Industrial Ecology, Pollution Prevention and the NY/NJ Harbor

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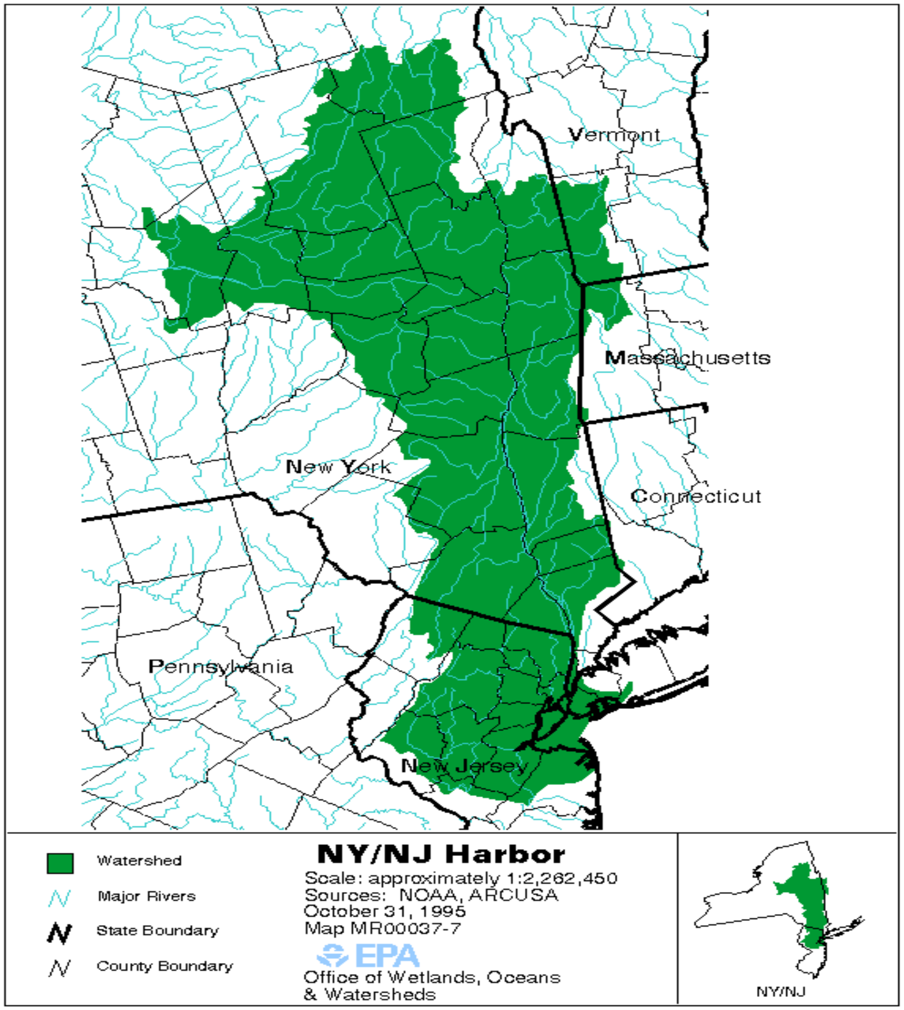


Bi-national Toxics Strategy Stakeholder Forum

December 6th, 2006
US EPA Region V, Chicago IL

Industrial Ecology, Pollution Prevention and the NY/NJ Harbor project

- **The NY/NJ Harbor:**
  - **Located in an economically, politically and socially complex urban system.**

- **Goals of the Project:**
- **The project aims to understand the causes of on-going pollution to the Harbor and reduce or prevent contaminant loadings**
  - **Track down** the flow and cycling of selected contaminants (Hg, Cd, PCBs, Dioxins and PAHs)**.**
  - **Identify P2 strategies** that most effectively contribute to reductions in loadings of these contaminants while allowing for an ecologically healthy and an economically viable harbor
  - **Promote the implementation** of the recommended strategies

Industrial Ecology, Pollution Prevention and the NY/NJ Harbor project

Approach to developing P2 strategies:

1) Research: science based review of a wide variety of data on contaminants, statistics on commercial activities, national and regional data sets, peer-reviewed literature, federal/state reports and data sets, in order to achieve Industrial Ecology and mass balance analyses.

2) Collaborative-based key stakeholders are encouraged to participate in guiding the research, developing and implementing the pollution prevention measures recommended

Consortium Members include representatives from academia and research institutions, industry, small business associations and labor; advocacy and non-profit organizations, and local, state and federal agencies / government

Why a Stakeholders' Consortium?

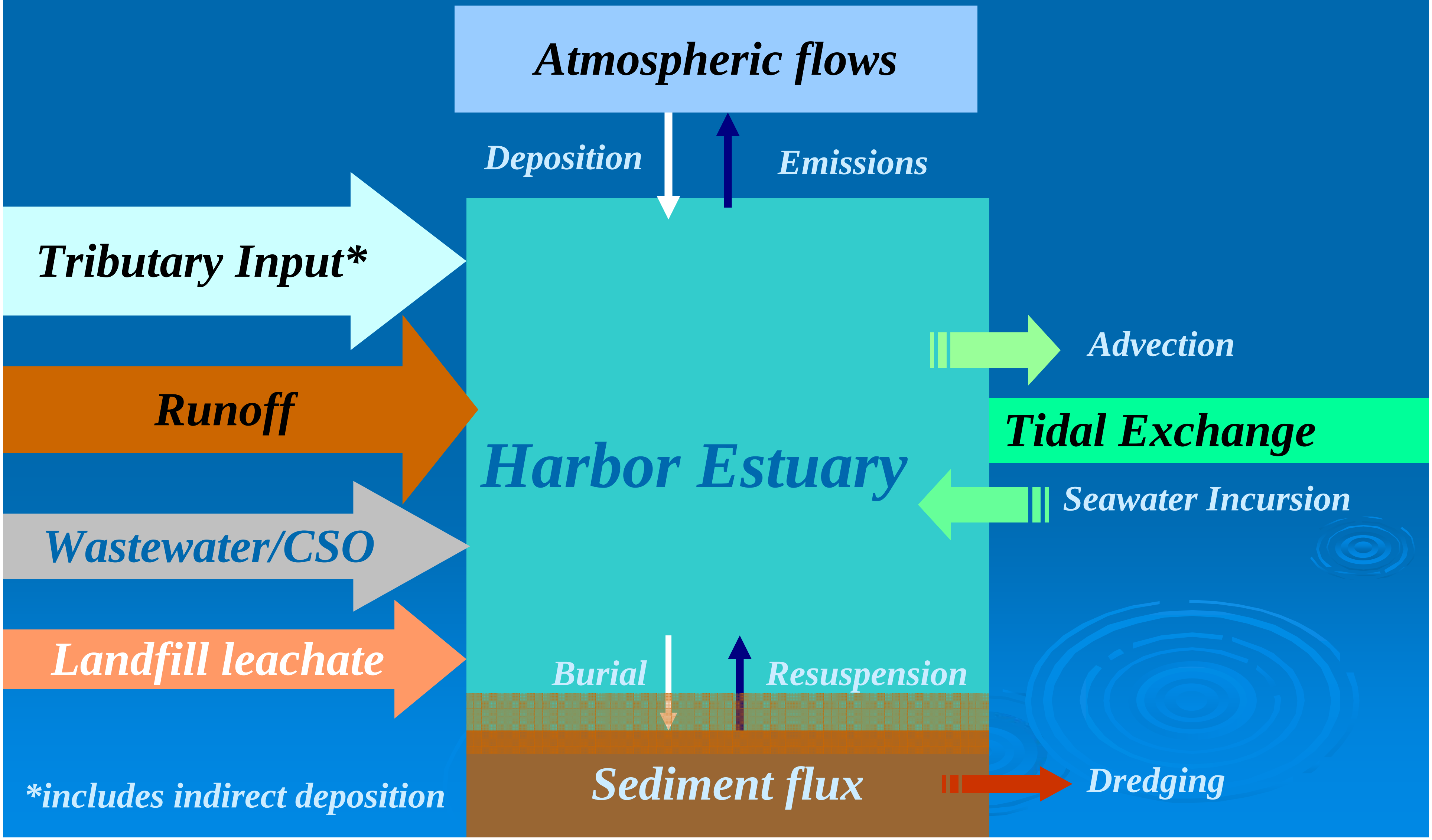
- **Emphasizes public involvement and communication:**
  - New Paradigm: Inform, Include, Decide
- **Involves stakeholders in research, development of P2 strategies & implementation**
  - Participants guide research and provide key data
  - Opportunity for mutual understanding and collaboration
  - Buy-in from participants results in higher implementation rates
- **Open process acts as educational forum**
- **Alternative valuation tool**
- **Diversity of sponsors**

Methodology

To achieve its goals the project uses:

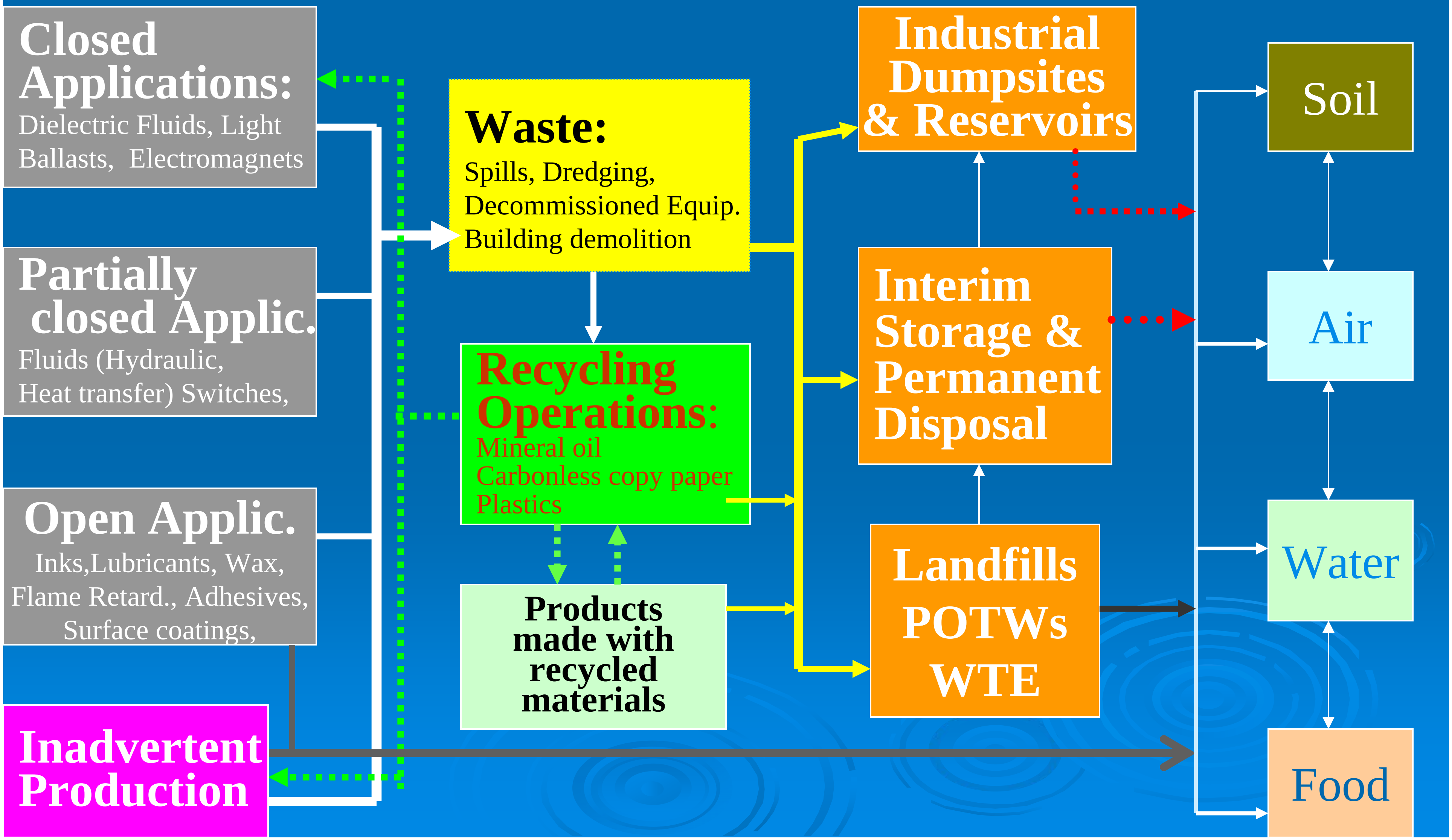
- Industrial Ecology analytical tools
  - Material and Substance Flow Accounting
  - Life Cycle Assessments, whenever required
  - Design for the Environment (DfE)
- Mass Balance
- Economic Analyses (cost assessments of alternative P2 options)
- Consortium deliberation on P2 strategies

Mass balance for the Harbor

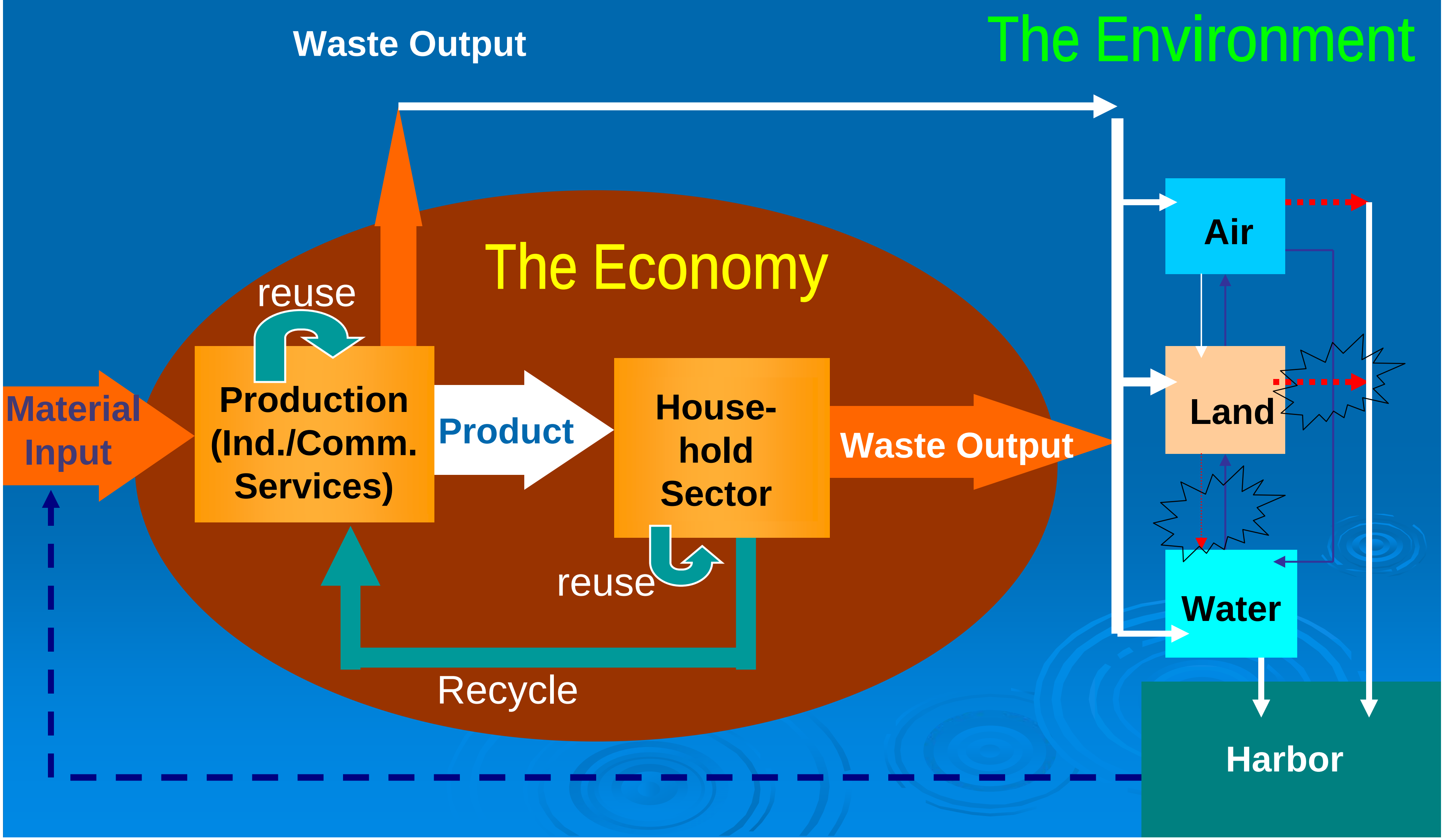


The Industrial Ecology Approach:

Understanding contaminant movements (PCBS)



Modeling system interactions



Developing P2 Action plans

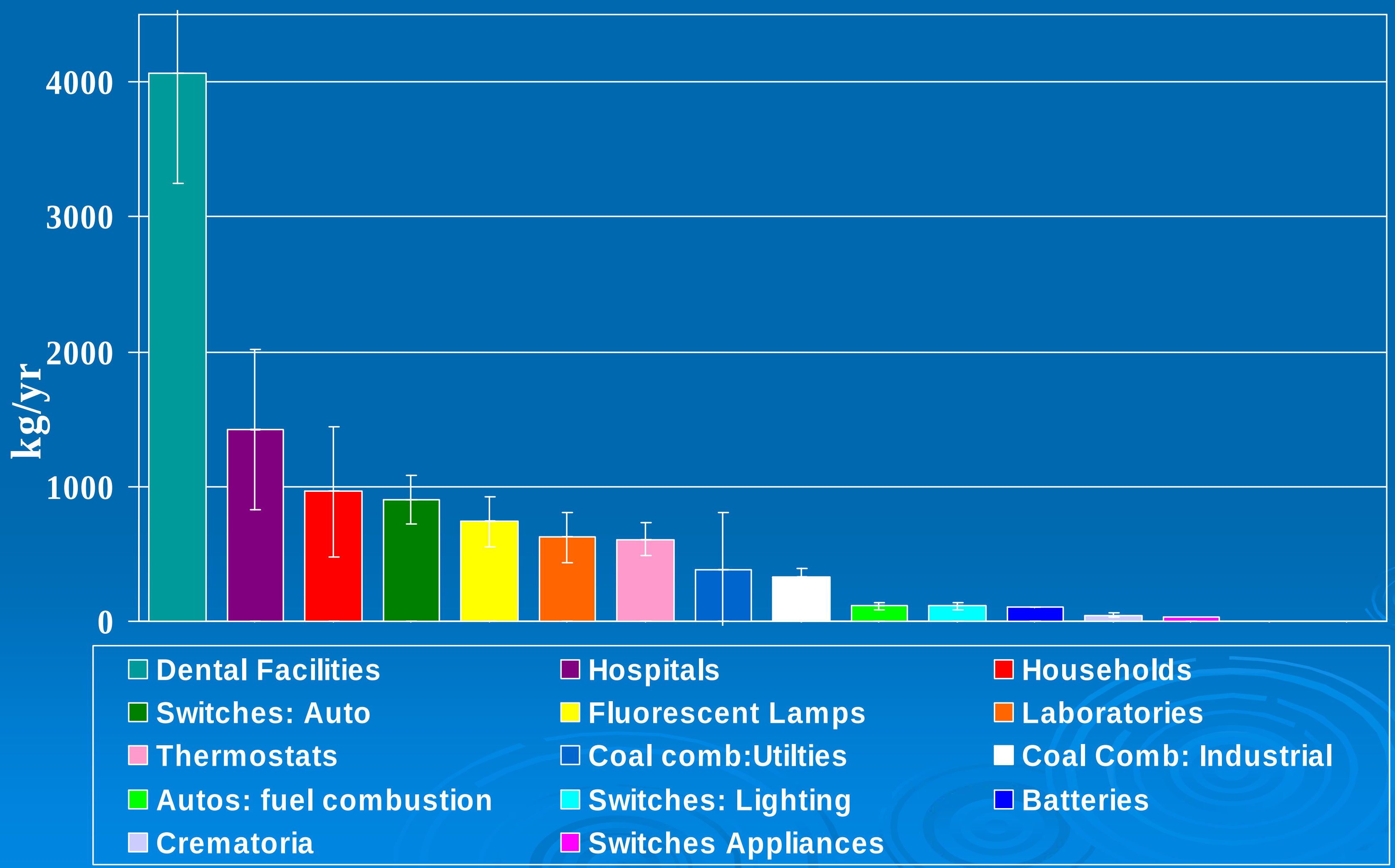
- **Find all leverage points for intervention**
  - Identify economic sectors, substitute materials, technologies and/or alternative practices that provide effective leverage for policy tools.
  - Determine costs (when feasible) associated with P2 plan
- **Setting priorities for action – multi-criteria**:
  - total ongoing releases
  - fate and transport and loadings to the harbor
  - toxicity of the contaminant in relation to receptors
- **Promoting implementation**
  - Identify implementers (relevant actors and sectors)
  - Partner with action oriented groups
  - Monitoring results

CASE STUDIES:

research findings & policy recommendations

Research Findings:

Hg initial releases to all media (kg/yr), by sector



Mercury - 2002

Original contributions:

- Cumulative impact of small quantity generators
- Role of WWTP in methylation of mercury

Wastewater Effluent

- Findings highlighted the importance of wastewater as a significant source of Hg and MeHg to the Harbor.
  - High methylation rates associated with wastewater in effluents.
  - Toxicity: methylmercury is more toxic than elemental mercury

Dental Facilities

- Many NY metropolitan region dentists still handling mercury
  - Even as small quantity generators, were in such significant numbers (8,500) as to be the largest contributors of mercury to the harbor.

Hospitals/Laboratories

- In addition, over 143 regional hospitals and 270 laboratories are also seen as important contributors of mercury to the harbor.

Atmospheric Inputs

- Another critical source are the atmospheric inputs of mercury - from the incineration of mercury containing products and combustion of fuels with trace amounts of mercury.

Hg - Relevance and Influence

New York

- **Sponsored workshop on BMPs for dental waste in partnership with Columbia University.**
- **Assisted NYSDEC with a community consultation meeting on dental amalgam waste.**
  - **-- NYSDEC was in consultation with NYAS prior to the issuance of their regulations**
    - **(6NYCRR Subpart 374-4 for Standards for the Management of Elemental Mercury and Dental Amalgam Wastes at Dental Facilities)**

New Jersey

- **Consortium members were part of the NJ Mercury Task Force**
  - **-- NJ Mercury Task Force concurred with the Consortium's findings that dental offices were a significant source of mercury**
  - **-- NJ's proposed regulations in 2006 reflect the Consortium's recommendations.**

Hg - Relevance and Influence

- **Consortium helped define the regulation that required that mercury switches be removed at the end of the life of vehicles:**
  - **NJ DEP is now requiring car manufacturers to pay a bounty for each removed mercury switch**
  - **We organized consultative meeting attended by representatives of the auto recyclers of NYS, the Clean Car Campaign, two secondary metal recovery facilities, as well as a representative from the Association of Home Appliance and NJDEP on mercury switches and vehicles and appliances.**
- **Australia & New Zealand**
  - **POTW engineers – using their reports to guide their track down efforts for mercury and cadmium.**
- **China**
  - **Exploring collaborations:** the Shanghai Academy of Sciences, and the Research Center for Urban Ecological Planning and Design at Fudan University (Shanghai)

Cadmium - 2003

Cadmium in the Harbor has decreased over the last 10-30 years due to:

- chemical characteristics of the metal itself and reaction in salt water,
- changes in the level of industrial activity in the region,
- better environmental management

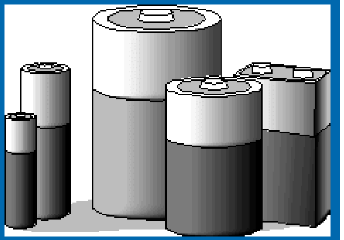
  (e.g., improved controls on waste incineration, secondary steel production and fertilizer composition)

Market for Cadmium has changed

- Major use of Cd today is Ni-Cd batteries

- Other sources include – pigments, plating, fossil fuel production, cement production

Cadmium: Key Findings



- Use of cadmium has changed dramatically over the last 20 years – (75% used for Ni-Cd batteries)
  - **New data gap: batteries imported in products no longer reported**
- Cd flows through the economy larger than inputs to the harbor – discrepancy between IE & MB assessments
- Assumption that discrepancy could be explained by battery recycling put to the test (survey)
  - **Survey finding: low recycling rates for region**
  - **Final fate of the disposal of batteries in the Harbor watershed is poorly tracked and understood**
  - Discrepancy explained by MSW management practices – NYC exports to other regions; NJ does not

Impacts on Harbor depend on current practices

P2 Recommendations & Implementation

Recommendations oriented toward better management of Ni-Cd batteries:

- To prevent exportation of our batteries to other regions in our trash.
- To prevent future potential impacts to the harbor should waste management approaches change to require local disposal of trash.
- To prevent the incineration of batteries that may lead to additional air emissions due to inadequate source separation. This is particularly important to NJ which incinerates 1/3 of their trash.

Working to promote Implementation

Outreach

NYAS visited 15 communities (CBs, city parks dept. , colleges, local organizations, schools.) to distribute information about what products contain Cd and Hg and where to recycle batteries, mercury thermometers.

Consortium members sent report to legislators

Relevance and Influence

New (11/ 2006) - New York City rule requires recycling of all rechargeable batteries , including Ni-Cd ones.

PCBs - 2005

- Upper Hudson watershed loadings represent greater than 50% of the load of PCBs to the Harbor.
- Contaminated sites within the watershed are likely contributors of PCBs to the harbor via runoff, CSOs and volatilization.

  However, this is not the focus of this study.

- Small PCB capacitors in household appliances and demolition debris enter the municipal solid waste stream each year.
  - It was decided in 1977 that they would not be regulated;

    however, this grossly overlooked the importance of the cumulative impact of individual small sources.
  - It is estimated that 60-70 metric tons of PCBs are likely to be disposed of within the next 5-10 years in our watershed.

Recommendation:

Quantify and track the fate of PCB capacitors that are entering the waste stream e.g., disposed of at demolition sites, recycling, dismantling and metal recovery facilities, household waste collection and consolidation centers.

NYAS conducting outreach to waste and pollution prevention offices of state/city agencies to provide information for the agency's brochures that are distributed to the construction/demolition sector, waste management facilities.

PCBs (continued)

- Inadvertently produced PCBs in the watershed region are entering the harbor and may constitute 5-10% of the harbor input.
- Among sources of concern are: water treatment flocculants, pigments and paints.
  - Contacted all POTWs and informed them of the problem with the water treatment flocculant containing PCBs.
- Provided PCBs P2 BMPs from Canada to pigment and paint manufacturers in the watershed as well as working with the Passaic Valley River Commission POTW to provide the information to appropriate facilities.

PCBs - key findings

- **HR Upstream and downstream PCB inputs** – different homologue patterns
- **SQG: cumulative impact of small capacitors overlooked:**
  - US (2004) : 40M – 50M units (960 – 1,200 tons) ?
  - Harbor watershed (2004) : ~2.5M - 3M (60 – 70 tons) ?
    - 10-20% disposal rate/yr: (6 - 14 T/yr)
- **Inadvertent production: ~ 10-15% of current PCB loadings**
- **Usage/disposal:**
  - uneven reporting requirements on usage/disposal (large capacitors)
  - Regulatory gap for PCB contaminated transformers
  - Limited recycling opportunities
- **Opportunities for P2 / BMPs**
- **Impact of 179 Superfund sites in Harbor region**
  - 27% - waste storage/treatment & 8% - recycling
  - 26% - manufacturing/industry
  - 23% - unknown; other – 9%
  - mining/extracting/processing – 3%
  - Government – 3%; residential – 2%

Dioxins - 2006

Dioxins were never intentionally produced, they are a by-product of other processes

- Ongoing sources: Uncontrolled combustion

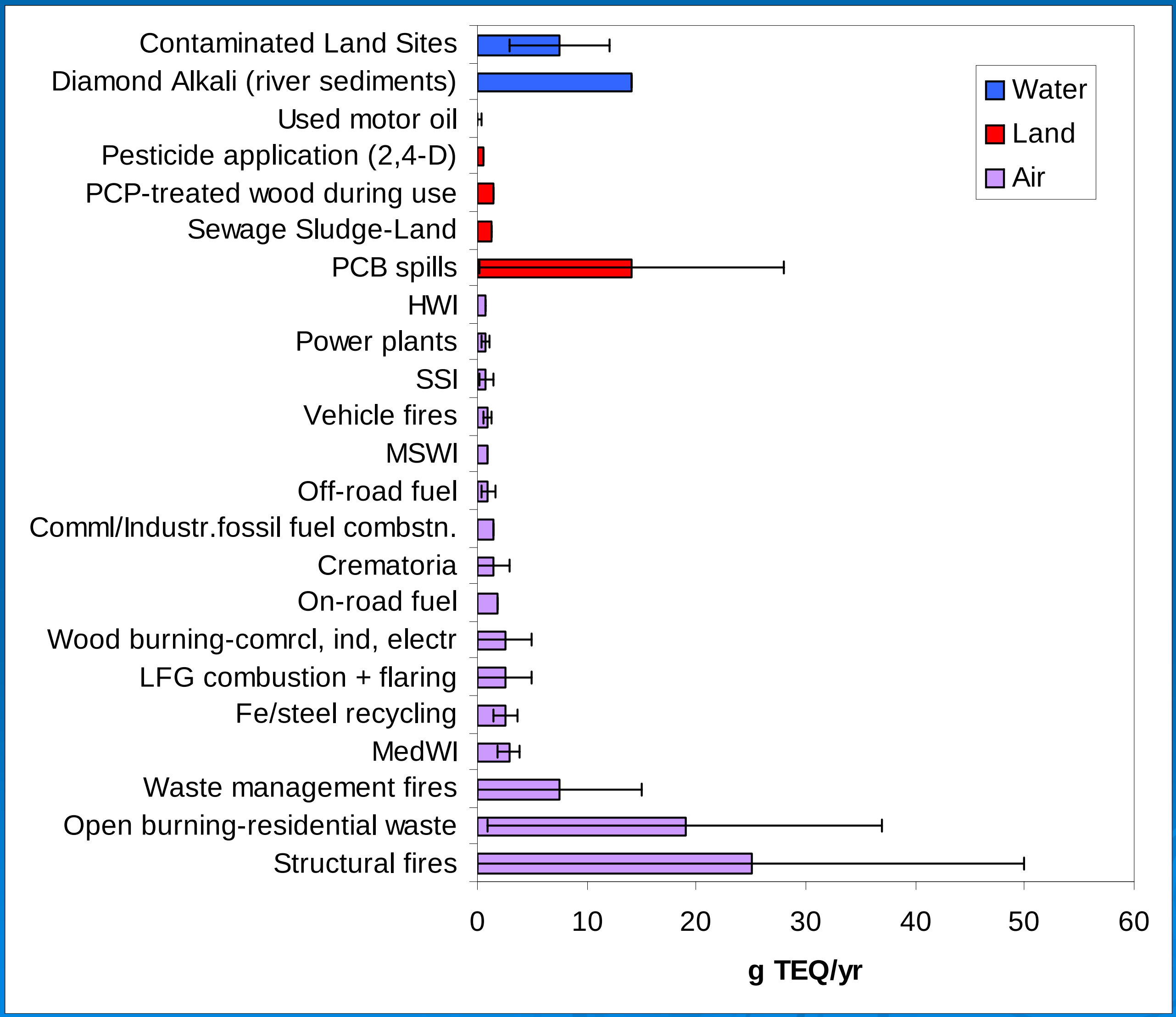
smaller diffuse combustion sources e.g. waste management fires in trucks, dumpsters, transfer station, compost piles, open burning of agricultural and residential waste, structural fires.

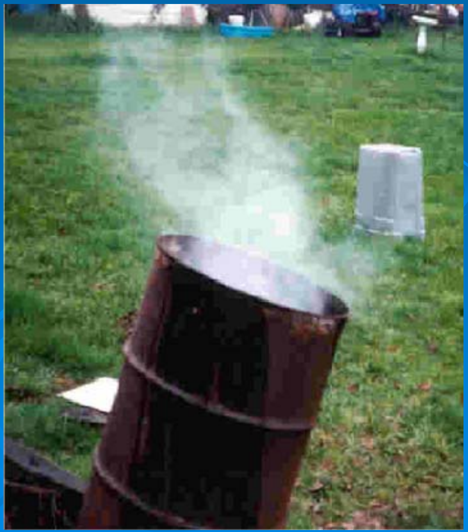
Pollution prevention strategies include

- limiting the impacts of open burning and structural fires
- BMPs by MSW managers to reduce fires at transfer stations, pickup trucks, recycling centers and landfills.
- implementing a zero waste approach to managing our waste and protecting the environment in the long term.

Consortium members and other stakeholders are using the NYAS dioxin report to press for bans against community burning of trash in NYS.

Dioxins: Local emissions





Evaluating the impact of “legacy” sites

Legacy sources : contaminated land and water sites and their associated sediments as a result of former production practices in the watershed

- **Estimating contaminant remobilization:**
  The amount of dioxins (or other contaminants), mobilized annually by soil runoff from a given site or area can be calculated as:
  Dioxins in Runoff = Soil Loss x Contaminated Area x Dioxin Concentration in Soil

- **Universal Soil Loss Equation**
  USLE = R x K x LS x C x P

- **RUSLE2** - software and databases for different geographical areas are available for download at the USDA-ARS National Soil Erosion Research Laboratory, Purdue University website (http://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Index.htm)

PAHs - Approach

- Identify typical PAH sources nationwide.
  - Establish critical sources and sectors
  - Develop emission factors
- Estimate regional emissions.
  - Atmospheric emissions
  - Surface water, wastewater, & runoff
  - Terrestrial and groundwater
- Apply fate and transport modeling to establish impacts on harbor.
- Recommendations.

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Prioritization for the P2 deliberation

Source	Estimated Release- kg/yr	Estimated Loading-kg/yr
Coal-tar sealants	34,500	10,500
Creosote treated wood	392,600	3,400
Tire wear	2,800	1,400
Oil leaks	2,700	1,100
Resident. Fuel Combust.(wood & fossil fuel)	353,200	1000
Vehicle Emissions	97,700	500
Industrial Fuel Combustion	2,700	200
Non-road/stationary engine emissions	32,500	206
Used motor oil disposal	152	80
Oil Spills	70	70
Personal Watercraft	1,100	60
Power Generation	12,500	50

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Prioritization …(cont.)

Vessels	700	40
Gasoline Distribution	6,800	12
Rail	1,300	5
Metal coating	2,400	5
Open Burning, House Hold Waste/Agricultural Plastics*	4,700	5
Steel Manufacturing	200	4
Tire Fire*	9,000	3
Airplanes	72	3
Waste Incineration*	400	2
Port Related Activity	137	1
Refineries	867	0
Cement Production	3,700	0

All recommendations are similar to those approved during the Dioxin Report review and will not be presented again here.

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Coal Tar Parking Lot Sealants

Background:

- Sealants used to protect asphalt surfaces (i.e. parking lots and driveways).

- Two types of sealant: Asphalt based and Coal-tar based.
(coal-tar sealants predominately used east of the Rockies)

Concerns associated with coal-tar sealants:

- Contain PAHs (approximately 5% wet weight).

-Abrade from surface over time and may be transported via runoff.

- Must be reapplied every 1-5 years.

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Watershed Consumption of Coal Tar Parking Lot Sealants

PAH in Coal-tar Sealant Concentrate	mg/kg
Naphthalene	1,889
Acenaphthylene	221
Acenaphthene	1,118
Fluorene	1,291
Phenanthrene	10,229
Anthracene	2,735
Fluoranthene	8,762
Pyrene	6,124
Benz[a]anthracene	2,989
Chrysene	2,993
Benzo[b]fluoranthene	2,803
Benzo[k]fluoranthene	1,981
Benzo[a]pyrene	2,792
Perylene	nr
Benzo[ghi]perylene	1,649
Dibenzo[ah]anthracene	795
Indeno[1,2,3-CD]pyrene	1,577
TOTAL	**~50,000**

Source: based on the average of 9 samples provided by the City of Austin

Watershed coal-tar sealant consumption:	1.4 million gallons of coal-tar sealant concentrate *Source: American Coke & Cole Chemical Institute, Bruce Steiner,* probably an underestimate.
Area Sealed/year:	6.5 million m^2

DRAFT – do not cite or reference Coal Tar Parking Lot Sealants, Estimating PAH Releases in the Watershed

	Mahler et al (2005)	City of Austin (2006)
PAH Release Rate:		
Release Rate =	~932 µg/m^2/rain event	~4.3% of material applied/year
Release estimates for the watershed		
PAHs Released/rain Event = **(based on annual consumption)**	6 kg	
PAHs Released/year = **(based on annual consumption)**	760 kg	13,600 kg
PAHs Released/year = **(assuming annual consumption is 1/5 of total paved area)**	3,800 kg	68,000 kg
% Released Over Lifetime = **(assuming replaced every 5 years)**	~1%	~20%
Uncertainties:	-Dissolved PAHs in stormwater -Yields calculated for 1 rain event. - Regional and temporal variances Surface Stress, i.e. driving patterns, snow plowing, snow chains, etc. Only considered commercial surfaces.	-Rate does not account for losses that can not be detected visually, i.e. releases of layered sealant, atmospheric. -Can't apportion releases to atmospheric, particulate, and dissolved in water. -Regional and temporal variances Surface Stress, i.e. driving patterns, snow plowing, snow chains, etc. Only considered commercial surfaces.

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Creosote-treated Wood

Background:

-In 2004, 87 million gallons of creosote were used in the U.S. to treat wood {Vlosky, 2006 #472}

-Use Breakdown {Vlosky, 2006 #472}.

- -55% railroad ties
- -30% utility poles
- -14% fence posts
- -0.17% marine piling

PAH content of Creosote:

-Contains ~80% PAHs

(approximately 20%-40% Priority PAHs).

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Creosote-treated Wood: Emission Factors

Criteria for emissions factors from Creosote-treated wood:

- Peer-reviewed mass balance-based study
- Data presented for several Priority PAHs
- Experimental conditions clearly described

On-land uses:

Kohler et al 2000 (“Inventory and Emission Factors of Creosote, Polycyclic Aromatic Hydrocarbons (PAHs), and Phenols from Railroad Ties Treated with Creosote”)

In-water uses:

Selected loss data from Bestardi et al. 1998 (“Distribution and Composition of Polycyclic Aromatic Hydrocarbons in Experimental Microcosms Treated with Creosote-Impregnated Douglas Fir Pilings”)

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Creosote-treated Wood: On land Uses Emission Factors

Procedure:

1. Computed a first-order PAH loss parameters, k, from WEI-A treated Beech ties for 4 PAHs corresponding with PAH loss data reported at 1, 6, and 32 years (Kohler et al. 2002, Table 2)
2. Compare k values with PAH physical properties including octanol-water partition coefficient (K_{ow}), aqueous solubility, and vapor pressure. Best predictor of PAH loss parameter is K_{ow}.
3. Estimate k values for remaining PAHs based on relative log K_{ow} values
4. Compute estimated releases of all PAHs over 30 years (total: 37%)

Uncertainties and Limitations:

1. K_{ow} may not be a good predictor of loss rate for all PAHs
2. Losses from ties may over-estimate losses from poles and under-estimate losses from fences because of different geometry
3. Swiss environmental conditions differ from those in New York area
4. Results may differ for other creosote-treated products with different wood type, seasoning, creosote formulation, and creosote treatment conditions.

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PAH Released from Pilings

	Creosote mg/kg	Co g/tie	log Kow	k (est) 1/yr	C@30y g/tie	30y % lost
Naphthalene	9500	152	3.4	0.0326	57	62%
Acenaphthyne	7	0.11	4.1	0.0239	0.05	51%
Acenaphthene	9500	152	4.0	0.0244	73	52%
Fluorene	19000	305	4.2	0.0225	155	49%
Phenanthrene	68000	1091	4.6	0.0177	642	41%
Anthracene	9000	144	4.5	0.0180	84	42%
Fluoranthene	55000	882	5.2	0.0096	661	25%
Pyrene	31000	497	5.2	0.0101	367	26%
Benz[a]anthracene	380	6.1	5.9	0.0010	5.9	3%
Chrysene	340	5.5	5.9	0.0010	5.3	3%
Benzo[b]fluoranthene	96	1.5	6.5	0.0005	1.5	2%
Benzo[k]fluoranthene	67	1.1	6.8	0.0005	1.1	2%
Benzo[a]pyrene	160	2.6	6.5	0.0005	2.5	2%
Perylene	nr	nr	6.5	0.0005	nr	1%
Dibenz[a,h]anthracene	16	0.3	7.2	0.0003	0.3	1%
Benzo[g,h,i]perylene	45	0.7	6.9	0.0003	0.7	1%
Indeno[1,2,3-CD]pyrene	40	0.6	7.7	0.0003	0.6	1%
Total	202151	3242			2058	
Percent	20%				63%	37%

assume 50% rate of 4-rings

assume 50% of rate of 5-rings

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Creosote Emissions from in-Water uses (Pilings)

State	Pilings ft^3/yr *	PAHs Released (kg/yr)[¥]
	Watershed	
New York	4,269	1,320
New Jersey	2,159	630
Total	**6,428**	**1,950**

*Source: Extrapolated from estimated US production published in Vlosky, 2006, based on the number of marinas reported to the 2004 Census. It is assumed that all of the pilings produced in the U.S. are consumed in the U.S.

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PAH Emissions From Creosote Treated Wood, Railway Ties and Utility Poles

	Railways ties treated with creosote*	**PAHs released (kg/yr)**
	Watershed	
New York	5,557,280	219,341
New Jersey	2,487,917	98,196
Total	**8,045,197**	**317,536**

*Source: Railway Tie Association

	Poles Treated With Creosote* (1,000)**	**PAHs released (kg/yr)**
	Watershed	
New York	698	146,960
New Jersey	245	52,919
Watershed	**933**	**199,879**

**Source: Pole miles reported to *UDI Directory of Electric Power Producers and Distributors, 28 poles/mile, and that 21% of the replacement poles are creosote.*

Next Steps

- Synthesis Report – Spring 2007
- Goal
  - Based on lessons learned to date describe how an industrial ecology approach within a collaborative watershed-based consortium can achieve real environmental outcomes
  - Consortium has expressed interest in the development of this document as has Region 2 and HQ.
- Objectives - Under Discussion
  - Compare and Contrast industrial ecology case studies carried out to date
  - Better understand the inherent opportunities and barriers to implementing P2 strategies in NY/NJ watershed
  - Describe the fundamental steps, data, and necessary conditions to apply an industrial ecology assessment within a watershed
  - Describe important considerations when pursuing science within a collaborative multi-stakeholder Consortium
- Outputs
  - Report
  - Workshop

Recognition

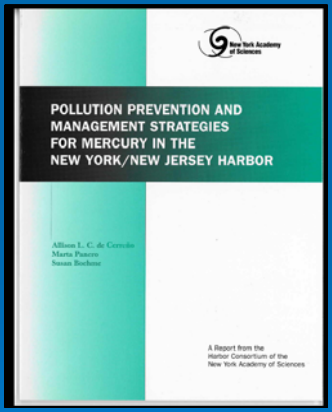
- **MVP2 Award (Most Valuable Pollution Prevention Writing Award) -- 2004**
  (awarded by the National P2 Roundtable)
- **Trees for the Future (carbon offset for the publication of mercury report)**
  (awarded by Trees for the Future, non-profit organization) -- 2004
- **Gordon Conference on Industrial Ecology (invited speaker) -- 2004**
- **EPA R2 Environmental Quality Award -- 2005**
- **International Society for Industrial Ecology – Stockholm 2005.**

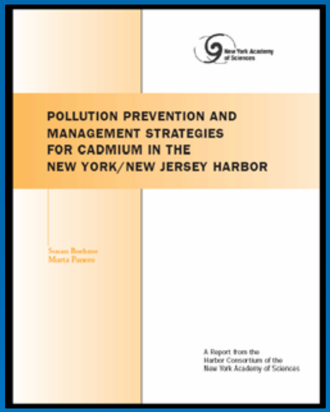
Funding:

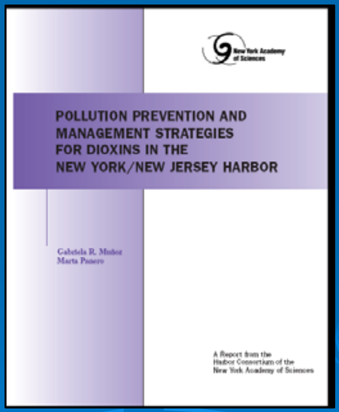
- Abby R. Mauzé Trust
- AT&T Foundation
- Commonwealth Fund
- U.S. Environmental Protection Agency
- J.P. Morgan
- NYC Environmental Fund
- NYS Energy Research and Development Authority
- Harbor Estuary Program
- Port Authority of NY/NJ
- Rockefeller Philanthropy Associates

NYAS Harbor Program reports

http://www.nyas.org/programs/harbor.asp







The PAHs are coming………