

An Assessment of Geological Carbon Sequestration in the Illinois Basin— A Research Update

presented by
Robert J. Finley and the MGSC
Project Team



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Pittsburgh, PA



Midwest Geological
Sequestration Consortium
www.sequestration.org



Acknowledgements

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- The **MGSC** is a collaboration led by the geological surveys of Illinois, Indiana, and Kentucky



Outline

- Basic questions
- The big geologic picture - basin and reservoir
- Test site geology at Decatur, Illinois
- The physical set up at the test site
- What about the delivery of the CO₂?
- CO₂ – Where will it go and how do we check on it?
- Expected outcomes
- Challenges and problems

Basic questions

How did we get to this point?

- MGSC work from 2003-05 showed high potential in the **Illinois Basin** for geological carbon sequestration
- Small-scale (a few thousand tons, truck delivered) CO₂ injection tests underway, 2005-09, mostly in oil fields, one in a coal seam
- DOE desired large-scale testing to begin before 2009; required major source of CO₂ and a suitable site in close proximity
- Discussions with ADM began in December 06
- Proposal submitted May 07; funded December 07

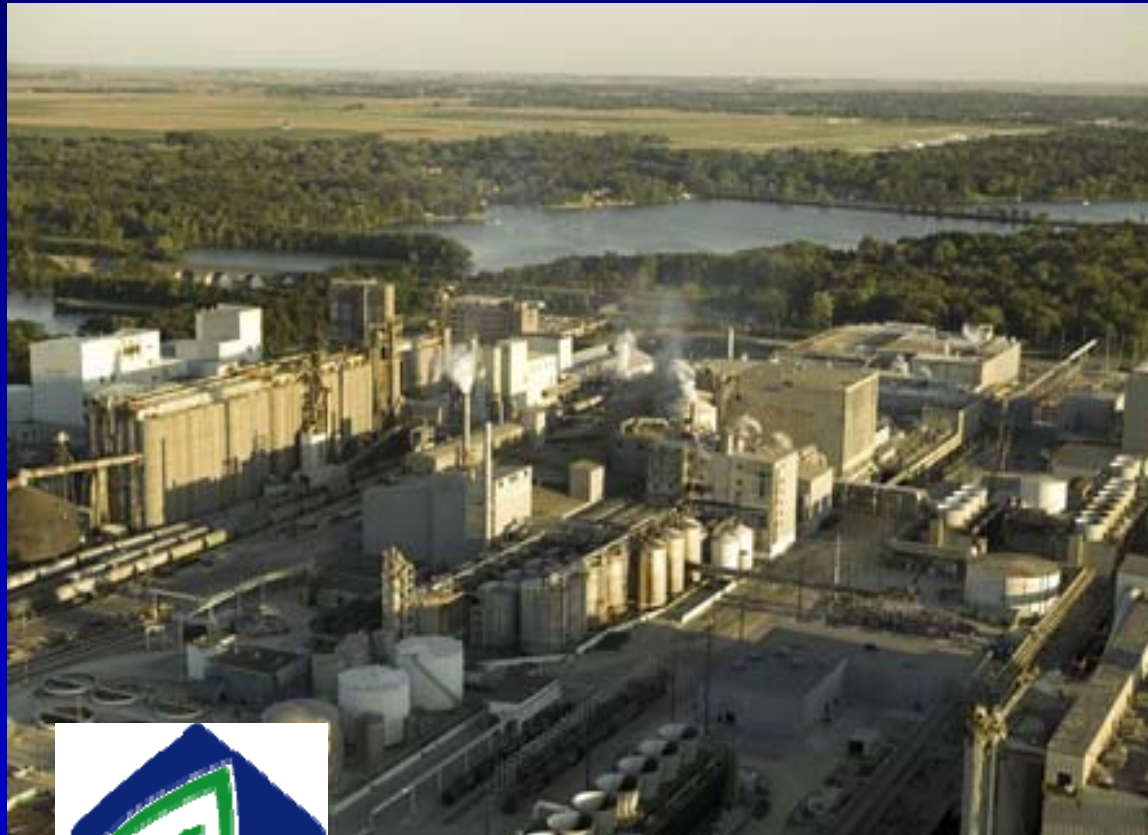
What are we doing in Phase III?

- A collaboration of the Archer Daniels Midland Company (ADM), the Midwest Geological Sequestration Consortium, Schlumberger Carbon Services, and other subcontractors plans to inject 1 million metric tons of carbon dioxide at a depth of 7,500 +/- ft to test geological carbon sequestration in a saline reservoir

Who are the major players?

- The Illinois State Geological Survey (ISGS) leads a research consortium of the Illinois, Indiana, and Kentucky geological surveys ([Midwest Geological Sequestration Consortium](#)), in place since 2003, to assess the geological carbon sequestration potential of the Illinois Basin
- National Energy Technology Laboratory, Office of Fossil Energy, leads for the [U.S. Department of Energy](#)
- [ADM](#) for CO₂ supply, permitting, site development, facilities engineering, CO₂ handling, outreach, and 24/7 operations
- [Schlumberger Carbon Services](#) will provide innovative technologies for well design, logging and completion, risk assessment, subsurface reservoir characterization, and geophysical monitoring

Archer Daniels Midland Company



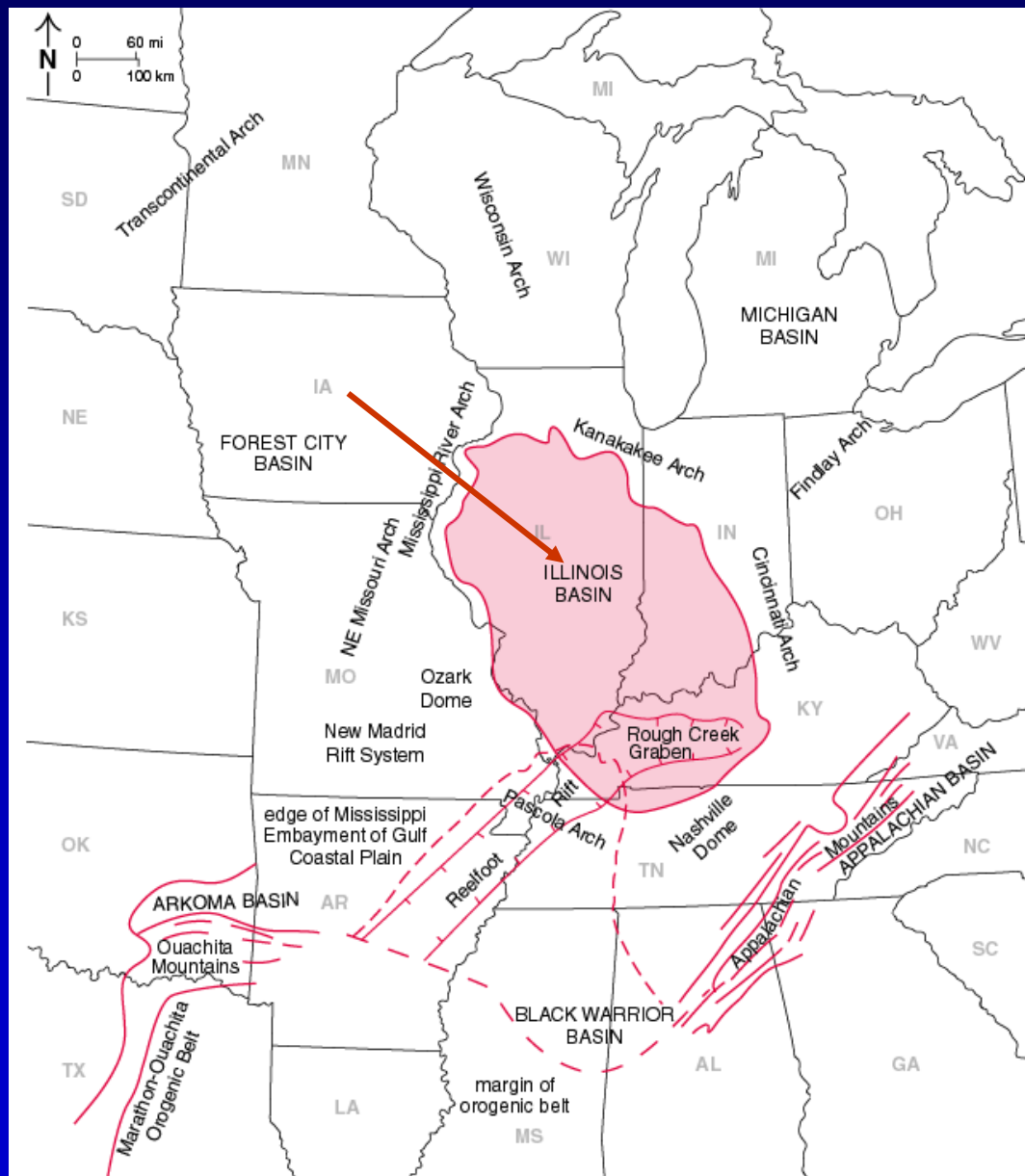
- Global company with \$44 billion sales, 27,000 employees
- Processes >500,000 bu corn/day at Decatur, IL
- Multiple products produced from corn

What is the Phase III project schedule?

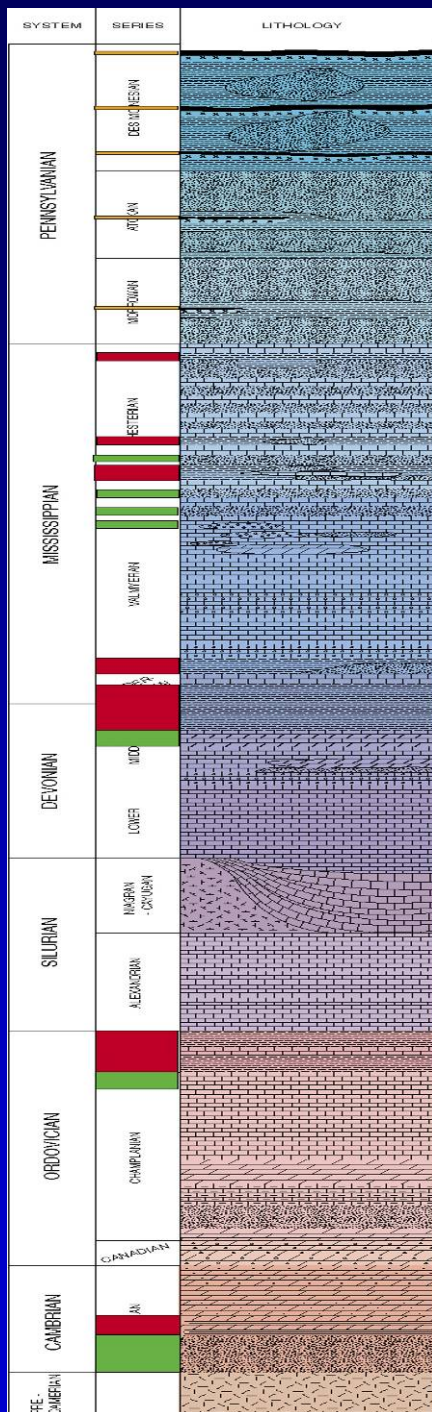
- The project was funded December 18, 2007
- Baseline environmental activities began late spring 08
- Preliminary UIC permit hearing on September 16, 2008
- Injection well drilling: potential start late in December 08;
 - ~ 68 days to drill; start dependent on permit and rig
- Final testing of compression, pipeline, and wellhead in late 09
- Injection to occur from about December 2009- December 2012, depending on equipment availability
- Verification wells would be drilled ~ spring 2009 and ~ summer 2012 (if second well funded)
- Environmental monitoring through December 2014

The big geologic picture - basin and reservoir

Illinois Basin



Illinois Basin Stratigraphic Column



Pennsylvanian coal seams

Mississippian sandstone and carbonate oil reservoirs

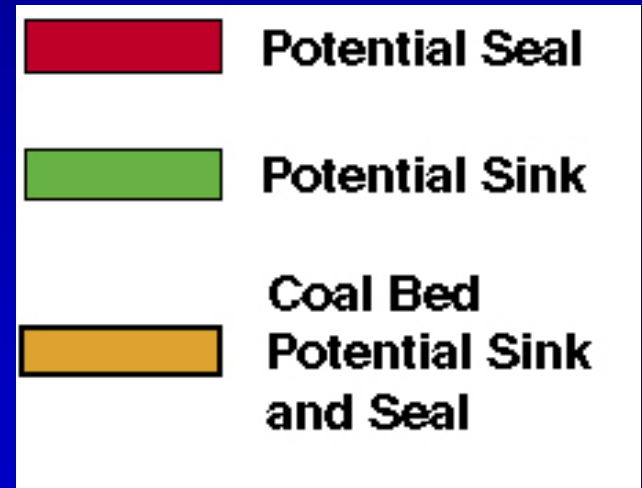
New Albany Shale

Maquoketa Shale

St. Peter Sandstone

Eau Claire Shale

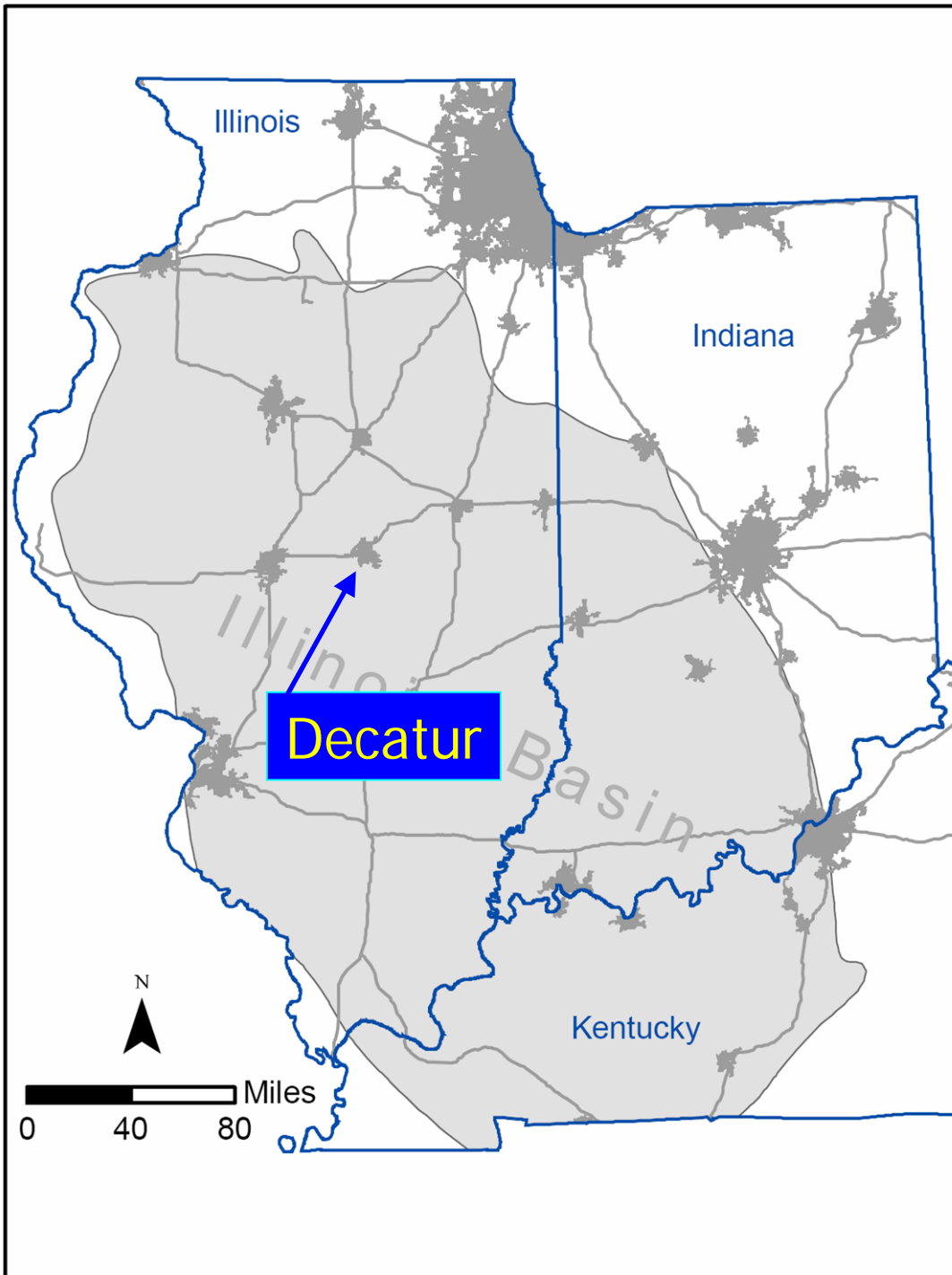
Mt. Simon Sandstone



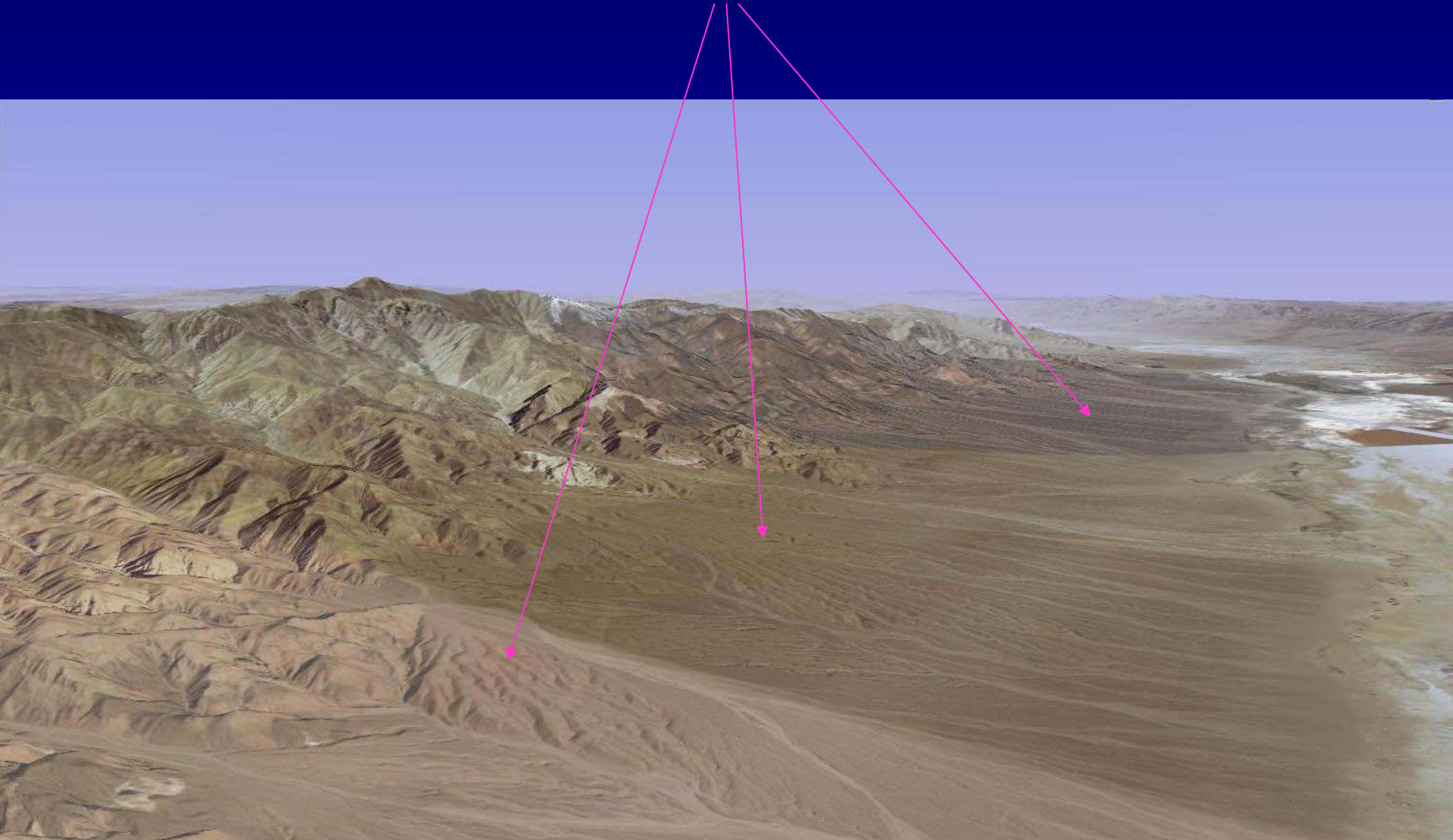
Test site geology at Decatur, Illinois

Decatur, Illinois Location

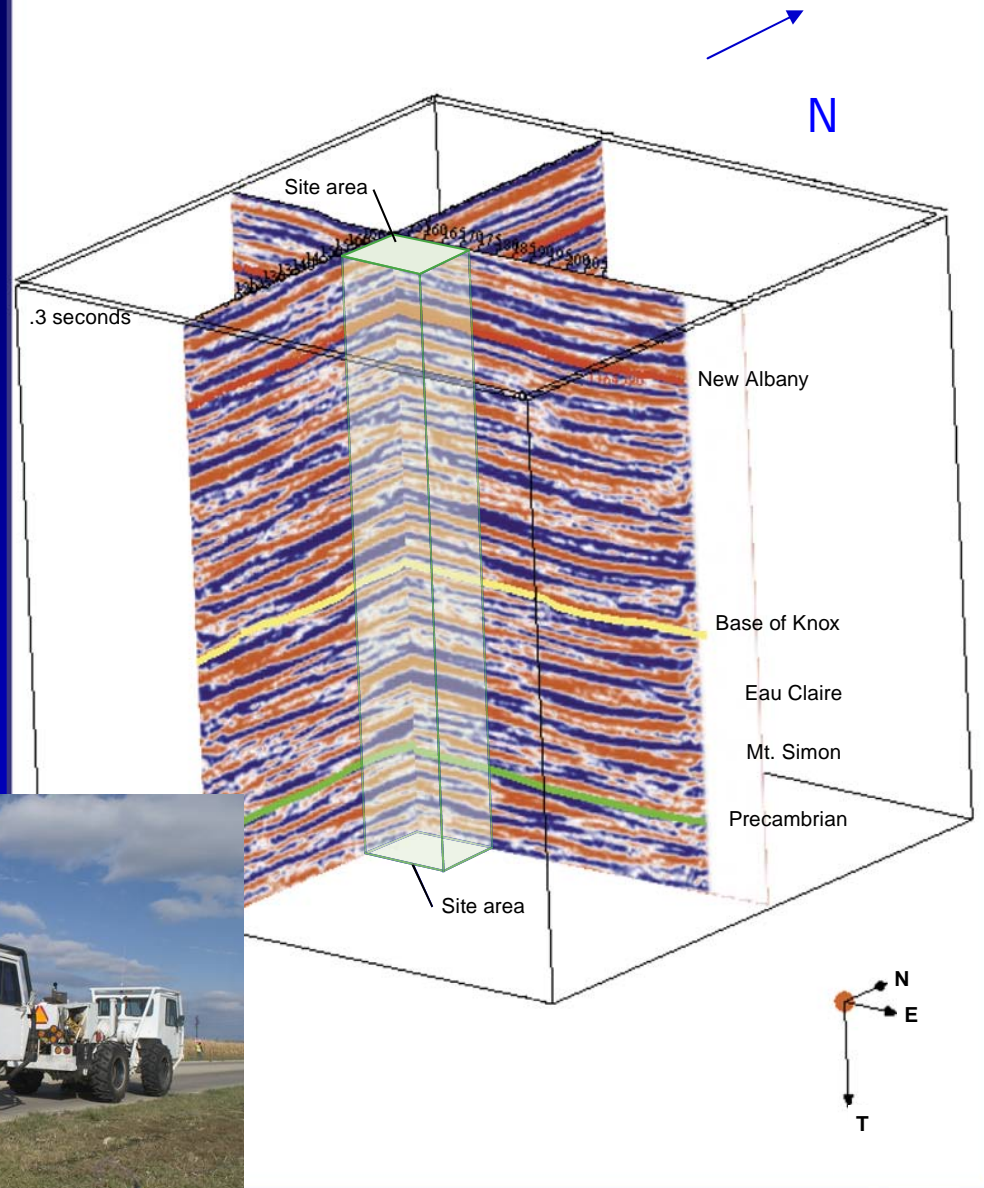
- Decatur, IL is located in central Illinois on the margin of the thickest part of the Mt. Simon Sandstone depocenter
- Regional geology suggest favorable reservoir quality and adequate seals and backup seals



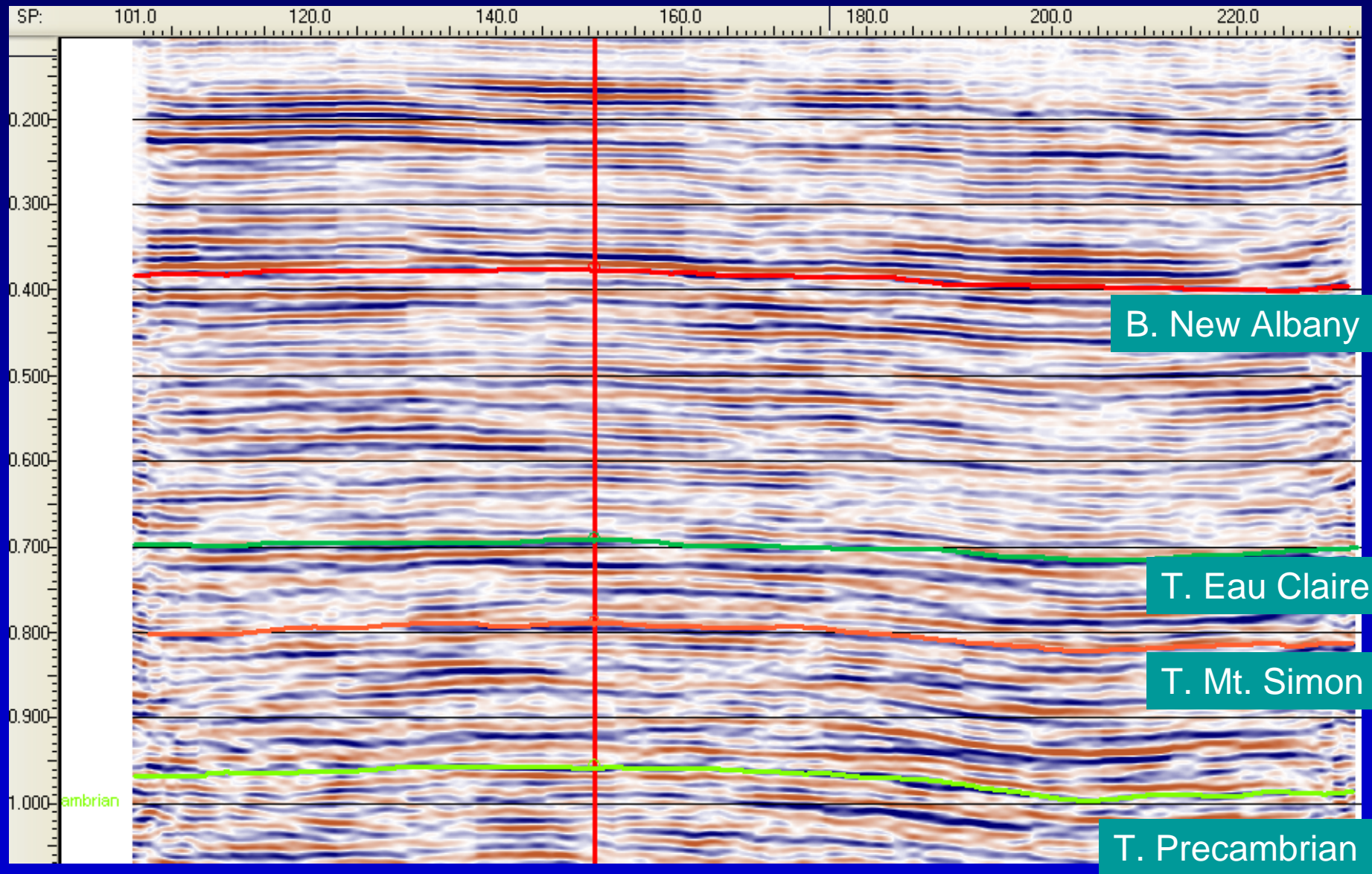
A Model for Mt. Simon Sandstone Deposition: Alluvial Fans in Death Valley



ADM 2D Survey

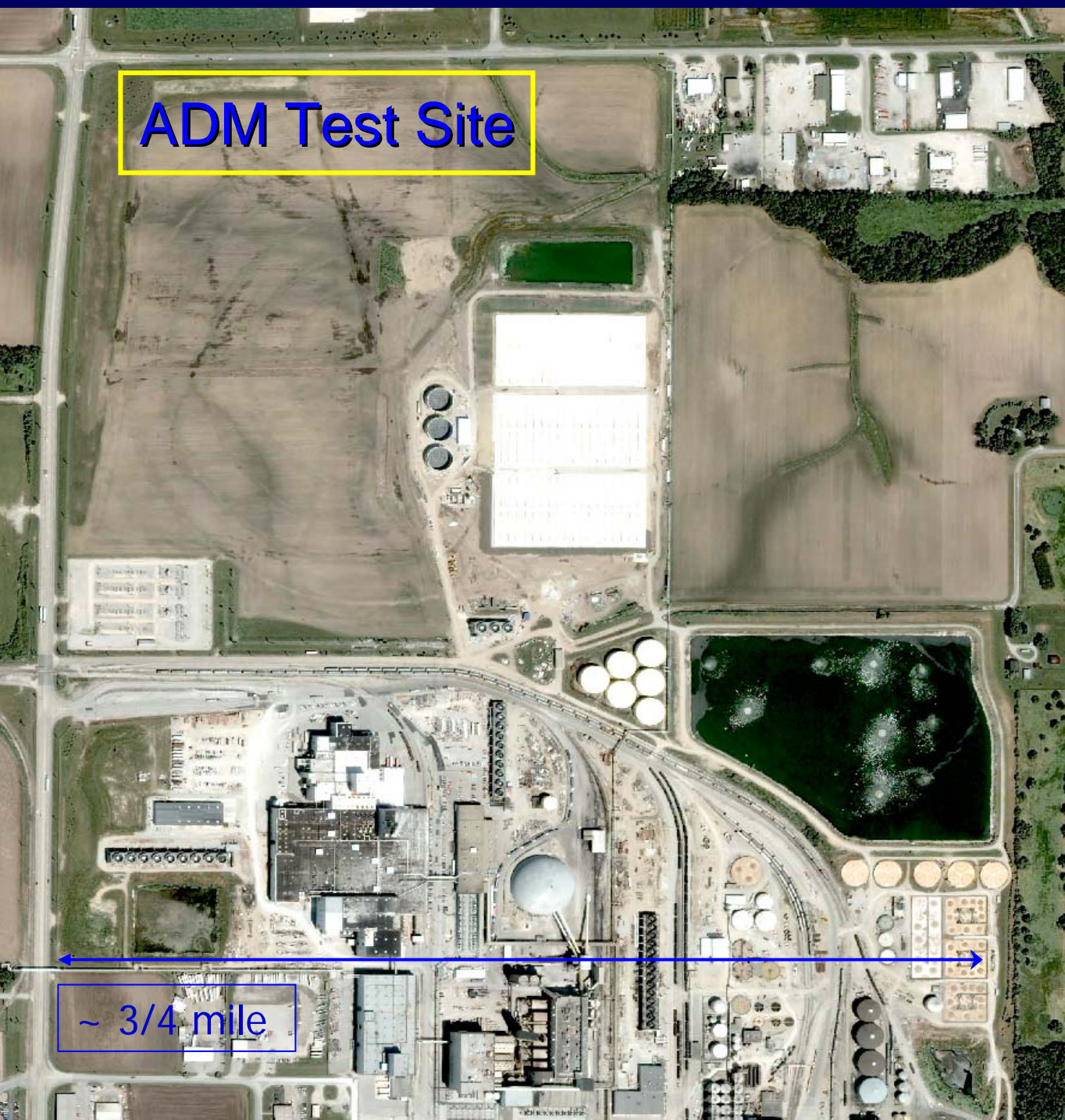


East-West Line



The physical set up at the test site

ADM Test Site



~ 3/4 mile

Views Across ADM site



Southwest



Northwest across well site

What about the delivery of the CO₂?

ADM Test Site

- **A** Dehydration/compression facility location
- **B** Pipeline route
- **C** Injection well site
- **D** Representative verification well sites
- **F** Anaerobic wastewater treatment facility



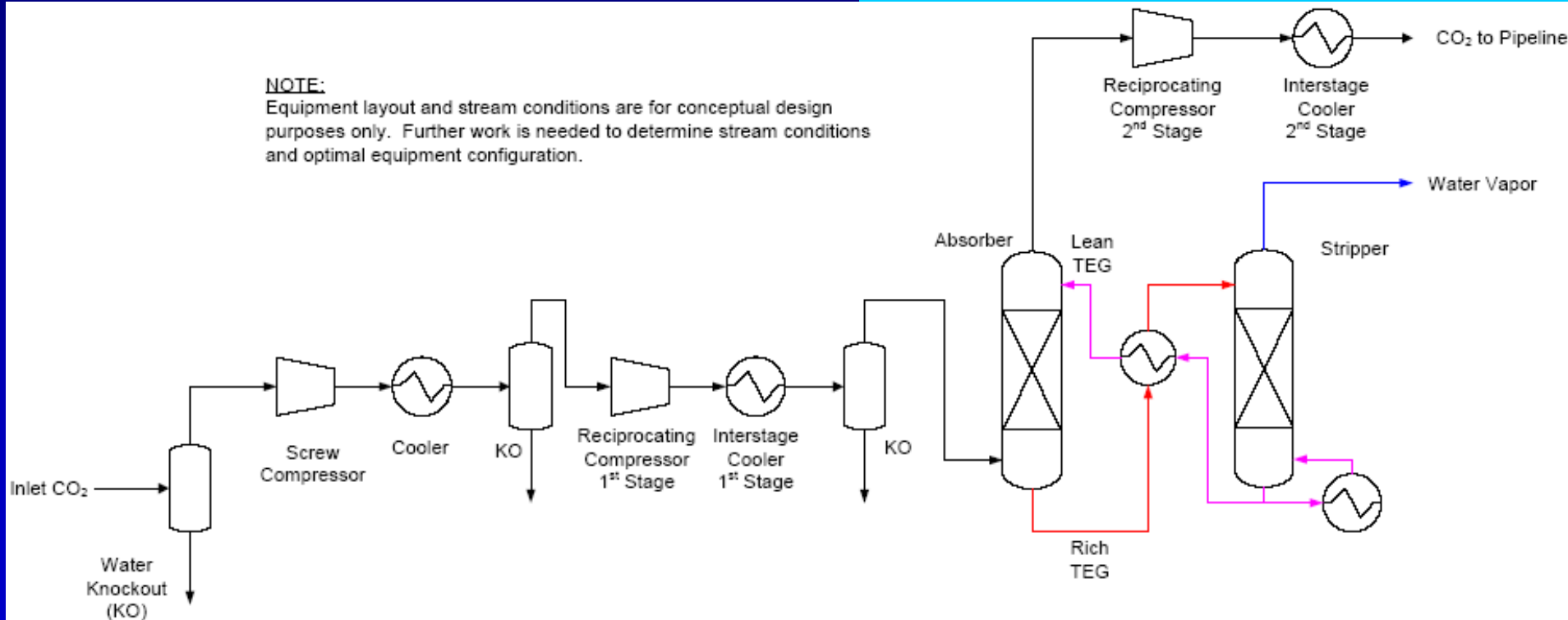
~ 3/4 mile

Preliminary CO₂ Process Flow Diagram for ADM Site

Output
Dry at ~1,300-1,500 psia

NOTE:

Equipment layout and stream conditions are for conceptual design purposes only. Further work is needed to determine stream conditions and optimal equipment configuration.

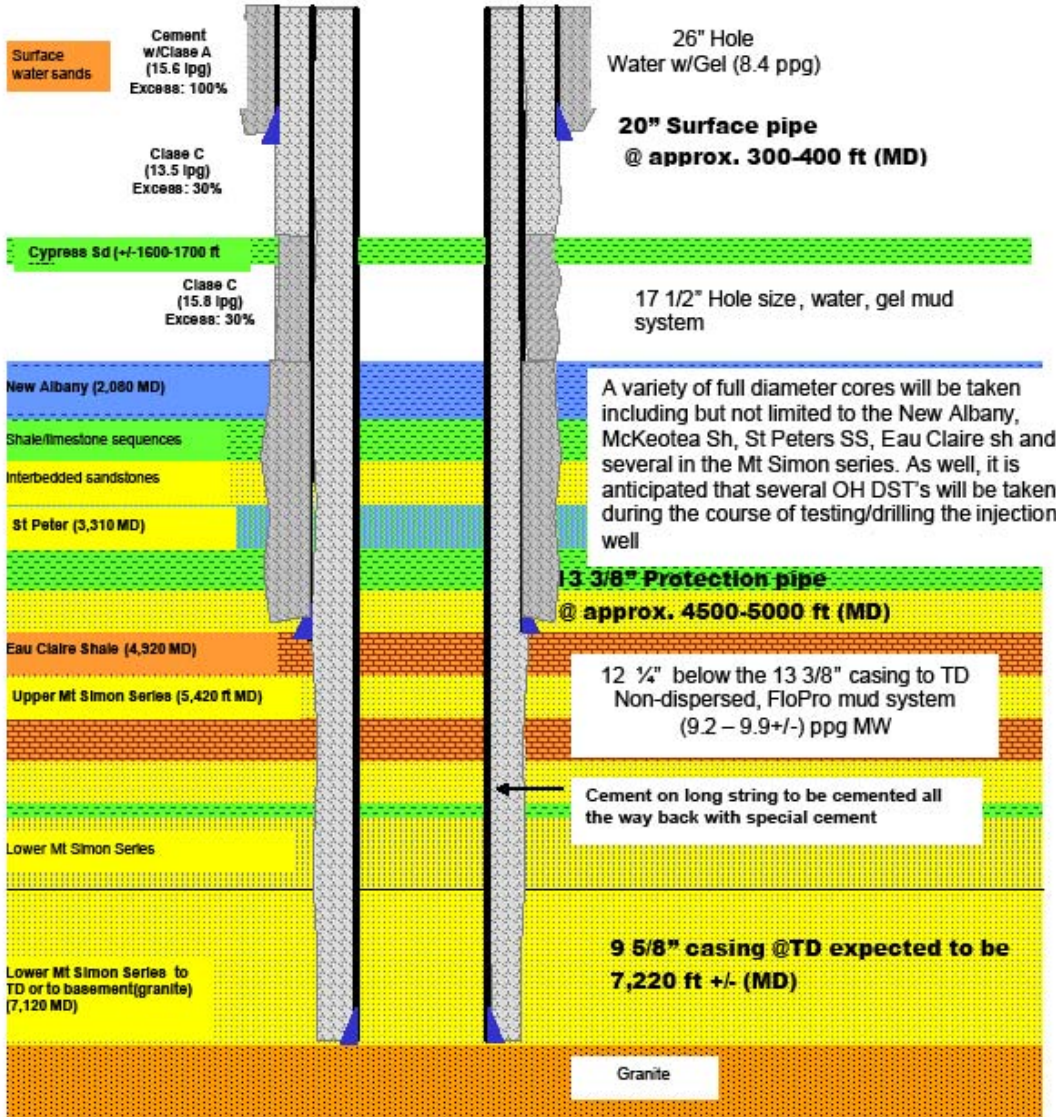


Input

Wet at 14.5 psia

from Trimeric Corporation

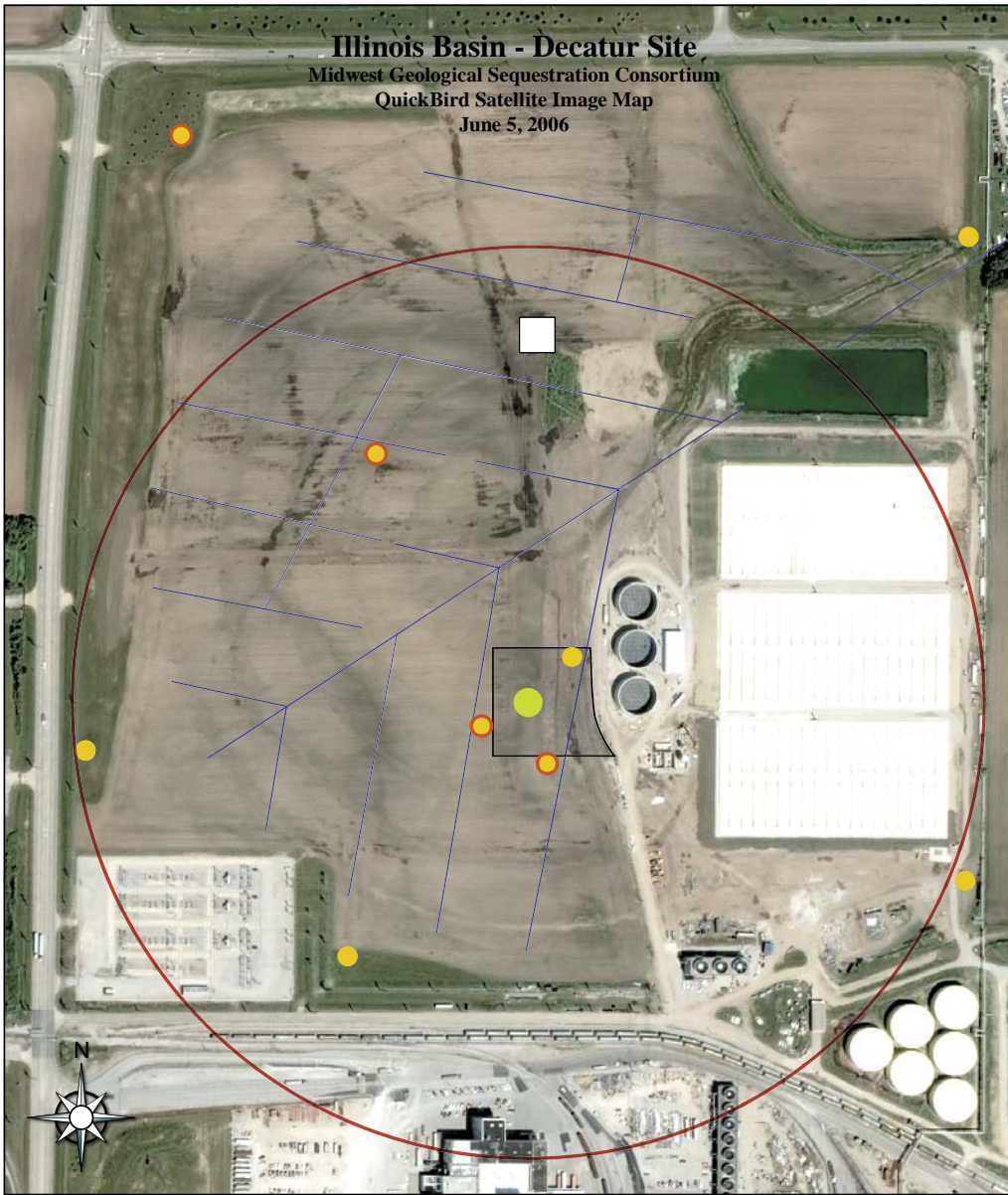
Wellbore Schematic



- Well logs, whole core, fluid sampling, sidewall cores before setting pipe
- Cement to surface in both intermediate and long strings
- Chrome steel casing in Mt. Simon and Eau Claire

CO₂ – Where will it go and how do we
check on it?

Illinois Basin - Decatur Site
Midwest Geological Sequestration Consortium
QuickBird Satellite Image Map
June 5, 2006

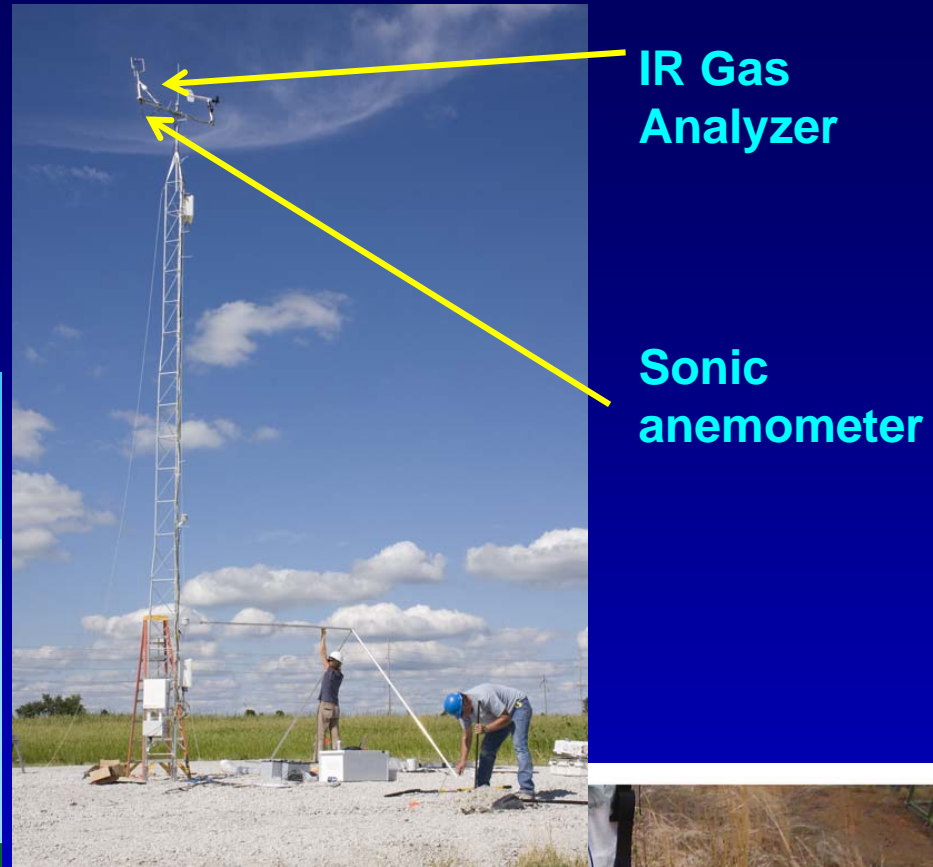
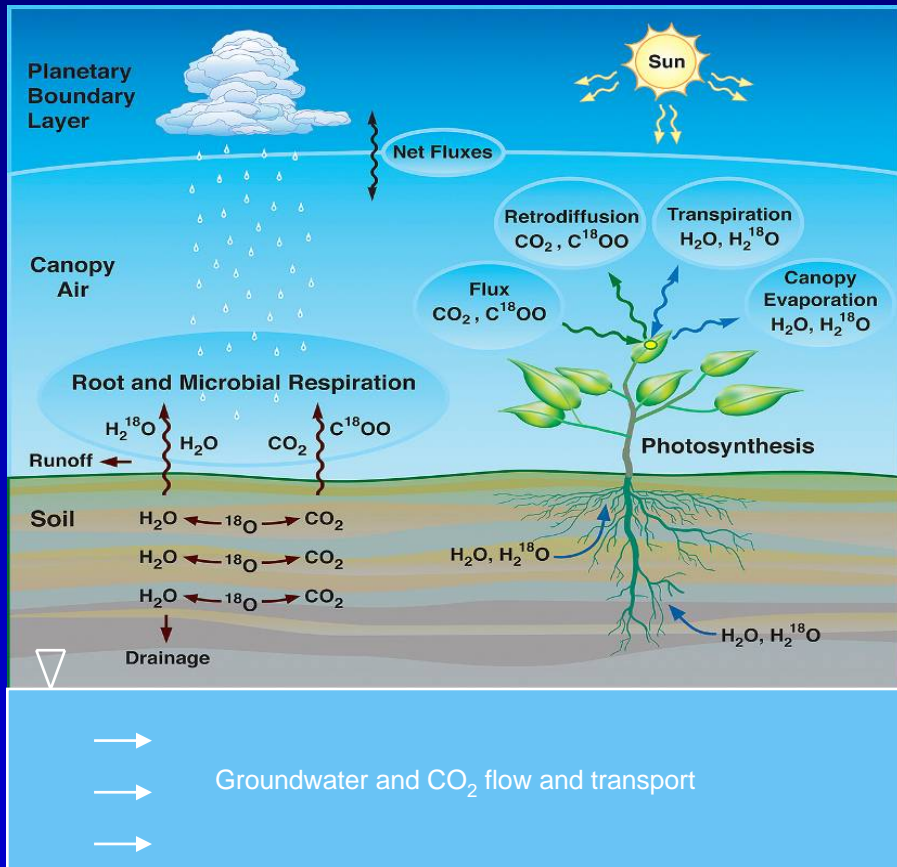


- Proposed CO₂ injection well
- Proposed USDW monitoring wells
- Proposed groundwater monitoring wells
- Proposed well pad
- Eddy Covariance tower
- Extent of CO₂ plume
- Drain tile

Basic Near-Surface Site Monitoring Plan

- Shallow ground water wells
- Instrument the drain tile system
- Electrical resistivity near injection well
- Surface flux chambers
- Atmospheric monitoring

Surface Monitoring of Air and Soil for CO₂



from Oldenburg, LBNL

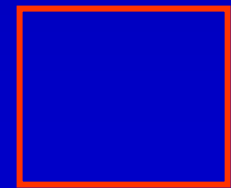
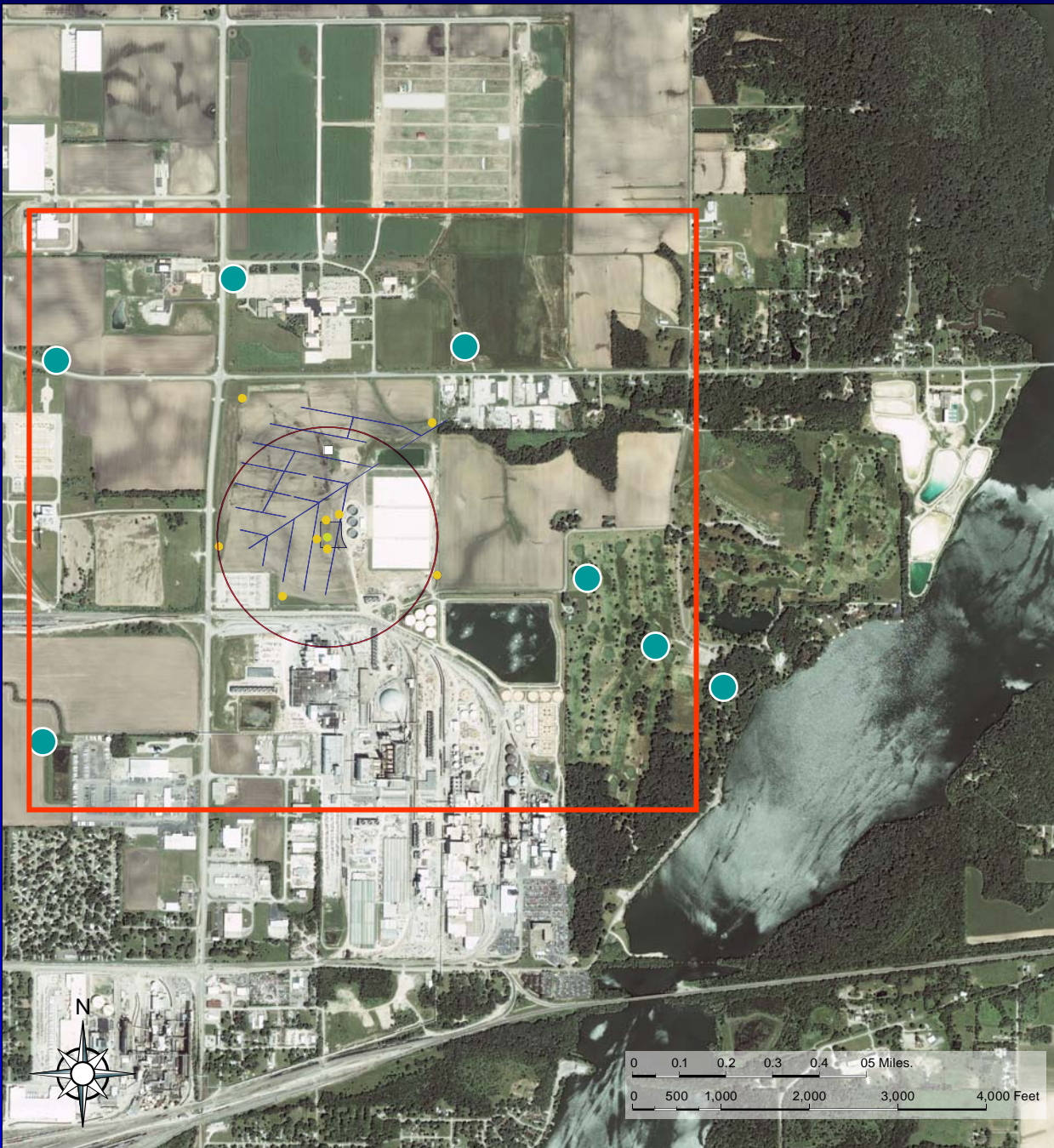
Shallow Groundwater Monitoring



Wells drilled and periodically sampled

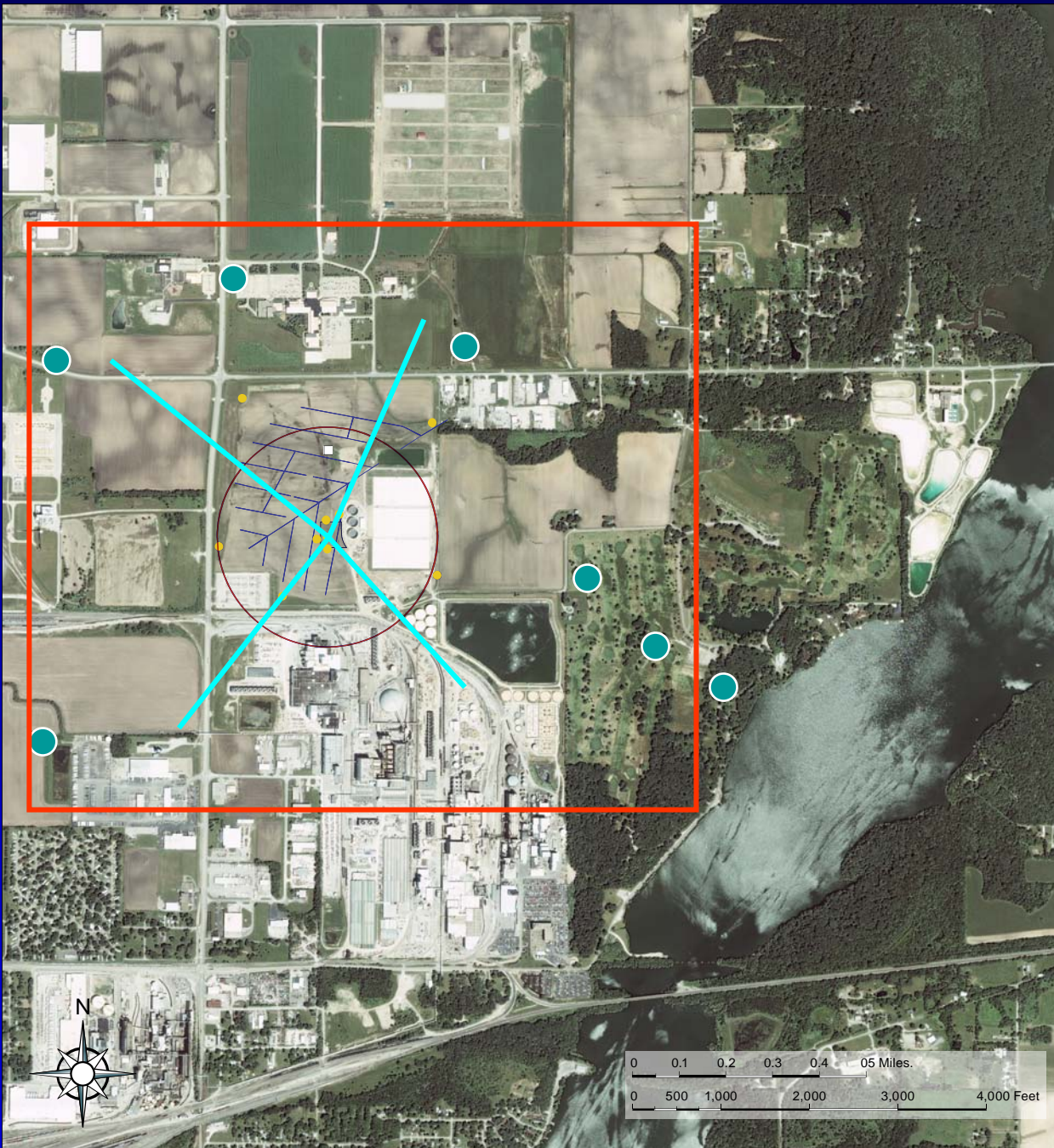
Area Monitoring

- Shallow ground water well ●
- CIR satellite imagery



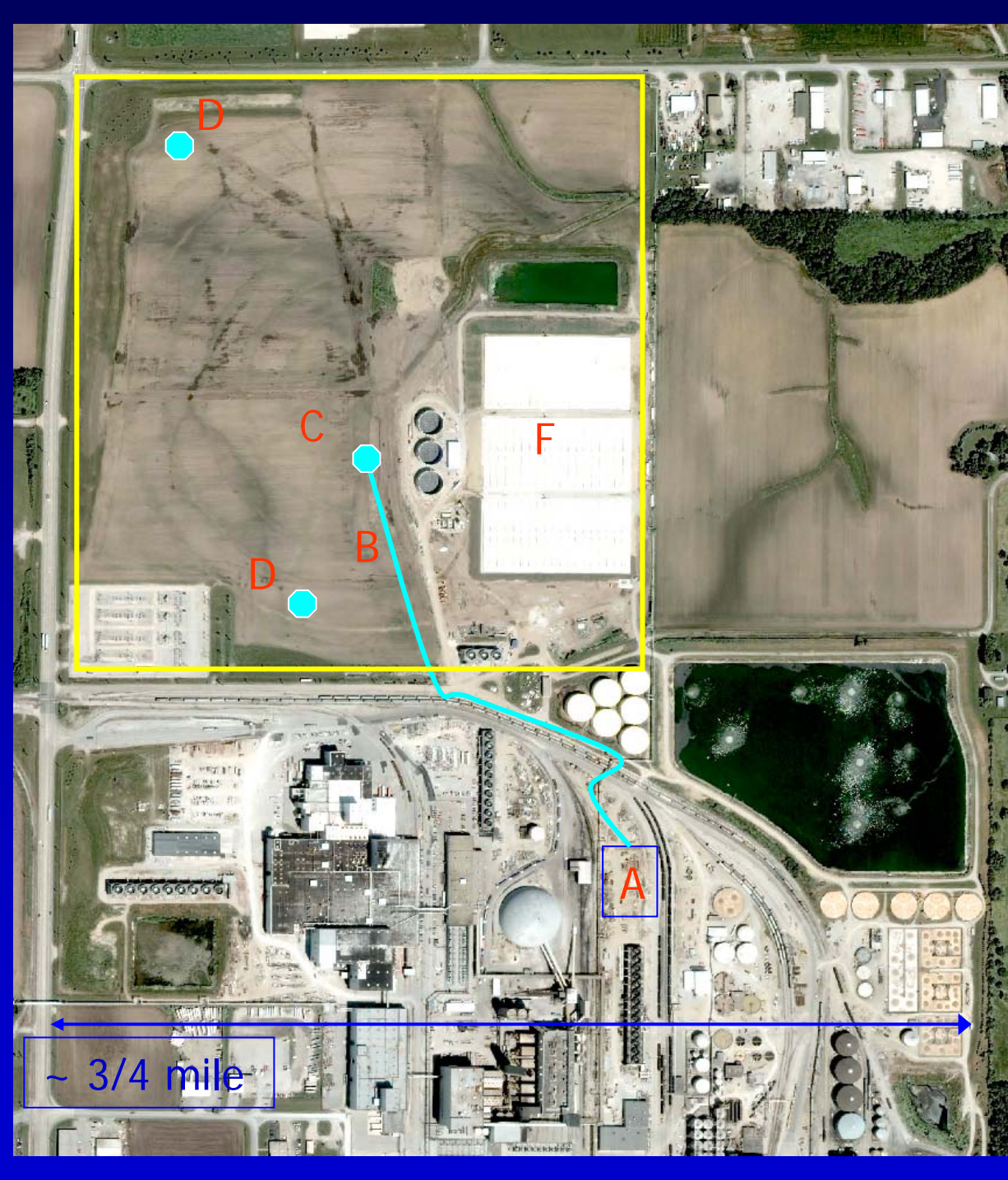
Area Monitoring

- Shallow ground water ●
- CIR satellite Imagery
- Radial repeat vertical seismic profiles



ADM Test Site

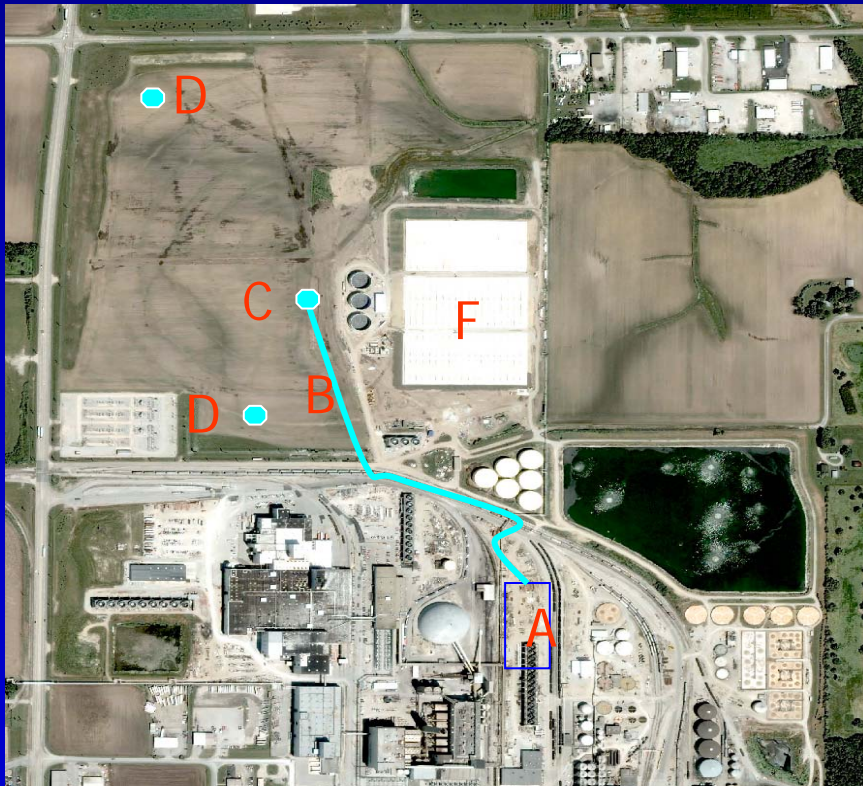
- **A** Dehydration/compression facility location
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~ 3/4 mile

Plume Monitoring Strategies

- Drill two verification wells (D) based on surface seismic and VSP data, generally one updip and one downdip, or placed based on VSP plume boundary imaging



- Open-hole logging and flexible (Westbay) fluid sampling strategy
- Pressure/temp. monitoring
- Cased-hole logging

packer

P port

sampling port



Expected outcomes

What are the Phase III outcomes?

- A large-scale injection of 1 million tonnes of CO₂ successfully demonstrated and associated safety, efficiency, and effectiveness requirements met
- Volume sufficient to monitor geophysically; overall effort scalable to IGCC
- A process model established for characterization permitting, equipment, injection, environmental monitoring, and outcome assessment that will support energy facility development with integrated carbon sequestration in the Illinois Basin, nationally, and globally
- An “active” geological site model developed and continually updated as new data are acquired

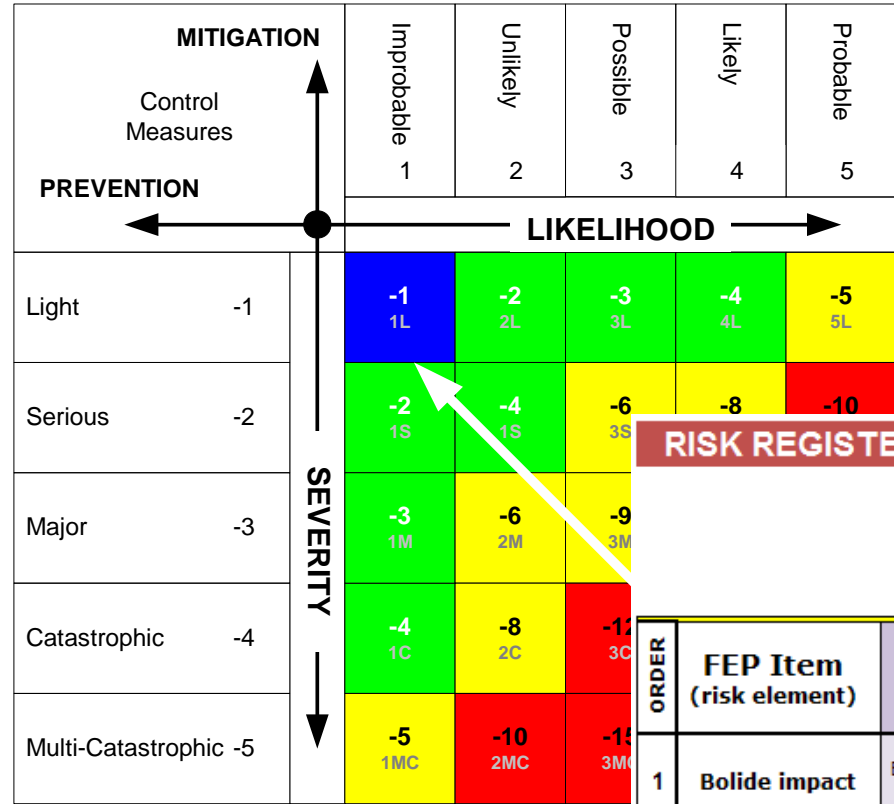
Outreach

- ADM Partnership building and project coordination
 - Public information session to announce Phase III and inform public
 - On-site visits during well construction
- Congressional Briefings
- Invited Briefing
- Public Information Meeting
- Public Hearing

Education

- Developing teacher workshops
 - Situated to benefit the Phase III local and regional community
 - Laying the groundwork for programs in Decatur schools
 - Illinois Basin region
- Earth Explorers Program in Decatur, Illinois – began Jan. 2008
 - Program designed to support local elementary school teachers
- Held Keystone Climate Change Workshop in August 2008
 - Brought in teachers from Illinois, Indiana, and Kentucky
- Richland Community College – involving faculty, hosting public info meeting
- Drilling activities to engage community during drilling period, museum display

-25 to -20	BLACK	NON-OPERABLE: Evacuate the zone and or area/country
-16 to -10	RED	INTOLERABLE: Do not take this risk
-9 to -5	YELLOW	UNDESIRABLE: Demonstrate ALARP before proceeding
-4 to -2	GREEN	ACCEPTABLE: Proceed carefully, with continuous improvement
-1	BLUE	NEGLIGIBLE: Safe to proceed



White arrow indicates decreasing risk

Risk Management and Safety

- FEP- base risk analysis led by SCS with 2 rounds and 27 evaluators
- 77 FEPs being ranked

RISK REGISTER - MGSC Phase III								wellsite SURFACE			
traffic, security, buildings, surface data acquisition, pits/cuttings/waste, office space, wildlife, wellhead, utility corridors, personal exposure (weather, fumes), soil contaminants, etc											
		DATA ENTRY COLUMNS									
		Allowed: 1,2,3,4,5; L,S,blank			Any text.						
ORDER	FEP Item (risk element)	Project-specific information about FEP-related risk		L LB	L Best Guess	L UB	S LB	S Best Guess	S UB	NOTES Highest L*S Scenario, most at-risk Values.	L*S
1	Bolide impact	Bolide impact could cause total CO2 release.		L	L	L	s	S	s		#VALUE!
2	Erosion and deposition	The ILADM project area is flat to rolling, and is unlikely to undergo erosion or deposition affecting project operations or longterm storage.		L	L	L	s	S	s		#VALUE!
3	Accidents and unplanned events	Surface operations, including those related to ADM industrial operations, could expose personnel, wellhead, wellbore, and image to risks.		L	L	L	s	S	s		#VALUE!
4	Soils and sediments	Where not occupied by buildings, the ILADM area is largely agricultural. Soil is (2) thick and has high organic		L	L	L	s	S	s		#VALUE!

Led by K. Hnottavange-Tellen

Challenges and problems

Impacts on Plans, Schedules, Costs, and Manpower

- Permit - timing, precedents
- Rig schedule and availability
- Cost (and availability) of pipe, cement, and services are major concerns as energy industry demands continue to rise
- Long lead times to acquire compression equipment based on tight global market



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