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McDonald, Jeffrey

From: McDonald, Jeffrey
Sent: Tuesday, January 21, 2014 12:40 PM
To: 'Gilmore, Tyler J'
Cc: Greenhagen, Andrew
Subject: FW: FG T&M table
Attachments: FutureGen T&M Strategy Tables.xlsx

Tyler,
As noted, we think that this might help you and the FGA people fill in some holes in testing and monitoring requirements. The folks here in the region went over it and agree with Molly's assessment. Let me know if you have any questions.
Jeff

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From: Bayer, MaryRose
Sent: Friday, January 17, 2014 3:45 PM
To: McDonald, Jeffrey
Cc: Greenhagen, Andrew
Subject: FG T&M table

Jeff,
Attached is the T&M table I had Cadmus pull together. This should be VERY helpful in getting them to narrow in on what they are planning. I would encourage you to take a quick look and send it on to Tyler ASAP!
Thanks,
Molly

Mary Rose Bayer
Geologist, UIC GS Team Leader
U.S. Environmental Protection Agency
Office of Ground Water & Drinking Water: Prevention Branch
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INTRODUCTION

This file is intended to summarize FutureGen's testing and monitoring strategy to comply with the Class VI requirements under:
- 40 CFR 146.90(d) for geochemical monitoring above the confining zone; and
- 40 CFR 146.90(g) for plume and pressure front monitoring.

The information presented in the following tabs for these monitoring strategies is compiled from the permit application revision dated May 2013 and subsequent communications in November and December 2013. Copies of submitted information are also presented in the "Submissions" tab for reference purposes.

d water d geochemical changes above the confining zone(s) that may be a result of carbon dioxide movement through

jection rate and volume, geology, the presence of artificial penetrations, and other factors; and
d under 146.82(a)(6) and on any modeling results in the AoR evaluation required by 146.84(c).

zone by detecting potential geochemical changes due to the introduction of the injectate or displaced formation fluids above the
ng zone that has a sufficient permeability to support collection and analysis of ground water samples. However, the decision
Program Director. The UIC Program Director may determine that monitoring ground water quality (or pressure) within additional

Active ars 1-3)	Frequency - DOE Active Injection (Years 4-5)	Frequency - Commercial Injection (Years 6-20)	Questions for Permit Applicant	Responses to Questions
	Annually	Annually	• The permit application lists this monitoring method as "under consideration." Will shallow aquifer sampling be carried out during the injection phase? • What are the locations of the private wells that will be used for sampling? Has the location of the project-installed well been finalized, as indicated in the November 2013 communication? The location information for these wells may need to be finalized for the permitting process. • What arrangements have been made to ensure access to these wells for the lifetime of the project? • Which target parameters will be selected for analysis at these wells and what is the justification for selecting these parameters? Also, if any anomalies are observed, more frequent fluid sampling may be necessary. FutureGen should specify triggers for identifying any evidence that USDWs may be affected by injection activities.	
	Annually	Annually	• Has the location and depth of this well been finalized, as indicated in the November 2013 communication? The location information for these wells may need to be finalized for the permitting process. • What arrangements have been made to ensure access to this well for the lifetime of the project? • Which target parameters will be selected for analysis at these wells and what is the justification for selecting these parameters? Also, if any anomalies are observed, more frequent fluid sampling may be necessary. FutureGen should specify triggers for identifying any evidence that USDWs may be affected by injection activities.	
	Semi-annually	Annually	• Has the location and depth of this well been finalized, as indicated in the November 2013 communication? The location information for these wells may need to be finalized for the permitting process. • What arrangements have been made to ensure access to this well for the lifetime of the project? • Which target parameters will be selected for analysis at these wells and what is the justification for selecting these parameters? Also, if any anomalies are observed, more frequent fluid sampling may be necessary. FutureGen should specify triggers for identifying any evidence that USDWs may be affected by injection activities.	

SC	Questions for Permit Applicant	Responses to Questions
	• The permit application lists this monitoring method as "under consideration." Will shallow aquifer sampling be carried out during the PISC phase? Also, if any anomalies are observed, more frequent fluid sampling may be necessary. FutureGen should specify triggers for identifying any evidence that USDWs may be affected by injection activities.	
	• If any anomalies are observed, more frequent fluid sampling may be necessary. FutureGen should specify triggers for identifying any evidence that USDWs may be affected by injection activities.	
	• If any anomalies are observed, more frequent fluid sampling may be necessary. FutureGen should specify triggers for identifying any evidence that USDWs may be affected by injection activities.	

dioxide.) e presence or absence of elevated pressure (e.g.,

ermines, based on site-specific geology, that such methods are not

cant".

DOE Active ip (Years 1-3)	Frequency - DOE Active Injection (Years 4-5)	Frequency - Commercial Injection (Years 6-20)	Questions for Permit Applicant	Responses to Questions
ally	Annually	Every 2 years	• Have the locations and depths of these wells been finalized, as indicated in the November 2013 communication? The location information for these wells may need to be finalized for the permitting process. • What arrangements have been made to ensure access to these wells for the lifetime of the project? • Which target parameters will be selected for analysis at these wells and what is the justification for selecting these parameters? Also, if any anomalies are observed, more frequent fluid sampling may be necessary. FutureGen should specify triggers for identifying any evidence that the plume is not behaving as expected.	
erly	Semi-annually	Annually	• Has the location and depth of this well been finalized, as indicated in the November 2013 communication? The location information for this well may need to be finalized for the permitting process. • What arrangements have been made to ensure access to this well for the lifetime of the project? • Which target parameters will be selected for analysis at these wells and what is the justification for selecting these parameters? Also, if any anomalies are observed, more frequent fluid sampling may be necessary. FutureGen should specify triggers for identifying any evidence that the plume is not behaving as expected.	
ne	None	None	• Please provide a description of the strategy that will be employed to track the plume using the data generated from each of these monitoring activities and how each activity will contribute to an overall monitoring strategy. This description, at a minimum, should provide the predicted values over time at each well and describe how the generated monitoring data will be compared to these results.	
ally	Annually	Annually		
uous	Continuous	Continuous		
nually	Semi-annually	Semi-annually		
uous	Continuous	Continuous		

Questions for Permit Applicant	Responses to Questions
omalies are observed, more frequent ing may be necessary. FutureGen should gers for identifying any evidence that is not behaving as expected.	
ovide a description of the strategy that loyed to track the plume using the data from each of these monitoring activities ach activity will contribute to an overall strategy. This description, at a should provide the predicted values it each well and describe how the monitoring data will be compared to ts.	

track the ... of the carbon dioxide plume and the presence or absence of elevated pressure (e.g.,

tools), unless the Director determines, based on site-specific geology, that such methods are not

rmit Applicant".

equency - Baseline	Frequency - DOE Active Injection Startup (Years 1-3)	Frequency - DOE Active Injection (Years 4-5)	Frequency - Commercial Injection (Years 6-20)	Questions for Permit Applicant	Responses to Questions
				• More specific monitoring strategy information is needed for this method (i.e., predicted pressure values at each well over time and how pressure monitoring results will be compared to these predicted values).	
				• More specific monitoring strategy information is needed for this method (i.e., predicted pressure values at each well over time and how pressure monitoring results will be compared to these predicted values).	
				• The Class VI Rule at 40 CFR 146.90(g)(2) requires indirect monitoring of the pressure front, unless the UIC Program Director determines that such methods are not appropriate for the site. What indirect monitoring methods will be used to track the pressure front and how will they contribute to the overall monitoring strategy?	

nit Applicant".

Frequency - PISC	Questions for Permit Applicant	Responses to Questions
	• The permit application states that "at least two wells in the injection zone will be retained for this purpose" during PISC (page 5.24). At which wells will monitoring take place? • More specific monitoring strategy information is needed for this method (i.e., predicted pressure values at each well over time and how pressure monitoring results will be compared to these predicted values).	
	• The Class VI Rule at 40 CFR 146.90(g)(2) requires indirect monitoring of the pressure front, unless the UIC Program Director determines that such methods are not appropriate for the site. What indirect monitoring methods will be used to track the pressure front and how will they contribute to the overall monitoring strategy?	

Table 5.3 from FutureGen's May 2013 Permit Application Revision:

Table 5.3. Monitoring Frequencies by Method and Project Phase for both Planned and C

Monitoring Category	Monitoring Method	Baseline 3 yr	DOE Active Injection (startup) ~3 yr
Monitoring Plan Update	NA	As required	As Required
CO_2 Injection Stream Monitoring	Grab sampling and analysis	Up to 6 events during commissioning	Quarterly
CO_2 Injection Process Monitoring	Continuous monitoring of injection process (injection rate, pressure, and temperature; annulus pressure and volume)	NA	Continuous
Well Mechanical Integrity Testing	Oxygen activation, radioactive tracer, and/or temperature logging	Once after well completion	Annual
	Injection well pressure fall-off testing	NA	Every 5 yr
Corrosion Monitoring of Well Materials	Corrosion coupon monitoring	NA	Quarterly
	Wireline monitoring of casing and/or tubing corrosion and cement	Once after well completion	During well workovers
Groundwater Quality and Geochemistry Monitoring	Early leak-detection monitoring in above confinement zone monitoring wells	3 events	Quarterly
	USDW aquifer monitoring (continuous parameter monitoring, aqueous sample collection as indicated)	1 yr continuous monitoring, 3 sampling events	Quarterly
Injection Zone Monitoring	Single-level monitoring wells	3 events	Annual
	Multi-level monitoring wells	3 events	Quarterly
Indirect Geophysical Monitoring Techniques (surface)	Integrated deformation monitoring	2 yr min	Continuous
	3D multi-component surface seismic monitoring	Once	NA
	Magnetotelluric (MT) sounding	3 events	Once
	Time-lapse gravity	Once	Semi-Annual

Table 5.3. (contd)

Monitoring Category	Monitoring Method	Baseline 3 yr	DOE Active Injection (startup) ~3 yr
Indirect Geophysical Monitoring Techniques (downhole)	Vertical seismic profile(ing) (VSP)	Once	Once
	Cross-well seismic imaging	Once	Once
	Passive seismic monitoring (microseismicity)	1 yr min	Continuous
	ERT	1 yr min	Continuous
	Real-time distributed temperature sensing (DTS)	1 yr min	Continuous
Indirect Geophysical Monitoring Techniques (wireline logging)	Pulsed-neutron capture, sonic (acoustic) logging, and gamma-ray logging	Once after well completion	Annual
Surficial Aquifer Monitoring	Continuous parameter monitoring in 1 project-installed well, aqueous sample collection as indicated	1 yr continuous monitoring, 3 sampling events	Quarterly
Soil-Gas Monitoring	Samples collected for CO_2, other noncondensable gases and tracers	4 events	Quarterly

Atmospheric Monitoring	Continuous CO_2 monitoring, tracer sampling and analysis	1-yr baseline monitoring	Quarterly
Ecological Monitoring	Eco survey for baseline, continuous surface-water monitoring, remote sensing of vegetation condition, as indicated	Eco survey once, 1-yr baseline monitoring	Annual

Update on indirect monitoring methods from November 2013 communication:

FutureGen Response
The screening of the indirect monitoring approaches was conducted as part of Engineering Design process. The selected indirect technologies will include th • pulsed neutron capture logging or determination of reservoir CO_2 s • integrated deformation monitoring • time-lapse gravity • microseismic monitoring. In addition, a baseline VSP survey in at least one of the "Above Caprock Zone" conducted after construction of the monitoring well network and if the EPA pr UIC permit application. The monitoring well locations have been identified; however land owner agre finalized. We anticipate that we will have the final agreements before the enc can map the locations at that time.

Considered Monitoring Activities

DOE Active Injection ~2 yr	Commercial Injection ~15 yr	Post Injection 50 yr
As Required	As Required	NA
Quarterly	Quarterly	NA
Continuous	Continuous	NA
Annual	Annual	NA (wells plugged)
Every 5 yr	Every 5 yr	NA
Quarterly During well workovers	Quarterly During well workovers	NA NA
Semi-Annual	Annual	Every 5 yr
Annual	Annual	Every 5 yr
Annual Semi-Annual	Every 2 yr Annual	Every 5 yr Every 5 yr
Continuous	Continuous	Continuous
Once	Every 5 yr	NA
Once Semi-Annual	Every 5 yr Semi-Annual	Every 5 yr Every 5 yr

DOE Active Injection ~2 yr	Commercial Injection ~15 yr	Post Injection 50 yr
Once	Every 5 yr	Every 10 yr
Once	Every 5 yr	Every 10 yr
Continuous	Continuous	Continuous
Continuous	Continuous	Continuous
Continuous	Continuous	Continuous
Annual	Annual	NA
Annual	Annual	Every 5 yr
Annual	Annual to every 5 yr	Every 5 yr

Semi-Annual	Annual to every 5 yr	Every 5 yr
Annual	Annual to every 5 yr	Every 5 yr

f the Front End
e following:
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(ACZ) wells will be
rovides approval of the

ements still need to be
d of January, 2014 and