Best Management Practices for Water and Fertilizer Use

12 Steps to Improved Water and Fertilizer Use

1. Complete an Environmental Farm Plan and the Self-Assessment (see pg. 3).
2. Map all water, wastewater and movement of that water on and off your property.
3. Review all fertilizer and chemical storage and mixing areas to ensure proper containment and separation from floor drains.
4. Identify areas on your property where current practices impact surface water or groundwater, and take steps to eliminate these impacts.
5. Monitor, calculate, and record your current water and fertilizer use per unit area.
6. Establish short- and long-term water and fertilizer conservation goals.
7. Implement BMPs to help meet your water and fertilizer conservation goals.
8. Determine water and fertilizer reuse, storage, and disposal options. Consult with appropriate regulatory agencies, including municipal and provincial governments, and local conservation authority.
9. Implement necessary treatment options for reuse or discharge. Consult with appropriate regulatory agencies, including municipal and provincial governments, and local conservation authority.
10. Monitor and document new practices and processes. Upgrade technologies where applicable. Adjust your plan where appropriate.
11. Develop contingency plans to manage water and wastewater, and to address spills to the environment.
12. Know and comply with all local, provincial, and federal bylaws and regulations.

Guiding BMP Principles

- Keep clean water clean.
- Know your water quantity and quality throughout the system.
- Manage water and nutrient inputs efficiently.
- Close production system to collect and reuse leached nutrient feedwater.
- Prevent discharge of leached nutrient feedwater and other wastewaters.

Note: Each greenhouse operation is unique, and not all BMPs in the following pages will suit the circumstances and goals of every operation.

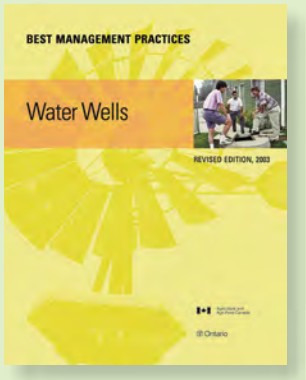
A PRE-PRODUCTION BEST MANAGEMENT PRACTICES

for water and nutrient management before water and nutrients enter the production system and greenhouse facility

GUIDING PRINCIPLES	GENERAL BMP	SPECIFIC BMPs	DETAILS
KEEP CLEAN WATER CLEAN	1. Capture and store rainwater for use in irrigation	Divert to cistern, storage tank, or lined pond	Use roof and eaves to collect rainwater Store in cistern, storage tank, or lined pond
	2. Keep stored municipal water clean	Use anti-backflow devices Use leak-proof storage tanks	
	3. Construct storm water management ponds or basins, where practical, to reduce sediment loads to surface water	Construct berms Use pond liners	Use berms to prevent unwanted runoff entering pond Use liners (e.g. synthetic liner, clay) to reduce loss and prevent contamination of the stored water
	4. Maintain all wells to minimize nutrients and pesticides reaching groundwater	Inspect and monitor wells Protect wells Maintain minimum separation distances Decommission abandoned wells	Test water regularly Construct berm around well Follow Environmental Farm Plan guidelines for separation distances from contaminant sources See BMP book: *Water Wells*

This greenhouse under construction features downspouts to direct rainwater to storm water retention pond.

Store clean water in durable, waterproof storage tanks.



See Best Management Practices book* Water Wells *for more information about well protection and maintenance.

A PRE-PRODUCTION BEST MANAGEMENT PRACTICES

for water and nutrient management before water and nutrients enter the production system and greenhouse facility

GUIDING PRINCIPLES	GENERAL BMP	SPECIFIC BMPs	DETAILS
KNOW YOUR WATER QUANTITY AND QUALITY THROUGHOUT THE SYSTEM	**5.** Take samples throughout the year or when changing water sources to identify chemical makeup and manage the water accordingly for optimal crop production	Test water for: • macronutrients • micronutrients • other components	• N, P, K, Mg, S, Ca • Mn, Mo, Cu, Cl, B, Zn, Fe • EC, pH, bicarbonates, Na, Si (see pg. 4 for legend) Use acid treatment to lower pH Undertake desalinization to remove ions in order to improve water quality Adjust nutrient solution following treatment *Note:* **Pretreatment systems may generate a waste by-product that may be subject to MOE requirements for disposal or discharge**
PREVENT DISCHARGE OF LEACHED NUTRIENT FEEDWATER AND OTHER WASTEWATERS	**6.** Map all water and wastewater and movement of that water on and off your property	Draw a diagram of all water and wastewater inputs and outputs	These may include, but are not limited to: • inputs from municipal water, wells, surface water, and storm water recapture • outputs from wastewater (regardless of how infrequent), excess leached nutrient feedwater, irrigation water, floor drains, tile drains, filter backwash, boiler blowdown, washwaters, greenhouse washdown, and any septic waste • outputs from storm water, including outdoor catch basins and roof gutters

A PRE-PRODUCTION BEST MANAGEMENT PRACTICES

for water and nutrient management before water and nutrients enter the production system and greenhouse facility

GUIDING PRINCIPLES	GENERAL BMP	SPECIFIC BMPs	DETAILS
PREVENT DISCHARGE OF LEACHED NUTRIENT FEEDWATER AND OTHER WASTEWATERS	**7.** Select or alter site to reduce infiltration of leached nutrient feedwater into groundwater	Assess site features	Consider depth to water table and bedrock Know off-site water sources – monitor incoming water quality and quantity from adjacent areas
		Modify site	Compact soil beneath production areas, cover ground with impermeable surface, or use subsurface drains to capture and collect
	8. Select or alter the site to minimize runoff to surface water	Assess site features	Consider slope, distance to surface water Monitor incoming water quality and quantity from adjacent areas
		Modify site	Construct berm or protect site from runoff
MANAGE WATER AND NUTRIENT INPUTS EFFICIENTLY	**9.** Replenish irrigation ponds during high flows to avoid water removal during periods of low flow	Schedule during high water conditions	Harvest water after peak flows for best quality and minimal impact on habitat
	10. Construct permanent water storage	Ensure storage is designed and sized with sufficient capacity to allow for variability in water quantity and quality	Use lined ponds, lined/treated concrete reservoirs, or heavy-duty plastic cisterns if treated surface water is used for irrigation system or other purposes

Modify site to reduce the risk of groundwater contamination. The ground is leveled, compacted, and prepared for installation of groundsheet plastic cover.

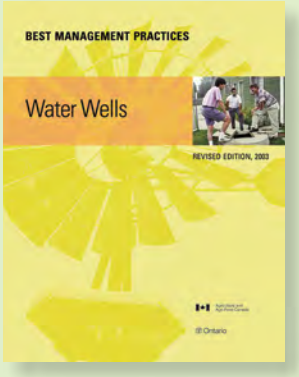
A PRE-PRODUCTION BEST MANAGEMENT PRACTICES

for water and nutrient management before water and nutrients enter the production system and greenhouse facility

GUIDING PRINCIPLES	GENERAL BMP	SPECIFIC BMPs	DETAILS
MANAGE WATER AND NUTRIENT INPUTS EFFICIENTLY	**11.** Obtain a Permit to Take Water (PTTW) from MOE if you take more than 50,000 L on any day from a surface water or groundwater source	Monitor and keep records for PTTW	Install water meters and other devices strategically to monitor volume used Test wells for sustainable pumping rates, drawdown and yield before using a well as your water source Pump water for 24 hours to test yield and water table drawdown; pumping pump-test water into municipal drains may require a permit, so contact town/municipality See BMP book: *Water Wells*
	12. Create a contingency plan to deal with issues of threatened water availability	Develop a low-water contingency plan	Ensure your plan includes: alternative water sources, logistics for delivery, backup storage, and water-efficient BMPs
	13. Hire an engineer familiar with irrigation methods to design your system	Hire an irrigation consultant	Get professionally designed irrigation system with optimal uniformity and efficiency, and able to optimize timing of irrigations

Store irrigation water in leak-proof containers such as above-ground, lined storage tanks.

See Best Management Practices book* Water Wells *for information on measuring yield and water table drawdown.



B PRODUCTION BEST MANAGEMENT PRACTICES
for water and nutrient management within the greenhouse facility and during crop production

GUIDING PRINCIPLES	GENERAL BMP	SPECIFIC BMPs	DETAILS
KNOW YOUR WATER QUANTITY AND QUALITY THROUGHOUT THE SYSTEM	**14.** Keep records of measurements of volume of water used for irrigation and other purposes – and its corresponding analysis where possible	Install sensors Calibrate output	Involves water meters, pressure sensors Use bucket under emitter (see Leachate Measurement diagram on pg. 12)
	15. Optimize water efficiency based on monitoring and record-keeping	Create management zones based on similar irrigation and climate needs	Group plants by size and cultivar, for example
CLOSE PRODUCTION SYSTEM TO COLLECT AND REUSE LEACHED NUTRIENT FEEDWATER	**16.** Design your operation to collect and recycle leached nutrient feedwater within your operation where practical	Monitor Conduct routine maintenance Repair fertigation system components	Install monitoring equipment – e.g. pressure gauges, EC, and pH meters Routinely check all components Test output for uniformity Monitor and clean nozzles Clean/replace filters

Water content meters can provide feedback that will improve irrigation efficiency.

Clean nozzles: application rates must be uniform to attain even production and reduce waste.

Create management zones by crop type, stage or size to manage inputs more efficiently.

In closed production systems, use reliable techniques to monitor the quality and quantity of recycled water. Use the information to treat effectively.

B PRODUCTION BEST MANAGEMENT PRACTICES

for water and nutrient management within the greenhouse facility and during crop production

GUIDING PRINCIPLES	GENERAL BMP	SPECIFIC BMPs	DETAILS
CLOSE PRODUCTION SYSTEM TO COLLECT AND REUSE LEACHED NUTRIENT FEEDWATER	**17.** Treat reused water for plant pathogens **18.** Consult qualified person to assist in design, setup, and safety (17 and 18 are continued on next page)	Ultra-violet (UV) – irradiation	Kills most pathogens at prescribed rates Requires pre-filtration of water
		Pasteurization	Kills most pathogens at prescribed temperatures Requires pre-filtration and acidification of water
		Reverse osmosis (RO)	Removes ions and pathogens Produces large volumes of filtrate (brine) solution Requires pre-filtration of water
		Ultra-filtration	Removes most pathogens (due to membrane technology) Requires high maintenance Requires pre-filtration of water

Use UV treatment systems to kill pathogens and other micro-organisms.

Heat disinfection will also kill pathogens and bacteria.

Reverse osmosis will remove salts (nitrates, sulphates, carbonates), pathogens, and other micro-organisms from irrigation water.

B PRODUCTION BEST MANAGEMENT PRACTICES
for water and nutrient management within the greenhouse facility and during crop production

GUIDING PRINCIPLES	GENERAL BMP	SPECIFIC BMPs	DETAILS
CLOSE PRODUCTION SYSTEM TO COLLECT AND REUSE LEACHED NUTRIENT FEEDWATER	(17 and 18 are continued from previous page) **17.** Treat reused water for plant pathogens **18.** Consult qualified person to assist in design, setup and safety	Slow sand	Filters out particulate matter and houses microbes that will suppress pathogens May require post-treatment
		Lava rock	Provides habitat for pathogen-reducing microbes (due to porous medium) Will not kill all pathogens May require post-treatment
		Ozonation	Is a potent oxidant Requires pre-filtration of water
		The following treatment options for reused water are also available but have potential risks for operator, plant and aquatic toxicity: • hydrogen peroxide • chlorination • chlorine dioxide • copper ionization	
MANAGE WATER AND NUTRIENT INPUTS EFFICIENTLY	**19.** Look for a system that suits your operation and a design that offers optimal uniformity and efficiency, and is able to optimize timing of irrigations	Hire an irrigation consultant	

Ozonation uses ozone, an oxidant with twice the effect of chlorine, to destroy pathogens and other microbes.

Slow sand filtration systems are designed to remove particulates and microbes. Sand filters are easy to establish and operate.

B PRODUCTION BEST MANAGEMENT PRACTICES

for water and nutrient management within the greenhouse facility and during crop production

GUIDING PRINCIPLES	GENERAL BMP	SPECIFIC BMPs	DETAILS
MANAGE WATER AND NUTRIENT INPUTS EFFICIENTLY	**20.** Keep inventory of fertilizers	Maintain an inventory of the amount of fertilizer (e.g. ammonium nitrate) purchased and used, and location of storage	Use your inventory to help assess efficiency
	21. Sample, test, and record fertilizer solutions	Analyze water sources and nutrient feedwater throughout year or when changes are made – identify its chemical makeup, EC, pH, and manage accordingly	Test feed solution for macronutrients, micronutrients or other components
	22. Schedule irrigation	Monitor plant and atmospheric data	Collect growth environment and plant moisture data for irrigation scheduling
	23. Match substrate stability to cropping cycle length	Conduct tests and trials	Verify substrate type is suitable for operation by conducting trials
	24. Crop nutrient management	Choose the right form	Use water-soluble fertilizers Should be good quality – containing no additional by-products or contaminants
		Apply the right rate	Match nutrient needs to crop type and growth stage – consult Ministry of Agriculture and Food and the Ministry of Rural Affairs crop production guidelines for more information Select fertilizer sources and adjust rates to account for remaining nutrients and limiters (sulphates, chlorides, sodium) in recycled irrigation water or available in growing substrates – this applies to all macronutrients and micronutrients
		Apply at the right time	Match nutrient needs to crop type, growth stage, and greenhouse climate conditions

Reduce nutrients in the leached nutrient feedwater by:

- ***matching fertilizer rates to meet crop requirements***
- ***adjusting fertilizer rates to account for fertilizers in growing substrates***
- ***selecting fertilizer sources to account for limiters (chlorides, sulphates, sodium)***
- ***accounting for nutrients remaining in recycled irrigation water.***

Lower nutrient feedwater concentrations of boron and molybdenum can increase opportunities for approved land application.

B PRODUCTION BEST MANAGEMENT PRACTICES
for water and nutrient management within the greenhouse facility and during crop production

GUIDING PRINCIPLES	GENERAL BMP	SPECIFIC BMPs	DETAILS
PREVENT DISCHARGE OF LEACHED NUTRIENT FEEDWATER AND OTHER WASTEWATERS	**25.** Reduce impact from spills	Equip all water-taking systems with anti-backflow devices to prevent unintentional contamination of the water source	Install a permanent anti-backflow device on the water supply line
		Use high-density polyethylene or stain-less-steel containers designed for the purpose of fertilizer solution storage	Store fertilizer to prevent contamination of nearby surface water or groundwater
		Ensure that secondary containment around concentrated fertilizer storages is in place	Note that size should be 110% of storage volume
		Have a written and posted contingency plan for spills of bulk fertilizer	Keep plan readily accessible for staff Inform staff of contingency plan
		Clean up any fertilizer spills immediately	Use appropriate technology and techniques to clean up solution spills (e.g. spill kits with portable barrier)
	26. Capture, collect, and store leached nutrient feedwater solutions	Ensure no floor drains lead to the outside environment from any fertilizer or pesticide storage or mixing areas	Close off floor drains or direct them to a separate isolated containment
		Use high-density polyethylene containers, lined concrete, lined steel-clad	Ensure correct container size for the volume generated by your specific operation

Use of technologies such as variable-speed soft-start irrigation pumps improves precision of irrigation scheduling.

Anti-backflow devices prevent contamination of the fresh water supply, which could be municipal water or well water. A restricted-flow valve controls the maximum flow rate to the greenhouse operation so as to minimize strain on the municipal supply system.

C POST-PRODUCTION BEST MANAGEMENT PRACTICES

for water and nutrient management outside the greenhouse facility, when water and nutrients are no longer required or usable for production

GUIDING PRINCIPLES	GENERAL BMP	SPECIFIC BMPs	DETAILS
		The disposal of nutrient feedwater must be managed in accordance with applicable legislation such as the *Ontario Water Resources Act, Environmental Protection Act,* and *Nutrient Management Act.*	
KNOW YOUR WATER QUANTITY AND QUALITY THROUGHOUT THE SYSTEM	**27.** Monitor water quantity and quality	Have your leached nutrient feedwater analyzed for nutrient concentrations and know the volumes in order to design the best system for your operation	Analysis of leached nutrient feedwater and environmental quality goals will assist in determining reused water treatment option Test water for macronutrients, micronutrients or other components – consult Ministry of Agriculture and Food and the Ministry of Rural Affairs production guidelines for more information
PREVENT DISCHARGE OF LEACHED NUTRIENT FEEDWATER	**28.** Collect and store separately leached nutrient feedwater from other greenhouse wastewaters	Leached nutrient feedwater storage should be designed to contain total volume of leached nutrient feedwater produced, and to ensure that the stored waters do not reach surface water or groundwater resources	
	29. Pre-treat leached nutrient feedwater or other post-production water	Drain inlet inserts (a storm water BMP)	Removes debris and prevents some sediment from entering drainpipe
		Sedimentation (recycling) ponds	Removes sand and silt
		Sand filters – fast	Removes particulates
		Sand filters – slow	Removes particulates and some pathogens

Leached nutrient feedwater is nutrient-rich and should be collected and stored separately from other greenhouse wastewaters.

C POST-PRODUCTION BEST MANAGEMENT PRACTICES

for water and nutrient management outside the greenhouse facility, when water and nutrients are no longer required or usable for production

GUIDING PRINCIPLES	GENERAL BMP	SPECIFIC BMPs	DETAILS
		The disposal of nutrient feedwater must be managed in accordance with applicable legislation such as the *Ontario Water Resources Act, Environmental Protection Act,* and *Nutrient Management Act.*	
PREVENT DISCHARGE OF LEACHED NUTRIENT FEEDWATER	**30.** Removal of nutrients from leached nutrient feedwater (continued on next page)	Bio-filter	Reduces N, but may not meet required environmental standards
		Inorganic filter	Reduces P, but may not meet required environmental standards
		Constructed wetland	Reduces N and P, but may not meet required environmental standards Reduces some pathogens, but may not meet required environmental standards
		Vegetated filter strips	Reduces some N, P and sediment, but may not meet required environmental standards
		Bio-retention swales	Reduces some N, P and sediment, but may not meet required environmental standards
		Bio-retention basins	Reduces some N, P and sediment, but may not meet required environmental standards Reduces some pathogens, but may not meet required environmental standards

With due regard to current regulations (such as the* Ontario Water Resources Act *and* Nutrient Management Act*) and nutrient management BMPs, leached nutrient feedwater can be land-applied to local field crops.

C POST-PRODUCTION BEST MANAGEMENT PRACTICES

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GUIDING PRINCIPLES	GENERAL BMP	SPECIFIC BMPs	DETAILS
		The disposal of nutrient feedwater must be managed in accordance with applicable legislation such as the *Ontario Water Resources Act, Environmental Protection Act,* and *Nutrient Management Act.*	
PREVENT DISCHARGE OF LEACHED NUTRIENT FEEDWATER AND OTHER WASTEWATERS	(continued from pg. 26) **30.** Removal of nutrients from leached nutrient feedwater	Buffer strips	Reduces sediment, but may not meet required environmental standards Reduces some N and P, but may not meet required environmental standards
		Grassed waterways	Reduces sediment, but may not meet required environmental standards Consider agronomic principles, soil characteristics, and application regulations, but may not meet required environmental standards
	31. Alternative use of leached nutrient feedwater	Land application	Allows nutrients to be used by crops Consider agronomic principles and soil characteristics Ensure plant pathogens will not affect receiving crops
	32. Disposal of leached nutrient feedwater	Municipal sewer where municipal bylaw permits	Contact your municipality to ensure bylaw compliance

Constructed wetlands will reduce particle and nutrient levels of post-production wastewaters.

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See especially: *Growing Greenhouse Vegetables in Ontario,* No. 836

BEST MANAGEMENT PRACTICES

The BMP Series of publications has many booklets on related topics.

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