附件三

「臺美環保技術合作協定雙年會」簡報

International Environmental Partnership
Site Remediation

Chihwei Chang(Ph.D.)
Senior Environmental Technology Sp…
Environmental Protection Adminis…
Executive Yuan, R.O.C. (Taiwan)

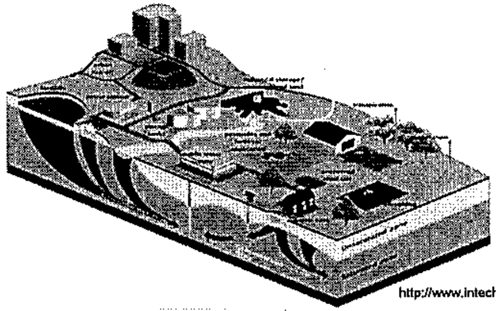
Outline

Site Remediation

International Environmental Partnership

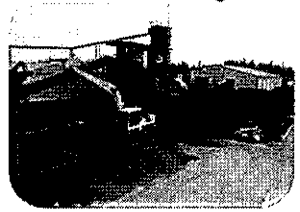
Future Outlook

Site Remediation

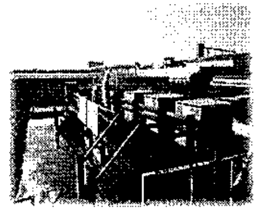


http://www.intechopen.com/

Thermal Treatment



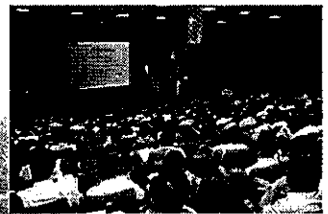
Wet (Separation) Treatment



Phyto/bio Treatment

International Environmental Partnership

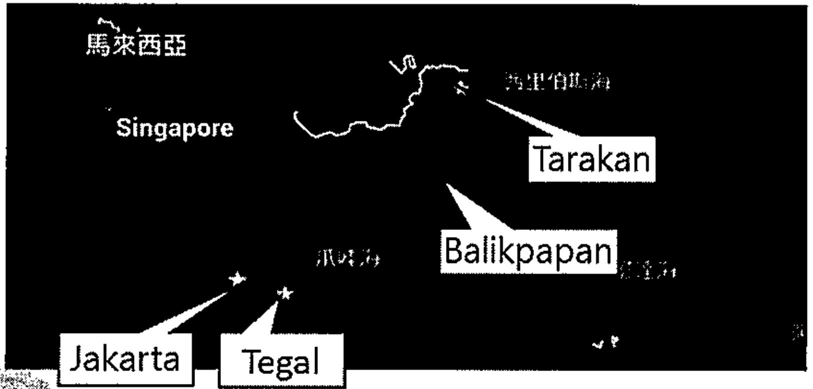
Share knowledge and experience among Taiwan, USA and other countries through meetings, field investigations, and remote conferences.



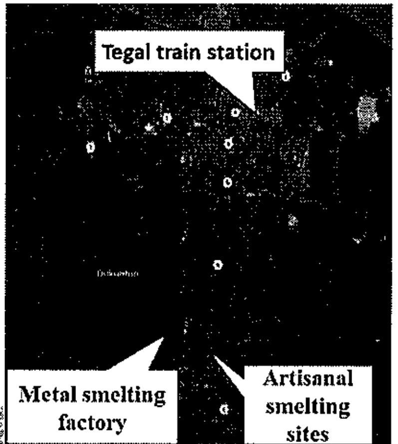
Annual Training Workshop

Field Study

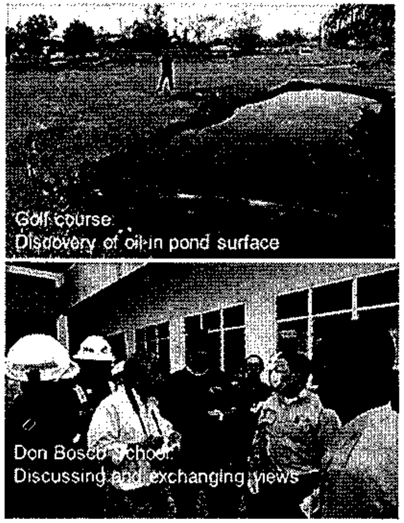
Collaboration with Indonesia



On-Site Investigation for Tegal Site



On-Site Investigation for Tarakan Site



Future Outlook

EPAT and USEPA will collaborate with other countries on site remediation through forum, workshop, training course, and technical assistance assignment.


THANK YOU FOR

Cities Clean Air Partnership (CCAP) & Bilateral cooperation on air quality protection

USEPA – EPAT
Biennial Program Review
Washington D.C.

August 11, 2015

Jia-Hua Yang

Department of Air Quality Protection and Noise Control
Taiwan Environmental Protection Administration

Cities Clean Air Partnership (*CCAP*)

CCAP is an initiative of

CLEAN AIR ASIA

Supported by the International Environmental Partnership (IEP)

CCAP Launch in August 2014

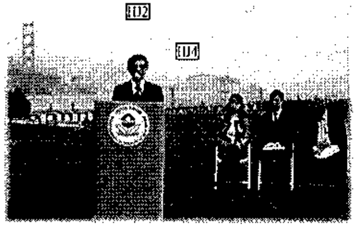
- CCAP was launched in San Francisco by Clean Air Asia, USEPA, EPAT, together with initial partners from Bay Area and South Coast Air Quality Districts

Elements of CCAP

- **C3 (city-to-city cooperation)**
  Sponsor peer-to-peer learning and technical assistance to cities
- **Knowledge platform & Experts database**
  Facilitate city learning and projects with online information, resources and tools (including CCAP exclusive experts database)
- **City certification**
  Provide incentives and recognition for city level clean air actions

Key Outputs (1/2)

➤ **2014**
- CCAP program launch in San Francisco
- Consensus reached on the three major elements of CCAP
- International consultation at Better Air Quality conference in Sri Lanka.
- Experts database wireframes drafted



投影片 5

HJ1 the registration form is not a significant output nor are the specific steps cities take to partner. this should focus on what was acomplished progammatically and substantively

HJ2 As I've said we have not confirmed which of the cities will be partnered with San Diego and San Jose. When we have that information you can add it to the presentation. Also this is supposed to be an international platform so its important to note Kitakyushu and Haiphong

HJ3 you should mention here what organziations joined the consultation .

HJ4 what's the output for certification this year? please ask CAA and include it

Key Outputs (2/2)

➤ **2015**
- Partnering program construct developed
- Experts database goes online
- C3 Program guidance and Action Lists for cities piloted
- First meeting of CCAP cities in Taipei in April 2015
- Potential cities partnered under the pilot program
- Core Experts group begins work on certification
- Woodrow Wilson Center fellows begin research on certification issues
- Governance structure is in place
- Criteria or list of actions are vetted by experts and undergo stakeholder consultations
- At least 10 cities volunteer in 2015 to be the inaugural (pilot) cities to undergo certification in 2016

List of countries / cities currently participating

C3 participants	Matching cities
Taiwan (5) Keelung, Taipei, Taichung, Tainan, Kaohsiung	**Confirmed by CAA** Taipei City with Pasig City Haiphong City with Kitakyushu City
Vietnam (1) Haiphong City	
Philippines(1) Pasig City	**Confirming (process is ongoing)** Bangkok City with a US city Taichung City with a US city
Japan (1) Kitakyushu City	
Thailand (1) Bangkok City	
US (2) San Diego, San Jose	

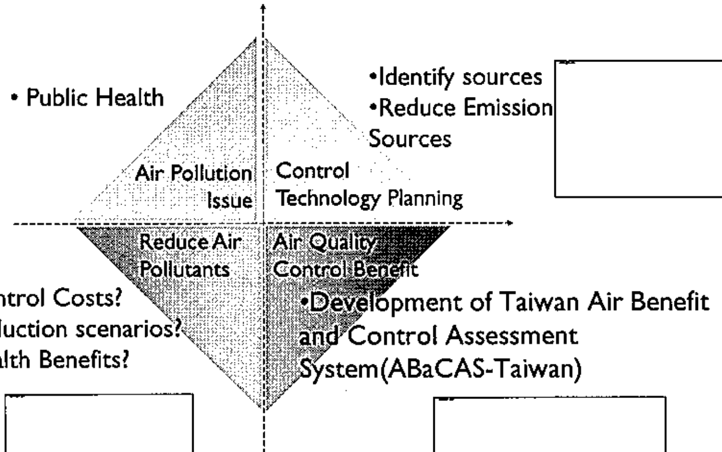
Bilateral Cooperation

Air quality modeling – ABACAS/BenMap

ABaCAS is an initiative of

Supported by the International Environmental Partnership (IEP)

Air Quality and Health Benefit Assessment



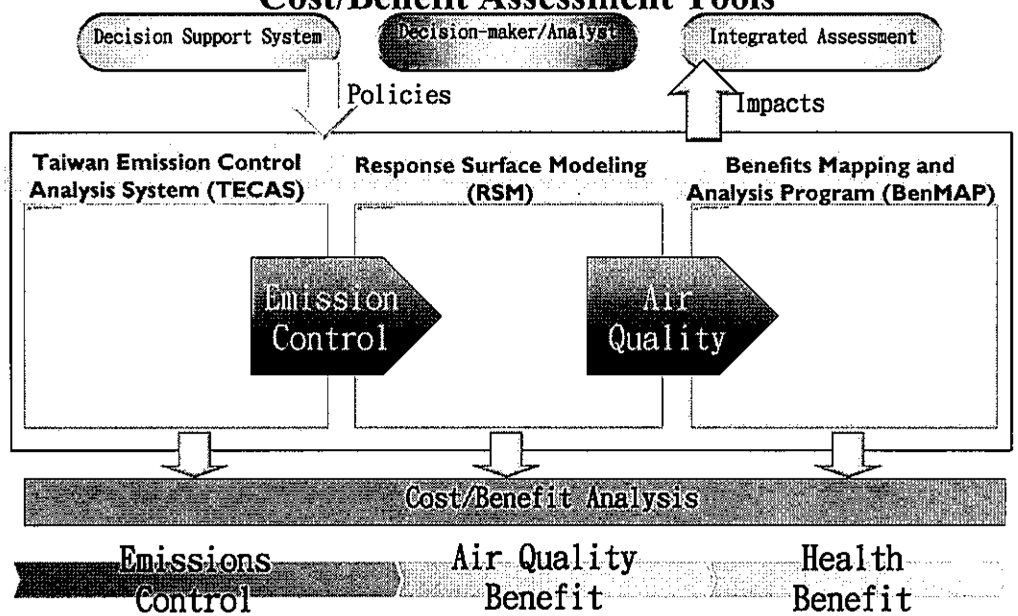
Development & Application of ABaCAS-Taiwan

TECAS | RSM/CMAQ | BenMAP-CE

Technology transfer and capacity building by Dr. Carey Jang of U.S. EPA and Professor Joshua Fu of University of Tennessee.

2005	• Taiwan Emission Cost Analysis System(TECAS) • CMAQ applications
2010	• Application of Taiwan clean air plan on TECAS
2011	• Preparing for ABaCAS Taiwan, data collection, Modeling training.
2013	• TECAS improvements, ABaCAS-Taiwan capacity building, database, BenMAP-CE & RSM/CMAQ applications, demon and documentation, training courses
2014	• ABaCAS-Taiwan pilot application, demo & documentation, training workshop.
2015	• ABaCAS-Taiwan application, support PM2.5 control policy analysis, training and hands-on workshop.

Effective AQ Management Requires Scientifically Sound Cost/Benefit Assessment Tools



Air Benefit and Cost and Attainment Assessment System-Taiwan (ABaCAS-Taiwan)

ABaCAS-Taiwan

TECAS

Provide Emission Control Cost Analysis and Estimate

- ABaCAS-Taiwan include Taiwan Emission Control Cost Analysis System(TECAS), Response Surface Modeling(RSM) and Benefits Mapping and Analysis Program (BenMAP).
- **TECAS Modification:**
  - Import Taiwan Emission Data System(TEDS).
  - Import Taiwan Emission Control Cost
  - Translation Chinese
  - Integrated with GIS

Air Benefit and Cost and Attainment Assessment System-Taiwan (ABaCAS-Taiwan)

RSM

- 3km x 3km resolution of Taiwan Region simulation was imported
- Emission sources of NOx, SOx, VOC, PM, NH3 can be evaluated now in RSM

BenMAP

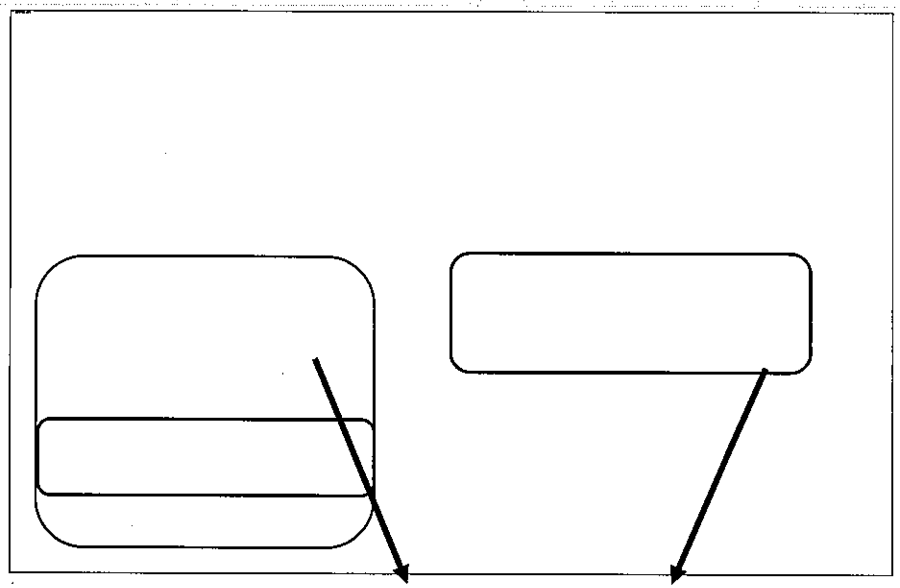
Provide Real-time Air Quality Response of Emission Control

- Taiwan-related databases was imported
- Traditional Chinese version was completed

Provide Health Impacts and Economic Benefits Estmate

"ABaCAS" : Air <u>Benefit</u> and <u>Cost</u> & <u>Attainment</u> Assessment System

(AQ Decision Support Tools Session by Dr. Carey Jang, 8/11, 3:00-4:30 pm)



Developed for "Scientists" and "Policy4Makers"

The Challenges and limitations for ABaCAS

➢ **Feasibilities**
- Using Air Quality Model simulations of health benefits analysis

➢ **Challenges**
- Investigate local emissions, control measures, control cost
- Establish Air Quality Model simulations
- The Establishment of detail Health Data by township level
  - Providing detail data pf outpatient visits, emergency room visits, and hospital admissions
  - Medical cost data of National Health Insurance are available
  - Cause of death data recode all cases of death
  - Cancer registry data recode all cases of cancer
- Local air pollution epidemiology studies
  - Long-term exposure study: Cohort(mult-icities, multiple pollutants)
  - Short-term exposure study: time-series, case cross over

➢ **Limitations**
- The value of a statistical life is not the actual personal value of life.
- Cost of illness calculating by National Health Insurance, not including non-NHI expenditure.

Prospect

- The integrated ambient air quality management plan for PM2.5 reduction should be developed by considering (1) emission sources, (2) geophysics and meteorology, (3) public health impact, (4) control measures, (5) cost effectiveness, and (6) outcome assessment.
- ABaCAS-Taiwan still need to add emission control measure and build control cost of NH3, and add area source of $PM_{2.5}$ emission factor design for RSM, to facilitate $PM_{2.5}$ control cost analysis and Public Health Data and Economic Data to assessing health benefits.
- Forward the Taiwan EPB using the system to assess air quality policy management, effective assessment of the public health risks and the economic costs benefits control

US EPA-EPAT
High-level Briefing

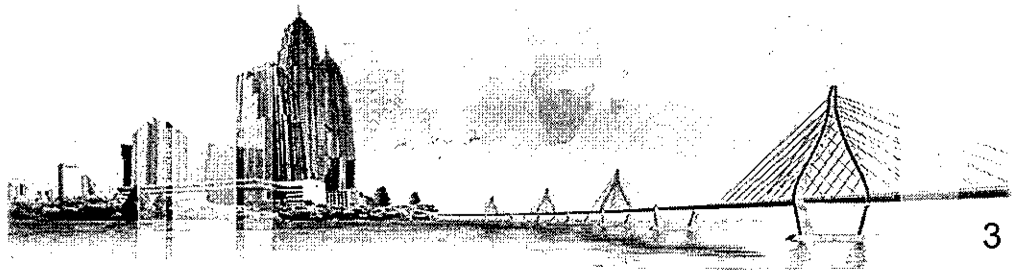
Taiwan's Climate Change Mitigation and Adaptation 2014 Achievements and 2015 Plans

Dr. Hui-Chen Chien
Executive Director, GHG Office
Environmental Protection Administration, Taiwan

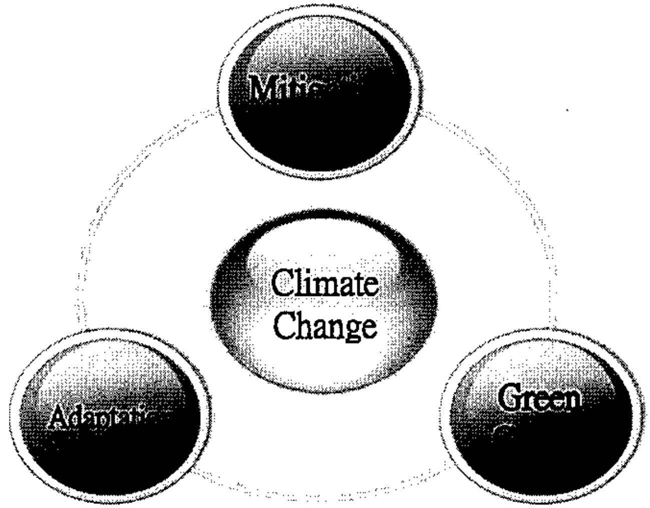
OUTLINE

1. Taiwan's Climate Change Policy and Achievements
2. IA 10 and 11
   - Activity 2 Air Quality protection, GHG emissions mitigation and global sustainability
   - Activity 5 Climate Change and Adaptation
3. International Partnership of IA-11

Taiwan's Climate Change Policy and Achievements



Greenhouse Gas Reduction & Management Act Vision



GHG Act Emission Reduction Target

Long-Term Goal

- Reducing greenhouse gas emissions by 50% below its 2005 level in 2025.
- This goal will change based on international and domestic conditions

Reduction Targets for Every Five Years

- Determined by principles governing selection of targets and control methods
- An advisory committee of diverse stakeholder representatives helps government to set these principles

Key Legislation and Frameworks

Mitigation

- Energy Management Act
- Renewable Energy Development Act
- GHG Reduction and Management Act
- Energy Tax Act (draft)

Adaptation

Strategic Framework on Climate Change Adaptation

- Disasters
- Health
- Agriculture & Biodiversity
- Energy Supply & Industry
- Infrastructure
- Water Resources
- Land Use
- Coastal Areas

Reduction Strategy Timeline

Legal basis	Air Pollution Control Act	GHG Reduction and Management Act	
	Mandatory reporting & voluntary reductions	Performance standard rewards	Cap-and-trade
Control threshold	• Specified industries • Emissions over 25,000 tons of CO_2e	Regulated emission sources	Reductions in responsibilities for emission sources
Management measures	• Emissions reporting • Verification bodies management • Early action, offset	• Set performance standards rewards • Encourage voluntary reductions	• Gradual transition from free allocation to sales • Emission credit auction and trading system

Competent Authorities

	Mitigation	Adaptation
Executive Yuan	GHG Reduction Action Plan	National Adaptation Policy Framework
Administrative Authorities	GHG Emission Control Action Program	Climate Change Adaptation Action Plan
Local	GHG Control Implementation Plans	Adaptation Assessment

IA 10 and 11

IA10 – 2014 and 2015 activities

IA11 – 2016 activities and onwards

IA10 - IA11

Activity 2: Air quality protection, GHG emissions mitigation and global sustainability

Mitigate / enhance GHG emissions from targeted activities and sectors, promote sustainability in the U.S. and Asia-Pacific regions.

Activity 5: Climate change and adaptation

Establish platform and sharing mechanisms for policy-making and implementation processes, and tools to enhance resilience.

Activity 5(IA 10)

Outcome

- Invited 19 foreign experts and national officials from US, Pacific island states, and Southeast Asian countries.
- Discussed climate change vulnerability and resilience as well as methods and tools for climate change adaptation.

Mechanism

- Establish adaptation partnerships.
- Promote inter-regional climate services and information exchange
- Establish tools to analyze climate change effects.

Cooperation

- International partnerships.
- Organizational frameworks.
- Platforms and sharing mechanisms.

Challenge

- Climate service model with big data and open data.
- A platform on climate information for exchange.

Activity 2(IA 10)

Outcome

- Arrangement #10 for technical cooperation in environmental protection between TECRO and AIT.
- Taiwan EPA and USEPA workshop to conduct review and experience sharing on GHG reporting systems.

Mechanism

- Successful series of discussions on GHG policies and reporting tools.
- USEPA agreed to provide materials to assist Taiwan EPA in improving its system.

Future Plans

- Hold workshop sessions with USEPA to discuss further relevant documents.
- Establish electronic verification checks for online reporting system.
- Set emissions benchmark values for voluntary offset programs.

Challenge

- Establish common MRV standards
- Create specific calculation methodologies for sectors

International Partnership of IA-11

Activity 5

2015 → 2016-17 →

Consensus building (2015)

- ☐ Workshop and forum in Vietnam on Climate Change Adaptation.
- ☐ Multilateral consensus building meeting
- ☐ Bi-lateral joint implementation projects.

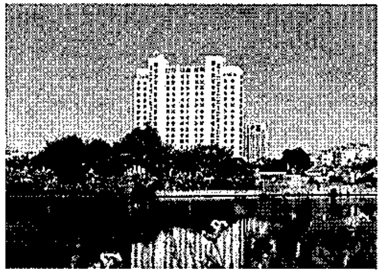
Partnership platform (2016-17)

- ☐ Construction and inception.
- ☐ International non-governmental organization (INGO)
- ☐ Multilateral joint implementation projects.

Regional adaptation network

- ☐ Adaptation Network on Climate Change.
- ☐ An exchange platform for climate information.

Pan-Pacific Partnership on Climate Change Adaptation Workshop



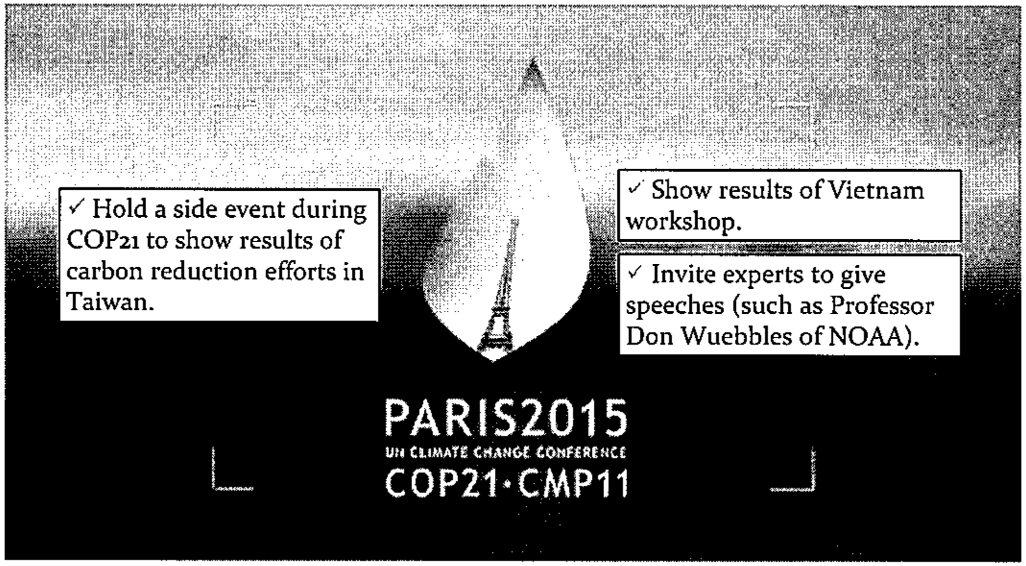
October 2015
Hanoi, Vietnam

Climate data sharing and analytical tools for accessibility of big/open data on climate

Bilateral and multilateral projects under the IEP structure

Cooperation agreement for founding Pan-Pacific Adaptation on Climate Change

Current Priorities for COP21 (2015)

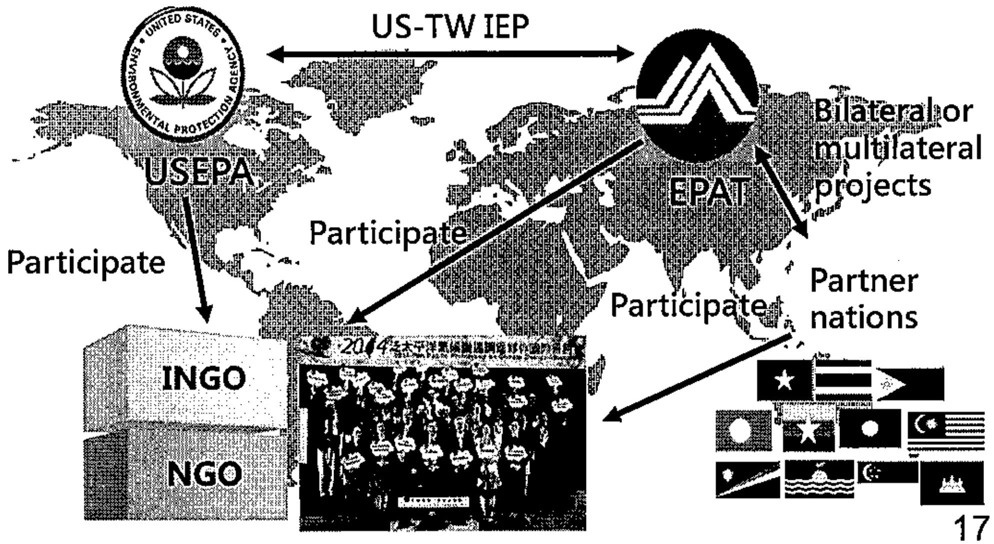


✓ Hold a side event during COP21 to show results of carbon reduction efforts in Taiwan.

✓ Show results of Vietnam workshop.

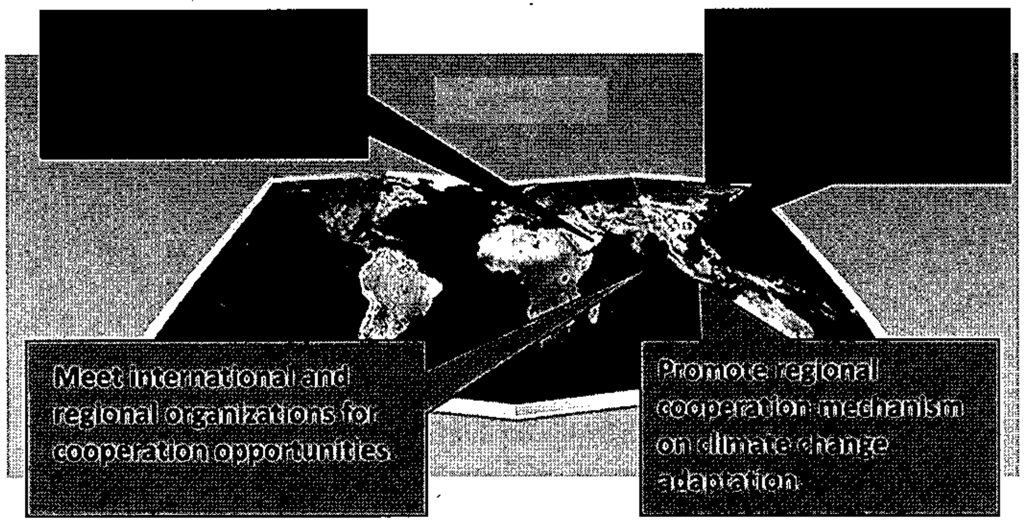
✓ Invite experts to give speeches (such as Professor Don Wuebbles of NOAA).

International Networking



17

Regional Adaptation Network



18

Activity 2

2015 → 2016-20 →

Technical cooperation
- ☐ Technical exchange workshops.
- ☐ Establish bilateral/multilateral MRV related common standards

Partnership
- ☐ Expansion of current common accreditation standards.
- ☐ Certified once, accepted everywhere.

Regional committees
- ☐ Establish committees under current framework.
- ☐ Technical support on MRV.
- ☐ Support countries in the Asia-Pacific region to establish their carbon markets

19

Activity 2 Cooperation Timeline

Sept.2015 — Receive materials

Phase 1 (1 year)

Review info from USEPA:
- Intensity value range for sectors.
- Automatic verification checks data elements.
- Third-party onsite inspection training manuals.

Phase 2 (½ year)

Working with USEPA
- Select & generate verification checks to correspond with subparts.
- Create Taiwan's own verification checks system/program.

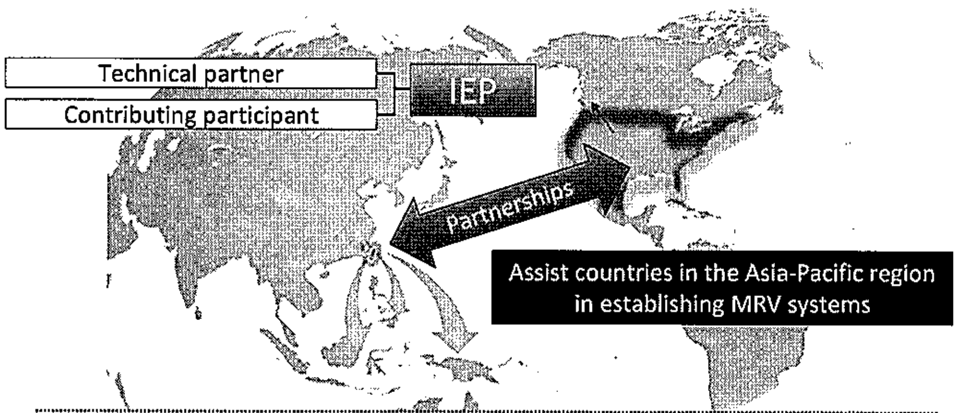
Phase 3 (½ year)

Continued cooperation
- Development of the internal verification program and its online software.
- Enhancement of third-party verification scheme

Also:
- Review MRV program
- Classify source categories into process-level subparts
- Create reporting criteria & emissions calculation methodology

20

Conclusions:



- Continued cooperation between the US and Taiwan.
- Transfer of knowledge and skills to assist countries in the Asia-Pacific region.
- Taiwan serves as technical partner and contributing participant in World Bank Partnership for Market Readiness (PMR).

21

Conclusions:

- Co-host side event at COP21, deploy new solutions on mitigation and adaptation efforts.
- Utilize the strengths of Taiwan and the US to promote island countries' adaptation capacities.
- Through IEP, develop a collaborative framework for climate change to build adaptation in Southeast Asia.

22

Conclusions:

- In the short term, technical collaboration with the USEPA will create the right environment for innovation, especially in deploying an effective reporting program.
- We hope to extend current partnership cooperation to collaborate on future projects.
- Through IEP, we can assist the US by strengthening the working relationships on MRV with countries in the Asia-Pacific Region.

23

Thank you for your attention!

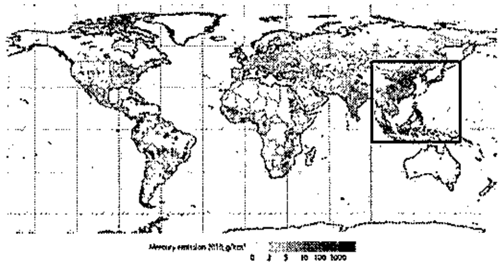
Update on the Asia-Pacific Mercury Monitoring Network (APMMN)

USEPA – EPAT
Biennial Program Review
Washington D.C.

August 11, 2015

Hung-Po Hsu
Department of Environmental Monitoring and Information Management
Taiwan Environmental Protection Administration

Global emissions of mercury from anthropogenic sources, 2010



Region*	Emission (range), tonnes**	%
Australia, New Zealand & Oceania	22.3 (5.4 - 52.7)	1.1
Central America and the Caribbean	47.2 (19.7 - 97.4)	2.4
CIS & other European countries	115 (42.6 - 289)	5.9
East and Southeast Asia	777 (395 - 1090)	39.7
European Union (EU27)	87.5 (44.5 - 226)	4.5
Middle Eastern States	37.0 (16.1 - 106)	1.9
North Africa	13.6 (4.8 - 41.2)	0.7
North America	60.7 (34.3 - 139)	3.1
South America	245 (128 - 465)	12.5
South Asia	154 (78.2 - 358)	7.9
Sub-Saharan Africa	316 (168 - 514)	16.1
Undefined (global total for emissions from contaminated sites)	82.5 (70.0 - 95.0)	4.2
Grand Total	1960 (1010 - 4070)	100

Country	Emission (tonnes)
Cambodia	3.9
China	575.2
Indonesia	78.2
Japan	17.2
Korea	7.1
Laos	1.3
Malaysia	6.1
Mongolia	6.9
Philippines	33.1
Singapore	0.9
Taiwan	5.5
Thailand	14.9
Vietnam	11.6

Source: United Nations Environment Programme (UNEP)
The Global Atmospheric Mercury Assessment: Sources, Emissions and Environmental Transport, 2013

The Mercury Cycle

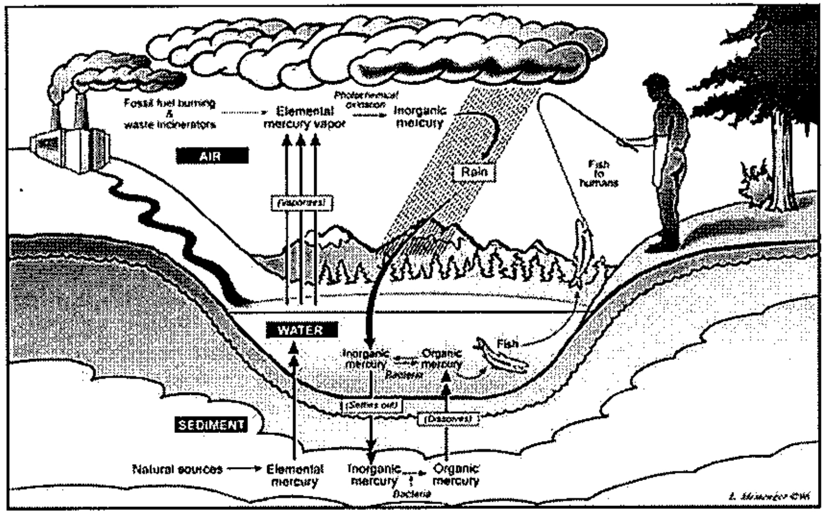
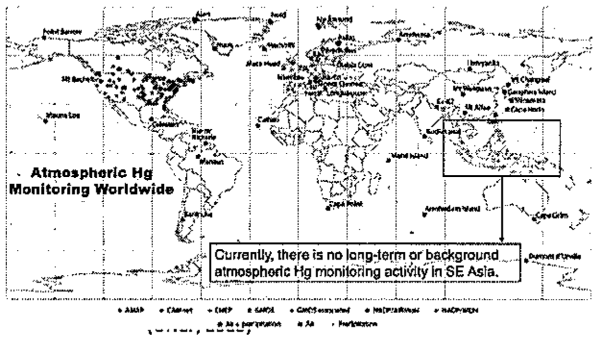


Image: http://www.mercury.utah.gov/atmospheric_transport.htm

Why are we developing the APMMN?

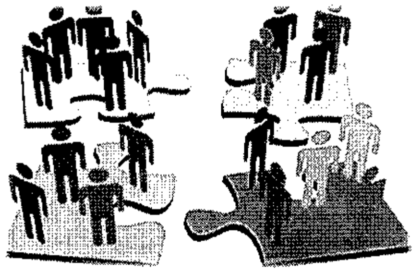
- Minamata Convention expected into force soon
  - Comprehensive Hg reductions expected
  - Provisions for monitoring and effectiveness evaluation
- Despite the magnitude of Hg emissions, few long-term measurements in region
- Many scientific papers published; but limited data
- Accurate and comparable data needed for modeling and assessments
- Opportunity to help other countries
  - Build technical capacity
  - Coordinate regional monitoring



Source: United Nations Environment Programme (UNEP), 2013

What is the Asia Pacific Mercury Monitoring Network (APMMN)?

- A group of countries, agencies, academics and monitoring groups
- Making measurements of mercury in <u>rainwater</u> and <u>air</u>
- Using the same instruments and standard operating procedures across the region
- Sharing data to solve the mercury problem



The purpose of the APMMN is to expand coordinated mercury monitoring capacity in the region

- Determine status and trends of mercury in the ambient air and in wet, dry, and total atmospheric deposition
- Characterize the influence of mercury emissions sources on atmospheric mercury transport and deposition to sensitive areas
- Generate a database for regional and global modeling
- Assist partners in developing their mercury monitoring and assessment capabilities
  - Provide training and demonstration of mercury wet deposition sampling operations

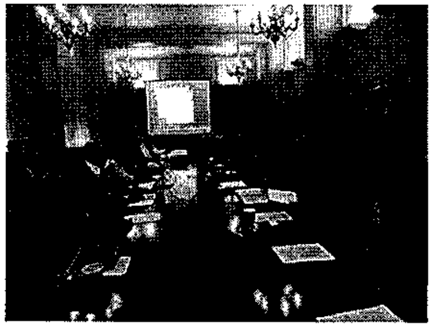
2012 Atmospheric Mercury Monitoring Workshop (Taipei)

Participants
·Canada, Indonesia, Japan, Korea, Taiwan, Thailand, and the U.S

Outcomes
·Identified key monitoring gaps in the region

·Articulated a need for a coordinated network to monitor mercury transport and deposition

2013 Mercury Monitoring Workshop (Washington D.C.)



Participants
·Canada, Indonesia, Japan, Korea, Taiwan, Thailand, Vietnam, and the U.S

Outcomes
·Agreement on major design elements of an operating mercury wet deposition pilot network for the region

·Established a science advisory group

·Devised a preliminary plan for deploying wet deposition collectors in Southeast Asia

2014 Asia Pacific Mercury Monitoring Network Workshop (Vietnam)

Participants
- Canada, Hong Kong, India, Indonesia, Japan, Korea, Philippines, Taiwan, Thailand, Vietnam, and the U.S

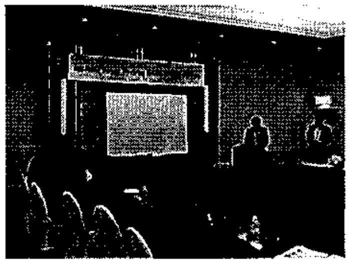
Outcomes
- Completed SOPs for mercury wet deposition
- Proposed pilot sites in Thailand, Vietnam, and Indonesia
- Trained partners on wet deposition operations and atmospheric mercury measurements

Summary of APMMN Progress

- Launched a 3-year pilot network for mercury wet deposition; initial sites in Thailand and Vietnam (red); Indonesia and Philippines coming soon (yellow)
- Developed SOPs based on NADP/MDN
  - Sample collection started Fall 2014
- Samples shipped to National Central University (NCU), Taiwan for total Hg analysis
- Established a Science Advisory Group to guide network decisions
- U.S. led capacity building and operator training workshops
- Developed APMMN website: apmmn.org.tw

Wet Deposition Sites

2015 Asia Pacific Mercury Monitoring Network Workshop (Japan)



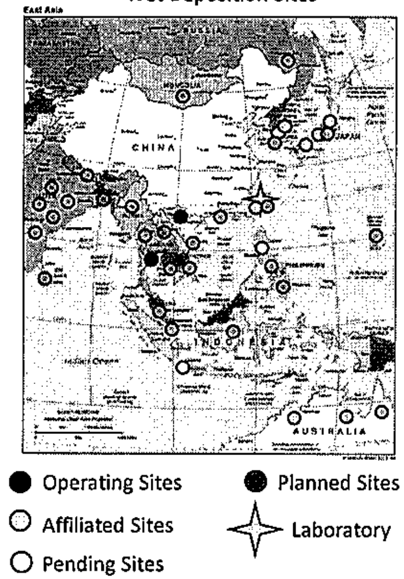
Participants
- Bangladesh, Cambodia, Laos, Indonesia, Japan, Malaysia, Myanmar, Philippines, Mongolia, Sri Lanka, Taiwan, Thailand, Vietnam, and the U.S

Outcomes
- Mercury monitoring network pilot update
- APMMN website and wet deposition technology transfer center
- Network expansion plans

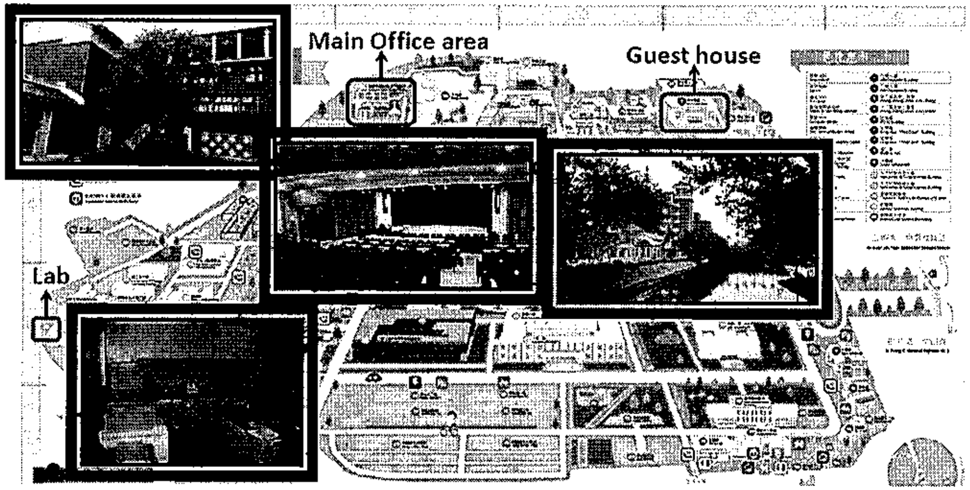
APMMN Near-Term Next Steps

- Expand regional monitoring coverage
  - Wet deposition samplers for 20 - 30 additional monitoring stations (blue)
- EPAT to establish Joint Center for Environmental Monitoring and Technology, NCU
  - NADP to assist in developing new lab and APMMN program office capabilities
- EPAT/NCU hire a network site liaison & technician
- EPAT procure three mercury wet deposition samplers Comparable with APMMN/NADP partners (to deploy in Taiwan)
- US (EPA, NADP), Taiwan (EPAT, NCU), Japan (NIES, NIMD, MOE) coordinate existing atmospheric monitoring stations (Tekran) in the region
- EPAT/NCU provide technical site support to Indonesia MoEF
- EPAT host 2016 APMMN site operator's meeting
- US (EPA and NADP) continue to provide training on monitoring methods
- US (NADP and NOAA) host an international Tekran Users Group meeting, September 2015

Wet Deposition Sites



Joint Center for Environmental Monitoring and Technology (NCU Campus)



☐ Location of Lab, Office and Guest House on NCU Campus

US EPA - EPAT
Review of bilateral program : RWGEI

Priority being addressed:

Participants

- Indonesia, Malaysia, Maldives, Vietnam, Thailand, Taiwan and the Philippines, the U.S.

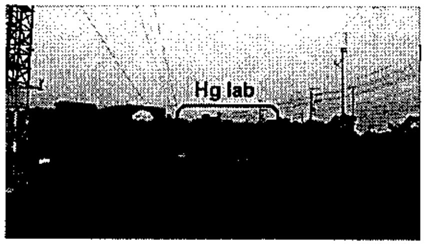
Outcomes

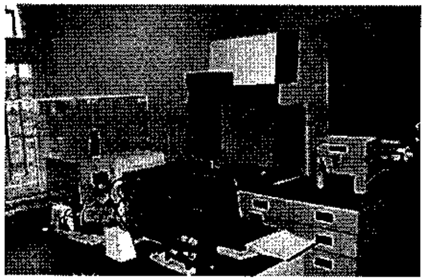
- Development of environmental information systems, environmental data quality, data sharing and exchange standard.
- Open data and citizen participation, environmental data visualization and analysis.

2014 RWGEI Workshop

Joint Center for Environmental Monitoring and Technology (NCU Campus)

- ☐ Wet Hg deposition sampling and analysis are currently underway with 3 sites in Vietnam, Thailand and Indonesia.
- ☐ Hg Lab serves as the regional center for ultra-trace level Hg analysis, training to help analyze rain water samples and some atmospheric Hg samples.
- ☐ Train researchers from other Asian countries for capacity building of ultra-trace level Hg sampling and analysis.





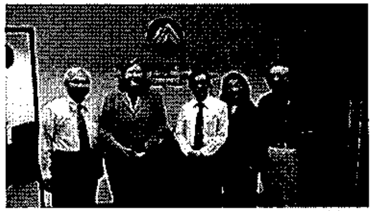
US EPA – EPAT
Biennial Program Review

Many thanks for your attention!

Environmental Law Compliance and Enforcement

Taiwan EPA

Bureau of Environmental Inspection(BEI)



Priorities

Improve the system for addressing violations of environmental law.

Strengthen the abilities of inspectors through training programs.

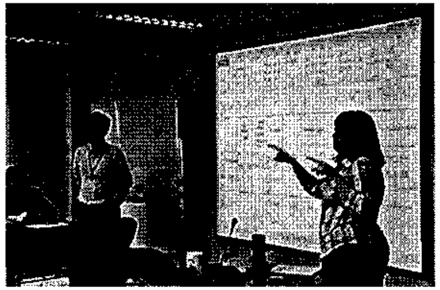
Cooperate with countries and organizations in the region.

Engagements with International Partners

2013

Regional partnership activity:

- ✓ Enforcement Workshop and Train-the-trainer session
- ✓ Experts from U.S., Taiwan, Thailand, Vietnam, Singapore, Philippine, Indonesia participated
- ✓ Show Taiwan's ... compliance achievements ... countries



Engagements with International Partners

Bilateral enforcement training:

2013

Workshop on Field Inspection & Enforcement

- Learned inspection skills on refineries from EPA R9 experts
- Cooperated closely with R9 in enforcement & compliance program

2014

Study tour to U.S. EPA R9

- Focused on system and measures of enforcement and compliance in the U.S.
- Developed long-term bilateral training program with R9

Engagements with International Partners

2015

Participated in the Next Generation Compliance Workshop in D. C. Washington in March:

- ✓ Exchanged experience with experts from U.S., Europe and Australia
- ✓ Invited participants to join the next conference co-sponsored by EPAT and U.S. EPA in Thailand during Sept. 2015

Upcoming Programs in 2015

- US EPA and EPAT will expand cooperation on enforcement processes and inspection training [illegible] to share and exchange enforcement and environmental management strategies.
- [illegible] from EPAT to U.S. Region 9 to discuss inspections, penalty calculations, and remedy selection in October.

Engagements with International Partners

2015

USEPA Region 9 enforcement experts visited Taiwan to share their remarkable experiences in April :

- ✓ Exchanged opinions and case studies with EPAT BEI's Northern, Central, and Southern Branches
- ✓ Introduce USEPA enforcement strategies and practices to Taiwan EPA and EPBs staff

Upcoming Programs in 2015

- **Regional workshop to share best enforcement and compliance practices among countries.**
  - Co-host Next Generation compliance workshop in Thailand with US EPA and AECEN in September.
  - Engage more than 21 partnership countries in the regional activities, including Australia and New Zealand.

Challenges

Need more effective tools to ensure compliance and appropriately enforce against violators.

[illegible]

Need more equitable sanctions and enforcement mechanisms to ensure appropriate deterrence.

附件四

美國環保署及馬里蘭環保局專題報告與座談簡報

US Experience Managing $PM_{2.5}$ Pollution

Alison C. Simcox, PhD
US EPA, Region 1

Contents

Air Pollution – A Brief History

- Pittsburgh - air quality from ~1800-1950 one of worst urban environmental problems in US history. Smoke cast city in shroud of perpetual darkness and city led nation in lung disease.


New York City

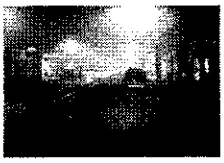
Constructing the Empire State Building in the NY smog - 1930

Credit: Neal Boenzi/NYT Pictures

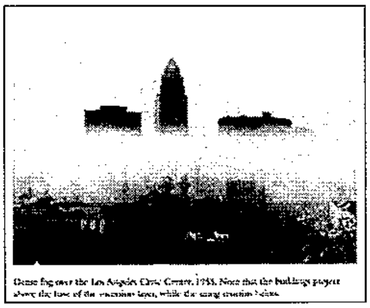
1966: New York City buried under a sea of smog

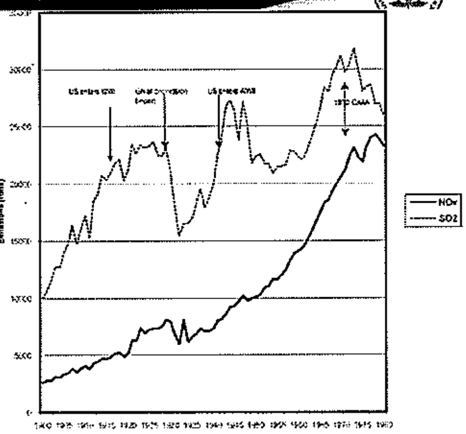
Donora, PA 1948


- In October 1948, a thick cloud of air pollution formed above the industrial town of Donora, PA.
- Cloud lingered for five days, killed 20 people and sickened 6,000 of town's 14,000 people.



Los Angeles 1955

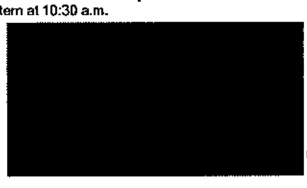




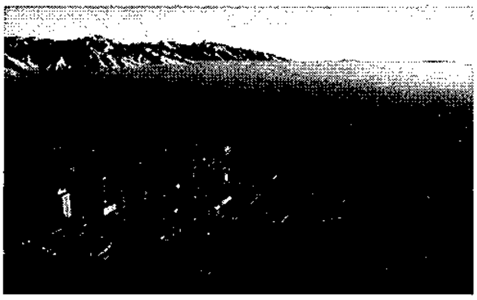
London – 1952

In a 5-day period in Dec 1952, a temperature inversion (static layer of cooler air close to ground) formed in the Thames River Valley, trapping acidic aerosols mostly from coal burning. The fog claimed at least 4000 lives (>8000 when delayed death reports included).


London buses escorted by lantern at 10:30 a.m.



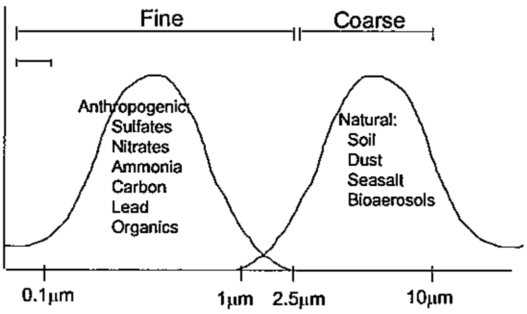
Salt Lake City, Feb 3, 2009



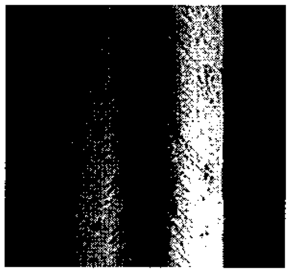
Particle Pollution

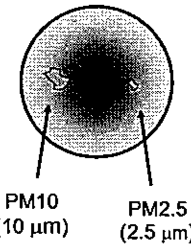
- Two size categories, the smaller of which is more easily inhaled with greater impacts on health.
- **Coarse particles (PM_{10})** - between 2.5 and 10 micometers (µm) in diameter. Occurs near roadways and dusty industries.
- **Fine particles ($PM_{2.5}$)** - less than 2.5µm in diameter. Present in smoke and haze
  - Direct $PM_{2.5}$ (primary $PM_{2.5}$) emitted directly into atmosphere (e.g., black carbon from diesel engines, smoke from fire)
  - $PM_{2.5}$ Precursors (secondary $PM_{2.5}$) particles formed from chemical reactions of sulfur dioxide (SO_2), nitrogen dioxide (NO_2), volatile organic compounds (VOCs), and ammonia (NH_3).
- Also **Ultrafine particles** ($PM_{0.1}$) - $PM_{2.5}$ particles less than 0.1µm in diameter unregulated but garnering attention.

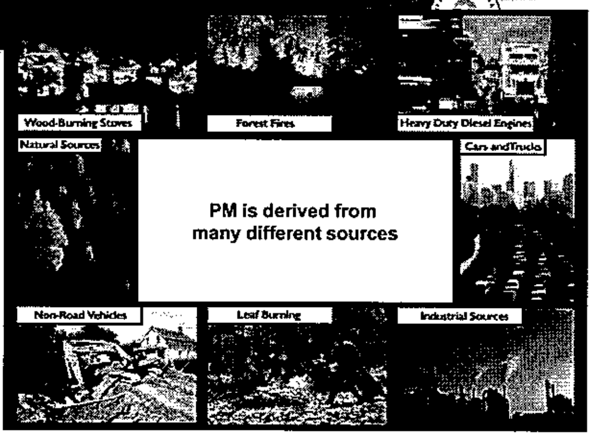
Particle Pollution



Particle Pollution







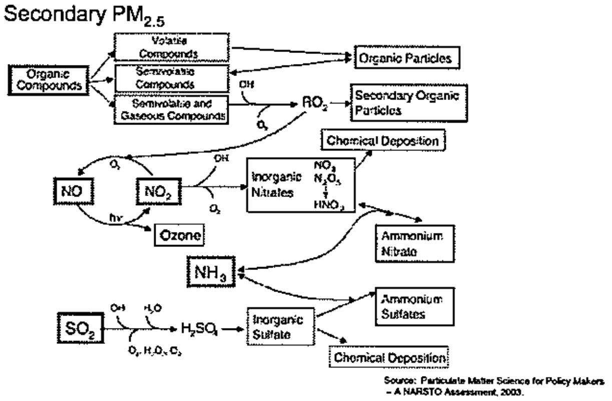
Main Sources of Primary $PM_{2.5}$ and $PM_{2.5}$ Precursors Emitted in US

- Stationary source fuel combustion (SO2, NOx, *primary* PM2.5)
- Industrial (SO2)
- Solvents/storage & transport/waste disposal (VOC)
- Non-road mobile (NOx, VOC, SO2)
- On-road mobile (NOx, VOC, NH3)
- Agricultural crops (NH3)
- Agriculture livestock (NH3)
- Fires (*primary* PM2.5)
- Unpaved roads (*primary* PM2.5)

Source: EPA 1999 NEI v.2

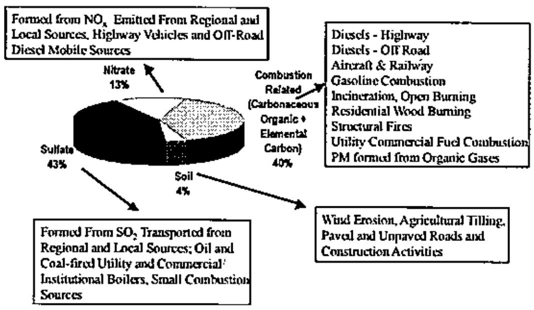
Precursor Gases and Secondary $PM_{2.5}$

ATMOSPHERIC AEROSOL PROCESSES



Source: Particulate Matter Science for Policy Makers – A NARSTO Assessment, 2003.

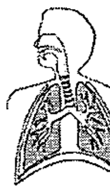
$PM_{2.5}$ Sources: Example US city

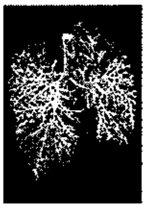


Elizabeth, New Jersey

PM and Health Effects

- Larger particles (> PM_{10}) deposit in the upper respiratory tract
- Smaller, inhalable particles (≤ PM_{10}) penetrate into the lungs
- $PM_{10-2.5}$ are thoracic coarse PM
- $PM_{2.5}$ go deeper than $PM_{10-2.5}$





- Smallest particles (ultrafines, $PM_{0.1}$) may enter bloodstream
- Deposited particles may accumulate, react, be cleared or absorbed

PM and Health Effects

Smaller particles ($PM_{2.5}$) have greatest effects. More vulnerable: people with pre-existing heart or lung diseases, children, older adults.

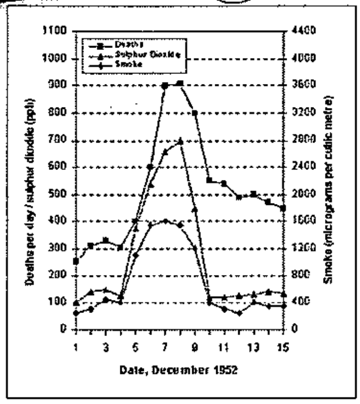
PM exposure linked to:
- Irritation of airways, coughing, difficulty breathing
- Reduced lung function
- Aggravated asthma
- Chronic bronchitis
- Irregular heartbeat
- Nonfatal heart attacks
- Premature death
- Some cancers (e.g., lung)

PM and Environmental Effects

- Reduced visibility (haze)
- Increased acidity of lakes and streams
- Nutrient balance changes in coastal waters and river basins
- Reduced levels of nutrients in soil
- Damage to forests and crops
- Reduced diversity in ecosystems
- Damage to stone and other materials

Time-series analysis –1952 London Fog

Daily mortality and average SO2 and smoke levels in Dec 1952. December deaths were 3 to 4 times higher than normal. Deaths mostly due to pneumonia, bronchitis, tuberculosis & heart failure.

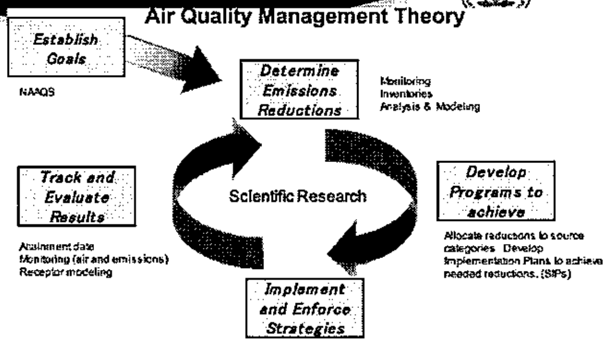


Source: http://www.portfolio.mvm.ed.ac.uk/ studentwebs/session4/27/greatsmog52.htm

Clean Air Act

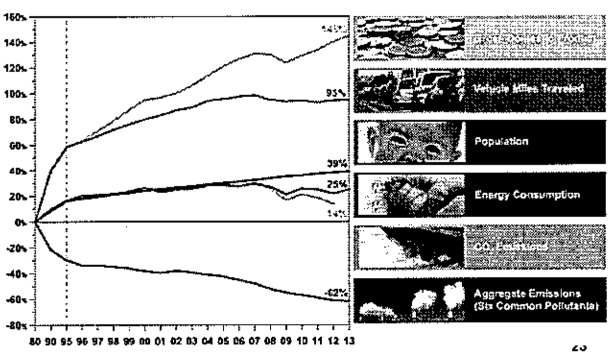
- Enacted under President Nixon in 1970 and revised 1977 & 1990. Sets the framework for US Air Quality Management (AQM).
- Controls common pollutants which formed dense smog in many US cities and industrial centers.
- Requires EPA to set national ambient air quality standards (NAAQS) based on latest science, and requires states to adopt enforceable plans to meet standards.
- States must control emissions that drift across state lines.

Air Quality Management Theory



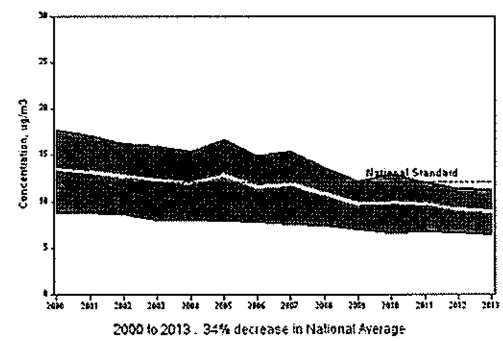
From Bachman, 2007: www.environmental-expert.com/Files%5C6477%5Carticles%5C15683%5Cbachman.pdf

Growth Areas and Emissions, 1980-2013



PM2.5 Air Quality, 2000 - 2013

(Seasonally-Weighted Annual Average)
National Trend based on 537 Sites



2000 to 2013 : 34% decrease in National Average

http://www.epa.gov/airtrends/pm.html

Clean Air Act

- Criteria pollutants:
  - Particulate matter
    - PM_{10} (PM < 10 microns)
    - $PM_{2.5}$ (PM < 2.5 microns)
  - Nitrogen dioxide (NO_2)
  - Sulfur dioxide (SO_2)
  - Ozone (O_3)
  - Carbon monoxide
  - Lead
- Every five years, EPA required to review scientific data and, if necessary, revise standards for a pollutant. Independent Clean Air Scientific Advisory Committee (CASAC) provides recommendations to EPA.

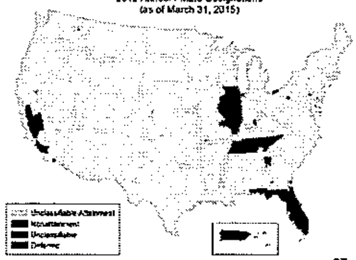
Current NAAQS: http://epa.gov/air/criteria.html
Plain English guide to the CAA - http://www.epa.gov/air/caa/peg/

State Implementation Plans (SIPs)

- A state's SIP describes actions adopted by a state for attaining & maintaining the NAAQS.
- When EPA approves a SIP submission, EPA amends the federal regulations that contain the state's SIP (i.e., 40 CFR Part 52 "Implementation of Plan").
- Once SIP is federally approved, EPA has same authority as the state to enforce the SIP.

NAAQS Implementation - 2012 $PM_{2.5}$

- In Dec 2012, EPA revised the annual $PM_{2.5}$ NAAQS from 15 µg/m³ to 12 µg/m³.
  - EPA retained the daily $PM_{2.5}$ standard of 35 µg/m³ set in 2006.
- **Implementation:**
  - o Dec 18, 2014 – EPA issued final designations for most of the country for 2012 annual $PM_{2.5}$ standard
  - o Attainment plans (SIPs) due 18 months from effective date of designations

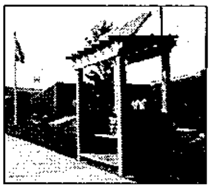


Notifying the Public - Air Quality Index

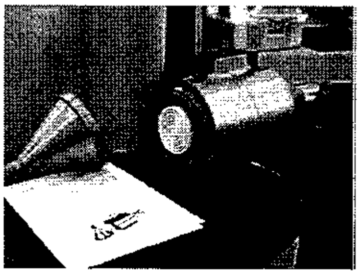
AQI Category	Index values
Good	0 - 50
Moderate	51 – 100
Unhealthy for Sensitive Groups	101 - 150
	151 - 200

- EPA/State partnership: pollution data via AIRNOW: epa.gov/airnow/
- Each day, data from > 1000 monitors across US are converted into an AQI value for each pollutant (ozone, $PM_{2.5}$, CO, SO_2) using standard EPA formulas.
- Highest AQI value = AQI value for day. EPA/states issue alerts when orange level (USG) reached and note which pollutant (usually ozone or $PM_{2.5}$) dominates. Many states and cities provide air-quality forecasts for the next day.

Air Quality Monitoring




PM Monitoring – 1940s



Original hivol sampler for Total Suspended Particles (TSP) with pleated filter for radiation measurements.

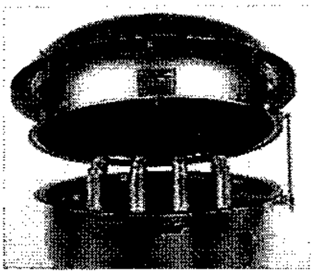
PM Monitoring – 1960s-1980s

Hivol sampler modified into the peaked-roof hivol for TSP (0 to ~30–50 µm)

PM Monitoring – PM_{10}

- Problems with early hivol samplers:
  - PM mass measured varied by wind speed and orientation into wind
  - Sampler collected non-inhalable as well as inhalable particles
- Health studies and development of new hivol inlets led EPA to establish PM_{10} as an indicator of excessive PM exposure.
- Existing Total Suspended Particle (TSP) network of hivol samplers retrofitted with new inlets

PM Monitoring – PM_{10}

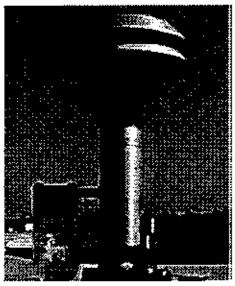


PM_{10} inlets with multiple impaction jets replaced peaked roof hivol inlets for compliance monitoring.

PM Monitoring – $PM_{2.5}$

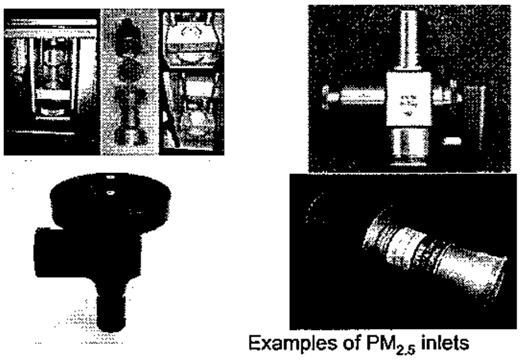
- Late 1980s - Low (~10 L/min) and medium (~100 L/min) volume filter samplers developed for more chemical-specific information (e.g., to identify road dust, wood combustion, diesel engine emissions).
- 1997 – EPA established $PM_{2.5}$ as the new indicator

PM Monitoring – PM_{10}



PM_{10} inlet for low-volume (16.7 L/min) sampler

PM Monitoring – $PM_{2.5}$



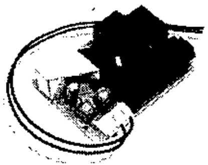
Examples of $PM_{2.5}$ inlets

Emerging: Low-Cost Sensors

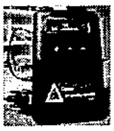
NO_2 sensor

CO_2 sensor

Particle sensor



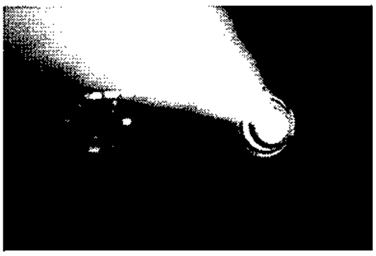
Particle sensor



Some are "raw" components that need additional electronics work

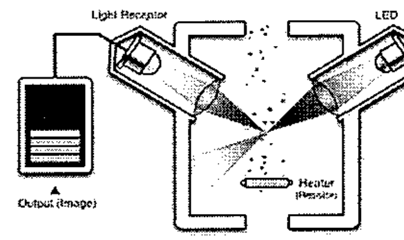
Credit: Dana Buchbinder & Gayle Hagler, EPA ORD, 2014
airnow.gov/index.cfm?action=naq_conf_2014.index

Example: Low-Cost Sensor



This particle sensor works by measuring the light scattered by particles.

Example: Low-Cost Sensor



Works best oriented up ("hot air rises")

Air intake small white heater resistor visible in this opening

Credit: www.shinyei.co.jp

Emission Inventories

- Sources and amount of an air pollutant emitted into air within an area during a specific time period.
- Purpose: to identify main sources of an air pollutant for air-quality modeling, targeting sources for action, and estimating reductions achieved.
- Methods include continuous monitoring, extrapolating results from source-emissions tests, and calculating emissions using published emission factors and known activity levels.
- Emission factors available through EPA's AP-42 link (www.epa.gov/ttn/chief/ap42/index.html). But conditions at a facility (e.g., raw materials used, combustion temperature, emissions controls) affect emissions. Therefore, if possible, local emission factors should be used.

Emission Inventories: calculating emissions

Process Rate (Activity) x Emission Factor = Emissions

Number of Units x Emissions per Unit = Total Emissions

EF: Rate of emission per unit of activity for a particular process. Based on results of emission testing.

Emission Inventory Development
Example: Mobile Source - diesel

- Basic Equation:
  - Pop*Activity*Emissions = tons/day
- Number of Sources (vehicle population)
- Activity (miles/km per vehicle)
- Emission Rate (grams per mile or km)

Source for EI examples: Bart E. Croes, California Air Resources Board, ppt for Centre for Science and the Environment, New Delhi, India, Nov 2000

Emission Inventory Development
Example: Area Source - agriculture

- Emission Factor (EF)
  - Emissions per unit of activity (e.g., lbs/PM_{10} per acre (hectare) tilled)
- Activity Data (Process Rate (PR))
  - Vehicle Miles (km) Traveled, Acre-Passes
- Emissions
  - Emissions = EF x PR

Emission Inventory Development
Example: Point Source - power plant

- SO_2 Estimation: Basic Equation
  - Activity*Mass Fraction*2 = SO_2/day
- Activity (tons fuel burned per day)
- Mass Fraction (tons S per ton fuel)

Emission Inventory Development
Example: Point Source - power plant

- NO_X Estimation: Emission Factor:
  - Emissions per unit of activity (i.e., lbs of NO_X per ft^3 of fuel burned)
- Activity Data (AD)
  - Cubic feet of fuel burned
- Emissions
  - Emissions = EF x AD

$PM_{2.5}$ Controls - examples

- Install PM (direct PM & precursor gases) controls on stationary sources
- Operate stationary-source NOx controls year-round
- Retrofit diesel vehicles (trucks, school buses, back-up generators)
- Reduce idling (trucks, trains, port equipment)
- Control fugitive dust (e.g., unpaved roads,)
- Use cleaner fuels (e.g.,low-sulfur diesel) and catalytic converters
- Reduce vehicle miles traveled (VMT or VKT) and congestion (e.g., carpooling, telework, pedestrian zones)
- Promote use of low- to zero-emission vehicles (hybrid cars, bicycles)
- Reduce emissions from wood/coal stoves and burning in barrels
- Reduce open burning of waste and debris
- Use lower VOC products (e.g., paints, surface coatings, solvents, gasoline)

More information available at http://www.epa.gov/pm/measures.html

Trends/Future

- Portable, cheaper AQ monitors
- Multi-pollutant monitoring strategies with multiple objectives (e.g, examining long-term trends, source apportionment modeling)
- Measurement of precursor gases (e.g. SO_2, NO_x) and hazardous air pollutants (HAPs or "air toxics")
- Health risks of air toxics
- Health effects at low pollutant concentrations
- Effects of ultrafine particles and black carbon (BC) on health and climate.
- Ongoing protection of the stratospheric ozone layer
- Climate change impacts on public health and welfare
- Showing climate co-benefits of PM (BC) reductions
- Integrating state & local smart-growth priorities and related energy and climate programs.

Stakeholder Communication

- EPA has an open & transparent rulemaking process
- Stakeholders (states, tribes, other federal agencies, industry, enviro groups, individuals) informed of upcoming rulemaking actions
- Anyone can comment on proposed rules, and EPA responds to comments in Response-to-Comment document. EPA holds stakeholder meetings.
- EPA's *Public Participation Guide* (on-line in 5 languages): http://www2.epa.gov/international-cooperation/public-participation-guide-process-planning

Stakeholder Communication

- EPA websites educate stakeholders and provide technical tools (i.e., models, calculators) and databases.
- EPA develops factsheets, press releases, and other materials to explain rulemaking actions and agency activities. Available on EPA websites.
- EPA has regular communication (conference calls, webinars, workshops, etc.) with stakeholders and is experimenting with new methods (e.g., social media, i-phone apps)

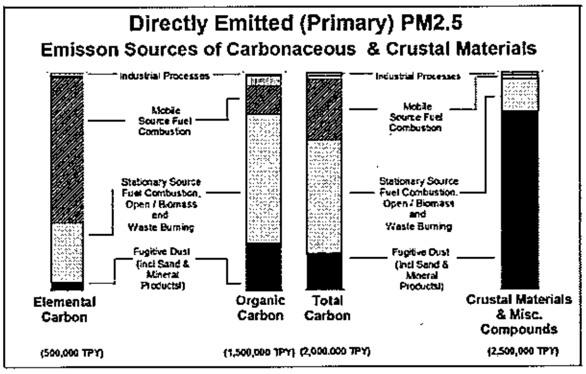
More Information

- PM pollution: www.epa.gov/airquality/particlepollution/index.html
- PM research: www.epa.gov/airscience/air-particulatematter.htm
- PM & health effects: www.epa.gov/air/particlepollution/2012/fshealth.pdf
- The Health Effects Institute: www.healtheffects.org/about.htm
- PM standards: www.epa.gov/ttn/naaqs/standards/pm/s_pm_index.html
- Air quality trends: www.epa.gov/airtrends/index.html
- Clean Air Act and progress: www.epa.gov/air/caa/index.html
- Industry emissions data: ampd.epa.gov/ampd/
- Emissions inventories & emission factors: www.epa.gov/ttn/chief/
- Public participation: www2.epa.gov/international-cooperation/public-participation-guide-process-planning

US EPA Contacts:

- Justin J. Harris, Office of International & Tribal Affairs (OITA) harris.justin@epa.gov
- Alison C. Simcox, Ph.D., Air Quality Planning Unit, Office of Ecosystem Protection (AQP, OEP), Boston, Massachusetts simcox.alison@epa.gov

Background Information



How Does PM Cause Health Effects?

Theories:

1. PM leads to lung irritation, which increases permeability in lung tissue
2. PM increases susceptibility to viral and bacterial pathogens leading to pneumonia
3. PM aggravates severity of chronic lung diseases causing rapid loss of airway function
4. PM causes inflammation of lung tissue, resulting in release of chemicals that affect heart function
5. PM causes changes in blood chemistry resulting in clots that can cause heart attacks

Health Effects Studies

- **Time-series studies** (Single or multi-site) – Emphasis on mortality and hospital admissions. Major approach to estimating short-term health effects of air pollution in epi studies for the last 2 decades.
- **Case-crossover studies** - Instead of obtaining information from two groups (cases and controls), exposure information is obtained from the same case group but during two time periods.
- **Panel studies** – Repeated observations of susceptible population subgroups. For evaluating short-term health effects.
- **Cohort studies** - Group of healthy people followed over time to determine if they develop a disease/outcome.
- **Birth outcome studies** - Low birthweight (<2500 g at birth) is outcome studied most in relation to air pollution.

Clean Air Act

- Established by US Congress in 1970, with major revisions in 1977 & 1990. 1970 CAA set Air Quality Management (AQM) framework, but 1990 CAA added breakthrough market-based program for power plant SOx emissions and tech-based standards for Hazardous Air Pollutants (HAPs).
- The CAA controls common pollutants which in 1970 formed dense smog in many US cities and industrial centers.
- The CAA requires EPA to set national ambient air quality standards (NAAQS) based on latest science, and requires states to adopt enforceable plans to meet standards.
- States must control emissions that drift across state lines.

Clean Air Act – Roles & Responsibilities

- **Congress:** Provides budget and oversight for EPA's activities
- **EPA:**
  - Develops scientific criteria and sets NAAQS
  - Provides support to state, tribal, and local programs through national emissions standards for stationary & mobile sources, *Federal Register* rules, grants & guidance, and enforcement.
- **States:**
  - Develop State Implementation Plans (SIPs) describing control measures & strategies for attaining & maintaining NAAQS
  - Works with EPA to develops and enforce CAA requirements, such as maintaining an ambient-monitoring network, facility monitoring and reporting, inspections and enforcement, etc.
- **Courts:** Resolve challenges to EPA's implementation of CAA

Clean Air Act – Roles & Responsibilities

- **Industry** (e.g., transportation, petroleum, power generation, metals, mining, chemicals, and agribusiness) involved in process of meeting federal & state requirements, and also in developing approaches to reduce emissions
- **Public and private stakeholders, scientists and engineers** involved at multiple stages – e.g., initiate or request meetings, provide technical advice and services, comment on EPA rules

PM Monitoring .. a little history

- 18th century: Inhalable particles first measured using optical microscopy, but detected mostly coarse fraction.
- Circa 1885 London - PM mass determined by drawing air through filter paper, measuring volume sampled, and weighing filter before and after sampling.
- From the 1920s - the British Smoke method quantified darkening caused by particles drawn through a filter.
- Late 1940s - filter method evolved into high volume (hivol) sampler used to sample airborne radioactivity after atmospheric testing of nuclear weapons.

Source: Junji Cao et al, 2013 http://aaqr.org/VOL13_No4_August2013/5_AAQR-12-11-OA-0302_1197-1211.pdf

Emission Factors

- Some resources for estimating emissions
  - MOVES and NONROAD models for mobile sources
  - EPA wood stove and fireplace emissions calculator http://www.epa.gov/burnwise/resources.html#air
  - PM emission inventory resource center http://www.epa.gov/ttn/chief/eiip/pm25inventory/index.html

PM Controls - Residential Wood Smoke

- Federal Standards
  - The 2015 New Source Performance Standards (NSPS) for new wood stoves and hydronic heaters.
- Public Education (www.epa.gov/burnwise)
  - Burn as cleanly as possible: right wood, right way, right appliance
  - AIRNow real-time data and forecasting
- Wood Stove/Fireplace Changeouts and Removal
  - Changing out one older, inefficient wood stove gives equivalent $PM_{2.5}$ pollution reduction to taking five diesel buses off the road
- Wood burning curtailment programs – examples
  - Sacramento: http://www.sparetheair.com/burncheck.cfm
  - Puget Sound: http://www.pscleanair.org/airq/burnban/default.aspx
- Guidance document:
  - http://www.epa.gov/ttncaaa1/t1/memoranda/strategies-doc-8-11-09.pdf

Information Resources Management (IRM) Strategic Plan

AUGUST 12, 2015

EPA IRM Strategic Plan - Driving Forces

- Legislative/Political
  - GPRA
  - GPEA
  - Clinger Cohen Act
  - E-Government Act/FISMA
  - OMB Lines of Business
  - President's Mgt. Agenda
  - Circular A-76
  - Circular A-11
  - Policy Drivers
  - Global Boundaries
  - Federalism Issues
  - Private/Commercial Self Regulation
- Business/Social
  - Climate change
  - Globalization
  - Population Growth/Diversity
  - Mobile workforce
  - Homeland security
  - Cross media research
  - Budget Pressures
- Technology
  - Service Oriented Architecture
  - IT Access/Analytics
  - Web Governance
  - Identity Management
  - Geospatial Services

EPA IRM Strategic Plan – Major Themes

1 Achieve Operational Excellence in Service Delivery

2 Unify IT Infrastructure Supporting Internal Communications Across All Programs

3 Integrate External Service Delivery to EPA Stakeholders

4 Apply Leading Edge Technology in Existing and New Programs

http://www2.epa.gov/aboutepa/epa-information-resources-management-strategic-plan

EPA

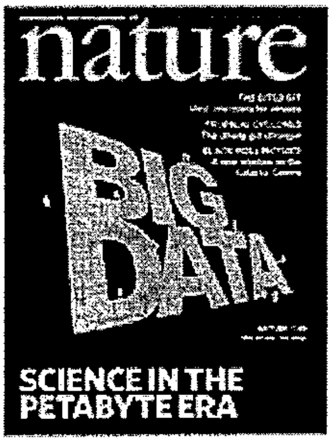
Advanced Data Analytics and Visualization: An Overview

August 12, 2015

EPA

Data Analytics and Visualization

- More insights and better decisions
- Predictive analysis
- Harness data across EPA and outside EPA
- Increasing data volume, velocity and <u>variety</u>
- New, powerful and inexpensive tools
- 130 People in the EPA Community of Practice



EPA

Why the Time is Right

- Increasing demand on data analytics for missions and operations
- Big data tech – attention, investment and deployment
- Data flows are starting to increase rapidly: volume / complexity
  - citizen science, continuous monitors, mobile devices
- Prepare before these increases become reality
- Technology and data combinations promise new opportunities

EPA

Benefits Across EPA

- Promote increased analytical capacities
  - New analyses that were previously impractical
  - Increase performance on analyses that are cumbersome
- Better visualization both for analysis and presentation
- Increase efficiencies through better analysis
- Improved environmental outcomes

EPA

Key Activities

People

- Build community – Data Analytics Community of Practice
- Build in-house skills – training at many skill levels
- Transfer and enhance those skills
- Establish cross federal and other external partnerships
- Build Use-cases and demonstration projects

Data and Technology

- New technology for data storage and query
- New techniques and tools for analytics
- Explore various IT tools through small deployments
- Build pilot platform for demonstration projects

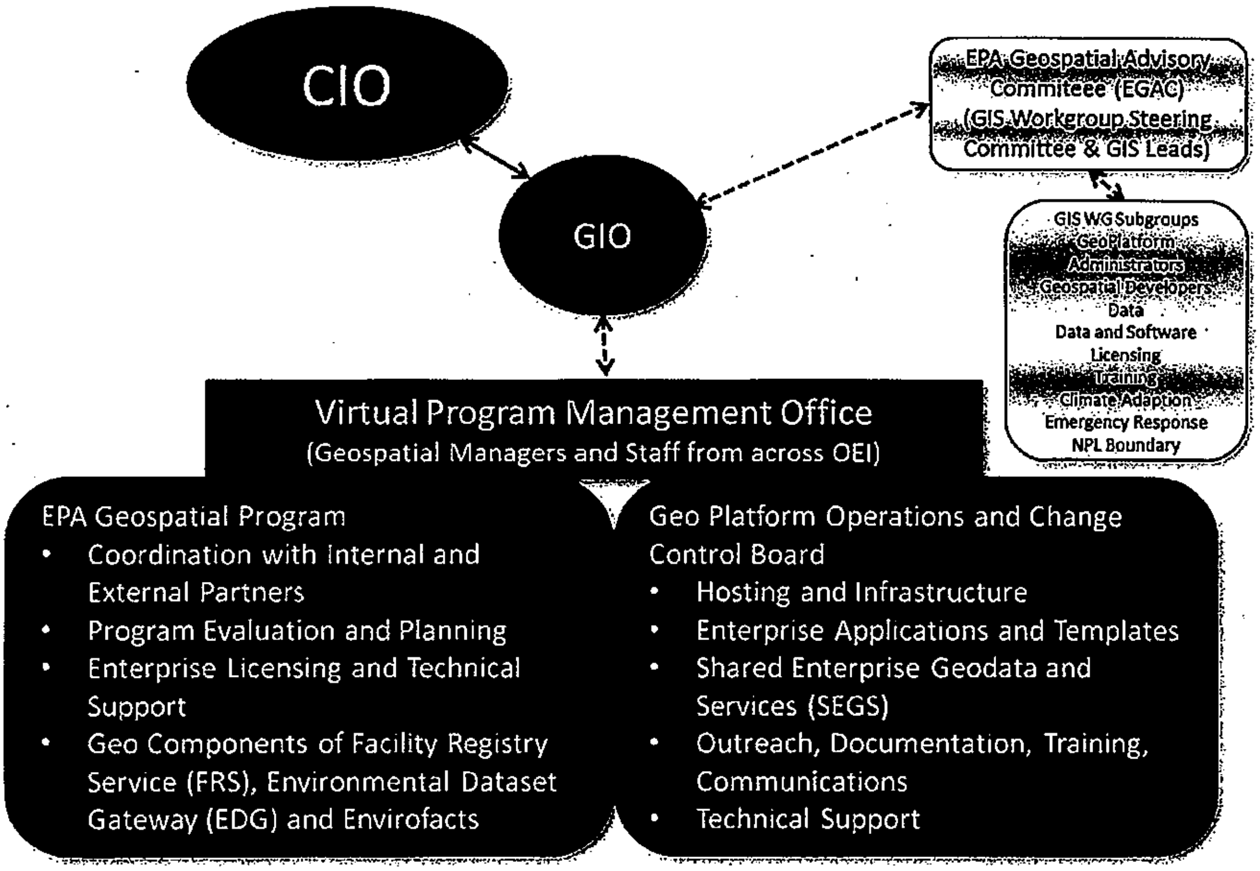
EPA Office of Environmental Information (OEI)
Geospatial Program

Organizational Leadership

Chief Information Officer – Ann Dunkin
Acting Deputy Chief Information Officer – Carol Rushin
Geospatial Information Officer – Harvey Simon

Description

The Geospatial Information Officer (GIO) carries out the Chief Information Officer (CIO) responsibilities to ensure that EPA's ability to use geospatial data, tools, policies, procedures and technologies to support EPA's place-based mission. The program supports a wide-range of EPA program activities and business processes. Agency geospatial resources are distributed across OEI, national program and regional offices and the GIO works with OEI managers and staff and others who to ensure the program meets Agency-wide needs. The EPA GeoPlatform has become an organizing principle



Briefing for Taiwanese Delegation: Potentially Responsible Party ("PRP") Searches

NANCY DECK, TEAM LEADER
NATIONAL PRP SEARCH ENHANCEMENT TEAM
AUGUST 12, 2015

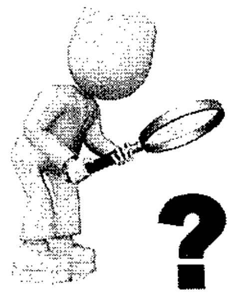
WHAT IS SUPERFUND?

- The Superfund law* authorizes EPA to conduct investigations to identify all parties who may be responsible for release of hazardous substances at a site and to evaluate their liability.
- The law defines four categories of potentially responsible party ("PRP")
  - Past and present site owners
  - Past and present operators
  - Arrangers
  - Transporters

**The official title of the Superfund law is the Comprehensive Environmental Response, Compensation, and Liability Act, commonly referred to by the acronym "CERCLA".*

Purpose of PRP Search

- Identify all parties involved at a site.
- Evaluate the extent of each party's involvement to determine liability.



What Information Is Needed?

- Names of individuals and business entities associated with the site (e.g., owners/operators, managers, employees, customers, suppliers, contractors, lessees).
- Records of previous environmental violations.
- History and descriptions of site operations.
- Site ownership history.
- Waste disposal records.
- Photographs and maps.

COMMON PRP SEARCH TASKS

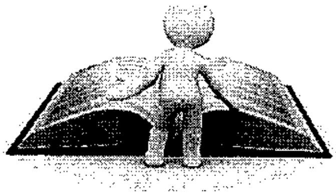
- Review Agency files and record collections, including records from other programs (e.g., RCRA, water, air, criminal enforcement).
- Collect and review records from the site and other sources.
- Issue information requests.
- Perform title searches.
- Conduct interviews.

RECORDS FROM OTHER SOURCES

- Site records (conducted by inspectors), from library, website, business filing
- Local, state and other federal agencies:
  - County/local property records
  - Historical societies and museums
  - Public libraries
  - Newspaper archives
  - Secretary of State's office
  - Other federal/state regulatory agencies

RECORDS FROM OTHER SOURCES (CONT'D)

- Corporate directories
- Trade journals
- Company websites
- Corporate filings (e.g., SEC)
- Corporate meeting minutes



INFORMATION REQUESTS

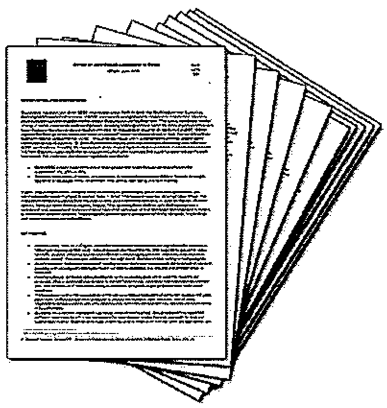
- CERCLA section 104(e) authorizes EPA to require anyone with information about the following to provide it to EPA:
  - Materials at the site
  - Waste management practices
  - Releases or threatened releases
  - Corporate relationships
  - Ownership and pre-purchase inquiries
  - Ability to pay for site cleanup
  - Insurance

TITLE SEARCHES

- Objectives:
  - Identify present and past owners/operators.
  - Identify owners/operators at time of disposal.
  - Document ownership.
  - Establish chain of title.
  - Identify adjacent property owners.

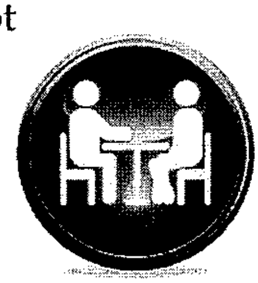
TYPES OF TITLE DOCUMENT

- Deeds
- Mortgages
- Easements
- Leases
- Agreements
- Mineral leases
- Plat maps



INTERVIEWS

- Anyone with possible knowledge of site activities is a potential interviewee (e.g., neighbors, security guards)
- Interviewees often have information not available in documentary records.
- Interviewees may be able to identify other people who also have valuable information about the site.



COMPILE INFORMATION

- Develop site operations history.
- Prepare "waste-in" lists that rank waste contributors according to volume.
- Determine current status of PRPs (e.g., defunct, bankrupt) and identify successors.
- Determine liability of PRPs.
- Determine financial viability of PRPs.
- Prepare written report for enforcement/settlement.
- Engage in settlement discussions.

CONTACTS

Cyndy Mackey, Director
Office of Site Remediation Enforcement
Mackey.Cyndy@epa.gov

Nancy Deck, Team Leader
National PRP Search Enhancement Team
Deck.Nancy@epa.gov

Meeting Agenda

Taiwan EPA – Maryland Department of the Environment (MDE)

August 13, 2015

I. US - Taiwan Eco-Campus Partnership Program Case Summary (10 mins)
Westland Middle School, Bethesda, Maryland -
Shen-Li Elementary School, Pingtung, Taiwan
By Fontaine Rodgers (Westland Middle School)

II. TMDL and Water Quality Protection (30-45 mins)
By Yen-Der Cheng (MDE)

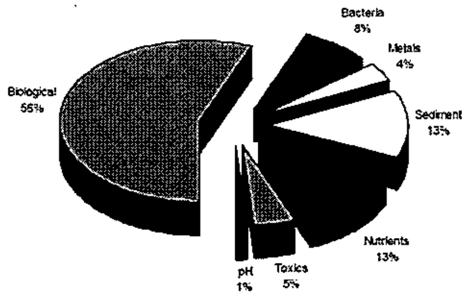
- TMDL and Chesapeake Bay Water Quality
- TMDL and NPDES permit
- Nutrient Trading

III. CO_2 Capture and Storage (CCS) – Policies and Technologies (30mins)
By C. T. Tien (MDE)

IV. Groundwater Protection in Maryland (30 Mins)
By C. T. Tien

- Aquifer in Maryland
- UIC (Underground Injection Control) Program and Protection of Underground Source of Drinking Water (USDW)
- Maryland Groundwater Discharge Permit for large onsite system and land application system.
- Groundwater Appropriation Permit and Groundwater Resource Protection

Distributions among MD TMDLs



* 556 TMDLs developed as of 3/1/2015.

MARYLAND

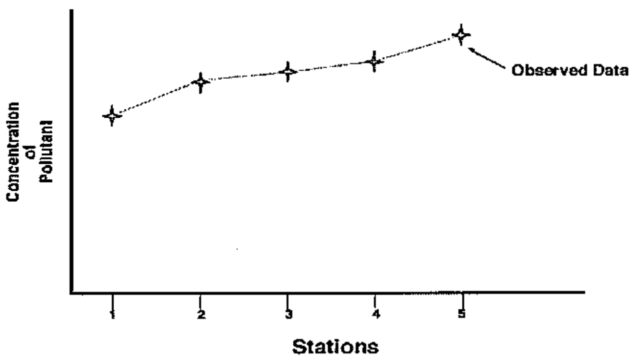
TMDL Development Process

- Data collection
  - Five-year cycling strategy, additional sampling for TMDL purposes, data solicitation
- Data analysis
- Selection of an assessment tool
  - Depends upon system, complexity of problem, available data, etc
- Evaluation of various load reduction scenarios

MARYLAND

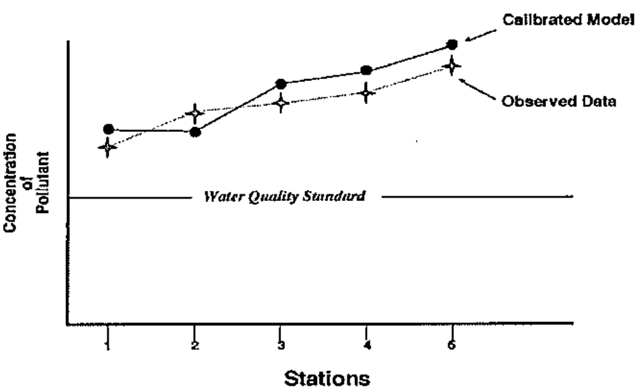
MDE

TMDL Modeling Process



MDE

TMDL Modeling Process



MARYLAND

Department of the Environment

TMDL Implementation in Discharge Permit for Water Quality Protection

August 13, 2015

MDE

Introduction of TMDL

MDE

What is TMDL ?

- Total Maximum Daily Load
- Requirement under the federal Clean Water Act
- Establishes the maximum amount of an impairing substance or a stressor that a waterbody can assimilate and still meet water quality standards
- Allocates load among pollution contributors (i.e., point and non-point sources)

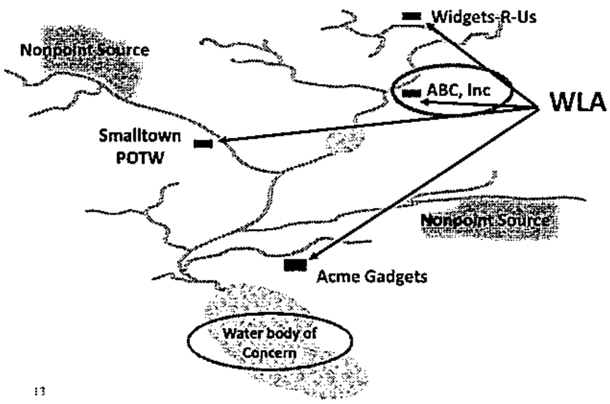
MARYLAND

Which water body needs TMDL?

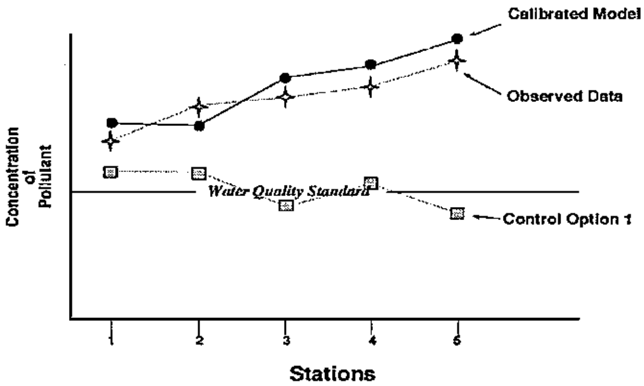
- State waters that do not or are not expected to meet water quality standards after all technology-based controls and/or other required pollutant controls are in place (MD 303(d) List)
- May develop more than one TMDL per waterbody if multiple impairing substances identified (i.e., more TMDLs than number of impaired waters)

MARYLAND

WLA from TMDL



TMDL Modeling Process



Implement WLA in the discharge permits

Annual or seasonal WLAs could be implemented as effluent limits

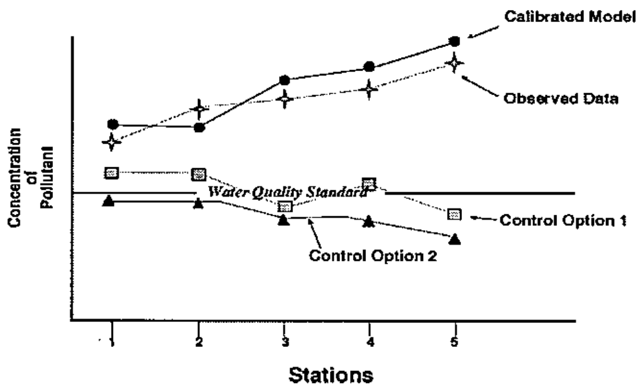
Continuous discharges

Annual or seasonal loading requirement
Annual or seasonal average concentration

Non-continuous discharges

Frequency
Total mass
Maximum rate of discharge of pollutants

TMDL Modeling Process

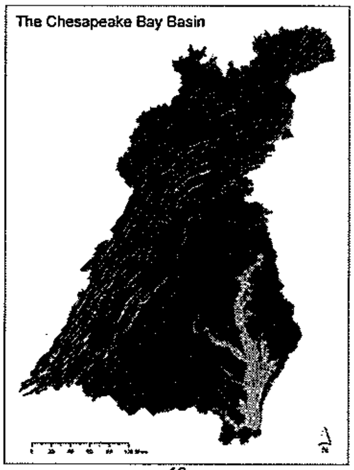


Chesapeake Bay Water Quality Issues

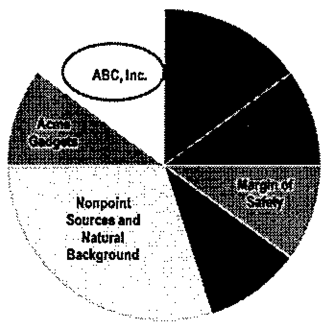
MDE

TMDL Components

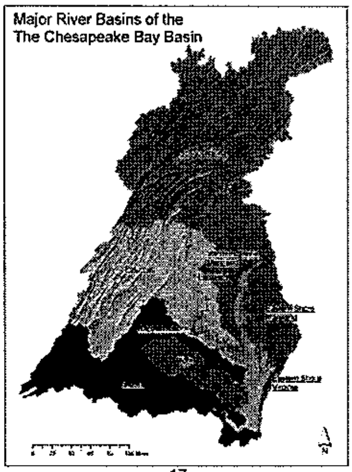
- TMDL = WLA + LA + MOS (+ FA)
  - WLA = Point Source Load Allocation/Urban Non-point source (MS4 Stormwater Permits)
  - LA = Non-point Source Load Allocation
  - MOS = Margin of Safety
  - FA = Future Allocation (included when applicable)
- Currently expressed as a "mass per unit time, toxicity, or other appropriate measure" (40 CFR 130.2(i))
- Documentation



WLA from a TMDL



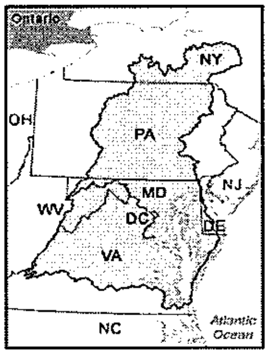
WLA = portion of the TMDL allocated to a specific point source



17

Chesapeake Bay Watershed-
By the Numbers

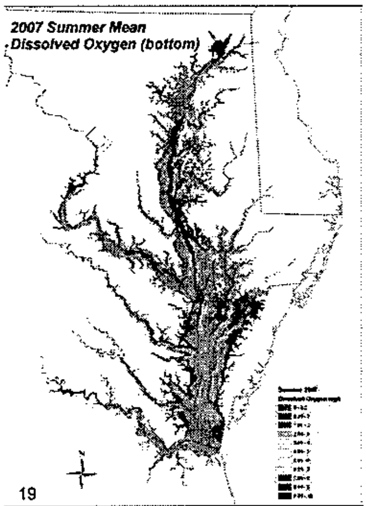
- Largest U.S. estuary
- Six-state, 64,000 square mile watershed
- 10,000 miles of shoreline (longer then entire U.S. west coast)
- Over 3,600 species of plants, fish and other animals
- Average depth: 21 feet
- $750 million contribution annually to local economies
- Home to 17 million people (and counting)
- 77,000 principally family farms
- Declared "national treasure" by President Obama



Source: www.chesapeakebay.net

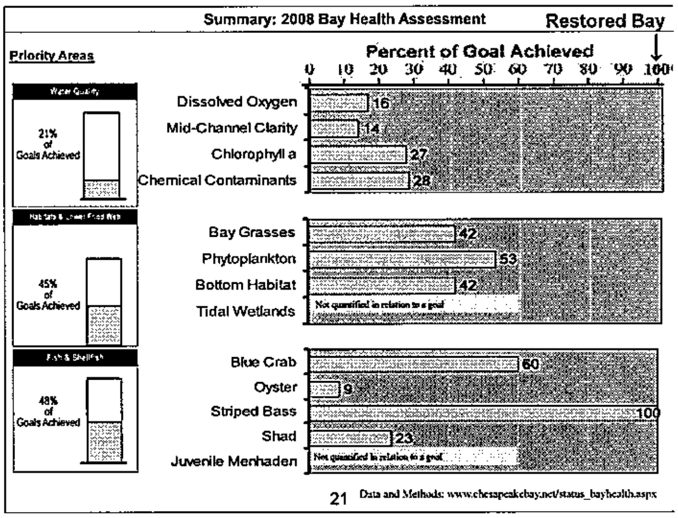
18

Low to no dissolved oxygen in the Bay every summer



19

Warning Signs in the Bay



21

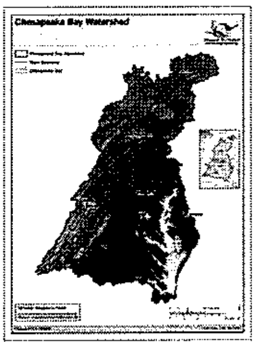
Chesapeake Bay TMDL

MDE

22

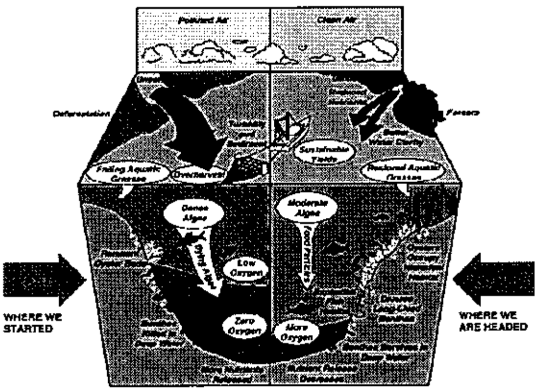
The Chesapeake Bay TMDL

- EPA sets pollution "diet" to meet states' Bay clean water standards (since 2010)
- Load caps on nitrogen, phosphorus and sediment loads for all 6 Bay watershed states and DC
- States set load caps for point and non-point sources



23

Chesapeake Bay Health-Past and Future

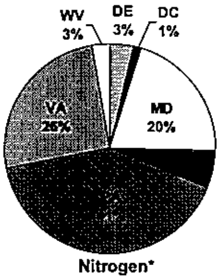


24

Setting the Basin-wide Target Loading

25

Nitrogen Loads by State



*EPA estimates a nitrogen load of 284 million lbs nitrogen in 2008. EPA assumes a reduction of 7 million lbs due to the Clean Air Act. This leaves 77 millions lbs to be addressed through the TMDL process.

26

What are the Target Pollutant Cap Loads for the Bay Watershed?

Current model estimates are that the states' Bay water quality standards can be met at basinwide loading levels of:

- 200 million pounds nitrogen per year
- 15 million pounds phosphorus per year

(Sediment target cap load under development-will be available by spring 2010)

27

Current State Target Loads

Nitrogen

State	Tributary Strategy	Target Load
DC	2.12	2.37
DE	6.43	5.25
MD	42.14	41.04
NY	8.68	10.54
PA	73.17	73.64
VA	59.30	59.22
WV	5.69	5.71
Total	197.53	197.76

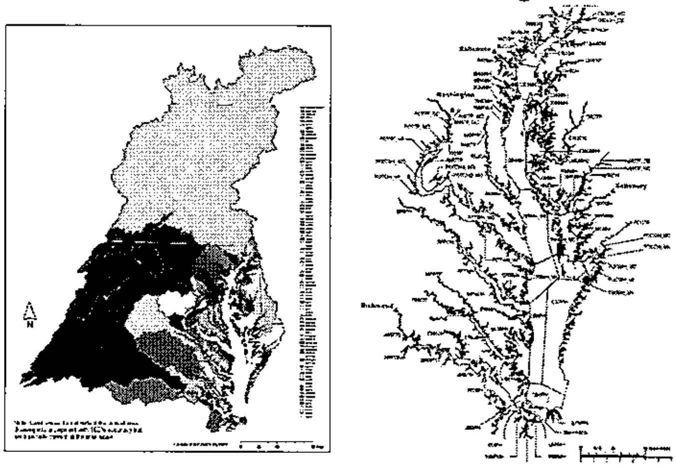
Phosphorus

State	Tributary Strategy	Target Load
DC	0.10	0.13
DE	0.25	0.28
MD	2.56	3.04
NY	0.56	0.56
PA	3.10	3.16
VA	7.92	7.05
WV	0.45	0.62
Total	14.93	14.84

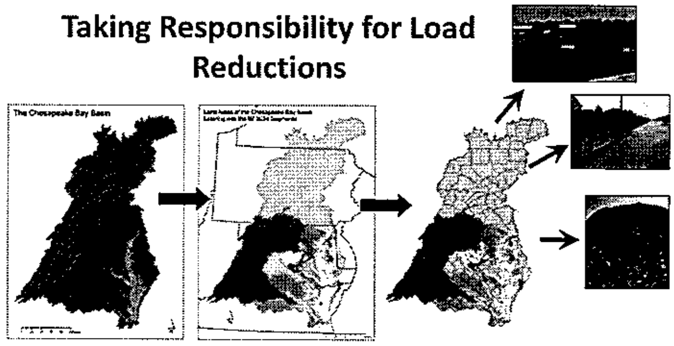
All loads are in millions of pounds per year.

28

Pollution Diet for Each Tidal Water Segment



Taking Responsibility for Load Reductions



Identify basinwide target loads

EPA, States, DC

Identify major basin by jurisdiction target loads

EPA, States, DC

Identify tidal segment watershed, county and source sector target loads

States, DC, local governments & local partners

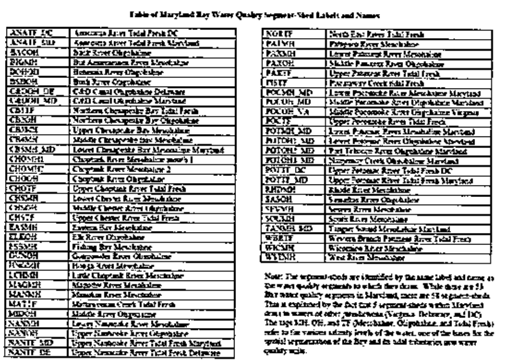
30

Guidelines for Distributing the Basinwide Target Loads

- Water quality and living resource goals should be achieved.
- Waters that contribute the most to the problem should achieve the most reductions.
- All previous reductions in nutrient loads are credited toward achieving final cap loads.

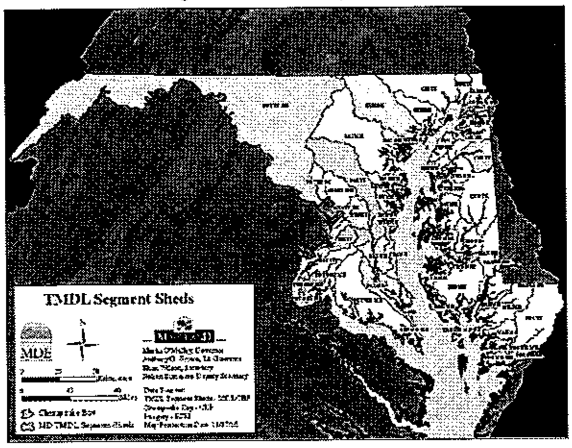
31

MD "Segment Sheds" in Bay TMDL



MD Nutrient Reduction Strategy for Municipal Point Sources

MD "Segment Sheds" in Bay TMDL



Establishing Nutrient Loading Caps

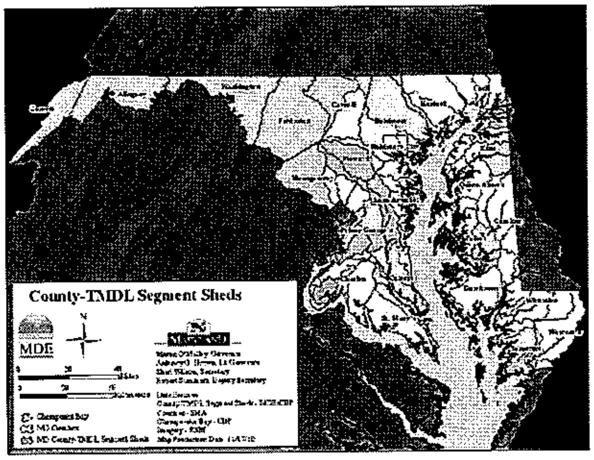
Major Facilities (Design Capacity above 0.5 MGD)*

1. Existing or Planned Flow Capacity
2. Annual average concentration (4.0 mg/L TN, 0.3 mg/L TP)

Minor Facility (Capacity less than 0.5 MGD)

1. 2020 projected flow or Design Capacity flow (whichever is lower).
2. annual average concentration (18 mg/L TN, 3 mg/L TP)

* Representing more than 98% total nutrient loads from WWTP sector in MD.



Nutrient Requirements for ENR facilities in the discharge permits

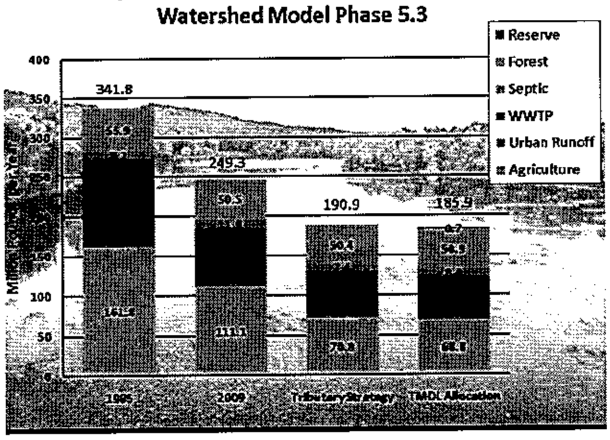
1. Annual/Seasonal Nutrient Loading Caps (all majors)

2. "Floating Caps" (majors with BRF funded upgrade)

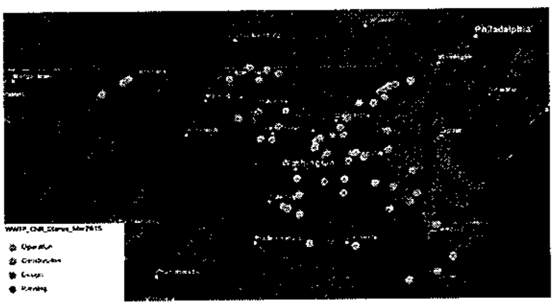
$$\frac{\text{AnnualCumulativeTN Loads}}{\text{AnnualCumulativeDischargedFlows}} \le 4\ \text{mg/L}$$

$$\frac{\text{AnnualCumulativeTP Loads}}{\text{AnnualCumulativeDischargedFlows}} \le 0.3\ \text{mg/L}$$

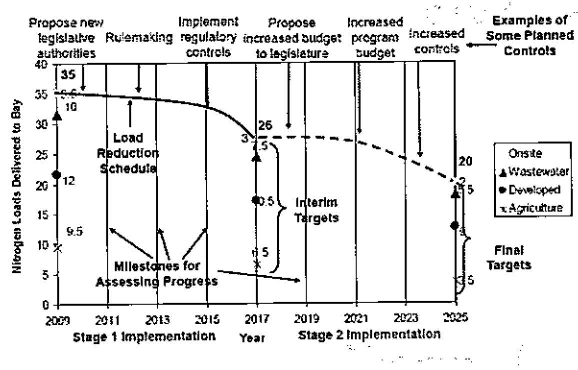
Nitrogen Loads by Source Sector and Scenario - Watershed Model Phase 5.3



Maryland Major Wastewater Treatment Plant ENR Upgrade Status (March, 2015)

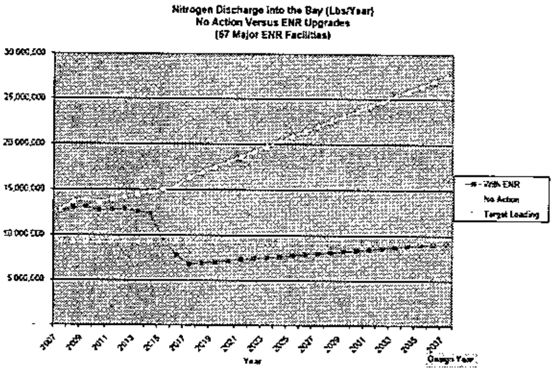


Moving Forward - Bay TMDL Milestones



Premise for Nutrient Trading

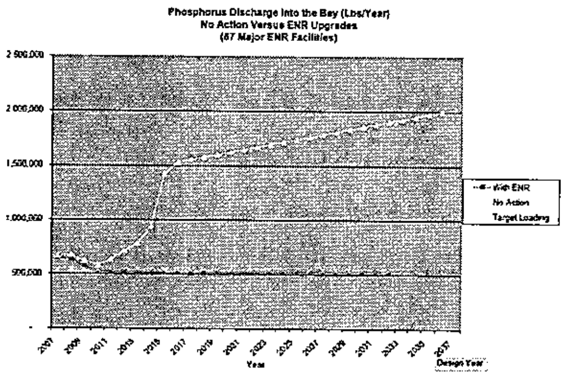
- If States' Bay Water Quality Standards can still be achieved...
  - The State may exchange nitrogen and phosphorus target loads within a basin; and/or
  - The State may exchange nitrogen and phosphorus loads from one basin to another within the State.



45

Nutrient Trading: Bottom-line

- No "net" increase of pollutant load to the Bay after the trade.
- The credit provider has to meet the TMDL loading cap first.
- No water quality "hot spot" will be created at the local water body after the trade.
- Accountability from Both the supplier and receiver of the credits (through vigorous monitoring requirements and inspection activities).



46

Examples : Nutrient Credit Transfer implemented in the discharge permits

- Transfer of nutrient WLA due to excess capacity between facilities within model segment
- Cease of discharge activity through connection with another facility.
- Connection of failing septic systems to a WWTP

Nutrient Trading vs. TMDL

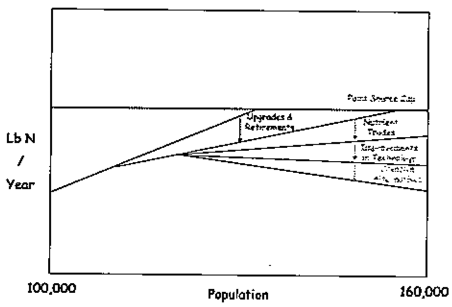
MDE

Questions?

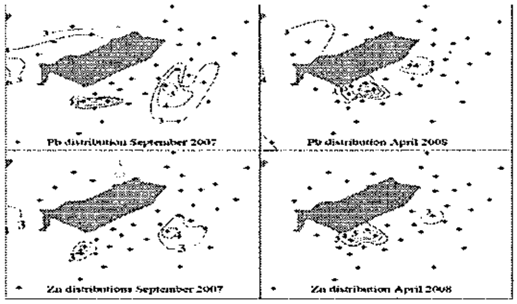
MDE

Reality Check

Living within the Cap



MDE



Summary Figure 1-3. Fall 2007 and spring 2008 distribution of Pb and Zn around HMI. Values are expressed in multiples of Sigma.

MARYLAND

MARYLAND

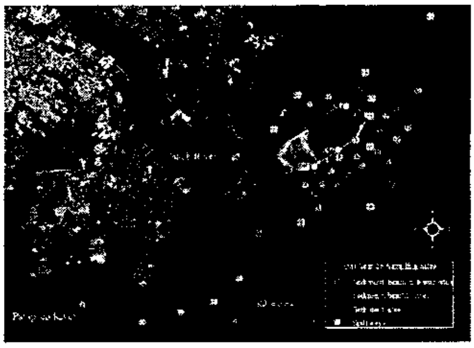
Department of the Environment

Monitoring of Dredging Sediment at Hart-Miller Island

Ching-Tzone Tien, Ph.D.,P.E., Chief
Groundwater Discharge Permit Division
Water Management Administration
Maryland Department of the Environment

MDE

MDE

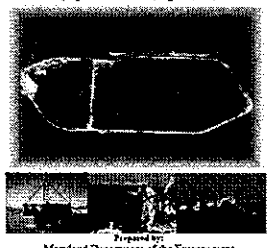


Summary Figure 1-1. Year 26 Hart-Miller Island monitoring locations. NOTE: After breakwaters were installed on the east side of HMI monitoring of station MDE-29 was discontinued.

MARYLAND

MDE

Assessment of Impacts from the Hart-Miller Island Dredged Material Containment Facility, Maryland.
Year 26 Exterior Monitoring Technical Report
(September 2007 – August 2008)



Prepared by:
Maryland Department of the Environment

MARYLAND

MDE

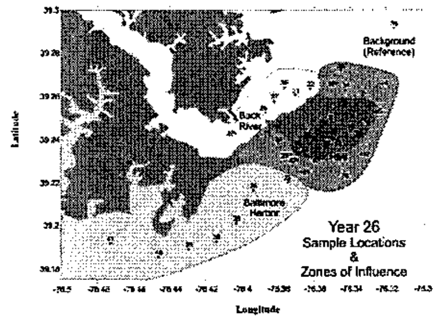
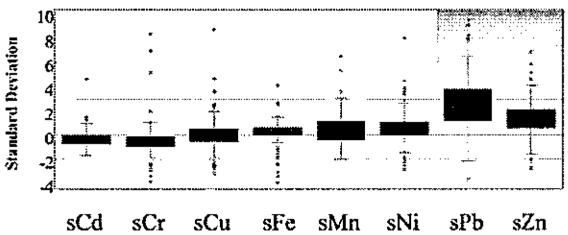


Figure 1-1. Sampling locations for Year 26. Contours show zones of influence found in previous studies. Stations 39 – 41 were added in Year 18 to measure the influence of Baltimore Harbor.

MARYLAND

MDE

Metals in the Sediment



Summary Figure 1-2. Year 26 concentration of metals at HMI relative to baseline values. Metal concentrations greater than 2 standard deviations (horizontal blue lines) are considered elevated above baseline.

MARYLAND

MDE

Groundwater Monitoring

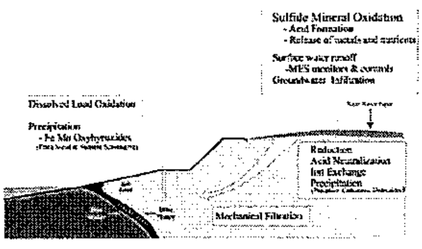


Figure 1-19. Schematic presentation of the processes which produce the ground water similar to those found in the South Cell wells.

MARYLAND

MDE

Table 1-3. Summary statistics for elements analyzed. [All concentrations are in ug/g unless otherwise noted]

	P (%)	Cd	Cr	Cu	Fe (%)	Mn	Ni	Pb	Zn
Ave	0.0738	0.69	92	41	4.04	2520	76	57	319
Std	0.0315	0.28	42	18	1.56	1287	34	27	162
Min	0.002	bdl	7	3	0.25	322	5	5	19
Max	0.122	1.6	301	79	6.15	6460	153	134	838
n	86	73	86	86	86	86	86	86	86
ERL	n/a	1.3	81	34	n/a	n/a	21	47	150
#>ERL	n/a	3	63	61	n/a	n/a	77	58	73
ERM	n/a	9.5	370	270	n/a	n/a	52	218	410
#>ERM	n/a	0	0	0	n/a	n/a	67	0	17

MARYLAND

MDE

Benthic Index of Biotic Integrity

low mesohaline metrics are presented in Table 2-14. The B-IBI was developed as a benchmark to determine whether any given benthic sample taken from the Bay either approximates (B-IBI score = 5), deviates slightly (B-IBI score = 3), or deviates greatly (B-IBI score = 1) from conditions at the best Reference sites (Weisberg et al., 1997). A B-IBI score greater than or equal to 3.0 represents a benthic community that is not considered stressed by *in situ* environmental conditions. The 20 benthic stations studied during Year 26 were compared to this benchmark.

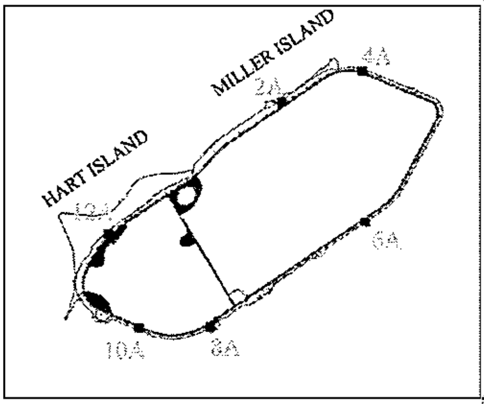
Table 2-14. Low mesohaline scoring criteria for measures used in calculating the Chesapeake Bay B-IBI in September 2007 (Weisberg et al. 1997).

Measure	Score		
	5	3	1
Total Abundance (individuals per square meter)	≥ 1500-2500	500-1500 or > 2500-6000	< 500 or ≥ 6000
% Pollution-indicative Taxa	≤ 10%	10-20%	> 20%
Shannon-Wiener Diversity Index	≥2.5	1.7-2.5	<1.7

MARYLAND

MDE

Groundwater Monitoring (2)



Summary Figure 1-4. Groundwater sampling wells locations.

MARYLAND

MDE

IBI <3 indicates Stress to Benthic Community

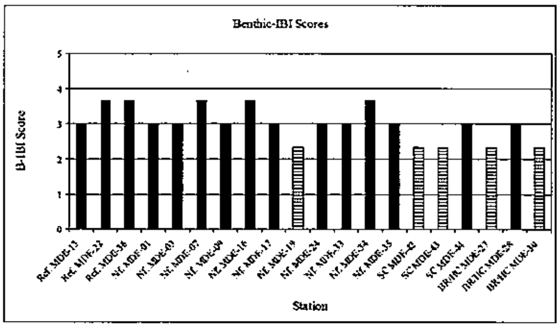


Figure 2-6. B-IBI Scores for all stations in September 2007 grouped by stations (Ref.=Reference; NF=Nearfield; SC=South Cell Exterior Monitoring; BR/HC=Back River Hawk Cove).

MARYLAND

MDE

Metals in the Groundwater

Table 1-4. Monitoring Wells Trace Metal Analyses for 2007 (two sampling periods). Detection Limit (*dl*), *Min*, *Max* and *MCL* are in units of mg/l.

	n	*n<dl*	*dl*	*Min*	*Max*	*MCL*
North Cell Type (2A and 6A)						
Al	4	4	0.05			0.05 - 0.2
As	4	0	0.01	0.016	0.038	0.05
Cd	4	4	0.002			0.005
Cr (total)	4	4	0.005			0.1
Cu	4	4	0.005			1.3
Fe	4	0		5.5	98	0.3
Pb	4	4	0.01			0.015
Mn	4	0		1.41	4.42	0.05
Zn	4	4	0.005			5
Ag	4	4	0.001			0.1
South Cell Type (4A, 8A, 10A and 12A)						
Al	8	8	0.05			0.05 - 0.2
As	8	0	0.001	0.007	0.021	0.05
Cd	8	8	0.002			0.005
Cr (total)	8	5	0.005	0.009	0.016	0.1
Cu	8	8	0.005			1.3
Fe	8	0		30.5	80.5	0.3
Pb	8	6	0.01	0.01	0.012	0.015
Mn	8	0		10.4	75	0.05
Zn	8	4	0.005	0.026	1.12	5
Ag	8	6	0.001			0.001

Note:
MCL – EPA and NOAA Maximum Concentration Level for Groundwater
North Cell Type – Maintained Pore water behavior
South Cell Type – Oxidation at Surface followed by neutralization and partial reduction

MARYLAND

MDE

Thank You and Question?

MARYLAND

MDE

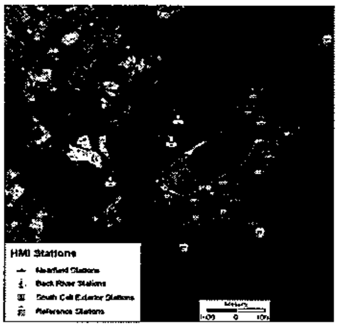


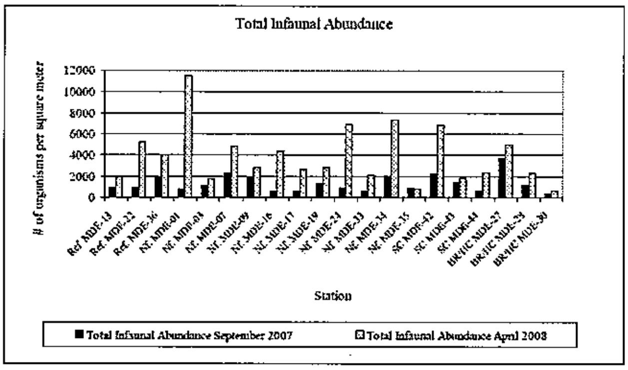
Figure 2-1. Year 26 benthic sampling stations for the HMI exterior monitoring program.

MARYLAND

MDE

MARYLAND

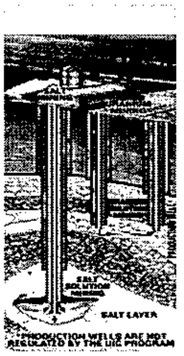
MDE



MARYLAND

UIC Program (Class III Wells)

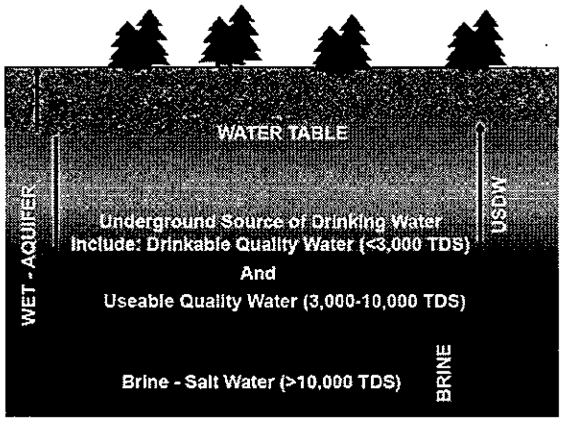
- Class III wells inject fluids to dissolve and extract minerals such as uranium, salt, copper, and sulfur. More than 50% of the salt and 80% of the uranium extraction in the United States involves the use of Class III injection wells. There are about 165 mining sites with approximately 18,500 Class III wells in operation across the nation.
- All Class III wells are operated under individual or area permits. Contamination from mining wells is prevented by implementing operational requirements such as (1) Operators of salt solution mining wells must test the well casing for leaks at least once every 5 years; or (2) Monitoring groundwater quality in the aquifers above and below.



Class III Wells - Minimize environmental impacts from solution mining operations.

Source: US EPA

MARYLAND



UIC Program (Class IV Wells)

Class IV Inject hazardous or radioactive wastes into or above USDWs. These wells are banned unless authorized under a federal or state groundwater remediation project.

Class IV wells are shallow wells used to inject hazardous or radioactive wastes into or above a geologic formation that contains a USDW. In 1984, EPA banned the use of Class IV injection wells for disposal of hazardous or radioactive waste. Now, these wells may only be operated as part of an EPA- or State-authorized groundwater clean-up action (such as pump and treat wells). There are about 32 waste clean-up sites with Class IV wells in the United States.


Class IV Wells - Prevent ground water contamination by prohibiting the shallow injection of hazardous waste except as part of authorized cleanup activities.

Source: US EPA

MARYLAND

Injection Wells and Well Classification

1. An Injection well is a device that places fluid deep underground into porous rock formations, such as sandstone or limestone, or into or below the shallow soil layer. These fluids may be water, wastewater, brine (salt water), or water mixed with chemicals.

The UIC Program defines an injection well as:

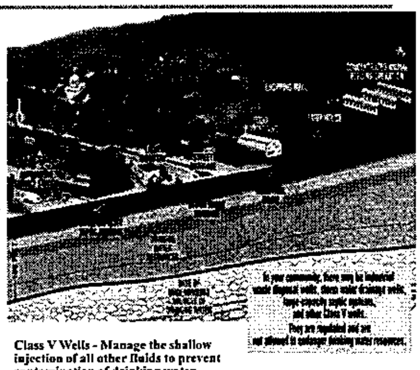
- A bored, drilled, or driven shaft, or a dug hole that is deeper than it is wide,
- An improved sinkhole, or
- A subsurface fluid distribution system.

2. UIC Program creates five classes of injection wells based on the injection activity, type of injected fluid, the depth of injection and impact of injection activity to USDW. There are Class 1, Class 2, Class 3, Class 4 and Class 5 Wells

MARYLAND

UIC Program (Class V Wells)

- Class V- All injection wells not included in Classes I-IV. In general, Class V wells inject non-hazardous fluids into or above USDWs and are typically shallow, on-site disposal systems. However, there are some deep Class V wells that inject below USDWs.
- National Inventory: 400,000 to 650,000 wells
Note: An inventory range is presented because a complete inventory is not available.
- Most Class V wells are shallow disposal systems that depend on gravity to drain fluids directly in the ground. There are over 20 well subtypes that fall into the Class Vcategory and these wells are used by individuals and businesses to inject a variety of non-hazardous fluids underground.
- Most of these Class V wells are unsophisticated shallow disposal systems that include storm water drainage wells, cesspools, and septic system leach fields.

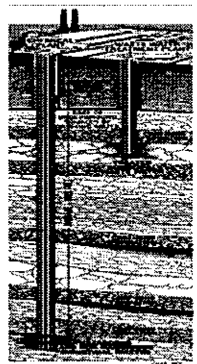

Class V Wells - Manage the shallow injection of all other fluids to prevent contamination of drinking water resources.

Source: US EPA

MARYLAND

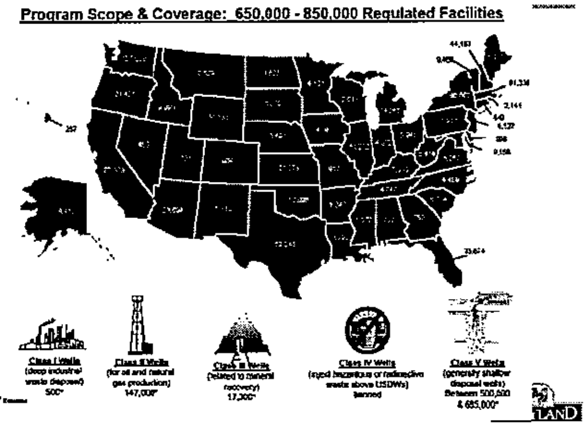
UIC Program (Class I Wells)

- Class I wells inject municipal wastewater, hazardous and non-hazardous wastes into deep, isolated rock formations that are thousands of feet below the lowermost USDW.
- Class I wells are used mainly by the following industries: Petroleum Refining, Metal Production, Chemical Production, Pharmaceutical Production, Commercial Disposal, Food Production, Municipal Wastewater Treatment.
  - There are approximately 550 Class I wells in the United States. The geology of the Gulf Coast and the Great Lakes area is best suited for these types of wells, and most Class I wells are found in these regions.
  - Class I injection wells inject far below the lowermost USDW. Injection zones typically range from 1,700 to more than 10,000 feet in depth. The injection zone is separated from USDWs by an impermeable "cap" rock called the confining layer, along with additional layers of permeable and impermeable rock and sediment that separate the injection layer from the USDW.



MARYLAND

Program Scope & Coverage: 650,000 - 850,000 Regulated Facilities



LAND

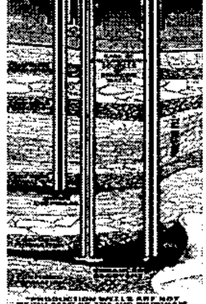
UIC Program (Class II Wells)

Class II well - Inject brines and other fluids associated with oil and gas production, and hydrocarbons for storage. They inject beneath the lowermost USDW.

National Inventory: 143,951 wells

Class II wells inject fluids associated with oil and natural gas production. Most of the injected fluid is salt water (brine), which is brought to the surface in the process of producing (extracting) oil and gas. In addition, brine and other fluids are injected to enhance (improve) oil and gas production. The approximately 144,000 Class II wells in operation in the United States inject over 2 billion gallons of brine every day. Most oil and gas injection wells are in Texas, California, Oklahoma, and Kansas.

Types of Class II wells: (1) Enhanced Recovery Well (80% of the Class II), (2) Disposal Well (20% of the Class II) for the disposal of brine and other fluids associated with oil and gas production only, and (3) Hydrocarbon Storage Wells (such as storing petroleum in salt cavern as part of the U.S. Strategic Petroleum Reserve). There are over 100 liquid hydrocarbon storage wells in operation.



MARYLAND

Source: US EPA

Regional Water Budget

- A method to evaluate the adequacy of groundwater resource for granting a groundwater appropriation
- Groundwater in a basin (or a watershed) = Groundwater out of a basin (or a watershed)± change of groundwater storage in a basin (or a watershed)
- The following equation is used by the Maryland Geological Survey (MGS)* in evaluating a regional water balance

$$P = GR + SR + ET \pm DIV \pm GU \pm CS + Q_w..$$

Where P = precipitation; GR = groundwater runoff flow (base flow); SR = surface runoff; ET = evaportranspiration; DIV = diversions into or out of a basin; GU = Groundwater underflow moving into or out of the basin across the drainage divide; CS: change in storage (groundwater storage, ponds, reservoirs, soil moisture storage etc) and Q_w : groundwater withdraws

* "Water Resources and Estimated effects of Groundwater Development, Cecil County Bulletin 34, MGS, Maryland Dept. of Natural Resources, (1988)"

29

Regional Water Budget (II)

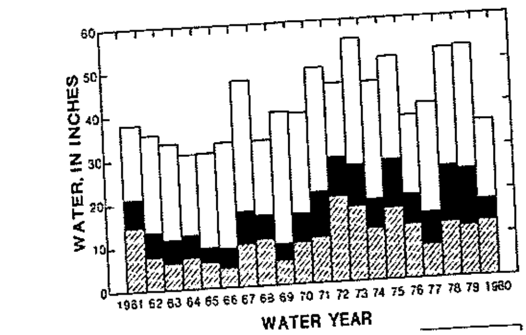
$$P = GR + SR + ET \pm DIV \pm GU \pm CS + Q_W$$

MGS report further indicates that the term DIV (diversions), GU (groundwater underflow), and CS (change in storage) terms are much smaller then other terms and is negligible. Q_w (withdrawals) in a basin is returned to the groundwater system within the basin via septic systems or wastewater treatment facilities. Therefore, Q_w term can also be negligible. The above equation is simplified to:

$$P = GR + SR + ET....$$

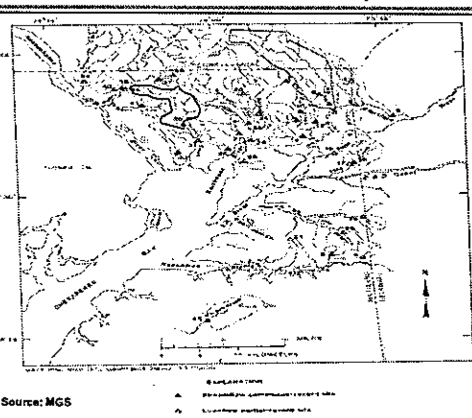
An example to demonstrate the above equation is shown in next two slides

Water Balance Chart at Big Elk Creek Basin in Cecil County, Maryland



Source: Maryland Geological Survey

Map Showing Streamflow Monitoring Stations (▲) and Stream Basins in Cecil County



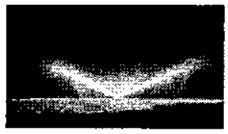
Source: MGS

Maryland Regulations for Groundwater Discharge

1. Code of Maryland Regulation (COMAR) 26.08.02.09.B. identifies three types (I, II, III) of aquifers based on permeability, transmissivity and TDS. Types I and II are drinking water aquifers.
2. COMAR 26.08.02.09. stipulates that discharge or disposal of water or wastewater into groundwater of the State requires the approval of MDE (a groundwater discharge permit).
3. COMAR 26.08.02.09. also stipulates that the discharge of wastewater into groundwater shall not cause groundwater quality in the mixing zone (monitoring wells) to exceed primary or secondary drinking water standards

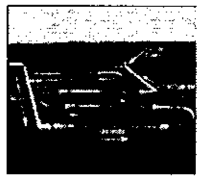
Examples of Groundwater Discharge in Maryland

spray irrigation of Treated Wastewater

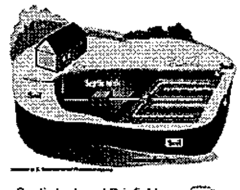


Golf Course irrigation

Infiltration Basin



Drip irrigation



Septic tank and Drinfield

Maryland Rules and Regulations in Groundwater Quantity Protection

1. Environment Article, Title 5-502 – Permit to Appropriate or Use State Waters (Annotated Code of Maryland)

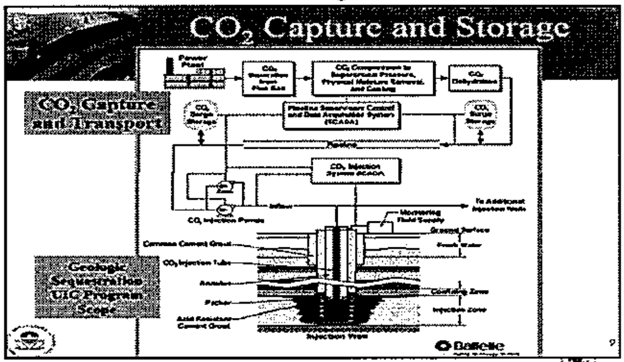
   Every person is required to obtain a permit from the Department (Environment) to appropriate or use or begin to construct any plant, building, or structure which may appropriate or use any waters of the State, whether surface or groundwater. The permit is obtained upon written application to the Department. The applicant shall provide the Department with satisfactory proof that the proposed withdrawal of water will not jeopardize the State's natural resources.

Appropriation Permit for Groundwater

- Purpose: To regulate the use of groundwater resources of a watershed or a political jurisdiction to maintain a steady state groundwater resources.
- Steady state means supply (recharge to the groundwater system) = demand (withdraw from the groundwater system)
- A Maryland groundwater appropriation permit is required for any activity that withdraws groundwater except for the following exceptions:
  1. Extinguishing a fire
  2. Agricultural use under 10,000 gal/day
  3. Individual domestic use except withdrawals for heating and cooling
  4. Temporary dewatering during construction if (a) quantity <10,000 gal/day; and (b) dewatering duration less than 30 days
  5. Residential subdivision with 10 lots or less

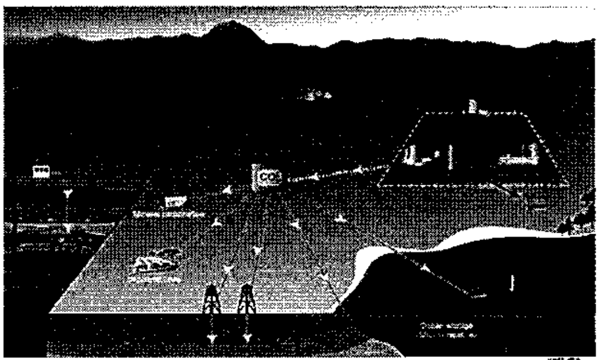
Source: Maryland Department of the Environment

MDE Schematic diagram of CO_2 Capture and Storage



Schematic diagram of possible CCS systems showing the sources for which CCS might be relevant, transport of CO_2 and storage options

MDE



(Courtesy of CO2CRC).

MDE Options For Geological Storage of CO_2

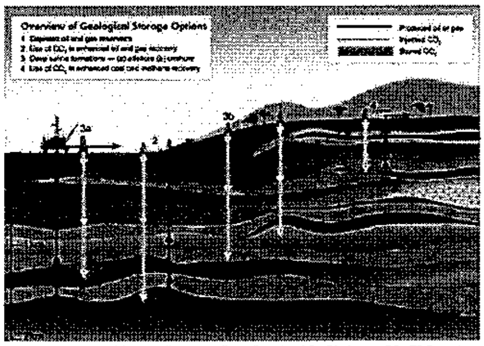
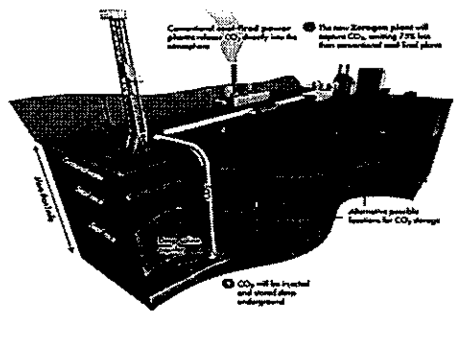


Figure 2.1. Examples of Geologic Formations Being Considered for GS. Source: CO2CRC, 2007

MDE Schematic Diagram of Liquid CO_2 Transport



Source: Greenwash Watch Catching CO2 with a Butterfly Net at http://www.treehugger.com/renewable-energy/greenwash-watch-catching-co2-with-a-butterfly-net.html

Water Balance at Big Elk Creek, Northeast Creek and Principio Creek Basins

MDE

MAJOR WATER-BUDGET ELEMENTS FOR SELECTED BASINS

[Water units are in million gallons per day per square mile (inches/year).]

Basin (Site location in fig. 17)	Drainage area (mi^2)	Precipitation1/	Runoff: Ground water2/	Runoff: Storm2/	Evapotranspiration3/
		Water years 1961-80			
Big Elk Creek above site 7	52.6	1.97 (41.34)	0.51 (10.8)	0.34 (7.1)	1.12 (23.5)
Northeast Creek above site 22	24.3	1.97 (41.34)	.41 (8.6)	.56 (11.8)	1.00 (21.0)
		Water years 1961-70			
Big Elk Creek above site 7	52.6	1.72 (36.08)	0.39 (8.3)	0.25 (5.2)	1.08 (22.6)
Northeast Creek above site 22	24.3	1.72 (36.08)	.33 (7.0)	.37 (7.8)	1.02 (21.3)
		Water years 1971-80			
Big Elk Creek above site 7	52.6	2.22 (46.60)	0.63 (13.2)	0.43 (9.0)	1.16 (24.4)
Northeast Creek above site 22	24.3	2.22 (46.60)	.49 (10.3)	.75 (15.7)	.98 (20.6)
Principio Creek above site 30	9.03	2.22 (46.60)	.50 (10.6)	.57 (12.0)	1.14 (24.0)

1/ Measured at University Farm, Newark, Del.
2/ Estimated from streamflow hydrographs.
3/ Precipitation minus runoff. Assumes other variables are negligible.

MDE The Groundwater Baseflow (GR) and Groundwater Appropriation in Maryland

$$P = GR + SR + ET....$$

For the Piedmont aquifer, the long term average GR ranges from 11-12"/yr. For the Coastal Plain aquifer, the long term average GR ranges from 13.7-15"/yr. (MGS)

The amount of groundwater allowed for appropriation (App) in a basin with a surface area (A) is determined based on a groundwater recharge rate during a 1 in the 10-year drought which can maintain adequate groundwater based flow to recharge to a stream to maintain a 7-day 10 year low flow (7Q10).

App (gal/day) = ([Drought Recharge] – [7Q10]) x A x(74.346)

1 acre-inch/yr = (27,154 gal/acre-inch)/365 days = 74.4 gal/day

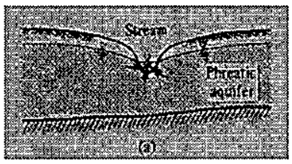
The Drought Recharge (green box) and 7Q10 (red box) for various river basins in Maryland are shown in the next slide

MDE The Groundwater Baseflow (GR) and Groundwater Appropriation in Maryland (II)

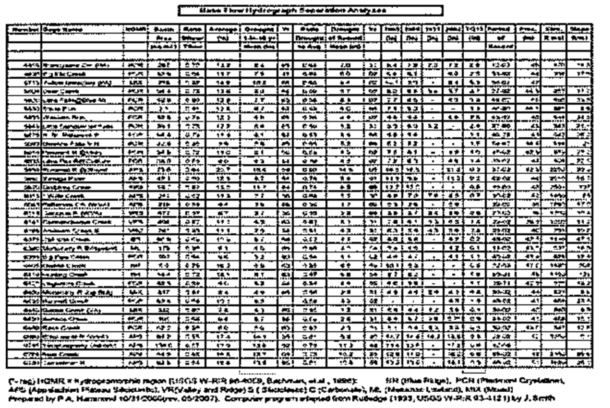
Definition of 7Q10 by USGS*:

The lowest (or the highest) streamflow that occurs over 7 consecutive days and has a 10-year recurrence interval period, or a 1 in 10 chance of occurring in any one year. Daily streamflows in the 7Q10 range are general indicators of prevalent drought conditions which normally cover large areas. 7Q10 values are also used by the State for regulating water withdrawals and discharges into streams.

*Source: Low Flow Frequency of Georgia Streams: U.S. Geological Survey Water-Resources Investigations Report 77-127, 104 p



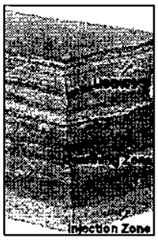
Baseflow Hydrograph data used for Maryland Groundwater Appropriation



Source: Maryland Department of the Environment

Site Characterization

- Basic requirements:
  - Injection zone that can accept fluids
  - Confining zone (system) above the injection zone, that contains all fluids



Proposed EPA Rule for GS

- **Proposed Rule -** *http://www.epa.gov/safewater/uic/wells_sequestration.html*
- **New UIC Well Class VI -** wells that will be used to inject CO2 into the subsurface for the purpose of long-term storage.

MARYLAND

Potential Risks of Geo-sequestration

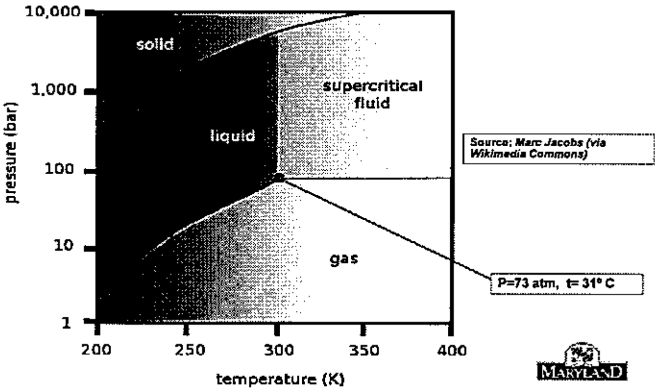
- Key vulnerabilities of CO2 injection (e.g. human health, sources of drinking water, habitat)
  - Organics leaching, dissolution of metals
  - Co-injection of other constituents
  - Escape of CO2 gas to the surface
- Storage capacity, pressure build-up
  - Alterations to ground water flow regimes
  - Increased risk of seismicity

Milestones
Geologic Sequestration of CO_2

Activity	Milestone
Workgroup Formation & Data Collection and Analysis	Ongoing
Two Stakeholder Meetings	December 2007/February 2008
Interagency Review of Proposed Rule	Late May - Early June 2008
Administrator's Signature of Proposed UIC Rule	July 2008
Public Comment Period for Proposed Rule	July – October 2008
Notice of Data Availability (if appropriate)	2009
Final UIC Rule for GS of CO_2	Late 2010 / Early 2011

MDE

CO_2 Phase Diagram



MARYLAND

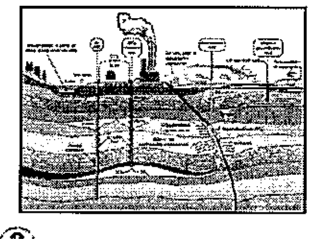
MDE

Status of GS Rule

1. USEPA proposed the Geologic Sequestration (GS) Rule in 7/2008
2. The National Class VI well Program of UIC became effective on September 7, 2011 to regulate the GS of CO_2 in minimizing the groundwater quality and public health impacts.

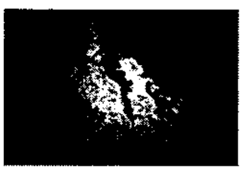
MARYLAND

Technical Challenges & Risks



- Abandoned wells are a key potential source of leakage
- Storage of significant volumes of CO_2 will likely cause large-scale displacement of native fluids
- Long-term behavior of CO_2 in the subsurface is not fully understood
- Key to GS is protecting underground sources of drinking water (USDWs)

Unique Challenges of GS of CO_2



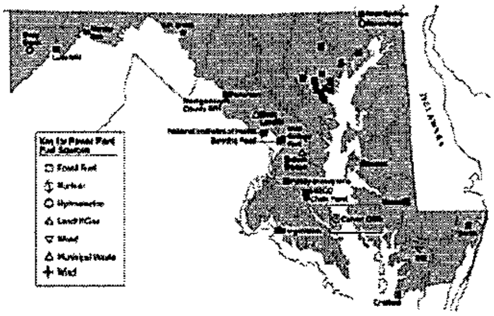
- Extremely large volumes may be injected
- Unlike other injected fluids, CO_2 is buoyant
- CO_2 is very mobile underground
- CO_2 may also be corrosive to operating equipment

Every 4×10^9 ton (4 giga ton) of fossil carbon burned contributes 1ppm CO_2 in air. Current CO2 emission 8 GT/yr globally. Currently, 385 ppm CO2 in air. IPCC (Inter governmental Panel on Climate Change) predicts 425 ppm in 2020. From 385 ppm to 450 ppm, the temperature increases 2° C. Cost of injection $20-50/ton

MARYLAND

MDE

Power Plants in Maryland

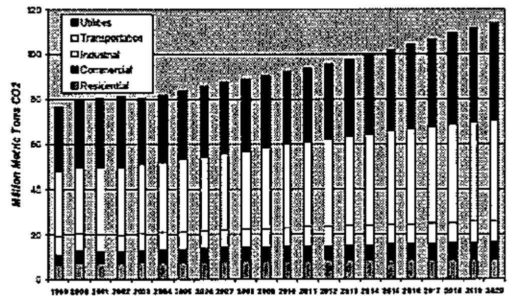


Source: Maryland Department of Natural Resource (DNR)

MARYLAND

MDE

Maryland Projected CO_2 Emissions (1999-2020)



Source: Maryland Dept. of Natural Resource (SAIC forecast)

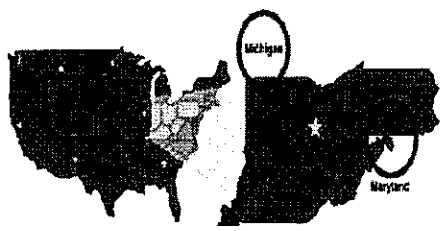
MARYLAND

MDE

States Belonging to the Midwest Regional Carbon Sequestration Partnership (MRCSP)

The MRCSP, lead by the Batelle Memorial Institute, will identify greenhouse gas sources in its region and determine the technical feasibility and cost of capturing and sequestering these emissions in deep geologic formations and agricultural forests and degraded land system. The studies conducted through the Maryland Geological Survey, the Maryland Power Plant Research Program (PPRP) and the Maryland Energy Administration.

Source: Maryland Department of Natural Resource (DNR)

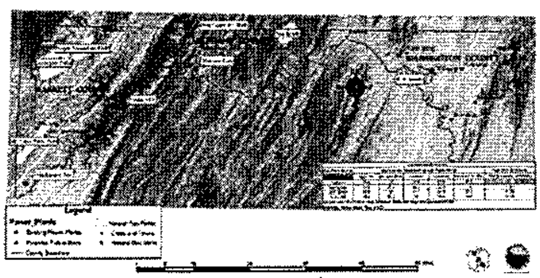


MARYLAND

MDE

Locations of CO_2 Sources (Power Plants) and Natural Gas Fields for CO_2 Storage in Western Maryland

CO2 Sources and Sinks in Western Maryland
Power Plants and Natural Gas Fields



Source: Maryland Department of Natural Resource (DNR)

MARYLAND

EPA Current Permitting Guideline and Proposed Regulations

Guideline

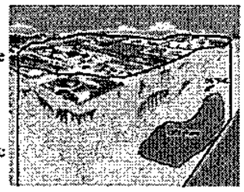
- Requirements
  - Site Characterization
  - Area Of Review
  - Well Construction
  - Well Operation
  - Monitoring
  - Post Closure Care
  - Public Participation

Proposed Regulation

- Similar but more closely defined requirements
- A New 'Class VI' Well Type
- Primacy Requirements

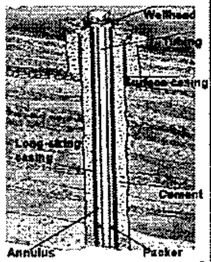
Area of Review

- Basic requirements:
  - Delineate the AoR
  - Identify all artificial penetrations and evaluate features that may allow upward migration
  - Determine if artificial penetrations and geologic features provide an adequate seal
  - Remediate (corrective action) if possible



Well Construction

- Basic requirements:
  - Cased and cemented in a manner that prevents movement of fluids into an USDW
    - Surface casing and long string casing
    - Tubing and packer

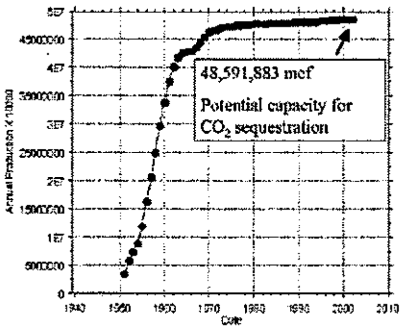


MDE

CO_2 Storage Study in Maryland

MARYLAND

Cumulative Natural Gas Production (in 10^6 ft^3) in Maryland

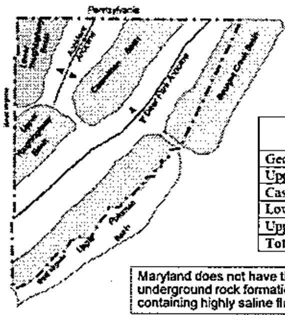


The volume vacated by gas production can be used for CO_2 storage ($48{,}591 \times 10^6$ cubic feet)

Source: Maryland Department of Natural Resource (DNR)

MARYLAND

Locations of Coal Basins in Western Maryland (Potential Sites for CO_2 Storage)



Maryland coal reserve is estimated at one billion tons of which 855 million tons is recoverable shown in the table below:

Basin	Recoverable Tons (Millions)
Georges Creek	354.1
Upper Potomac	223.5
Casselman (Castleman)	116.0
Lower Youghiogheny	107.0
Upper Youghiogheny	54.3
Total	854.9

Maryland does not have the Saline formation which is a deep underground rock formation composed of permeable materials and containing highly saline fluids.

Source: Maryland Department of Natural Resource (DNR)

MARYLAND

MDE

Thank You and Question?

MARYLAND

MARYLAND

Department of the Environment

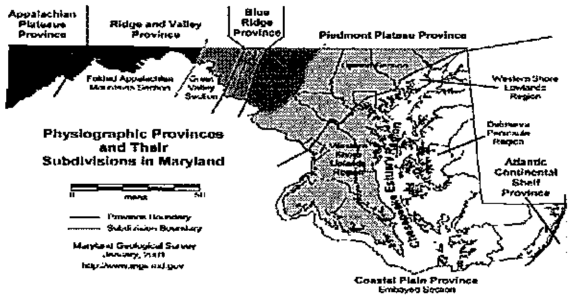
Groundwater Protection in Maryland

Ching-Tzone Tien, Ph.D.,P.E., Chief
Groundwater Discharge Permit Division
Water Management Administration
Maryland Department of the Environment

MDE

MDE

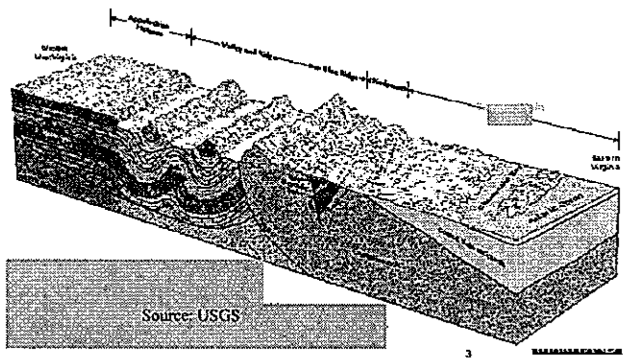
Maryland Geologic Formation



MARYLAND

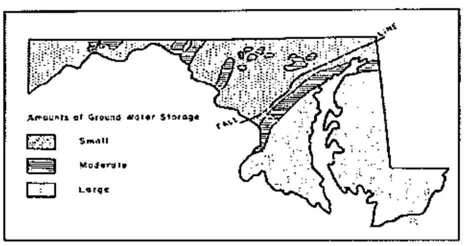
MDE

Profile View of Maryland Geologic Formations



MDE

Groundwater Storage in Maryland

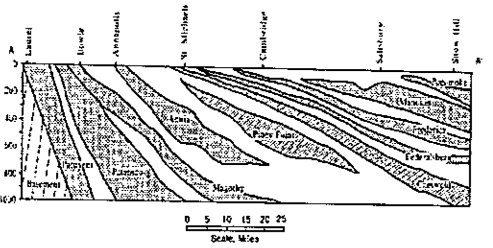


Ground Water Storage in Maryland (Walker, 1970)

MARYLAND

MDE

Major Aquifers in the Maryland Coastal Plain Geologic Formation (Profile view of Section A-A' of previous slide, Laurel to Snow Hill)



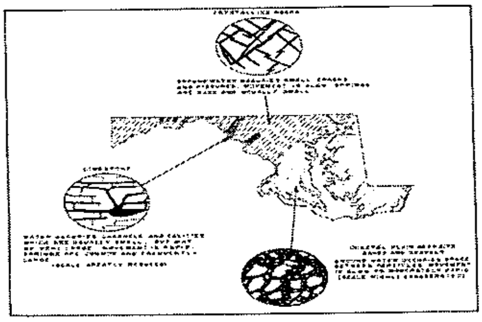
Cross Section Showing Major Aquifers of the Maryland Coastal Plain

Source: "The quantity and natural quality of groundwater in Maryland (1987)", Dept. of Natural Resources

MARYLAND

MDE

Groundwater Storage in Unconsolidated, Crystal Rock and Limestone Aquifers



Source: "The quantity and natural quality of groundwater in Maryland (1987)", Dept. of Natural Resources

MARYLAND

MDE

Physical Characteristics of Four Major Aquifers in Maryland

Aquifer Name	Outcrop Area	Transmissivity ($x10^3$ gal/day/ft width of aquifer)	Major users
Patuxent	Along I-95 between Elkton and DC area	0.97-80	Anne Arundel County wells at Dorsey road (3.2 mgd) Bethlehem Steel (2.2 mgd) City of Bowie (1.6 mgd)
Patapsco	Major outcrop is between Baltimore and DC area	1.2-50	Anne Arundel County wells at Dorsey road (3.6 mgd) Naval Academy (2.3 mgd) Naval facility at Indian Head (1.4 mgd)
Magothy	Anne Arundel Crofton Area and northern Prince George County Laurel area	3.7-90	City of Annapolis (3.7 mgd) Waldorf well (2.9 mgd) Easton Utilities (1 mgd)
Aquia	Between stream bed of Sassafras River in Cecil County and Stream bed of Potomac River in western Charles County	0.75-41	Patuxent Naval Air Station (1 mgd) Campbell Soup Company in Kent County (0.7 mgd)

MARYLAND

Source: "The quantity and natural quality of groundwater in Maryland (1987)", Dept. of Natural Resources

---

MDE

Chemical Characteristics of Four Major Aquifers in Maryland

Aquifer Name	Iron (mg/l) [SDWR or SMCL = 0.3 mg/l]	Chloride (mg/l) [SDWR or SMCL = 250 mg/l]	Hardness (mg/l as $CaCO_3$) [No SDWR or SMCL] [Soft water <70-140 mg/l, Hard water> 320-530 mg/l]	Total Dissolved Solids (mg/l) [SDWR or SMCL = 500 mg/l]	pH [SDWR or SMCL = 6.5-8.5]
Patuxent	0-12	0-2580	0 to >1000	8.8 to >5120	4.0 – 9.9
Patapsco	0-30	0-2580	0-1030	33-5120	3.9-8.9
Magothy	0.08-27.9	0.3-85	0-178	90-812	3.8-8.7
Aquia	0-8.2	0-80	10-403	131-698	5.2-8.6

Source: "The quantity and natural quality of groundwater in Maryland (1987)", Dept. of Natural Resources

MARYLAND

Superfund Amendments and Reauthorization Act (SARA) of 1986

MDE

- To keep the major clean- up liability requirements of CERCLA unchanged and to allocate more funding for abandoned HW sites.
- **Under CERCLA, the current landowner is liable for clean-up even that the landowner did not cause the contamination. SARA allows "innocent" purchasers of properties to limit their clean-up liability.**
- **Innocent and " no reason to know" to a new property owner- SARA stipulates that a judge should consider in determining whether or not the buyer had " no reason to know' about the contamination. (such as contamination was not there at the time of purchase but occurs at later date). This causes a buyer more cautious in purchasing a property. The buyer will proceed a study of the site prior to purchase. The study includes Phase I (preliminary evaluation), Phase II (Soil and groundwater testing) and Phase III (remediation efforts involved).**
- **SARA Title III- Reporting requirements for facilities exceeding certain poundage of release (including spill) of HW to submit annual report to EPA.**

MARYLAND

SDWA and Groundwater Protection

MDE

- The Safe Drinking Water Act (SDWA) was originally passed by Congress in 1974 to protect public health by regulating the nation's public drinking water supply. The law was amended in 1986 and 1996 and requires many actions to protect drinking water and its sources: rivers, lakes, reservoirs, springs, and groundwater wells.
- Part C of the SDWA entitled "Protection of Underground Sources of Drinking Water" includes various requirements in protecting groundwater quality. Part C has a total of 9 sections (Sec 1421-1429).
- Section 1421 of SDWA requires the EPA Administrator to promulgate regulations establishing minimum requirements for effective Underground Injection Control (UIC) program. The UIC program is to regulate underground injection of fluids into wells. The injected fluid may contain pollutants to endanger the underground source of drinking water (USDW).

MARYLAND

SDWA and Groundwater Protection (II)

MDE

- Section 1422 of SDWA requires the EPA administrator to list in the Federal Register " Each State for which in his judgment a State UIC program may be necessary to assure that underground injection will not endanger drinking water source"
- Section 1423 of SDWA provides procedures for EPA enforcement of UIC requirements
- Under Section 1428 of SDWA entitled "State programs to establish wellhead protection areas", the Governor or Governor's designee of each State shall, within 3 years of June 19, 1986, adopt and submit to the Administrator a State program to protect wellhead areas within their jurisdiction from contaminants which may have any adverse effect on the health of persons

MARYLAND

UIC Program

MDE

The purpose of the UIC Program is to prevent contamination of underground sources of drinking water (USDWs) by regulating injection activities. A USDW is defined as an aquifer, or its portion, which serves as a source of drinking water for human consumption, or contain a sufficient quantity of water to supply a public water system and contains fewer than 10,000 mg/l total dissolved solids.

The UIC regulations address activities throughout the life of an injection well, including siting, construction, operation and monitoring, and closure. These requirements are designed to prevent contaminants from moving into drinking water sources. There are UIC requirements specific to each class of wells to address the uses of the wells and the potential threats to USDWs each may pose.

MARYLAND

Groundwater Protection Rules and Regulations in the USA

MDE

Applicable Federal rules and regulations for protecting national groundwater include the following:

1. Safe Drinking Water Act (SDWA) of 1974 (recent amended on 12/31/2002) and UIC Rules
2. Resource Conservation and Recovery Act (RCRA) of 1976
3. Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980
4. Hazardous and Solid Waste Amendments (HSWA) of 1984
5. Superfund Amendments and Reauthorization Act (SARA) of 1986

MARYLAND

Resource Conservation and Recovery Act (RCRA) of 1976

MDE (Section 14.3 of textbook, pp550-558)

- RCRA became effective in Nov. 1980 to regulate the handing and disposal of hazardous waste (HW) , to minimize waste generation, and to ensure the treatment, storage and disposal (TSD) of HW is protective to human health and environment.
- **Definition of HW – ignitable, reactive, corrosive and toxic (via TCLP test)**
- **Manifest Program to track the fate of HW follow the waste from "cradle to grave" from generation, transportation to TSD facilities (manifest form must be completed in every stage). 1st step in eliminating HW into groundwater.**
- **TSD facilities must obtain permits from authority in handing HW. HW transporter must have EPA ID number.**
- Groundwater monitoring requirements- installing groundwater monitoring wells (locations), defining monitoring parameters and sampling frequency
- **Closure and post-closure requirements - closure plans required to identify how long the HW contaminated site will be operated and how to handle the HW waste currently onsite. The facility can be closed if (1)No need of further maintenance; (2) Capable of controlling, minimizing or eliminating HW in protecting human health and Environment; (3) meeting applicable closure requirements.**

MARYLAND

Hazardous and Solid Waste Amendments (HSWA) of 1980 (

MDE

- To ban the land disposal of HW, to reduce the exemption of small HW generators (<1000 kg/month), to regulate the underground storage tank (UST) containing gasoline, and to regulate the HW disposal or solid waste management units (SWMUs).
- **The Land Ban- to ban certain classes of land disposal facilities which are no longer effective in containing the HW in reducing risk to public health and environment. The land disposal facilities include land fill, surface impoundment. waste pile, injection well, land treatment site, salt dome formation (formed on top of the dense sedimentary rock formation) and underground cave or mine. However, if HW is treated to be a non-hazardous waste which can be disposed of at a land disposal site.**
- **Small HW generator- To regulate generators with 100 kg/mo<HW< 1000kg/mo after March 1986 including requirements of manifesting and permitting.**
- **UST was regulated by RCRA but not UST with gasoline. The HSWA provides the authority in regulating gasoline USTs in May, 1986 including integrity of the UST.**

MARYLAND

CERCLA of 1980 (Section 14.5 of textbook, pp562-572)

MDE

- To provide legal authority in clean up of hazardous substance (HS) and reporting of HS.
- **Create Superfund Tax Act to collect tax on oil and certain HS and form superfund for cleaning up National Priority Sites**
- **Superfund Site – EPA identifies the National Priority Site (or Superfund Site) , provides a National Priority List (NPL,) and prepare a plan for clean up using superfund. The ranking system of NPL is complex and is defined in 40CFR Part 300, Appendix A.**
- **Remediation Investigation (RI) and feasibility study (FS) of a superfund site must be conducted to meet EPA clean up goals in zero risk and groundwater reuse. Considering all I/A remediation technologies in the RI/FS stage**
- **Reporting of release of HS into soil and groundwater**
- **Property owner is liable for cleaning up of the release of HS. This requirement affects property ownership transfer.**

MARYLAND