Update on Municipal Wastewater Study and Reference Tool on Safer Chemical Alternatives

Presented by: Sonya Kleywegt
Ontario Ministry of the Environment

Presented to: Great Lakes Bi-National Toxic Strategy Integration Workshop Meeting

June 15, 2011

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Purpose of the Presentation

To provide:

- An update from the December 1st meeting on the MOE's municipal wastewater studies and,

- An overview of the project to develop a Reference Tool for Safer Chemical Alternatives under the Ontario Toxics Reduction Strategy.

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Content

Wastewater project

- Overview of the project
- Study site updates

Reference Tool for Safer Chemical Alternatives

- Project objective
- Reference Materials

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Wastewater Project Update

Description:

- **E**valuation of **T**reatment **E**fficacy for the **R**eduction of **C**hemicals and **E**nvironmental impacts (ETERCE) in water and wastewater
- Pilot- and full-scale study of 3 Ontario STPs
- Evaluates removal of harmful pollutants (legacy and contaminants of emerging concern) by 8 different sewage treatment technologies
- Assesses toxicity of STP effluent using whole organism tests (standard tests; life cycle tests) and micro-scale endocrine disruption tests
- Investigates links between treatment, chemistry and removal of effluent toxicity
- Baseline study: characterizes conventional activated sludge nitrifying technology without disinfection, chemistry and toxicity.
- Pilot and Full-Scale study: evaluates relative effectiveness of different conventional and advanced treatment technologies in reducing chemical contaminants and environmental impacts.

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Project Design

Chemistry: Characterized influent and effluent including:

- TSS, FSS, VSS, DOC, TOC, $CBOD_5$, COD, TKN, TP, PO_4^-, TAN, NO_2^-, NO_3^-
- Metals, VOCs, alkylphenol polyethoxylates, pharmaceuticals, hormones, industrial organics, halohydrocarbons

Ecotoxicity: Environment Canada standardized test methods for:

- Rainbow trout acute lethality (96-h)
- *Daphnia magna* (zooplankton) acute lethality (48-h)
- Fathead minnow (*Pimephales promelas*) survival, growth (7-d)
- *Ceriodaphnia dubia* (zooplankton) survival, reproduction (7-d)
- Duckweed (*Lemna minor*) growth inhibition (7-d)
- Algae (*Pseudokirchneriella subcapitata*) growth inhibition (72-h)

***In vitro* rapid screening tests:**

- Yeast estrogenic screening (YES) assay
- Yeast androgenic screening (YAS) assay
- Thyroid transport receptor (T_4/hTTR) binding assay

6-month Fathead minnow life-cycle test: Environment Canada

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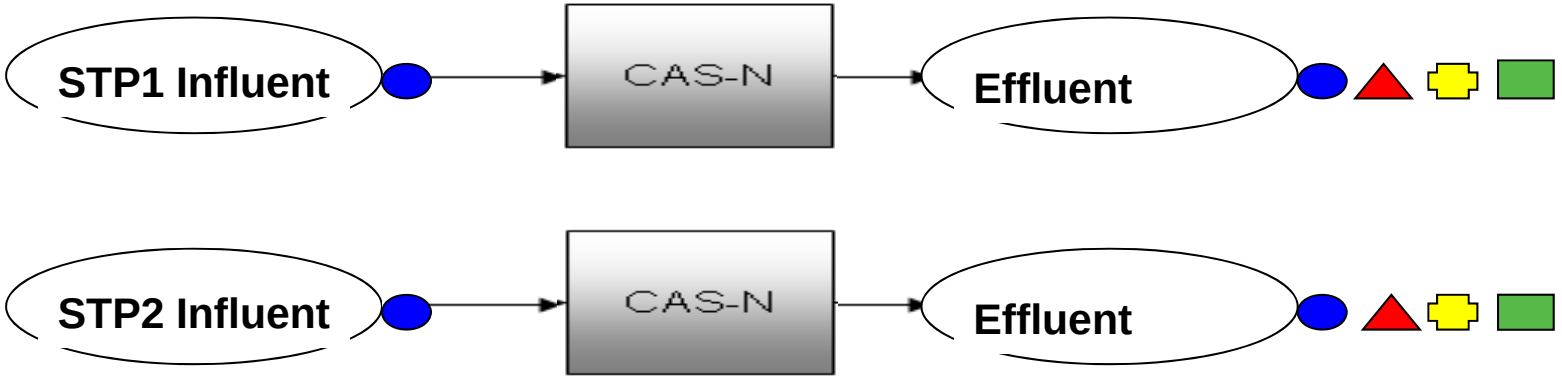
Baseline Study

- Concurrent 6-month background evaluation of two Ontario STPs both operating as nitrifying activated sludge systems without disinfection (UV only in Summer to early Fall)
- Data collection complete. Data being analyzed summer 2011.



Chemistry: x 18 sampling events

Ecotoxicity tests: x 3 sampling events

Screening tests: x 3 sampling events

Fathead minnow

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Baseline study – STP #1: Initial results

- Occurrence and Reduction Efficiencies:
  - Data still being analyzed
- Toxicity assessed 3 times over 5-month test period
  - No acute toxicity (100% survival) to rainbow trout or Daphnia magna following exposure to 100% effluent
  - No longer-term toxicity following exposure to 100% effluent to:
    - Fathead minnow survival or biomass (7-d)
    - Ceriodaphnia dubia survival, reproduction (7-d)
    - Lemna minor frond number or dry weight (7-d)
    - Pseudokirchneriella subcapitata growth (72-h)
  - No significant effects on T4/hTTR in vitro assay
  - No estrogenic activity (17-β estradiol (E2) standard)
  - No androgenic activity (Testosterone (T) standard)

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Baseline study – STP #2: Initial results

- Reduction Efficiencies:
  - Conventionals: 85-90%
  - VOCs: 6-67%
  - BDEs: 87-93%
  - Pharmaceuticals 94-95%

- Toxicity assessed 3 times over 5-month test period
  - No acute toxicity (100% survival) to rainbow trout or Daphnia magna following exposure to 100% effluent
  - No longer-term toxicity following exposure to 100% effluent to:
    - Fathead minnow survival or biomass (7-d)
    - Ceriodaphnia dubia survival, reproduction (7-d)
    - Lemna minor frond number or dry weight (7-d)
    - Pseudokirchneriella subcapitata growth (72-h)
  - No significant effects on T4/hTTR in vitro assay
  - No estrogenic activity (17-β estradiol (E2) standard)
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Full Scale / Pilot Studies
Phase 1

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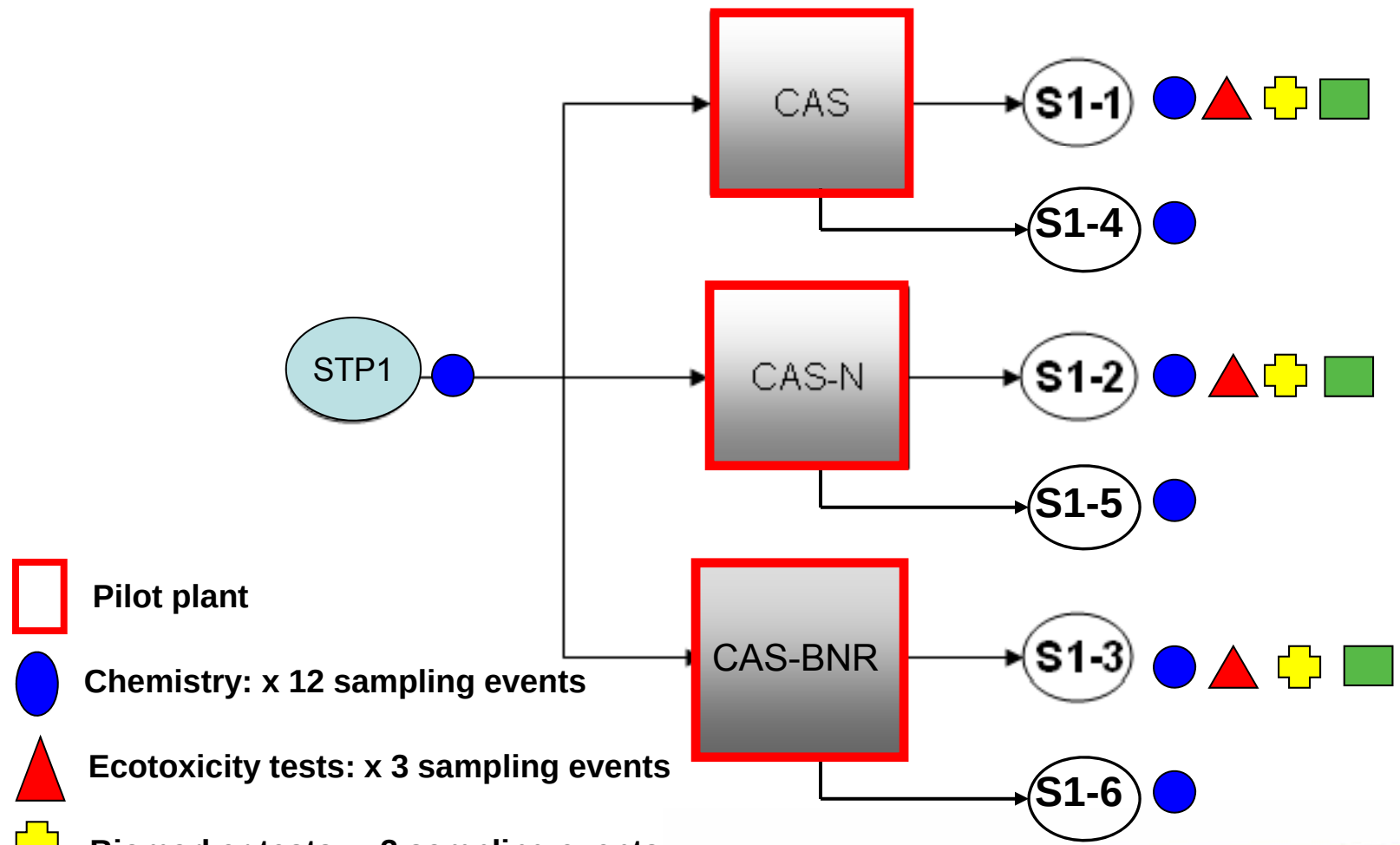
Sewage Treatment Pilot Plants (STP) #1-Feed



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Sewage Treatment Pilot Plants (STP) #1:Update

- Data collection complete.
- Data analysis under way (Summer 2011).
- Initial observations:
  - Occurrence Chemistry Data for NPEs (next slide)
  - No acute toxicity (100% survival) to rainbow trout or *Daphnia magna* following exposure to 100% effluent
  - No longer-term toxicity following exposure to 100% effluent to:
    - Fathead minnow survival or biomass (7-d)
    - *Ceriodaphnia dubia* survival, reproduction (7-d)
    - *Lemna minor* frond number or dry weight (7-d)
    - *Pseudokirchneriella subcapitata* growth (72-h)

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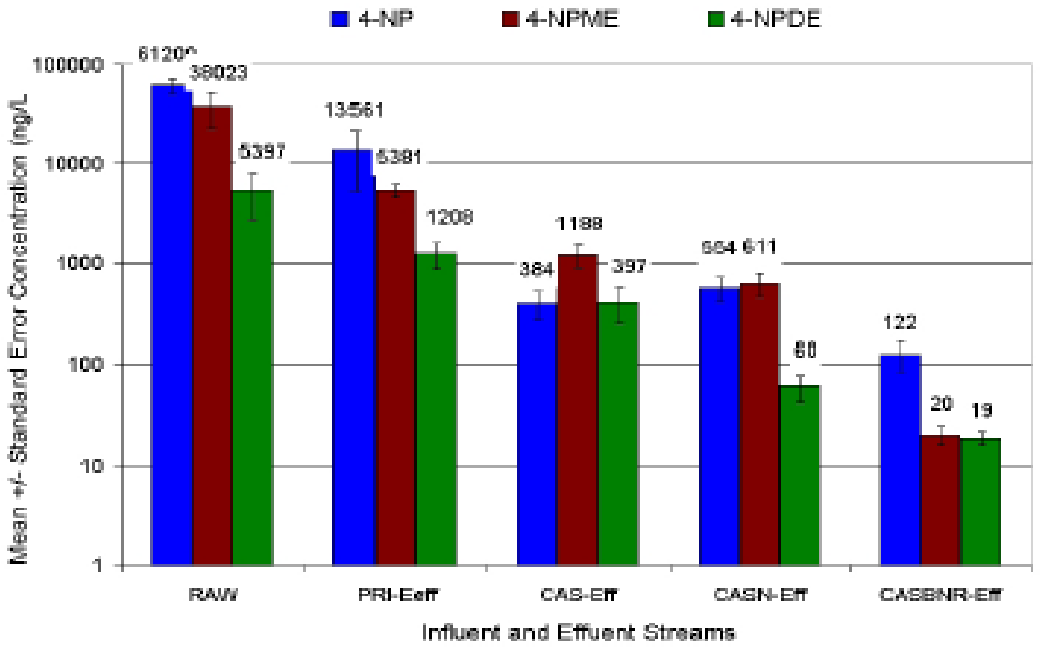
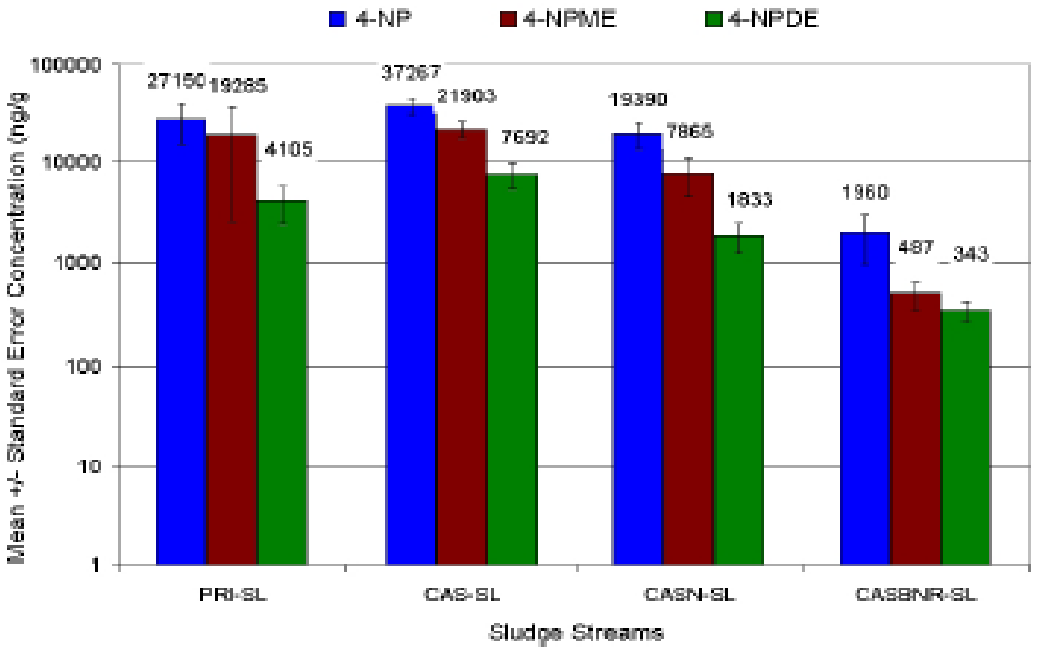


(a) NPEs in liquid streams



(b) NPEs in sludge streams

NPEs Through The Pilot Treatment Process

- 4-NP, 4-NPME and 4-NPDE show lowest concentration in the effluent and sludge of the CAS-BNR pilot plants
- Differences exist between CAS and CAS-N pilot plants but need to be evaluated for significance
- Octylphenol was consistently below DL in all samples

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Treatment Comparisons and Reduction of NPEs

Two sample comparison test for one-tailed hypothesis for effluent concentrations between treatments at the 95% confidence level

Effluent Comparison	p-value for WMW or t-Test		
	4-NP	4-NPME	4-NPDE
CAS vs CASN	0.20	0.07	**0.03**
CAS vs CASBNR	**0.04**	**0.006**	**0.02**
CASN vs CASBNR	**0.01**	**0.004**	**0.02**

4-NP: CASBNR > CASN = CAS
4-NPME: CASBNR > CASN = CAS
4-NPDE: CASBNR > CASN > CAS

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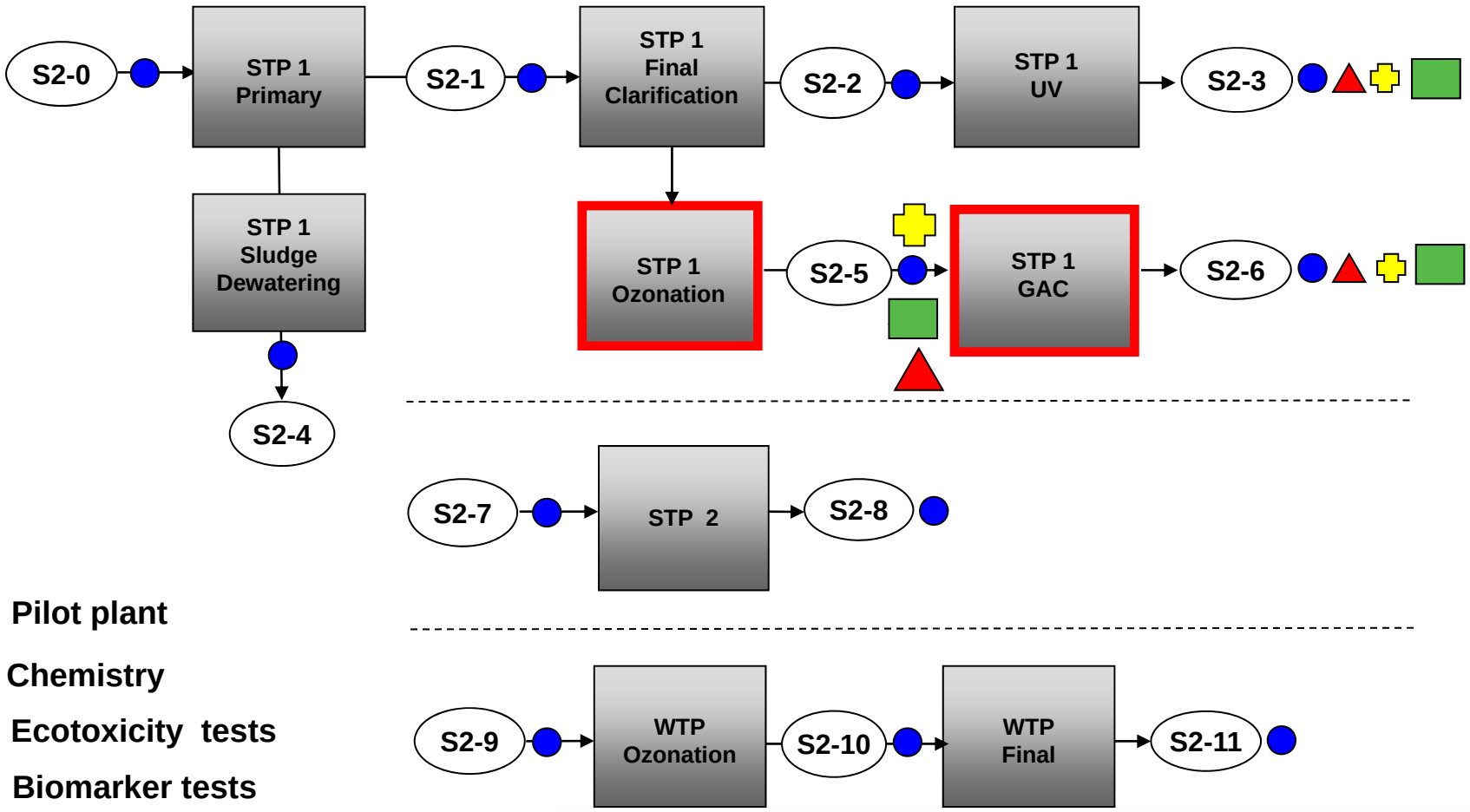
STP #2 - Wastewater & Water Treatment Set-up



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STP #2 - Update

- Phase 1 Project underway – to be completed July 2011.
- Initial observations from baseline study:
  - Toxicity assessed 3 times over 5-month test period
  - No acute toxicity (100% survival) to rainbow trout or Daphnia magna following exposure to 100% effluent
  - No longer-term toxicity following exposure to 100% effluent to:
    - Fathead minnow survival or biomass (7-d)
    - Ceriodaphnia dubia survival, reproduction (7-d)
    - Lemna minor frond number or dry weight (7-d)
    - Pseudokirchneriella subcapitata growth (72-h)
  - No estrogenic activity (17-β estradiol (E2) standard)
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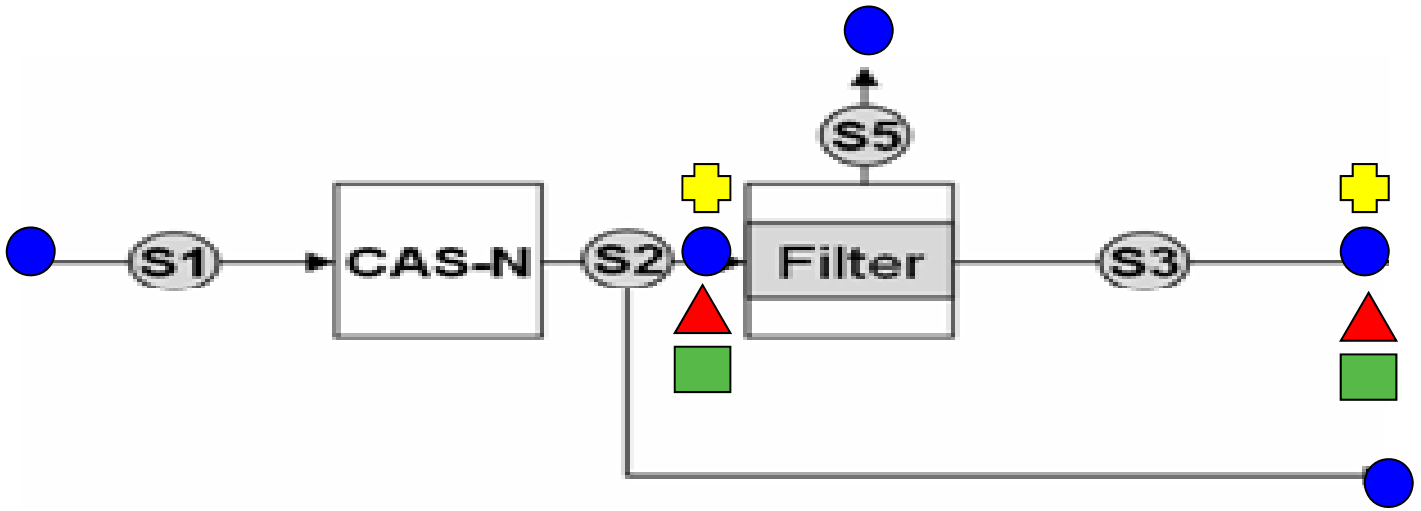
Sewage Treatment Plant (STP) #3 (NEW)



- Chemistry: x 18 sampling events
- Ecotoxicity tests: x 3 sampling events
- Screening tests: x 3 sampling events
- Fathead minnow

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STP #3 - Update

- Project currently underway – to be completed July 2011.
- Initial observations:
  - Chemistry data not analyzed yet
  - No acute toxicity (100% survival) to rainbow trout or *Daphnia magna* following exposure to 100% effluent
  - No longer-term toxicity following exposure to 100% effluent to:
    - Fathead minnow survival or biomass (7-d)
    - *Ceriodaphnia dubia* survival, reproduction (7-d)
    - *Lemna minor* frond number or dry weight (7-d)
    - *Pseudokirchneriella subcapitata* growth (72-h)

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Toxics Reduction Strategy: Safer Chemical Alternatives Update

- Toxics Reduction Strategy (TRS) includes promotion of green chemistry and engineering to stimulate innovation and commercialization of new technology to reduce toxics.

- The two main deliverables for the project included:
  - a jurisdictional review of programs and approaches that are used to assess and promote safer chemical alternatives and,
  - a reference tool that provides assessment tools, best practices and criteria that may be considered in evaluating a chemical as a safer alternative and its feasibility for use in chemical substitution that would be applicable to Ontario stakeholders.

- A Technical Steering Committee (TSC) was formed and a multi-stakeholder engagement meeting was held to review the materials.

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Safer alternatives Project *continued*

Details and Status Update:

1) Jurisdictional Review

Objectives:

- conduct a jurisdictional scan / literature review of programs and approaches that are used to assess and promote safer chemical alternatives including:
  - Technical aspects – how much detail is provided on the guidance?
  - Is the program / guidance applicability to all sectors and industries or only specific stakeholder groups? (i.e., how broadly can the guidance be implemented)
  - Is technical support provided as part of the program?
  - Is there open accessibility of the information? Have communication networks been established?
  - What are the roles, responsibilities and resources provided by government?
- More than 50 programs and approaches were evaluated.
- The jurisdictional review is complete and comments from the TSC and Stakeholders have been incorporated.

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Safer alternatives Project *continued*

Details and Status Update:

2) Reference Tool

Objectives:

- Based on the knowledge and information gained from the jurisdictional review, a reference tool has been drafted to assist Ontario government, industry (with particular attention to the manufacturing and mineral processing sectors) and other stakeholders in assessing chemicals that may be used as safer alternatives.
- Components of the tool include:
  - Factors to consider in identifying and assessing safer alternatives
  - Technical criteria and considerations
  - Social and economic considerations
  - Framework for identifying and assessing safer alternatives (process)
    - Guidance on each of the proposed steps
    - Criteria and methods to consider
    - Testing protocols
  - Recommendations and Conclusions
- A framework has been developed with reference materials and resources.
- The Reference Tool is complete and comments from the TSC and Stakeholders have been incorporated.

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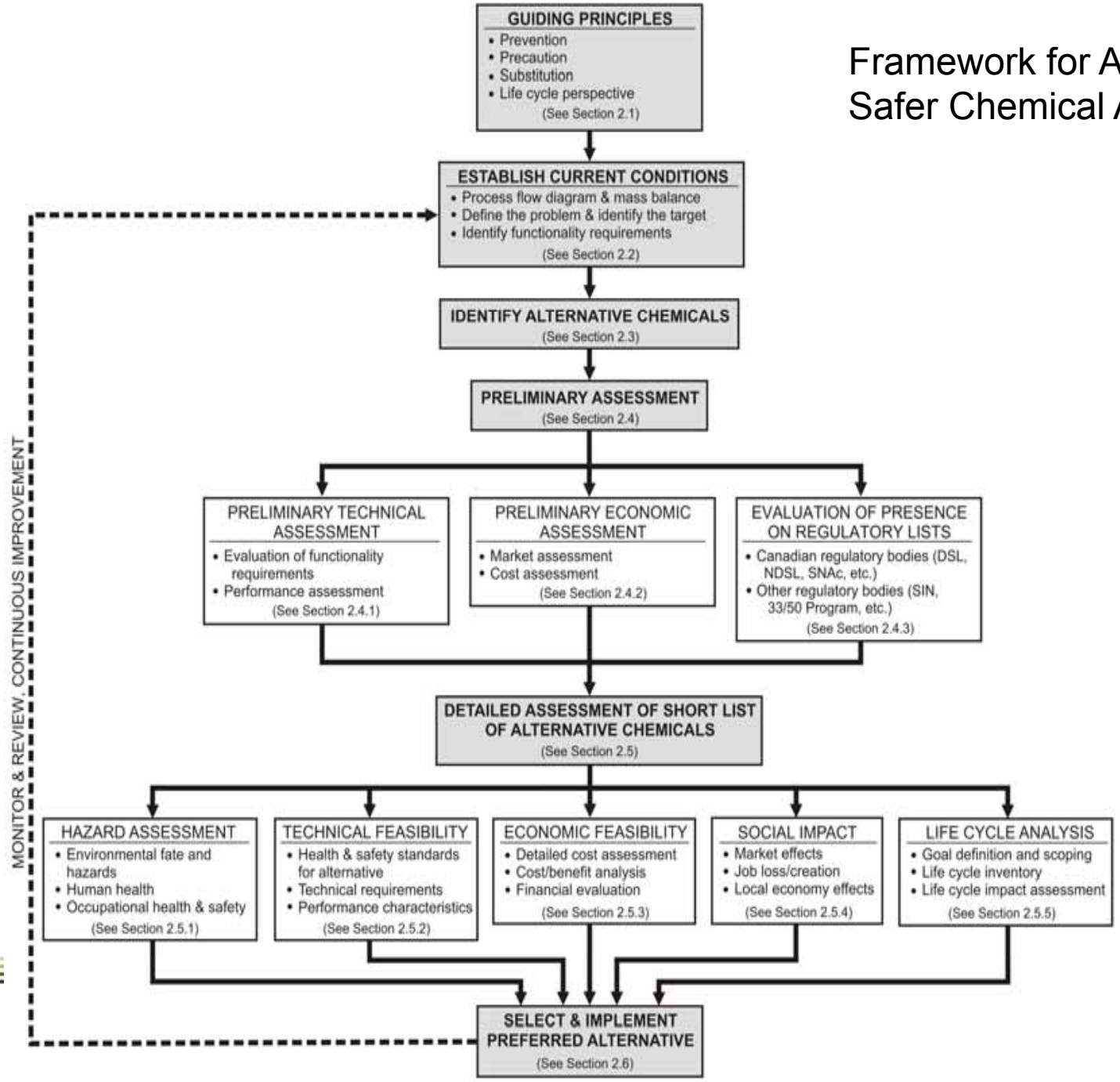
Framework for Assessing Safer Chemical Alternatives



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Safer Alternatives Project *continued*

Details and Status Update:

- Working on final internal approval to have both the Jurisdictional Review and Reference Tool posted to the Ministry of the Environment's website (2011).

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Questions or Comments?

Thank you for your time.

Sonya.Kleywegt@Ontario.ca

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