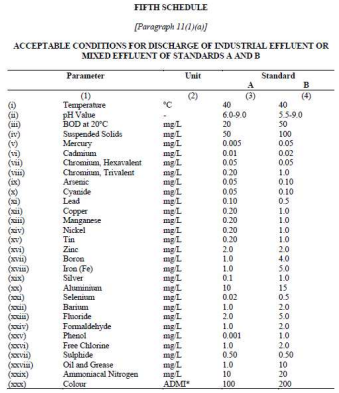
Existing regulatory requirement limits oil in water discharge to less than 100 mg/ L for EEZ and less than 30 mg/ L for marine pollution control. Meanwhile, the produced water discharge from onshore facilities are required to comply to industrial effluent regulation under EQA 1974.

- Environmental Quality (Marine Pollution) Regulations
  - ✓ OIW <30 mg/ L (<12nm)
- Exclusive Economic Zone Act (EEZ)1984
  - ✓ OIW <100 mg/ L (12-200nm)
- Environment Quality Act (EQA) 1974, Industrial Effluent Regulation 2009
  - ✓ Limiting discharge of 30 parameters inclusive of oil and grease <1 mg/ L for Standard A and <10 mg/ L for Standard B.
  - ✓ Some of the facility even have to meet zero liquid discharge especially for those located near tourism areas







FIFTH SCHEDULE

[Paragraph 11(1)(a)]

ACCEPTABLE CONDITIONS FOR DISCHARGE OF INDUSTRIAL EFFLUENT OR MIXED EFFLUENT OF STANDARDS A AND B

	Parameter	Unit	Standard A	Standard B
	(1)	(2)	(3)	(4)
(i)	Temperature	°C	40	40
(ii)	pH Value	-	6.0-9.0	5.5-9.0
(iii)	BOD at 20°C	mg/L	20	50
(iv)	Suspended Solids	mg/L	50	100
(v)	Mercury	mg/L	0.005	0.05
(vi)	Cadmium	mg/L	0.01	0.02
(vii)	Chromium, Hexavalent	mg/L	0.05	0.05
(viii)	Chromium, Trivalent	mg/L	0.20	1.0
(ix)	Arsenic	mg/L	0.05	0.10
(x)	Cyanide	mg/L	0.05	0.10
(xi)	Lead	mg/L	0.10	0.5
(xii)	Copper	mg/L	0.20	1.0
(xiii)	Manganese	mg/L	0.20	1.0
(xiv)	Nickel	mg/L	0.20	1.0
(xv)	Tin	mg/L	0.20	1.0
(xvi)	Zinc	mg/L	2.0	2.0
(xvii)	Boron	mg/L	1.0	4.0
(xviii)	Iron (Fe)	mg/L	1.0	5.0
(xix)	Silver	mg/L	0.1	1.0
(xx)	Aluminium	mg/L	10	15
(xxi)	Selenium	mg/L	0.02	0.5
(xxii)	Barium	mg/L	1.0	2.0
(xxiii)	Fluoride	mg/L	2.0	5.0
(xxiv)	Formaldehyde	mg/L	1.0	2.0
(xxv)	Phenol	mg/L	0.001	1.0
(xxvi)	Free Chlorine	mg/L	1.0	2.0
(xxvii)	Sulphide	mg/L	0.50	0.50
(xxviii)	Oil and Grease	mg/L	1.0	10
(xxix)	Ammoniacal Nitrogen	mg/L	10	20
(xxx)	Colour	ADMI*	100	200

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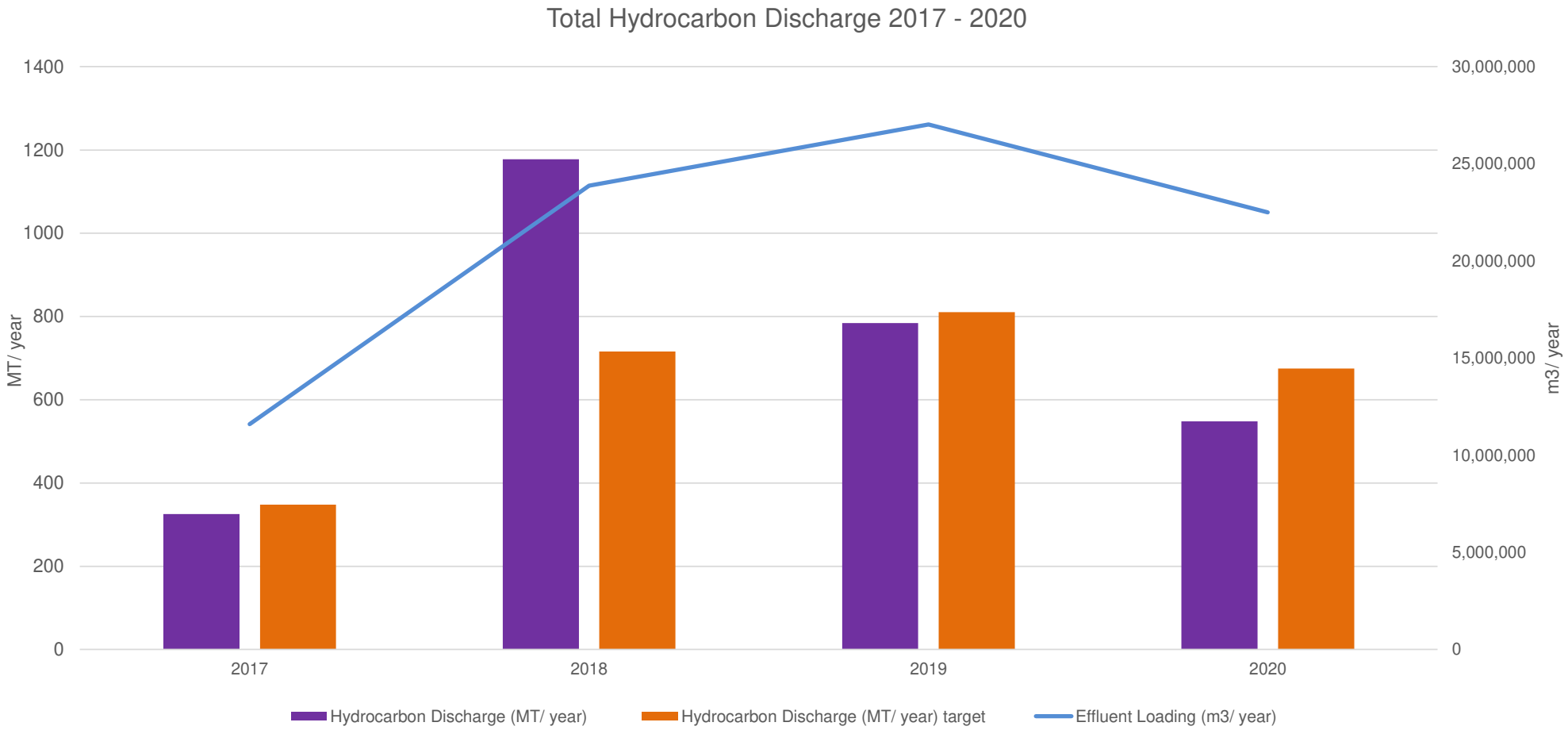
The result showed positive impact towards reduction of hydrocarbon discharge to the water bodies.



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However, this comes with multiple challenges

- Absence of true hydrocarbon accounting due to lack of comprehensive narration in deferment data related to produced water.
- Domino effect of emulsion at from off-shore to on-shore and subsequently to our customers
- Emulsion presence in both Oil-in-Water (OIW) and Water-in-Oil (WIO) which limits production and increase OPEX for chemical injection
- Presence of different contaminants levels at each fields and distributions line that stabilizes OIW emulsion leading to difficulty to consistently meet the produced water commitment
- Increasing produced water volume also resulted in higher produced sand leading to pipeline erosion. Fine produced sand also contributed to stable emulsion.

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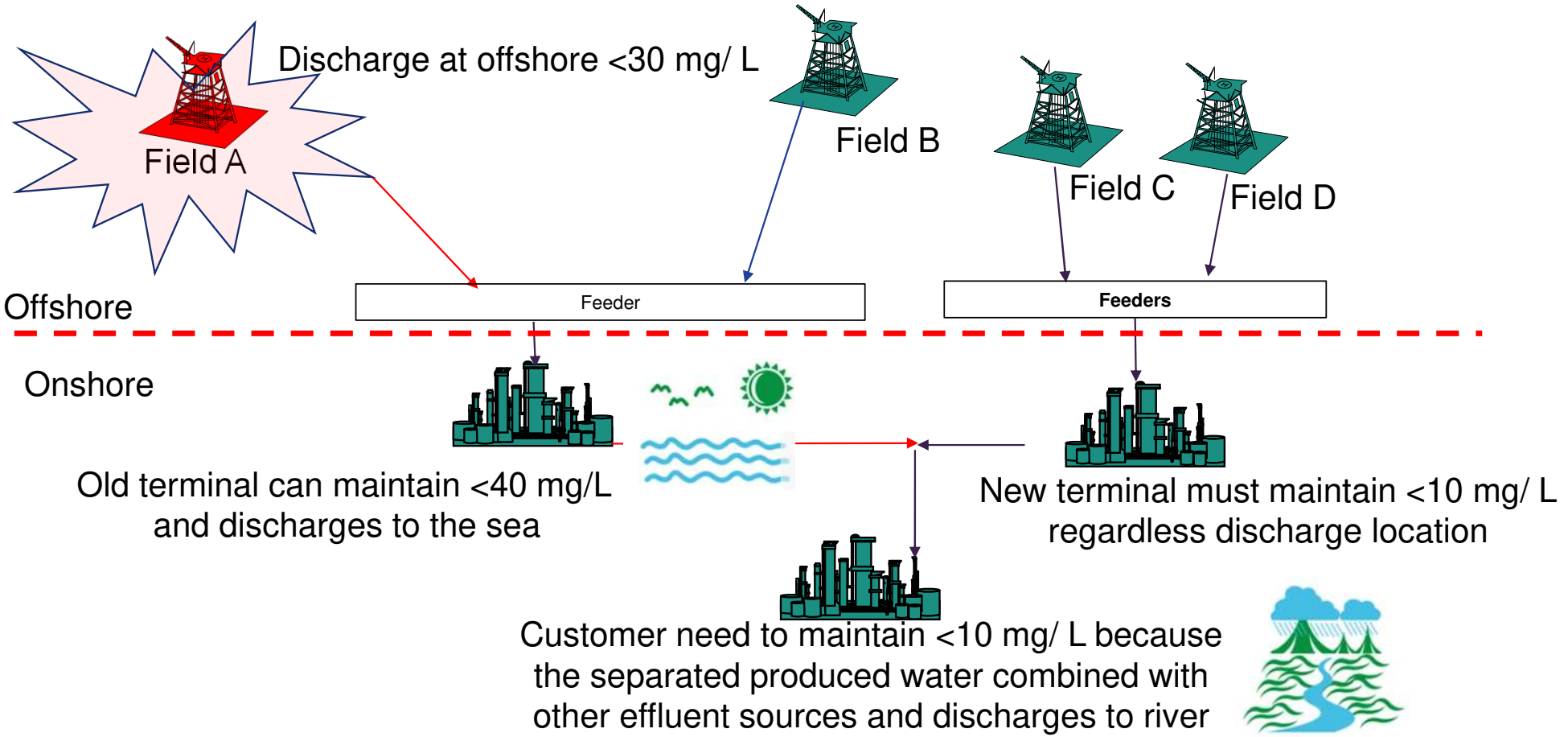
The configuration of produced water system differs from region to region. Certain region will have a mixture of produced water treatment offshore and onshore. Another region push all the produced water to an onshore treatment facility. This complicates the treatment regime due to different requirement offshore and onshore. One contaminated field can lead to emulsion that carried over to our customer.



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Complex produced water emulsion caused by the contaminants leads to requirement for chemical treatment. However, effective retention time unable to be achieved and sludge accumulates in separators and clog small pipings.

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Oil in Water (OIW)	Water in Oil (WIO)
Formation – soap dispersion	Formation – soap precipitation
Ionic • Na^+, K^+ soaps and sulphides • Sodium naphtenes and creslates • Precipitated sulfides plus surfactants • Organic amines	Ionic • Multivalent metal soap e.g. Cu, Fe • Sulfide ion plus carbon particles • Multivalent metal oxides e.g. Fe_2O_3, Fe_3O_4 • Mercaptans, CH_4S • Naphthenic or cresylic acids
Electrolytes which favor stability • Salts of univalent cations e.g. Na^+, K^+ • Salts of di- and trivalent cations	Electrolytes which favor stability • Salts of di- and trivalent cations

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A dual function de-emulsifier has been formulated in house using prediction tools. The application is unique from field to field.

MAIN TYPE	DESCRIPTION	CHARGE	USAGE
Inorganic	Polyvalent metal salts such as alum, $AlCl_3$, $FeCl_3$, $Fe_2(SO_4)_3$	Cationic	O/W
	Mineral acids such as H_2SO_4, HCl, HNO_3	Cationic	O/W and W/O
	Adsorbents (adding solid) – pulverized clay, lime	None	O/W
Organic	Polyamines, polyacrylates and their substituted copolymers	Cationic	O/W
	Alkyl substituted benzene sulfonic acids and their salts	Anionic	W/O
	Alkyl phenolic resins, substituted polyalcohols	Nonionic	W/O

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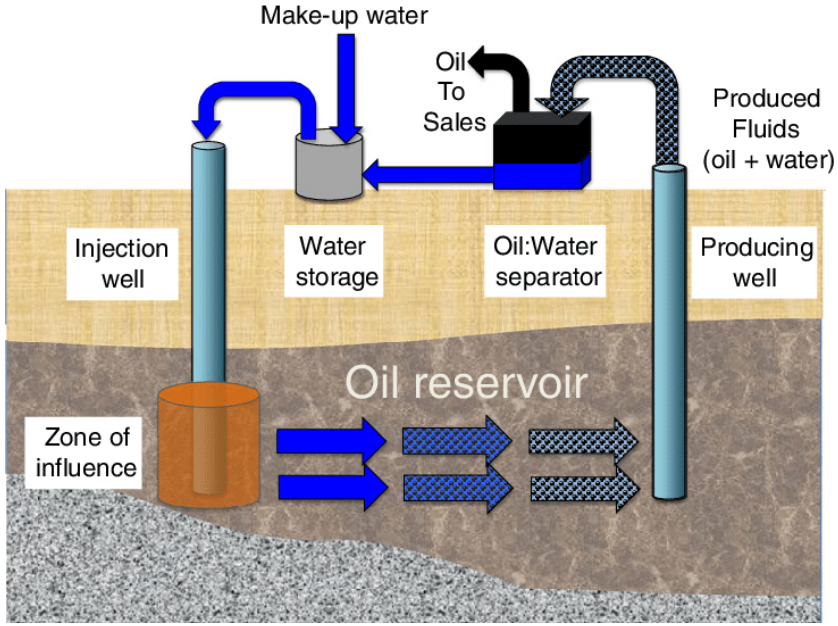
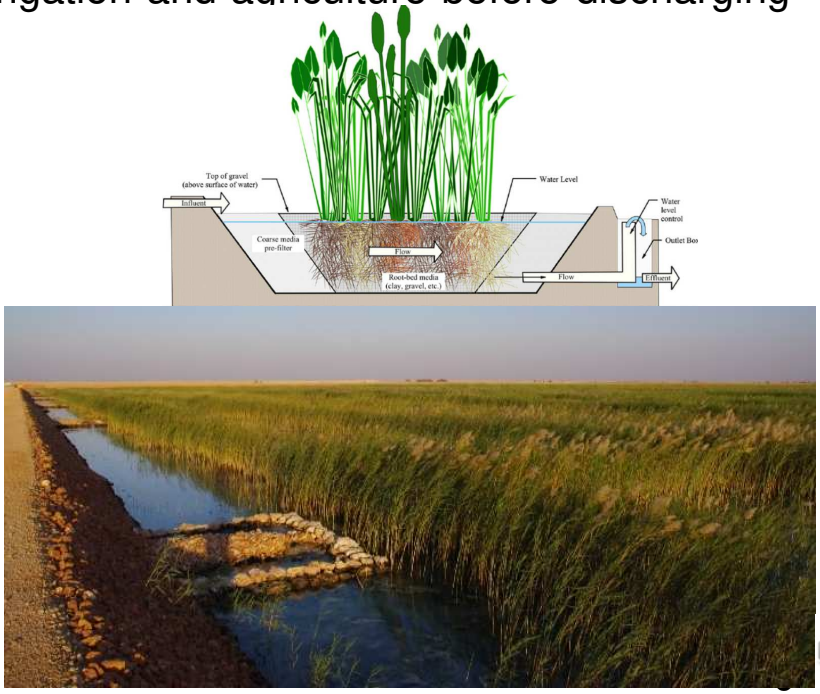
Customized solutions is required for each region in Malaysia depending on network and produced water system configuration in order to sustain PETRONAS Produced Water Commitment. This include identification of opportunities to maximize utilization of produced water instead of just to treat and discharge.

- Strengthening the understanding of operating and maintaining produced water treatment and utilization of most effective technology suitable for its characteristics
- Finding opportunity to utilized produced water;
    - Offshore for pressure maintenance
    - Onshore for using treated produced water for forest irrigation and agriculture before discharging to the water bodies





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