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VEGETABLE WASHING FACILITY WATER USE SELF-ASSESSMENT TOOL FOR:

Holland Marsh Growers' Association

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Vegetable Washing Facility Water Use Self-Assessment Tool

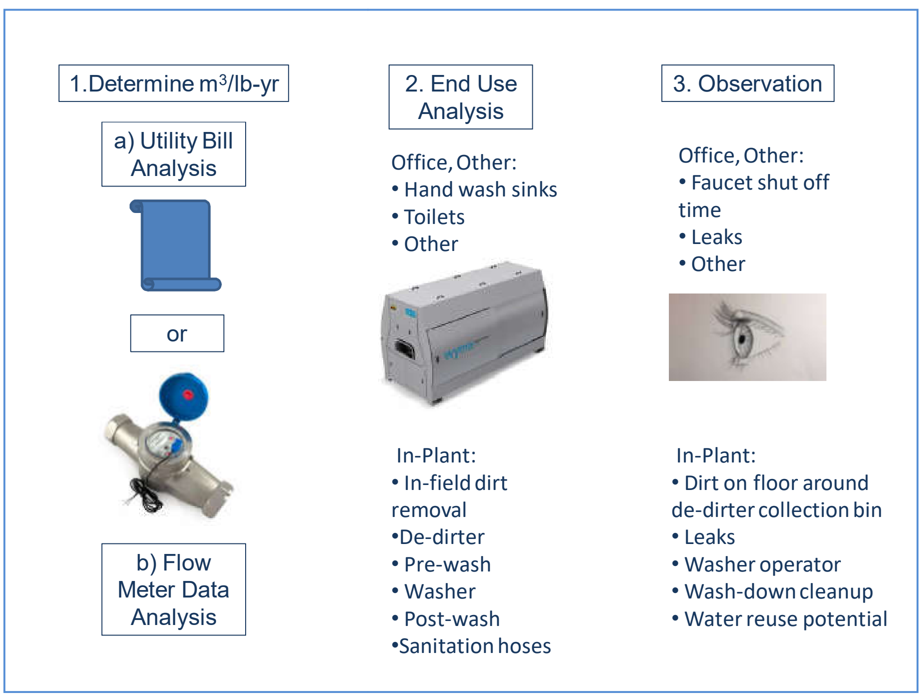
Why Assess Your Wash System's Performance?

- Establish baseline water use with the existing system (m^3/lb);
- The baseline allows you to identify potential issues related to system water use & to address those issues;
- Identify opportunities to improve washing efficiency & reduce water consumption;
- Establish the new water use baseline after upgrades have been made;
- Save money, save water, improve product throughput, reduce treatment costs.

How Do You Assess Your Wash System's Performance?

1. Determine annual water use for all product washed (m^3/lb-yr) by:
    a. Utility bill analysis, &/or;
    b. Flow meter readings;
    c. Total product washed/yr.
    d. NOTE: compare water use and production for the same year.
2. Measure water consumed by key end uses using:
    a) Timed grab samples, &/or;
    b) Flow meter readings.
3. Observation.

Figure 1: Water Use Assessment Process



1. Annual Water Use vs. Total Vegetables Washed (m^3/lb-yr):

Determine annual water use (m^3) for washing vegetables (lbs) to establish m^3/lb-yr. Annual water use can be found through a utility bill analysis and/or a flow meter data analysis.

NOTE: it is important to compare water use and washed product for the same year.

a) Utility Bill Analysis:

If the facility is on municipal water, your bills will give you monthly, bi-monthly or quarterly water use. Add up the water use for each billing period to get the total annual water use. For example:

Billing Period 2020	Water Use (m^3)
Jan 1 – Feb 29	8,001
Mar 1 – Apr 30	7,251
May 1 – June 30	3,427
July 1 – Aug 31	2,285
Sept 1 – Oct 31	8,697
Nov 1 – Dec 1	9,250
Total Annual	***38,911***

b) Flow Meter Data Analysis:

You can calculate total water use for the desired time period by subtracting End of time period reading from Beginning of time period reading.

If your flow meter does not log data, manually record the flow meter reading on a routine basis such as daily (ideally), weekly, monthly, and record the time you take the reading. A sample flow meter reading record keeping sheet is provided in Table 1.

Table 1: Sample Flow Meter Reading Record Sheet

Date	Time	Flow Meter Reading	Initials

c) Calculate Total Annual Water Use/Pound of Product Washed (m^3/lb-yr):

If 38,204,987 lb of vegetable are washed annually using 38,911 m^3 of water, then:

$$\frac{38{,}911 \text{ m}^3}{38{,}204{,}987 \text{ lb}} = 0.001 \text{ m}^3\text{/lb-yr}$$

2. End Use Analysis:

Estimate water consumption for all end uses in office & other non-processing areas, & in the vegetable storage & wash area(s). If there are multiple water sources, such wells or municipal services or both, end use estimates should be made for each source.

Steps to estimate annual water consumption by end use:

a) Identify all water consuming end uses;
b) Estimate hours of operation for each end use;
c) Measure end use water consumption using timed grab samples;
d) Calculate annual water consumption for each end use.

a) Identify All Water Consuming End Uses:

Are the office & non-processing areas on the same water supply as the vegetable processing area? If yes, then you need to account for their water use.

i. Office & Other Non-Processing Areas:
   - Hand wash sinks;
   - Toilets;
   - Other.

ii. Vegetable Harvesting, Storage & Wash Areas:
   - In-field dirt removal;
   - Back flow preventer;
   - Flume;
   - De-dirter;
   - Pre-soak tank;
   - Pre-wash spray or dribble bar;
   - Washer/Polisher:

- Dirty water collection under washer & reuse;
- Final rinse after polisher discharge;
- Preservative spray bar;
- Sanitation hoses;
- Other.

b) Estimate Hours of Operation for Each End Use:

This estimate will be used to calculate annual water consumption by an end use. Estimate:

- Hours/day;
- Days/week;
- Weeks/year.

There may be 2 or 3 different operating profiles for the facility; for example:

- Fall (Peak) washing: Sept-Nov, 10 hr/day, 6 days/week, 13 weeks;
- Winter washing: Dec-Aug, 7 hr/day, 5 days/week; 39 weeks.

For toilets and sinks, the number of staff is required:

- Assume:
  - Hand wash: 5 /day-person;
  - Toilet flush: 5 /day-person.
- Example:
  - Plant – Fall: Sept – Nov, 50 staff;
  - Plant – Winter: Dec – Aug, 35 staff;
  - Office – Fall: Sept – Nov, 5 staff;
  - Office – Winter: Dec – Aug, 5 staff.

c) Measure End Use Water Consumption:

Where possible, measure water consumption for each end use using a timed grab sample.

Tools: Examples of tools used to collect the timed samples include (Figure 2):

- Buckets;
- Pails;
- Measuring cups;

- Bags (for smaller discharges with little clearance);
- Large garbage cans (for big flows like sanitation hoses).

Collection devices may need to be attached to a pole in order to reach a discharge point.

If the collection device will not fit under the entire discharge, such as a long dribble bar or multiple spray nozzles over a conveyor or table, collect from a portion of the end use; for example, half of the dribble bar or one of the spray nozzles. Extrapolate the results for the entire end use.

Time the sample collection:

- Two people may be required, one to collect the sample, the other to time it.
- Depending on the flow rate, the sample time may be 10 seconds (lots of flow), 1 minute, 15 minutes (slow flow), or other intervals. Be sure the interval can be extrapolated to 1 minute or 1 hour.
- You may want to repeat the timed sample to ensure consistency.

Figure 2: Timed Grab Sample Collection Tools

d) Calculate Annual Water Consumption for Each End Use:

Examples are presented below to reflect different scenarios that may be encountered requiring different approaches to calculating savings.

NOTE: Very few systems run all the time; in examples 2 and 3, 10 hr/d (winter) & 8 hr/d (summer) represent staff hours. Using these hours may over-estimate actual equipment operating time. Be sure to adjust operating hours to account for lunch and break time, equipment down time, etc.

Example 1: Install Soft Durometer Finger De-Dirter:

- Assume no de-dirter is in place;
- 25% reduction in washer water use[1] by installing a soft durometer finger de-dirter with finger cleaning system;
- If the washer uses 10,000 m^3/yr (based on 1 week of flow meter data extrapolated to a year; otherwise, assume 85% of total plant water use), then:

Savings:

2,500 m^3/yr = 10,000 m^3/yr (based on flow meter reading) * 25% savings estimate

Other Considerations:

- The de-dirter will knock off about 50%[2] of the dirt, which will increase the amount of dirt collected in bins for removal by 50%;
- It is assumed bumpers are in place on the harvester;
- Reducing the amount of dirt entering the treatment system will result in treatment cost savings.

Example 2: More Efficient Spray Nozzles (unable to measure flow rate):

- Existing spray nozzles that apply preservative to product pre-packaging;
- Assume existing nozzles deliver 1.9 lpm/nozzle;
- Spray nozzle operation:
    - Winter: 10 hr/d, 5 d/wk, 35 wk/yr
    - Summer: 8 hr/d, 5 d/wk, 17 wk/yr
- 4 nozzles in place;
- Assume more efficient nozzles deliver 0.7 lpm/nozzle.

[1] Vegetable washer 25% reduction in water use estimate is based on work done by OMAFRA.
[2] 50% dirt removal by a finger de-dirting system with bumpers on harvester estimate is based on work done by OMAFRA.

Savings:

1.2 lpm/nozzle = 1.9 lpm/current nozzle – 0.7 lpm/more efficient nozzle

Total: 4.8 lpm = 1.2 lpm/nozzle x 4 nozzles

Winter: 504,000 l/yr = 4.8 lpm x 60min/hr x 10hr/d x 5 d/wk x 35 wk/yr

Summer: 195,840 l/yr = 4.8 lpm x 60min/hr x 8 hr/d x 5 d/wk x 17 wk/yr

Annual: 699,840 l/yr (699 m^3/yr) = 504,000 l/yr (winter) + 195,840 l/yr (summer)

Other Considerations:

- In addition to reducing water consumption costs, wastewater fees will be reduced as well;
- Reducing the amount of water requiring treatment will reduce the size of the treatment operation when designing a new system, or may extend the service life of an existing system if there are plans to increase production.

Example 3: More Efficient Spray Nozzles (flow rate measured):

- 2 spray nozzles on a pre-wash soaker bar;
- 1 nozzle output measured;
- Sample time: 30 seconds;
- Sample volume: 0.95 litres/30 sec;
- Existing nozzle litres/minute: 1.9 lpm = 0.95 litre x (30 seconds x 2 = 1 min) [for one nozzle];
- Soaker bar operation:
    - Winter: 10 hr/d, 5 d/wk, 35 wk/yr;
    - Summer: 8 hr/d, 5 d/wk, 17 wk/yr.

Savings:

1.2 lpm/nozzle = 1.9 lpm/current nozzle – 0.7 lpm/more efficient nozzle

Total: 2.4 lpm = 1.2 lpm/nozzle x 2 nozzles

Winter: 252,000 litres/yr = 2.4 lpm x 60 min/hr x 10 hr/d x 5 d/wk x 35 wk/yr

Summer: 97,920 litres/yr = 2.4 lpm x 60 min/hr x 8 hr/d x 5 d/wk x 17 wk/yr

Annual: 349,920 litres/yr (350 m^3/yr)

Other Considerations:

- In addition to reducing water consumption costs, wastewater fees will be reduced as well;

Reducing the amount of water requiring treatment will reduce the size of the treatment operation when designing a new system, or may extend the service life of an existing system if there are plans to increase production.

3. Observation:

Walk around the plant and look for:

- Dirt on floor around de-dirter collection bin or elsewhere that will be washed down:
    - Improve dirt collection so it does not end up somewhere that will be washed down. The less dirt to wash, the less water that will be used. The less treatment required.
- Leaks:
    - Pure cost, no productive value, affect bottom line. Fix them.
- Water left on when not required:
    - Worse than leaks. Completely preventable. Affects bottom line. Explain & train why it is important to shut off.
- Washer operator:
    - Do they use different blends of washer reuse: fresh water to clean the incoming dirty vegetables? Is too much fresh water being used?
    - Set standards for clean so the operator has a target for each product (carrots, parsnips, beets) & level of dirt.
    - Invest in a rotameter or other type of flow meter to establish benchmark fresh water use for different vegetables & dirt levels.
- Is the water hitting the vegetables?
    - Beets tend to role to one side of the washer leaving 50% of the water discharging from the pipe (in a pipe with offset holes) completely missing the vegetables.
- Wash-down cleanup at end of the day:
    - Is the dry cleanup of dirt, vegetables, and other waste on the floor effectively scraped or swept up before washdown?
    - Is the cleanup crew having fun chasing stuff around the floor with the hoses?
    - Have the sanitation hose nozzles been removed or reamed out?
- Water reuse potential:
    - Does the washer have a collection tank underneath from which the wash water can be pumped & reused to wash the incoming dirty product?

    - Can dirty water being generated elsewhere be reused to pre-wash or wash the incoming dirty vegetables or can it be used elsewhere in the plant?
- Hand wash stations:
    - Faucets with electronic eye shut off: How long does water run after hand washing is done? Does it shut off when hands are removed?

Good Practices

In-Field Dirt Removal:

- Bumpers: rods or finger sets on the harvester knock dirt off the vegetables after pulling.

In-Plant Operations:

- Pre-Washed Product: Should be relatively dirt-free & only require a potable water rinse; therefore:
    - Can you bypass soak tanks or pre-wetting systems?
    - Can you avoid fluming product into the polisher? Is it possible to dry convey product in?
    - Turn off the recycled or potable water being delivered by the pipe for the initial dirty wash in the front 2/3rd of the polisher.
    - Turn down the amount of potable water being used to rinse the product in the polisher before discharge (water delivery pipe in back 1/3rd of polisher).
- Facilities Receiving Product from Other Growers:
    - Require growers to have bumpers on harvesters to remove as much dirt as possible in the field;
    - Consider establishing a ‘dirty’ benchmark for vegetables being received from growers. Apply a dockage fee if dirt levels exceed the benchmark. Clearly communicate the benchmark & dockage fee to the growers.
- De-Dirter:
    - Install a de-dirter such as a soft durometer finger de-dirter with scraper system to clean the fingers;
    - Install shields under de-dirter to direct dirt into bin in order to minimize the amount of dirt falling on the floor;
    - Prevent water from splashing on product entering or moving over de-dirter.

- Wash Water Reuse in Polisher: wash water is collected in a tank under the washer & pumped to wash the dirty vegetables in the intake 2/3rd of the polisher, reducing or eliminating the amount of fresh water required;
- Automate Polisher Potable Water Shut Off: when polisher is not in use, a solenoid shuts the water off & turns it on when the polisher begins operating.
- Install a Water Flow Meter on Polisher Potable Water Supply:
    - Establish flow rates for different vegetables; e.g., beets may need less water to wash than other vegetables;
    - Establish different flow rates for pre-washed, less dirty, moderately dirty & very dirty product;
    - Post the flow rate targets by the polisher so that the operator can adjust the flow according to the product being washed.
    - NOTE: Wide variety of flow meters and price points are available. A scaled flow meter is presented in Figure 3 and an electronic model in Figure 4.

Figure 3: Scaled Flow Meter

Figure 4: Electronic Flow Meter

- Is Wash Water Hitting Product?
    - Look inside the washer to see where vegetables lie in the rotating drum & where the water from the supply pipes is falling.

  - Beets roll to one side of the drum. Some discharge pipes have holes cut along the side of the pipe, alternating left – right down the pipe's length, resulting in 50% of the water not hitting the product.
  - In a washer dedicated to one vegetable, plug the discharge holes that are delivering ineffective wash water.
- Establish Specifications for Clean for Each Product being Washed:
  - Post specifications (possibly images) beside polisher as a guide for the operator to:
    - Manage water consumption to meet the specifications;
    - Manage polisher throughput to meet the specifications.
- Post-Production Dry Clean Up:
  - Scrape or sweep vegetables, dirt, and other dry waste from the floor before washing down with sanitation hoses.
- Sanitation Hose:
  - Consult with a spray gun vendor to assess whether a restricted flow nozzle is appropriate for your operation;
  - NOTE: the success of these nozzles is very dependent on matching the nozzle to the end use, & educating staff on why they are being used.
- Staff Training:
  - Why optimize water use;
  - How to report & repair water leaks;
  - Polisher operator:
    - Target water flow rates based on incoming vegetable dirt level & type of vegetable;
    - Clean vegetable specifications;
    - Shutting off water to polisher & other systems when not operating in non-automated systems.
- Rain Water Harvesting:
  - Can rainwater be collected from roof surfaces & stored for non-potable uses; for example, toilets, fluming, vegetable soak tanks, the incoming dirty vegetable initial wash?

Estimated Costs of Key Opportunities

The estimated costs to implement the most commonly identified opportunities are presented in the following table.

Recommendation	Details	Estimated Installed Cost ($)
Install De-Dirter	Example: 30” (W) x 48” (L) finger de-dirter plus finger cleaning system	$11,000 Costs vary depending on dimensions, cleaning system
Replace Spray Nozzles with Efficient Nozzles	$10 CDN / 0.7 lpm nozzle Labour: $20/hr * ½ hour / nozzle Additional supplies	$25 / nozzle
Install Flow Meter on Polisher Potable Water Supply	Scaled: 1.5” PVC, 10-70 GPM (SCH 40), $125 Electronic 1” NPT thread, 10 – 100 lpm: $250 Labour: $100/hr * 2 hrs Additional supplies	Scaled: $400 Electronic: $600 NOTE: Flow meter costs vary significantly. The costs provided are examples of 2 different meter types for typical flow ranges & pipe diameters