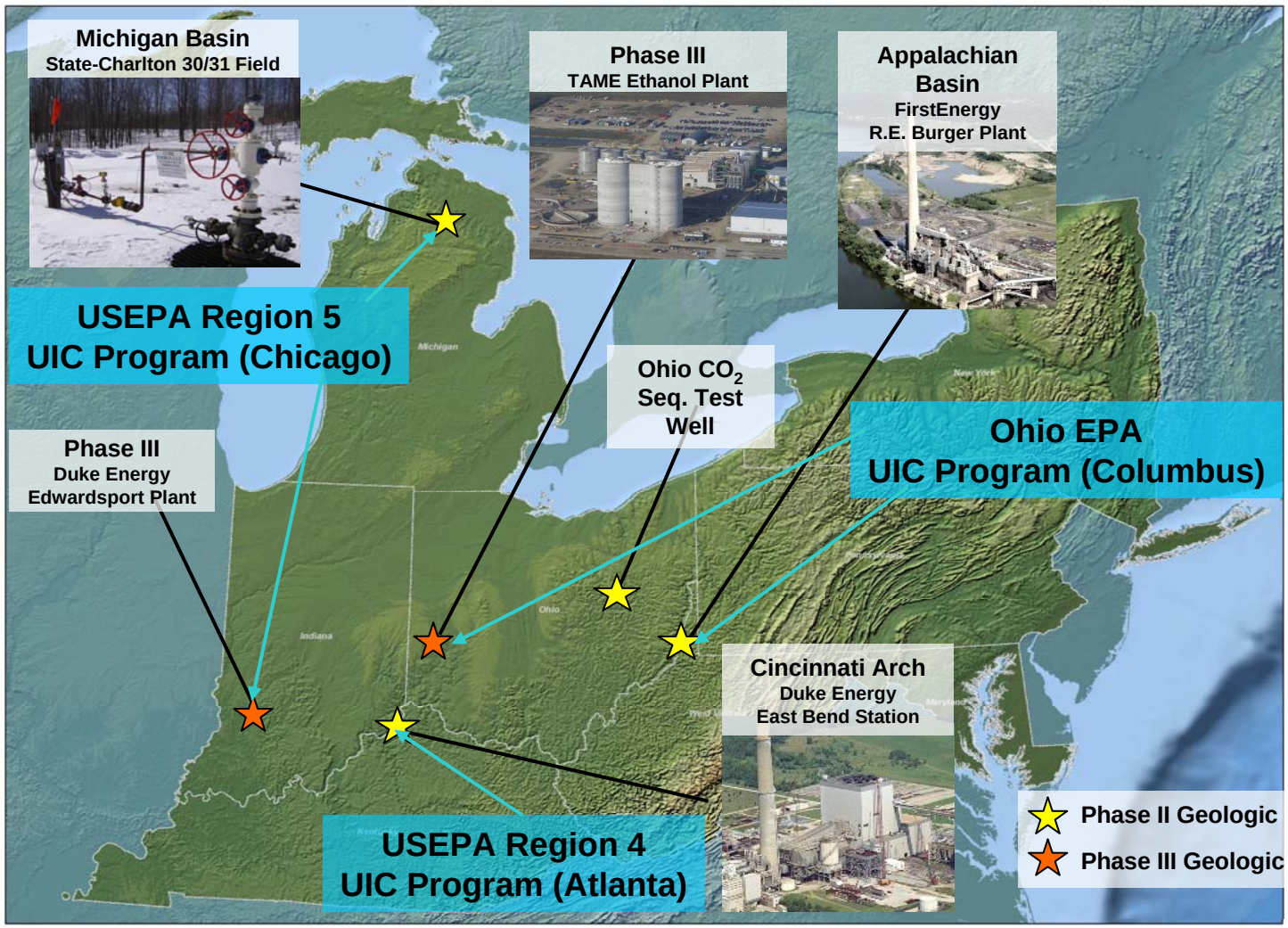
CO_2 Sequestration Permitting Approach

Midwest Regional Carbon Sequestration Partnership

Neeraj Gupta and Joel Sminchak, Battelle
gupta@battelle.org, 614-424-3820

Regional Carbon Sequestration Partnerships Initiative Review Meeting
October 6-8, 2008, Pittsburgh, PA

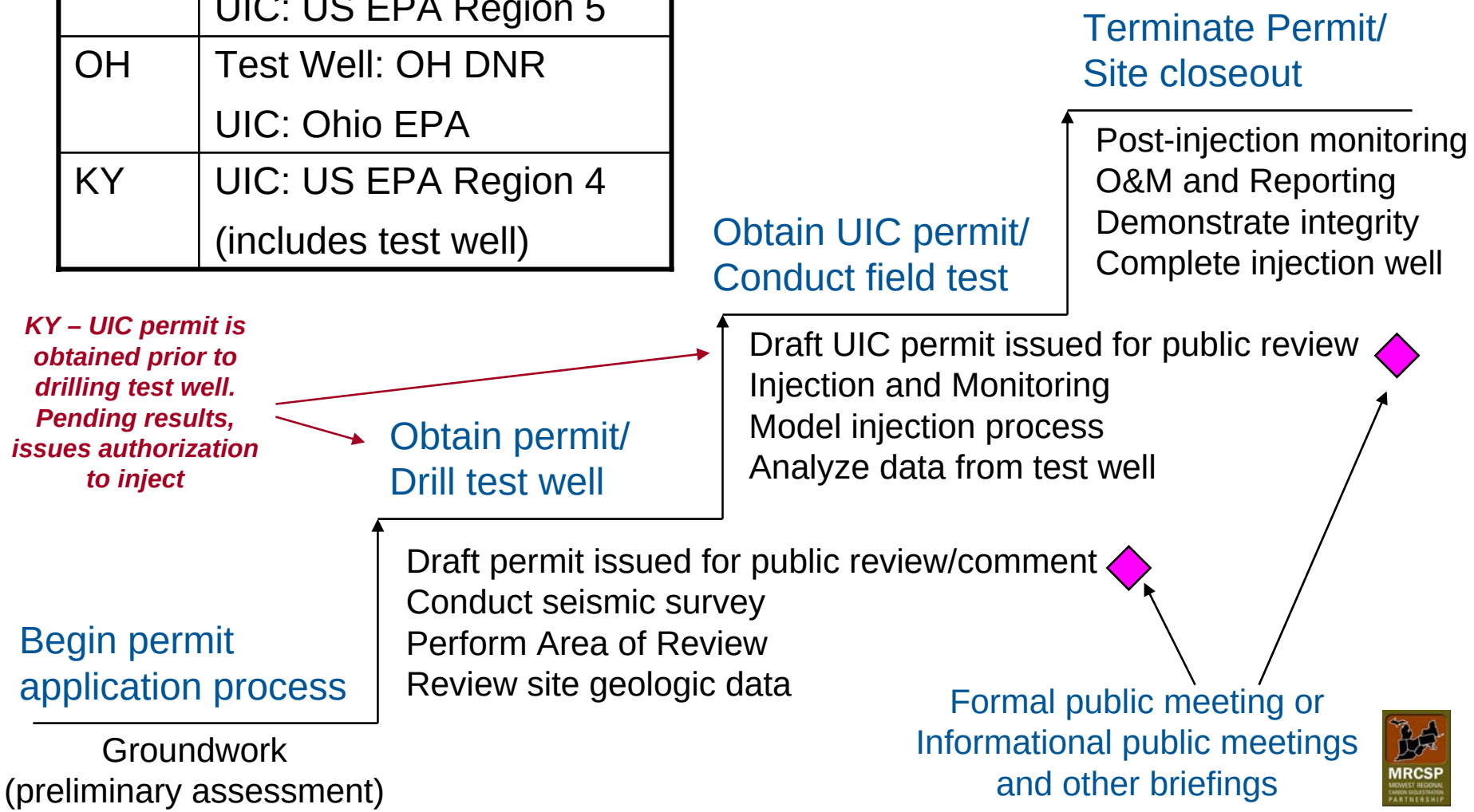
MRCSP Field Test Sites



Key Regulatory Steps

State	Regulators
MI	Test well: MI DNR UIC: US EPA Region 5
OH	Test Well: OH DNR UIC: Ohio EPA
KY	UIC: US EPA Region 4 (includes test well)

Suggest the following four slides as replacement slides for flowcharts and block diagrams (slides 8-13)



Key Regulatory Steps - Michigan

State	Regulators
MI	Test well: MI DNR UIC: US EPA Region 5

Terminate Permit/
Site closeout Early 2009

Post-injection monitoring
O&M and Reporting
Demonstrate integrity
Complete injection well
Feb 2008

UIC permit application submitted April 2007
Draft permit issued July 2007
Public review ended Aug 2007
UIC Permit issued Aug 2007 was appealed.
Appeal denied by EPA Dec 2007

Obtain UIC permit/
Conduct field test

Draft UIC permit issued for public review
Injection and Monitoring
Model injection process
Analyze data from test well

Obtain permit/
Drill test well

Draft permit issued for public review/comment
Conduct seismic survey
Perform Area of Review
Review site geologic data
Fall 2006

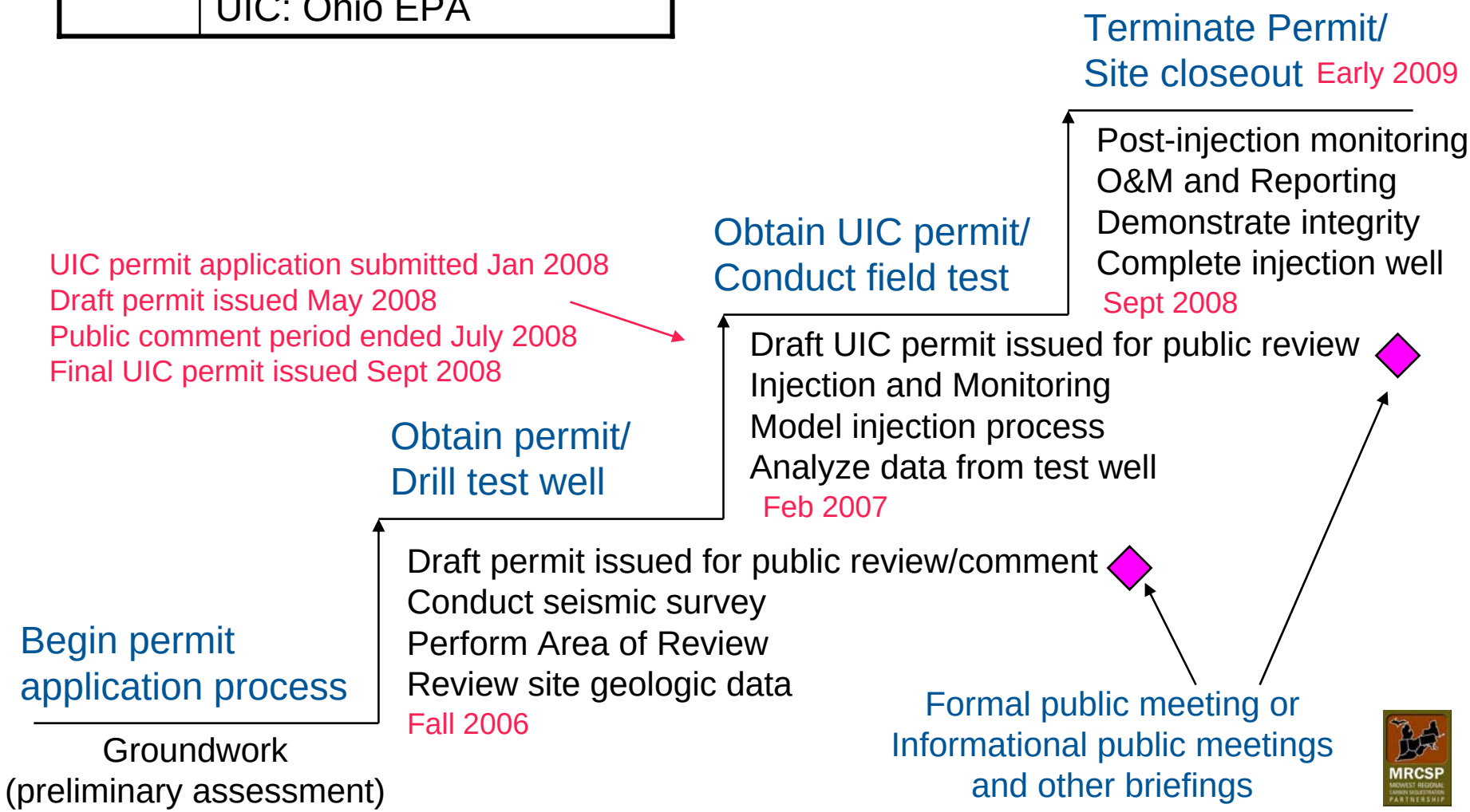
Begin permit
application process

Groundwork
(preliminary assessment)

Formal public meeting or
Informational public meetings
and other briefings

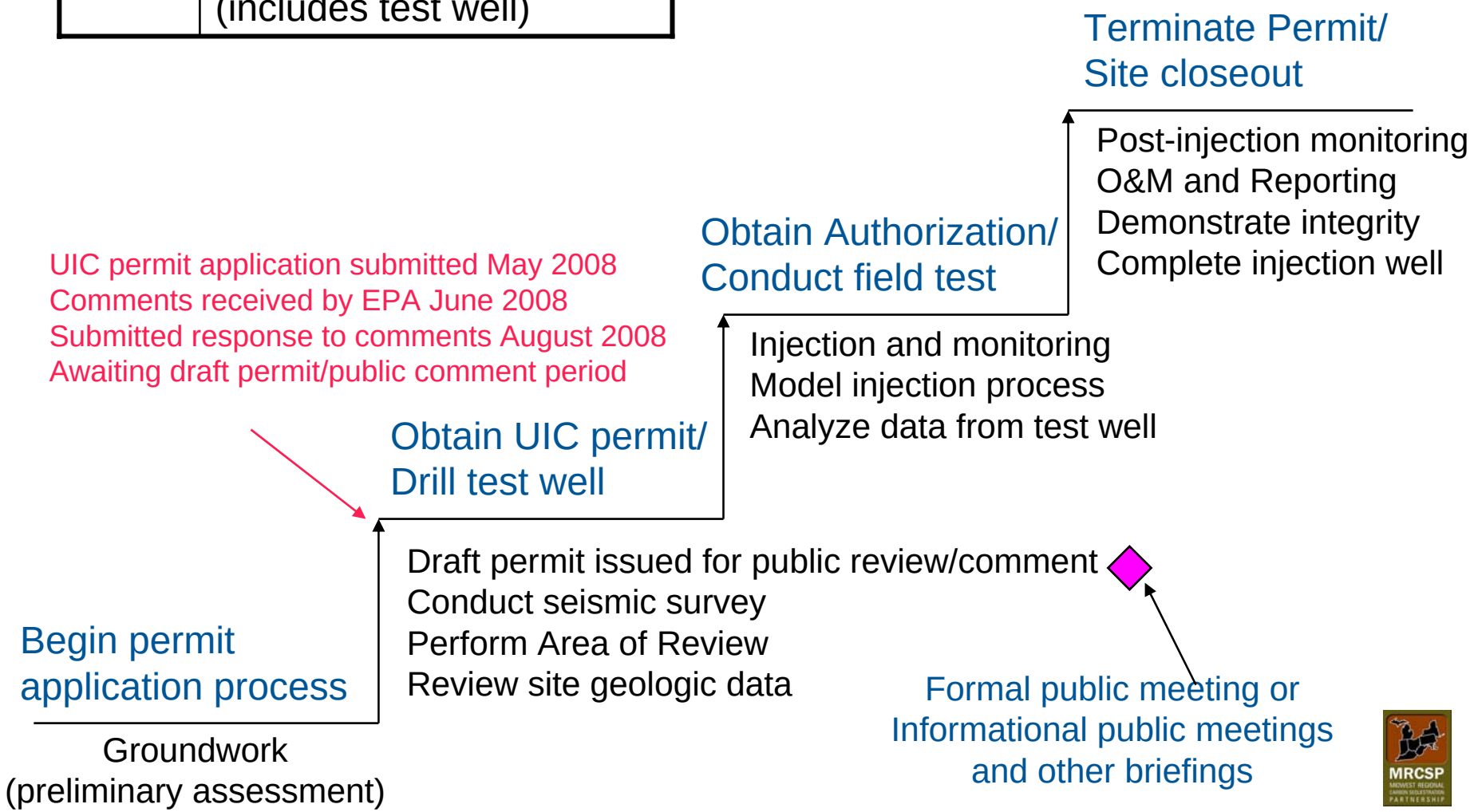
Key Regulatory Steps - Ohio

State	Regulators
OH	Test Well: OH DNR UIC: Ohio EPA

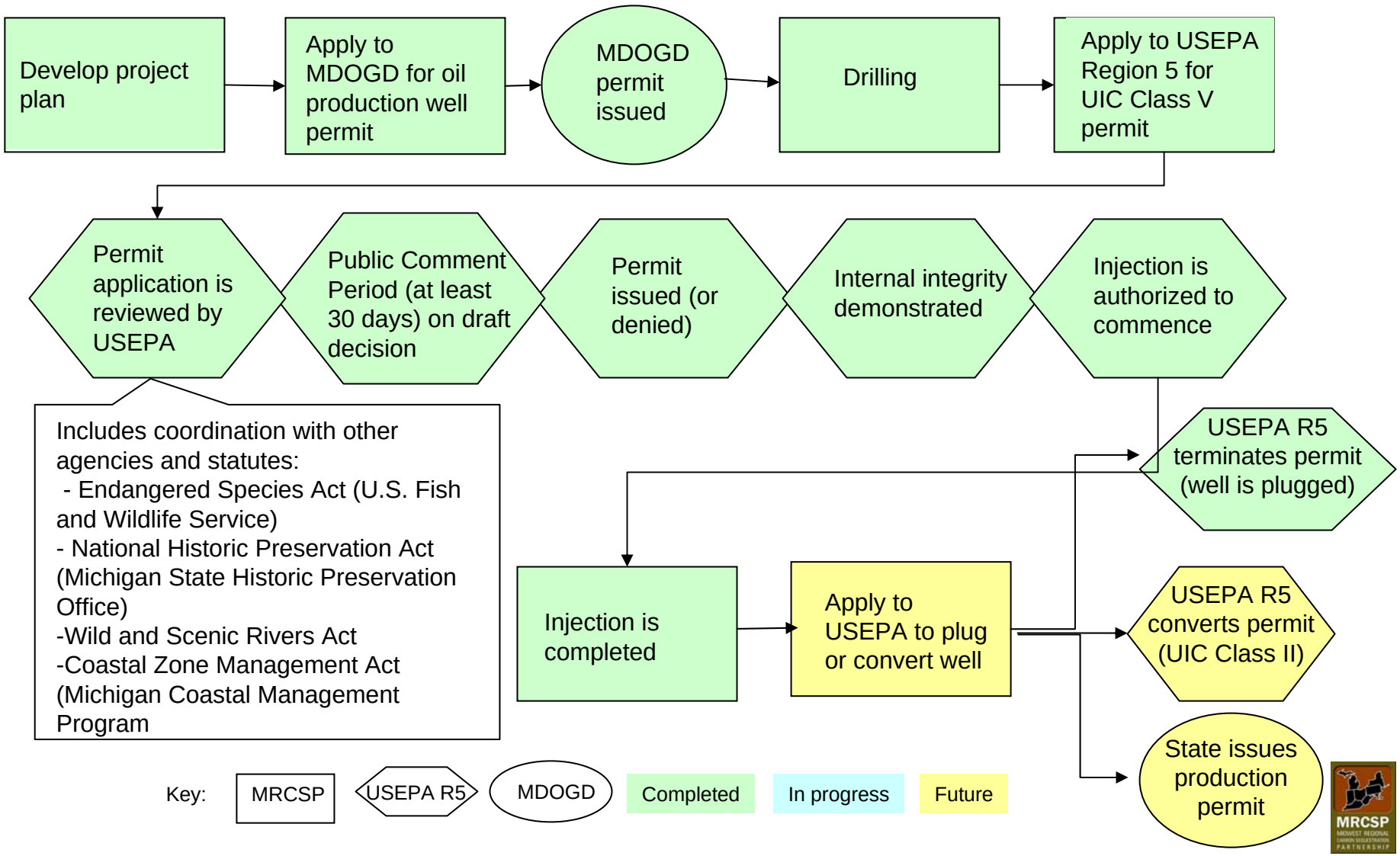


Key Regulatory Steps - Kentucky

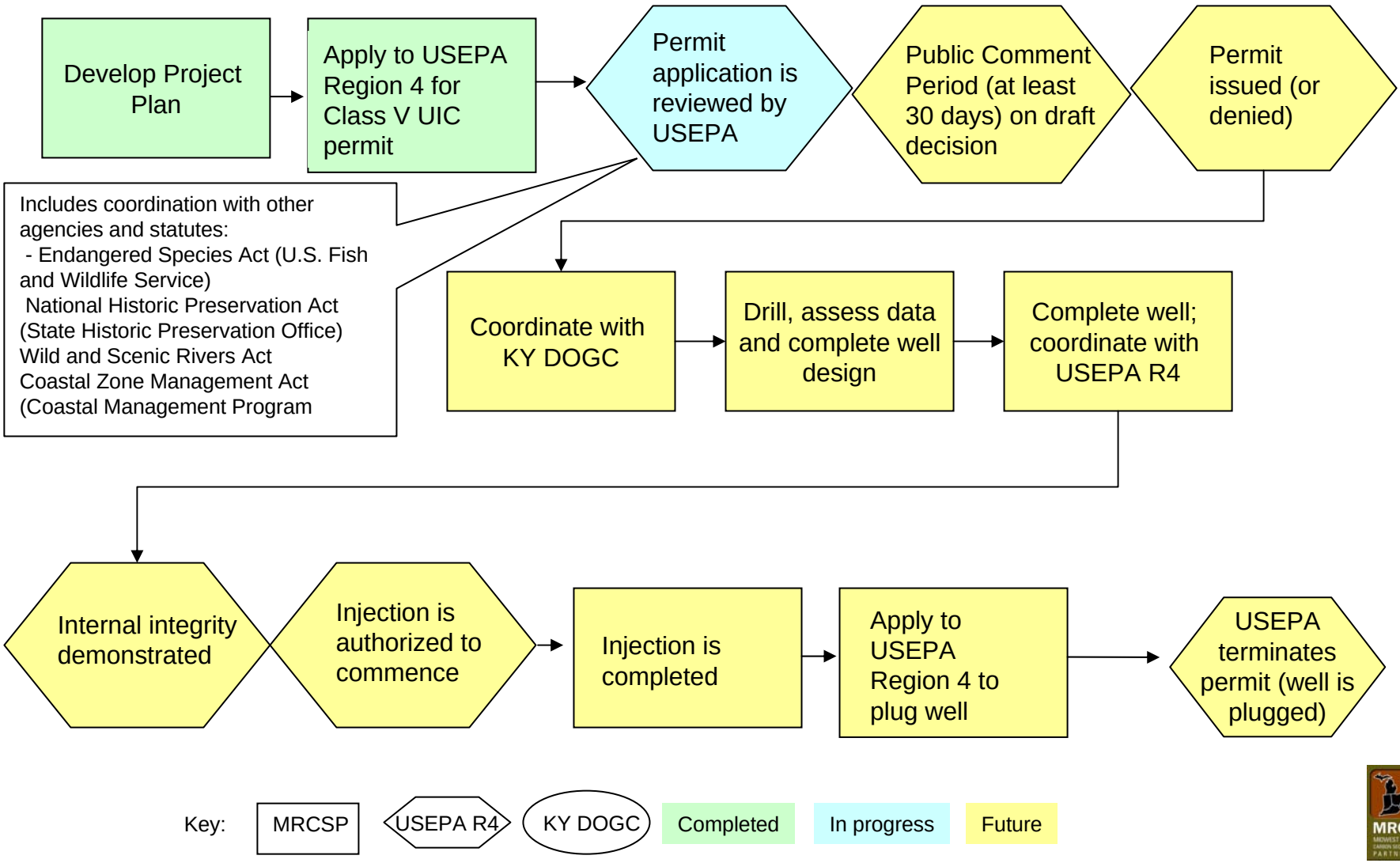
State	Regulators
KY	UIC: US EPA Region 4 (includes test well)



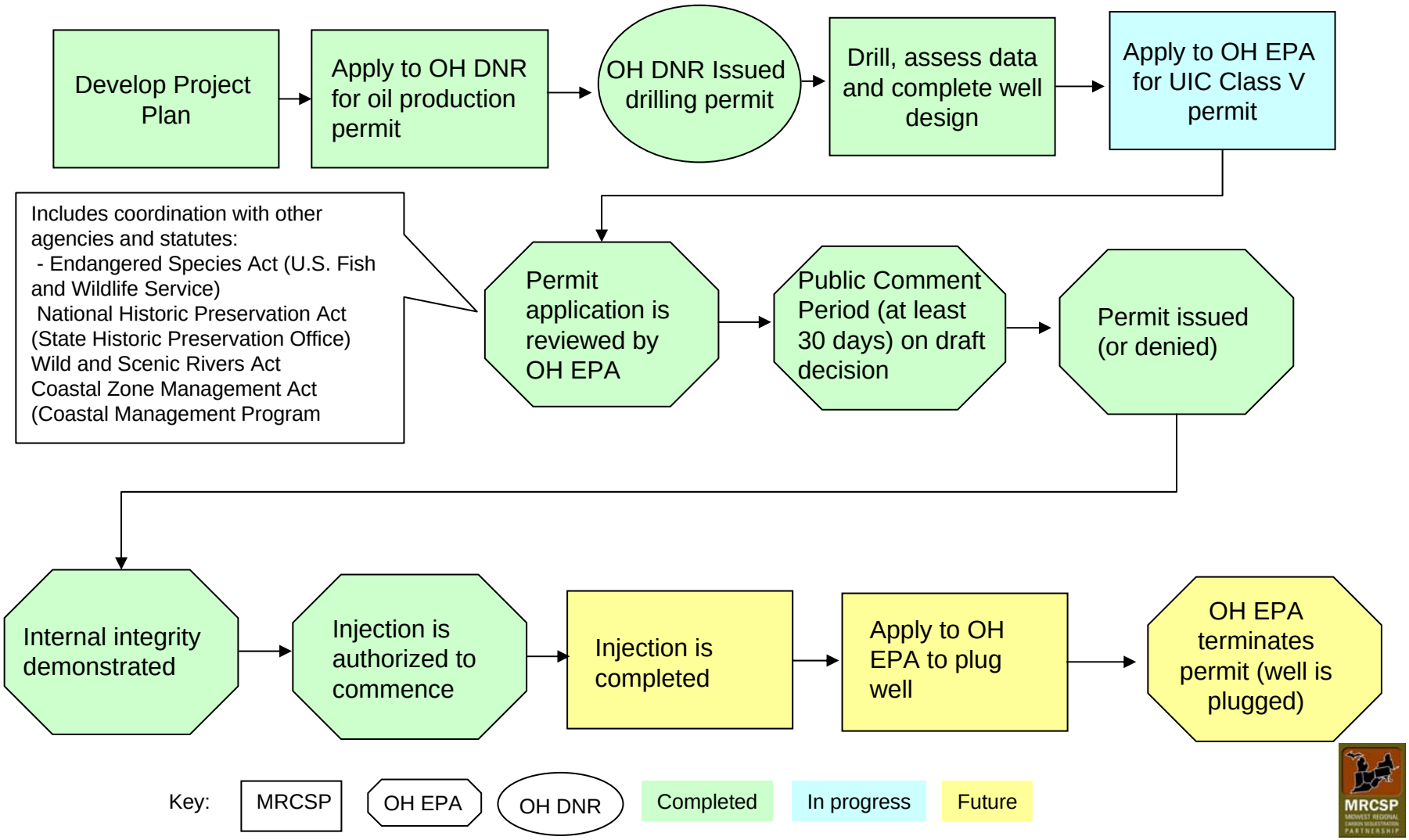
Key Regulatory Steps In Michigan



Key Regulatory Steps In Kentucky

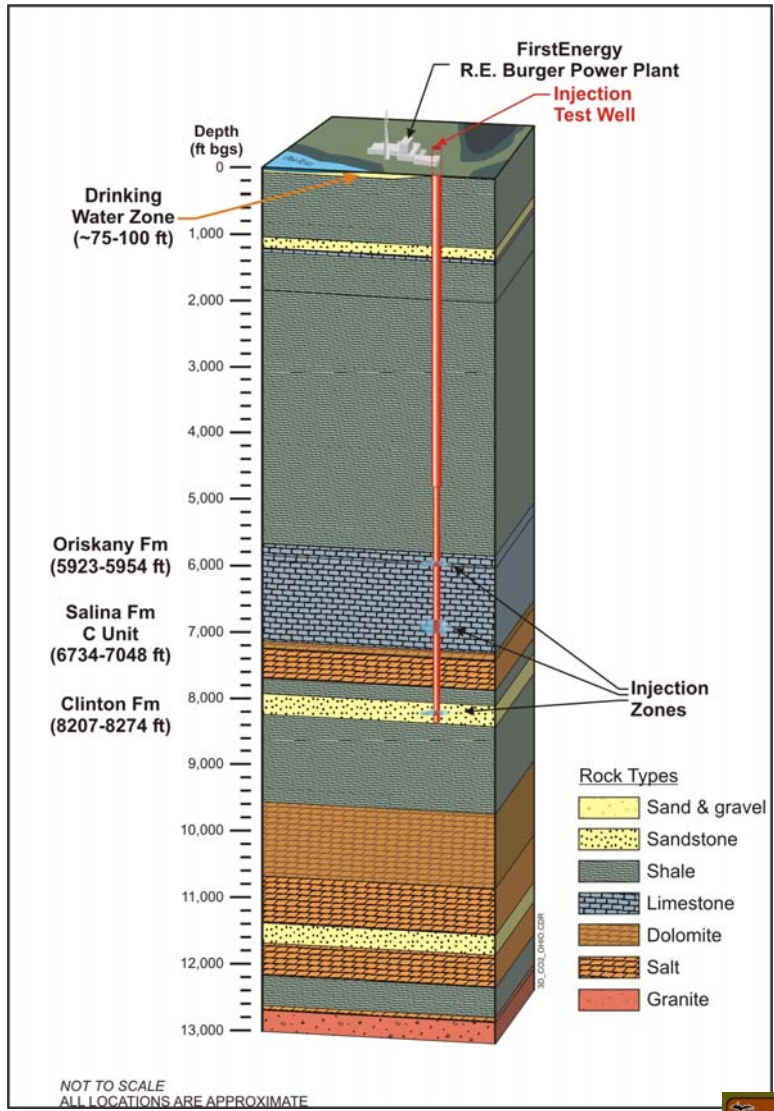


Key Regulatory Steps in Ohio (R.E. Burger Pilot)



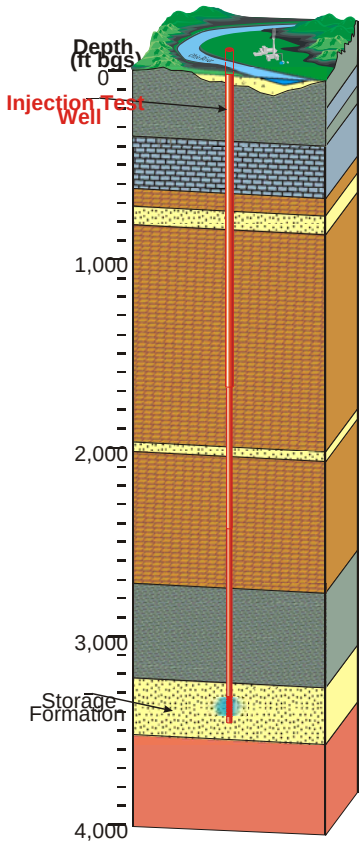
Permitting - Appalachian Basin R.E. Burger Site

- Drilling permit prepared and approved by ODNR MRM Fall 2006.
- Test well drilled Jan-Feb 2007.
- UIC Class 5 permit application submitted to Ohio EPA UIC program January 17, 2008.
- Draft permit issued May 29, 2008.
- Public meeting June 24, 2008.
- Public notice June 21-July 21, 2008.
- Permit issued September 3, 2008.
- Field injection testing underway in October 2008.



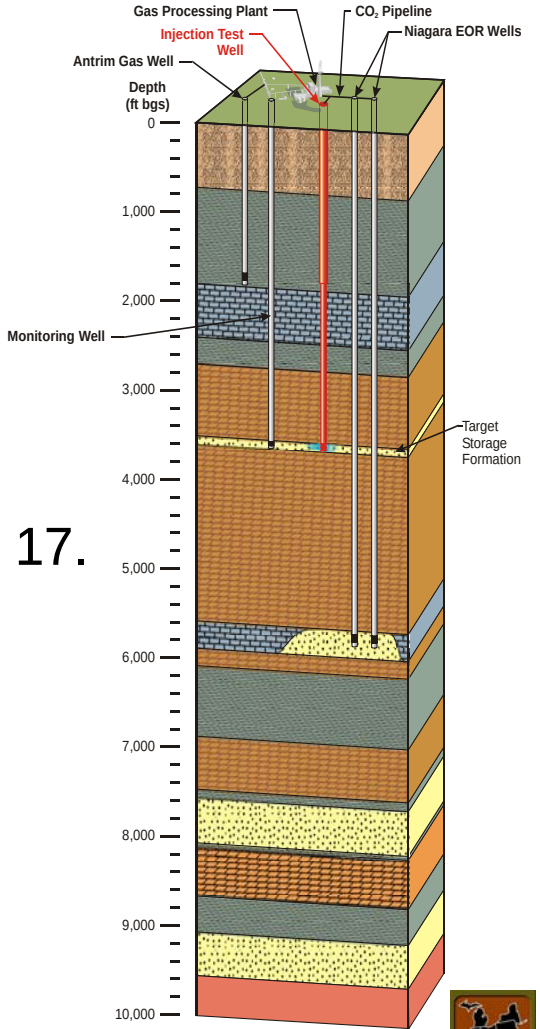
Permitting - Cincinnati Arch East Bend Site

- Pursuing UIC Class 5 permit under Region 4 EPA (Atlanta) UIC program
- UIC Permit Application submitted May 1, 2008.
- Comments received on June 30, 2008.
- Response to comments sent August 4, 2008.
- Currently awaiting draft permit, public notice period.



Permitting - Michigan Basin Otsego County Site

- UIC Class 5 injection permit under Region 5 EPA (Chicago) UIC program
- Drilling permit obtained from MIDNR in Fall 2006.
- Test well drilled November 2006.
- UIC permit application submitted April 18, 2007.
- Comments were received May 2 and addressed May 17.
- Draft permit posted by Region 5 July 11 and public review period July 23-August 23, 2007.
- Revised permit posted August 22. Appeal filed September 23, 2007.
- Final Permit granted December 2007.

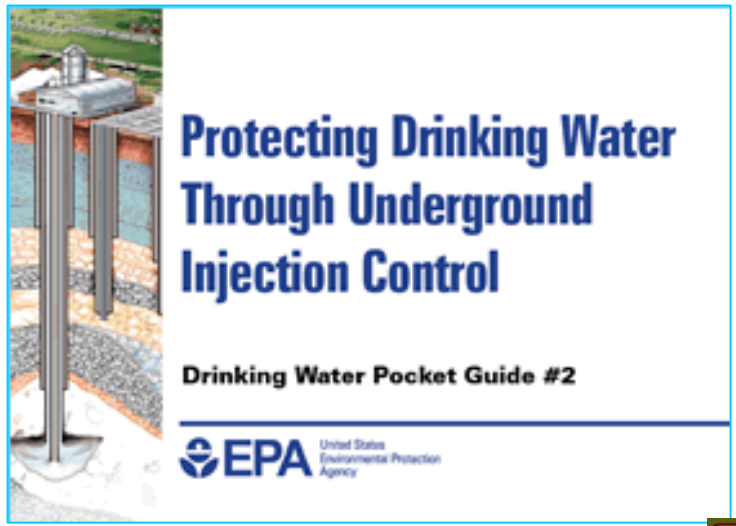


UIC Permit Requirements

- Include items such as:
  - Area of review determination
  - Description of injection and confining intervals
  - Maximum injection pressure calculations
  - Well abandonment plans and bonding

- EPA UIC permitting requires technical review of the permit application.

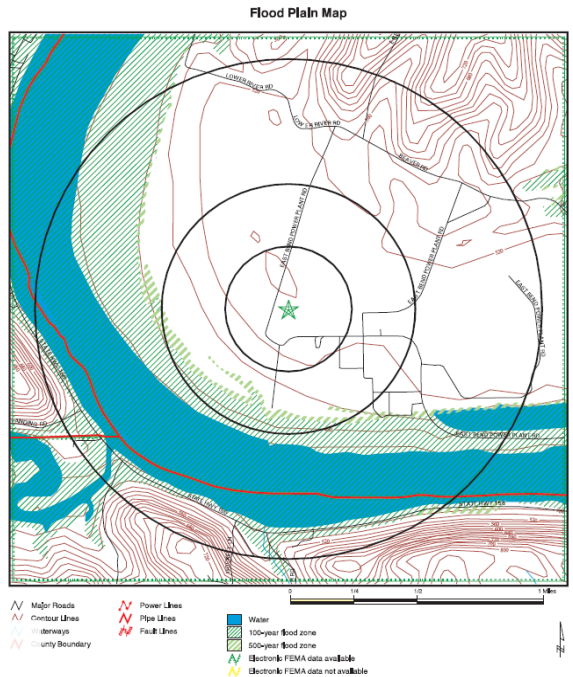
- The process also allows a public comment period.



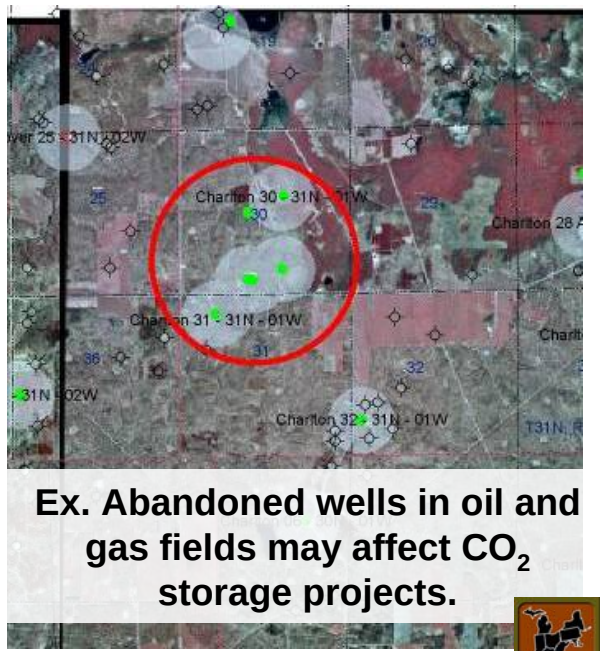
Area of Review

- All sites defaulted to the minimum ¼-mile AOR, even though CO_2 would not move more than a few hundred feet from the injection well.
- AOR generally determined with STOMPCO2 modeling or analytical equations for CO_2 and pressure.
- Drinking water wells and abandoned oil and gas wells had to be identified for up to 1-mile radius.

Ex. historical aerial photo



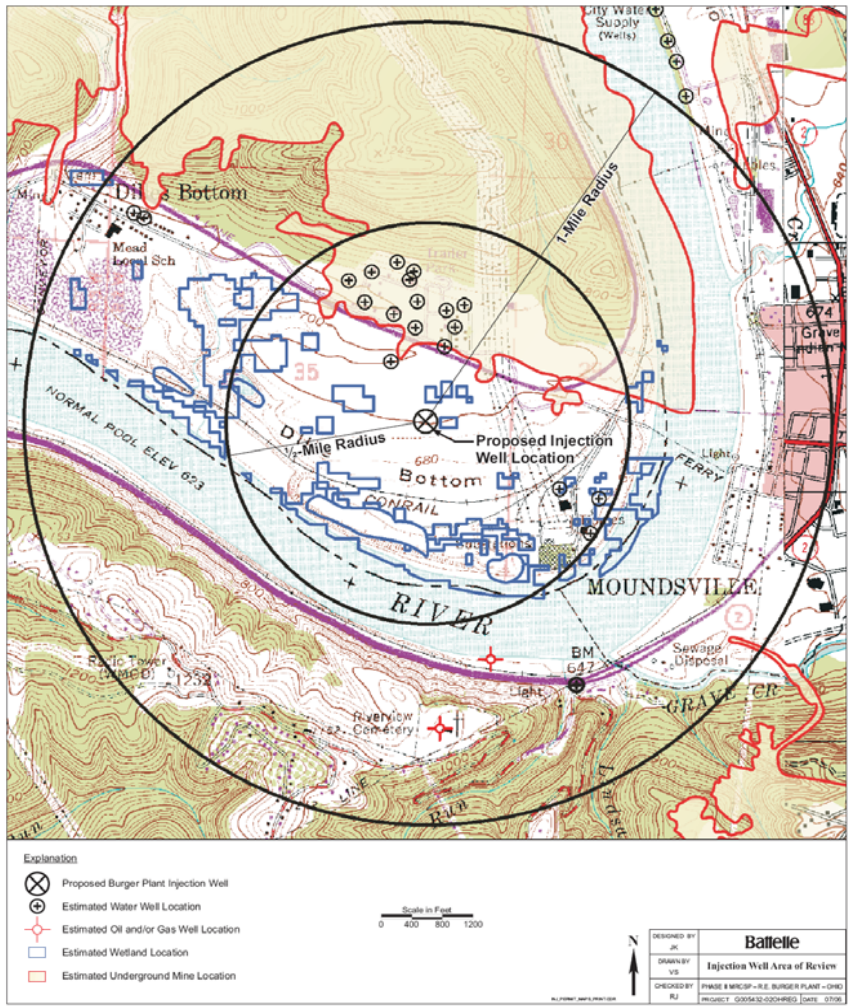
Ex. floodplain map.



Ex. Abandoned wells in oil and gas fields may affect CO_2 storage projects.

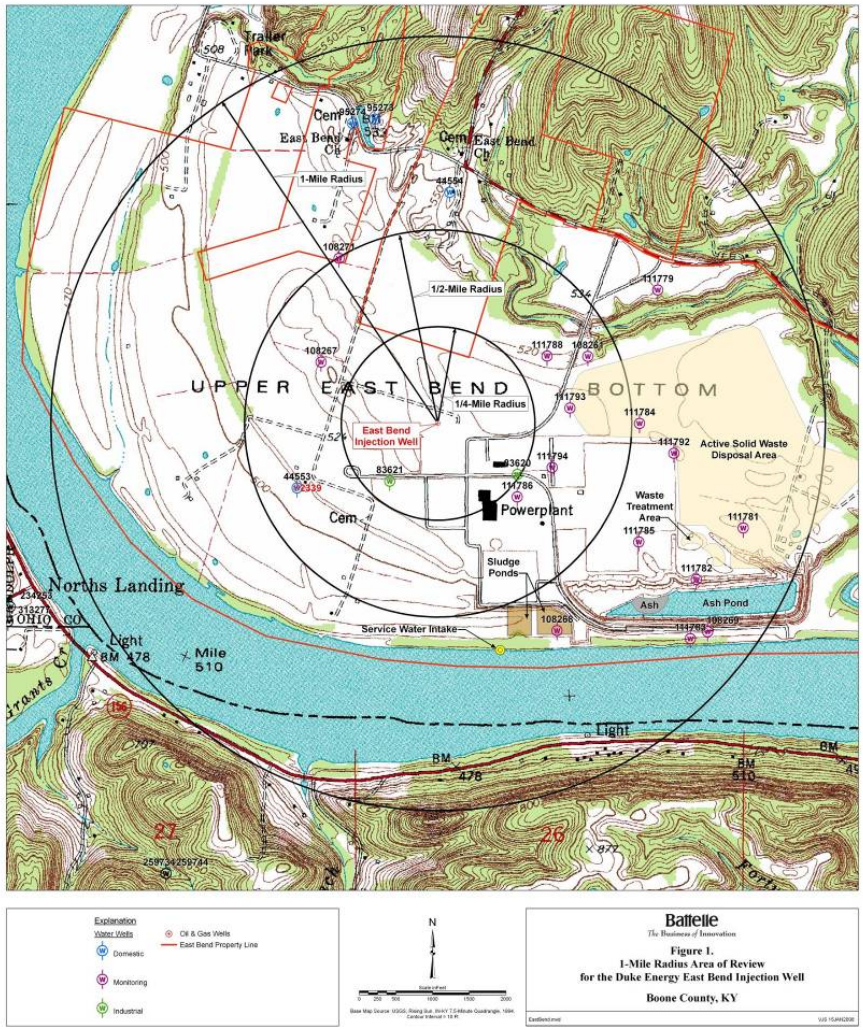
Example- Area of Review Map

Area of Review- R.E. Burger Site
Actual AOR is ¼ miles and falls entirely in Ohio



Example 2 - Area of Review Map

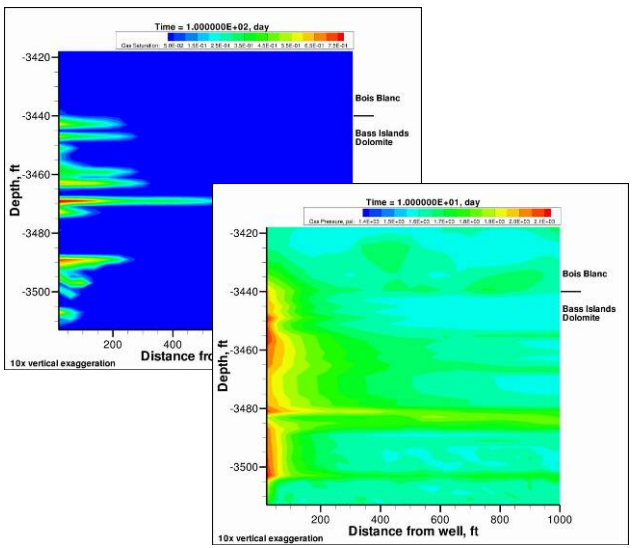
Area of Review Map- Cincinnati Arch East Bend Site
Actual AOR is the Smallest Circle (1/4 mile) on this map



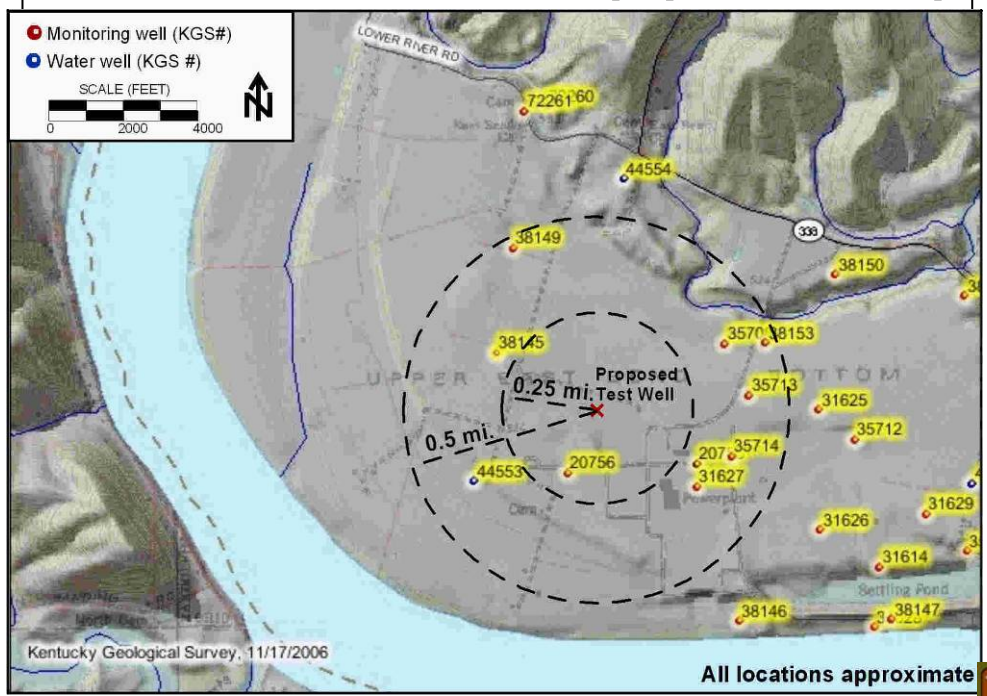
Example- Attachment B Maps of Well / Area of Review

- All sites defaulted to the minimum ¼-mile AOR, even though CO_2 would not move more than a few hundred feet from the injection well.

STOMPCO2 Simulations

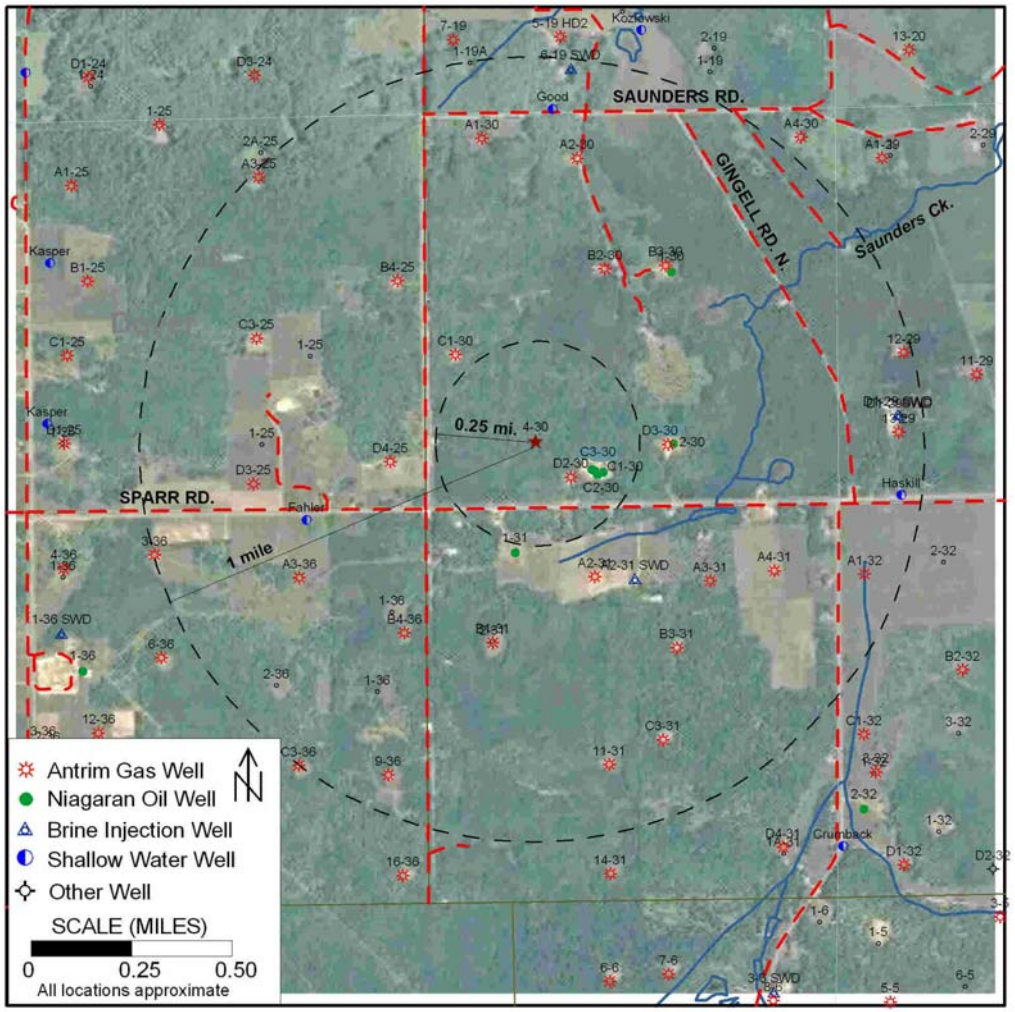


Ex. Area of Review Map (East Bend)



Example 3 - Area of Review Map

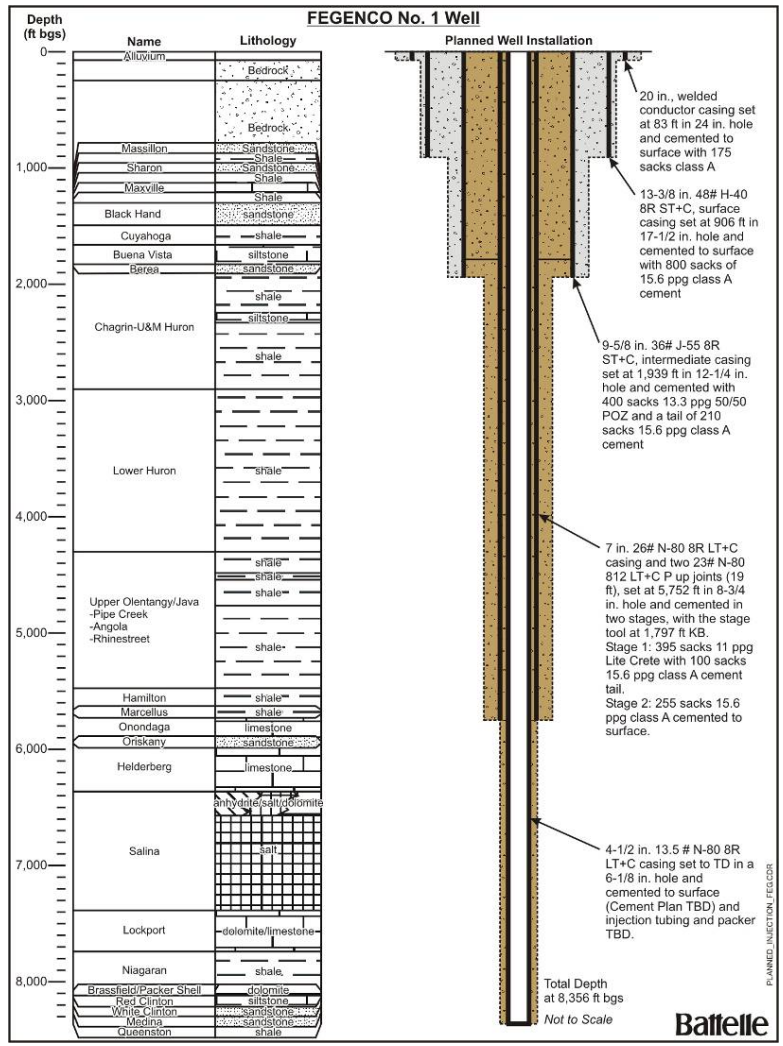
Area of Review Map- Michigan Basin Site



Example- Attachment Well Construction Details

- Drilling records
- Well completion materials
  - Casing
  - Cement
  - Wellhead
- Well testing/logging records
  - Wireline logs
  - Cement Bond Logs
- Well completion plan
  - Packer
  - Perforations
  - Injection tubing

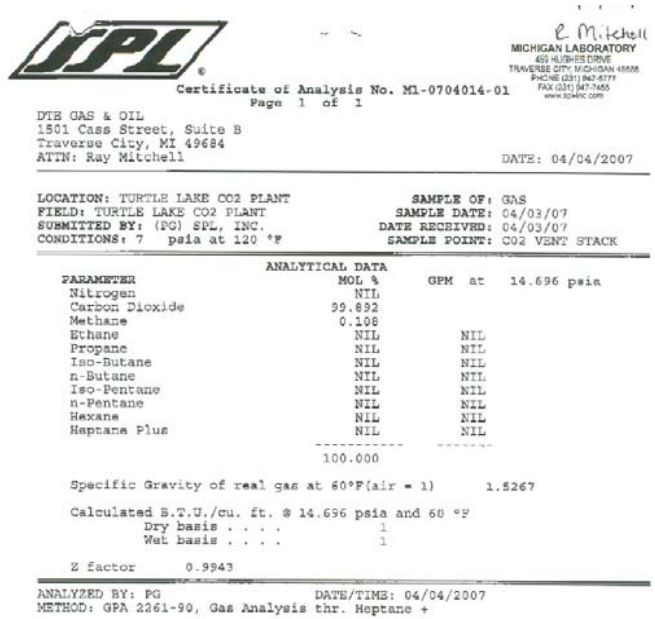
Ex. Well Completion Diagram (R.E. Burger)



Example- Attachment Operating Data

- Injectate characterization
- Injection rate
- Injection pressures
- Injection pressure limit

Ex. Michigan Basin Site Gas Analysis



SPL

Certificate of Analysis No. MI-0704014-01
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MICHIGAN LABORATORY
455 HUGHES DRIVE
TRAVERSE CITY, MICHIGAN 49686
PHONE (231) 947-5777
FAX (231) 947-1456
www.spinc.com

DTE GAS & OIL
1501 Cass Street, Suite B
Traverse City, MI 49684
ATTN: Ray Mitchell

DATE: 04/04/2007

LOCATION: TURTLE LAKE CO2 PLANT
FIELD: TURTLE LAKE CO2 PLANT
SUBMITTED BY: (PG) SPL, INC.
CONDITIONS: 7 psia at 120 °F

SAMPLE OF: GAS
SAMPLE DATE: 04/03/07
DATE RECEIVED: 04/03/07
SAMPLE POINT: CO2 VENT STACK

ANALYTICAL DATA

PARAMETER	MOL %	GPM at 14.696 psia
Nitrogen	NIL	
Carbon Dioxide	99.892	
Methane	0.108	
Ethane	NIL	NIL
Propane	NIL	NIL
Iso-Butane	NIL	NIL
n-Butane	NIL	NIL
Iso-Pentane	NIL	NIL
n-Pentane	NIL	NIL
Hexane	NIL	NIL
Heptane Plus	NIL	NIL
	100.000	

Specific Gravity of real gas at 60°F(air = 1) 1.5267

Calculated B.T.U./cu. ft. @ 14.696 psia and 60 °F
Dry basis 1
Wet basis 1

Z factor 0.9943

ANALYZED BY: PG DATE/TIME: 04/04/2007
METHOD: GPA 2261-90, Gas Analysis thr. Heptane +

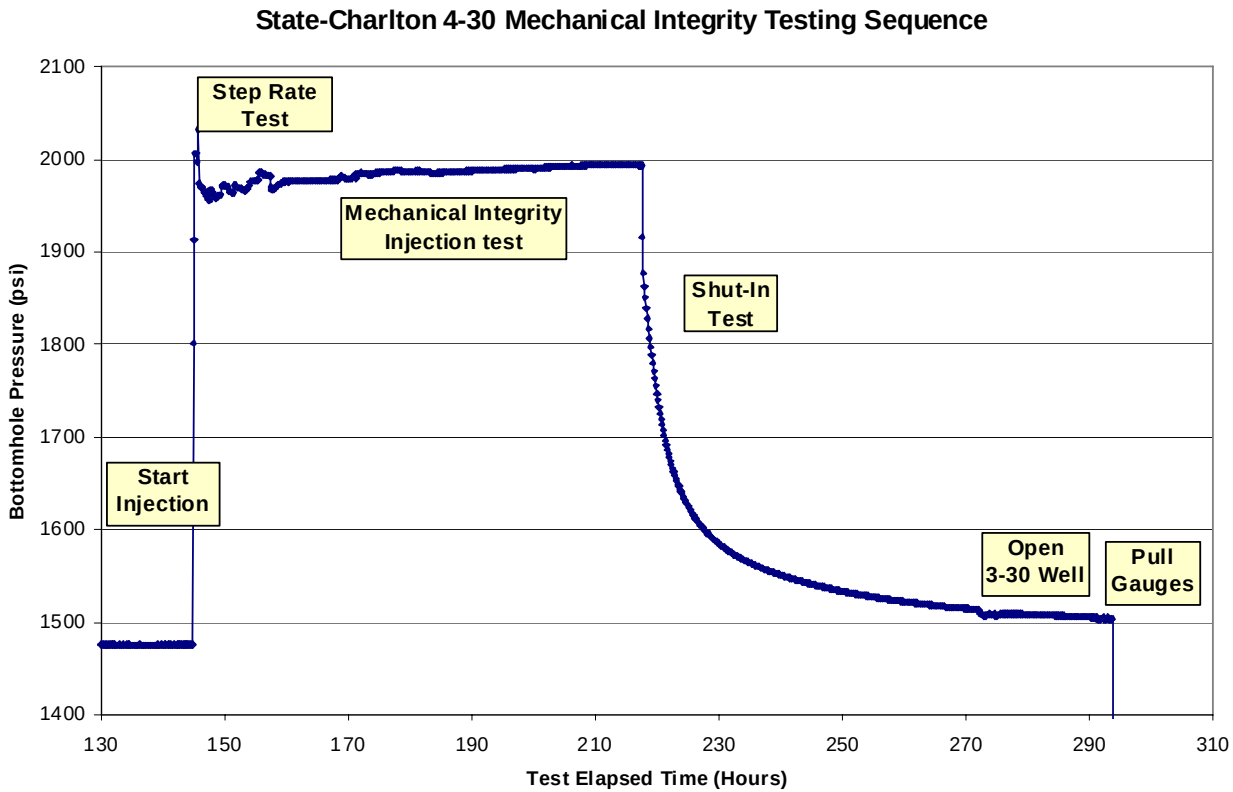
Ex. R.E. Burger Max. Surf. Inj. Pressure (PSIG):

Depth x [(FG – 0.433 x (S.G. + safety factor)] – 14.7
Depth (depth at top of injection interval)
FG = fracture gradient = 0.75 psi/ft
S.G. (average specific gravity of CO2 in borehole) = 0.89
Safety factor = 0.05
14.7 = general friction factor

Oriskany Interval = 5923 ft x [(0.75 psi/ft - 0.433 x (0.89 + 0.05)] – 14.7 psi = 2,017 psi
Salina (C) Interval = 6734 ft x [(0.75 psi/ft - 0.433 x (0.89 + 0.05)] –14.7 psi = 2,295 psi
Clinton Interval = 8207 ft x [(0.75 psi/ft - 0.433 x (0.89 + 0.05)] – 14.7 psi = 2,800 psi

CO_2 Mechanical Integrity Testing – Example from MRCSP MI Site

- Initial step-rate test and shut-in test completed with CO_2 prior to sustained injection as part of UIC mechanical integrity testing, February 7-13, 2008.
- Testing provides data on hydraulic behavior of the reservoir system.



MRCSP Phase III UIC Guidance from Ohio EPA

- Safe Drinking Water Act
- US EPA determined that CO_2 disposal is regulated under the UIC program
- Applicable Ohio Law – Section 6111.043 to .047 of the Ohio Revised Code (ORC)
- Applicable Ohio Rules – Chapter 3745-34 of the Ohio Administrative Code
- ***Ohio EPA has advised Battelle that a Class I – Non Hazardous UIC permit will be more applicable to Phase III test in Western Ohio***

Ohio EPA Permit Application Process OAC 611.044

- Permit received and reviewed for completeness.
- Sent to Ohio DNR for review and comment.
- Deficiencies in the application sent to applicant and addressed.
- Draft action on application public noticed and a public hearing is held.
- Public comments addressed and final action issued.

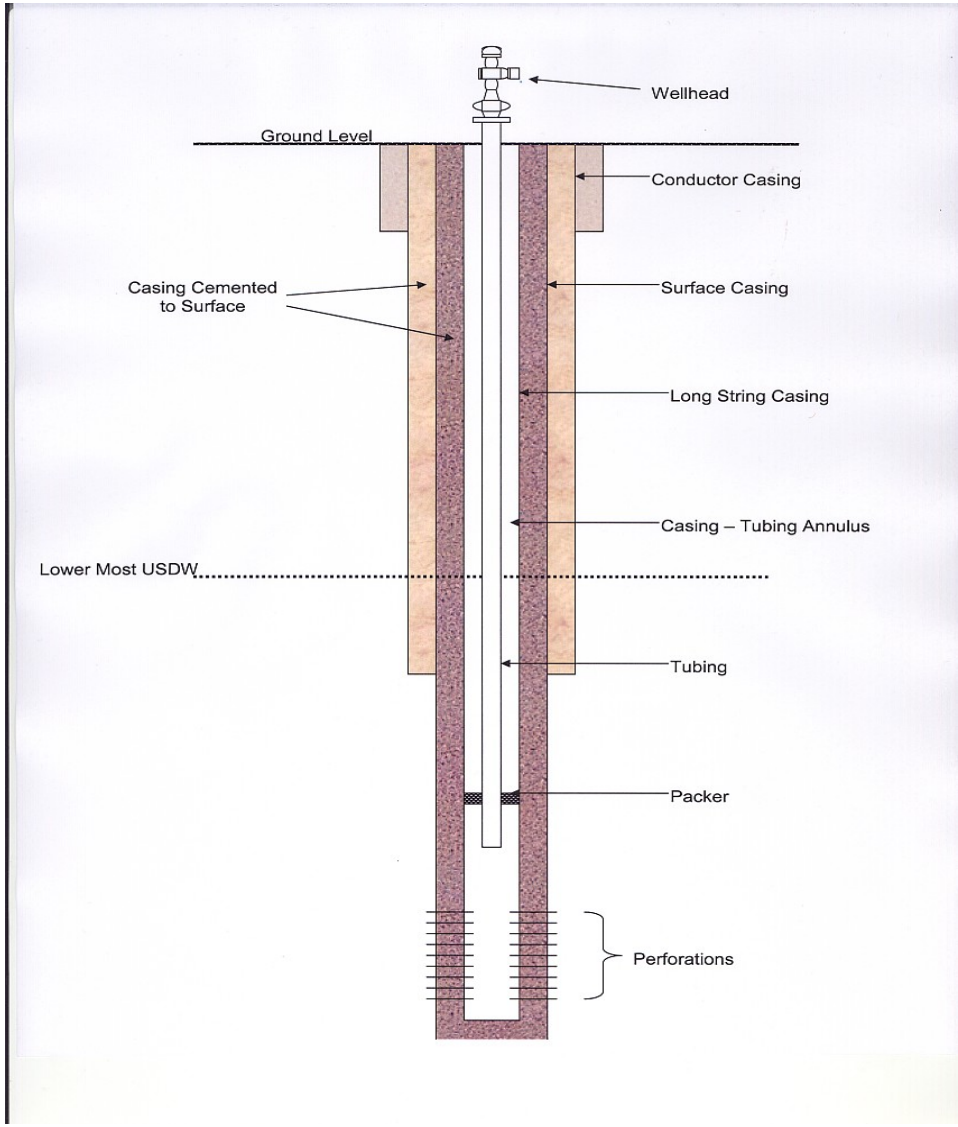
Ohio EPA Permit to Drill Requirements

- Proposed well owner and operator, well location and substance to be injected
- Proposed depth and stratigraphy
- Plan for drilling, constructing the well as well as any testing that will need to be performed.
- Seismic survey results
- Plan for plugging and abandoning the well or borehole.
- Initial calculation of Area of Review (AOR) and identification of relevant well/penetrations in the AOR.

Ohio EPA Permit to Operate Application Requirements

- As built well construction plans.
- Results of testing performed on the borehole and well – Cement bond log, mechanical integrity, etc.
- Plans for monitoring well performance, periodically testing the well for mechanical integrity and seismic monitoring if necessary.
- Plan for plugging and abandoning the well as well as financial assurance documents.
- Revised AOR designation, list of relevant boreholes and wells, and plan for remediation.

Ohio EPA Well Construction Example



Ohio EPA Testing Requirements

- Mechanical Integrity demonstrations:
  - Cement Bond Log
  - Annular Pressure Test
  - Temperature Log
  - Pressure falloff tests
- Monthly operating reports (amount and rate of injection, annulus pressure readings, etc.)
- Quarterly operating reports (seismic, ground water, etc.)

Summary

- 3 MRCSP Phase II Tests are being conducted under Class V – CO_2 UIC process.
- Process has been generally similar to either Class II or Class I-NH permits, with some flexibility due to small injection size and R&D nature.
- Permitting process requires team effort, sustained attention, and communication with regulatory agencies. *Collaboration with host sites is critical for Compliance*
- Perception issues (vs. reality) seem biggest difficulty with public concerns.
- *Other observations may include:*
  - *Currently established permitting procedures have been useful for drilling and underground injection for MRCSP sites*
  - *Much of the environmental permitting involves basic tasks that would be completed with any large construction project. They also help out with other aspects of the project.*
  - *Monitoring program for MRCSP tests likely to exceed typical injection wells due to research objectives of the project.*
  - *We believe that the permitting experience with the tests is helping federal and state agencies in developing new regulations*

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