

# **WATER SOLUBLE OIL AND BTEX REMOVAL FROM PRODUCED WATER**

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**Dow Water & Process Solutions**



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SEMINAR 2016**

# Abstract

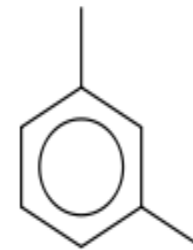
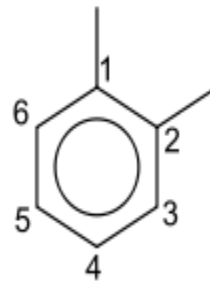
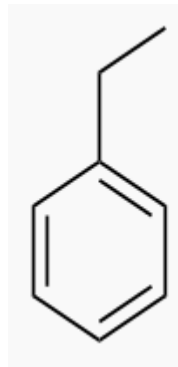
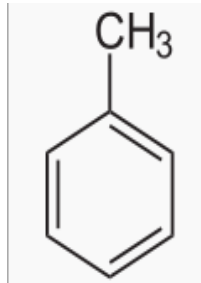
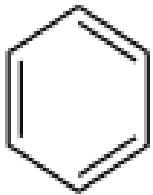
**Water soluble oil or BTEX are of growing concern. Some regulators are discussing limits that reference the drinking water standards of a few ppb.**

**This paper will discuss technology for BTEX/WSO removal. Preliminary data will be presented on field installation of technology for removal of BTEX and water soluble oils.**



# Definitions

- **BTEX – Benzene, Toluene, Ethylbenzene & Xylene**
- **AKA Water Soluble Oil**
- **Gasoline Range Organics**



# Dissolved Organics Removal

## Options

- **Air Stripping**
- **Activated Carbon / Surfactant Modified Clays**
- **Synthetic Adsorbent – OPTIPORE**
- **Advanced Oxidation Processes**

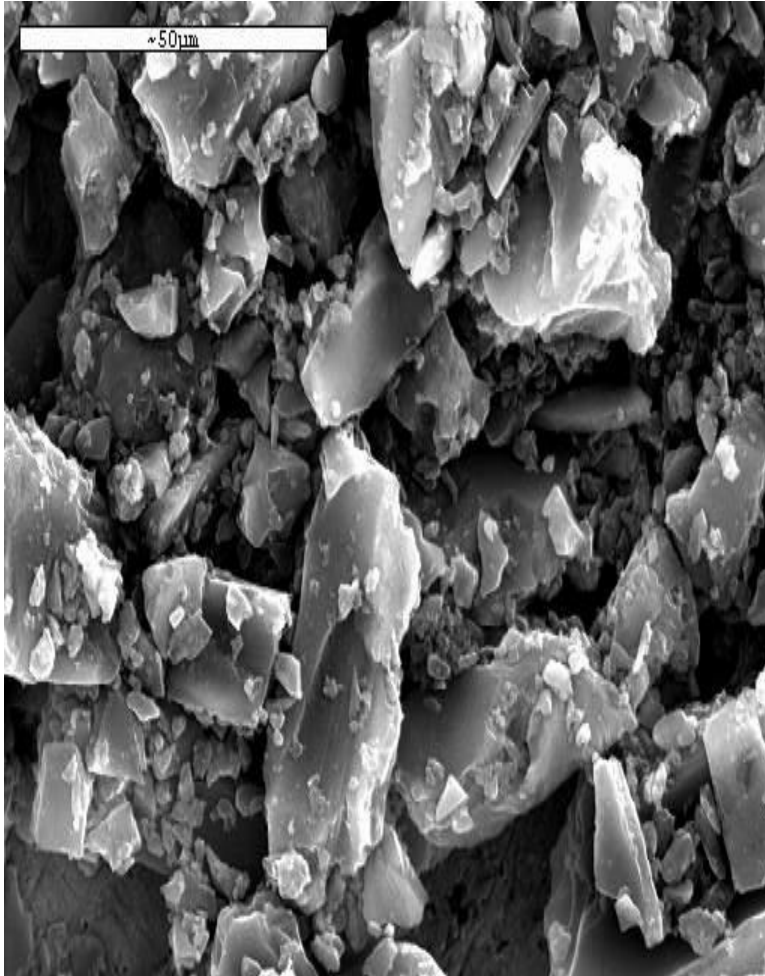


# Air Stripping

- **Not all contaminants can be air stripped**
  - **Phenol and Naphthenic acids**
- **Semi-volatiles can be air stripped but now generate an **air permit issue****
- **Concentrations are usually too low for direct flaring so **fuel addition** is needed**



# Activated Carbon



- **Activated carbon can be used as a disposable media**
- **Loading capacity is limited so significant amounts of AC can be required**
- **For remote sites (off shore) costs can be very high**
- **No option for recovery of hydrocarbons**
- **\$10 to \$20 per lb of BTEX**



# Advanced Oxidation Processes

- **Use of oxidizing agents such as ozone or peroxide to destroy the BTEX to CO<sub>2</sub> plus UV**
- **Significant amounts of oxidizer are required**



# Economic Benchmarking

	<b>\$/lb BTEX</b>	<b>\$/bbl-water</b>
<b>Activated Carbon</b>	<b>13.33</b>	<b>0.48</b>
<b>Advanced Oxidation</b>		
<b>OPTIPORE L 493</b>	<b>1.63</b>	<b>0.06</b>

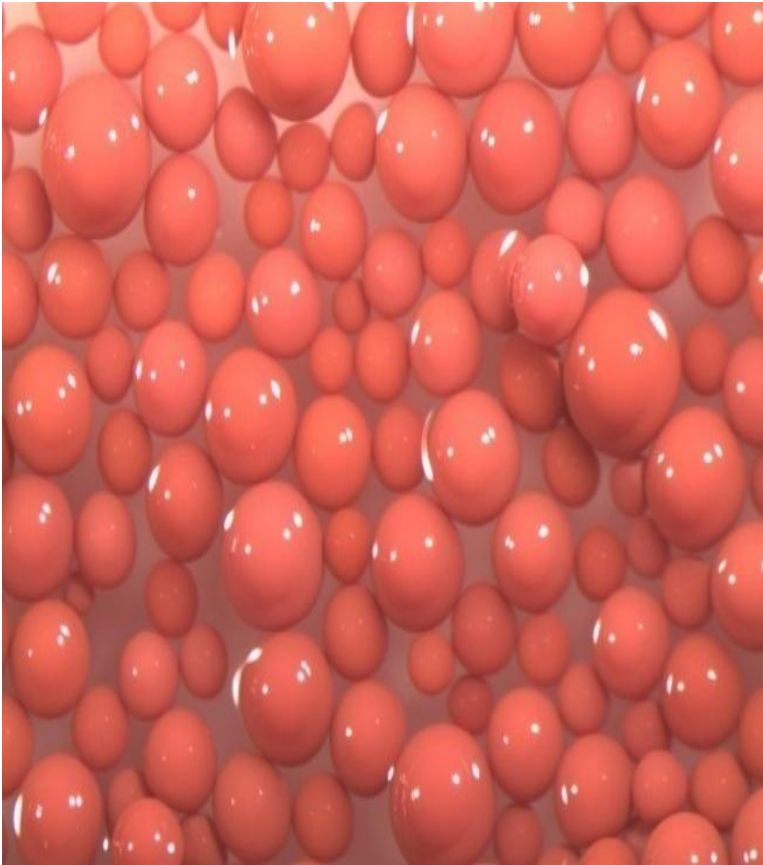
**Based on 25,000 Bpd and 150 ppm BTEX**



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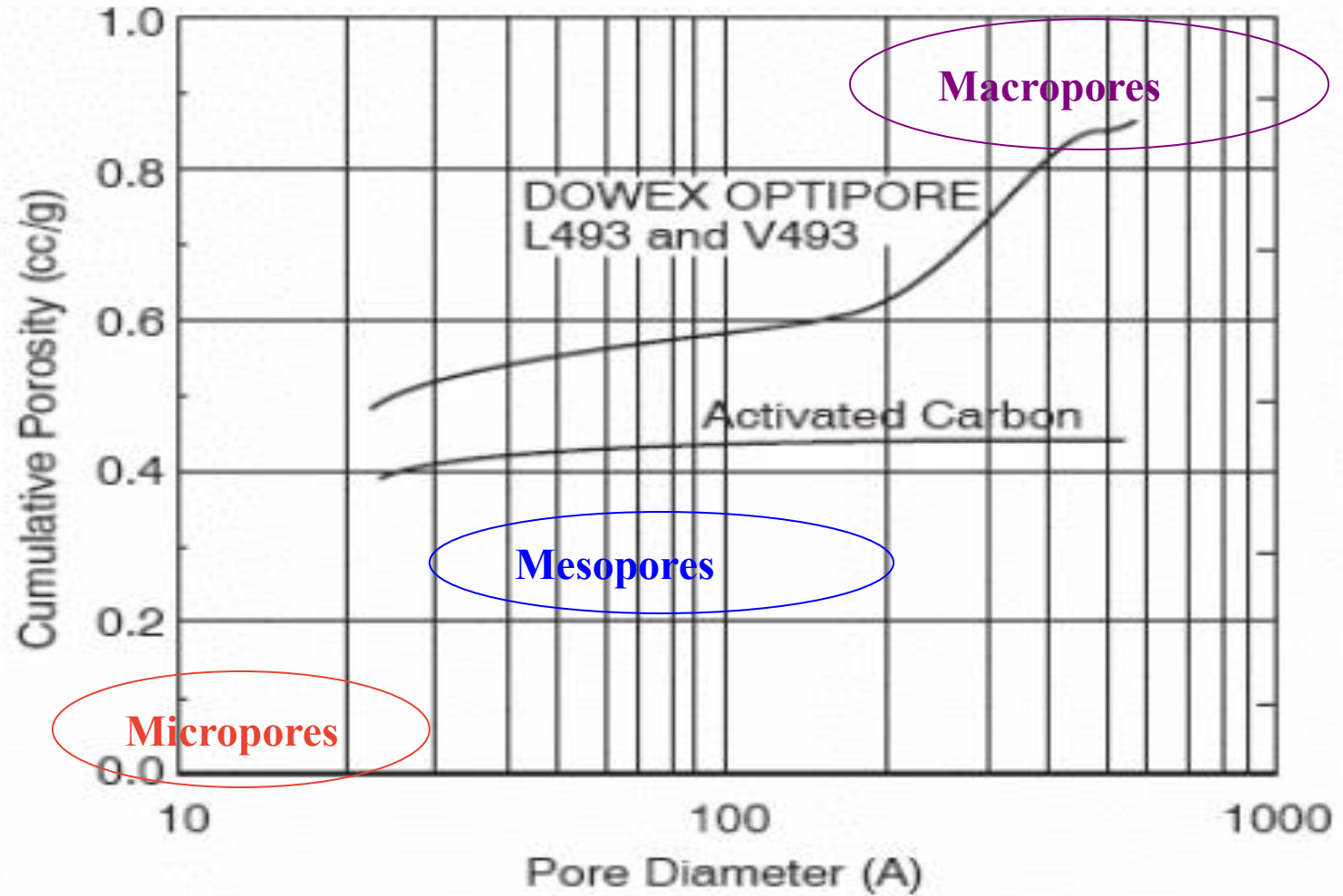
# COMPETITIVE TRAITS OF DOWEX OPTIPORE L493



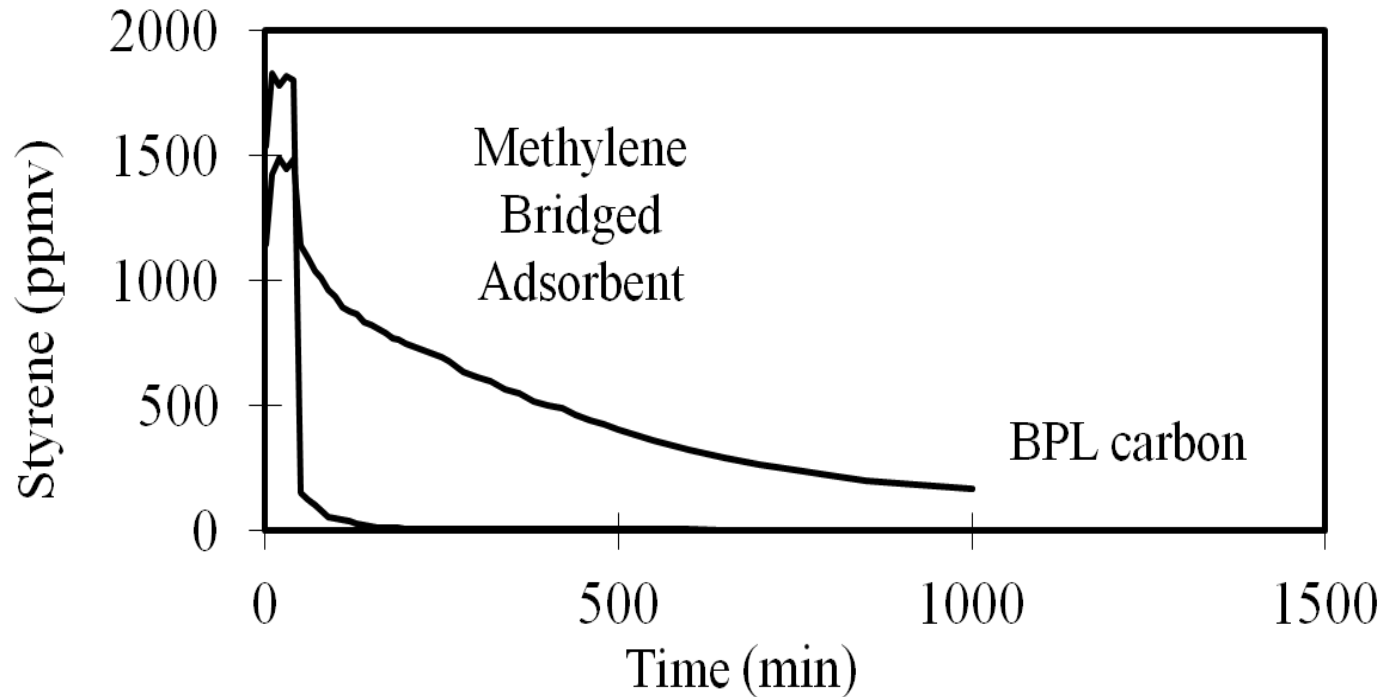
- **Good/fast adsorption capacity**
- **Suited for steam regeneration**
- **Can be chemically modified for different uses**
- **Minimal waste**
- **Good recovery of constituents (BTEX, phenols, etc)**
- **Simple process (adsorption)**
- **Less expensive**



Figure 1. Pore size distribution



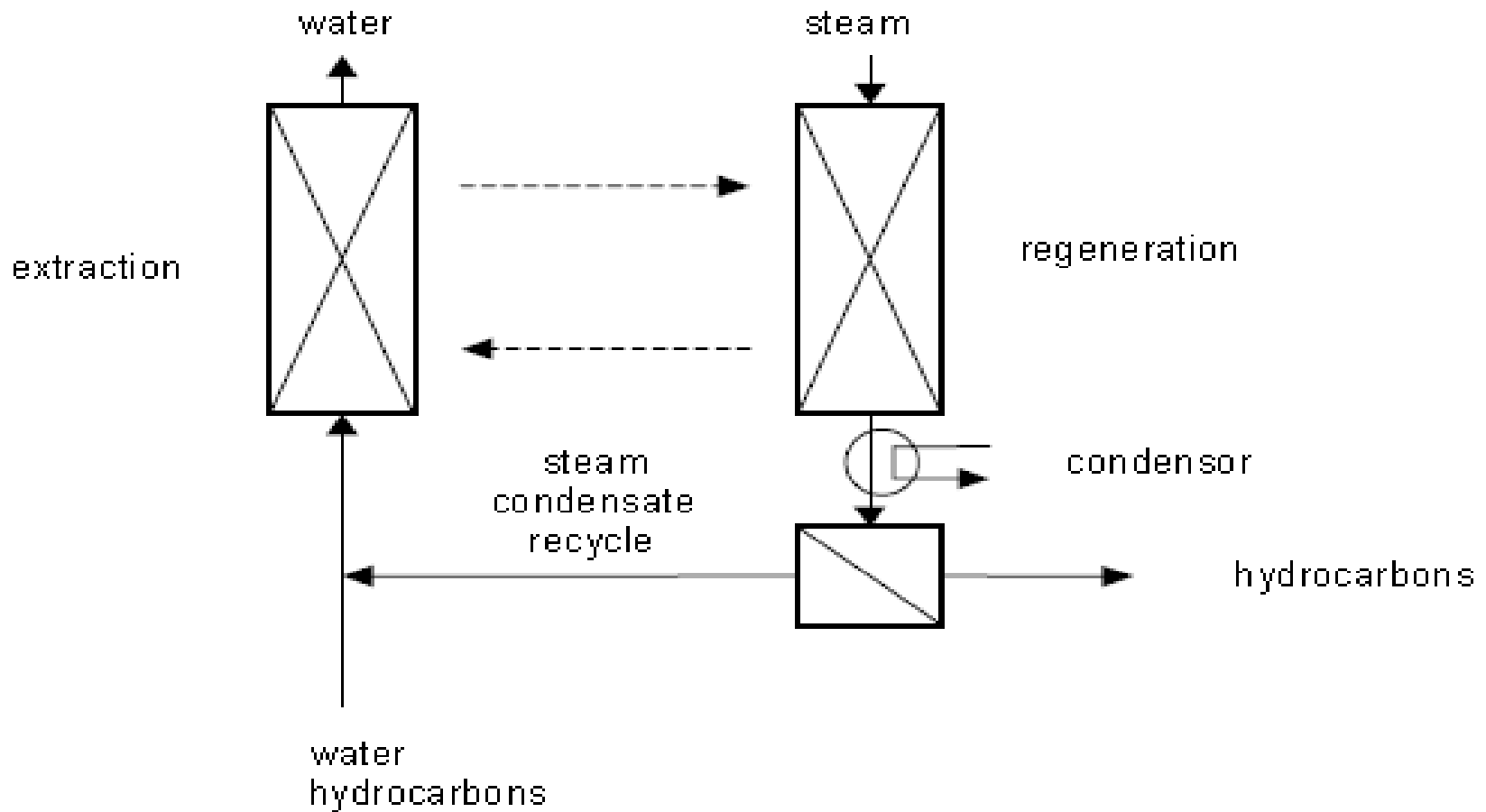
# Desorption Comparison



**Styrene desorption from Methylene Bridged Adsorbent and BPL carbon with 24 volumes per minute of 124 C air**

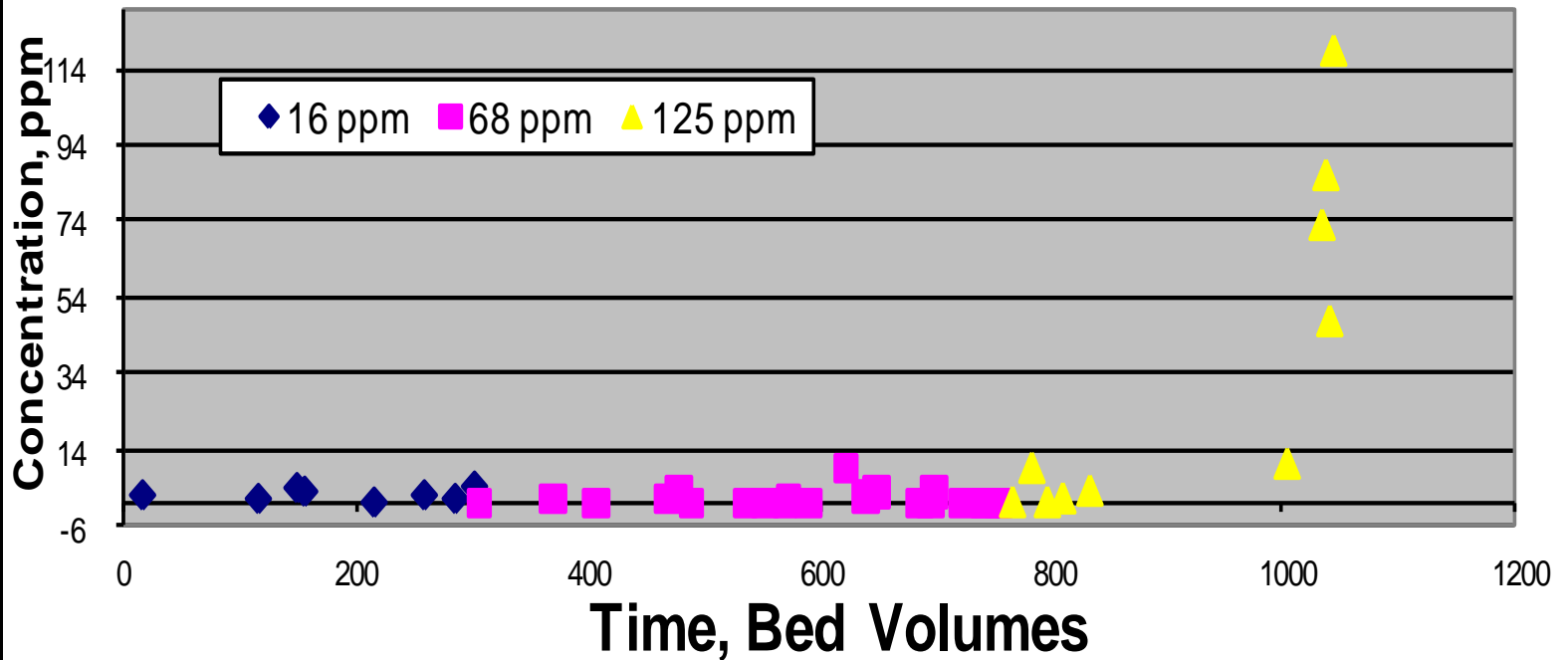


# Schematic of OPTIPORE Treatment



# Typical Column Loading w/ Mock Solution

## BTEX Loading to Saturation



# Produced Water Fortified with Toluene, Ethylbenzene and Xylene Mix

## Test Solution

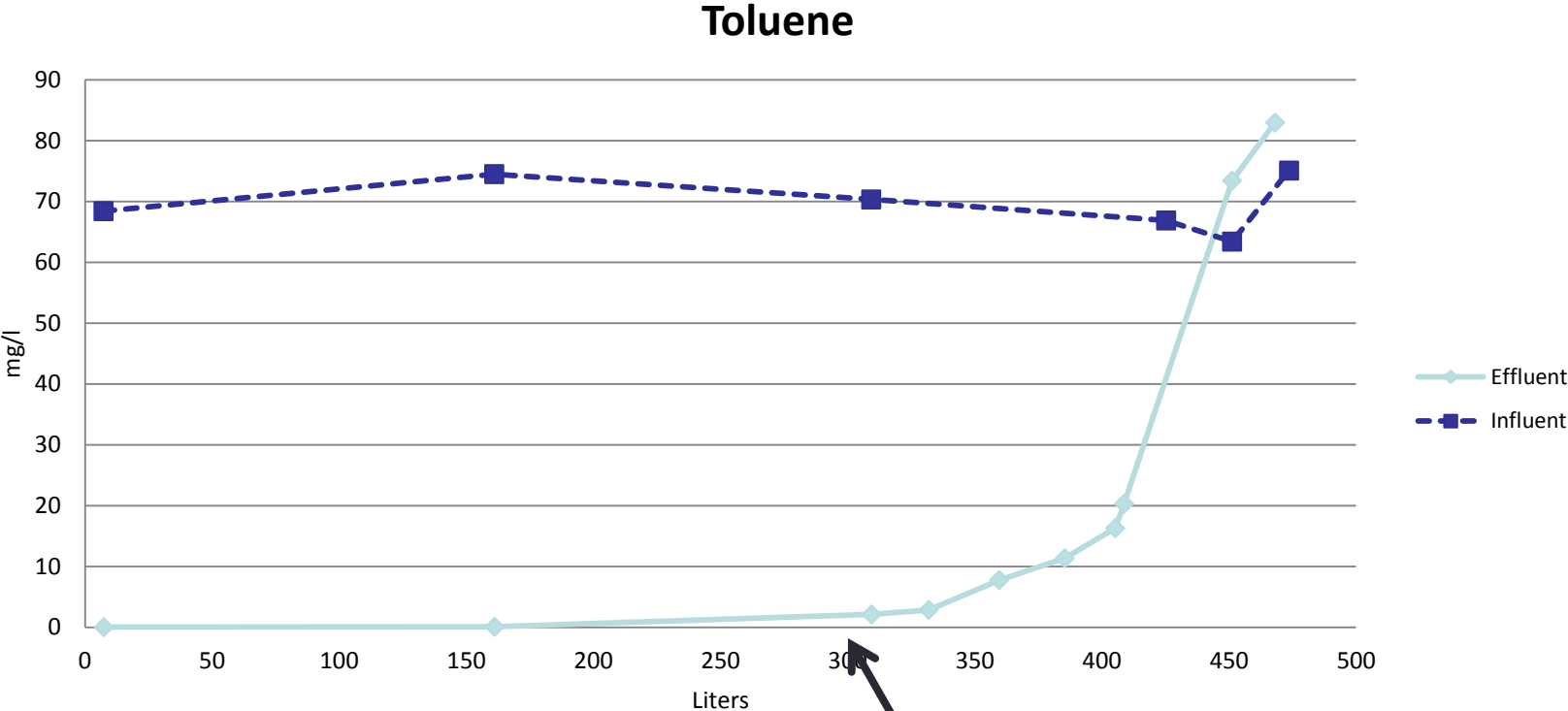
- 275 gal produced water from Advanced Hydrocarbons on Rock Prairie Rd, College Station, TX
- Water “fortified” w/ 1 liter each
  - Toluene
  - Ethylbenzene
  - Xylene (mixed)
- Reticulated 48 hours

## Test Media

- 500 mls column of DOWEX OPTIPORE L493
- Flow rate of
  - 0.12 li/min
  - 7.2 lph
  - 14.4 BV/hr
- Monitored T, E & X concentrations in treated effluent



# Toluene data

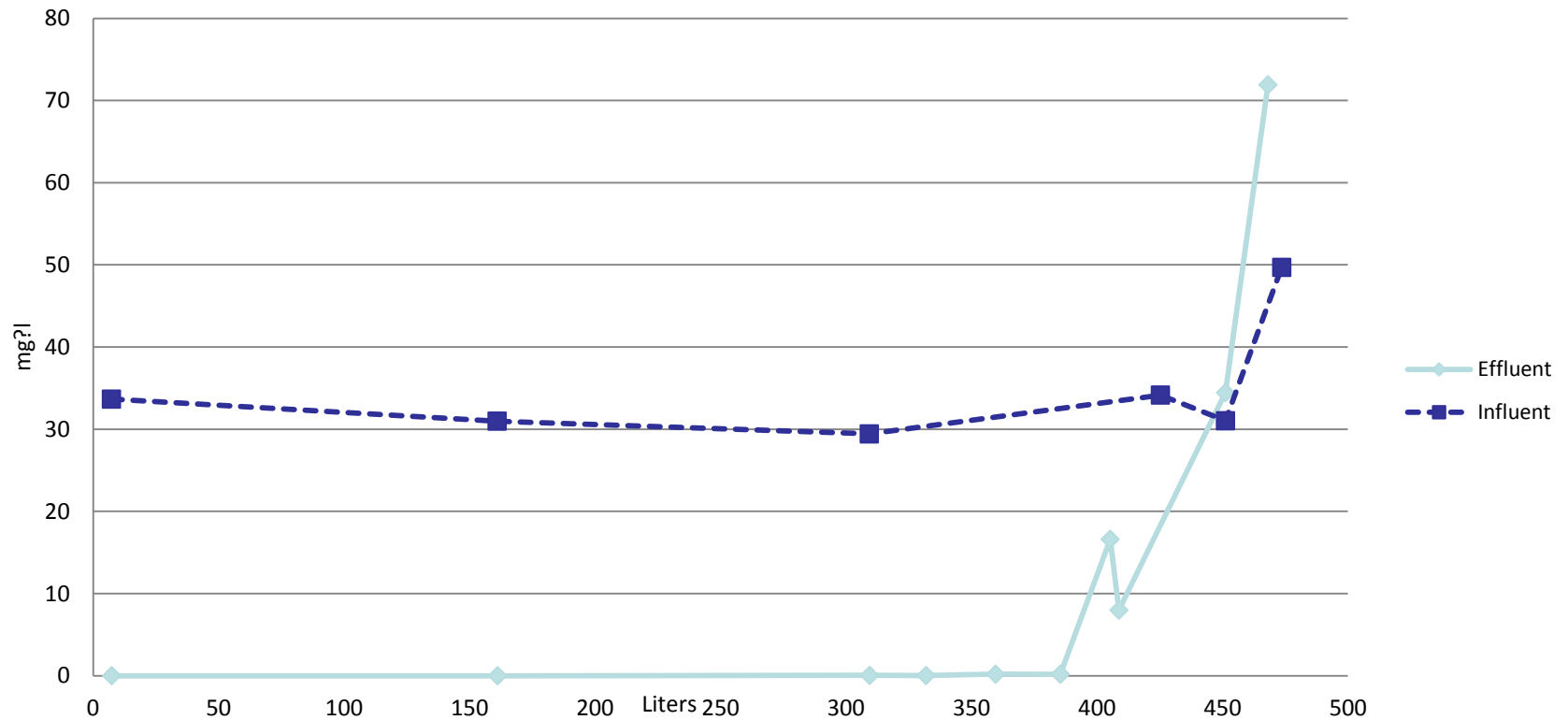


**99.9% Removal  
at 600 BV**



# Ethylbenzene

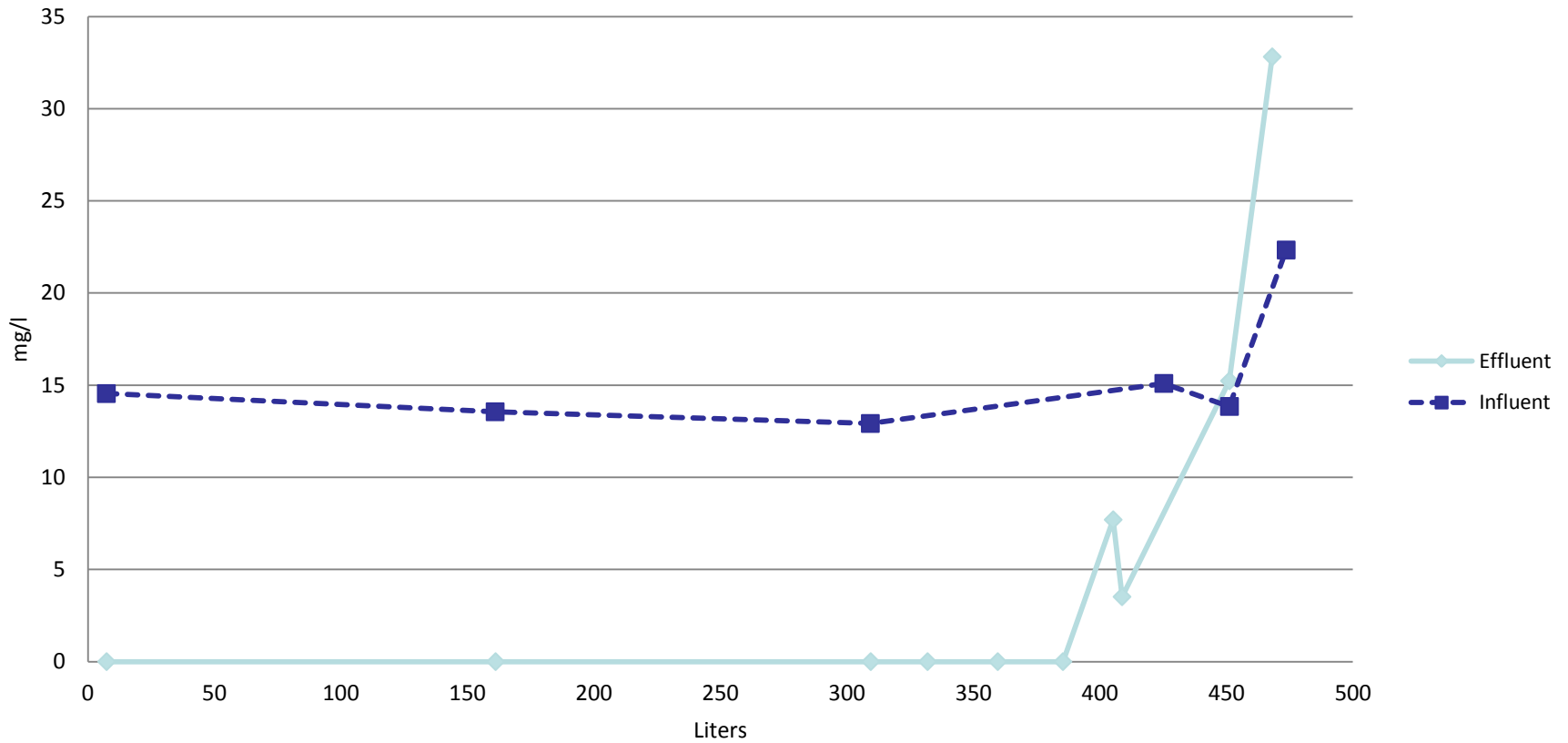
## Ethylbenzene





# Xylene

## Xylene



# TEX Treated Water (ppm)

Volume (L)	Volume BVs	Toluene	Ethylbenzene	Total Xylene
<b>Feed</b>		<b>70</b>	<b>30</b>	<b>15</b>
7.37	14.7	0.004	0.000	0.000
161.14	322	0.056	0.000	0.000
309.42	618	2.103	0.041	0.000
331.890	662	2.856	0.029	0.000
359.630	718	7.756	0.184	0.000
385.400	770	11.332	0.181	0.000
405.260	810	16.278	16.603	7.700
408.760	816	20.303	7.978	3.520
451.22	902	73.414	34.448	15.233



# OPTIPORE Pilot



Photo courtesy of Light Environmental

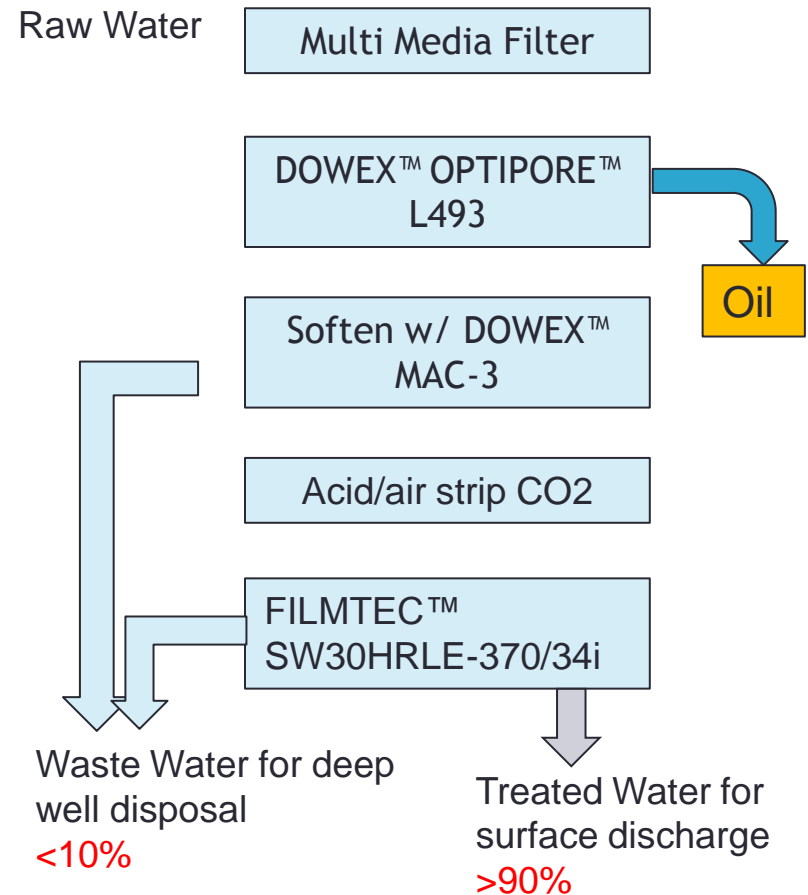


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# Treatment Process

## Unit Operations:

- **Conventional oil/water separator**
- **Multimedia filters for solids removal**
- **DOWEX™ OPTIPORE™ L493**
- **DOWEX™ MAC-3 weak acid cation exchange resin**
- **Decarbonator/ air stripper to remove CO<sub>2</sub>**
- **HERO™ process FILMTEC SW<sub>30</sub> HRLE-370 34i**
- **Final pH adjustment and discharge**



# WSO Removal/Recovery

## Purpose

- Remove the dissolved, water soluble oil & BTEX
- Protect downstream RO



# Commissioning grab sample

Component	units	Inlet	Outlet	% Removal
Benzene	ug/L (ppb)	15,506	16.4	99.91%
Toluene	ug/L	27,715	28.6	99.92%
Ethyl Benzene	ug/L	832	<1	100%
m,p- Xylene	ug/L	9,438	8.1	99.94%
o-Xylene	ug/L	1,922	2	99.93%
GRO	ug/L	159,769	206	99.91%
DRO	mg/L (ppm)	9	1	77.78%
TPH	mg/L	169	2	98.82%
Oil & Grease (HEM)	mg/L	1		

**Data is pre/post Optipore, and does not represent the entire water treatment process**



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# Conclusions

- **Data is only a grab sample of the water treated and does not represent the complete water treatment**
- **Work is underway to optimize performance and run time**
- **A polisher bed of media will allow even better removal if desired**



# Acknowledgements

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