



Guidelines

07--2012

Reducing Commercial/Industrial Janitorial Water Use

Background/Rationale: Janitorial functions for commercial/industrial (manufacturing plant, office building, hotel, restaurant, institution) cleaning often include a good deal of water use, an increasingly valuable global resource. Janitorial water use typically involves the use of specifically designed equipment for cleaning floors and surfaces in production/service areas, and production equipment/tools. Examples in this guideline include low flow spray nozzles, water brooms and microfiber mops, use of cold water washes and water reclaim systems. It may also involve an unnecessary and expensive amount of energy use (electricity or natural gas) for heating water. Any person/business seeking to make operations more sustainable should take steps to fully understand the janitorial water use and implement strategies to conserve water and energy resources. Optimizing water use and reducing energy consumption will, in turn, indirectly help reduce greenhouse gas emissions and any adverse environmental impact associated with excess emissions.

Some improvements may be relatively simple and inexpensive to implement, while others may be more complex and require assistance from experienced professionals. The material contained in these guidelines is intended for use by persons who have a basic level of technical training/competence and familiarity with source reduction concepts and strategies.

Step 1: Assess the Current Situation/Define the Scope of the Situation

1.1. Collect and analyze information about current operations, including but not limited to:

- identify key/relevant sources of information (see **Appendix 1, all examples**):
 - the environmental cause champion,
 - maintenance and/or facility supervisor(s),
 - purchasing or accounts payable personnel,
 - key suppliers/vendors,
 - business representative at local water utility
 - municipal building code or plumbing inspectors
 - local health department sanitarian (if situation involves food handling, human sanitation, or public health)
- collect pertinent documents and information (see **Appendix 1, all examples**):
 - policies/procedures related to water use:
 - formal/informal guidelines/expectations regarding use
 - formal/informal guidelines/expectations for routine equipment maintenance
 - maintenance records, equipment specifications
 - utility bills identifying billing rates and water/energy usage
- keep track of, document and distinguish between key assumptions, known or reported values, and information which is calculated (see **Appendix 1, all examples**)
- identify number/location/type of equipment in question (see **Appendix 1, all examples**):

- develop map using existing blueprints or new diagram to represent system being analyzed so that everyone involved understands the scope and details of what is being analyzed
- may require expert consultation for some aspects (e.g. how much pressure required from spray nozzles to complete the task satisfactorily)
- conduct use analysis (see **Appendix 1, all examples**):
 - identify type and number of uses per day/week/year per piece of equipment
 - identify the temperature of the water being used
 - identify routine and special uses through interviews, direct observation or using testing equipment:
 - per area/unit
 - identify current and optimal water use requirements taking into account industry standards, employee preferences, and tasks involved
 - identify unnecessary uses by direct observation or interviews with key personnel
 - identify maintenance schedule
 - identify tasks performed, frequency
 - identify reports, documentation related to maintenance
- calculate amount/cost of water for entire facility and amount/cost associated with janitorial water use to compare the impact on the overall water use at the facility (Note: Identifying flow rates or water used for specific activities may require estimates, bucket/stopwatch testing, or other assumptions. This may be the most difficult part of the project.) (see **Appendix 1, all examples**):
 - calculate full water costs, i.e. water supplied + water disposed (sewer)
 - verify utility rates per gallon from evaluation of the water bills
 - estimate the annual gallons used/calculate cost for water by area/unit
 - measure volume of water lost to identified leaks/drips
 - consider preparing full water balance map of facility to categorize janitorial uses
 - tag and possibly photograph areas needing adjustment (leaks/replacement), and plot on diagram or map of facility.
 - prioritize equipment for adjustment—fixing largest water uses first
- calculate amount/cost of electricity for entire facility and amount/cost associated with hot water use to compare the impact on the overall water use at the facility (see **Appendix 1, Example 3**):
 - verify utility rate per kWh from evaluation of the electric bills
 - estimate the annual gallons used/calculate cost for heating water by area/unit
- calculate life cycle impact on greenhouse gas emissions from the water use reductions (see **Appendix 3** for examples)

1.2. Conduct necessary research and calculations using the following useful material:

The following references are used to help calculate water waste and to identify potential strategies for improving efficiency of domestic water use and the water/energy nexus related to hot water use:

1. WaterSense, an EPA Partnership Program with suggestions/resources for water conservation, available online at: <http://www.epa.gov/watersense/pubs/indoor.html>
2. American Water Works Association Water Wiser Drip Calculator available online at: <http://www.awwa.org/Resources/Waterwiser.cfm?navItemNumber=1561&showLogin=N>
3. *Water Efficiency Manual for Commercial, Industrial and Institutional Facilities*, N.C. Department of Environment and Natural Resources, Division of Pollution Prevention and Environmental Assistance/Division of Water Resources, May 2009, available online at: <http://infohouse.p2ric.org/ref/01/00692.pdf>

4. The “Save Water” section of the Food Service Technology Center Website available online at: http://www.fishnick.com/savewater/bestpractices/Water_Conservation_in_CFS.pdf
5. *Watergy: A Water and Energy Conservation Model for Federal Facilities*, Sharon deMonsabert and Barry L. Liner, 1996, available online at: <http://www.mendeley.com/research/watergy-a-water-and-energy-conservation-model-for-federal-facilities/>
6. *Water Conservation in the Professional Car Wash Industry*, Chris Brown, Water Conservation Consultant, 2002, available online at: http://www.carwash.org/industryinformation/Documents/Water_Conservation_withDate.pdf
7. *Commercial, Institutional and Industrial Task Force Best Management Practices Report to the Legislature*, draft report State of CA Department of Water Resources, January 6, 2012, available online on Water Use and Efficiency Web site: <http://www.water.ca.gov/wateruseefficiency/sb7/committees/urban/u1/>

The following reference is used to calculate life cycle impact on greenhouse gas emissions:

1. U.S. EPA’ Pollution Prevention (P2) Greenhouse Gas (GHG) Calculator, available online through the National Pollution Prevention Roundtable at: <http://www.p2.org/category/general-resources/p2-data-calculators/>

Step 2: Identify Feasible P2 Opportunities

2.1. In general:

- research a full range of possible operational improvements/modifications/suggestions relevant for the situation at hand (several commonly applicable suggestions are listed below)
- be specific about the “unit” for application, i.e. which equipment to modify
- keep track of, document and distinguish between key assumptions, known or reported values, and information which is calculated (see examples throughout appendices)
- include a thorough cost analysis: use a chart to compare current to proposed costs and calculate payback period
- include relevant vendor information (the vendor information included in these guidelines is for example only)
- identify how to monitor/measure impact for each suggestion if implemented, e.g. compare water bills, monitor use & satisfaction with equipment features

2.2. Selected strategies to consider, including techniques and calculations to perform:

- detect and repair leaks (see [Guideline #6](#))
- conduct employee training re: responsible water use (see [Appendix 2, Example 2](#))
- use high performance/low flow spray nozzles (see [Appendix 2, Example 3](#))
- floor cleaning:
 - use water broom (see [Appendix 2, Example 4a](#))
 - use microfiber mop (see [Appendix 2, Example 4b](#))
- vehicle washing:
 - install water reclaim system (see [Appendix 2, Example 5a](#))
 - use high performance/low flow washer gun (see [Appendix 2, Example 5b](#))
 - use cold water (see [Appendix 2, Example 5c](#))
- calculate life cycle impact on greenhouse gas emissions compared to current processes
 - see [Appendix 3](#) for examples

Step 3: Identify Barriers to and Benefits of Implementation for Each Opportunity

After analyzing the equipment and practices and identifying feasible opportunities for realizing savings, you will want to make as strong a business case as possible for making changes. Be proactive and identify key barriers to and benefits of implementing the opportunities you want to recommend. To help you do this, the P3 program offers the following information.

Based on experiences over the past 15 years, the P3 program has found that simple projects with thorough documentation and short pay back periods or projects with compelling cost and environmental savings have a high likelihood of being implemented. For example, suggestions for replacing existing spray nozzles with newer more effective and efficient ones are often implemented. Companies are typically receptive to opportunities which reduce utility costs, especially if it doesn't inconvenience employees or interrupt work flow. Steps to reduce environmental impact often simultaneously have a positive impact on the satisfaction with the working environment.

On the other hand, suggestions which are high cost, with long payback periods, or which have complex implementation logistics, or are not adequately researched or quantified are typically not implemented. For example, a suggestion for replacing or retrofitting a vehicle washing station to reclaim rinse water for future washes may not be favorably considered, at least in the short run. Interestingly, some low cost, quick payback suggestions which involve changing employee behavior may not be implemented due to the common human tendency of resistance to change. For example, implementing a "report leaks" campaign may not be a strategic priority.

See [Appendix 2](#) for examples of implemented P2 water conservation suggestions from the Nebraska intern program. These are annotated to make it clear what information is needed to perform these calculations for a different location and to explain why some suggestions were implemented and others were not.

Common Barriers: Beliefs & Attitudes

- resistance to change—employees enjoy familiarity/convenience of full flow equipment for cleaning
- skepticism—employees skeptical about time/inconvenience of operating reduced flow equipment
- other/higher strategic priorities—the company may have other issues it sees as more important to address in the short run
- misinformation or lack of understanding about the costs of water and energy for hot water:
 - that small fixes can yield measurable results, e.g. the amount of water that is lost by even a small drip
 - how using unnecessary water/energy can affect the physical and political environment
 - lack of technical understanding that certain tasks require less water

Costs and Investments

- cost (time, effort and money) of implementing suggestions
 - capital investment-“up-front costs”
 - operating constraints: interrupting operations to implement changes
 - time/costs of retrofitting equipment
- timeline for return on investment (ROI)—length of payback period
- perception of cheap and available water
- overall low cost of water relative to entire bottom line
 - the cost of disposal via the sanitary sewer usually doubles the cost of water

Technical Issues: What to Do and How

- lack of knowledge/skills re: what needs to be done/how to implement strategies
 - access to equipment for analyzing/adapting equipment
 - access to plumber for modifications
 - concern re: managing logistics and process changes, including down time
-

Common Direct and Indirect Benefits:

Cost Savings

- reduces costs and improves efficiency of operations by using less water to accomplish same tasks
- reduces costs and improves efficiency of operations by using less energy to heat water to accomplish tasks
- potential opportunity for grant \$\$/utility incentives to pay for projects

Environmental Impact

- reduces impact of water use on the environment:
 - reduces use of natural resources/raw materials to produce water/energy
 - reduces greenhouse gas emissions related to water/energy production
 - conserves/preserves/provides clean environment/quality of life for future generations

Education

- educates employees and general public in efficiency and responsibility when information is posted about the change and why it was made

Company Image

- demonstrates social responsibility and best management practices
- positions company in good stead in community concerned about scarce water resources

Step 4: Make the Business Case for Change

4.1. Develop a written report for submission to decision makers.

- include a thorough assessment of the system, with process descriptions, flow charts and use/cost information.
- outline specific P2 Opportunities/Suggestions with the following information:
 - recommended action
 - brief summary of current operations
 - cost of implementing recommendation
 - include labor costs/savings in your economic analyses.
 - summary of benefits (acknowledge barriers but discuss how benefits outweigh):
 - potential cost savings (\$)
 - water/electricity use reduction(s)
 - simple payback
 - indirect benefits: safety, risk/liability reduction, GHG reductions, etc.
- always identify how to monitor/measure impact for future analysis: e.g. install water meter, monitor employee satisfaction
- incentives to change: conclude the report with a summary of the benefits to be realized from implementing the recommendations made. Stress environmental stewardship. Call for action!
 - you may want to reference previous successes in similar businesses as a selling point
 - see [Appendix 2](#) for example projects implemented and their results

4.2. Make an oral presentation to summarize your findings and call to action:

- focus on pertinent details of system assessment and P2 opportunities
- make it interesting yet include sufficient technical detail to be convincing and make the business case for change— include a picture of the product/change in action
- develop a final “impact” slide with table of metrics—call for action/change
- allow time for question/answer period

4.3. Advocate for change based on metrics/facts and environmental ethic:

- use informal interactions to establish trust in your abilities and to build a foundation for change
- use written report and formal presentation to communicate your findings and provide the formal information/rationale for implementing recommendations
- emphasize sustainability (triple bottom line) and preserving resources for future generations
 - water/energy conservation and the relationship to greenhouse gas emissions is particularly important for hot water applications
- use examples of implemented suggestions from past projects (see [Appendix 2](#))

4.4. Report potential Greenhouse Gas (GHG) emission reductions as an important indirect benefit:

- include in written report and oral presentation
- include explanation of why GHG emissions are relevant/of concern to all businesses
- calculate potential carbon dioxide equivalent (CO₂e) emission reductions for each recommendation
- include an appendix in written report documenting calculations (see [Appendix 3](#) for details and example calculations for domestic/commercial indoor water use)
- see [Appendix 4](#) for additional tips for making the business case for change.

Appendix 1

Example Assessments of Janitorial Water Use

Note: Several examples of janitorial water use assessments are included below. Each of these addresses one or more of the steps needed to accomplish a thorough assessment. In these examples, we have attempted to clarify for the reader what information is known or reported, what is logically assumed, and what has been calculated. This is embodied within the narrative for easy reference. In an actual report, these details would likely be in attached appendices so as not to interrupt the flow of the report.

Example #1: Assessment of Water Waste Due to Drips and Leaks (adapted from report by Andrew Anderson, 2009--also included in Guideline #6)

Leaky faucets and showerheads can contribute to substantial water loss over extended periods of time if left unrepaired. Four fixtures were observed to have continuous drip leaks while assessing the facility. Using an online calculator that translates drips per minute into annual water usage, an estimated 15,768 gallons could be lost annually from these four observed fixtures (see calculations below). This doesn't include the fixtures not observed to be dripping or future drips, which would waste even more water.

Not included in this analysis was a hard-to-measure continuous leak from the wall observed at the base of a showerhead in one of the upper story dressing rooms, which contributes even more wasted water to the sewer. This leaky water not only costs money (both for using municipal water and the sewer charges), but affects the image of the facilities by employees, venue artists, and event goers.

Calculations for Dripping Fixtures

Using the drip calculator from the American Water Works Association website:
www.awwa.org/awwa/waterwiser/dripcalc.cfm

<p>Fixture 1: $\frac{14 \text{drips}}{10 \text{sec}} \times \frac{60 \text{sec}}{1 \text{min}} = 84 \frac{\text{drips}}{\text{min}}$</p>	<p>Fixture 3: $\frac{11 \text{drips}}{10 \text{sec}} \times \frac{60 \text{sec}}{1 \text{min}} = 66 \frac{\text{drips}}{\text{min}}$</p>
<p>Fixture 2: $\frac{15 \text{drips}}{10 \text{sec}} \times \frac{60 \text{sec}}{1 \text{min}} = 90 \frac{\text{drips}}{\text{min}}$</p>	<p>Fixture 4: $\frac{5 \text{drips}}{5 \text{sec}} \times \frac{60 \text{sec}}{1 \text{min}} = 60 \frac{\text{drips}}{\text{min}}$</p>

TOTAL = 300 drips/minute

Yearly waste for 300 drips/min = 15,768 gallons/year

$$15,768 \text{ gal} \times \frac{1 \text{unit}}{748 \text{gal}} = \frac{21.1 \text{units}}{\text{year}}$$

$$21.1 \text{units} \times \frac{\$1.65 + \$1.62}{\text{unit}} = \sim \$70 \text{ per year}$$

After evaluation of the water and sewer bills it was determined that a unit of water used costs \$1.65, while a unit of water sent to the sewer costs \$1.62. The public water utility uses a unit of water which is 748 gallons for calculation purposes. The calculation indicated the cost of the drips is approximately \$70/year.

Example #2: Total Facility Water Material Balance to Determine Total Janitorial Water Use
(adapted from report by Lindsay Grim, 2009)

A material balance/water flow analysis was conducted for a food processing plant. Most of the water used is for the cleaning process, as shown in Figure 1 below. The following information and assumptions were used to create the diagram. Information obtained from company personnel/observed:

- Approximately 18,824,000 gallons of water used annually in the plant's two facilities
- 16 hoses used 4 to 6 hours/day during the night shift cleaning process
 - equipped with nozzles that have a flow rate of 7 gallons per minute (gpm)
- 1 hose in Facility #2 washroom used 12-14 hours/day
 - Used 8 hours during the day shift and 4-6 hours during night shift for cleaning
 - equipped with a nozzle that has a flow rate of 15 gpm (based on bucket test)
- 2 hoses in Facility #1 washrooms used 7-8 hour/day each
 - Used 2 hour each during the day shift and 5-6 hours each during the night shift for cleaning
 - equipped with nozzles that have a flow rate of 15 gpm (based on bucket test)
- 5 hoses in knife cleaning room used 15 minutes/day for cleaning
 - equipped with nozzles that have a flow rate of 7 gpm

Assumptions:

- About 70% of total water use is for cleaning process
- 20% of total water use is in the cooling process (including evaporation)
- About 10% of total water use is for domestic and landscaping purposes
- 22 production days/month
- The cost of 1 gallon of water is approximately \$0.00125; the cost of disposal of 1 gallon of water is approximately \$0.00118; therefore the total cost for 1 gallon water (water + sewer costs) used is \$.00243, based on data supplied by company.

Calculations:

- $16 \text{ hoses} \times 4 \text{ hrs/day} (300 \text{ min/day}) \times 7 \text{ gpm} = 26,880 \text{ gal/day}$ for night shift
- $1 \text{ hose} \times 8 \text{ hrs/day} (480 \text{ min/day}) \times 15 \text{ gpm} = 7,200 \text{ gal/day}$ for day shift
- $1 \text{ hose} \times 4 \text{ hrs/day} (300 \text{ min/day}) \times 15 \text{ gpm} = 3,600 \text{ gal/day}$ for night shift
- $2 \text{ hoses} \times 2 \text{ hr/day} (120 \text{ min/day}) \times 15 \text{ gpm} = 3,600 \text{ gal/day}$ for day shift
- $2 \text{ hoses} \times 5 \text{ hrs/day} (360 \text{ min/day}) \times 15 \text{ gpm} = 9,000 \text{ gal/day}$ for night shift
- $5 \text{ hoses} \times 15 \text{ min/day} \times 7 \text{ gpm} = 525 \text{ gal/day}$ for day shift
- $\text{Total} = 50,800 \text{ gal/day} \times 22 \text{ days} \times 12 \text{ months} = 13,400,000 \text{ gal/yr}$

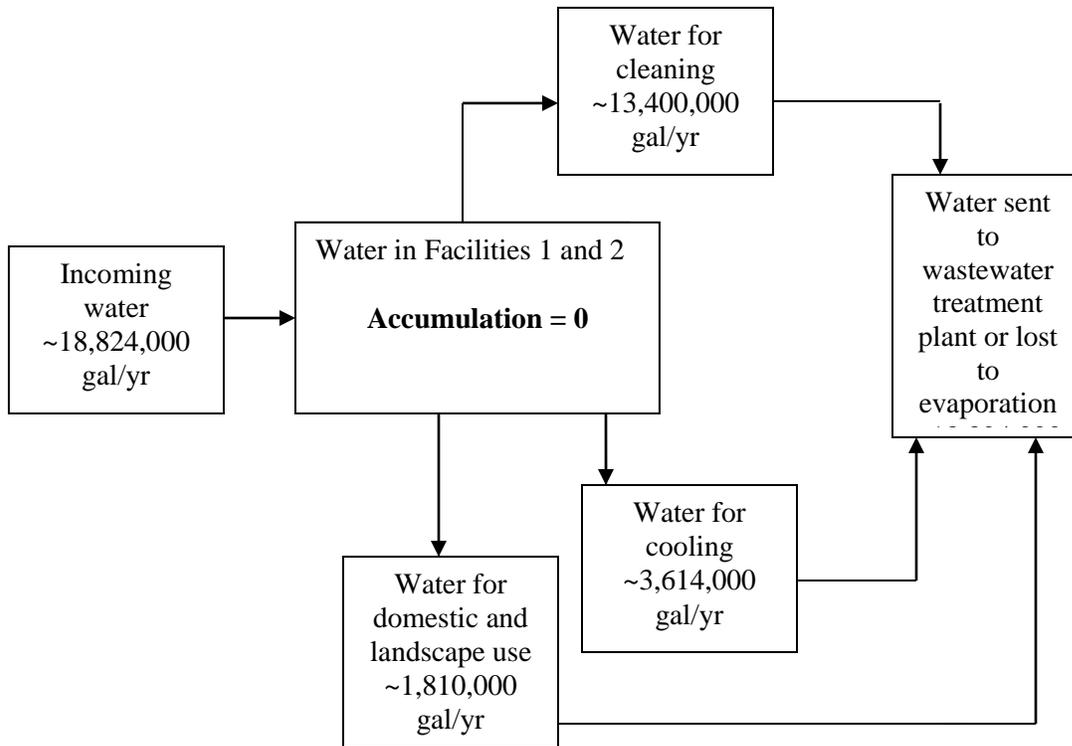


Figure 1. Water Usage at Plant's Facilities

The material balance/ water flow analysis has shown that approximately 70% of total water use is for cleaning process or approximately **13,400,000 gallons/year**. Based on the cost of water and sewerage at the facility this used costs **\$32,560/year**.

Example #3: Assessment of Water and Energy Use for Cold and Hot Water Use (adapted from report by Lindsay Grim, 2009)

Vehicles in the company fleet are washed routinely with heated water and kept clean to foster a positive public image for the company. The following information was gathered from maintenance staff, utility invoices, and through observation in order to determine the environmental impacts of the vehicle washing process as shown in the calculations below:

Calculations for Water/Energy Use

Known Values:

- wash water heated to 200°F by natural gas
- boiler runs at 85.7 boiler horsepower (Bhp)
- Conversion from BHp to BTU/hr is 1 BHp to 33,475 BTU/hr--wash spray valve flow rate: 17 gallons per minutes (gpm)
- 345 working days per year
- natural gas cost- average of \$0.895/therm
- cost of water is \$0.00129/gallon

Assumptions:

- 6-7 vehicles washed/day
- 20 minute wash/vehicle

Calculations:

$$\text{Annual Water Use: } 7 \frac{\text{vehicles}}{\text{day}} \times 20 \frac{\text{minutes}}{\text{vehicle}} \times 345 \frac{\text{days}}{\text{year}} \times \frac{17}{\text{gpm}} = 821,100 \frac{\text{gal}}{\text{yr}}$$

$$\text{Annual Cold Water Cost: } 821,100 \frac{\text{gal}}{\text{yr}} \times \$0.00129 = \$1,060 \text{ year}$$

$$\text{Annual Hot Water Energy Use: } 85.7 \text{ bhp} \times \frac{33,475 \frac{\text{Btu}}{\text{hr}}}{\text{bhp}} = 2,868,807 \frac{\text{Btu}}{\text{hr}} \times 805 \frac{\text{hrs}}{\text{yr}} \times 1 \frac{\text{therm}}{100,000 \text{ Btu}} = 23,000 \frac{\text{therms}}{\text{yr}}$$

$$\text{Annual Hot Water Cost: } 23,000 \frac{\text{therms}}{\text{yr}} \times \frac{\$0.895}{\text{therm}} = \$20,580 \text{ year}$$

To wash vehicles with hot water on a routine basis costs the company **\$20,580/year in natural gas** in addition to the **\$1,060 cost of the water**.

Appendix 2

Example P2 Opportunities for Reducing Janitorial Water Use

Note: Several examples of opportunities for reducing janitorial water use are included below (see separate Guideline # 006 for Domestic Water Use). Each of the examples below addresses a different way to improve practices and achieve direct and/or indirect savings and each uses different techniques for encouraging implementation. In these examples, calculations are embodied within the narrative for easy reference, although in an actual report, these would likely be in appendices at the end so as not to interrupt the flow of the report.

Example #1: Detect and repair leaks (adapted from report by Michael McKinney, 2009—also included in Guideline #6: Domestic Water Use)

It was observed that water continuously leaked from the nozzle connected to the flex hose for washing.. The hose appeared to be mounted to the wall properly, but was leaking from within the nozzle at a rate of 250 drops per minute. Using the water waste calculator available online at www.awwa.org/awwa/waterwiser/dripcalc.cfm , it is estimated that the dripping nozzle wastes approximately 13,000 gal/year water.

Assuming that the cost of a unit (750 gallons) of water in Lincoln, NE is \$3.84, the cost for 13,000 gallons water/year is approximately \$70:

$$\frac{13,000 \text{ gal}}{\text{yr}} \times \frac{\$3.84}{750 \text{ gal}} = \frac{\$66.56}{\text{yr}}$$

A replacement nozzle costs approximately \$26. The payback period for replacing the nozzle is 4.5 months ($\$26/\$70 \times 12 \text{ months} = 4.5 \text{ months}$).

Implementation Status: Not yet reassessed to determine impact

Example #2: Conduct employee training (adapted from report by Lindsay Grim, 2009)

Create an employee training program on responsible water use and efficient cleaning.

- Inform employees that it is not necessary to wash equipment that has not been used during the day
- Train employees on accurate hosing of equipment and how to check for water leaks in pipes and hoses
- Encourage employees to use the minimal amount of water necessary to properly clean equipment
- Explain that conserving water is important to assure a continuing abundance of water to use for ourselves and for future generations
- Explain the importance of water conservation, highlighting these potential savings (calculations are shown below):
 - Annual water savings: 3,388,000 gallons
 - Annual cost savings: \$8,200
 - Based on goal to reduce water usage in the cleaning process by 30%

The payback period would be immediate, as costs for training are negligible. After training, monitor the water usage compared to the baseline (pre-training) level and reward employees for conserving water and efficient cleaning.

Calculations for Reducing Water Use

Known Values:

--Annual water used for cleaning: 11,294,390 gallons/year (as explained in the report's waste assessment section – not included in this guideline)

--Total water cost \$0.00243 per gallon based on bills reviewed

Assume reduce water use 30% as a result of employee training/monitoring:

--.30 X 11,294,390 = 3,388,317 gallons/year saved

--3,388 X \$0.00243/gal = \$8,233/year saved

Implementation Status: **Not yet reassessed to determine impact.**

Example #3: [Install high performance/low-flow spray valves](#) (adapted from report by Lindsay Grim, 2009)

Across the country, water and sewer rates are rising. It is important that the plant reduce its water consumption in order to contain costs and to demonstrate a corporate commitment to water conservation and sustainability.

Currently, eight hoses are used for varying amounts of time during the day-shift for cleaning small equipment. These hoses use high-flow nozzles that spray large volumes of water at low pressure, which is an inefficient use of water for cleaning small equipment. According to calculations using current flow rates, 2,989,800 gallons/water/year are consumed. At a cost of \$.00243/gallon, that results in almost \$7300/year. The installation of low-flow spray valves will decrease the amount of water used each day and the cost of buying and disposing of water. A high performance, low-flow spray valve's cleaning performance may be as good as or better than the high-flow units. This means that productivity may be improved as well.

Spray valves were researched and the following alternatives were found (see detailed product information below):

- Fisher Manufacturing pre-rinse spray valve
 - Flow rate of 1.15 gpm at 60 psi
 - Test proven to clean fast with less splash back and mist
 - Even and consistent spray pattern cleans a larger surface area
 - Comfortable grip
 - Cost: \$45.95/ea
- T&S Brass B-0108
 - Flow rate of 1.48 gpm at 60 psi
 - Chrome plated brass spray valve with a stainless steel trigger
 - Innovative **ergonomic** design to reduce hand fatigue
 - Cost: \$88.90/ea

Table 2 below shows the water and cost savings, and payback periods for the spray valve alternatives. Calculations are shown below.

Table 2. Spray Valve Alternatives

Spray valve	Current high flow	Fisher Mfing low flow	T&S Brass B-0108 low flow
Water: gal/year	2,989,800	241,300	310,400
gal/yr savings		2,748,500	2,679,400
Cost \$/year	7,300	600	800
\$/yr savings		\$6,700	\$6,500
Payback period		20 days	40 days

Calculations for Water Reduction

Current Water Use Calculations:

- 1 hose X 8 hrs/day (480 min/day) X 15 gpm = 7,200 gal/day for day shift
- 2 hoses X 2 hr/day (120 min/day) X 15 gpm = 3,600 gal/day for day shift
- 5 hoses X 15 min/day X 7 gpm = 525 gal/day for day shift
- Total: 7,200 + 3,600 + 525 = 11,325 gal/day X 22 days/mo X 12 mo/yr = 2,989,800 gal/yr
- Cost: 2,989,800 X \$0.00243/gal = \$7,265/year

Alternative #1: Fisher Valves Water Use/Cost:

- 1 hose X 8 hrs/day (480 min/day) X 1.15 gpm = 552 gal/day for day shift
- 2 hoses X 2 hr/day (120 min/day) X 1.15 gpm = 276 gal/day for day shift
- 5 hoses X 15 min/day X 1.15 gpm = 86 gal/day for day shift
- Total: 552 + 276 + 86 = 914 gal/day X 22 days/mo X 12 mo/yr = 241,296 gal/yr X 0.00243/gal = \$586/yr

Savings:

- Water: 2,989,800 – 241,296 = 2,748,504 gal/year
- Cost: \$7,265 - \$586 = \$6,679/year

Alternative #2: T&S Brass Valves Water Use/Cost:

- 1 hose X 8 hrs/day (480 min/day) X 1.48 gpm = 710 gal/day for day shift
- 2 hoses X 2 hr/day (120 min/day) X 1.48 gpm = 355 gal/day for day shift
- 5 hoses X 15 min/day X 1.48 gpm = 111 gal/day for day shift
- Total: 710 + 355 + 111 = 1176 gal/day X 22 days/mo X 12 mo/yr = 310,464 gal/yr X 0.00243 = \$754/yr

Savings:

- Water: 2,989,800 – 310,464 = 2,679,336 gal/year
- Cost: \$7,265 - \$754 = \$6511/year

Payback Period Calculations:

--initial costs: 8 spray valves (Fisher) @ \$45.95/ea = \$368
 (T&S Brass) @ 88.90/ea = \$711

$$\frac{\text{initial cost}}{\text{present operating cost} - \text{proposed operating cost}} = \frac{368}{6679} = .055 \text{ yrs} = 20 \text{ days Fisher}$$

$$\frac{\text{initial cost}}{\text{present operating cost} - \text{proposed operating cost}} = \frac{711}{6511} = .11 \text{ yrs} = 40 \text{ days T\&S Brass}$$

Implementation Status: Not yet reassessed to determine impact.

Area #4: Floor Cleaning

Example #4a: Use water brooms for floor cleaning (adapted from report by Ben Stewart, 2008)

Floors in the plant are currently hosed down to clean and collect debris. This practice is an inefficient use of water and time, requires unsafe bending motions on the part of employees, and results in occasional clogs in floor drains that require maintenance to resolve. Using a water broom is more efficient and effective for cleaning and allows for a more easily controlled stream of water, reducing overall water use and resulting in less strain on employees, thereby providing a health and safety benefit for employees and the company.

To determine the potential savings of incorporating water brooms into the nightly cleaning process, it was estimated that there would be about a 20% reduction in water-cleaning time, eliminating over three hours of water cleaning time/week. Because the cleaning crew will remain working until the end of their shift, the reduction in cleaning time will not ultimately result in labor cost savings. Rather, this will result in reduced stress, improved safety and improved cleanliness and provide additional time for other maintenance tasks. Since a smaller volume of water is used, additional savings will result from the reduction in gas needed to heat the water from 55°F to 140°F for cleaning. Table 1 summarizes the potential water and gas cost savings from using water brooms. Detailed calculations are shown below in Table 2.

Table 1. Savings from Water Broom Use

Annual Water Use Reduction (gal)	Annual Water Cost Savings	Annual Gas Use Reduction (therms)	Annual Gas Cost Savings
56,000	\$100	400	\$350

Supporting Calculations:

Water Reduction Calculations:

The water broom is estimated to reduce water use in the cleaning process by 56,160 gallons per year. A breakdown of the assumptions, estimates and calculations can be found in the table in Table 2 below.

Gas Use Reduction Calculations:

Water Use (m³) * Mass of Water Per Unit Volume (lbs/m³) * Change in Temperature (Fahrenheit) * Heat Capacity (1) = Gas Use (btu) * 0.0001 (therms/btu) = Gas Use (Therms)

$$56,160 \text{ gal.} * (1 \text{ m}^3/264.172 \text{ gal}) * 2,200.55 \text{ lb/m}^3 * (140-55 \text{ F}) * 1 = 3.98 \times 10^7 \text{ btu} = 398 \text{ therms}$$

Table 2. Water Use and Cost for Cleaning with Water Broom

High Pressure hose = 5 gpm
 Cost of water = \$.001734/gallon

Area	Cleaning Frequency	Time Spent on Floor (min)	Water Used (gallons per week)	20% (est) Reduction in Water Use (gallons per week)	Reduction in Water Costs
<i>Line 1</i>	Daily	30	750	150	\$0.26
<i>Line 2</i>	Daily	30	750	150	\$0.26
<i>Line 3</i>	Daily	30	750	150	\$0.26
<i>Line 4</i>	Daily	30	750	150	\$0.26
<i>Line 5</i>	Daily	30	750	150	\$0.26
<i>East Loading Dock</i>	Daily	30	750	150	\$0.26
<i>South Loading Dock</i>	Daily	30	750	150	\$0.26
<i>West Loading Dock</i>	Weekly	30	150	30	\$0.05
TOTAL (nightly avg)			1,080	216	\$0.38
TOTAL (weekly)		1080	5,400	1,080	\$1.89
TOTAL (annual)		56,160	280,800	56,160	\$98.05

Implementation Status: [Not yet reassessed to determine impact.](#)

Example #4b: [Use microfiber mopping](#) (adapted from report by Tanner Augustin, 2005)

A hospital requested assistance from the P3 program to analyze its wastewater discharge and to identify areas, processes or wastes that could be reduced, eliminated or better managed. While the hospital had already undertaken initiatives to reduce and manage other waste in environmentally ethical ways (e.g., eliminated mercury, recycled batteries and electronics, used green-tip light bulbs, reverse distributed pharmaceuticals), additional opportunities were identified. Hospital employees provided information on the types and volumes of wastes discharged to the sanitary sewer.

One of those opportunities to reduce water use involved implementing the 3M Easy Scrub mopping system that uses microfiber as opposed to the standard string mop to reduce the amount of chemicals and water needed for mopping floors. The microfiber is blended from polyester and nylon and split into a fiber that is a fraction of the diameter of a hair. The microscopic size of the fibers permits these mops to clean better since they can reach into the tiny pockets of flooring surfaces and “grab” the dirt. The spaces around the microfibers provide more surface areas for trapping dirt and bacteria. The conventional string mops tend to “push” the dirt around as opposed to picking it up.

A clean mop pad is used in every room so the potential risk of cross contamination from the mop is virtually eliminated. The microfiber mop applies less chemical to the floor so the floor dries faster, reducing the potential hazard to employees, patients, and visitors of slip, trip, and fall incidents. The

microfiber mop weighs only two pounds when wet, compared to eight pounds for the standard string mop, reducing the potential for employee injury to wrists and backs from use. Using a microfiber mop saves an average of six minutes of labor per room and makes it easier to reach easily under beds and tables. The annual savings of the 3M System is approximately \$4,870, based on reduced mop and chemical costs as shown in the calculations below. The savings is predominately in chemical costs but the amount of water conserved annually is over 23,000 gallons/year. The cost to implement the system is approximately \$4,200, with a payback period of 0.9 years.

Calculations for Microfiber vs. Traditional Mopping

	Standard mop	Microfiber mop	Savings
Mop Heads			
# mop heads used daily	34	102	
Cost per mop head	\$10.70	\$7.40	
Cost per day for mops	\$363.80	\$754.80	
Avg # laundering before replacement	70	350	
# time mops replaced per year	5.21	1.04	
Total Mops Cost/Yr	\$1897	\$787	\$1110
Water/Chemical Use			
# times water changed/day	34	34	
# gallons water used/time	2	0.117	
Daily usage (gallons)	68	3.978	
Total Water Used Gal/Yr	24,820	1452	23,368
Total Cost of water/yr(\$0.005/gallon)	\$124.10	\$7.26	\$117
# gallons chemical used/yr	194	11	
cost per gallon	\$19.95	\$19.95	
Total Chemical Cost/Yr	\$3868	\$226	\$3642
Total Annual Cost Savings			\$4870

Area #5: Vehicle Washing

Example #5a: Install water reclaim/recycle system for washing vehicles (adapted from report by Brent Hanson, 2009)

The company's current wash bay plans do not include a water recycle system but planning has begun to construct new vehicle washing facilities. With the construction phase not started yet, this recommendation could easily be incorporated into the design. Current plans have the company using fresh water for both the soap application and the rinse of the vehicle. Instead, the company could capture the rinse water following the final rinse step of the washing process and use this for the application of soap on the next vehicle. This would reduce the amount of water used and wastewater produced. Savings from this process are detailed in Table 3 below. Estimates are based on the assumption that the company will use only 50% of the amount of water/year as it currently does once a reclaim/recycle system is installed. Detailed calculations are shown below.

Table 3. Economic Analysis of Water Reuse System

	Yearly Water Costs (\$)	Yearly Wastewater Costs (\$)	Total Yearly Costs (\$)	Water Savings (gallons)	Yearly Savings (\$)	Capital Cost (\$)	Payback Period (years)
Current Design	1,180	1,260	2,440	-	-	-	-
Water Reuse Method	590	630	1,220	273,750	1,220	750	0.61

Calculations for Capture of Rinse Water for Reuse

Current Annual Costs:

Water Costs

Fresh water use is 547,500 gallons/year at a cost of ~\$1,180/year

Wastewater produced is 547,500 gallons at a cost of ~\$1,260/year

Total water cost = ~\$2,440/year

Water Reuse System Costs:

Assumption: Reuse System will reduce use by 50%

Water Costs

Fresh water use = 750 gallons/day*365 days = 273,750 gallons

Cost per 1000 gallons = \$2.16

Total cost of fresh water = 274 * \$2.16 = ~\$590

Wastewater produced = 750 gallons/day*365 days = 273,750 gallons

Cost per 1000 gallons = \$2.30

Total cost of wastewater = 274* \$2.30 = ~\$630

Total water cost = \$1,220

Capital Costs = ~\$750 for equipment*

¾ hp Centrifugal Pump = \$265

275 gallon reservoir tank = \$408

1.25 in PVC pipe = \$7.87/10 ft

1 in PVC pipe = \$5.80/10 ft

*Estimate does not include change to design plans

Payback: start up cost divided by annual savings = \$750/1220 = .61 years = 7 months

Implementation Status: Not yet reassessed to determine impact.

Example #5b: Use high performance, low-flow washer gun (Appendix 2, Example #3 above shows the details for calculation and presentation of this suggestion.)

Example #5c: Use cold water for washing vehicles (adapted from report by Lindsay Grim, 2009)

Currently, vehicle washing water is heated to 200°F by natural gas. Because vehicle washing does not require hot water, company should consider not using hot water for vehicle washing. This would save a significant amount of energy and money each year as shown below in Table 5.

Table 5. Savings from Eliminating Water Heat in Vehicle Washing

	Hours of Washing/ year	Energy Use/ year	Energy Savings/ year	Cost/ year	Cost Savings/ year	Payback Period
Heating of water	805	23,000 therm	-	\$20,600		
No heating of water	805	0 therm	23,000 therm	\$0	\$20,600	Instantaneous

- (Note to Reader: Calculations of these values are shown in Appendix 1, Example 3 of this Guideline.)

Implementing this opportunity would generate other benefits as well. Employee safety would improve due to the reduction in temperature of the water. According to the EPA Greenhouse Gas Equivalencies Calculator, saving 23,000 therm of natural gas is equivalent to saving **122 metric tons of CO2e** from being emitted. See Appendix 3 for details.

Implementation Status: Not yet reassessed to determine impact.

Appendix 3

Greenhouse Gas Reductions Explanation and Calculations

Relevance of Greenhouse Gas Emission Estimates

This issue is an increasingly important one for business decision makers as it relates to regulations, stakeholder interests and day-to-day business operations and energy use. There are several important dimensions of analysis for any pollution prevention opportunity. One is certainly direct environmental impact (e.g. reductions in solid or hazardous waste, water use, air pollution, or energy use). Another important dimension is cost. Yet another is the intangible (not quantifiable) impact, such as reduced liability, increased worker safety/satisfaction, or improved corporate image. A final important dimension is indirectly estimating the impact on greenhouse gas (GHG) emissions that can be achieved by implementing any given pollution prevention opportunity.

GHGs include a number of different gases such as carbon dioxide, methane, nitrous oxide, ozone, chlorofluorocarbons and water vapor. These gases contribute to the “greenhouse effect” in the Earth’s atmosphere. While GHGs make the planet warm enough to be habitable, an excessive amount of these gases is believed to be building up in the atmosphere and causing the average global temperature to rise, leading to climate change and instability. A significant spike in GHG concentrations in the atmosphere has occurred since the industrial revolution, pointing to the man-made nature of this change. This is why a new emphasis, and discussion of possible regulations, has been placed on reducing GHG emissions in all parts of our society, including government, business and industry.

The most widely recognized unit for measuring GHG emissions is carbon dioxide equivalent (CO₂e). Each of the GHGs has a different capacity to heat the earth’s atmosphere, called its global warming potential (GWP). Carbon dioxide (CO₂) has a GWP of 1, so in order to standardize reporting, when GHG emissions are calculated, they are reported as equivalent to a given volume of CO₂.

Array of Calculation Tools

Reductions in GHG emissions can be estimated using a variety of calculation tools and computer models. The direct environmental/cost benefits estimated or realized are used as quantified input for these calculations, therefore the resulting GHG emission reduction estimates are considered indirect benefits. Some commonly used tools are listed below:

- Nationally recognized conversion factors from the U.S. Department of Energy and the American Water Works Association: these are used to estimate GHG emissions for electricity, natural gas, and water use. For example, kilowatt-hours (kWh) of electricity used can be converted to GHG emissions using a factor of 1.404 pounds CO₂ e per kWh.

- EPA’s WASTE Reduction Model (WARM): this tool is used to determine GHG emissions related to solid waste. This online calculator uses a life-cycle approach to determine the change in GHG emissions caused by alternative end-of-life waste management decisions or disposal methods for a number of different kinds of wastes. For example, using the weight of a solid waste diverted from a landfill and recycled, an approximate reduction in GHG can be calculated. WARM is periodically updated and new material types are added by the EPA as new information from climate change research becomes available.

- Economic Input Output Life Cycle Assessment (EIO-LCA): this model used to estimate GHG reductions has been developed by researchers at Carnegie Mellon University. This model provides a useful approximation of GHG reductions through the full life-cycle production of a material or

chemical, based on the cost savings from reductions in use. For example, if a business reduces its lubricating oil purchases by \$50,000, the EIO-LCA estimates the GHG emissions to produce that oil through the mining, extracting, refining, packaging and delivery (to list a few) steps in the process of getting that oil to the end user.

--Recycled Content (ReCon) Tool: EPA created the ReCon Tool to help companies and individuals estimate life-cycle greenhouse gas (GHG) emissions and energy impacts from purchasing and/or manufacturing materials with varying degrees of post-consumer recycled content.

--Pollution Prevention (P2) Greenhouse Gas (GHG) Calculator: designed by U.S. EPA in conjunction with a panel of professionals from the P2 community with state and local governments, business facilities, grantees, and project managers in mind. The tool was reviewed in national webinars and conferences reaching over 600 participants and reworked to be more robust and user friendly. The tool is available in an Excel format and finalized as of **November 2011**. U.S. EPA will periodically update the tool as new information and data sources become available. It is designed to help calculate GHG emissions reductions in metric tons of carbon dioxide equivalent (MTCO_{2e}) from electricity conservation, green energy, fuel and chemical substitutions, water conservation, and improved materials and process management in the chemical manufacturing sector.

Selecting the Most Appropriate Tool(s):

When using one of these models to estimate GHG emission reductions for a client, always provide an explanation of which model was used, why it is most relevant for the issue at hand, what assumptions were applied, and the importance of reducing GHG emissions as a business and global sustainability strategy.

A summary sentence stating the amount of GHG reduction should be included with each recommendation, e.g. "Using cold water for vehicle washing will approximately 23,000 therms of energy (natural gas) and reduce GHG emissions by approximately 122 MTCO_{2e}/year. A detailed appendix should be developed which shows how the GHG emission reductions were calculated. An example of an appendix documenting such follows.

Example Appendix of Greenhouse Gas Calculations

Opportunity #1 – Use cold water for washing vehicles

GHG calculated using EPA's P2 GHG Calculator

Savings:

--23,000 therms reduction in natural gas usage per year

Assumptions:

--GHG conversion based on Nebraska conversion factor

--11.728 lb CO_{2e} (Metric Ton of Carbon Dioxide Equivalent) per therm based on the EPA GHG Calculator

--1 MTCO_{2e} is equal to 2204.6 lb

Calculations:

$$\text{Gas: } 23,000 \text{ therms} * 11.728 \frac{\text{lb CO}_2\text{e}}{\text{therm}} * 1 \frac{\text{MTCO}_2\text{E}}{2204.6 \text{ lb}} = 122.355 \text{ MTCO}_2\text{E}$$

Sources:

--The Climate Registry, "General Reporting Protocol" 2008.

(<http://www.theclimateregistry.org/downloads/GRP.pdf>)

--IPCC Second Assessment Report, 1995, Chapter 2, Table 2.14, Page 212. (<http://www.ipcc.ch/ipccreports/ar4-wg1.htm>)

Opportunity #2 – Use high performance, low-flow spray valves for cleaning

GHG calculated using EPA's P2 GHG Calculator

Savings:

--2,748,500 gallons water per year = 8.160 MTCO₂e

Assumptions:

--GHG conversion based on regional conversion factor

Calculations:

MTCO₂e = Water Conserved (gal.) * (3,300 kwh / 1,000,000 gal. water used)* [either National or Regional emissions factor]

Regional Conversion factor: (0.000498 to 0.00090 MTCO₂e/kwh)

Sources:

(a) Source 10: Water and Sustainability: U.S. Electricity Consumption for Water Supply & Treatment—The Next Half Century, EPRI, Palo Alto, CA: 2000. 1006787.

(b) Source 1: U.S. EPA, Clean Energy. "eGRID 2010 Version 1.1." May 2011.

(c) Source 2: US EPA, Downloadable Document: "Unit Conversions, Emissions Factors, and Other Reference Data, 2004." Table I, Page 1.

Appendix 4

Tips for Making the Business Case for Change

Tip # 1: Writing an Executive Summary

An executive summary is a brief overview of a report designed to give readers a quick preview of its contents. Its purpose is to consolidate the principal points of a document in one place. After reading the summary, your audience should understand the main points you are making and your evidence for those points without having to read every part of your report in full. It is called an executive summary because the audience is usually someone who makes funding, personnel, or policy decisions and needs information quickly and efficiently in order to make decisions and respond appropriately.

Guidelines:

An executive summary should communicate independently of the report. It should stand on its own as a complete document.

It should explain why you wrote the report, emphasize your conclusions or recommendations, and include only the essential or most significant information to support those conclusions.

Use subtitles, bullets, tables, selective bolding or other types of organizational structure to add clarity to your summary

It should be concise—about 10% of the length of the full report.

It should be organized according to the sequence of information presented in the full report. Don't introduce any new information that is not in your report.

To help with organizing the executive summary, after you have written the full report, find key words; words that enumerate (first, next, finally); words that express causation (therefore, consequently); words that signal essentials (basically, central, leading, principal, major); and contrast (however, similarly, less likely).

Read the completed summary with fresh eyes. Check spelling, grammar, punctuation, details, and content. Ask someone else to read it.

Tip #2: Technical Writing Tips:

Use these tips as a **checklist** as you prepare your report.

- **Proof reading.** Write your report, let it sit, then proof read it for grammar, jargon, clarity, multiple meanings, and technical correctness before submittal. Re-read the report from the recipient's point of view. Reading the report aloud may help.
- **Figures and tables.** Refer to each figure and table in the text prior to inserting it. Always place the figure or table in the report soon after you have referred to it. Include a title and number for all figures and tables, capitalizing the title when referring to a specific table or figure, e.g., "All of the wastes generated by the shop are listed in Table 1
- **Transitions.** Provide brief transition sentences between sections of the report and before a bulleted list to explain what the list consists of and how it is organized.
- **Parallel construction.** Use parallel construction in all numbered or bulleted lists. For example, all items should be a complete sentence or none should be; or all items might begin with an active verb, e.g., "use," "change," "remove" or a noun, like this list.
- **Format.** A general format/outline has been suggested, although this may need to be modified to address a client's requests. Generally you should:
 - Move from generalities to specifics, in each section and across the report as a whole.
 - Use page numbers.
 - Keep section headings with the narrative that follows at page breaks.
 - Rarely split a table across two pages.
- **Abbreviations.** On first use, spell the term out completely, followed by the abbreviation in parentheses. For example, "Volatile Organic Compounds (VOCs) are another waste that could be minimized." Subsequently, just the abbreviation is sufficient unless it is used at the beginning of a sentence. Never start a sentence with an abbreviation or a numeral.
- **Professional tone.**
 - Avoid slang, informal terminology (inexpensive vs. cheap), or imprecise (there, that, it) language.
 - Be careful how you word suggestions. Avoid making recommendations outside of your area and level of expertise in source reduction and waste minimization.
 - Use tact and be positive in your conclusions. Remember a reader likes to be complimented, but can see through phoniness.
 - Be careful to confirm your information if you state it as a fact; or cite your source, e.g., "According to Mr. Jones, Plant Engineer, . ." or state that the information is a potential based on xyz assumptions.
- **Common errors.**
 - i.e. vs. e.g.: i.e. means "that is" or "in other words," and e.g. means "for example."
 - compliment vs. complement: a compliment is a nice comment, and a complement is a part of a whole
 - how many vs. how much: how many can be counted, and how much is uncountable, e.g., how many bottles of water vs. how much water.
 - policies vs. procedures vs. practices: policies are formal written positions or statements about some issue; procedures are written directives aimed at accomplishing a task or complying with a policy; practices are typically informal steps people take, which may or may not follow written policies and procedures

Tip #3: General Recommendations

General recommendations are made to help a company establish the culture and infrastructure needed to establish and sustain a commitment to source reduction and sustainability. Examples of commonly made general recommendations include:

1. A pollution prevention policy statement should be generated and periodically updated by management to formally reflect management's commitment to incorporating pollution prevention in the company's operations. Some examples of formal policy statements follow:

This company is committed to continued excellence, leadership, and stewardship in protecting the environment. Environmental policy is a primary management responsibility, as well as the responsibility of every employee.

The corporate objective is to reduce waste and achieve minimal adverse impact on the air, water, and land through excellence in environmental control.

Minimizing or eliminating the generation of hazardous waste is a prime consideration in process design and plant operations and is viewed by management as having a priority as high as safety, yield, and loss prevention.

2. To further implement the corporate pollution prevention policy, one or more "cause champions" should be selected to lead the pollution prevention program and overcome the resistance present when changes are made to existing operations. These "cause champions" may include a project manager, an environmental coordinator, or anyone else dedicated to implementing the pollution prevention ideal and company policy. These individuals must be given authority by management to carry out the policy.

3. Input from employees should be considered, encouraged, and valued. Since the employees must deal with the waste, they may have insight into how a specific pollution prevention opportunity may be implemented. Many companies offer incentives to employees who suggest innovations to minimize or reduce waste generation.

4. Goals should be established to help implement and track the progress of the corporate pollution prevention policy. Specific, quantitative goals should be set that are acceptable to those willing to work to achieve them, flexible to changing requirements, and achievable with a practical level of effort. To document the progress of the pollution prevention goals, a waste accounting system should be used.