

Soil Removal and Turbidity Monitoring for Carrot Washing



Tim Brook, OMAFRA
John Van de Vegte, OMAFRA

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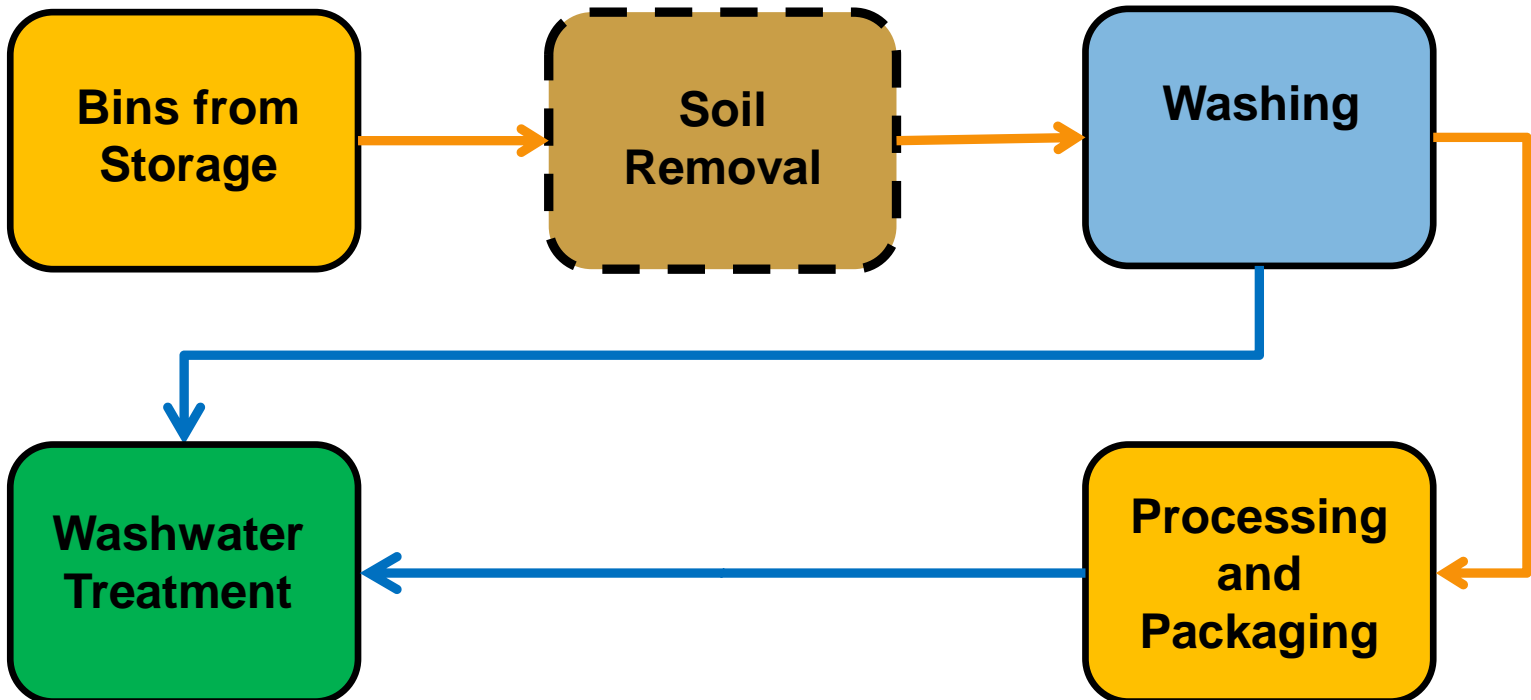
- Measure the amount of soil removed by different de-dirting techniques.
- Quantify the benefit of soil removal on water use and wash-water treatment.
- Test turbidity monitoring for active control of carrot washing process.

Overview – Soil Removal

Carrot Harvest



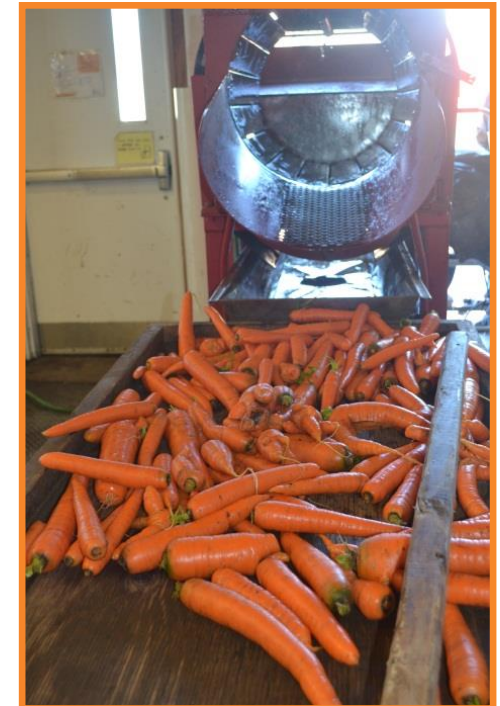
Carrot Wash



- Created “Lots” of Bushels
- Weighed the Carrots
- De-dirted each Lot
- Washed each Lot
- Monitored Washwater



**Soil
Removal**



De-dirting Techniques

Equivalent Length of Conveyor	Grade - Low		Grade - High	
	Air - OFF	Air - ON	Air - OFF	Air - ON
3'	✓	✓	✓	✓
9'	✓	✓	✓	✓
15'		✓		

Soil Removal



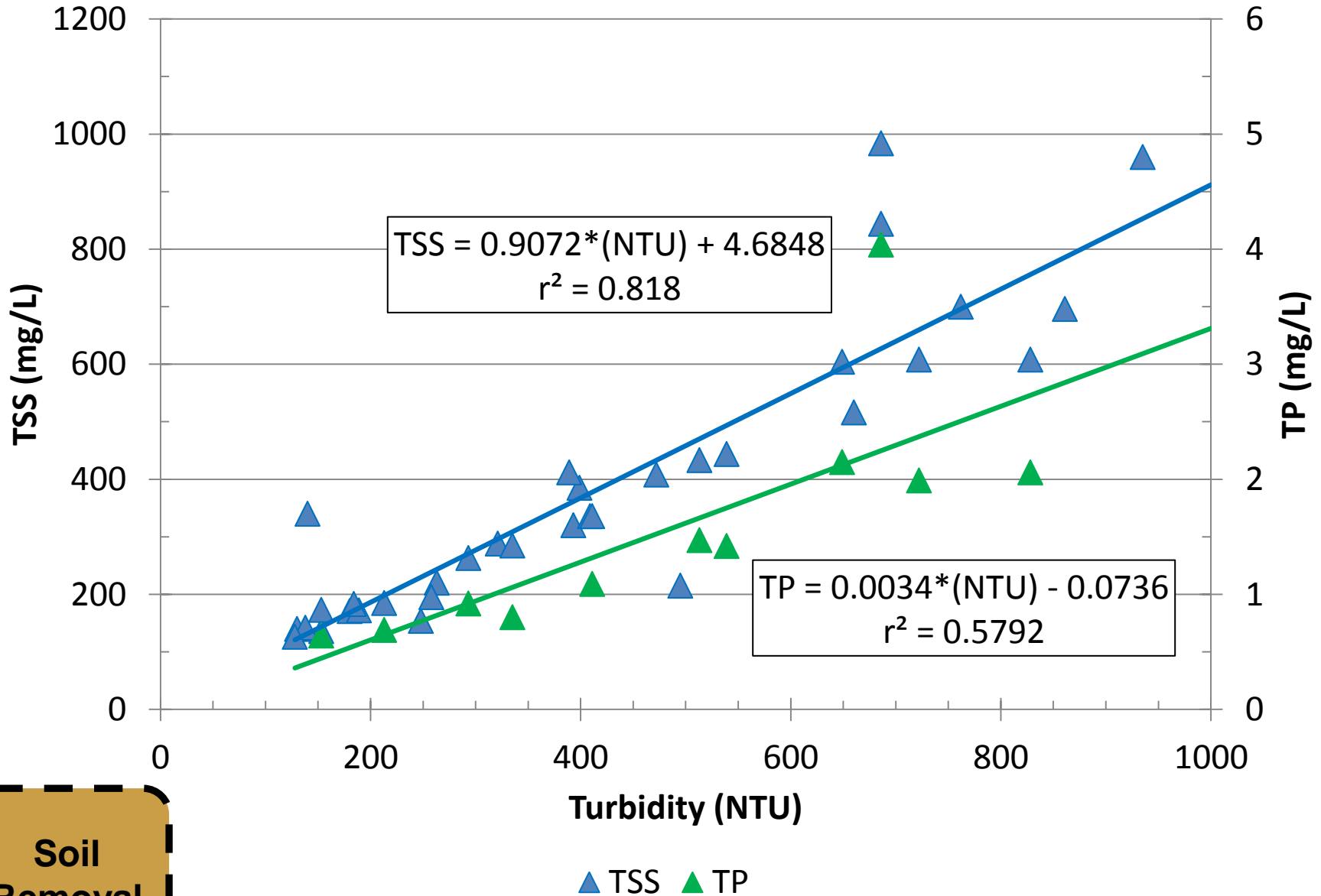
Monitoring Washwater

- Inexpensive Turbidity Sensor
- Grab Samples
 - Turbidity
 - Total Suspended Solids
 - Total Phosphorus
- Turbidity as a Surrogate for TSS/TP



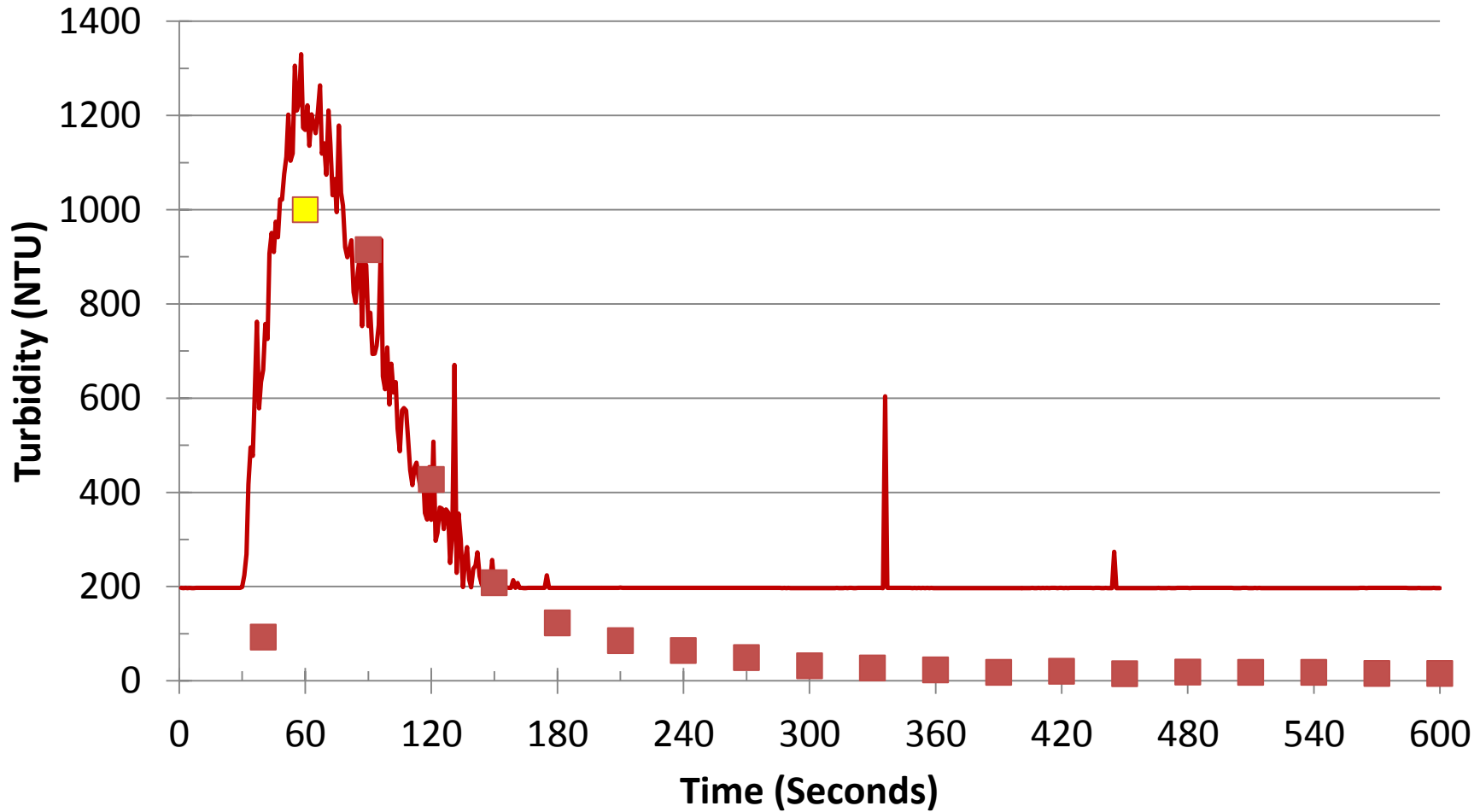
Soil
Removal

TSS/TP vs. Turbidity Correlation



Soil Removal

Washwater Turbidity Data

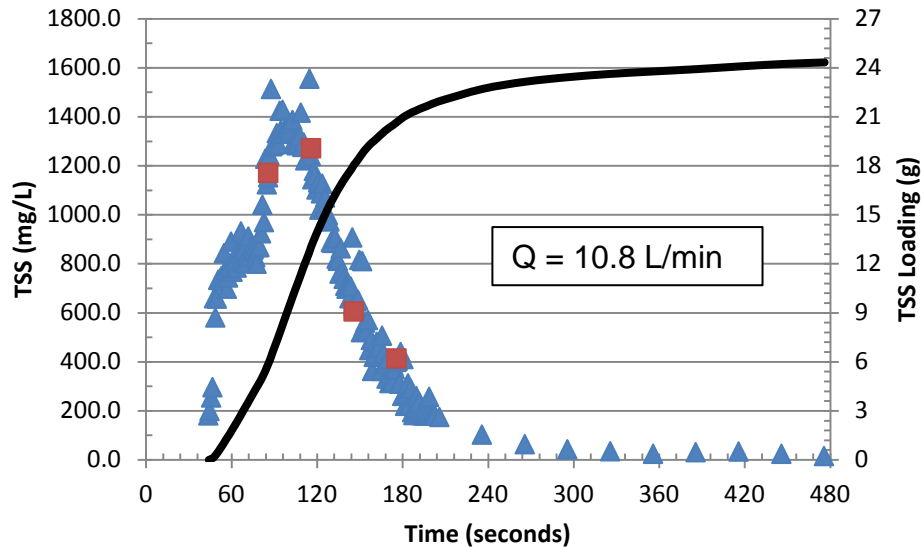


■ Turbidity - grab — Turbidity - sensor

Soil Removal

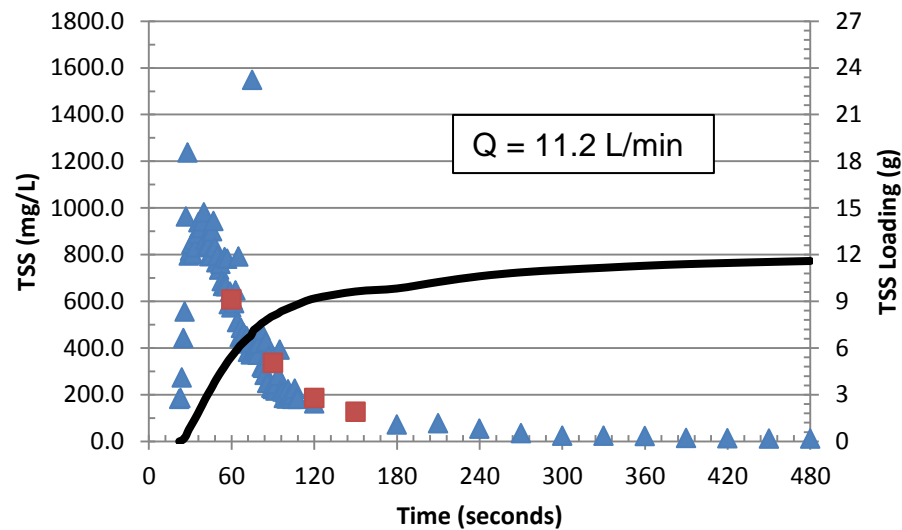


TSS Concentration and Loading



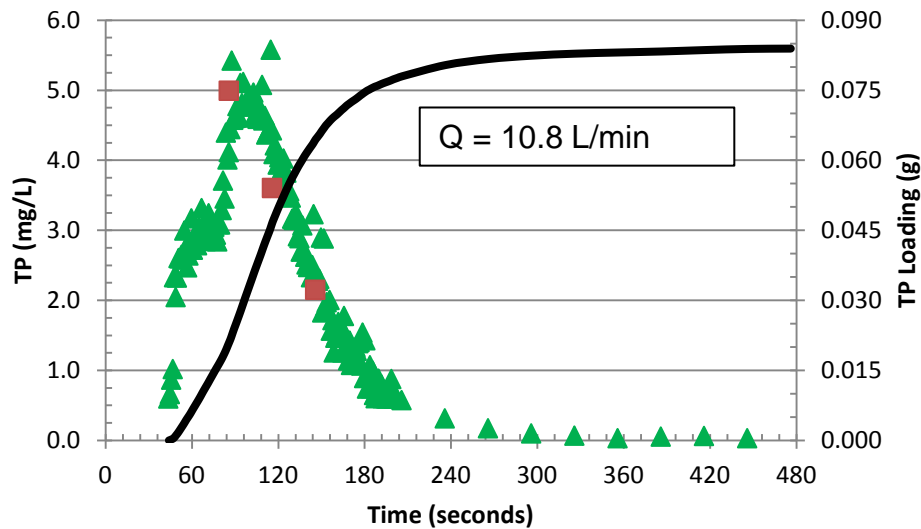
▲ TSS - Calculated ■ TSS - Laboratory — TSS - Loading

TSS Concentration and Loading



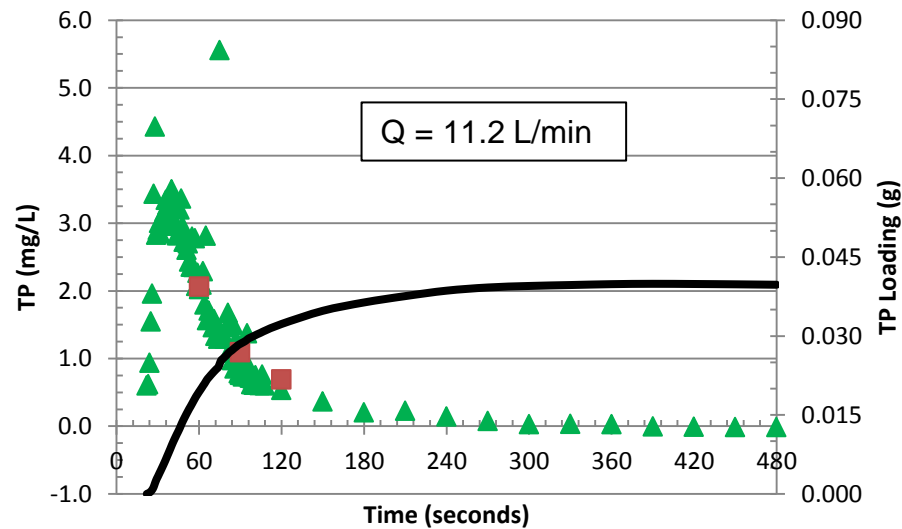
▲ TSS - Calculated ■ TSS - Laboratory — TSS - Loading

TP Concentration and Loading



▲ "TP - Calculated" ■ TP - Laboratory — TP - Loading

TP Concentration and Loading



▲ "TP - Calculated" ■ TP - Laboratory — TP - Loading

Washwater Quality and Loading

De-dirting Technique	TSS		TP		Water	
	(g/kg)	Reduction	(mg/kg)	Reduction	(L/kg)	Reduction
As Harvested	1.3		4.6		1.6	
3', Low Grade	1.0	23%	3.4	26%	1.3	19%
9', Low Grade	0.9	31%	2.9	37%	1.0	38%
3', Low Grade with Air	0.9	31%	2.9	37%	1.2	25%
9', Low Grade with Air	0.7	46%	2.2	52%	1.0	38%
15', Low Grade with Air	0.7	46%	2.1	54%	0.9	44%
3', High Grade	0.8	38%	2.8	39%	1.1	31%
9', High Grade	0.7	46%	2.4	48%	1.0	38%
3', High Grade with Air	0.9	31%	3.2	30%	1.1	31%
9', High Grade with Air	0.7	46%	2.3	50%	0.9	44%

**Soil
Removal**

Conclusions - Soil Removal

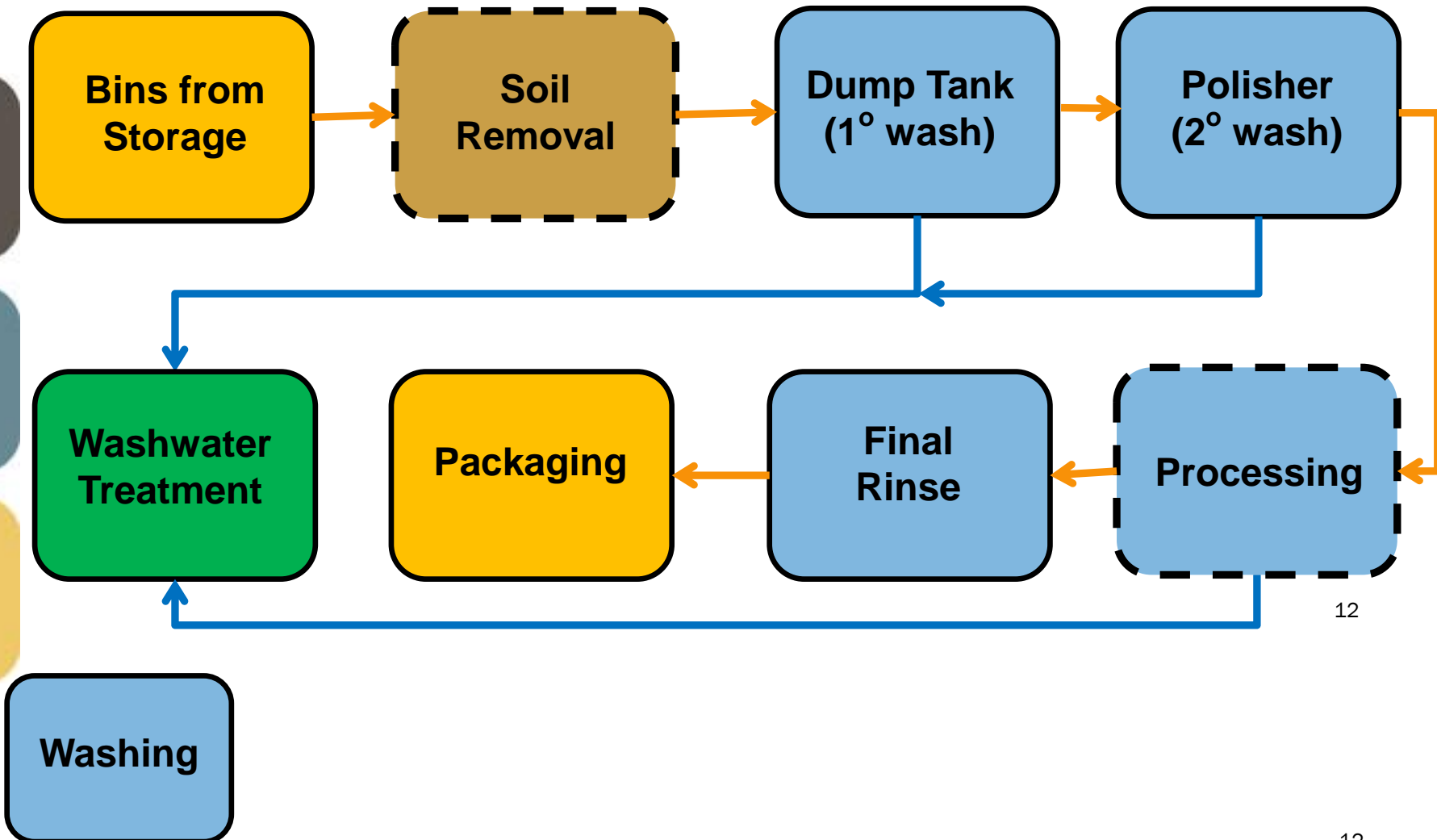
- Reduction in TSS, TP and water achieved by:
 - Additional de-dirtting before wash process
 - Longer de-dirtting conveyor
 - Addition of high velocity air
 - Increased conveyor grade*
- Need to optimize de-dirtting techniques
 - harvest equipment
 - packing house

**Soil
Removal**

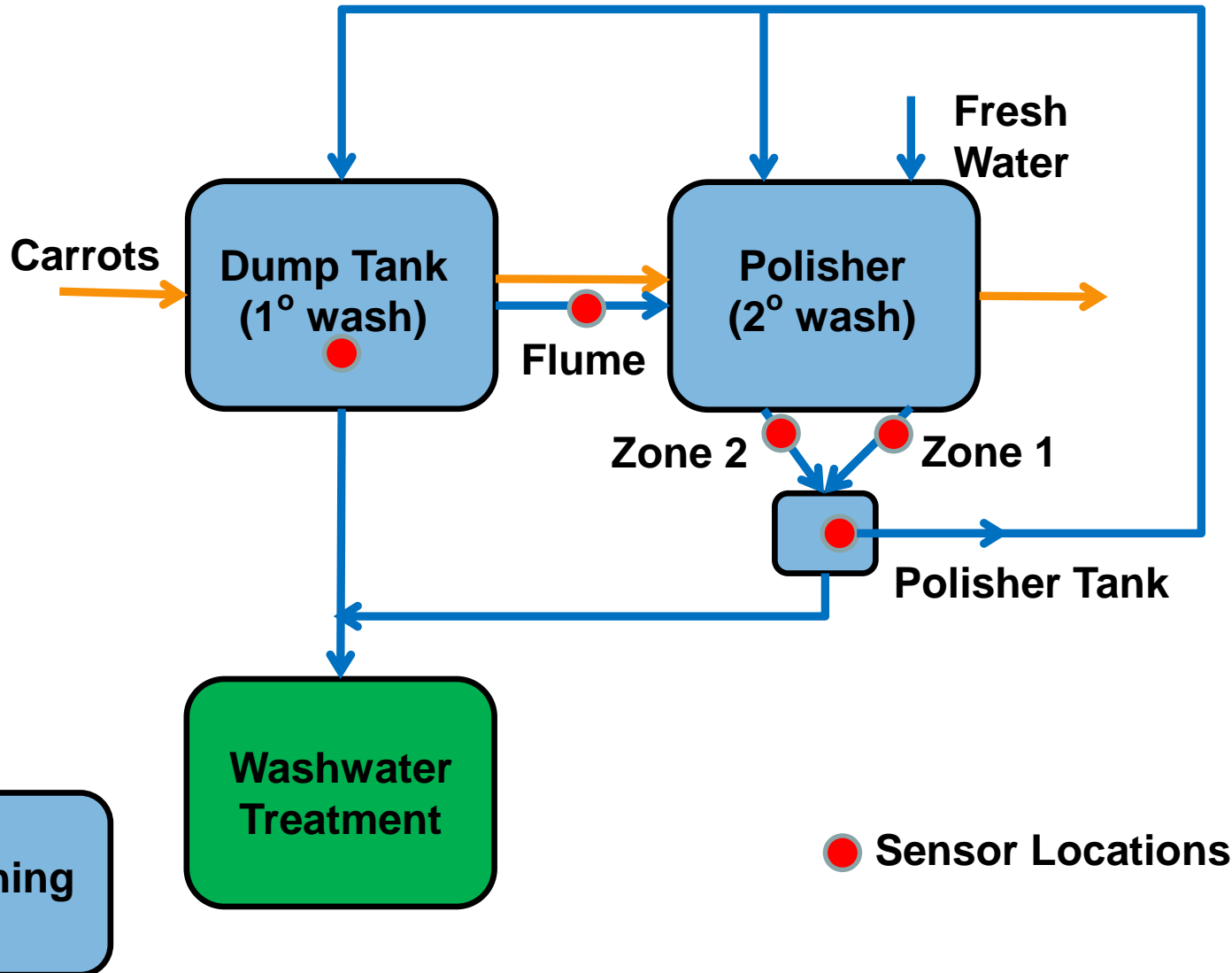
* Increased grade resulted in breakage of some carrots

Overview – Water Quality Monitoring

Carrot Processing



Carrot Washing



Water Monitoring



**Sensor installed
in Dump Tank**



**Sensor installed
in Dump Tank**



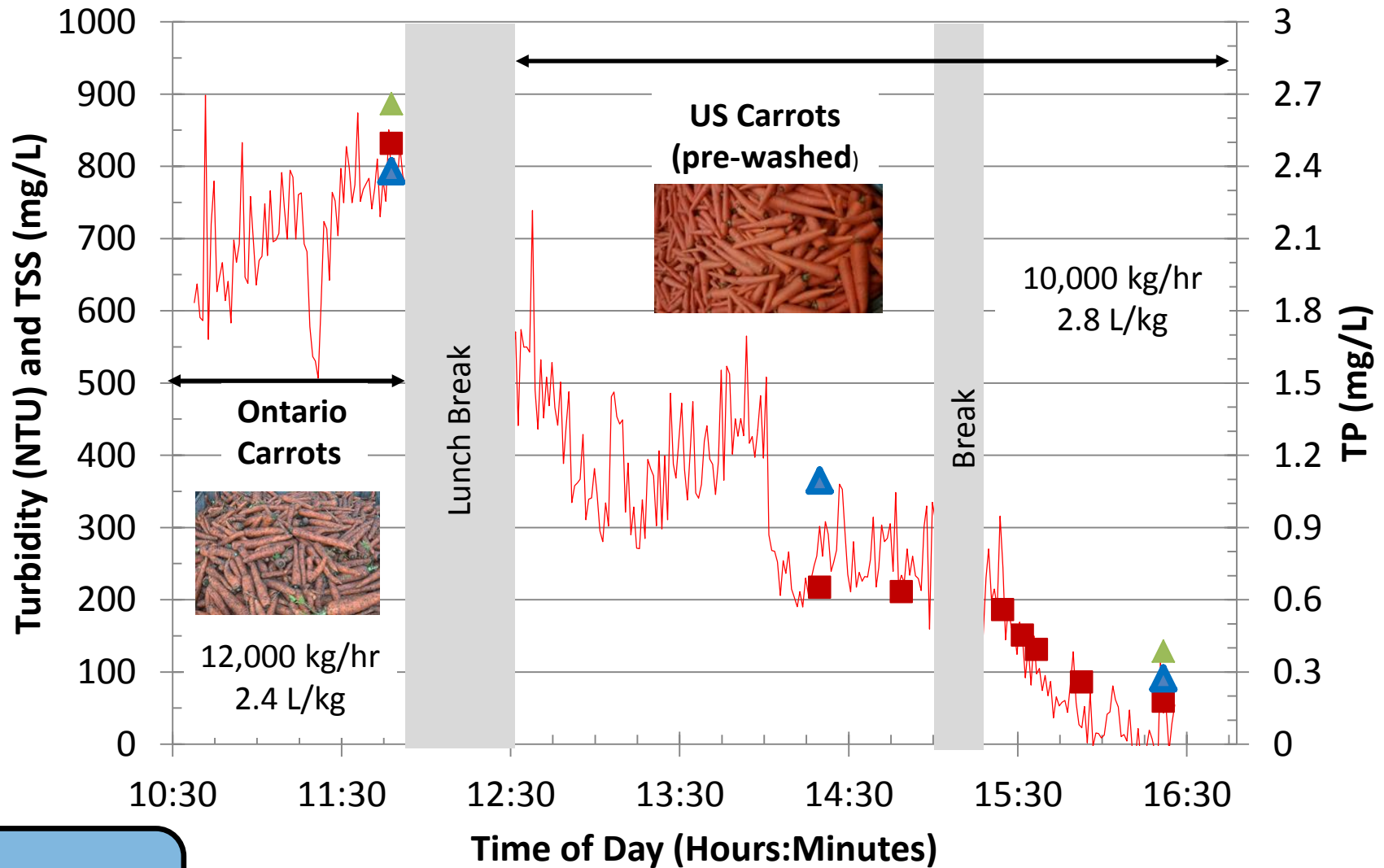
**Sensor installed
in Flume**



**Sensor installed
in Polisher Tank**

Washing

Water Monitoring and Control



Washing

Conclusions – Water Quality Monitoring

- Continuous turbidity monitoring can be used to optimize wash process water consumption.
 - Control the operation of the waste valves in the dump tank and polisher tank to reduce the overall volume of washwater generated.
 - Adjust washwater flow rates in polishers to appropriate level for carrot soil loading.
 - Maximize the use of recycled water (e.g. minimize the need for fresh water added in the dump tank)
 - Demonstrate the need for either reducing water use or implement means to by-pass wash process for pre-washed (e.g. US-sourced carrots).

Washing

Multiple benefits to additional de-dirting and continuous turbidity monitoring

Financial

- Reduce expenditure on washwater treatment systems by reducing the soil loading and flow rate.
- Increase wash system throughput by optimizing equipment speed and water consumption for actual carrot soil loading.

Environmental

- Reduce Total Suspended Solids and Total Phosphorous entering surface water (e.g. Holland Canal and Lake Simcoe).

Acknowledgements

- Co-operator Growers/Packers
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