

# **POLLUTION PREVENTION PRACTICES (P2) IN METAL FINISHING**

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P2 does not look like this



# Housekeeping issues





# Best/Good Practices



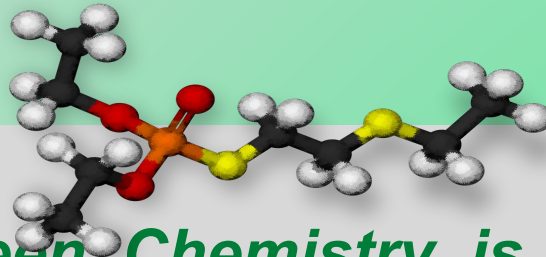
- Good housekeeping is the 1<sup>st</sup> principle of safety.
- Decrease risk.
- Minimize accidents.
- Makes a difference.
- Improve efficiency/productivity.
- Help in good control over processes.
- Maintain product quality





- ❖ Green Chemistry
- ❖ Finding GC
- ❖ The Intersection
- ❖ The Hierarchy of P2
- ❖ Benefits of P2

# Green Chemistry



## The 12 principles

1. Prevention
2. Atom Economy
3. Less Hazardous Synthesis
4. Design Benign Chemicals
5. Benign Solvents & Auxiliaries
6. Design for Energy Efficiency
7. Use of Renewable Feedstocks
8. Reduce Derivatives
9. Catalysis (vs. Stoichiometric)
10. Design for Degradation
11. Real-Time Analysis for Pollution Prevention
12. Inherently Benign Chemistry for accident prevention

*“Green Chemistry is the utilization of a set of principles that reduces or eliminates the use or generation of hazardous substances in the design, manufacture and application of chemical products.”*

*-Paul Anastas*

Paul Anastas: “we need to recognize that there are and should be many more aspects to sustainable chemistry”.

The aspects that he is referring, among others, is an “interdisciplinary engagement...education, regulation, metrics and [**more**] awareness” (Anastas & Zimmerman, 2008).



# Metrics of Greenness

| GC3 Metrics   | Proposed Metrics  |
|---|---|
| <ol style="list-style-type: none"><li>1. Molecular/Process</li><li>2. Product and Material</li><li>3. Firm and Sector Level</li><li>4. Societal Level</li></ol> | <ul style="list-style-type: none"><li>✓ Raw Materials</li><li>✓ Chemicals of concern</li><li>✓ Process changes</li><li>✓ Manufacturing Practices</li><li>✓ Operations &amp; Maintenance</li></ul> |



1. Ann Blake, *Measuring Progress Toward Green Chemistry*.  
[www.greenchemistryandcommerce.org](http://www.greenchemistryandcommerce.org)

# Measuring Greenness

- **Process Substitution**
- **Product change/reformulation**

Changing one or more process, parameters or equipment used in that process, to reduce the amount of waste generated.

- **Materials Substitution**

Change or replace existing raw materials used in a process with other materials that produce less waste, or a non-toxic waste in a any medium; Air, Water or Land.

- **Reduction/Elimination of CECs**

Examine whether their products contain any of the listed “chemicals of concern” and, if so, whether a safer alternative chemical exists.

DTSC



## Process Substitution or Reformulation/Modification

- **Trivalent chemistries**
- **Zinc/Nickel instead of Cadmium Plating**
- **Zirconization instead of phosphating in coating pretreatment**
- **H<sub>2</sub>SO<sub>4</sub> Anodizing instead of Chromic acid**
- **Dragout Reduction**
- **Wastestream segregation**
- **Sand Blasting instead of acid cleaning**
- **Automated systems (in-line product quality/changes in operating settings)**

## Material or Chemical Substitution

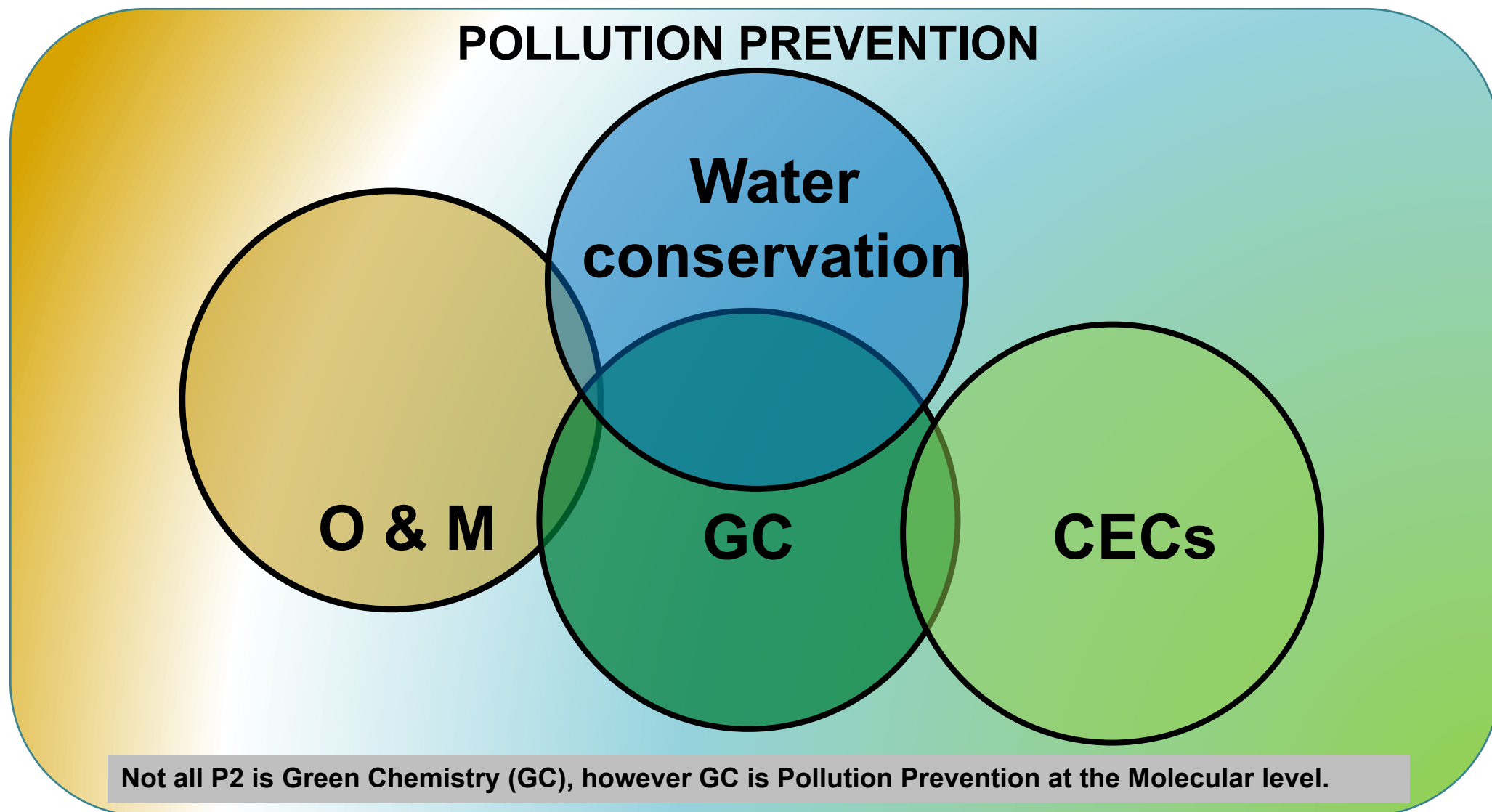
- **Alkaline degreasing instead of organic solvents**
- **Water based (non-halogenated) solvents**
- **Non-cyanide chemistries**
- **Ultrasonic cleaning**
- **Substituting polyelectrolytes in coagulation/flocculation**
- **Trivalent chemistries**

# Elimination/reduction of CECs

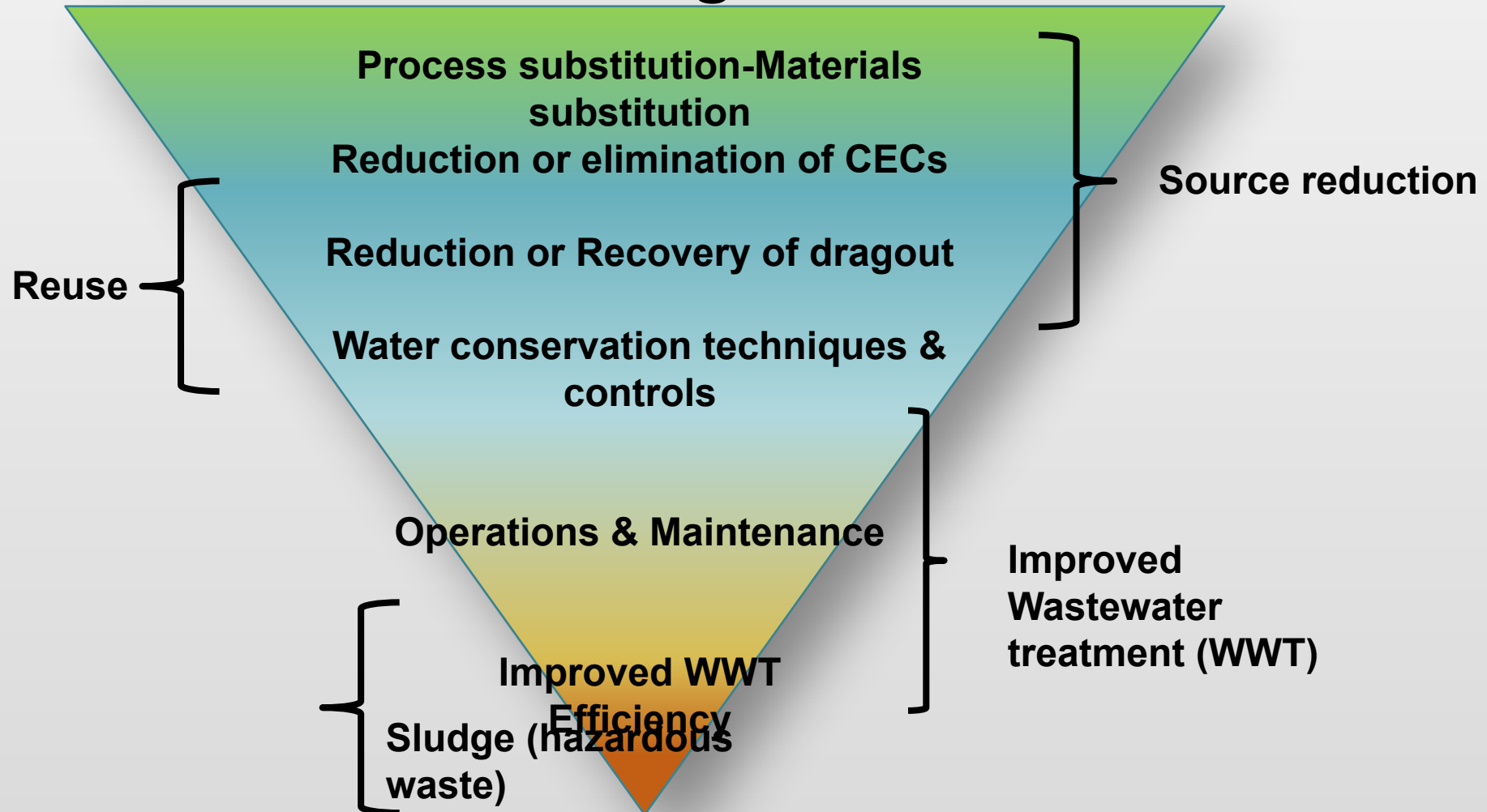
- **Hex-chrome free baths**
- **Tin Plating instead of lead**
- **Elimination of Cadmium from plating operations**
- **Cyanide free**
- **Carbonate based developers instead of 1,1,1, trichloroethane or Caustic instead of dichloromethane**
- **Filter cake delisting from RCRA regulations**






# The intersection (Greenness)



# Hierarchy of P2 & Waste Management Strategies



# Benefits of P2-The takeaway

| Benefits  | Type of benefits   |
|---|--|
| <b>Economic</b><br>    | <ul style="list-style-type: none"><li>▪ Cost effective</li><li>▪ Reduce raw material loss</li><li>▪ Financial impact of Rejects/rework</li><li>▪ Recovery of precious bath constituents</li><li>▪ Water, Energy, Chemicals</li></ul> |
| <b>Regulatory</b><br> | <ul style="list-style-type: none"><li>❖ End of pipe treatment</li><li>❖ Waste generation</li><li>❖ Disposal</li></ul>  |
| <b>Liability</b><br> | <ul style="list-style-type: none"><li>❑ Workers Compensation</li><li>❑ Health &amp; Safety</li></ul>   |



# Questions?



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