

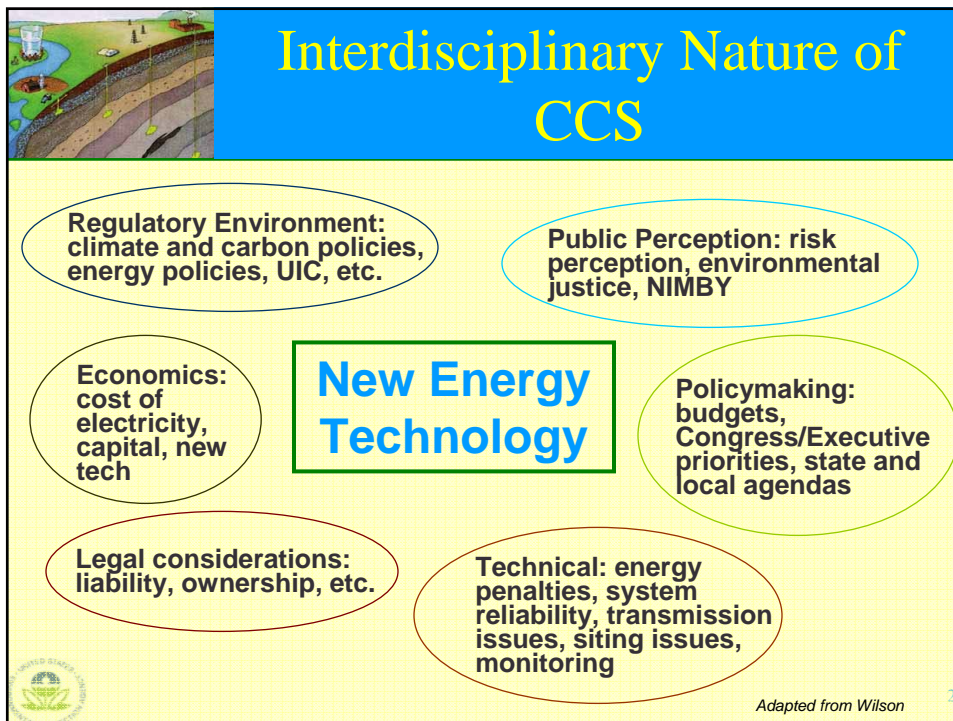
# Workshop Overview

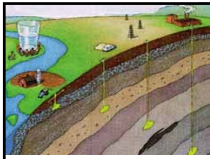
## *Geologic Sequestration of Carbon Dioxide Under the Safe Drinking Water Act's Underground Injection Control Program*



**Robert Brenner, Director, Office of Policy Analysis and Review, Office of Air  
Stephen Heare, Director, Drinking Water Protection Division, Office of Water  
U.S. Environmental Protection Agency**

**EPA Public Workshop: Geologic Sequestration of CO<sub>2</sub>  
Crystal City Sheraton Hotel, Arlington, VA  
February 26-27, 2008**



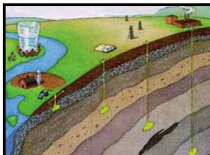


## Advanced Coal Technology Work Group

- ☐ Formed under Clean Air Act Advisory Committee
- ☐ Operated for one year, through Jan. 31, 2008
- ☐ Broad cross-section of stakeholders
- ☐ 13 consensus-based recommendations on how to accelerate the deployment of technologies, with a focus on CCS
- ☐ Presents path forward on a critical policy area



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## 13 Final Recommendations

### ***Congress/Other***

- ☐ Early Deployment Fund
- ☐ Incentives
- ☐ State Actions
- ☐ National Policies
- ☐ Technology Advancing Agreements

### ***EPA “traditional OAR”***

- ☐ Energy Efficiency Improvements
- ☐ Clean Air Act Authorities

### ***CCS for EPA***

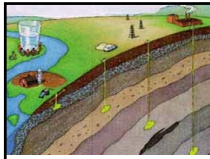
- ☐ UIC Program
- ☐ Educ & Outreach
- ☐ CO2 Accounting Protocol
- ☐ Training

### ***CCS, other***

- ☐ CO2 specifications
- ☐ Pipeline Study



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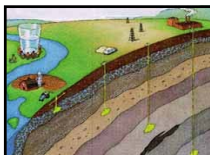


## EPA's Rulemaking

**Collaborative effort among the Office of Water, Office of Air, and others**



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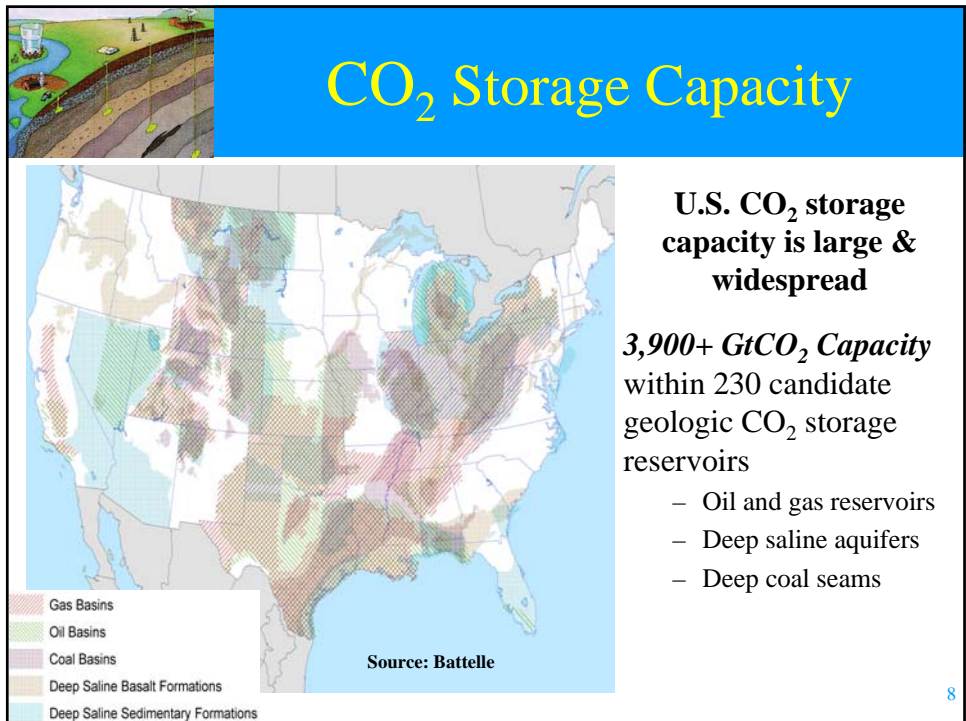
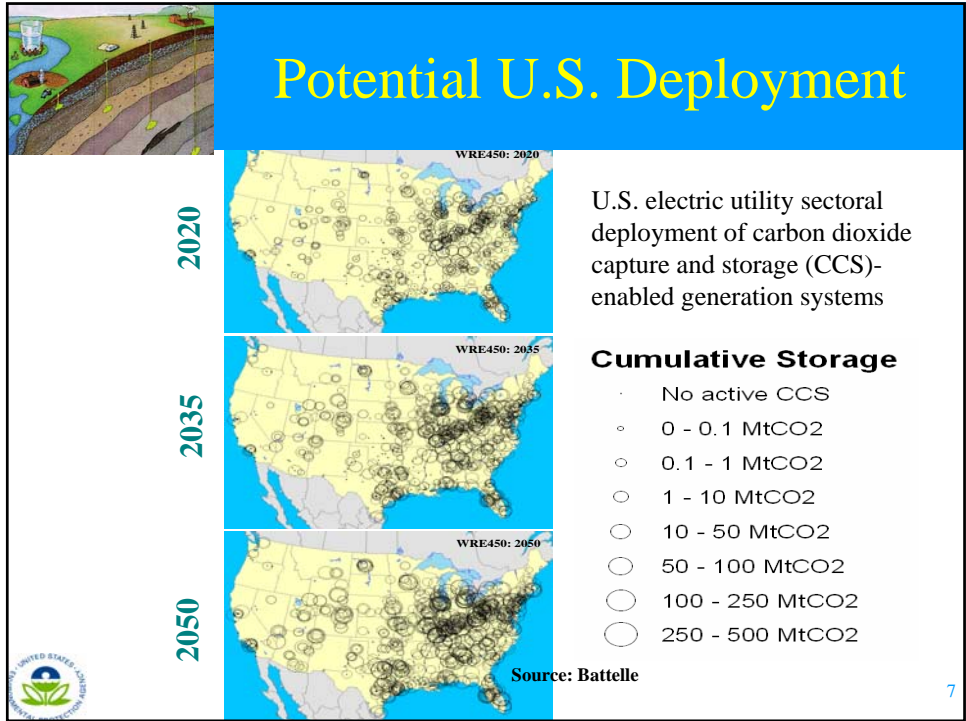


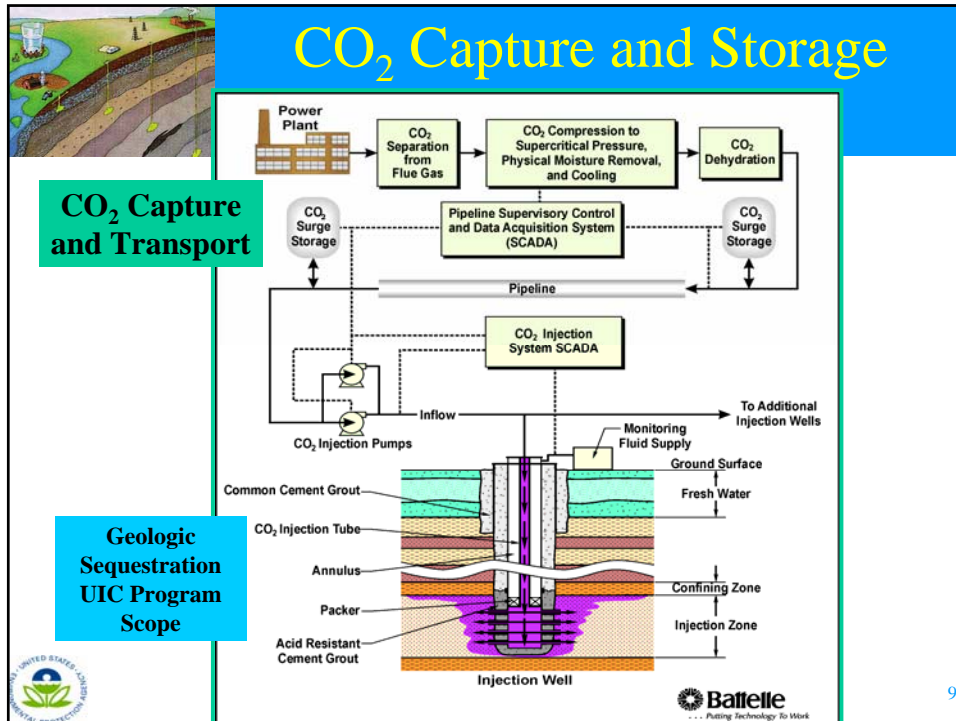
## Importance of CCS

- Carbon Capture and Storage (CCS) is a key climate change mitigation technology
- Geologic sequestration (GS) regulations will enable protection of Underground Sources of Drinking Water (USDWs)
- The Safe Drinking Water Act *protects underground sources of drinking water* from underground injection of fluids, including carbon dioxide (CO<sub>2</sub>)



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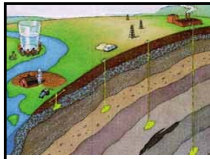




## Interest in Geologic Sequestration of CO<sub>2</sub>

- Congressional interest is generating legislation and greater focus on this technology
- Stakeholders are expressing a desire for management framework
- EPA's Strategic Plan (2006-2011) highlights carbon capture and sequestration

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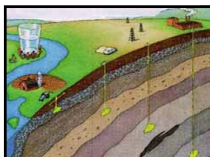


## Agency Activities

- Released the Underground Injection Control (UIC) Class V Experimental Technology Well Guidance (March 2007)
- EPA and primacy states are receiving, reviewing and issuing UIC permit applications for GS projects (2007 and ongoing)
- Holding technical workshops (ongoing)
- EPA's Administrator, Steve Johnson, announced on October 11, 2007, that EPA would develop a **Proposed Rule** for commercial scale GS of CO<sub>2</sub> by Summer 2008



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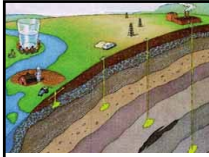


## Agency Activities

- EPA is holding workshops to involve a diverse stakeholder community
- EPA's Office of Water (OW) and Office of Air and Radiation (OAR) are collaborating to
  - Ensure that cross-programmatic goals are achieved
  - Clarify relationship between various statutes (SDWA, CAA, etc.) and EPA regulations
  - Conduct technical and cost analyses
- EPA continues to work closely with the Department of Energy
- EPA is increasing coordination with
  - Department of Transportation
  - Bureau of Land Management
  - United States Geologic Survey
- EPA has formed an internal Agency workgroup to focus on this rulemaking



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**Thank You!**

### **More information about the UIC Program**

- ☐ EPA Geologic Sequestration of Carbon Dioxide Website –  
[http://www.epa.gov/safewater/uic/wells\\_sequestration.html](http://www.epa.gov/safewater/uic/wells_sequestration.html)
  
- ☐ Code of Federal Regulations: Underground Injection Control Regulations 40 CFR 144-148 –  
[http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?sid=d6ee71a544eca89c533c825135913f13&c=ecfr&tpl=/ecfrbrowse/Title40/40cfrv22\\_02.tpl](http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?sid=d6ee71a544eca89c533c825135913f13&c=ecfr&tpl=/ecfrbrowse/Title40/40cfrv22_02.tpl)



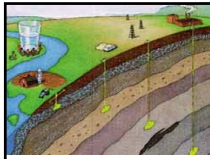
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## **EPA's Proposed Rulemaking Update** *Geologic Sequestration of Carbon Dioxide Under the Safe Drinking Water Act's Underground Injection Control Program*



**Ann M. Codrington, Chief, Prevention Branch  
U.S. Environmental Protection Agency  
Office of Ground Water and Drinking Water**

**EPA Public Workshop: Geologic Sequestration of CO<sub>2</sub>  
Crystal City Sheraton Hotel, Arlington, VA  
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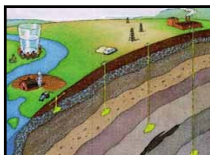


## Purpose

- Discuss December Workshop
- Identify how EPA is addressing stakeholder input
- Review rulemaking schedule



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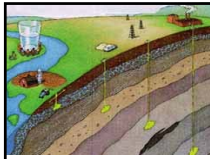
## EPA's Underground Injection Control Program

- The 1974 Safe Drinking Water Act (SDWA) requires EPA to develop minimum federal regulations for state and tribal Underground Injection Control (UIC) programs to ***protect underground sources of drinking water (USDW)***
  - The UIC program regulates underground injection of all fluids – liquid, gas, or slurry
  - Natural gas storage, oil & gas production, and some hydraulic fracturing fluids are exempt from UIC requirements
- The existing UIC program provides a regulatory framework for geologic sequestration of carbon dioxide



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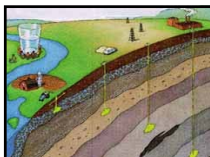


## Stakeholder Workshops

- Stakeholder participation is integral to the rulemaking
  - December 3-4, 2007 (Washington, DC)
    - Inform stakeholders of rulemaking process
    - Identify and discuss stakeholder issues, questions, and considerations related to the proposed rulemaking
  - February 26-27, 2008 (Arlington, VA)
    - Update stakeholders on rulemaking progress and how their concerns are being addressed
    - Discuss and hear feedback on specific technical and policy issues related to the proposed rulemaking



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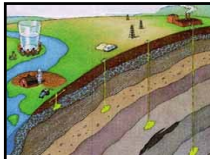


## December Workshop

- Over 250 participants
  - Industry
  - Environmental and public interest groups
  - Government
  - General public
- A range of topics
  - EPA's proposed rulemaking process
  - Existing UIC program regulations
  - CO<sub>2</sub> geologic sequestration (GS) technology
  - Perspectives for approaching proposed regulations of GS of CO<sub>2</sub>
  - Potential challenges related to GS of CO<sub>2</sub> and USDW protection



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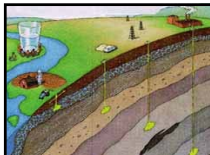


## December Workshop *Summary*

- **Technical Challenges**
  - Area of Review (AoR)/Site Characterization
    - Geologic considerations
    - Evaluation techniques
    - Artificial penetrations
  - CO<sub>2</sub> properties
  - Monitoring
    - For verification
    - Plume location and movement
    - Pressure front
    - Surface monitoring



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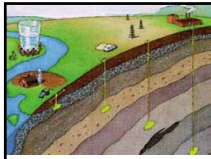


## December Workshop *Summary (cont.)*

- **Policy Challenges**
  - Relationship between primacy states and federal authorities
  - Property rights
  - Surface access
  - Pore space ownership
  - Post-closure
    - Duration of post-closure care
    - Long term care



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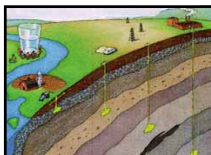


## December Workshop *Summary (cont.)*

- Overarching Challenges
  - Public education and outreach
  - Flexibility
  - Adaptability
  - Cost and benefits



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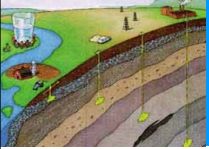
## Post-Workshop *Integrating Information*

In support of the rulemaking:

- EPA reviewed December stakeholder meeting input
- EPA's internal GS workgroup is deliberating
- EPA is addressing information in the context of
  - Geologic Siting Criteria
  - Area Of Review
  - Well Construction Standards
  - Mechanical Integrity Testing
  - Operation and Monitoring Requirements
  - Well Closure and Post-Closure Care, and Financial Responsibility
- Public Participation and Communication




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## EPA's Proposed Rule-Making *Recent Activities*

- Technical workshop on measurement, monitoring, and verification (January 16, 2008)
- Preparation of
  - cost analysis
  - options development
  - background documents
- Data collection and analysis (ongoing)
- Increased coordination (ongoing) with
  - The Department of Transportation
  - The Bureau of Land Management
  - The United States Geological Survey




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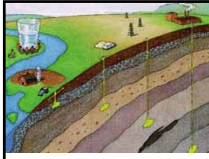


## Milestones *Geologic Sequestration of CO<sub>2</sub>*

Activity	Milestone
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 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 <sub>2</sub>	Late 2010 / Early 2011



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Thank you!

### More information about the UIC Program

- EPA Geologic Sequestration of Carbon Dioxide Website – [http://www.epa.gov/safewater/uic/wells\\_sequestration.html](http://www.epa.gov/safewater/uic/wells_sequestration.html)
- Code of Federal Regulations: Underground Injection Control Regulations 40 CFR 144-148 – [http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?sid=d6ee71a544eca89c533c825135913f13&c=ecfr&tpl=/ecfrbrowse/Title40/40cfrv22\\_02.tpl](http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?sid=d6ee71a544eca89c533c825135913f13&c=ecfr&tpl=/ecfrbrowse/Title40/40cfrv22_02.tpl)



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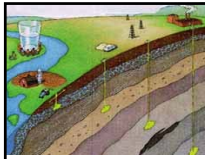
## Proposed Rule: Geologic Sequestration of CO<sub>2</sub>



Lee Whitehurst  
U.S. Environmental Protection Agency  
Office of Ground Water and Drinking Water

*EPA Public Workshop: Geologic Sequestration of CO<sub>2</sub>  
Crystal City Sheraton Hotel, Arlington, VA  
February 26-27, 2008*

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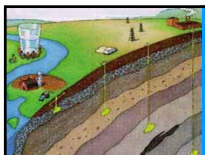


## Outline

- Provide a brief background on the proposed rule development
- Set the stage for tomorrow's breakout sessions by outlining key issues for stakeholder input:
  - Site Characterization – Secondary confinement (Breakout)
  - Area of Review – Periodic re-evaluation (Breakout)
  - Well Construction – Corrosion resistance
  - Monitoring – Tracers and air/soil gas monitoring (Breakout)
  - Post Closure Care - Timeframe (Breakout)
  - Public Participation – Adapting to new technologies (Breakout)
- Provide an opportunity for clarification questions



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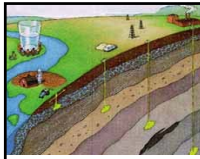


## Rulemaking Background: Process

- EPA Administrator announced proposed rule will be published by summer 2008
  - The rule will propose minimum federal requirements for GS of CO<sub>2</sub>
  - Builds on the existing UIC regulatory framework and adapts to accommodate new information
- A proposed rule is comprised of:
  - Preamble
  - Amended rule text
  - Docket
- Agency workgroup was initiated in November to develop a set of regulatory alternatives to address GS of CO<sub>2</sub>
- Includes ~48 representatives from EPA (program offices and regions), 4 state co-regulators, and the Department of Energy



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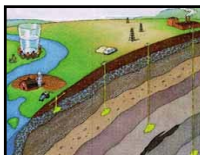


## Rulemaking Background: Scope

- The scope of the proposed rule will be limited to authorities under the Safe Drinking Water Act, which requires EPA to develop minimum federal requirements for state and tribal UIC programs to protect underground sources of drinking water (USDWs)
- The proposal will not address accounting for climate impacts (e.g. carbon credits or releases to atmosphere)



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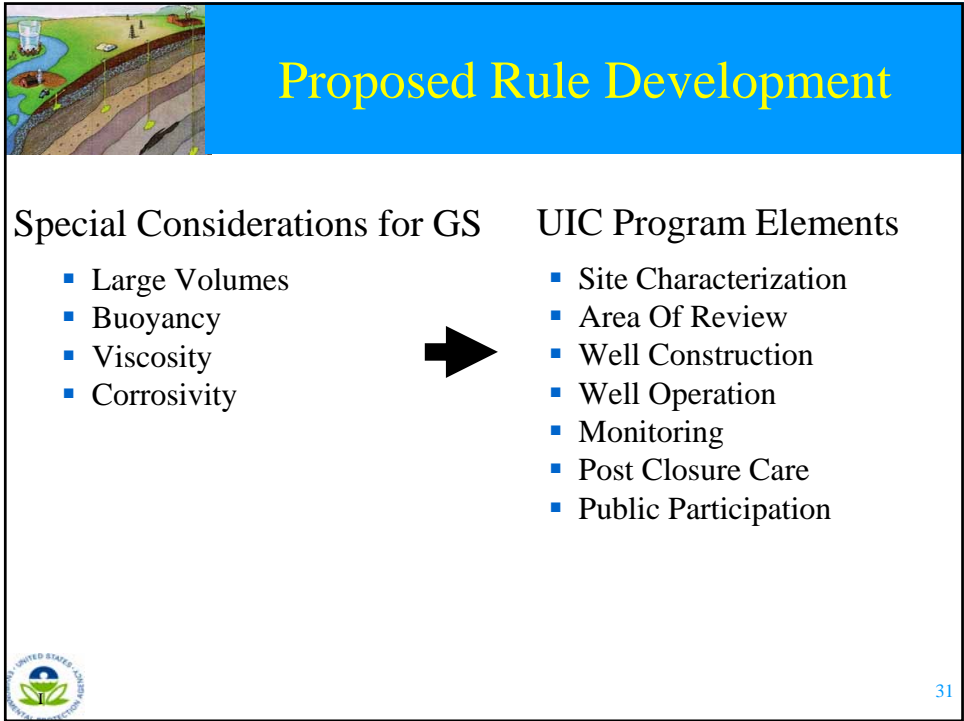


## Rulemaking Background: Schedule

Activity	Milestone
Information 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 for GS of CO <sub>2</sub>	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 <sub>2</sub>	Late 2010 / Early 2011




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## Proposed Rule Development


### Special Considerations for GS

- Large Volumes
- Buoyancy
- Viscosity
- Corrosivity

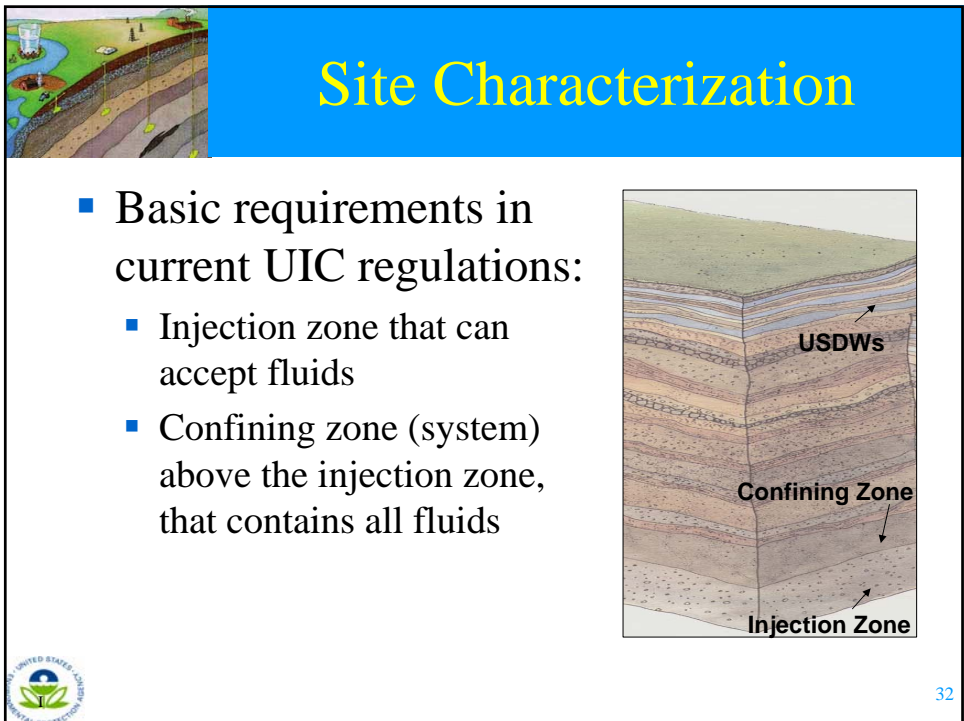


### UIC Program Elements

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

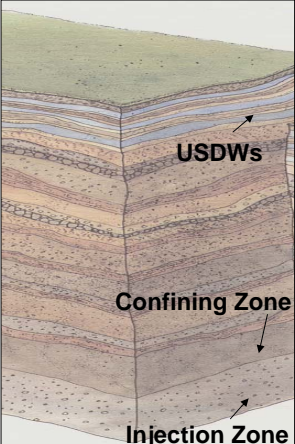


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## Site Characterization

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

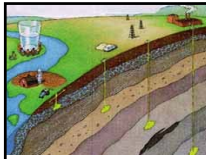


The diagram shows a geological cross-section with three distinct layers. The top layer is labeled 'USDWs' (Unconsolidated Deposits) and is shown as a thin, light-colored layer. Below it is a thicker, darker layer labeled 'Confining Zone'. The bottom layer is labeled 'Injection Zone' and is shown as a porous, light-colored layer. Arrows point from the text labels to their respective layers in the diagram.



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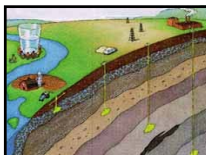


## Site Characterization

- Seeking Stakeholder Input:
  - Should a Secondary Containment/Confining System (SC/CS) be required?
- Considerations:
  - Could provide enhanced protection in case of leakage
  - Would provide an additional zone for monitoring
  - A well characterized primary confining system could be sufficient
  - SC/CS may not be possible in certain geographic areas



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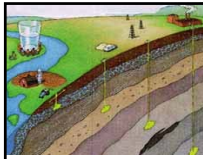


## Site Characterization

- Range of Approaches:
  - Don't require SC/CS
  - Director's discretion
  - Require where local geologic conditions allow
  - Mandatory identification of SC/CS

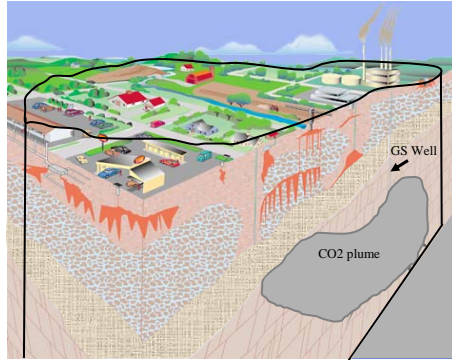


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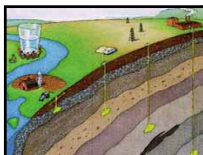


## Area of Review

- Basic requirements in current UIC regulations:
  - 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



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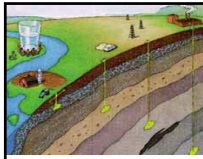


## Area of Review

- Seeking Stakeholder Input:
  - Should periodic re-evaluation of AoR be required?
- Considerations:
  - Allows better understanding of the plume/pressure front location and movement
  - Provides opportunity for phased corrective action
  - Could be time intensive



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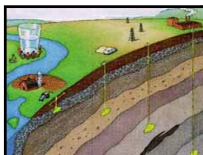


## Area of Review

- Range of Approaches:
  - Re-evaluation of AoR not required
  - Director's discretion
  - Fixed time interval
  - Re-evaluate upon significant operational changes (e.g. new wells, increased injection rate)
  - Combination of the above

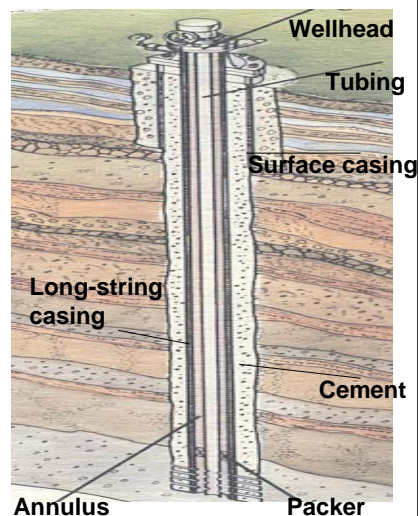


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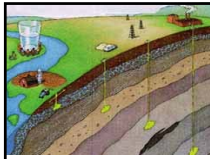


## Well Construction

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



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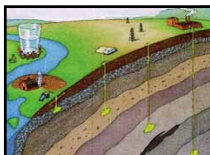


## Well Construction

- Seeking Stakeholder Input:
  - Should corrosion resistant construction materials be required?
- Considerations:
  - CO<sub>2</sub> when mixed with water can form a corrosive acid
  - Certain impurities in the CO<sub>2</sub> stream can be corrosive (e.g. H<sub>2</sub>S)
  - Conflicting information on need for non-standard oil field materials to protect USDWs



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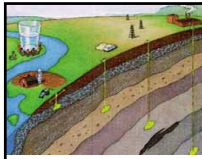


## Well Construction

- Range of Approaches:
  - Don't require corrosion resistant materials
  - Director's discretion
  - Performance standard (e.g. wells must be constructed to withstand a CO<sub>2</sub> rich environment for the life of the well)
  - Prescribe specific well materials (e.g. alloy casing and corrosion resistant cement)



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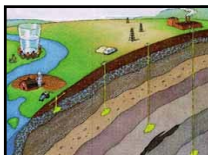


## Intermission

Questions?



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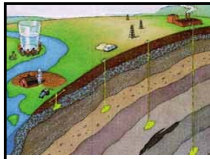


## Well Operation and Monitoring

- Basic requirements in current UIC regulations:
  - Injection may not fracture confining zone
  - Monitor injection pressure, flow rate and volumes
  - Monitor the nature of the injected fluid
  - Perform mechanical integrity tests



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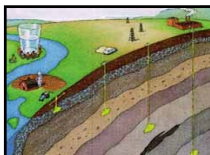


## Well Operation and Monitoring

- Seeking Stakeholder Input:
  - Should tracers or surface air/soil gas monitoring be required to protect USDWs?
- Considerations:
  - Final opportunity for leak detection
  - Could provide a side benefit of public health protection
  - Can be difficult to connect detection to source
  - Cost/benefit uncertainty
  - Perception



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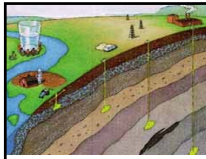


## Well Operation and Monitoring

- Range of Approaches:
  - Tracers or surface air/soil gas monitoring not required
  - Director's discretion
  - Required as part of an owner/operator developed comprehensive monitoring plan
  - Specific monitoring requirements detailed in regulation



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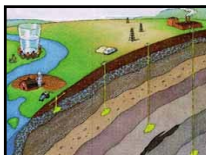


## Well Closure and Post-Closure Care

- Basic requirement under existing UIC regulations:
  - Wells must be closed in a manner that protects USDWs from endangerment
  - Owner/operator must demonstrate and maintain financial assurance (trust fund, bond, or other approved mechanisms) to close and abandon the injection operation
  - Liability stays with owner/operator



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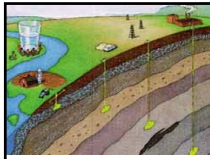


## Post-Closure Care

- Seeking Stakeholder Input:
  - Should the owner/operator be required to demonstrate and maintain financial assurance for corrective action, remediation and post closure monitoring in addition to well closure?
  - If so, for what timeframe?
- Considerations:
  - CO<sub>2</sub> GS projects could pose a threat to USDWs beyond the injection phase
  - A lengthy post-closure care period may be unrealistic
  - Transfer of owner/operator liability is outside the scope of the SDWA and this rulemaking



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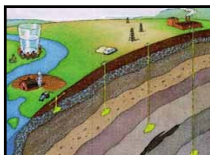


## Post-Closure Care

- Range of Approaches:
  - Director's discretion to require the o/o to demonstrate and maintain financial assurance for corrective action, remediation and post closure monitoring
  - Fixed time period
  - Some multiple of the operating life of a GS project
  - Until the plume and pressure front no longer pose an endangerment to USDWs
  - Reservoir pressure die-off



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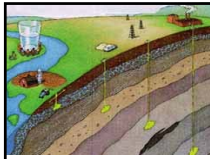
## Public Participation

- Basic requirement under existing UIC regulations:
  - Provide public notice of a pending permitting action via newspapers, postings, and mailings and in some cases a public hearing
    - Provides opportunity for public input
    - Allows transfer of information between the permitting authority and the public to better inform permit decision making



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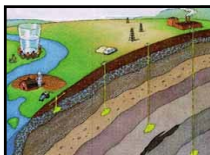


## Public Participation

- Seeking Stakeholder Input:
  - Should the notification process be adapted to incorporate new technologies (e.g. webpages, discussion boards)?
  - Should stakeholders be engaged earlier in the permitting process (e.g. during site evaluation/selection)



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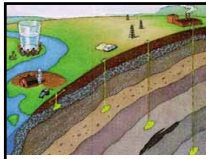


## Class V Experimental Wells

- March 2007 Guidance classified experimental GS projects as Class V wells
- A number of experimental wells have been permitted and will be permitted before the rule is finalized
- Class V GS projects are currently being built to deep well construction standards



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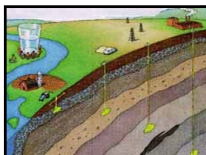


## Class V Experimental Wells

- Seeking Stakeholder Input:
  - Should the well **construction** of existing Class V experimental wells be “grandfathered”?
- Range of Proposed Approaches:
  - Not allowed
  - Director’s discretion
  - Grandfather by rule



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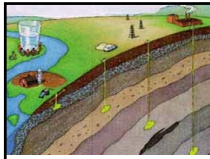


## Class II EOR/EGR wells

- Class II owners/operators that use CO<sub>2</sub> to enhance oil and natural gas recovery may wish to transition to a GS project
- Most existing Class II wells are authorized under a separate section of the SDWA and are typically regulated by “oil and gas” agencies
- These Class II UIC programs do not necessarily match minimum federal requirements but must demonstrate effectiveness



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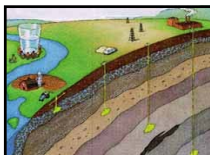


## Class II EOR/EGR wells

- Considerations:
  - Transitioning Class II well to GS well can be administratively complex and technically challenging
  - Existing EOR wells may not meet the new GS well construction standards
  - Just like other wells in the program, Class II wells must not endanger USDWs



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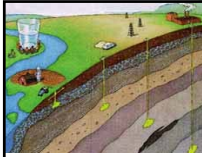


## Class II EOR/EGR wells

- Seeking Stakeholder Input:
  - How should Class II EOR/EGR wells injecting CO<sub>2</sub> be distinguished from GS wells?
- Range of Approaches:
  - Performance standard (e.g. once the primary purpose is no longer production)
  - Economic algorithm (e.g. CO<sub>2</sub> costs outweigh production revenue)
  - EOR/EGR wells remain Class II as long as the field is producing oil or gas



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Questions?

***Thank You!!***

**More information about the UIC Program:**

EPA Website:

<http://www.epa.gov/safewater/uic/index.html>



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