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Potential impact of severe weather on hydraulic performance of a field-scale wastewater treatment plant: A case study of baffle-based pond

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Presentation Structure

- introduction
- Objective
- Methodology
- Result
- Conclusion

2

Introduction

- Wastewater treatment schemes are essential due to current water pollution situation in Thailand.

- Waste Stabilization Pond with baffles (WSPB) can be one of the possible strategies.

- WSPB is potentially disturbed by the external factors such as a heavy rainfalls, stormwater, causing the overflow into the waste water treatment plant.
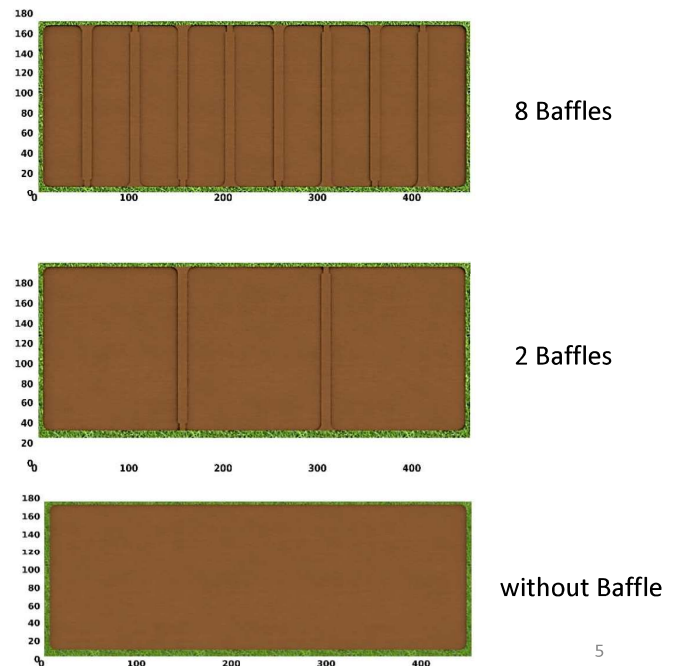
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Objective

- To Understand the hydraulic behaviors in operating condition and an extreme event.

- To Investigate the development scheme of WSPB and applying to design schemes of wastewater treatment management.
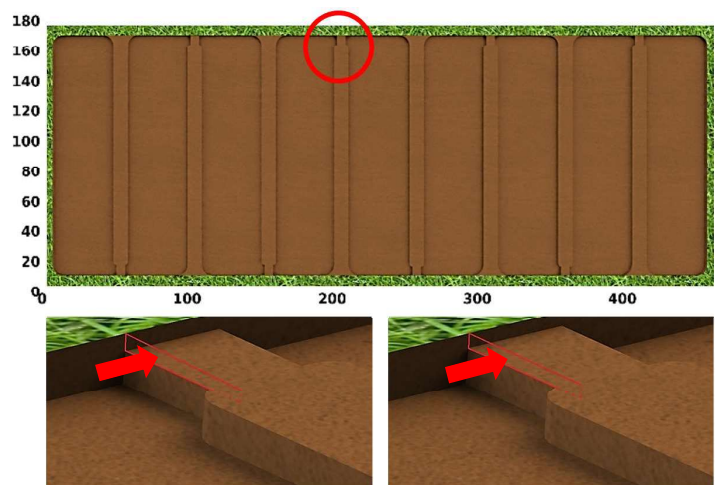
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Methodology

- **Operating condition**
  - **Select number of baffle**
- **Stormwater condition**
  - Study effect of spillway
  - Study effect of filter
  - Flooding situation
  - Improvement scheme
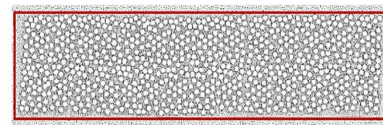   - Porous media + 2 elevated Baffles

8 Baffles

2 Baffles

without Baffle

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Methodology

- **Operating condition**
  - Select number of baffle
- **Stormwater condition**
  - **Study effect of spillway**
  - Study effect of filter
  - Flooding situation
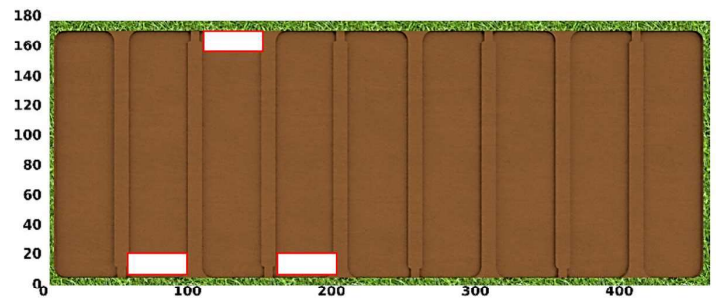 - Improvement scheme
    - Porous media + 2 elevated Baffles

Inlet 1

$2.5\ m^2$

Inlet 2

$1.5\ m^2$

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Methodology

- **Operating condition**
  - Select number of baffle
- **Stormwater condition**
  - Study effect of spillway
  - Study effect of filter
  - Flooding situation
  - Improvement scheme
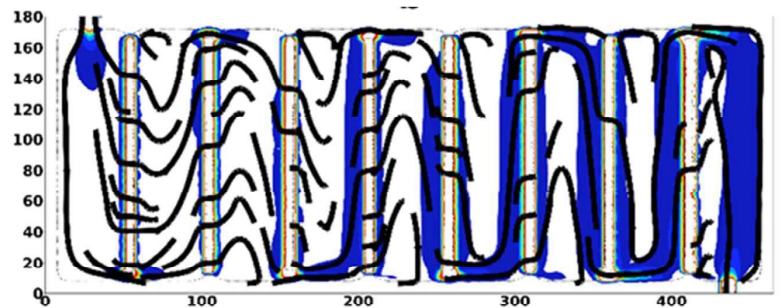   - Porous media + 2 elevated Baffles

Mixing sizes of Obstacles
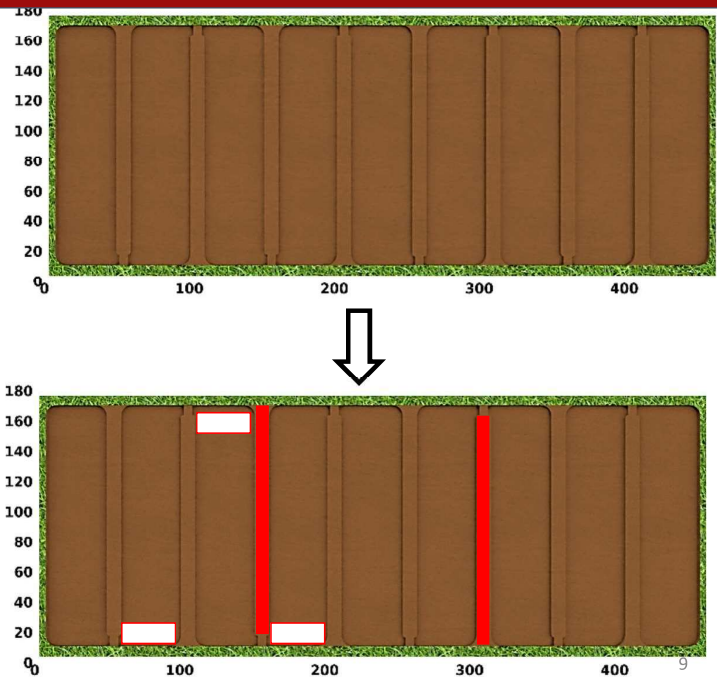

Methodology

- **Operating condition**
  - Select number of baffle
- **Stormwater condition**
  - Study effect of spillway
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  - Flooding situation
  - Improvement scheme
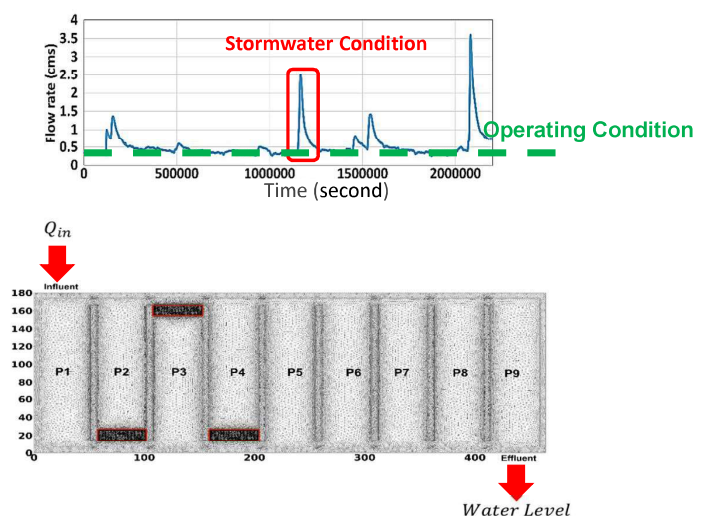   - Porous media + 2 elevated Baffles

Methodology

- Operating condition
  - Select number of baffle
- **Stormwater condition**
  - Study effect of spillway
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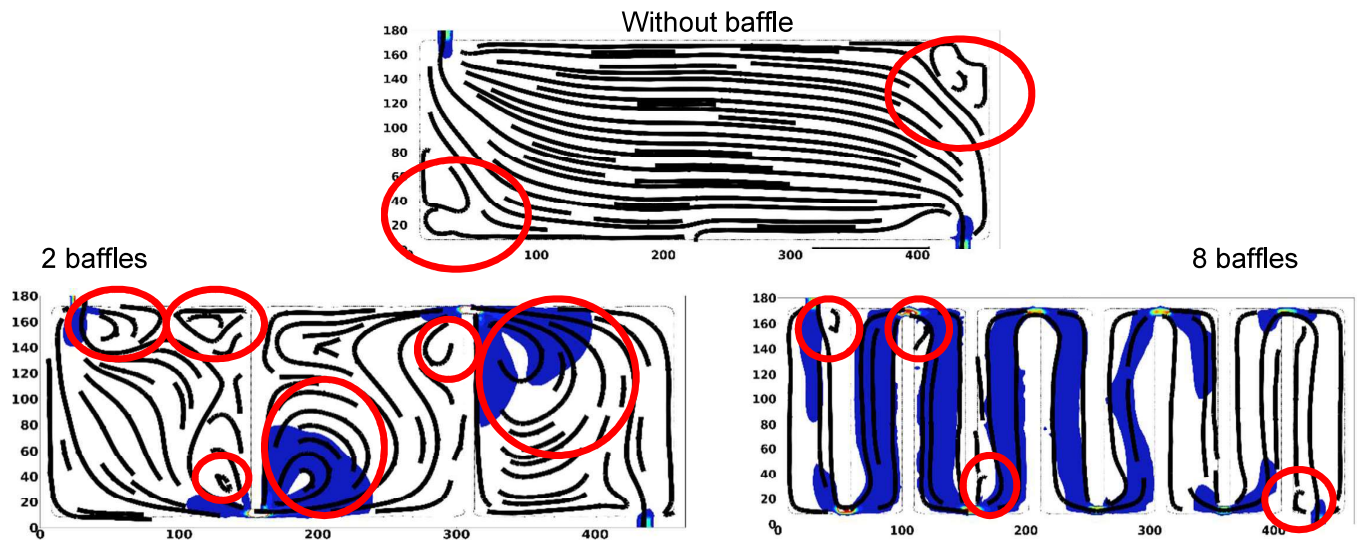   - Porous media + 2 elevated Baffles

Methodology

- **Computational Detail**
  - A synthetic flow rate is setup to
    be upstream condition.

  - The outlet is prescribed with the free surface (Water level)

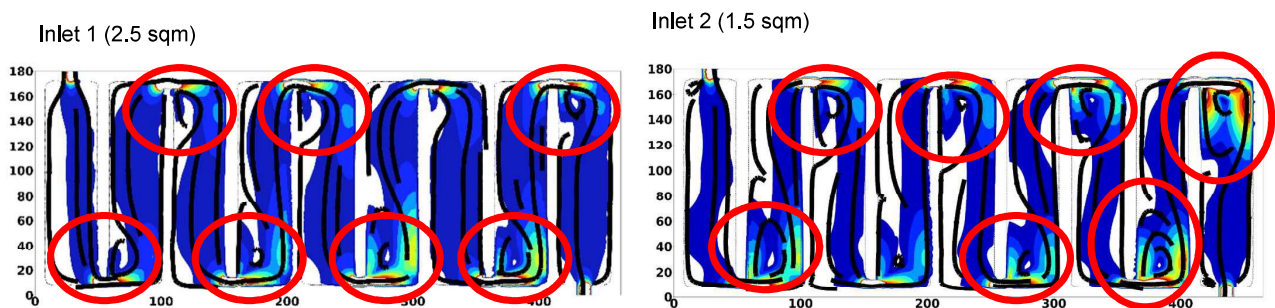 - Open software "SCHISM" (Ref. www.schism.wiki)

Result

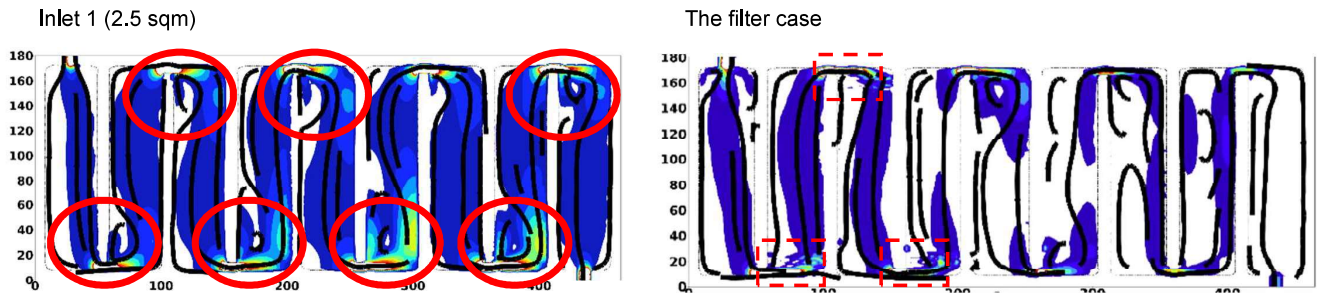**Operating condition**: Select number of baffle

Without baffle

2 baffles

8 baffles

Result

Stormwater condition: effect of spillway

Inlet 1 (2.5 sqm)

Inlet 2 (1.5 sqm)

Result

Stormwater condition: effect of Porous media filter

Inlet 1 (2.5 sqm)

The filter case

Result

Stormwater condition: Flooding situation
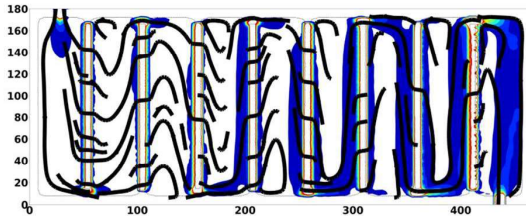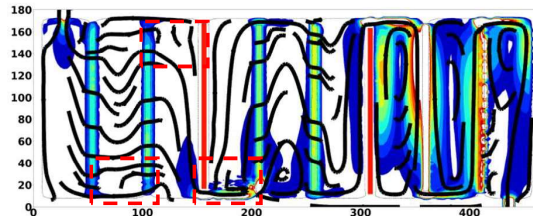
Inlet 1 (2.5 sqm)
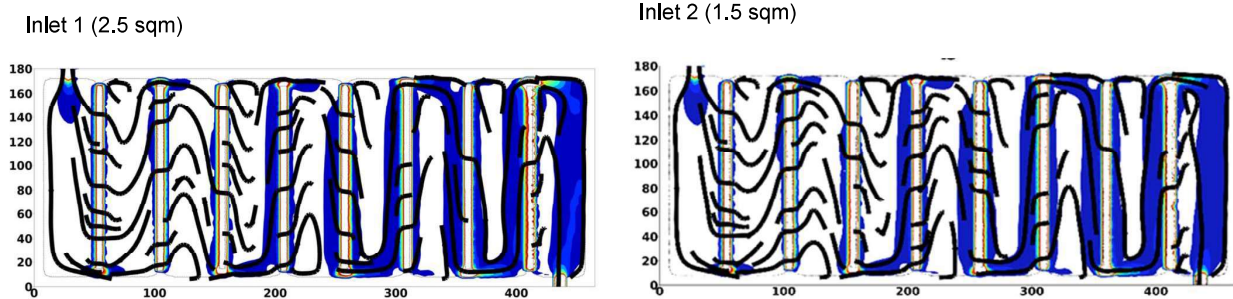
Inlet 2 (1.5 sqm)

Result

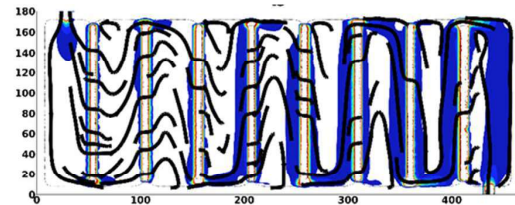**Stormwater condition:** Improvement scheme
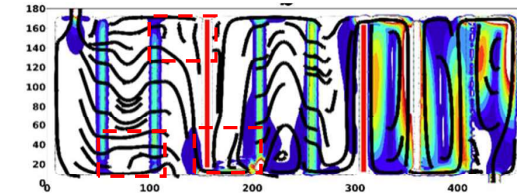
Inlet 1 (2.5 sqm)

Modified case : inlet 1

Inlet 2 (1.5 sqm)

Modified case : inlet 2

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Conclusion

- The number of baffles and inlet size influence eddy cell's development in WSP.

- The best result is 8 baffles with the inlet(spillway) size of 2.5 square meters.

- Porous-media-like filter structures could improve overall performance.

- Numerical simulation helps improve design scheme of wastewater treatment plants/infrastructures.
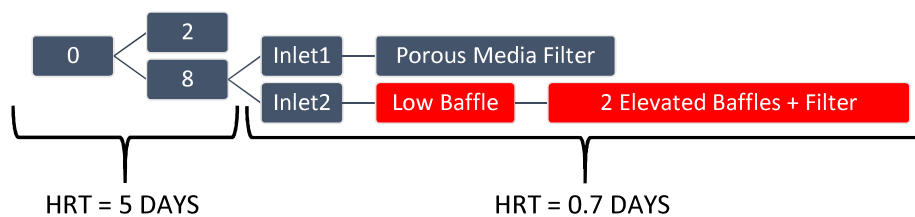
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THANK YOU

Result

Extreme event: Modified model
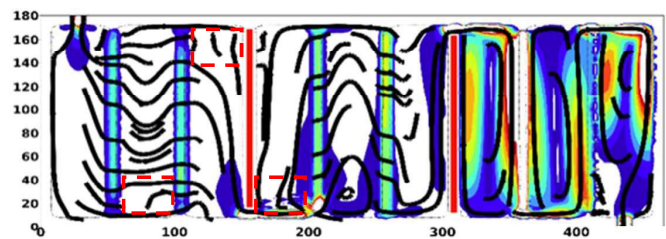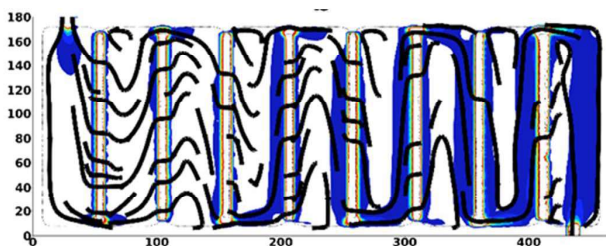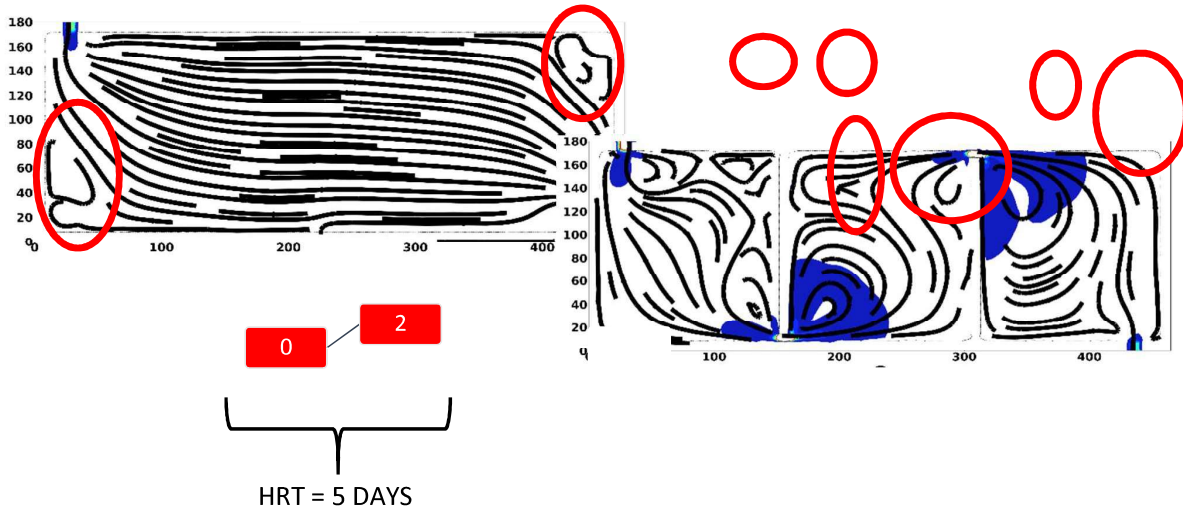

| 0 | 2 |
| | 8 |

Inlet1 — Porous Media Filter

Inlet2 — Low Baffle — 2 Elevated Baffles + Filter

HRT = 5 DAYS   HRT = 0.7 DAYS

Result

Operating condition

HRT = 5 DAYS

Result
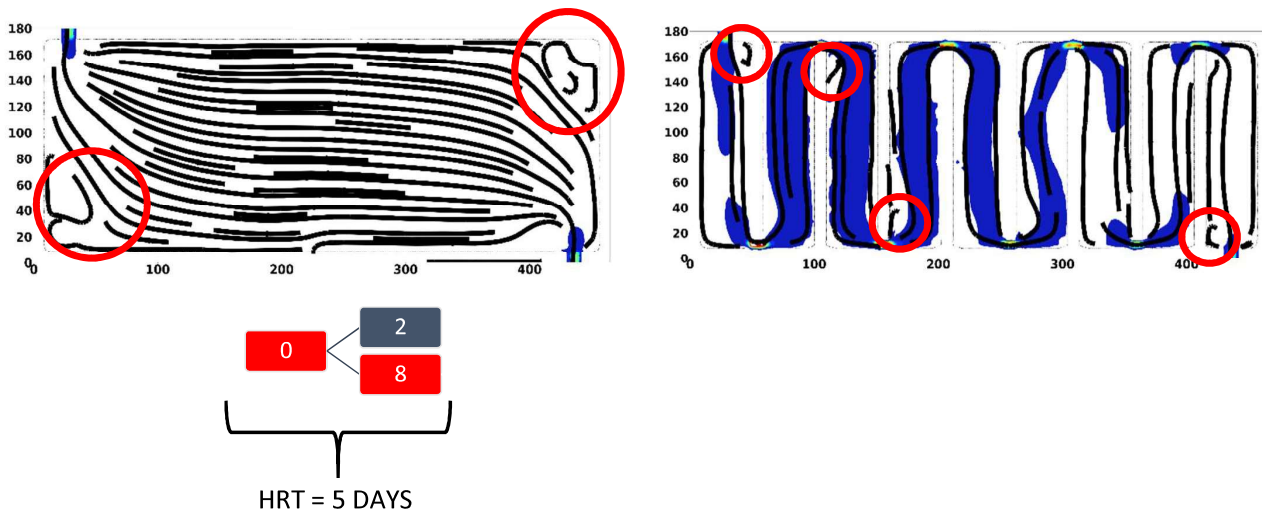
Operating condition

HRT = 5 DAYS

Methodology

Computational Detail

- A synthetic flowrate is setup to be upstream condition.

- The outlet is prescribed with the free surface (Water level)

- Open software "SCHISM" (Ref. www.schism.wiki)

Q_{in}

Influent

P1   P2   P3   P4   P5   P6   P7   P8   P9

Effluent

Water Level
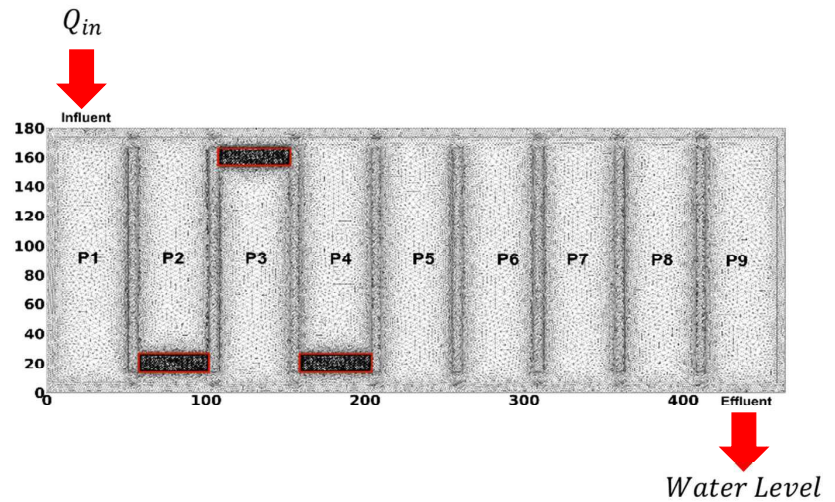
Methodology

- Design Waste Stabilization ponds by testing effect of baffle and observing hydraulic efficiency.
  - Pond's size: L1/L2 = 1/2.6 = 5/13
  - Number of baffle: 0 2 and 8

- Study a porous media behavior by Mixing Obstacles which the diameters 0.15 and 0.5 meters

- Study effect of stormwater by setting the synthetic flow to be inlet
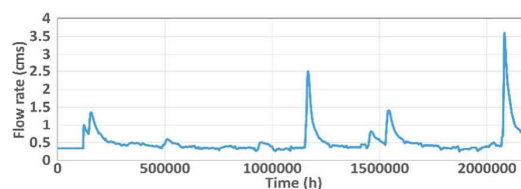
Methodology

- Create a initial pond
- Select number of baffles (2 8)
- Study effect of spillway
- Study effect of stormwater
- Improvement scheme

  - Elevated Baffles
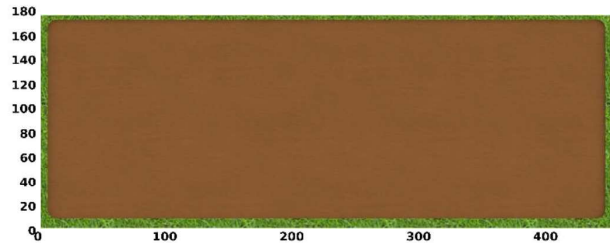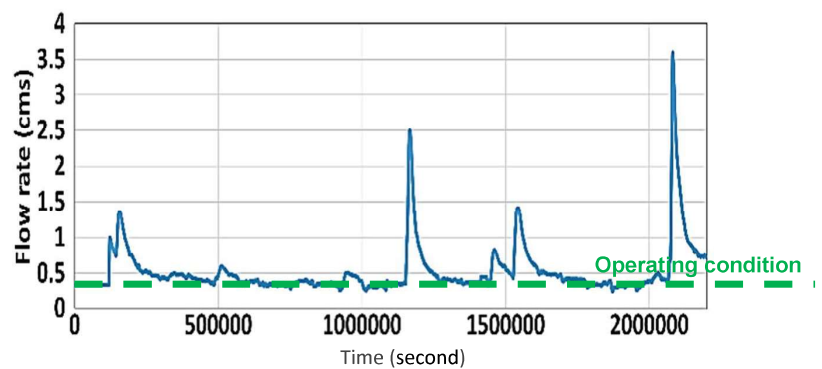

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Methodology

- Operating condition
  - Select number of baffle
- Stormwater condition
  - Study effect of spillway
  - Study effect of filter
  - Flooding situation
  - Improvement scheme

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Methodology

- Create initial pond
- Select number of baffles (2 8)
- Study effect of spillway
- **Stormwater Characteristic**
- Improved WSP
  - Filter
  - Elevated Baffles

Stormwater HRT 0.7 days

HRT 5 days
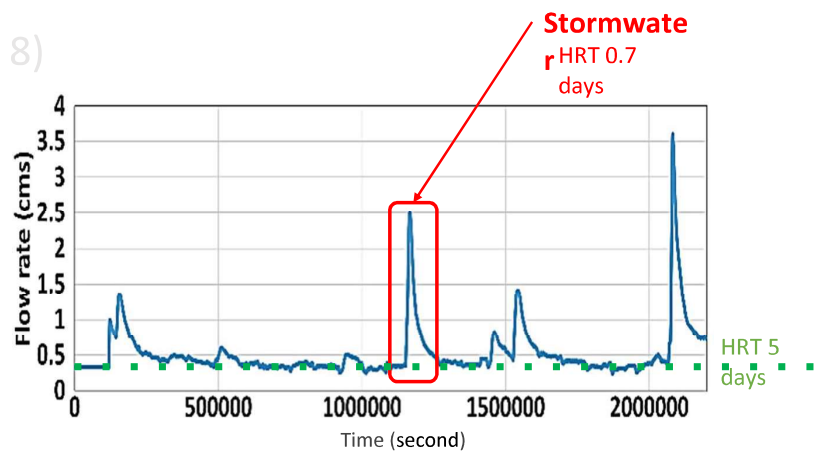
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Methodology

Forcing data

- Create initial pond
- Select number of baffles (2 8)
- Study effect of spillway
- **Stormwater Characteristic**
- Improved WSP
  - Filter
  - Elevated Baffles

Stormwater HRT 0.7 days

Inflow Period

HRT 5 days

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Result

Extreme event

Inlet 2

| 2 |
| 8 |
| 0 |

| Inlet | Filter | Low Baffle | 2 Elevated Baffles + Filter |
| Inlet2 | Filter | Low Baffle | 2 Elevated Baffles + Filter |

2 Elevated Baffles + Filter

HRT = 5 DAYS   HRT = 0.7 DAYS

Result

Extreme event

Lorem Ipsum

Lorem Ipsum

20XX   20XX   20XX   20XX

Lorem Ipsum

Lorem Ipsum

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Lorem Ipsum   Lorem Ipsum   Lorem Ipsum

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| 0 | 8 |

| Inlet | Filter | Low Baffle | 2 Elevated Baffles + Filter |
| Inlet2 | Filter | Low Baffle | 2 Elevated Baffles + Filter |

Lorem Ipsum

2 Elevated Baffles + Filter

HRT = 5 DAYS   HRT = 0.7 DAYS

Methodology

- Operating condition
  - Select number of baffle
- **Stormwater condition**
  - Study effect of spillway
  - Study effect of filter
  - Flooding situation
  - Improvement scheme

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