Research Update: Nutrient Management and Control

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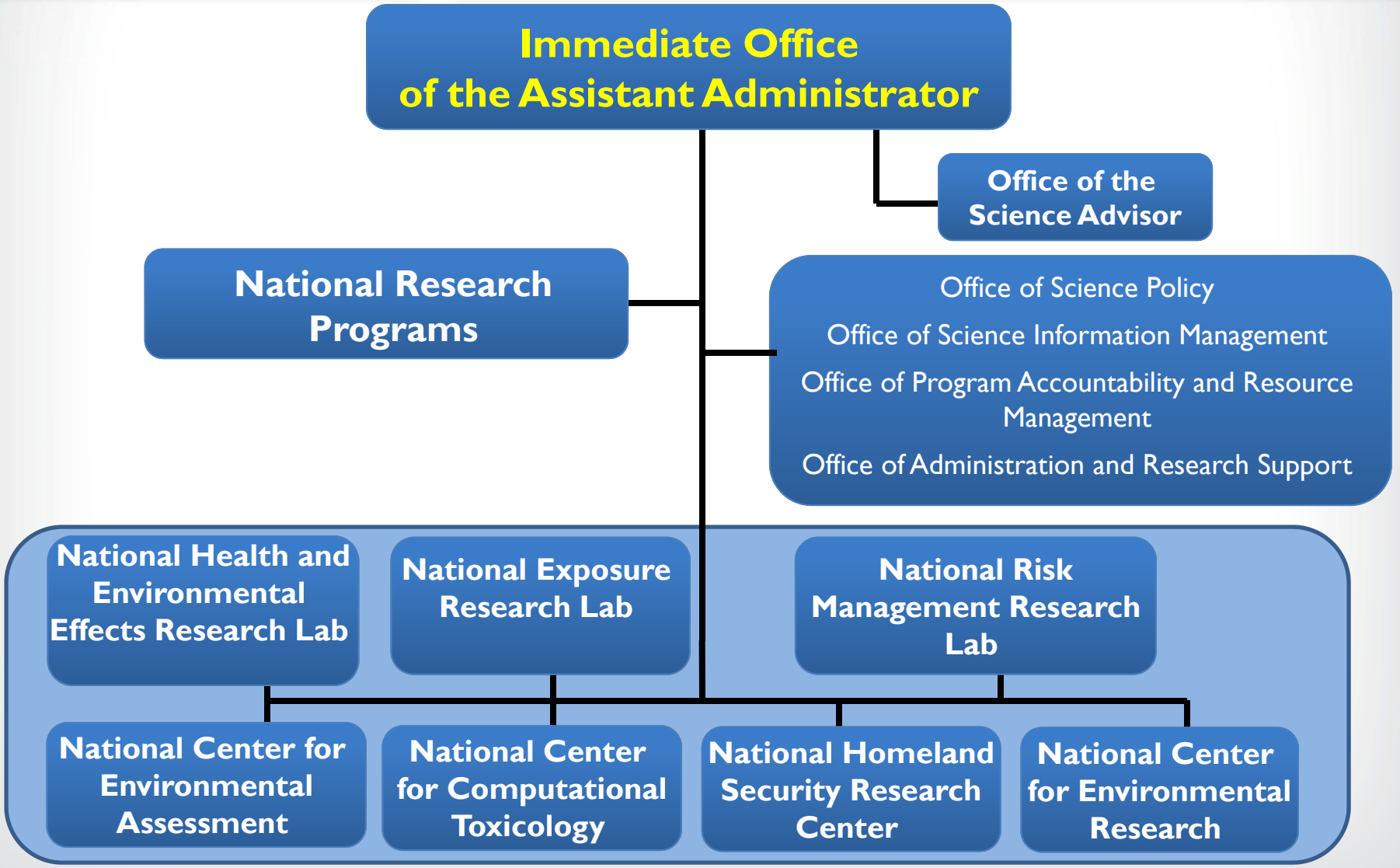
Presentation Outline

- U.S. EPA, ORD Overview
- Research Plans – Safe and Sustainable Water Program
- Project Examples:
  - Green Infrastructure Performance Monitoring
  - LCA of Nutrient Control Technologies
  - Nutrient Control Design Manual
- Accessing Research Results and Tools

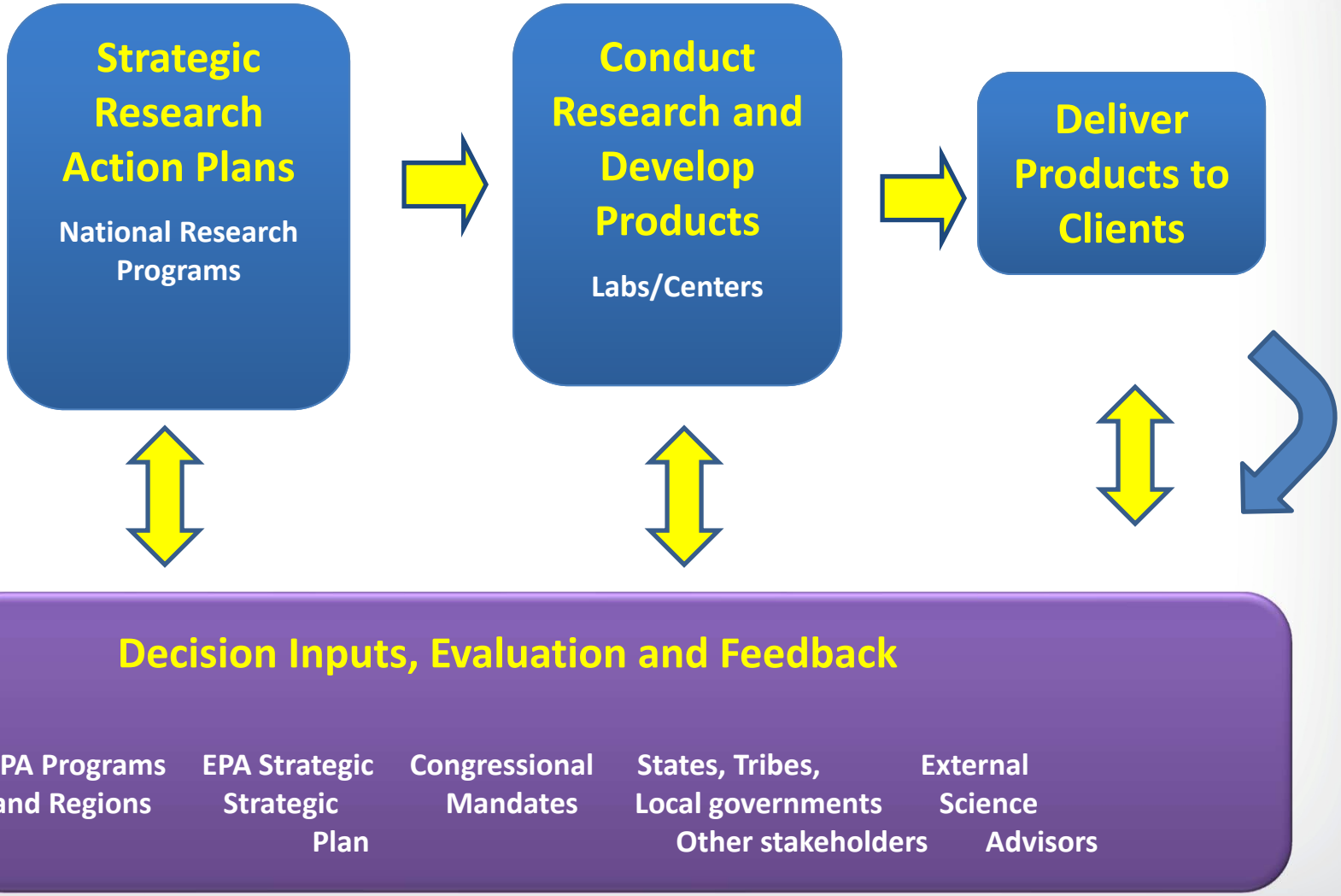
ORD Organizational Chart



Our Mission

Provide the science, technical support, technology, and tools to inform EPA's mission to protect public health and the environment

How ORD Develops its Research Programs



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Safe and Sustainable Water Resources

STRATEGIC RESEARCH ACTION PLAN 2016-2019

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SSWR Research Topics and Projects

- **Watershed Sustainability**: ambient water quality criteria; energy and mineral resources; scalable tools and methods for integrated assessment and management; national water quality benefits.
- **Nutrients**: thresholds and targets for appropriate nutrient levels; management tools and practices; metrics; harmful algal blooms.
- **Water Systems**: current and transformative systems; emerging contaminants in drinking water and sources; technology advances.
- **Green Infrastructure**: models and tools; community benefits; linkage to aquifer storage and recovery.

USEPA Nutrients Research in Cincinnati: Monitoring GI Performance at sites in the Mill Creek Watershed

Sites, periods of monitoring data collection:

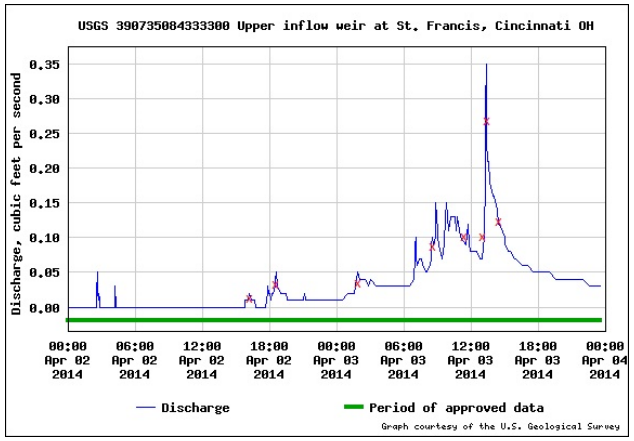
Lick Run - St. Francis Apartments Rain Garden, 2012-2015

Congress Run - Stream restoration and daylighting, 2016 - present

- Hydrology monitoring by Inter-Agency Agreements with USGS.
- Base-flow sampling (monthly) and storm event sampling (8-10 events per year).
- Flow-proportional and timed sample collection (paired ISCOs), minimum of 8 sample times per location and storm event.
- GCLAS used to estimate storm event load totals.
- Data being used to calibrate and validate GIFMod rain garden module.

Lick Run; Rain Garden (Project Groundwork).

Congress Run; Daylighting and Restoration



Nutrients and methods (by Lachat FIA):

Total N	AWWA 4500 N_{org} D / USEPA 353.2
Total P	AWWA 4500-P B.5 / USEPA 365.3,
DRP	USEPA 365.1
NO_2-NO_3	USEPA 353.2
NH_4	USEPA 350.1

Also: TOC, DOC, TSS, VSS, SSC, COD, Turbidity, pH, Temp., DO, SC, ORP, metals, anions, e. coli, and total coliforms for each sampled time and location at both field sites.

LCA of 5-Level Nutrient Removal Treatment Train

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Level	Total Nitrogen, mg/l	Total Phosphorus, mg/l
1	*	*
2	8	1
3	4-8	0.1-0.3
4	3	0.1
5	<2	<0.02

Level	Type of Biological Treatment	Phosphorus Precipitation	Fermenter	Sand Filter	Other
1	Plug Flow Activated Sludge				
2	Anaerobic/ Anoxic/Oxic				
2	Activated Sludge, 3-Sludge System	√			
3	5-Stage Bardenpho	√	√	√	
3	University of Cape Town Process, Modified	√	√	√	
4	5-stage Bardenpho	√	√	√	Denitrification Filter (100%)
4	4-stage Bardenpho Membrane Bioreactor	√			
5	5-Stage Bardenpho	√	√	√	Denitrification Filter (10%) Ultrafiltration And Reverse Osmosis (90%)
5	5-stage Bardenpho Membrane Bioreactor	√	√		Reverse Osmosis (85%)

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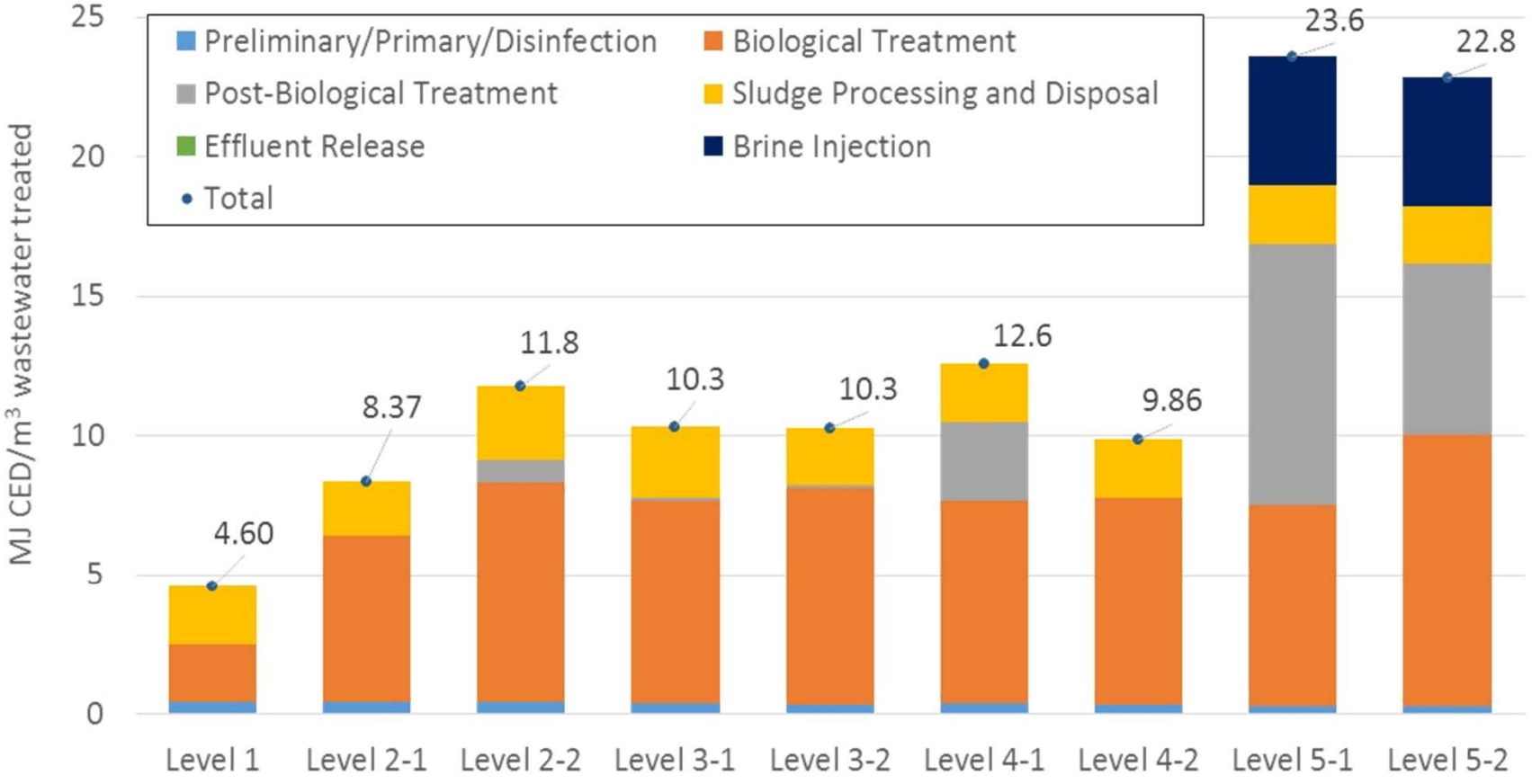
Cumulative Energy Demand



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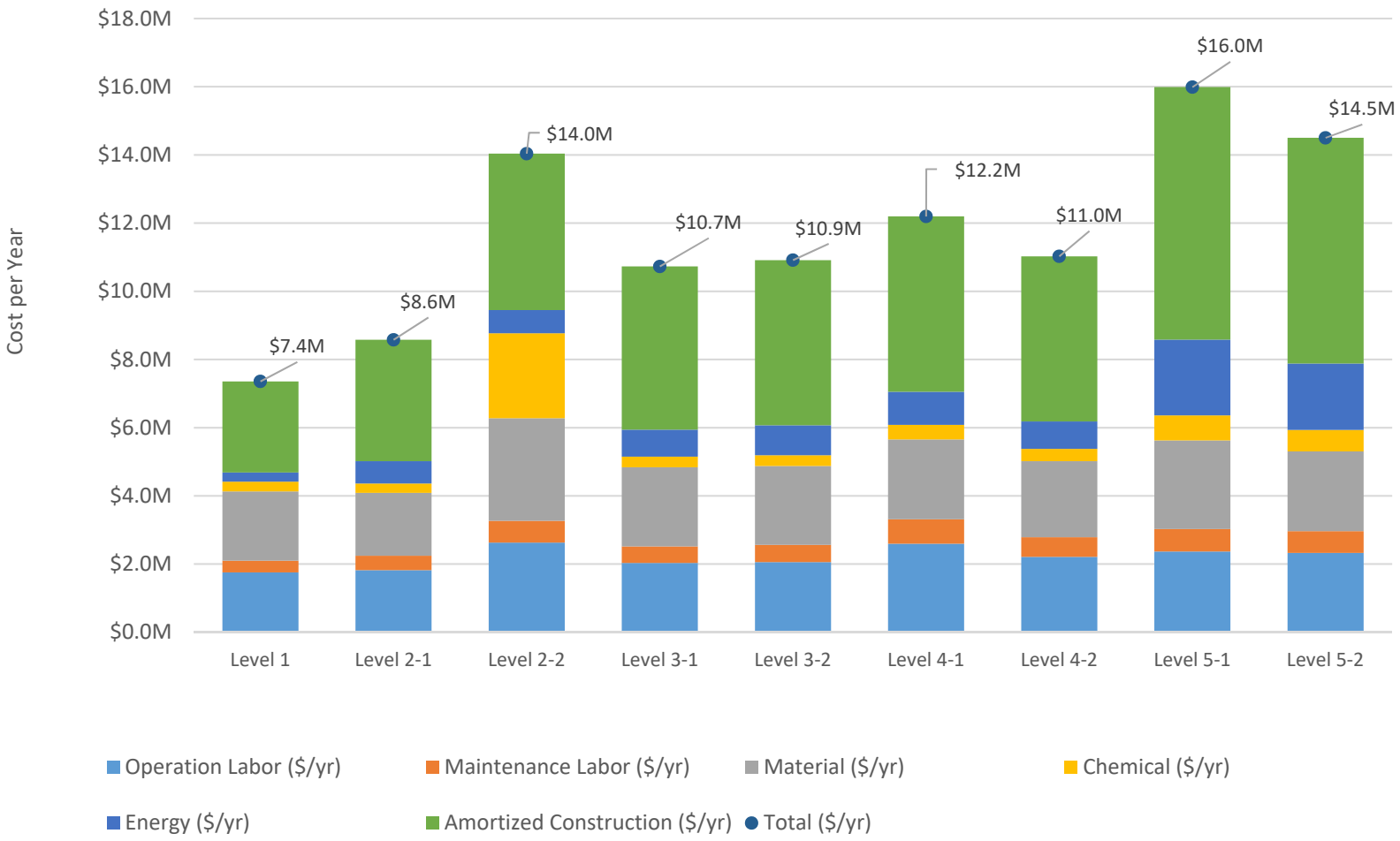
Annual Life Cycle Costs



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History of Nutrient Control Design Guidance at ORD

- Nitrogen Control
  - Process Design Manual for Nitrogen Control – 1975
  - Manual – Nitrogen Control - 1993
- Phosphorus Control
  - Process Design Manual for Phosphorus Removal – 1971
  - Process Design Manual for Phosphorus Removal – 1976
  - Design Manual – Phosphorus Removal – 1987
  - Handbook – Retrofitting POTWs for Phosphorus Removal in the Chesapeake Bay Drainage Basin - 1987

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ORD's Latest Nutrient Control Technology Design Guidance

- January 2009 – Nutrient Control Design Manual: State of Technology Review Report (EPA/600/R-09/012)
- August 2010 – Nutrient Control Design Manual (EPA/600/R-10/100)

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Nutrient Control Design Manual Contents

- Need for Nutrient Control
- Principles
  - Phosphorus Removal by Chemical Addition
  - Biological Nitrogen Removal
  - Biological Phosphorus Removal
- Technology Overview
  - Nitrogen Removal
  - Phosphorus Removal
  - Combined N/P Removal
  - Effluent Filtration

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Nutrient Control Design Manual Contents (cont'd)

- Design
  - Objectives
  - Process Selection
  - Design Approaches
    - Phosphorus Removal by Chemical Addition
    - Biological Nutrient Removal
    - Effluent Filtration
- Operation and Optimization
- Instrumentation and Control
- Sustainable Nutrient Recovery and Reuse

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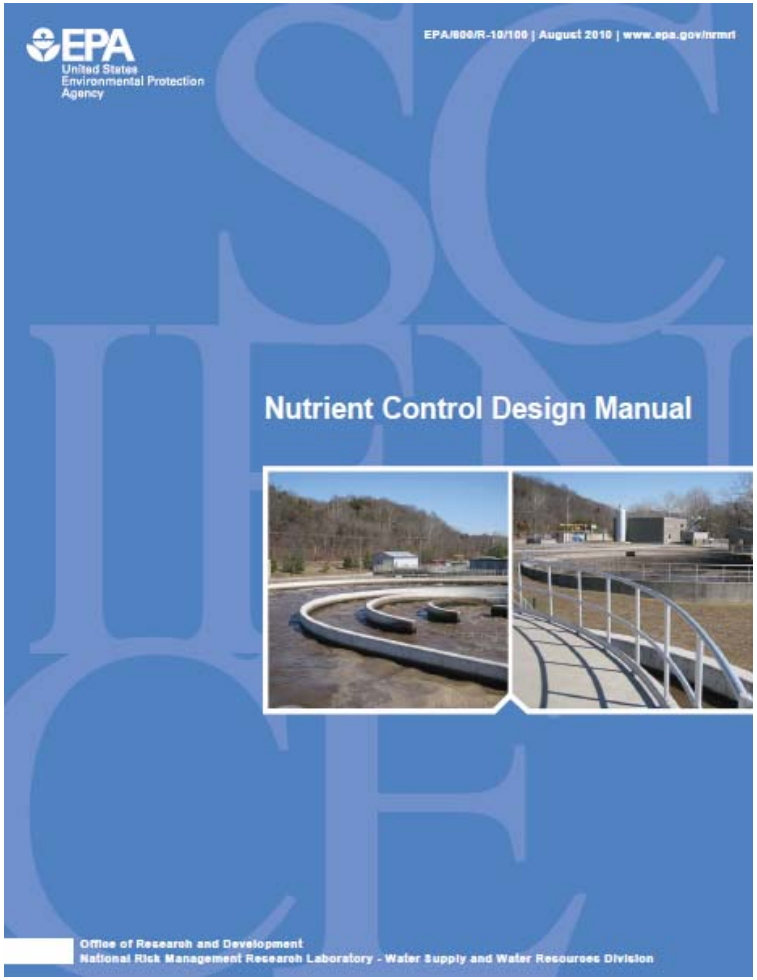

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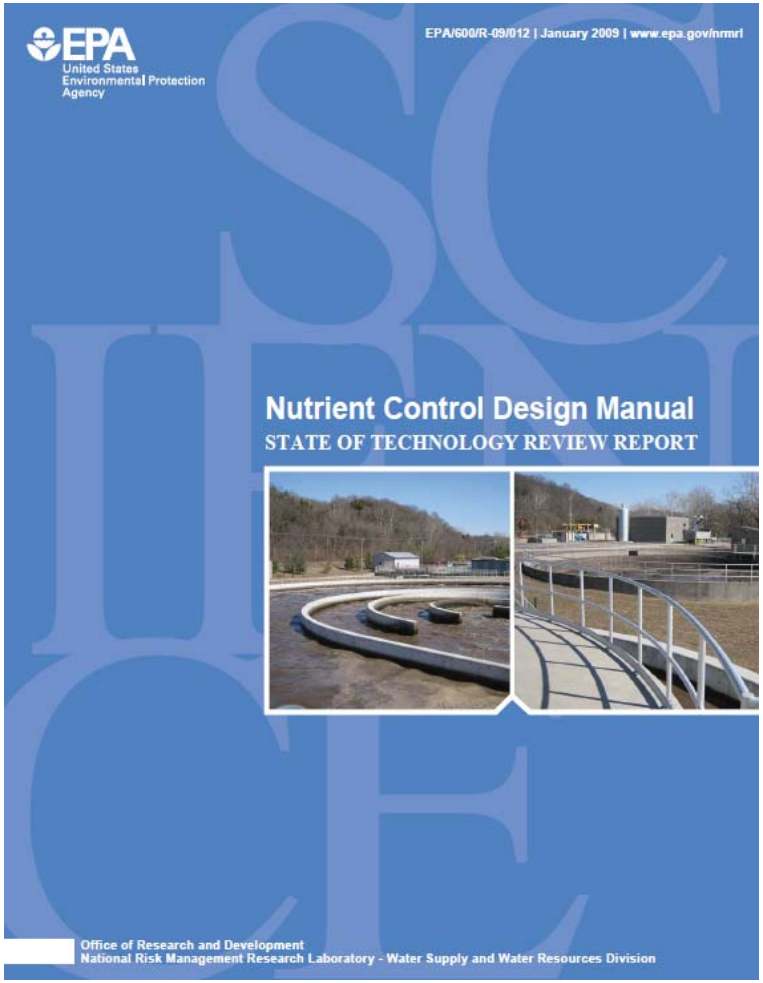

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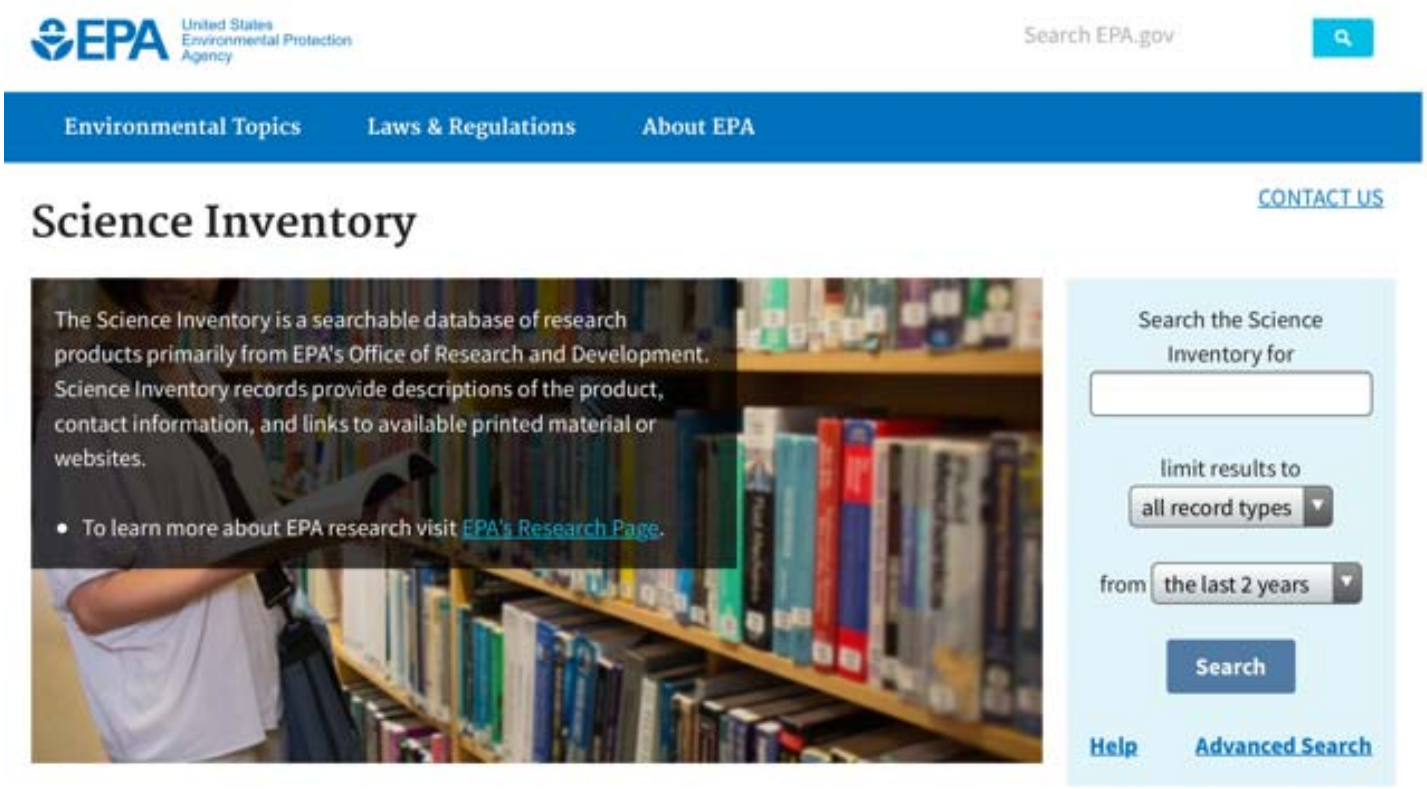
U.S. EPA's Science Inventory



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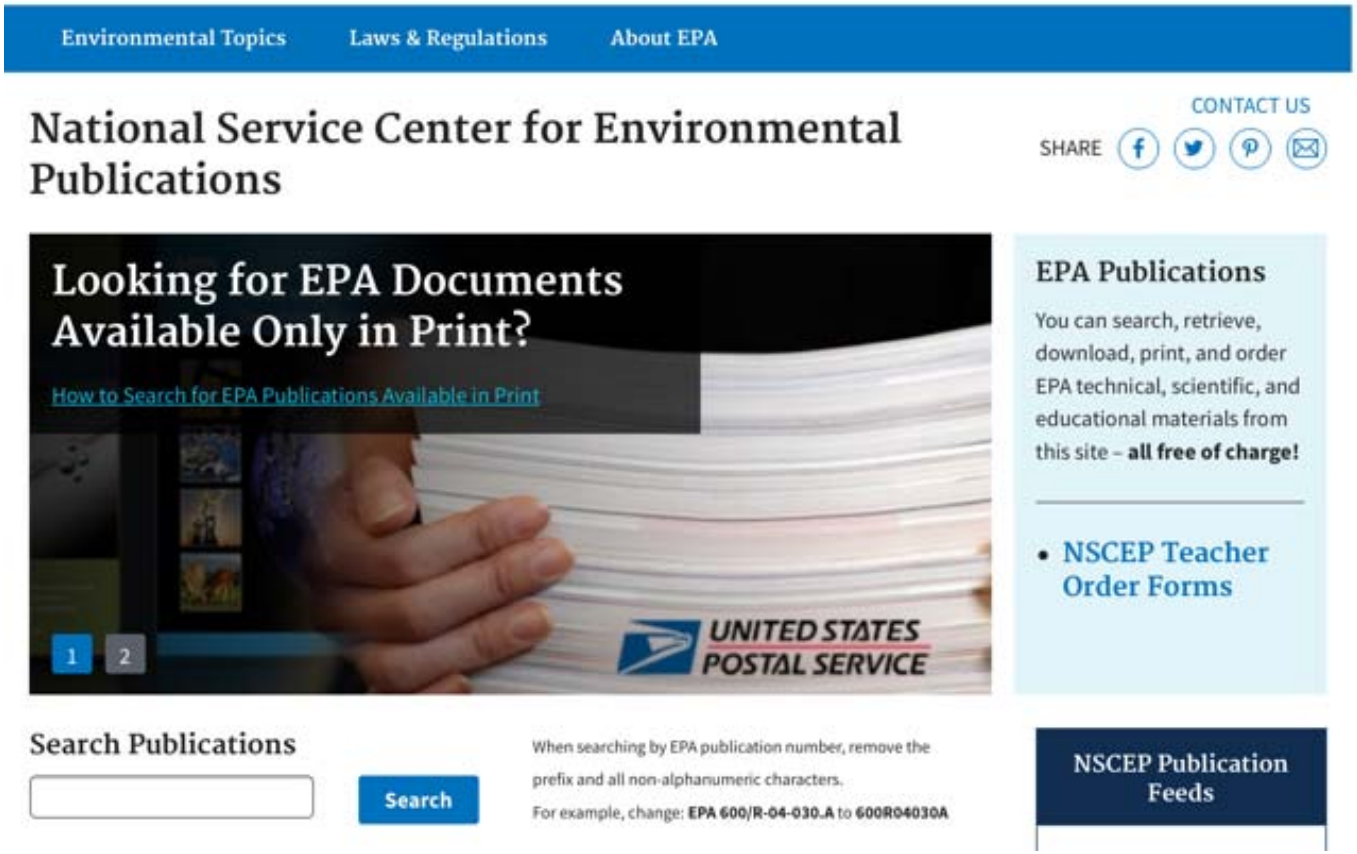
U.S. EPA's Online Publication Warehouse



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