APS CHOLLA CO2 TEST 1 FEE

NW SE 30-18N-20E (977)

COUNTY NAVAJO AREA HOLBROOK LEASE NO. APS FEE

WELL NAME APS CHOLLA CO2 TEST #1 FEE

LOCATION NW SE SEC 30 TWP 18N RANGE 20E FOOTAGE 1,782' FSL & 2,079' FEL

ELEV 5,130' GR _____ KB SPUD DATE 7-31-09 STATUS D&A COMP. DATE 6-4-2010 TOTAL DEPTH 3853

CONTRACTOR Bearcat Drlg Reach TD 3853' 8-27-09

CASING SIZE	DEPTH	CEMENT	LINER SIZE & DEPTH

DRILLED BY ROTARY ✓

DRILLED BY CABLE TOOL

PRODUCTIVE RESERVOIR

INITIAL PRODUCTION

FORMATION TOPS	DEPTHS	SOURCE L.L.	SOURCE E.L.	REMARKS

ELECTRIC LOGS	PERFORATED INTERVALS	PROD. INTERVALS

SAMPLE LOG

SAMPLE DESCRP.

SAMPLE NO. 1924

CORE ANALYSIS

DSTs

REMARKS

APP. TO PLUG

PLUGGING REP.

COMP. REPORT

WATER WELL ACCEPTED BY

BOND CO. LIBERTY MUTUAL INSURANCE CO BOND NO. 024-016-685 DATE 9-6-2005

BOND AMT. $ 25,000 CANCELLED ORGANIZATION REPORT YES 11-3-2008

FILING RECEIPT 3160 LOC. PLAT X WELL BOOK X PLAT BOOK X

API NO. 02-017-20022 DATE ISSUED 11-5-2008 DEDICATION N/A - STRATIGRAPHIC TEST

PERMIT NUMBER 977

(over)

WELL COMPLETION OR RECOMPLETION REPORT AND WELL LOG

DESIGNATE TYPE OF COMPLETION

New Well ☑ | Temporary Abandon ☐ | Work-Over ☐ | Deepen ☐ | Plug Back ☐ | Same Reservoir ☐ | Different Reservoir ☐ | Oil ☐ | Gas ☐ | Dry ☑

DESCRIPTION OF WELL AND LEASE

Operator Arizona Public Service Company	Address & Phone No. PO Box 188/Mail Station 4451, Joseph City, AZ 86032 928-288-1541
Federal, State or Indian Lease Number or name of lessor if fee lease Fee - Arizona Public Service Company	Well Number: Cholla CO2-Test 1 Field & Reservoir: N/A
Location 2,079 ft. from east line (FEL) & 1,782 ft. from south line (FSL)	County Navajo County
Sec. Township-Range or Block & Survey Section 30, Township 18 North, Range 20 East	

Date spudded	Date total depth reached	Date completed, ready to produce	Elevation (DF, KB, RT or Gr.)	Elevation of casing head flange
07/29/09 (drill and set conductor)	08/27/09	08/31/09	5,142 KB feet	feet

Total depth	P.B.T.D.	Single, dual, or triple completion?	If this is a dual or triple completion furnish separate report for each completion
3,853 ft.	2,530 ft.	N/A	N/A

Producing interval(s) for this completion	Rotary tools used (interval)	Cable tools used (interval)
None	0 - 3,853 ft.	

Was this well directionally drilled?	Was directional survey made?	Was copy of directional survey filed?	Date filed
No	No	N/A	N/A

Type of electric or other logs run (check logs filed with the Commission)	Date filed
Platform Express, Sonic, Combinable Magnetic Resonance, Elemental Capture, Formation Micro-scanner, Rotary Cores	Included in this Report

CASING RECORD

Casing (report all strings set in well -- conductor, surface, intermediate, producing, etc.)

Purpose	Size hole drilled	Size casing set	Weight (lb./ft.)	Depth set	Sacks cement	Amount pulled
Conductor	22-inch	14-inch OD	1/4-inch wall thickness	47 ft. KB	Grout to surface	None
Surface	12-1/4-inch	9-5/8-inch OD	36 lb/ft	958 ft. KB	178 sx lead/69 sx tail	None
Protection	8-1/2-inch	5-1/2-inch OD	15.5 lb/ft	2,504 ft. KB	342 sx lead/267 sx tail	None

TUBING RECORD

Size	Depth set	Packer set at
in.	ft.	ft.

LINER RECORD

Size	Top	Bottom	Sacks cement	Screen (ft.)
in.	ft.	ft.		

PERFORATION RECORD

Number per ft.	Size & type	Depth interval
None		

ACID, SHOT, FRACTURE, CEMENT SQUEEZE RECORD

Amount & kind of material used	Depth interval
None	

INITIAL PRODUCTION

Date of first production	Producing method (indicate if flowing, gas lift or pumping -- if pumping, show size & type of pump)
None	

Date of test	Hours tested	Choke size	Oil prod. during test	Gas prod. during test	Water prod. during test	Oil gravity
			bbls.	MCF	bbls.	°API

Tubing pressure	Casing pressure	Calculated rate of production per 24 hrs.	Oil	Gas	Water	Gas - oil ratio
			bbls.	MCF	bbls.	

Disposition of gas (state whether vented, used for fuel or sold)

CERTIFICATE: I, the undersigned, under the penalty of perjury, state that I am the CONRAD M. SPENCER of the APS CHOLLA POWER PLANT (company), and that I am authorized by said company to make this report; and that this report was prepared under my supervision and direction and that the facts stated therein are true, correct and complete to the best of my knowledge.

20 MAR 2010
Date

Signature

Permit No. 977

Mail completed form to:
Oil and Gas Program Adminiastrator
Arizona Geological Survey
416 W. Congress, #100
Tucson, AZ 85701

STATE OF ARIZONA
OIL & GAS CONSERVATION COMMISSION

Well Completion or Recompletion Report and Well Log

File One Copy

Form No. 4

DETAIL OF FORMATIONS PENETRATED

PN 977

FORMATION	TOP	BOTTOM	DESCRIPTION *
Moenkopi	Surface	190 ft KB	
Coconino	190 ft KB	530 ft KB	
Schnebly Hill	530 ft KB	883 ft KB	
Supai	883 ft KB	2,638 ft KB	
Ft Apache	1,590 ft KB	1,698 ft KB	
Naco	2,638 ft KB	3,437 ft KB	
Martin	3,437 ft KB	3,651 ft KB	
Granite Wash	3,651 ft KB	3,678 ft KB	
Basement	3,678 ft KB	TD	
			Rotary Cores at 1,340', 2,140', 2,191', 2,240', 2,682', 3,069', 3,191', 3,259', 3,301', 3,322', 3,433', 3,469', 3,492', 3,521', 3,526', 3,538', 3,546', 3,585', 3,588', 3,600', 3,613', 3,633', 3,654', 3,678', 3,740'
			Drill Stem Test 1 - 3,498' to 3,633 ft - Martin Formation No Cushion, Gauge at 3,477 ft. KB Initial Hydrostatic = 1,873 psig Initial Flow = 29 - 36 psig (15 minutes) - No Blow Initial Shut-in = 1,442 psig (1 hour) Final Flow = 42 - 44 psig (15 minutes) - No Blow Final Shut-in = 635 psig (10 minutes) Final Hydrostatic = 1,871 psig Final Temperature = 97 oF Recovered 20 ft. (0.098 barrels) drilling mud, Resistivity = 0.069 ohmm @ 70 oF, Cl- = 117,000 ppm
			Drill Stem Test 2 - 2,144' to 2,298 ft - Supai Formation No Cushion, Gauge at 2,121 ft. KB Initial Hydrostatic = 1,145 psig Initial Flow = 81 - 361 psig (15 minutes) - Good Blow Throughout Initial Shut-in = 848 psig (1 hour) Final Flow = 376 - 602 psig (1 hour) - Good Blow Throughout Final Shut-in = 853 psig (3 hours) Final Hydrostatic = 1,1151 psig Final Temperature = 85 oF Recovered 372 ft. (5.28 barrels) drilling mud cut with salt water 774 ft. (5.31 barrels) salt water Resistivity = 0.059 ohmm @ 70 oF, Cl- = 142,000 ppm

* Show all important zones of porosity, detail of all cores, and all drill-stem tests, including depth interval tested, cushion used, time tool open, flowing and shut-in pressures, and recoveries.

INSTRUCTIONS:

Attach drillers log or other acceptable log of well.

This Well Completion or Recompletion report and well log shall be filed with the Oil and Gas Program Administrator, Arizona Geological Survey, 416 W. Congress #100, Tucson, AZ 85701 not later than thirty days after completion pursuant to A.A.C. R12-7-121.

Form No. 4

PLUGGING RECORD

Operator	Address & Phone number
Arizona Public Service Company	4801 Frontage Rd, Joseph City, AZ 86032 (928) 288-1541

Federal, State, or Indian Lease No. or lessor's name if fee lease	Well No.	Field & Reservoir
Arizona Public Service Fee	CO2 Test 1	None

Location of Well	Sec - Twp - Rge	County
NW quarter of the SE quarter of Section 30, Township 18 North, Range 20 East, of the Gila and Salt River Baseline and Meridian.		Navajo

Application to drill this well was filed in name of	Has this well ever produced oil or gas?	Character of well at completion (initial production) Oil (bbls/day)	Gas (MCF/day)	Dry?
Arizona Public Service Company	None			Yes

Date plugged	Total depth	Amount well producing when plugged: Oil (bbls/day)	Gas (MCF/day)	Water (bbls/day)
06/04/2010	3,853 feet RKB	None	None	None

Name of each formation containing oil or gas. Indicate which formation open to wellbore at time of plugging	Fluid content of each formation	Depth interval of each formation	Size, kind & depth of plugs used. Indicate zones squeeze cemented, giving amount of cement
None			

CASING RECORD

Size pipe	Put in well (ft.)	Pulled out (ft.)	Left in well (ft.)	Give depth and method of parting casing (shot, etc.)	Packers and shoes
14"	47'		47'		
9-5/8"	958'		958'		Float Collar/Shoe Joint/Setshoe - 917'-958'
5-1/2"	2,505	163'	2,342'	split-shot	Float Collar/2 Shoe Joints/Setshoe - 2,425'-2,505'

Was well filled with heavy drilling mud, according to regulations?	Indicate deepest formation containing fresh water
Mud filled below 5-1/2" shoe, cement filled from shoe to surface	Coconino/Schnebly Hill

NAME AND ADDRESSES OF ADJACENT LEASE OPERATORS OR OWNERS OF THE SURFACE

Name	Address	Direction from this well
Arizona Public Service Company	4801 Frontage Rd, Joseph City, AZ 86032	400 feet radius surrounding well

In addition to other information required on this form, if this well was plugged back for use as a fresh water well, give all pertinent details of plugging operations to base of fresh water sand, perforated interval to fresh water sand, name and address of surface owner, and attach letter from surface owner authorizing completion of this well as a water well and agreeing to assume full liability for any subsequent plugging which might be required.

None

Use reverse side for additional detail Additional details on next page

CERTIFICATE: I, the undersigned, under the penalty of perjury, state that I am the Principal Environmental Scientist of the Arizona Public Service Co. (company) and that I am authorized by said company to make this report; and that this report was prepared under my supervision and direction and that the facts stated therein are true, correct and complete to the best of my knowledge.

Date 8/2/2010 Signature John Z Boyer

Permit No. 977

Mail completed form to:
Oil and Gas Program Administrator
Arizona Geological Survey
416 W. Congress, #100
Tucson, AZ 85701-1315

STATE OF ARIZONA
OIL & GAS CONSERVATION COMMISSION
Plugging Record
Form No. 10 File One Copy

Permit 977

Form No. 10 Additional Detail – Cement Plugs

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Plug	Casing (in)	Volume	Top Depth (ft)	Bottom Depth (ft)
Plug 1	5-1/2	80 cu-ft	1,825	2,425
Plug 2	5-1/2	80 cu-ft	1,225	1,825
Plug 3	5-1/2	80 cu-ft	625	1,225
Plug 4	5-1/2	39 cu-ft	204	625
Plug 5	5-1/2 by 9-5/8	105 cu-ft	0	204

- Note the 5-1/2-inch casing was never perforated. Prior to abandonment, workstring tagged top of cement in casing at 2,424 feet rig Kelly bushing depth

APPLICATION TO PLUG AND ABANDON

FIELD Arizona Public Service Company, Cholla Plant

OPERATOR Arizona Public Service Company ADDRESS & PHONE 4801 Frontage Rd, Joseph City, AZ 86032 (928)288-1541

LEASE NUMBER (Lessor's name if fee) Arizona Public Service Fee WELL NO. CO2 Test 1

LOCATION NW quarter of the SE quarter of Section 30, Township 18 North, Range 20 East, of the Gila and Salt River Baseline and Meridian. Approximately 2,069 feet FEL and 1,832 feet FSL

TYPE OF WELL Stratigraphic Test (Oil, Gas, or Dry) TOTAL DEPTH 3,853 ft RKB

ALLOWABLE (If Assigned) N/A

LAST PRODUCTION TEST OIL -- (Bbls.) WATER -- (Bbls.)

GAS -- (MCF) DATE OF TEST --

PRODUCING HORIZON None PRODUCING FROM _____ TO _____

1. COMPLETE CASING RECORD:

14" Conductor, 1/4" Wall set to 47' RKB

9-5/8" Surface, 36-lb/ft, J-55 set to 958' RKB

5-1/2" Protection, 15.5 lb/ft, J-55, set to 2,505' RKB

2. FULL DETAILS OF PROPOSED PLAN OF WORK:

See Attached Scope of Work

DATE COMMENCING OPERATIONS November 2009

NAME OF PERSON DOING WORK Sandia Technologies, LLC ADDRESS 6731 Theall Rd, Houston, Tx 77381

Signature [signature]

Title PLANT MANAGER, CHOLL

Address 4801 CHOLLA LAKE ROAD JOSEPH CITY AZ 86032

Date 2 DEC 2009

Mail two copies of completed form to:
Oil and Gas Program Administrator
Arizona Geological Survey
416 W. Congress #100
Tucson, AZ 85701

Date Approved 12-8-2009

STATE OF ARIZONA
OIL & GAS CONSERVATION COMMISSION

By [signature]

STATE OF ARIZONA
OIL & GAS CONSERVATION COMMISSION
Application to Plug and Abandon
File Two copies

Form No. 9

Permit No. 00977

2/96

OMB No. 2040-0042 Approval Expires 12/31/2011

EPA

United States Environmental Protection Agency
Washington, DC 20460

PLUGGING AND ABANDONMENT PLAN

Name and Address of Facility
Arizona Public Service Company, Cholla Plant
4801 Frontage Road, Joseph City, AZ 86032

Name and Address of Owner/Operator
Arizona Public Service Company, Cholla Plant
4801 Frontage Road, Joseph City, AZ 86032

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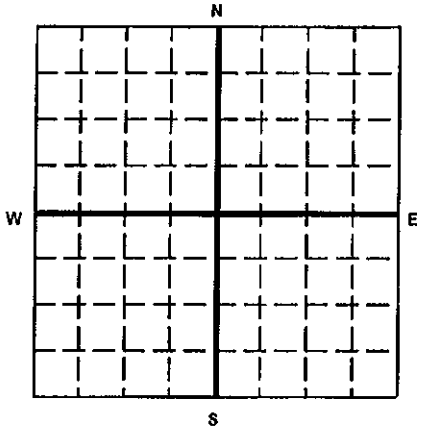
Locate Well and Outline Unit on Section Plat - 640 Acres



State	County	Permit Number
Arizona	Navajo	AZ50800004

Surface Location Description
ne 1/4 of SW 1/4 of nc 1/4 of sc 1/4 of Section 30 Township 18 Range 20

Locate well in two directions from nearest lines of quarter section and drilling unit
Surface Location 1,740 ft. frm (N/S) S Line of quarter section
and 2,000 ft. from (E/W) E Line of quarter section.

TYPE OF AUTHORIZATION
- [x] Individual Permit
- [ ] Area Permit
- [ ] Rule

Number of Wells 1

Lease Name APS Fee

WELL ACTIVITY
- [ ] CLASS I
- [ ] CLASS II
  - [ ] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Well Number 1

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
14"	1/4" wall	47	47	22"
9-5/8"	36	958	958	12-1/4"
5-1/2"	15.5	2505	2342	8-1/2"

METHOD OF EMPLACEMENT OF CEMENT PLUGS
- [x] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [ ] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche	8-1/2"	5-1/2"	5-1/2"	5-1/2"	5-1/2"		
Depth to Bottom of Tubing or Drill Pipe (ft	2683	2405	1825	1225	625	204	
Sacks of Cement To Be Used (each plug)	75						
Slurry Volume To Be Pumped (cu. ft.)		80	80	80	39	105	
Calculated Top of Plug (ft.)	2560	1825	1225	625	300	0	
Measured Top of Plug (if tagged ft.)	2560				204	0	
Slurry Wt. (Lb./Gal.)	15.5	15.8	15.8	15.8	15.8	15.8	
Type Cement or Other Material (Class III)	Class G	Class G	Class G	Class G	Class G	Class G	

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To
Open Hole -2,683'	3853		

Estimated Cost to Plug Wells

Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (Ref. 40 CFR 144.32)

Name and Official Title *(Please type or print)*	Signature	Date Signed
John L. Boyer, Principal Environmental Scientist	John L Boyer	08/02/2010

EPA Form 7520-14 (Rev. 12-08)

Project Name	Sandia Project No.	Date
APS Cholla CO2 Test Well Plug and Abandon	1271-EP-09 Cholla CO2 Test 1 Fee	June 4, 2010

OPERATIONS SUMMARY

6/4/10

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Sandia, Triple P Well Service, Weatherford, Schlumberger Cementing, and JetWest Geophysical arrived on location. A Safety Orientation was given to all personnel by APS Cholla. Sandia conducted a Safety Meeting with all personnel and discussed field operations for the day.

The 2-3/8" work string was lowered in the well and tagged cement at 204'. The work string was removed from the well.

JetWest Geophysical was rigged up. A 4.65" OD gauge ring and junk basket was connected to the wireline and lowered into the well. The gauge ring would not pass below 167' and was removed from the well. A 2" OD Owen split-shot was connected to the wireline and lowered into the well. The split-shot was activated at 163' below ground level and removed from the well.

The "B" section of the wellhead was removed exposing the 5-1/2" casing stun and slips. A 5-1/2" casing spear was picked up and engaged in the 5-1/2" casing. Four joints of 5-1/2" casing were laid down. JetWest Geophysical was rigged down and released from location.

The 2-3/8" work string was lowered in the well to 204 feet. Cement was circulated down the work string until cement returns reached surface. Total cement volume pumped was 18.7 barrels or 105 cu.ft. The 2-3/8" work string was removed from the well. The 9-5/8" wellhead was cut off and an additional barrel of cement was placed in the 9-5/8" casing.

Schlumberger Cementing washed up cement pumping equipment, rigged down, and was released from location. The Triple P well service rig was rigged down and moved to the edge of location. The fluids circulated from the well were pumped from the rig fluid tank into a Red J Environmental fluid tank. The rig fluid pump, fluid tank, and BOP skid were loaded onto trucks and released from location. The 2-3/8" work string, 5-1/2" casing tools, and wellhead equipment were loaded onto trucks and released from location. The Triple P rig crew was released from location.

Weatherford welded flat plate across the 9-5/8" casing. A marker pole was welded onto the flat plate extending 5 feet above ground level. Cinch Construction backfilled the well cellar with soil and placed 8 yards of soil in 25 cu. yard roll-off box. A sign was secured to the marker pole to identify the abandoned well. Diamond S Trucking picked up 25 cu. yard roll-off box.

Field Operations complete!

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NO ACCIDENTS

NO SPILLS

FIELD COST ESTIMATE

Daily Field Cost Estimate: $51,232	Cumulative Field Cost Estimate: $172,673

Activity Forecast

6/5/2010	Sandia personnel returns to Houston
6/7/2010	Triple P moved rig off location and travels to yard in Farmington, NM. RSC Rental picks up forklift. Red J Environmental removes fluid tank from location.

Project Name	Sandia Project No.	Date
APS Cholla CO2 Test Well Plug and Abandon	1271-EP-09 Cholla CO2 Test 1 Fee	June 3, 2010

OPERATIONS SUMMARY

6/3/10

977

Sandia, Triple P Well Service, Weatherford, Schlumberger Cementing, and Schlumberger Wireline arrived on location. A Safety Orientation was given to all personnel by APS Cholla. Sandia conducted a Safety Meeting with all personnel and discussed field operations for the day.

Schlumberger Wireline was rigged up. 1-11/16" OD Temperature and Cement Bond Log tools were connected to the wireline. The tools were tested on surface and lowered into the 5-1/2" casing. The casing was pressured to 1,000 psi and the Cement Bond Log was repeated fron 1,250 feet to 100 feet. The cement evaluation was reviewed with EPA Region 9 and deemed acceptable. The 5-1/2" casing was successfully pressure tested for 30 minutes. The starting pressure was 2,524 psi with a final pressure 2,503 psi for a 0.8% pressure loss over 30 minutes.

The 2-3/8" work string was lowered into the 5-1/2" casing and tagged total depth at 2,424 feet KB referenced tubing measured depth. The 5-1/2" casing was filled with cement from 2,424 feet to 300 feet with a series of four cement plugs placed with the balanced plug method. Each of the first three plugs were comprised of 14.3 barrels or 80.2 cu.ft of 15.8 pound per gallon Class G cement. The fourth cement plug was comprised of 6.8 barrels or 39 cu.ft of 15.8 pound per gallon Class G cement. After balancing the fourth cement plug the end of the 2-3/8" work string was raised to 311 feet, with the intention of reverse circulating the well clean from 311 feet to surface with fresh water. Attempts to do so were compromised with a mechanical problem on the pump. The decision was made to remove the 2-3/8" work string from the well and repair the mechanical on the pump. A faulty valve actuator was repaired and the cement pumping equipment was cleaned with fresh water.

The well was secured and field operations were suspended for the day.

FIELD COST ESTIMATE	
Daily Field Cost Estimate: $47,058	Cumulative Field Cost Estimate: $121,441

Activity Forecast

6/4/2010	Cut 5-1/2" casing at 230 feet and remove from well. Balance cement plug in 9-5/8" casing from 300 feet to surface. Rig down well service rig. Cut off 9-5/8" casing below ground level and weld plate across the casing strings.
6/5/2010	Release well service rig. Return all rental equipment to vendors. Grade location. Operations complete.

Project Name	Sandia Project No.	Date
APS Cholla CO2 Test Well Plug and Abandon	1271-EP-09 Cholla CO2 Test 1 Fee	May 29-June 2, 2010

OPERATIONS SUMMARY

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5/29/10

Triple P Well Service mobilized well service rig from Farmington, NM to location. The rig was spotted on location, and the rig crew returned to Farmington for Memorial weekend.

6/1/10

Triple P Well Service mobilized the rig crew and ancillary equipment (fluid pump, fluid tank, and pressure control equipment) from Farmington, NM to location. The ancillary equipment was unloaded and delivery trucks returned to Farmington. Schlumberger Wireline logging services mobilized from Farmington to Holbrook. Sandia Technologies mobilized Senior Site Supervisor from Houston, TX to Holbrook, AZ.

6/2/10

Sandia, Triple P Well Service, Weatherford, and Schlumberger Wireline arrived on location. A Safety Orientation was given to all personnel by APS Cholla. Sandia conducted a Safety Meeting with all personnel and discussed field operations for the day. The well service rig was spotted on the well and rigged up. The "B" section of the wellhead was removed, inspected, and reinstalled. The wellhead was successfully pressure tested to 1,500 psi for 10 minutes.

Weatherford delivered the 2-3/8" rental work string and 5-1/2" casing tools. Cinch Construction mobilized a backhoe to location and dressed the location around the wellhead. Diamond S Trucking delivered a 25 cu. yard roll-off box, a 6,000 gallon water storage tank, and filled the water storage tank with water. RSC Rentals delivered a forklift to location.

Schlumberger Wireline was rigged up. 1-11/16" OD Temperature and Cement bond Log tools were connected to the wireline. The tools were tested on surface and lowered into the 5-1/2" casing. Prior to reaching total depth, communication was lost with the tool string. Several attempts were made to log the well and the tools were removed from the well. Subsequent diagnostics revealed a faulty ground connection in the wireline rope socket. Repairs were made and the 1-11/16" tool string was lowered into the well. The correlated total depth (TD) of the well was located at 2,407 feet. The well was successfully logged from TD to 100 feet from surface. The 1-11/16" tool string was laid down. A 3-3/8" OD Ultra Sonic Imaging Tool (USIT) was connected to the wireline and lowered into the 5-1/2" casing. The well was logged from 2,385 feet to surface. The 3-3/8" tool string was removed from the well and laid down.

The well was secured and field operations suspended for the day.

NO ACCIDENTS NO SPILLS 977

FIELD COST ESTIMATE

Daily Field Cost Estimate: $30,777 Cumulative Field Cost Estimate: $74,383

Activity Forecast

6/3/2010	Review cement logs with EPA Region 9. Pressure test 5-1/2" casing to 2,425 psi. Balance four cement plugs in 5-1/2" casing from TD to +/-300 feet.
6/4/2010	Cut 5-1/2" casing at 230 feet and remove from well. Balance cement plug in 9-5/8" casing from 300 feet to surface. Rig down well service rig. Cut off 9-5/8" casing below ground level and weld plate across the casing strings.
6/5/2010	Release well service rig. Return all rental equipment to vendors. Grade location. Operations complete.

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Plugging and Abandonment of Arizona Public Service Company, Cholla CO_2 Test Fee 1

Note: Prior to cementing operations, Sandia will run a cement bond log in the 5-1/2-inch casing to determine the depth of the top of cement in the 5-1/2-inch x 9-5/8-inch annulus. If the depth of the top of cement is acceptable the following procedure (Procedure A) will be used. If the depth is unacceptable Procedure B will be used.

PROCEDURE A

1. Move in and rig up well servicing rig.
2. Rig up Schlumber Wireline Services. Run temperature survey from surface to total depth. Run Ultra Sonic Inspection tool in combination with Cement Bond Log tool. Review log for cement quality and cement top outside of the 5-1/2" casing.
3. Remove wellhead and perform top-out cement job in the 5-1/2-inch by 9-5/8-inch casing annulus using tremie pipe in the annular space to deepest attainable depth.
4. Nipple up blowout preventers.
5. Pick up workstring and lower to bottom of 5-1/2-inch casing.
6. Pressure test 5-1/2" casing to 2,425 psi for 30 minutes using a digital transducer. A pressure loss less than 5% in 30 minutes is an acceptable test (pressure loss between 5-10% will be reviewed with US EPA Region 9).
7. Place a balanced cement plug from deepest attainable depth (float collar @ 2,425 ft) to 1,825 ft using 70 sacks (80 cubic ft) Class G cement mixed at 15.8 pounds per gallon (lb/gal).
8. Retrieve the workstring to +/-1,825 ft and reverse circulate to remove any cement from workstring.

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9. Place a balanced cement plug from 1,825 ft to 1,225 ft using 70 sacks (80 cubic ft) Class G cement mixed at 15.8 pounds per gallon (lb/gal).
10. Retrieve the workstring to +/-1,225 ft and reverse circulate to remove any cement from workstring.
11. Place a balanced cement plug from 1,225 ft to 625 ft using 70 sacks (80 cubic ft) Class G cement mixed at 15.8 pounds per gallon (lb/gal).
12. Retrieve the work string to +/-625 feet and reverse circulate to remove any cement from workstring.
13. Place a balanced cement plug from 625 ft to surface using 73 sacks (84 cubic ft) Class G cement mixed at 15.8 pounds per gallon (lb/gal).
14. Cut off casing flush or below the ground surface and fill any remaining open annular spaces with cement.
15. Rig down well servicing rig and release all equipment.
16. Weld plate across cut-off casing.

PROCEDURE B

977

1. Move in and rig up well servicing rig.
2. Rig up Schlumber Wireline Services. Run temperature survey from surface to total depth. Run Ultra Sonic Inspection tool in combination with Cement Bond Log tool. Review log for cement quality and cement top outside of the 5-1/2" casing.
3. Nipple up blowout preventers.
4. Pick up workstring and lower to bottom of 5-1/2-inch casing.
5. Pressure test 5-1/2" casing to 2,425 psi for 30 minutes using a digital transducer. A pressure loss less than 5% in 30 minutes is an acceptable test (pressure loss between 5-10% will be reviewed with US EPA Region 9).
6. Place a balanced cement plug from deepest attainable depth (float collar @ 2,425 ft) to 1,825 ft using 70 sacks (80 cubic ft) Class G cement mixed at 15.8 pounds per gallon (lb/gal).
7. Retrieve the workstring to +/-1,825 ft and reverse circulate to remove any cement from workstring.
8. Place a balanced cement plug from 1,825 ft to 1,225 ft using 70 sacks (80 cubic ft) Class G cement mixed at 15.8 pounds per gallon (lb/gal).
9. Retrieve the workstring to +/-1,225 ft and reverse circulate to remove any cement from workstring.
10. Place a balanced cement plug from 1,225 ft to 625 ft using 70 sacks (80 cubic ft) Class G cement mixed at 15.8 pounds per gallon (lb/gal).
11. Retrieve the work string to +/-625 feet and reverse circulate to remove any cement from workstring. Remove workstring from the well. Wait on cement to harden a minimum of 4 hours.
12. Lower workstring and tag top of cement in 5-1/2" casing.
13. Retrieve workstring to surface.

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14. Cut 5-1/2-inch casing above cement top (+/-500 ft) as indicated by cement bond log. Pull and lay down casing. (Note: casing is range 3, with longest joint length of 40.8 ft).
15. Lower workstring to top of cement in 5-1/2-inch casing. Place a balanced cement plug from 625 ft to surface using 203 sacks (234 cubic ft) Class G cement mixed at 15.8 pounds per gallon (lb/gal).
16. Cut off casing flush or below the ground surface and fill any remaining open annular spaces with cement.
17. Rig down well servicing rig and release all equipment.
18. Weld plate across cut-off casing.

OMB No. 2040-0042 Approval Expires 12/31/2011

EPA

United States Environmental Protection Agency
Washington, DC 20460

PLUGGING AND ABANDONMENT PLAN

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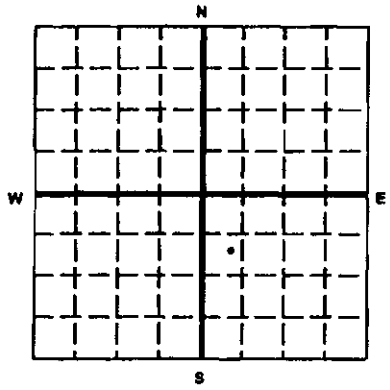
Name and Address of Facility
Arizona Public Service Company, Cholla Plant
4801 Frontage Road, Joseph City, AZ 86032

Name and Address of Owner/Operator
Arizona Public Service Company, Cholla Plant
4801 Frontage Road, Joseph City, AZ 86032

Locate Well and Outline Unit on Section Plat - 640 Acres



State	County	Permit Number
Arizona	Navajo	AZ50800004

Surface Location Description
ne 1/4 of sw 1/4 of ne 1/4 of se 1/4 of Section 30 Township 18 Range 20

Locate well in two directions from nearest lines of quarter section and drilling unit

Surface Location 782 ft. frm (N/S) S Line of quarter section
and 2,079 ft. from (E/W) E Line of quarter section.

TYPE OF AUTHORIZATION
- [x] Individual Permit
- [ ] Area Permit
- [ ] Rule

Number of Wells 1

Lease Name APS Fee

WELL ACTIVITY
- [ ] CLASS I
- [ ] CLASS II
  - [ ] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Well Number 1

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
14"	1/4" wall	47	43	22"
9-5/8"	36	958	954	12-1/4"
5-1/2"	15.5	2505	2501	8-1/2"

METHOD OF EMPLACEMENT OF CEMENT PLUGS
- [x] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [ ] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche	8-1/2"	5-1/2"	5-1/2"	5-1/2"			
Depth to Bottom of Tubing or Drill Pipe (ft	2683	2505	1050	100			
Sacks of Cement To Be Used (each plug)	75	25	25	12			
Slurry Volume To Be Pumped (cu. ft.)							
Calculated Top of Plug (ft.)	2560	2300	834	0			
Measured Top of Plug (if tagged ft.)	2560						
Slurry Wt. (Lb./Gal.)	15.5	15.8	15.8	15.8			
Type Cement or Other Material (Class III)	Class G	Class G	Class G	Class G			

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To
Open Hole -2,683'	3853		

Estimated Cost to Plug Wells

Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (Ref. 40 CFR 144.32)

Name and Official Title *(Please type or print)*	Signature	Date Signed
CONRAD M. SPENCER Plant Manager		9 FEB 2010

EPA Form 7520-14 (Rev. 12-08)

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Paperwork Reduction Act Notice

The public reporting and record keeping burden for this collection of information is estimated to average 4.5 hours for operators of Class I hazardous wells, 1.5 hours for operators of Class I non-hazardous wells, 3 hours for operators of Class II wells, and 1.5 hours for operators of Class III wells.
Burden means the total time, effort, or financial resources expended by persons to generate, maintain, retain, or disclose or provide information to or for a Federal agency. This includes the time needed to review instructions; adjust the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able to respond to the collection of information; search data sources; complete and review the collection of information; and, transmit or otherwise disclose the information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for EPA's regulations are listed in 40 CFR Part 9 and 48 CFR Chapter 15.
Please send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including the use of automated collection techniques to Director, Office of Environmental Information, Collection Strategies Division, U.S. Environmental Protection Agency (2822), Ariel Rios Building, 1200 Pennsylvania Ave., NW., Washington, DC 20460; and to the Office of Information and Regulatory Affairs, Office of Management and Budget, 725 17th Street, NW., Washington, DC 20503, Attention: Desk Officer for EPA. Please include the EPA ICR number and OMB control number in any correspondence.

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PLUGGING AND ABANDONMENT PLAN – ARIZONA PUBLIC SERVICE COMPANY CHOLLA CO_2 TEST FEE 1

The proposed well plugging procedures for the Arizona Public Service Inc., Cholla CO_2 Test Fee 1 well follow Arizona Oil and Gas Conservation Commission requirements for proper well abandonment (R12-7-127) and guidance from United States Environmental Protection Agency Region 9 staff. This proposed plugging and abandonment plan is based on final as-built well construction shown in **Figure 1**. The well-specific plan includes: 1) information on type, number and placement of the proposed plugs; 2) type, grade, and quality of the cement(s) to be used; and, the method that will be used to place the plugs. This plan is shown schematically in **Figures 2a and 2b** and is being submitted in advance of well plugging for review and approval.

Note, notify regulatory agencies a minimum of 48 hours prior to beginning abandonment operations.

Plugging operations for the Cholla CO_2 Test Fee 1 well will be conducted as follows:

1. Survey final "as built" well location.
2. Spot a crane/mast unit over the wellhead and rig up a wireline truck on location. Rig up and run a cement bond log from total depth (record tag depth in 5-1/2-inch casing). Note top of cement and make decision to either top off the 5-1/2-inch by 9-5/8-inch casing annulus or cut and pull the free 5-1/2-inch protection casing during abandonment operations.
3. Rig up surface transducer gauge and low-volume/high pressure pump to the wellhead. Pressure test the casing to 1,000 psi (or 70% of the casing yield pressure, whichever is lower). Use a digital recording device to document the test. Hold the pressure for a minimum of 30 minutes. A successful test is demonstrated by a pressure loss of less than 5 percent over the 30-minute test period (if loss is between 5% and 10% - review with EPA). Bleed off pressure from the casing.
4. Move and rig up workover rig onto location.
5. Record any shut-in tubing and/or casing pressures. Bleed off pressure in well, if necessary.

6. Remove wellhead and nipple up blow out preventers. (Note, if 5-1/2 casing is not to be pulled, perform top-out cement job in the 5-1/2-inch by 9-5/8-inch casing annulus and allow to harden. Then nipple up the bow out preventers)
7. If the tagged total depth inside the 5-1/2-inch casing is deeper than 2,300 feet, place a balanced 25 sack (29 cubic foot or 5.2 barrels) cement plug on bottom using Class G cement mixed at 15.8 pounds per gallon. Plug should extend approximately 200 feet off bottom. Displace excess cement out of the work string and pull up the work string to +/-1,000 feet. Reverse circulate the hole clean. Allow cement to set a minimum of 4 to 6 hours and tag top of plug to verify depth to top of plug.
8. Run in the well open-ended to the base of the cased hole in the 5-1/2-inch protection casing string. Mix up mud at location and displace fluid from the well from total depth with the prepared plugging mud. Plugging mud, at a minimum, will be made with 15 pounds per barrel of sodium bentonite and a nonfermenting polymer. The mud will be mixed at a minimum consistency of 9 pounds per gallon (or greater), a minimum viscosity of 50 seconds per quart (or higher), and be mixed with fresh water.
9. Pull up to 1,050 feet and place a balanced 25 sack (29 cubic foot or 5.2 barrels) cement plug using Class G cement mixed at 15.8 pounds per gallon opposite the base of the surface casing, located at +/-958 feet. Plug should extend from 1,050 feet to +/-834 feet, which exceeds the minimum of 50 feet above and below the surface casing shoe depth. Displace excess cement out of the work string and pull up the work string to +/-500 feet. Reverse circulate the hole clean. Allow cement to set a minimum of 4 to 6 hours and tag top of plug to verify top of plug depth.
10. If decision is made to pull and retrieve the free 5-1/2-inch protection casing, rig up wireline unit and run in with cutter to just above the cement top as indicated on the cement bond log. Cut and pull the 5-1/2-inch casing. Place a balanced 55 sack (64 cubic foot or 11.4 barrels) cement plug using Class G cement mixed at 15.8 pounds per gallon 100 feet below the cut-off point. Plug should extend from 100 feet below the cut-off to 100 feet above the cut-off. Displace excess

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cement out of the work string and pull up the work string to +/-200 feet. Reverse circulate the hole clean. Allow cement to set a minimum of 4 to 6 hours and tag top of plug to verify top of plug depth (**Figure 2b**).

11. Pull up to 100 feet and set a 12 sack (13.4 cubic foot or 2.4 barrels) surface cement plug using Class G cement mixed at 15.8 pounds per gallon. Mix and pump cement until returns to surface are observed. Note, if the 5-1/2-inch casing has been pulled, this will be a 38 sack plug in the 9-5/8-inch surface casing.
12. All open annular spaces in the surface casing by protection casing annulus will also be cemented ("topped off") at the top of all casings.
13. Cut off casing flush or below the ground surface and fill any remaining open annular spaces with cement. Weld on a plate to the top of the casing. The well will be marked by a piece of metal pipe, welded onto the cap plate and set in cement, not less than 4-inches in diameter, extending a minimum four feet above ground level. The marker pole will be inscribed with the operator's name, lease and well number, and legal description of the well location
14. Rig down workover rig and release all equipment.
15. Backfill well cellar and grade location to level.
16. Remove and dispose of any remaining site debris.
17. Operations Complete.

A plugging report will be prepared and filed with the Arizona Oil and Gas Conservation Commission within 15 days after completion of closure operations and Form 7520-13 will be filed with US EPA Region 9 within 60 days after completion of closure operations. These reports will include: 1) the method used in plugging the well; 2) casing record details; 3) the size, kind, and depth of plugs used; and 4) the name and depth interval of each formation containing fresh water, oil or gas, or geothermal resources. The plugging information will be incorporated into the project Well Installation Report which will be filed with the Arizona Department of Environmental Quality and the Environmental Protection Agency.

POST CLOSURE PLAN

Post-closure monitoring is not proposed for the Cholla CO_2 Test Fee 1 well since no injection activities were conducted.

Arizona Public Service – Cholla CO_2 Test 1 Fee

Permit No. AOGCC Permit #00977, ADEQ P-106019, EPA AZ50800004

Proposed Plugging Schematic

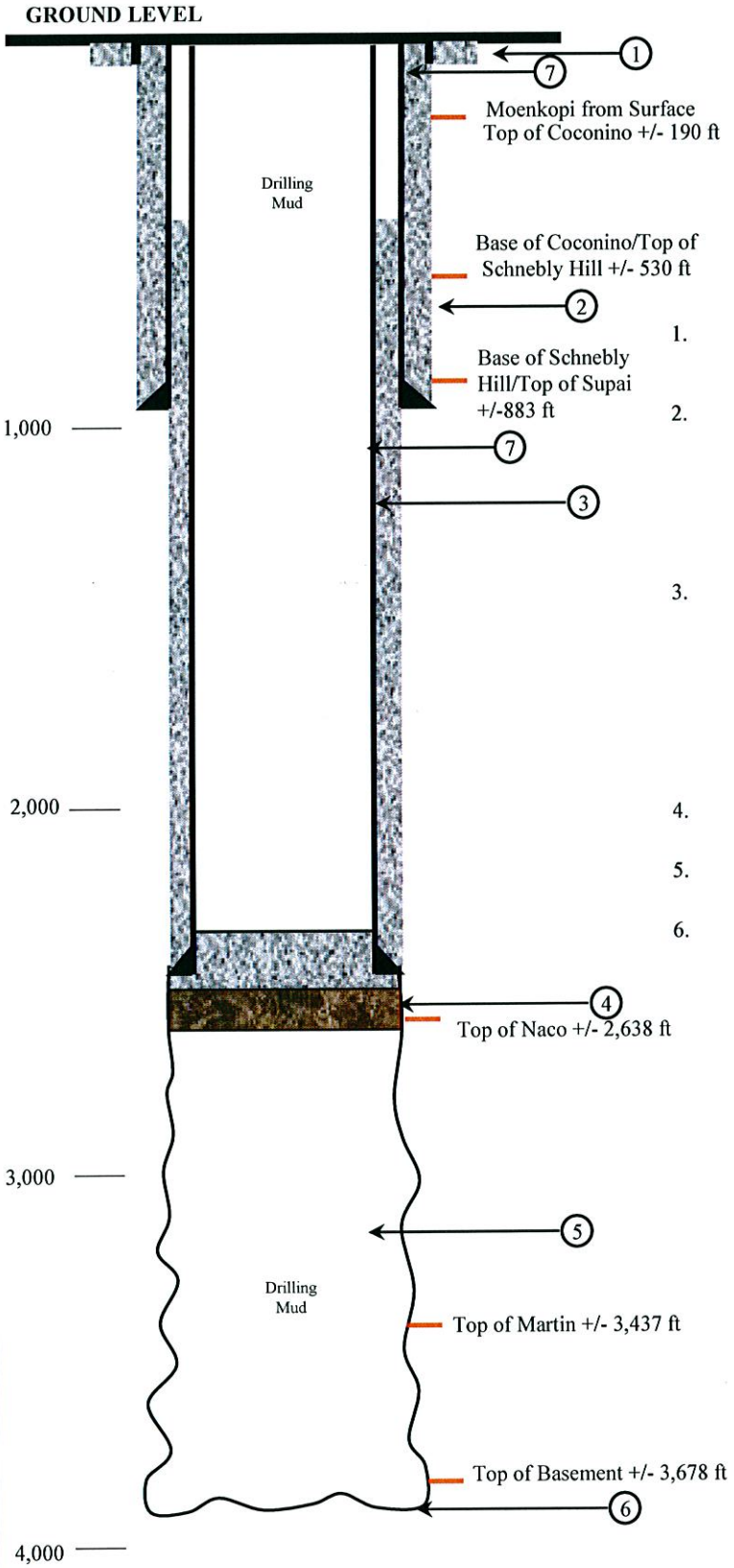

Figure 1 Current Well Schematic

All depths reference Bearcat Rig 2 Kelly Bushing

Rig Kelly Bushing = 12' above Ground Level

Ground Level ~ 5,130'

COMPLETION DETAILS

1. Conductor Casing: Augered 22-inch hole to 47 feet (35 feet below ground) and set 14-inch by ¼-inch wall thickness casing to 47 feet. Grouted to surface.
2. Surface Casing: 9-5/8-inch, 36-pounds per foot. J-55, ST&C, Set from surface to 958 feet in a 12-1/4-inch hole. Cemented with Lead Slurry of 178 sacks of Class G cement mixed at ~12.5 pounds per gallon (w/2% D079 extender + 0.2% D046 anitfoamer + 0.25 lb/sx D029 LCM additive (cellophane flakes)) and Tail Slurry of 69 sacks Class G cement mixed at ~15.5 pounds per gallon (w/0.25 lb/sx D029 LCM additive (cellophane flakes)). Total of 30 barrels of cement returned to surface.
3. Protection Casing: 5-1/2-inch, 15.5-pounds per foot. J-55, LT&C, Set from surface to 2,505 feet in a 8-1/2-inch hole. Pumped a 20 barrel chemical wash and 20 barrel spacer and cemented with Lead Slurry of 342 sacks of Txi/G cement mixed at ~11.7 pounds per gallon (w/56 lb/sx D049, 24 lb/sx D907, 0.25 lb/sx DO29 LCM additive, 2% D079 extender, and 0.2% D046 anitfoamer and Tail Slurry of 267 sacks Lite-crete cement mixed at ~12.5 pounds per gallon (w/12.5 lb/sx D127, 7 lb/sx D154, 76 lb/sx D907, 0.6% D065, and 0.25% D167). Chemical wash and spacer water returned to surface, top of cement estimated at ~400 feet.
4. Cement Plug: Set from 2,560 to 2,683 feet w/ 75 sacks Class G neat.
5. Drilling mud plug CleanFaze Water Base Mud mixed at 10.1 lb/gal.
6. Total Depth: 3,853 feet.

Sandia Technologies, LLC

6731Theall Road, Houston, TX 77066

Tel: (832) 286-0471 Fax: (832) 286-0477

Drawn by: djc	Date: Jan. 2010	*Drawing not to scale*

Arizona Public Service – Cholla CO_2 Test 1 Fee

Permit No. AOGCC Permit #00977, ADEQ P-106019, EPA AZ50800004

Proposed Plugging Schematic

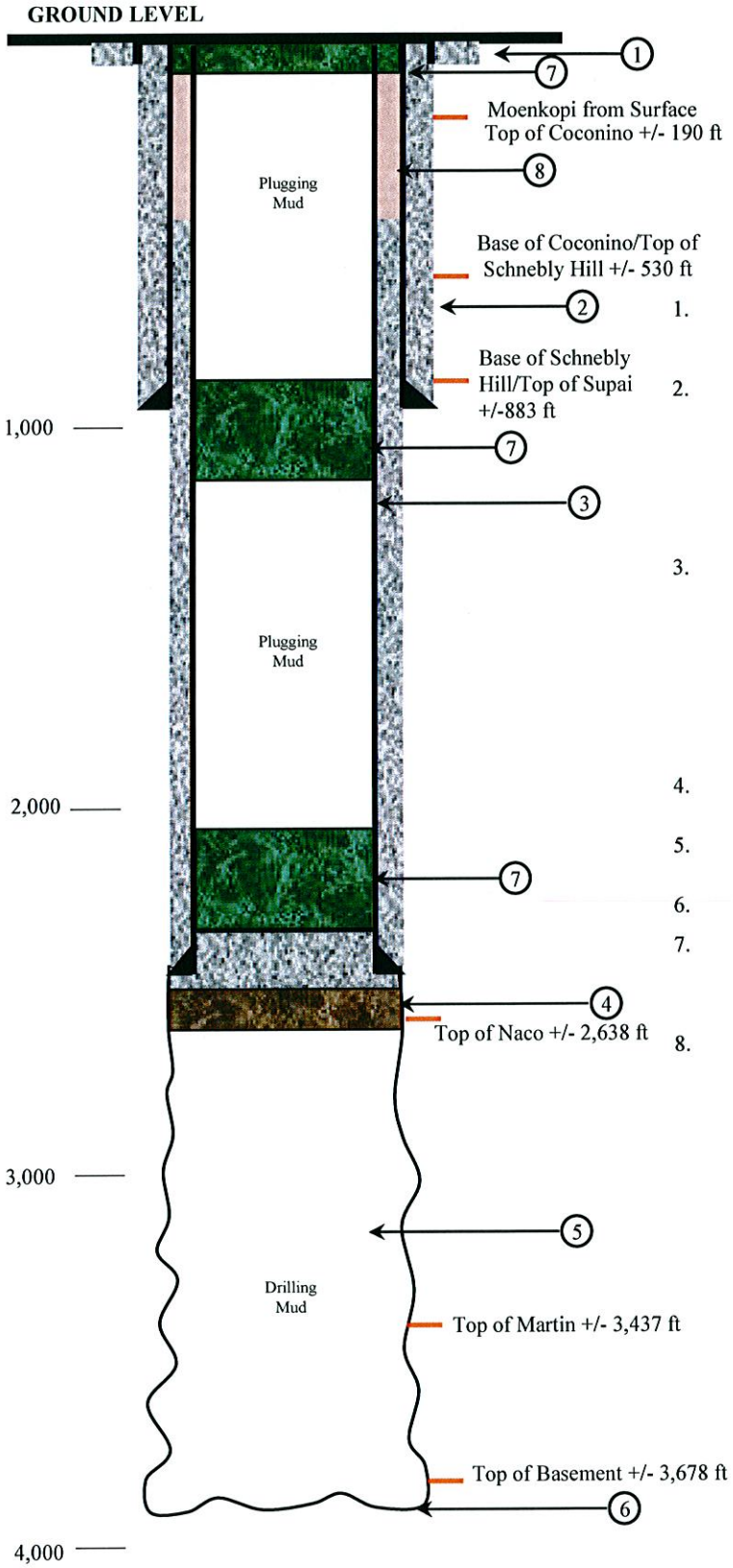

Figure 2a Proposed Plugging Well Schematic
(Casing left in Place)

All depths reference Bearcat Rig 2 Kelly Bushing

Rig Kelly Bushing = 12' above Ground Level

Ground Level ~ 5,130'

COMPLETION DETAILS

1. Conductor Casing: Augered 22-inch hole to 47 feet (35 feet below ground) and set 14-inch by ¼-inch wall thickness casing to 47 feet. Grouted to surface.
2. Surface Casing: 9-5/8-inch, 36-pounds per foot. J-55, ST&C, Set from surface to 958 feet in a 12-1/4-inch hole. Cemented with Lead Slurry of 178 sacks of Class G cement mixed at ~12.5 pounds per gallon (w/2% D079 extender + 0.2% D046 anitfoamer + 0.25 lb/sx D029 LCM additive (cellophane flakes)) and Tail Slurry of 69 sacks Class G cement mixed at ~15.5 pounds per gallon (w/0.25 lb/sx D029 LCM additive (cellophane flakes)). Total of 30 barrels of cement returned to surface.
3. Protection Casing: 5-1/2-inch, 15.5-pounds per foot. J-55, LT&C, Set from surface to 2,505 feet in a 8-1/2-inch hole. Pumped a 20 barrel chemical wash and 20 barrel spacer and cemented with Lead Slurry of 342 sacks of Txi/G cement mixed at ~11.7 pounds per gallon (w/56 lb/sx D049, 24 lb/sx D907, 0.25 lb/sx DO29 LCM additive, 2% D079 extender, and 0.2% D046 anitfoamer and Tail Slurry of 267 sacks Lite-crete cement mixed at ~12.5 pounds per gallon (w/12.5 lb/sx D127, 7 lb/sx D154, 76 lb/sx D907, 0.6% D065, and 0.25% D167). Chemical wash and spacer water returned to surface, top of cement estimated at ~400 feet.
4. Cement Plug: Set from 2,560 to 2,683 feet w/ 75 sacks Class G neat.
5. Drilling mud plug CleanFaze Water Base Mud mixed at 10.1 lb/gal.
6. Total Depth: 3,853 feet.
7. Cement Plugs : Proposed contingency plug at total depth, Plug 1 – 25 sacks Class G cement mixed at 15.8 lb/gal set from ~834' to 1,050'. Proposed Plug 2 – 12 sacks Class G set from 100' to surface.
8. Top out cement in 5-1/2-inch by 9-5/8-inch casing annulus.

NOTES:

Casings cut off at 4 feet below grade and all annular spaces filled with cement. Steel plate to be welded on top with well identification. Cellar to be filled in and graded level to surface. Set a 4-inch diameter or larger metal pipe securely in cement that extends at least 4 feet above ground level to mark the well location. Weld on a plate to the top of the metal pipe with the operator's name, lease name or number, well identifier number and legal description of the well location permanently inscribed on the marker plate.

Sandia Technologies, LLC

6731Theall Road, Houston, TX 77066
Tel: (832) 286-0471 Fax: (832) 286-0477

Drawn by: djc	Date: Rev. Jan. 2010	*Drawing not to scale*

Arizona Public Service – Cholla CO_2 Test 1 Fee

Permit No. AOGCC Permit #00977, ADEQ P-106019, EPA AZ50800004

Proposed Plugging Schematic

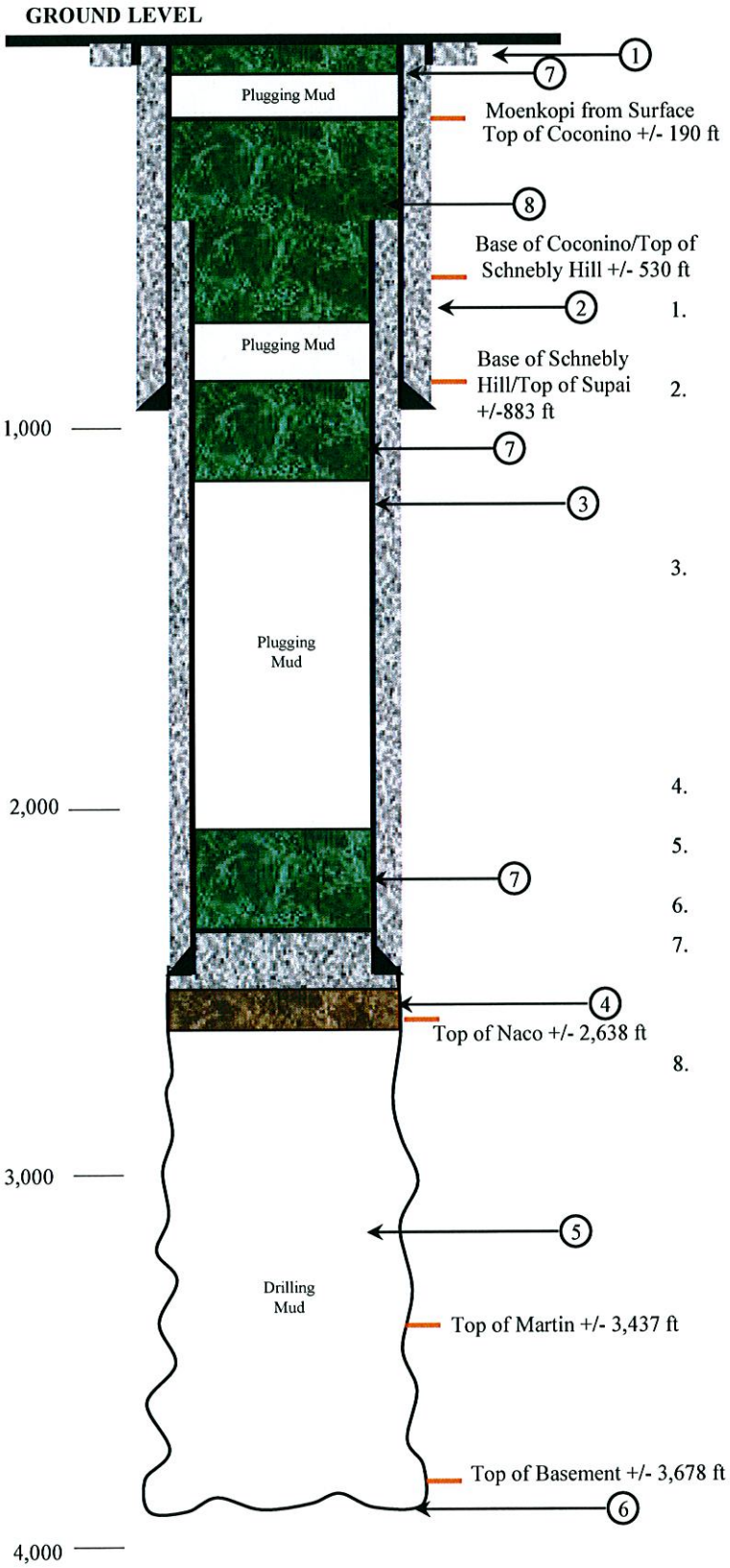

Figure 2b Proposed Plugging Well Schematic
(5-1/2-inch Casing Cut & Pulled)

All depths reference Bearcat Rig 2 Kelly Bushing
Rig Kelly Bushing = 12' above Ground Level
Ground Level ~ 5,130'

COMPLETION DETAILS

1. Conductor Casing: Augered 22-inch hole to 47 feet (35 feet below ground) and set 14-inch by ¼-inch wall thickness casing to 47 feet. Grouted to surface.
2. Surface Casing: 9-5/8-inch, 36-pounds per foot. J-55, ST&C, Set from surface to 958 feet in a 12-1/4-inch hole. Cemented with Lead Slurry of 178 sacks of Class G cement mixed at ~12.5 pounds per gallon (w/2% D079 extender + 0.2% D046 anitfoamer + 0.25 lb/sx D029 LCM additive (cellophane flakes)) and Tail Slurry of 69 sacks Class G cement mixed at ~15.5 pounds per gallon (w/0.25 lb/sx D029 LCM additive (cellophane flakes)). Total of 30 barrels of cement returned to surface.
3. Protection Casing: 5-1/2-inch, 15.5-pounds per foot. J-55, LT&C, Set from surface to 2,505 feet in a 8-1/2-inch hole. Pumped a 20 barrel chemical wash and 20 barrel spacer and cemented with Lead Slurry of 342 sacks of Txi/G cement mixed at ~11.7 pounds per gallon (w/56 lb/sx D049, 24 lb/sx D907, 0.25 lb/sx DO29 LCM additive, 2% D079 extender, and 0.2% D046 anitfoamer and Tail Slurry of 267 sacks Lite-crete cement mixed at ~12.5 pounds per gallon (w/12.5 lb/sx D127, 7 lb/sx D154, 76 lb/sx D907, 0.6% D065, and 0.25% D167). Chemical wash and spacer water returned to surface, top of cement estimated at ~400 feet.
4. Cement Plug: Set from 2,560 to 2,683 feet w/ 75 sacks Class G neat.
5. Drilling mud plug CleanFaze Water Base Mud mixed at 10.1 lb/gal.
6. Total Depth: 3,853 feet.
7. Cement Plugs : Proposed contingency plug at total depth 25 sacks Class G cement mixed at 15.8 lb/gal set from total depth to ~2,300', Plug 1 – 25 sacks Class G cement mixed at 15.8 lb/gal set from ~834' to 1,050'. Proposed Plug 3 – 38 sacks Class G set from 100' to surface.
8. Proposed Plug 2 – 55 sacks Class G cement mixed at 15.8 lb/gal set from ~100' below to 100' above casing cut-off point.

NOTES:

Casings cut off at 4 feet below grade and all annular spaces filled with cement. Steel plate to be welded on top with well identification. Cellar to be filled in and graded level to surface. Set a 4-inch diameter or larger metal pipe securely in cement that extends at least 4 feet above ground level to mark the well location. Weld on a plate to the top of the metal pipe with the operator's name, lease name or number, well identifier number and legal description of the well location permanently inscribed on the marker plate.

Sandia Technologies, LLC
6731Theall Road, Houston, TX 77066
Tel: (832) 286-0471 Fax: (832) 286-0477

Drawn by: djc	Date: Rev. Jan. 2010	*Drawing not to scale*

October 27, 2009

PLUGGING AND ABANDONMENT PLAN – ARIZONA PUBLIC SERVICE COMPANY CHOLLA CO_2 TEST FEE 1

The proposed well plugging procedures for the Arizona Public Service Inc., Cholla CO_2 Test Fee 1 well follow Arizona Oil and Gas Conservation Commission requirements for proper well abandonment (R12-7-127). This proposed plugging and abandonment plan is based on final as-built well construction shown in **Figure 1** The well-specific plan includes: 1) information on type, number and placement of the proposed plugs; 2) type, grade, and quality of the cement(s) to be used; and, 3) the method that will be used to place the plugs. This plan is shown schematically in **Figure 2** and is being submitted in advance of well plugging for review and approval.

Plugging operations for the Cholla CO_2 Test Fee 1 well will be conducted as follows:

1. Survey "as built" well location.
2. Move workover rig onto location.
3. Remove wellhead and nipple up blow out preventers.
4. Run in the well open-ended to the base of the cased hole in the 5-1/2-inch protection casing string. Mix up mud at location and displace fluid from the well from total depth with the prepared plugging mud. Plugging mud, at a minimum, will be made with 15 pounds per barrel of sodium bentonite and a nonfermenting polymer. The mud will be mixed at a minimum consistency of 9 pounds per gallon (or greater), a minimum viscosity of 50 seconds per quart (or higher), and be mixed with fresh water.
5. Pull up to 1,050 feet and place a balanced 25 sack (29 cubic foot or 5.2 barrels) cement plug using Class G cement mixed at 15.8 pounds per gallon opposite the base of the surface casing, located at +/-958 feet. Plug should extend from 1,050 feet to +/-834 feet, which exceeds the minimum of 50 feet above and below the surface casing shoe depth. Displace excess cement out of the work string and pull up the work string to +/-500 feet. Reverse circulate the hole clean. Allow cement to set a minimum of 4 to 6 hours and tag top of plug to verify top of plug depth.
6. Pull up to 100 feet and set a 12 sack (13.4 cubic foot or 2.4 barrels) surface cement plug using Class G cement mixed at 15.8 pounds per gallon. Mix and pump cement until returns to surface are observed.
7. All open annular spaces in the surface casing protection casing annulus will also be cemented ("topped off") at the casing cut-off point.
8. Cut off casing four feet below ground surface (as designated by the Arizona Public Service Company (surface owner) and fill any remaining open annular spaces with cement.

9. Set a 4-inch diameter or larger metal pipe securely in cement that extends at least 4 feet above ground level to mark the well location. Weld on a plate to the top of the metal pipe with the operator's name, lease name or number, well identifier number and legal description of the well location permanently inscribed on the marker plate.
10. Rig down workover rig and release all equipment.
11. Backfill well cellar and grade location to level.
12. Remove and dispose of any remaining site debris.
13. Operations Complete.

The Arizona Oil and Gas Conservation Commission (OGCC) should be notified at least 48 hours before starting abandonment operations to allow an opportunity for the Arizona OGCC to witness well plugging and abandonment. A plugging report will be prepared and filed with the Arizona OGCC 15 days after completion of closure operations. This report will include: 1) the method used in plugging the well; 2) casing record details; 3) the size, kind, and depth of plugs used; and 4) the name and depth interval of each formation containing fresh water, oil or gas, or geothermal resources. The plugging information will be incorporated into the project Well Installation Report which will be filed with the Arizona Department of Environmental Quality and the Environmental Protection Agency.

POST CLOSURE PLAN

Post-closure monitoring is not proposed for the Cholla CO_2 Test Fee 1 well since no injection activities were conducted.

Arizona Public Service – Cholla CO_2 Test 1 Fee

Permit No. AOGCC Permit #00977, ADEQ P-106019, EPA AZ50800004

Proposed Plugging Schematic

977

All depths reference Bearcat Rig 2 Kelly Bushing

Rig Kelly Bushing = 12' above Ground Level

Ground Level ~ 5,130'

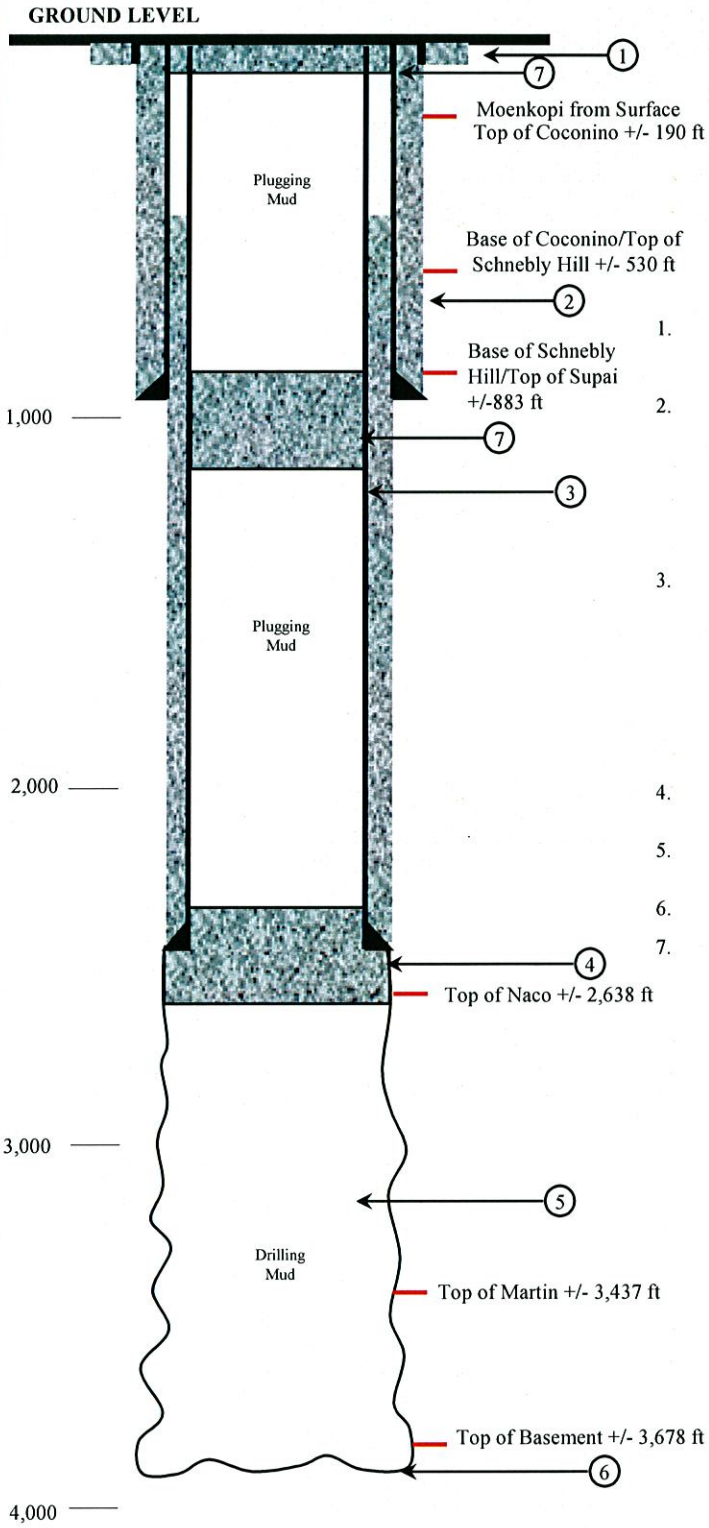

Figure 2 Proposed Plugging Well Schematic

COMPLETION DETAILS

1. Conductor Casing: Augered 22-inch hole to 47 feet (35 feet below ground) and set 14-inch by ¼-inch wall thickness casing to 47 feet. Grouted to surface.
2. Surface Casing: 9-5/8-inch, 36-pounds per foot. J-55, ST&C, Set from surface to 958 feet in a 12-1/4-inch hole. Cemented with Lead Slurry of 178 sacks of Class G cement mixed at ~12.5 pounds per gallon (w/2% D079 extender + 0.2% D046 anitfoamer + 0.25 lb/sx D029 LCM additive (cellophane flakes)) and Tail Slurry of 69 sacks Class G cement mixed at ~15.5 pounds per gallon (w/0.25 lb/sx D029 LCM additive (cellophane flakes)). Total of 30 barrels of cement returned to surface.
3. Protection Casing: 5-1/2-inch, 15.5-pounds per foot. J-55, LT&C, Set from surface to 2,505 feet in a 8-1/2-inch hole. Pumped a 20 barrel chemical wash and 20 barrel spacer and cemented with Lead Slurry of 342 sacks of Txi/G cement mixed at ~11.7 pounds per gallon (w/56 lb/sx D049, 24 lb/sx D907, 0.25 lb/sx DO29 LCM additive, 2% D079 extender, and 0.2% D046 anitfoamer and Tail Slurry of 267 sacks Lite-crete cement mixed at ~12.5 pounds per gallon (w/12.5 lb/sx D127, 7 lb/sx D154, 76 lb/sx D907, 0.6% D065, and 0.25% D167). Chemical wash and spacer water returned to surface, top of cement estimated at ~400 feet.
4. Cement Plug: Set from 2,560 to 2,683 feet w/ 75 sacks Class G neat.
5. Drilling mud plug CleanFaze Water Base Mud mixed at 10.1 lb/gal.
6. Total Depth: 3,853 feet.
7. Cement Plugs : Proposed Plug 1 – 25 sacks Class G cement mixed at 15.8 lb/gal set from ~834' to 1,050'. Proposed Plug 2 – 12 sacks Class G set from 100' to surface.

NOTES:

Casings cut off at 4 feet below grade and all annular spaces filled with cement. Steel plate to be welded on top with well identification. Cellar to be filled in and graded level to surface.

Sandia Technologies, LLC

6731Theall Road, Houston, TX 77066
Tel: (832) 286-0471 Fax: (832) 286-0477

Drawn by: djc	Date: Oct.. 2009	*Drawing not to scale*

Arizona Public Service – Cholla CO_2 Test 1 Fee

Permit No. AOGCC Permit #00977, ADEQ P-106019, EPA AZ50800004

977

Current Completion Schematic

All depths reference Bearcat Rig 2 Kelly Bushing

Rig Kelly Bushing = 12' above Ground Level

Ground Level ~ 5,130'

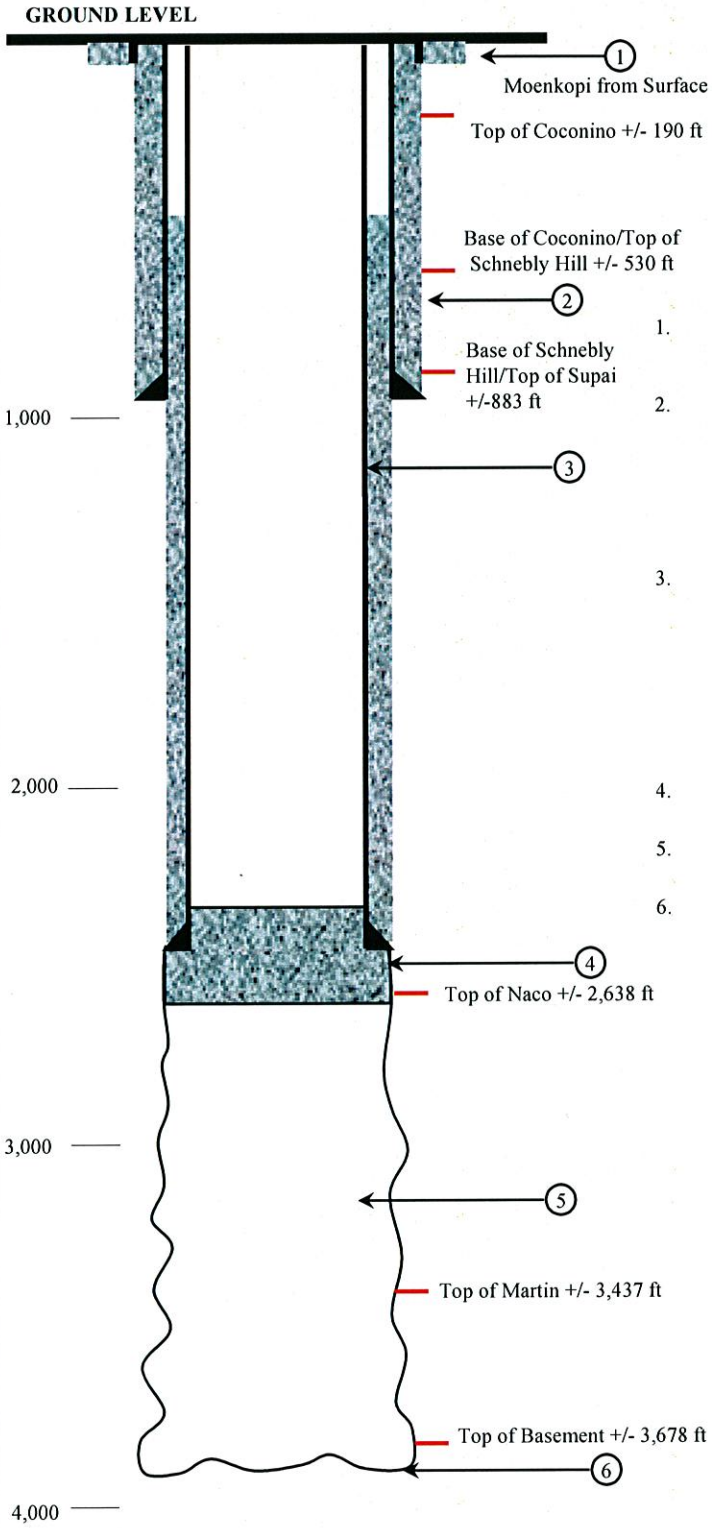

Figure 1 Current Well Schematic

COMPLETION DETAILS

1. Conductor Casing: Augered 22-inch hole to 47 feet (35 feet below ground) and set 14-inch by ¼-inch wall thickness casing to 47 feet. Grouted to surface.
2. Surface Casing: 9-5/8-inch, 36-pounds per foot. J-55, ST&C, Set from surface to 958 feet in a 12-1/4-inch hole. Cemented with Lead Slurry of 178 sacks of Class G cement mixed at ~12.5 pounds per gallon (w/2% D079 extender + 0.2% D046 anitfoamer + 0.25 lb/sx D029 LCM additive (cellophane flakes)) and Tail Slurry of 69 sacks Class G cement mixed at ~15.5 pounds per gallon (w/0.25 lb/sx D029 LCM additive (cellophane flakes)). Total of 30 barrels of cement returned to surface.
3. Protection Casing: 5-1/2-inch, 15.5-pounds per foot. J-55, LT&C, Set from surface to 2,505 feet in a 8-1/2-inch hole. Pumped a 20 barrel chemical wash and 20 barrel spacer and cemented with Lead Slurry of 342 sacks of Txi/G cement mixed at ~11.7 pounds per gallon (w/56 lb/sx D049, 24 lb/sx D907, 0.25 lb/sx DO29 LCM additive, 2% D079 extender, and 0.2% D046 anitfoamer and Tail Slurry of 267 sacks Lite-crete cement mixed at ~12.5 pounds per gallon (w/12.5 lb/sx D127, 7 lb/sx D154, 76 lb/sx D907, 0.6% D065, and 0.25% D167). Chemical wash and spacer water returned to surface, top of cement estimated at ~400 feet.
4. Cement Plug: Set from 2,560 to 2,683 feet w/ 75 sacks Class G neat.
5. Drilling mud plug CleanFaze Water Base Mud mixed at 10.1 lb/gal.
6. Total Depth: 3,853 feet.

Sandia Technologies, LLC

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Tel: (832) 286-0471 Fax: (832) 286-0477

Drawn by: djc	Date: Sept. 2009	*Drawing not to scale*

OMB No. 2040-0042 Approval Expires 4/30/07

United States Environmental Protection Agency
Washington, DC 20460

EPA

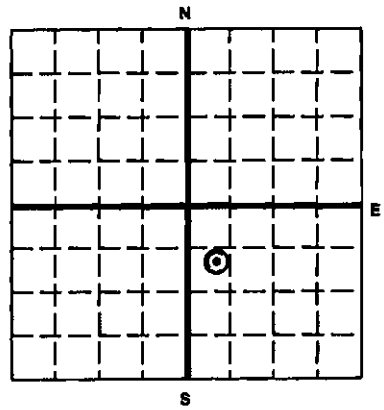
PLUGGING AND ABANDONMENT PLAN

977

Name and Address of Facility
Arizona Public Service Company, Cholla Plant
4801 Frontage Rd, Joseph City, AZ 86032

Name and Address of Owner/Operator
Arizona Public Service Company, Cholla Plant
4801 Frontage Rd, Joseph City, AZ 86032

Locate Well and Outline Unit on Section Plat - 640 Acres



State	County	Permit Number
Arizona	Navajo	AZ50800004

Surface Location Description
NE 1/4 of SW 1/4 of NE 1/4 of SE 1/4 of Section 30 Township 18 Range 20

Locate well in two directions from nearest lines of quarter section and drilling unit
Surface Location 1,782 ft. frm (N/S) S Line of quarter section and 2,079 ft. from (E/W) E Line of quarter section.

Survey of as-built well location will occur prior to plugging and abandonment.

TYPE OF AUTHORIZATION
- [x] Individual Permit
- [ ] Area Permit
- [ ] Rule

Number of Wells 1

Lease Name APS Fee

WELL ACTIVITY
- [ ] CLASS I
- [ ] CLASS II
  - [ ] Brine Disposal
  - [ ] Enhanced Recovery
  - [ ] Hydrocarbon Storage
- [ ] CLASS III

Well Number 1

CASING AND TUBING RECORD AFTER PLUGGING

SIZE	WT (LB/FT)	TO BE PUT IN WELL (FT)	TO BE LEFT IN WELL (FT)	HOLE SIZE
14	1/4" wall	47	43	22"
9-5/8	36	958	954	12-1/4"
5-1/2	15.5	2505	2501	8-1/2"

METHOD OF EMPLACEMENT OF CEMENT PLUGS
- [x] The Balance Method
- [ ] The Dump Bailer Method
- [ ] The Two-Plug Method
- [ ] Other

CEMENTING TO PLUG AND ABANDON DATA:	PLUG #1	PLUG #2	PLUG #3	PLUG #4	PLUG #5	PLUG #6	PLUG #7
Size of Hole or Pipe in which Plug Will Be Placed (inche	8-1/2"	5-1/2	5-1/2"				
Depth to Bottom of Tubing or Drill Pipe (ft	2683	1050	100				
Sacks of Cement To Be Used (each plug)	75	25	12				
Slurry Volume To Be Pumped (cu. ft.)							
Calculated Top of Plug (ft.)	2560	834	0				
Measured Top of Plug (if tagged ft.)	2560						
Slurry Wt. (Lb./Gal.)	15.5	15.8	15.8				
Type Cement or Other Material (Class III)	Class G	Class G	Class G				

LIST ALL OPEN HOLE AND/OR PERFORATED INTERVALS AND INTERVALS WHERE CASING WILL BE VARIED (if any)

From	To	From	To
Open Hole - 2,683	3853		

Estimated Cost to Plug Wells
$160,000

Certification

I certify under the penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment. (Ref. 40 CFR 144.32)

Name and Official Title *(Please type or print)*	Signature	Date Signed
CONRAD M. SPENCER, PLANT MANAGER		2 Dec 07

EPA Form 7520-14 (Rev. 8-01)

Activity Summary for Tuesday, September 1, 2009

977

Well: APS Cholla Pilot CO2 Well Rig: Bearcat Rig 2
Activity: Drilling in Basement Formation

The rig tanks were cleaned of mud and solids and ancillary equipment was rigged down. Pipe handling equipment was removed from the rig floor and the flowline was rigged down. The rig mast was lowered and placed into the cradle. The mast was disassembled from the rig unit and prepared for transport to Farmington, NM along with the rest of the equipment. The substructure was loaded out and departed the site. At the end of the day approximately 60% of the equipment had been demobilized from the site. A final cut was made on the casing stub for installation of tubing head. Drilling mud and solids were hauled off for disposal.

NO ACCIDENTS **NO SPILLS**

NOTES/OBSERVATIONS

- Daily activities summarized to 8:00 p.m. September 1.
- A flatbed truck was scheduled for the morning of September 2 to return the 5-1/2-inch and 9-5/8-inch casing to the supplier for credit.

ACTIVITY FORECAST

9/02/09 Demob remainder of Bearcat Rig 2 from site. Install tubing head onto wellhead.
9/03/09 Demob remaining equipment from site.

Kirk Delaune
Sandia Technologies, LLC

977

Activity Summary for Monday, August 31, 2009

Well: APS Cholla Pilot CO2 Well Rig: Bearcat Rig 2
Activity: Drilling in Basement Formation

The workstring was retrieved to the casing shoe and the hole was circulated while waiting on the open-hole cement plug to harden. After 6 hours of waiting on cement the workstring was lowered into the wellbore to 2,530 feet, and the well was circulated from that depth. Cement was observed in the drilling mud, confirming that the cement plug was in place. The workstring was retrieved from the wellbore while laying it down. Casing rams (5-1/2") were installed in the blowout preventers and casing running equipment was rigged up.

A total of 63 joints of 5-1/2" casing were installed, with the end of the casing placed at 2,504 ft. The casing was cemented using lead and tail cements, and the cement was displaced with fresh water to the float collar at 2,424 ft. Mud returns were present throughout the cement job. The 20-bbl chemical wash spacer and 5 bbl of water (20 bbl total pumped) were circulated to surface (cement returns did not reach surface). Casing running and cementing equipment was rigged down and the casing slips were installed in the wellhead. The casing was cut above the slips and the blowout preventers were removed from the wellhead. Rigging down and cleaning of rig tanks began.

NO ACCIDENTS **NO SPILLS**

NOTES/OBSERVATIONS

- Daily activities summarized to 6:00 a.m. August 31.
- The casing was reciprocated throughout the cement job. Casing centralizers were installed on every other joint of casing.
- Lead cement: 342 sacks of 75/25 TXI/G cement + additives, mixed at 11.7 lb/gal. Cement volume pumped was 35% excess over open-hole caliper.
- Tail cement: 267 sacks of Lite-Crete + additives, mixed at 12.5 lb/gal. Cement volume pumped was 20% excess over open-hole caliper.

ACTIVITY FORECAST

9/01/09 Rig down drilling rig; clean rig tanks, and prepare for demobilization.
9/02/09 Demob Bearcat Rig 2 from site.
9/03/09 Demob remaining equipment from site.

Kirk Delaune
Sandia Technologies, LLC

Subject: 08-30-2009 Field Activity Report
From: "Trautz, Robert" <rtrautz@epri.com>
Date: Mon, 31 Aug 2009 08:20:03 -0700
To: <steve.rauzi@azgs.az.gov>, <rumrill.nancy@epa.gov>, <robin.george@epa.gov>, <mb10@azdeq.gov>, <Winstead.Carrolette@azdeq.gov>
CC: "John Henry Beyer" <JHBeyer@lbl.gov>, "John Boyer" <John.Boyer@aps.com>, "Daniel Collins" <dan.collins@sandiatech.com>, <John.Roznovak@aps.com>

977

Sandia's site activity report for Sunday, 8-30-09 is attached.

We had a successful drill stem test (DST) in the Supai Formation yesterday. When we opened the downhole value, the formation produced "good blow" at the surface, meaning formation water entered the boring and drill pipe at a sustained rate causing displaced air in the drill pipe to be forced out the top of the well. Out flow of air at the top of the well is referred to qualitatively as "blow." We will analyze the results of the DST further to evaluate the formation permeability.

Maximum chloride concentrations measured on the recovered fluids from the DST were 145,000 mg/L.

Rob Trautz
Senior Project Manager
Electric Power Research Institute
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Ph. (650) 855-2088
Cell (650) 704-5378
rtrautz@epri.com

08-30-09_DrillSumRpt.pdf	**Content-Description:**	08-30-09_DrillSumRpt.pdf
	Content-Type:	application/octet-stream
	Content-Encoding:	base64

Activity Summary for Sunday, August 30, 2009

977

Well: APS Cholla Pilot CO2 Well Rig: Bearcat Rig 2
Activity: Drilling in Basement Formation

The DST dual packer isolation assembly was set, isolating the open-hole section from 2,144 to 2,298 ft. The downhole valve was opened, exposing the formation in that interval to ambient pressure for 15 minutes. A good blow was indicated. The tool was shut in for 1 hour to allow formation pressure to stabilize. The tool was re-opened for 1 hour, with good blow indicated. The tool was shut in for 3 hours to allow formation pressure to stabilize. Initial attempts to unset the DST tool were unsuccessful, as the tool remained stuck against the borehole. The tension pulled on the tool string was increased gradually in successive attempts to engage the downhole jars. The jars were functioned and the tool was freed on the second jarring event. The tool string was retrieved from the wellbore. The DST assembly was broken down at surface and loaded out.

The bottomhole assembly and workstring were lowered into the wellbore to 2,732 ft and the wellbore was circulated until returns were clean. The workstring was retrieved from the wellbore and the bottomhole assembly was laid down. Drill pipe (open-ended) was lowered into the wellbore to 2,683 ft. A pre-job safety meeting was held and Schlumberger cementing equipment was rigged up. A balanced cement plug was placed in the interval from 2,683 to 2,505 ft. The workstring was pulled up to 2,505 ft and the well was circulated at that depth to ensure no cement remained in the borehole above that depth.

NO ACCIDENTS **NO SPILLS**

NOTES/OBSERVATIONS

- Daily activities summarized to 6:00 a.m. August 31.
- Approximately 1,400 feet of fluid was recovered from the DST of Supai formation. Maximum chloride reading from recovered fluid was 145,000 mg/l.

ACTIVITY FORECAST

8/31/09	Verify placement of cement plug; lay down drill pipe; Run casing and cement.
9/01/09	Rig down drilling rig; clean rig tanks, and prepare for demobilization.
9/02/09	Demob Bearcat Rig 2 from site.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Saturday, August 29, 2009

Well: APS Cholla Pilot CO2 Well Rig: Bearcat Rig 2

Activity: Drilling in Basement Formation

977

Drill stem testing (DST) tools were assembled and lowered into the wellbore. The dual packer isolation assembly was set, isolating the open-hole section from 3,498 to 3,636 ft. The downhole valve was opened, exposing the formation in that interval to ambient pressure for 30 minutes. No flow was observed, with only slight blow indicated. The tool was shut in for 1 hour to allow formation pressure to stabilize. The tool was re-opened for 15 minutes, with another minor blow indicated. The tool was unset and retrieved from the wellbore. The DST assembly was broken down at surface. The DST assembly was re-configured to straddle 148 feet of interval and lowered into the wellbore. At report time the crew was lowering the assembly into the wellbore on the workstring.

NO ACCIDENTS **NO SPILLS**

NOTES/OBSERVATIONS

- Daily activities summarized to 6:00 a.m. August 30.
- No fluid was recovered from DST of Martin formation.

ACTIVITY FORECAST

8/30/09	Complete Drill Stem Test of Lower Supai formation; Make wiper trip; Path forward will depend on results of Drill Stem Test.
8/31/09	Path forward pending results of Drill Stem Testing

Kirk Delaune
Sandia Technologies, LLC

Subject: 08-28-2009 Field Activity Report
From: "Trautz, Robert" <rtrautz@epri.com>
Date: Sun, 30 Aug 2009 08:21:41 -0700
To: <steve.rauzi@azgs.az.gov>, <rumrill.nancy@epa.gov>, <robin.george@epa.gov>, <mb10@azdeq.gov>, <Winstead.Carrolette@azdeq.gov>
CC: "John Henry Beyer" <JHBeyer@lbl.gov>, "John Boyer" <John.Boyer@aps.com>, "Daniel Collins" <dan.collins@sandiatech.com>, <John.Roznovak@aps.com>

977

Sandia's site activity report for Saturday, 8-29-09 is attached.

As noted in the Sandia activity report, we conducted a drill stem test (DST) across 138 feet of the Martin formation (3,498 to 3,636 ft) yesterday afternoon. Open-hole logs were consulted prior to selecting the most promising test interval for the DST. Unfortunately, the logs showed very poor permeability and porosity across most of the Martin. When the downhole valve was opened during the DST, very little fluid entered the hole confirming that the Martin Formation at this location is very tight.

We pulled the DST assembly out of the hole last night, reconditioned it and ran it back into the hole early this morning to set up for a second DST across a shallower sandstone interval in the Supai formation (2144-2298 ft). This interval is much shallower than the 800 m (2624 ft) depth that one would typically consider for a CO2 storage target; however, the Supai does exist deeper in other areas of Northeast Arizona. Therefore, WESTCARB views the Supai DST at the Holbrook site as an opportunity to collect important geologic information needed for regional assessment of potential storage reservoirs.

Rob Trautz
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08-29-09_DrillSumRpt.pdf	**Content-Description:**	08-29-09_DrillSumRpt.pdf
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	Content-Encoding:	base64

Activity Summary for Friday, August 28, 2009

977

Well: APS Cholla Pilot CO2 Well Rig: Bearcat Rig 2
Activity: Open Hole Logging

Logging tools were lowered into the wellbore to 3,808 ft – unable to lower tools past ledge in open hole. A total of four open hole wireline logging runs were conducted, with the following formation evaluation services performed:

- Platform Express (GR-SP-Cal-Resistivity-Density Porosity-Neutron Porosity) from 3,806 ft to 956 ft.
- Combinable Magnetic Resonance Log from 3,806 ft to 2,600 ft.
- Hostile Natural Gamma Rap Spectroscopy and Elemental Capture Sonde Log from 3,806 ft to 958 ft.
- Formation Micro Imager from 3,700 ft to 2,000 ft.
- Sonic Scanner Log from 3,700 ft to 958 ft.
- A total of 25 rotary sidewall cores were collected from various intervals in the borehole.

Schlumberger wireline equipment was rigged down and released.

NO ACCIDENTS **NO SPILLS**

NOTES/OBSERVATIONS

- Daily activities summarized to 6:00 a.m. August 29.

ACTIVITY FORECAST

8/29/09 Conduct Drill Stem Test
8/30/09 Complete Drill Stem Test; Make wiper trip; Path forward will depend on results of Drill Stem Test.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Thursday, August 27, 2009

977

Well: APS Cholla Pilot CO2 Well Rig: Bearcat Rig 2
Activity: Drilling in Basement Formation

Drilling continued from 3,691 ft to 3,853 ft at an average ROP of 13 ft/hr. A short trip was made to the casing shoe and the workstring was lowered to the bottom of the wellbore. A bridge in the open-hole section was tagged and was washed through. No fill was observed on bottom. The wellbore was circulated until fluid returns were clean and the inclination survey tool was dropped through the workstring. The workstring was retrieved from the wellbore and the survey tool was recovered (3/4 deg at 3,829 ft). Schlumberger wireline equipment was rigged up to run open-hole logs.

NO ACCIDENTS **NO SPILLS**

NOTES/OBSERVATIONS

- Daily activities summarized to 6:00 a.m. August 28.
- A total of 12.5 hours were spent drilling during last 24 hrs.
- The total depth of 3,853 ft was selected based on casing tally measurements.
- Drilling Fluid Properties: MW = 10.2 lb/gal; PV = 7 cp; YP = 16 lb/100 ft^2; F/L = 4.7 cc/30 min.
- Chlorides = 117,000 ppm; Solids = 4.5 %.
- Samples are 100% granite wash at TD.

ACTIVITY FORECAST

8/27/09 Run Open Hole Logs.
8/28/09 Complete Open Hole Logging; Conduct Drill Stem Test
8/29/09 Complete Drill Stem Test; Make wiper trip; Rig up to run casing.

Kirk Delaune
Sandia Technologies, LLC

977

Activity Summary for Wednesday, August 26, 2009

Well: APS Cholla Pilot CO2 Well Rig: Bearcat Rig 2
Activity: Drilling in Basement Formation

Drilling continued from 3,415 ft to 3,691 ft at an average ROP of 11.7 ft/hr.

NO ACCIDENTS **NO SPILLS**

NOTES/OBSERVATIONS

- Daily activities summarized to 6:00 a.m. August 27.
- A total of 23.5 hours were spent drilling during last 24 hrs.
- Drilling Fluid Properties: MW = 10.2 lb/gal; PV = 7 cp; YP = 19 lb/100 ft^2; F/L = 3.9 cc/30 min.
- Chlorides = 120,000 ppm; Solids = 4.2 %.
- Mud Loggers predict top of basement at 3,654 ft +/-; Samples are 60% granite wash, 20% shale and 20% limestone at 3,686 ft.

ACTIVITY FORECAST

8/27/09 Continue drilling in basement to TD. Short trip; Retrieve workstring.
8/28/09 Run Open Hole Logs.
8/29/09 Complete Open Hole Logging; Conduct Drill Stem Test

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Tuesday, August 25, 2009

Well: APS Cholla Pilot CO2 Well Rig: Bearcat Rig 2
Activity: Drilling in Naco Formation

(977)

Drilling continued from 3,200 ft to 3,395 ft. Obtained borehole inclination survey at 3,250 ft (1 degree). Drilling continued from 3,395 ft to 3,415 ft.

NO ACCIDENTS **NO SPILLS**

NOTES/OBSERVATIONS

- Daily activities summarized to 6:00 a.m. August 26.
- A total of 22.5 hours were spent drilling during last 24 hrs.
- Drilling Fluid Properties: MW = 10.1 lb/gal; PV = 5 cp; YP = 15 lb/100 ft^2; F/L = 4.0 cc/30 min.
- Chlorides = 125,000 ppm; Solids = 4.0 %.
- Mud Loggers indicate 40% shale, 30% limestone, and 30% siltstone at 3,410 ft.

ACTIVITY FORECAST

8/26/09 Drill Naco and Martin Formations. Trip to replace drilling bit.
8/27/09 Continue drilling in Martin Formation.
8/28/09 Drill through Martin Formation into basement.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Monday, August 24, 2009

977

Well: APS Cholla Pilot CO2 Well Rig: Bearcat Rig 2
Activity: Drilling in Naco Formation

The workstring was retrieved from the wellbore due to low rate of penetration. The bit was inspected and indicated severe damage (locked cones, broken and chipped cutters). The bit was replaced and the workstring was lowered into the wellbore. The wellbore was reamed from 2,982 ft to 3,022 ft to ensure the wellbore was clear of solids fill (no fill located on bottom). Drilling resumed and continued from 3,022 ft to 3,200 ft.

NO ACCIDENTS **NO SPILLS**

NOTES/OBSERVATIONS

- Daily activities summarized to 6:00 a.m. August 25.
- A total of 16 hours were spent drilling during last 24 hrs.
- Drilling Fluid Properties: MW = 10.1 lb/gal; PV = 5 cp; YP = 16 lb/100 ft^2; F/L = 4.2 cc/30 min.
- Chlorides = 125,000 ppm; Solids = 3.8 %.
- Mud Loggers indicate 60% shale, 30% limestone, and 10% anhydrite at 3,185 ft.

ACTIVITY FORECAST

8/25/09 Continue drilling in Naco Formation.
8/26/09 Continue drilling in Martin Formation.
8/27/09 Drill through Martin Formation into basement.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Sunday, August 23, 2009

Well: APS Cholla Pilot CO2 Well Rig: Bearcat Rig 2

Activity: Drilling in Naco Formation

977

Drilling continued from 2,855 ft to 2,890 ft at an average ROP of 10.8 ft/hr. A borehole inclination survey was taken, and indicated a hole angle of 1 degree at 2,850 ft. Drilling continued from 2,890 ft to 3,022 ft at an average ROP of 6.8 ft/hr. The rotating head rubber was replaced.

NO ACCIDENTS **NO SPILLS**

NOTES/OBSERVATIONS

- Daily activities summarized to 6:00 a.m. August 24.
- A total of 22.25 hours were spent drilling during last 24 hrs.
- Drilling Fluid Properties: MW = 10.1 lb/gal; PV = 7 cp; YP = 15 lb/100 ft^2; F/L = 4.7 cc/30 min.
- Chlorides = 125,000 ppm; Solids = 3.7 %.

ACTIVITY FORECAST

8/24/09	Retrieve workstring to replace drilling bit. Continue drilling in Naco Formation
8/25/09	Continue drilling in Naco Formation.
8/26/09	Continue drilling in Martin Formation.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Saturday, August 22, 2009

(977)

Well: APS Cholla Pilot CO2 Well Rig: Bearcat Rig 2
Activity: Drilling in Supai Formation

The well was circulated to clean the hole and the workstring was retrieved to the casing shoe. Operations were suspended to allow the crews to obtain H2S Safety Training. The crew resumed retrieval of the workstring but operations were suspended to cut drill line (damaged section of line observed). The bit was retrieved from the wellbore and replaced. The drilling assembly was lowered into the wellbore to bottom (no fill on bottom) and drilling resumed. Drilling continued from 2,721 ft to 2,855 ft at an average ROP of 11.6 ft/hr.

NO ACCIDENTS **NO SPILLS**

NOTES/OBSERVATIONS

- Daily activities summarized to 6:00 a.m. August 23.
- A total of 11.5 hours were spent drilling during last 24 hrs.
- Drilling Fluid Properties: MW = 10.0 lb/gal; PV = 5 cp; YP = 14 lb/100 ft^2; F/L = 4.0 cc/30 min.
- Chlorides = 125,000 ppm; Solids = 3.5 %.

ACTIVITY FORECAST

8/23/09	Obtain drift check & drill into Naco Formation
8/24/09	Continue drilling in Naco Formation.
8/25/09	Continue drilling in Martin Formation.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Friday, August 21, 2009

(977)

Well: APS Cholla Pilot CO2 Well Rig: Bearcat Rig 2
Activity: Drilling in Supai Formation

Drilling continued from 2,515 ft to 2,530 ft. The workstring was retrieved to the casing shoe to replace packing on the swivel. The swivel packing was replaced and the workstring was lowered to 2,530 ft. Drilling continued from 2,530 ft to 2,721 ft.

NO ACCIDENTS **ONE SPILL (See details below)**

NOTES/OBSERVATIONS

- Daily activities summarized to 6:00 a.m. August 22.
- Approximately 12 barrels (500 gallons) of drilling mud were spilled onto the ground while attempting to fill the wellbore during the trip to the casing shoe. The mud was contained and collected in the well cellar. Contaminated soil was placed in roll-off boxes along with cuttings.
- Drilling Fluid Properties: MW = 10.1 lb/gal; PV = 5 cp; YP = 14 lb/100 ft^2; F/L = 3.8 cc/30 min.
- Chlorides = 130,000 ppm; Solids = 3.3 %.

ACTIVITY FORECAST

8/22/09	Retrieve workstring and replace bit. Continue drilling in Supai Formation.
8/23/09	Continue drilling in Supai Formation.
8/24/09	Continue drilling in Naco Formation.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Thursday, August 20, 2009

977

Well: APS Cholla Pilot CO2 Well Rig: Bearcat Rig 2
Activity: Drilling in Supai Formation

Drilling continued from 2,140 ft to 2,352 ft. An inclination survey was obtained at 2,312 ft (1/2 deg). Drilling continued from 2,352 ft to 2,515 ft.

NO ACCIDENTS **NO SPILLS**

NOTES/OBSERVATIONS

- Daily activities summarized to 6:00 a.m. August 21.
- Drilling Fluid Properties: MW = 10.1 lb/gal; PV = 5 cp; YP = 16 lb/100 ft^2; F/L = 4.0 cc/30 min.
- Chlorides = 152,000 ppm; Solids = 2.5 %.

ACTIVITY FORECAST

8/21/09 Continue drilling in Supai Formation.
8/22/09 Continue drilling in Naco Formation.
8/23/09 Drill through Naco Formation into Martin Formation.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Wednesday, August 19, 2009

977

Well: APS Cholla Pilot CO2 Well Rig: Bearcat Rig 2
Activity: Drilling in Supai Formation

Drilling continued from 1,659 ft to 1,711 ft. A short trip was made to condition the wellbore and the drilling fluid. Drilling continued from 1,711 ft to 1,879 ft. An inclination survey was obtained at 1,835 ft (1 deg) and drilling resumed. Drilling continued from 1,835 ft to 2,140 ft.

NO ACCIDENTS **NO SPILLS**

NOTES/OBSERVATIONS

- Daily activities summarized to 6:00 a.m. August 20.
- Drilling Fluid Properties: MW = 10.1 lb/gal; PV =6 cp; YP = 16 lb/100 ft^2; F/L = 3.0 cc/30 min.
- Chlorides in drilling mud increased from 125,000 to 160,000 ppm due to drilling of anhydrites, salts.
- Added approximately 700 barrels of water to hole yesterday to account for fluid losses while drilling.

ACTIVITY FORECAST

8/20/09 Continue drilling in Supai Formation.
8/21/09 Continue drilling in Supai Formation.
8/22/09 Continue drilling in Supai and Naco Formations.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Tuesday, August 18, 2009

977

Well: APS Cholla Pilot CO2 Well Rig: Bearcat Rig 2
Activity: Drill 8-1/2-inch hole.

Drilling continued from 978 ft to 1,022 ft. A leakoff test was conducted to test the casing shoe and indicated a fracture pressure of 10.7 lb/gal mud weight equivalent. Drilling continued from 1,022 ft to 1,405 ft. An inclination survey was obtained at 1,365 ft (1 deg) and drilling resumed. Drilling progressed to 1,659 ft.

NO ACCIDENTS **NO SPILLS**

NOTES/OBSERVATIONS

- Daily activities summarized to 6:00 a.m. August 19.
- Drilling Fluid Properties: MW = 9.6 lb/gal; PV = 8 cp; YP = 16 lb/100 ft^2; F/L = 4.0 cc/30 min.
- Chlorides in drilling mud increased to 125,000 ppm due to drilling of anhydrites, salts.

ACTIVITY FORECAST

8/19/09	Drill 8-1/2-inch hole in Supai Formation
8/20/09	Continue drilling in Supai Formation
8/21/09	Continue drilling in Supai Formation.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Monday, August 17, 2009

977

Well: APS Cholla Pilot CO2 Well Rig: Bearcat Rig 2
Activity: Align Rotary, Drill Mousehole & Rathole, Pick up workstring & drill cement.

The wellbore was circulated until fluid returns were clean and the 9-5/8-inch casing was pressure-tested to 1,401 psig for 30 minutes with a loss rate of 4.4 percent (Good Test). Cement inside the casing was drilled to the casing shoe at 955 ft (drill pipe measurement); Mud materials were added to the drilling fluid (water) to convert the system to a drilling mud (Clean Faze). Operations were suspended for 3 hours while the rig made repairs to the possum belly (crack in inlet from flowline). Drilling progressed from 955 to 968 feet (10 feet below casing shoe). A formation integrity test to 11.3 lb/gal equivalent mud weight was performed.

After the test was performed, the rig was instructed to resume drilling. The driller failed to open the pipe rams after the test and attempted to circulate and rotate the pipe, causing the pipe rams to become dislodged within the ram cavity of the blowout preventers (BOPs). The problem was diagnosed further and the ram bonnets were opened to inspect the rams. Replacement rams were installed in the BOPs and the pipe rams were pressure-tested to 250 psi (low) and 1,000 psi (high). The workstring was lowered into the wellbore to 968 ft. Drilling resumed and continued from 968 to 978 ft.

NO ACCIDENTS **NO SPILLS**

NOTES/OBSERVATIONS

- Daily activities summarized to 6:00 a.m. August 18.
- A total of 13 hours of downtime were incurred by Bearcat during the past workday.

ACTIVITY FORECAST

8/18/09	Drill 8-1/2-inch hole in Supai Formation
8/19/09	Continue drilling in Supai Formation
8/20/09	Continue drilling in Supai Formation.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Sunday, August 16, 2009

Well: APS Cholla Pilot CO2 Well Rig: Bearcat Rig 2
Activity: Align Rotary, Drill Mousehole & Rathole, Pick up workstring & drill cement.

Pressure-testing of well control equipment was completed. Bearcat adjusted the chain from the drawworks to the rotary table and rigged up to drill the rathole. The rathole was drilled to 28 feet below ground level with little effort, but the kelly shuck could not be lowered completely into it due to a rock at 20 feet below ground level and loose sediments falling into the hole. The bit was worked through this tight interval and an additional five feet of hole were drilled. The kelly shuck was lowered into place and the mousehole was drilled to 25 feet below ground level and the mousehole shuck was installed. An 8-1/2-inch bit and drilling bottomhole assembly was picked up and lowered into the wellbore on the 4-1/2-inch workstring. Cement was tagged at 899 feet and was drilled down to the float collar at 917 feet. The float collar and cement below were drilled up to 950 feet.

NO ACCIDENTS **NO SPILLS**

NOTES/OBSERVATIONS

- Daily activities summarized to 6:00 a.m. August 17.

ACTIVITY FORECAST

8/17/09	Pressure-test surface casing. Drill out float shoe and test formation for integrity. Make up drilling fluid for protection hole. Drill 8-1/2-inch hole.
8/18/09	Drill 8-1/2-inch hole in Supai Formation.
8/19/09	Continue drilling in Supai Formation.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Saturday, August 15, 2009

977

Well: APS Cholla Pilot CO2 Well Rig: Bearcat Rig 2
Activity: Rig up Bearcat 2; Install Well Control Equipment & Test

Rig equipment was spotted on location and rigged up. The rig mast was raised and guy wires were attached. The well control equipment was installed on the wellhead and pressure-tested to 250 psi (low) and 1,000 psi (high).

NO ACCIDENTS **NO SPILLS**

NOTES/OBSERVATIONS

- Daily activities summarized to 6:00 a.m. August 16.
- Operations were slowed due to high winds throughout the day.

ACTIVITY FORECAST

8/16/09	Drill mousehole and rathole. Pick up drilling assembly and drill out to float shoe. Pressure-test surface casing. Drill out float shoe and test formation for integrity. Make up drilling fluid for protection hole. Drill 8-1/2-inch hole.
8/17/09	Drill 8-1/2-inch hole in Supai Formation.
8/18/09	Continue drilling in Supai Formation.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Friday, August 14, 2009

977

Well: APS Cholla Pilot CO2 Well Rig: Bearcat Rig 2
Activity: Install Storm Anchors; Begin Rig Mob

Bearcat equipment began arriving at the site at 06:30 a.m. Bearcat rig personnel were given the site awareness orientation and the Health and Safety Plan was reviewed. Equipment was set down on location but could not be placed into position because the rig's substructure (first piece of equipment that must be positioned) was delayed at the Arizona Port of Entry due to excessive height. The trucking company dispatched a float with a lower profile to the border and transferred the substructure onto it. The substructure was allowed entry into the state and arrived at the job site at 4:30 p.m. The substructure was positioned over the well and aligned. The ramp to the substructure could not be placed into position because the surface location was uneven. The surface was graded level and the ramp was placed into position. Operations were suspended at 8:00 p.m. due to darkness.

NO ACCIDENTS **NO SPILLS**

OBSERVATIONS

- Daily activities summarized to 8:00 p.m. August 14.
- Drilling measurements are referenced from kelly bushing (KB) of Bearcat drilling rig (12 ft above GL).
- Surface Casing: 9-5/8" OD, 36 lb/ft Grade J-55 STC; set at 958 ft KB.

ACTIVITY FORECAST

8/15/09	Rig up Bearcat Rig 2. Begin 24-hr operations. Install and test well control equipment.
8/16/09	Drill mousehole and rathole. Pick up drilling assembly and drill out to float shoe. Pressure-test surface casing. Drill out float shoe and test formation for integrity. Make up drilling fluid for protection hole. Drill 8-1/2-inch hole.
8/17/09	Drill 8-1/2-inch hole in Supai Formation.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Thursday, August 13, 2009

Well: APS Cholla Pilot CO2 Well Rig: Bearcat Rig 2
Activity: Install Storm Anchors; Begin Rig Mob

977

Storm anchors for Bearcat Rig No. 2 were set and pull-tested. Bearcat began trucking its rig from Farmington, N.M. to the site. Rig mobilization operations were delayed leaving Farmington, N.M. and the trucking company elected not to attempt to deliver equipment to the site this day.

NO ACCIDENTS **NO SPILLS**

OBSERVATIONS

- Daily activities summarized to 5:00 p.m. August 13.
- Drilling measurements are referenced from kelly bushing (KB) of Bearcat drilling rig (12 ft above GL).
- Surface Casing: 9-5/8" OD, 36 lb/ft Grade J-55 STC; set at 958 ft KB.

ACTIVITY FORECAST

8/14/09	Rig equipment to arrive at 7:00 a.m. Spot and rig up Bearcat Rig 2. Begin 24-hr operations.
8/15/09	Install and test well control equipment. Pick up drilling assembly and drill out to float shoe. Pressure-test surface casing. Drill out float shoe and test formation for integrity. Make up drilling fluid for protection hole. Drill 8-1/2-inch hole.
8/16/09	Drill 8-1/2-inch hole in Supai Formation.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Wednesday, August 12, 2009

977

Well: APS Cholla Pilot CO2 Well Rig: WDC Rig 161
Activity: Demob Rig; Install cellar and wellhead

WDC personnel cleaned out solids from its rig tank and loaded out the remainder of the equipment on location. The annular space between the 14-inch and 9-5/8-inch casing was grouted to surface. A 6-foot diameter x 5-foot deep cellar was installed around the wellhead and a 13-3/8-inch x 9-5/8-inch 3,000 psi slip-on wellhead was installed and pressure-tested to 2,700 psig for one hour. Operations were suspended for the day at 7:30 p.m.

NO ACCIDENTS **NO SPILLS**

OBSERVATIONS

- Daily activities summarized to 7:30 p.m. August 12.
- Drilling measurements are referenced from kelly bushing (KB) of Bearcat drilling rig (12 ft above GL).
- Surface Casing: 9-5/8" OD, 36 lb/ft Grade J-55 STC; set at 958 ft KB.

ACTIVITY FORECAST

8/13/09	Install rig anchors. Mobilize Bearcat Drilling Rig No. 2 to site.
8/14/09	Rig up Bearcat Rig 2. Begin 24-hr operations.
8/15/09	Install and test well control equipment. Pick up drilling assembly and drill out to float shoe. Pressure-test surface casing. Drill out float shoe and test formation for integrity. Make up drilling fluid for protection hole. Drill 8-1/2-inch hole.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Tuesday, August 11, 2009

977

Well: APS Cholla Pilot CO2 Well Rig: WDC Rig 161
Activity: Run and Cement 9-5/8-Inch Casing

WDC personnel cleaned the rig tanks and rigged down the drilling rig. The cement level in the 9-5/8-inch annulus gradually fell to approximately 100 feet below ground level. The 9-5/8-inch casing was left in tension for 13 hours after cementing to allow the cement in the wellbore to harden. The 14-inch and 9-5/8-inch casings were cut just above ground level. The rig mast was lowered and the rig unit was pulled away from the wellbore. Approximately 80% of WDC's rig equipment has been demobilized from the drill site. Operations were suspended for the day at 6:30 p.m.

NO ACCIDENTS **NO SPILLS**

OBSERVATIONS

- Daily activities summarized to 6:30 p.m. August 11.
- Drilling measurements are referenced from kelly bushing (KB) of Bearcat drilling rig (12 ft above GL).
- Surface Casing: 9-5/8" OD, 36 lb/ft Grade J-55 STC; set at 958 ft KB.

ACTIVITY FORECAST

8/12/09	Demob remainder of WDC equipment. Add cement to 9-5/8-inch casing annulus from surface. Dig cellar and install wellhead.
8/13/09	Install rig anchors. Mobilize Bearcat Drilling Rig No. 2 to site.
8/14/09	Rig up Bearcat Rig No. 2. Begin 24-hr operations.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Monday, August 10, 2009

Well: APS Cholla Pilot CO2 Well Rig: WDC Rig 161
Activity: Run and Cement 9-5/8-Inch Casing

977

The workstring was retrieved from the wellbore and a 12-1/4-inch bit and one drill collar were assembled. The workstring was lowered into the wellbore to 610 ft where drag was experienced due to bentonite strung along the borehole. The kelly was assembled and the hole was washed and reamed from 610 ft to 960 ft. The well was circulated until fluid returns were clean. The workstring was retrieved from the wellbore and laid down.

A prejob safety meeting and job safety analysis on running casing was held and casing running equipment was rigged up. A total of 25 joints of casing (9-5/8-inch OD, 36 lb/ft, Grade J-55, STC connection) were assembled and lowered into the wellbore. The casing located the bottom of the wellbore at 959 ft. A prejob safety meeting and job safety analysis on cementing was held, and cementing equipment was rigged up.

The well was circulated while the casing was reciprocated to clean the hole and cementing operations began. The well was cemented with 178 sacks (67 bbl) lead cement mixed at 12.5 lb/gal density and 69 sx (14.4 bbl) tail cement mixed at 15.5 lb/gal density. The cement was displaced with 71 barrels of fresh water until the cement wiper plug was seated in the float collar. Fluid returns were present during the entire cement job and a total of 30 barrels of cement were circulated to surface. The cementing equipment was rigged down and released from service. WDC personnel began cleaning the rig tanks and rigging down.

NO ACCIDENTS **NO SPILLS**

OBSERVATIONS

- Daily activities summarized to 6:00 am August 11.
- Drilling measurements are referenced from kelly bushing (KB) of Bearcat drilling rig (12 ft above GL).
- Surface Casing: 9-5/8" OD, 36 lb/ft Grade J-55 STC; set at 958 ft KB.
- Water losses to formation: 200 bbl/24 hrs; Cumulative: 3220 bbl

ACTIVITY FORECAST

8/11/09 Rig down WDC rig and clean rig tank. Prepare equipment for demobilization.

Subject: 08-09-2009 Field Activity Report
From: "Trautz, Robert" <rtrautz@epri.com>
Date: Mon, 10 Aug 2009 15:57:44 -0700
To: <steve.rauzi@azgs.az.gov>
CC: "John Henry Beyer" <JHBeyer@lbl.gov>, "John Boyer" <John.Boyer@aps.com>, "Daniel Collins" <dan.collins@sandiatech.com>

(977)

Sorry for not getting this out earlier. Sandia's site activity report for Sunday, 8-9-09 is attached.

Sandia attempted to collect a representative sample of groundwater from the base of freshwater (above the Supai formation), yesterday but was unsuccessful. After pumping for an extended period of time, the sample appeared to be cross-contaminated with freshwater used in the drilling process. We contacted the ADEQ and received verbal permission to set the surface casing without attempting to collect additional samples because of concern over losing the hole.

Rob Trautz
Senior Project Manager
Electric Power Research Institute
3420 Hillview Ave., Palo Alto, CA
Ph. (650) 855-2088
Cell (650) 704-5378
rtrautz@epri.com

08-09-09_DrillingRpt.pdf	**Content-Description:**	08-09-09_DrillingRpt.pdf
	Content-Type:	application/octet-stream
	Content-Encoding:	base64

Activity Summary for Sunday, August 9, 2009

Well: APS Cholla Pilot CO2 Well Rig: WDC Rig 161
Activity: Ran Formation Evaluation Logs; Attempt to Collect Formation Water Sample

(977)

Drilling progressed from 956 ft to 960 ft at an average ROP of 4 ft/hr. The workstring was retrieved from the wellbore. Schlumberger Wireline Services was rigged up and its Platform Express logging suite was logged from 957 ft to 62 ft wireline measurement. The suite included spontaneous potential, gamma ray, 1-arm caliper, array induction resistivity, density porosity, and neutron porosity logging tools. The wireline equipment was rigged down

An attempt was made to collect a formation water sample from the Schnebly Hill formation. WDC personnel placed gravel in the open hole from 960 ft to 890 ft. A bentonite seal was placed above the gravel from 890 ft to 882 ft (calculated depth interval). A joint of slotted pipe (20 feet of slots) was attached to the workstring and lowered into the wellbore and placed at 884 ft, with the slots placed in the interval from 882 ft to 862 ft. A borehole inclination survey was run and indicated 0 degrees inclination at 860 ft. Gravel was placed in the annular space to a calculated depth of 857 ft and bentonite was placed in the annular space to a calculated depth of 849 ft.

Air was circulated through the workstring to lower the hydrostatic head and induce the well to flow. Flow from the well was achieved and sustained at approximately 25 gpm. Analysis of fluid samples indicated wellbore fluids were being circulated through the slotted pipe. Additional bentonite chips were dumped into the wellbore in an attempt to effect an upper seal, with no success. After 3 hours of flowback at 25 gpm, recovered fluids were confirmed as wellbore fluids, as the upper bentonite seal failed to prevent wellbore fluids from entering the slotted pipe. The air line was retrieved from the bore of the workstring and the crew began retrieving the workstring from the wellbore.

NO ACCIDENTS **NO SPILLS**

OBSERVATIONS

- Daily activities summarized to 6:00 am August 10.
- Drilling measurements are referenced from kelly bushing (KB) of Bearcat drilling rig (12 ft above GL).
- Conductor pipe: 14" OD, set at 47 ft KB.
- Montgomery & Associates representative picks top of Supai formation at 908 ft.
- Water losses to formation: 160 bbl/24 hrs; Cumulative: 3020 bbl

Activity Summary for Saturday, August 8, 2009

Well: APS Cholla Pilot CO2 Well Rig: WDC Rig 161
Activity: Drilling 12-1/4" Surface Hole

977

Drilling progressed from 862 ft to 956 ft at an average ROP of 3.9 ft/hr.

NO ACCIDENTS **NO SPILLS**

OBSERVATIONS

- Daily activities summarized to 6:00 am August 9.
- Drilling measurements are referenced from kelly bushing (KB) of Bearcat drilling rig (12 ft above GL).
- Conductor pipe: 14" OD, set at 47 ft KB.
- Montgomery & Associates representative picks top of Supai formation at 908 ft.
- Water losses to formation: 490 bbl/24 hrs; Cumulative: 2860 bbl

ACTIVITY FORECAST

8/09/09 Drill to casing point at 960 ft. Retrieve workstring. Conduct formation evaluation logging. Lower workstring and pack well with gravel. Obtain fluid sample from Coconino formation.
8/10/09 Retrieve workstring; Trip in with bit and circulate out gravel. Retrieve workstring. Rig up and run casing.
8/11/09 Cement casing. Rig down WDC rig and clean rig tank. Demob WDC equipment.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Friday, August 7, 2009

977

Well: APS Cholla Pilot CO2 Well Rig: WDC Rig 161
Activity: Drilling 12-1/4" Surface Hole

Drilling progressed from 752 ft to 862 ft at an average ROP of 4.9 ft/hr. A total of 1.5 hours were incurred repairing the rig (leak on the discharge tank and broken top ring on kelly bushing).

NO ACCIDENTS **NO SPILLS**

OBSERVATIONS

- Daily activities summarized to 6:00 am August 8.
- Drilling measurements are referenced from kelly bushing (KB) of Bearcat drilling rig (12 ft above GL).
- Conductor pipe: 14" OD, set at 47 ft KB.
- Mud loggers picked top of Schnebly Hill formation at 608 ft.
- Water losses to formation: 400 bbl/24 hrs; Cumulative: 2370 bbl

ACTIVITY FORECAST

8/08/09 Drill to casing point in Supai Formation. Retrieve workstring.
8/09/09 Conduct formation evaluation logging. Lower workstring and pack well with gravel. Obtain fluid sample from Coconino formation. Retrieve workstring;
8/10/09 Trip in with bit and circulate out gravel. Retrieve workstring. Rig up and run casing.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Thursday, August 6, 2009

Well: APS Cholla Pilot CO2 Well Rig: WDC Rig 161
Activity: Drilling 12-1/4" Surface Hole

977

Drilling progressed from 596 ft to 752 ft at an average ROP of 6.6 ft/hr.

NO ACCIDENTS **NO SPILLS**

OBSERVATIONS

- Daily activities summarized to 6:00 am August 7.
- Drilling measurements are referenced from kelly bushing (KB) of Bearcat drilling rig (12 ft above GL).
- Conductor pipe: 14" OD, set at 47 ft KB.
- Mud loggers picked top of Schnebly Hill formation at 608 ft.
- Water losses to formation: 400 bbl/24 hrs; Cumulative: 1970 bbl

ACTIVITY FORECAST

8/07/09 Continue drilling 12-1/4-inch surface hole.
8/08/09 Drill to casing point in Supai Formation. Retrieve workstring.
8/09/09 Conduct formation evaluation logging. Lower workstring and pack well with gravel. Obtain fluid sample from Supai formation.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Wednesday, August 5, 2009

977

Well: APS Cholla Pilot CO2 Well Rig: WDC Rig 161
Activity: Drilling 12-1/4" Surface Hole

Wireline pipe recovery equipment and personnel arrived at the site. WDC ceased fluid circulation and retrieved the air line from inside the kelly and drill string. A freepoint survey was conducted to determine where the drill string was stuck. The survey indicated the following: 100% free down to 370 ft; 50% free down to 430 ft; 0% free from 435 ft (bit @ 482 ft). Downhole fishing tools were ordered from Weatherford. The workstring was unscrewed (blind backoff) and retrieved in order to add 10 feet of drill pipe and reposition the kelly in the hole. The drill string was lowered into the wellbore and screwed into the top drill collar at 330 ft. WDC rigged up a centrifugal pump to circulate water through the bore of the workstring. Attempts were made to work the string free while circulating water at high rate (estimated at 400 gal/min), with no success. Fluid circulation stopped and WDC displaced the water from the drill string with intermittent cycles of air. The air in the wellbore expanded as it exited into the annular space above 482 feet, displacing water ahead of it. This action successfully removed differential pressure in the wellbore and freed up the workstring. The workstring was rotated and reciprocated while the wellbore was circulated to clean it up. The hole was reamed to bottom (534 ft) and drilling operations resumed. Drilling progressed from 540 ft to 596 ft at an average ROP of 6.6 ft/hr.

NO ACCIDENTS **NO SPILLS**

OBSERVATIONS

- Daily activities summarized to 6:00 am.
- Drilling measurements are referenced from kelly bushing (KB) of Bearcat drilling rig (12 ft above GL).
- Conductor pipe: 14" OD, set at 47 ft KB.
- Mud loggers indicate 100% sand at 596 ft (Coconino formation).
- Water losses to formation: 430 bbl/24 hrs; Cumulative: 1570 bbl

ACTIVITY FORECAST

8/06/09	Continue drilling 12-1/4-inch surface hole.
8/07/09	Continue drilling 12-1/4-inch surface hole.
8/08/09	Drill to casing point in Supai Formation. Retrieve workstring.

Kirk Delaune
Sandia Technologies, LLC

977

Activity Summary for Tuesday, August 4, 2009

Well: APS Cholla Pilot CO2 Well Rig: WDC Rig 161
Activity: Stuck in Hole at 484 ft.

Drilling progressed from 512 ft to 534 ft at an average rate of penetration (ROP) of 7.3 ft/hr. An inclination survey was obtained at 500 ft (1 deg). Drilling resumed and continued from 534 ft to 540 ft. Drilling was suspended to replace packing in the kelly swivel. Three joints of drill pipe were laid down and the kelly was lowered down into the wellbore to access the swivel. WDC replaced the swivel packing, but were unable to lift the work string after completing the task. Efforts to free the stuck pipe were unsuccessful. The inner air line was installed through the kelly and circulation of the hole was achieved. A small amount of cuttings were recovered. Wireline pipe recovery equipment was sourced and dispatched to the site. WDC continued circulating the hole and worked the pipe intermittently throughout the night.

NO ACCIDENTS **NO SPILLS**

OBSERVATIONS

- Daily activities summarized to 6:00 am.
- Drilling measurements are referenced from kelly bushing (KB) of drilling rig (12 ft above ground level (GL).
- Conductor pipe: 14" OD, set at 47 ft KB.
- Mud loggers indicate 100% sand (Coconino formation).
- Water losses to formation: 480 bbl/24 hrs; Cumulative: 1140 bbl

ACTIVITY FORECAST

8/05/09 Fishing operations – attempt to free work string.
8/06/09 Continue drilling 12-1/4-inch surface hole.
8/07/09 Continue drilling 12-1/4-inch surface hole.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for Monday, August 3, 2009

977

Well: APS Cholla Pilot CO2 Well Rig: WDC Rig 161
Activity: Drilling

Drilling progressed from 375 ft to 472 ft at an average ROP of 8.5 ft/hr. A steel air line inside the kelly sheared off while drilling. The workstring was short-tripped to engage the air line inside the drill string, and the line was repaired (welded). Drilling resumed and continued from 472 ft to 512 ft at an average ROP of 5.5 ft/hr.

NO ACCIDENTS **NO SPILLS**

OBSERVATIONS

- Daily activities summarized to 6:00 am.
- Drilling measurements are referenced from kelly bushing (KB) of Bearcat drilling rig (12 ft above GL).
- Conductor pipe: 14" OD, set at 47 ft KB.
- Mud loggers indicate 100% sand (Coconino formation).
- Water losses to formation increased - 660 bbl lost during last 36 hrs.
- Received 9-5/8-inch surface casing and float equipment.
-

ACTIVITY FORECAST

8/04/09 Continue drilling 12-1/4-inch surface hole.
8/05/09 Continue drilling 12-1/4-inch surface hole.
8/06/09 Drill 12-1/4-inch surface hole to Supai formation. Retrieve drilling assembly from wellbore.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for August 2, 2009

977

Well: APS Cholla Pilot CO2 Well Rig: WDC Rig 161
Activity: Drilling

Drilling progressed from 195 ft to 264 ft at average rate of penetration (ROP) of 6 ft/hr. Top of Coconino formation was picked by mud logger at 200 ft. An inclination survey was conducted at 264 ft (0 degree hole angle). Drilling progressed from 264 ft to 375 ft at average ROP of 9.2 ft/hr

NO ACCIDENTS **NO SPILLS**

OBSERVATIONS

- Daily activities summarized to 6:00 am.
- Drilling measurements are referenced from kelly bushing (KB) of Bearcat drilling rig (12 ft above GL).
- Conductor pipe: 14" OD, set at 47 ft KB.
- Mud loggers indicate 100% sand (Coconino formation).
- Slight water losses to formation.

ACTIVITY FORECAST

8/03/09 Continue drilling 12-1/4-inch surface hole.
8/04/09 Continue drilling 12-1/4-inch surface hole.
8/05/09 Continue drilling 12-1/4-inch surface hole.

Kirk Delaune
Sandia Technologies, LLC

977

Activity Summary for August 1, 2009

Well: APS Cholla Pilot Test Well Rig: WDC Rig 161
Activity: Drilling

Drilling progressed from 71 ft to 146 ft. An inclination survey was conducted (1/4 deg at 146 ft). Drilling progressed from 146 ft to 195 ft.

NO ACCIDENTS

NO SPILLS

OBSERVATIONS

- Daily activities summarized to 6:00 am.
- Drilling measurements are referenced from kelly bushing (KB) of Bearcat drilling rig (12 ft above GL).
- Conductor pipe: 14" OD, set at 47 ft KB.
- Mud loggers indicate 10% anhydrite, 40% shale, 50% sand (Moenkopi formation).
- Minimal water losses to formation.

ACTIVITY FORECAST

8/02/09 Continue drilling 12-1/4-inch surface hole. Obtain inclination survey at 250 ft +/-
8/03/09 Continue drilling 12-1/4-inch surface hole.
8/04/09 Continue drilling 12-1/4-inch surface hole.

Kirk Delaune
Sandia Technologies, LLC

977

Activity Summary for July 31, 2009

Well: APS Cholla Pilot Test Well Rig: WDC Drilling
Activity: Mob & Rig Up

Rig-up operations were finalized and a safety audit was conducted by Sandia, Montgomery & Associates, and WDC personnel on July 31, 2009. Minor deficiencies were observed and corrected, and drilling operations began at 2:00 p.m. Drilling progressed from 47 ft to 71 ft.

NO ACCIDENTS **NO SPILLS**

OBSERVATIONS

- Daily activities summarized are from midnight to midnight.
- 6:00 am August 1, 2009 update: Drilling at 89 ft.
- Drilling measurements are referenced from kelly bushing (KB) of Bearcat drilling rig (12 ft above GL).
- Conductor pipe: 14" OD, set at 47 ft KB.
- Drilling progressing slowly due to lack of weight on bit. Rate of penetration will increase as additional drill collars are added to BHA.

ACTIVITY FORECAST

8/01/09 Continue drilling 12-1/4-inch surface hole. Obtain inclination survey at 117 ft +/-

8/02/09 Continue drilling 12-1/4-inch surface hole. Obtain inclination survey at 250 ft +/-

8/03/09 Continue drilling 12-1/4-inch surface hole.

Kirk Delaune
Sandia Technologies, LLC

Activity Summary for July 30, 2009

977

Well: APS Cholla Pilot Test Well Rig: WDC Drilling
Activity: Mob & Rig Up

WDC Exploration personnel mobilized to the APS Facility and additional crew members received the site safety awareness orientation. WDC personnel continued rigging up the drilling equipment. The conductor casing was cut approximately one foot above grade and a "Tee" was welded onto the cut piece. The rig unit arrived and was spotted over the conductor casing. The "Tee" section was welded back onto the conductor casing to facilitate fluid circulation while drilling. All ancillary equipment was positioned for drilling operations. The rig mast was raised and secured. Well water was hauled to location and placed into the two 400-barrel frac tanks. The mud logging trailer arrived at the site and was spotted on location. At the end of the workday, rig-up operations were 80% complete.

NO ACCIDENTS **NO SPILLS**

OBSERVATIONS

A near miss occurred during the day. The vacuum truck hauling water from a local water well stopped on the BNSF railroad tracks because the foot on its jack stand contacted a bolt protruding above the surface of the railroad track base. A BNSF train approaching the intersection observed the truck on the tracks and initiated stopping procedures. The vacuum truck backed off the track with ample time before the train reached the intersection. BNSF and APS personnel and local police were dispatched to investigate the incident. No violations were assessed, and additional precautions were taken by the vacuum truck driver on subsequent crossings.

ACTIVITY FORECAST

7/31/09 Finalize rig-up of WDC rig. Fill water tanks. Begin drilling operations. Begin 24-hour operations.

8/01/09 Continue drilling 12-1/4-inch surface hole.

8/02/09 Continue drilling 12-1/4-inch surface hole.

Kirk Delaune
Sandia Technologies, LLC

Fri 7-10-09 Bill Victor, M+A Scottsdale, 480-948-7747
Spud Cholla Tues 7-14 + set 40' conductor

PERMIT TO DRILL

This constitutes the permission and authority from the

OIL AND GAS CONSERVATION COMMISSION,
STATE OF ARIZONA,

To: APS
(OPERATOR)

to drill a well to be known as

CHOLLA CO2 TEST 1 FEE
(WELL NAME)

located 1,782' FSL & 2,079' FEL

Section 30 Township 18N Range 20E, NAVAJO County, Arizona.

The N/A - STRATIGRAPHIC TEST of said Section, Township and Range is dedicated to this well.

Said well is to be drilled substantially as outlined in the attached Application and must be drilled in full compliance with all applicable laws, statutes, rules and regulations of the State of Arizona.

Issued this 5 day of November 2008, 19 .

OIL AND GAS CONSERVATION COMMISSION

By S L Rainey
EXECUTIVE DIRECTOR
OIL AND GAS PROGRAM ADMINISTRATOR

PERMIT 00977

RECEIPT NO. 3160

A.P.I. NO. 02-017-20022

State of Arizona
Oil & Gas Conservation Commission
Permit to Drill

FORM NO. 27

APPLICATION FOR PERMIT TO DRILL OR RE-ENTER

APPLICATION TO DRILL ☒ RE-ENTER OLD WELL ☐

NAME OF COMPANY OR OPERATOR

Arizona Public Service Company

Address	City	State	Phone Number
P.O. Box 188 / Mail Station 4451	Joseph City	Arizona 86032	928-288-1541

Drilling Contractor: Pending

Address:

DESCRIPTION OF WELL AND LEASE

Federal, State or Indian Lease Number, or if fee lease, name of lessor: Fee - Arizona Public Service Company	Well number: Cholla CO2-Test1	Elevation (ground): 5,130
Nearest distance from proposed location to property or lease line: N/A Strategraphic Test Well feet	Distance from proposed location to nearset drilling, completed or applied-for well on the same lease: No other wells feet	
Number of acres in lease: N/A Strategraphic Test Well	Number of wells on lease, including this well, completed in or drilling to this reservoir: No other wells	

If lease purchased with one or more wells drilled, from whom purchased. Name: N/A Address:

Well location (give footage from section lines): 2,079 ft. FEL & 1,782 ft. FSL	Section - Township - Range or Block and Survey: Section 30 T18N R20 E	Dedication per A.A.C. R12-7-104(A)(3): N/A Strategraphic Test Well
Field and reservoir (if wildcat, so state): N/A - Stratigraphic Test Well	County: Navajo County	

Distance in miles and direction from nearest town or post office: 4.5 miles SE from Joseph City, Arizona

Proposed depth: 4,500 feet	Rotary or cable tools: Rotary	Approximate date work will start: January 5, 2009
Bond status: Attached Amount: $25,000	Organization Report On file Or attached X	Filing Fee of $25.00 Attached X

Remarks

CERTIFICATE: I, the undersigned, under the penalty of perjury, state that I am the: Cholla Power Plant Manager of the Arizona Public Service Company (company), and that I am authorized by said company to make this report; and that this report was prepared under my supervision and direction and that the facts stated therein are true, correct and complete to the best of my knowledge.

API # 02-017-20022

Signature

3 Nov 2008

Date

Mail completed form to:
Oil and Gas Program Administrator
Arizona Geological Survey
416 W. Congress, #100
Tucson, AZ 85701-1315

Permit Number: 977

Approval Date: 11-5-2008

Approved By: SC Rains

NOTICE: Before sending in this form be sure that you have given all information requested. Much unnecessary correspondence will thus be avoided.

STATE OF ARIZONA

OIL & GAS CONSERVATION COMMISSION

Application to Drill or Re-enter
File Two Copies

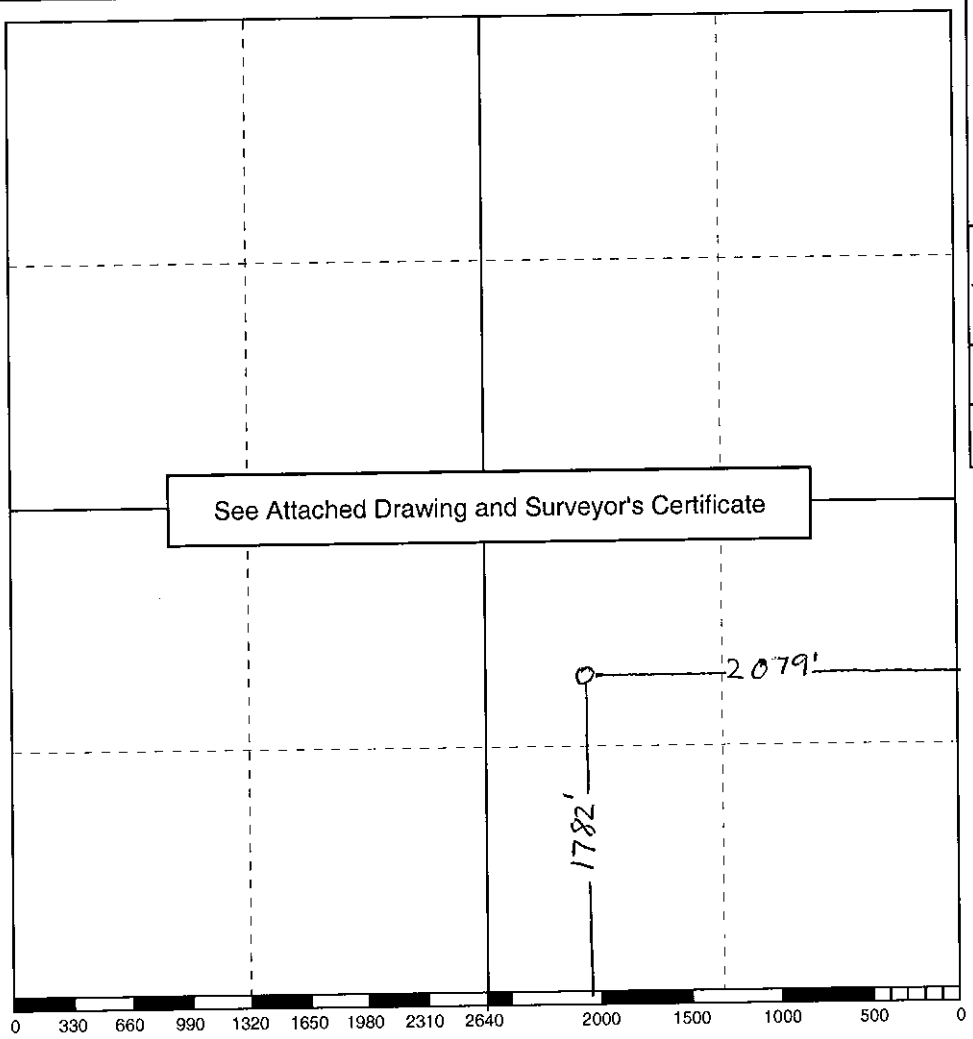
Form No. 3

(Complete Reverse Side)

P/N 977

1. Operator shall outline on the plat the acreage dedicated to the well in compliance with A.A.C. R12-7-107.
   N/A Stratigraphic Test Well
2. A registered surveyor shall show on the plat the location of the well and certify this information in the space provided.
3. ALL DISTANCES SHOWN ON THE PLAT MUST BE FROM THE OUTER BOUNDARIES OF THE SECTION.
4. Is the operator the only owner in the dedicated acreage outlined on the plat below ? YES X NO ____
5. If the answer to question four is no, have the interests of all owners been consolidated by communitization agreement or otherwise?
   YES ____ NO ____ If answer is yes, give type of consolidation ____
6. If the answer to question four is no, list all the owners and their respective interests below:

Owner	Land Description
Arizona Public Service Company	Section 30 T18N R20E
	G & SRM



CERTIFICATION

I hereby certify that the information abov is true and complete to the best of my knowledge and belief.

Name

Position

Company

Date

I hereby certify that the well location shown on the plat was plotted from field notes of actual surveys made by me or under my supervision, and that the same is true and correct to the best of my knowledge and belief.

Date Surveyed

Registered Land Surveyor

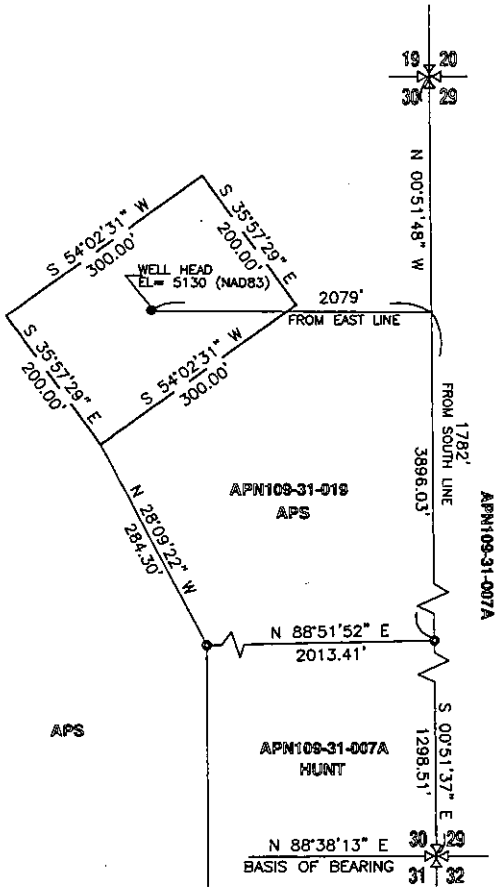
Certificate No.

PROPOSED CASING PROGRAM

Size of Casing	Weight	Grade & Type	Top	Bottom	Cementing Depths	Sacks Cement	Type
Conductor - 13-3/8"	48 lb/ft	H-40	0 ft	40 ft	0 - 40 ft	2 cu. yds	Concrete/Grout
Surface Casing 9-5/8"	36 lb/ft	J-55	0 ft	965 ft	0 - 965 ft	300 sacks	Class G
ProductionCasing 5-1/2"	15.5 lb/ft	J-55	0 ft	4,000 ft	0 - 4,000 ft	380 sacks/Lead Slurry	Class G
						120 sacks/Tail Slurry	50-50Pozmix

RESULTS OF SURVEY
FOR
APS WELL SITE

SE 1/4, SEC 30, T 18 N, R 20 E
GILA & SALT RIVER MERIDIAN
NAVAJO COUNTY, ARIZONA



LEGAL DESCRIPTION

WELL LOT

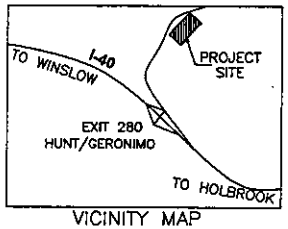
A PARCEL OF LAND SITUATED WITHIN SECTION 30, TOWNSHIP 18 NORTH, RANGE 20 EAST, GILA & SALT RIVER MERIDIAN, NAVAJO COUNTY, ARIZONA AND MORE PARTICULARLY DESCRIBED AS FOLLOWS:

COMMENCING AT THE SOUTHEAST CORNER OF SAID SECTION 30, THENCE N 00° 51' 37" W, ALONG THE EAST SECTION LINE, A DISTANCE OF 1298.51 FEET TO A APS REBAR & CAP; THENCE S 88° 51' 52" W A DISTANCE OF 1298.51 FEET A APS REBAR & CAP; THENCE N 28° 09' 22" W A DISTANCE OF 284.30 FEET TO

THE POINT OF BEGINNING:

THENCE N 35° 57' 29" W A DISTANCE OF 200.00 FEET;
THENCE N 54° 02' 31" E A DISTANCE OF 300.00 FEET;
THENCE S 35° 57' 29" E A DISTANCE OF 200.00 FEET;
THENCE S 54° 02' 31" W A DISTANCE OF 300.00 FEET;
TO THE **POINT OF BEGINNING**.

SAID PARCEL CONTAINS 1.38 ACRES, MORE OR LESS.



VICINITY MAP

LEGEND

- FOUND SECTION CORNER AS NOTED
- FOUND 5/8" REBAR & APS CAP
- WELL HEAD

SURVEYOR'S NOTE:

THIS DRAWING DOES NOT REFLECT ANY **RIGHT-OF-WAYS, EASEMENTS,** OR OTHER **ENCUMBRANCES** WHICH WOULD BE REVEALED BY A CURRENT TITLE REPORT.

BASIS OF BEARING

N 88°38'13" E ALONG THE SOUTH LINE OF SECTION 30 AS DETERMINED BY RTK GPS OBSERVATION.

SURVEYORS CERTIFICATION

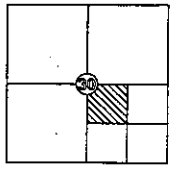
REGISTERED LAND SURVEYOR CERTIFICATE NO. 19810 Harold Baldwin DATE SIGNED 11-7-08 ARIZONA, U.S.A.

REGISTRATION EXPIRES 3/31/11

I HAROLD BALDWIN CERTIFY THAT THE SURVEY SHOWN HEREON WAS DONE UNDER MY DIRECT SUPERVISION DURING THE MONTH OF OCTOBER, 2008 AND IS CORRECT AND ACCURATE TO THE BEST OF MY ABILITY AND KNOWLEDGE, AND THAT THE SURVEY MONUMENTS SHOWN HEREON HAVE BEEN LOCATED AS SHOWN.

N

0 50 100 200



S30, T18N, R20E

SCALE	1" = 100'
DRAWN BY	CA
CHECKED BY	HB
FIELD WORK BY	ED, CA
DATE	OCT 2008
JOB NO.	08078
MAP NO.	1 OF 1
REVISION	N/A
PREPARED FOR	APS

RESULTS OF SURVEY
FOR
APS WELL SITE
SECTION 30, T.18N., R.20.E
GILA, & SALT RIVER MERIDIAN
NAVAJO COUNTY, ARIZONA

ALPHA-OMEGA ENGINEERING & SURVEY, LLC
15138 N. MAIN ST. SNOWFLAKE, AZ 85937
PH. 928-536-7971 / FAX 928-536-5697

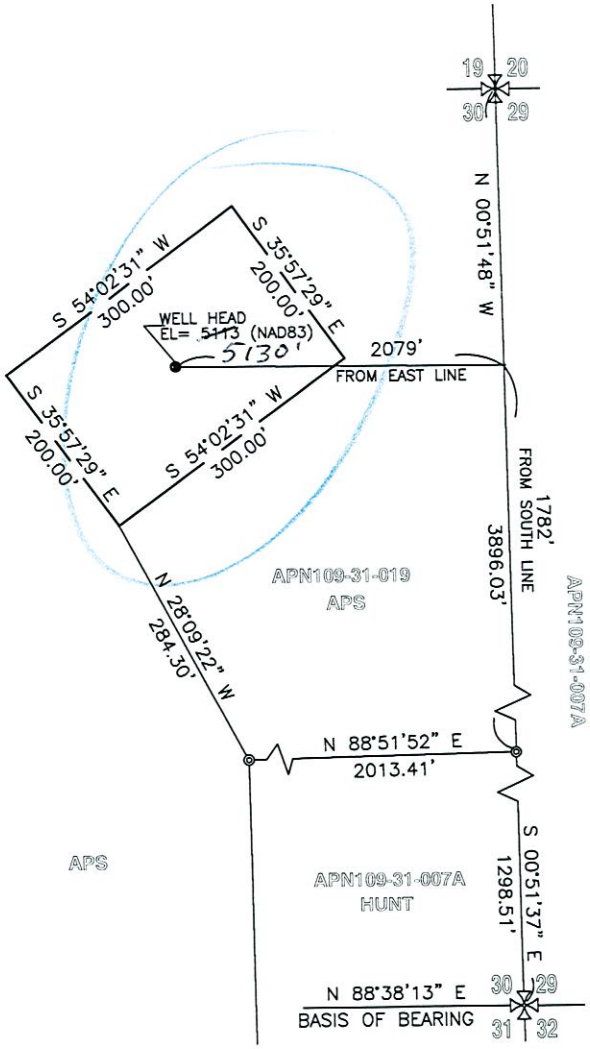
977

RESULTS OF SURVEY

FOR

APS WELL SITE

SE 1/4, SEC 30, T 18 N, R 20 E
GILA & SALT RIVER MERIDIAN
NAVAJO COUNTY, ARIZONA



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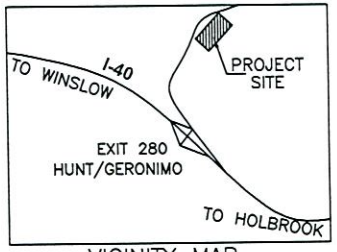

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REGISTERED LAND SURVEYOR
CERTIFICATE NO. 19810
Harold Baldwin
Date Signed
ARIZONA, U.S.A.

REGISTRATION EXPIRES 3/31/11

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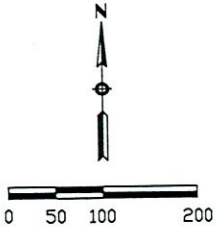

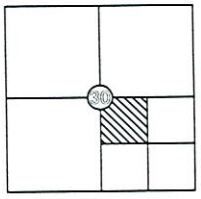

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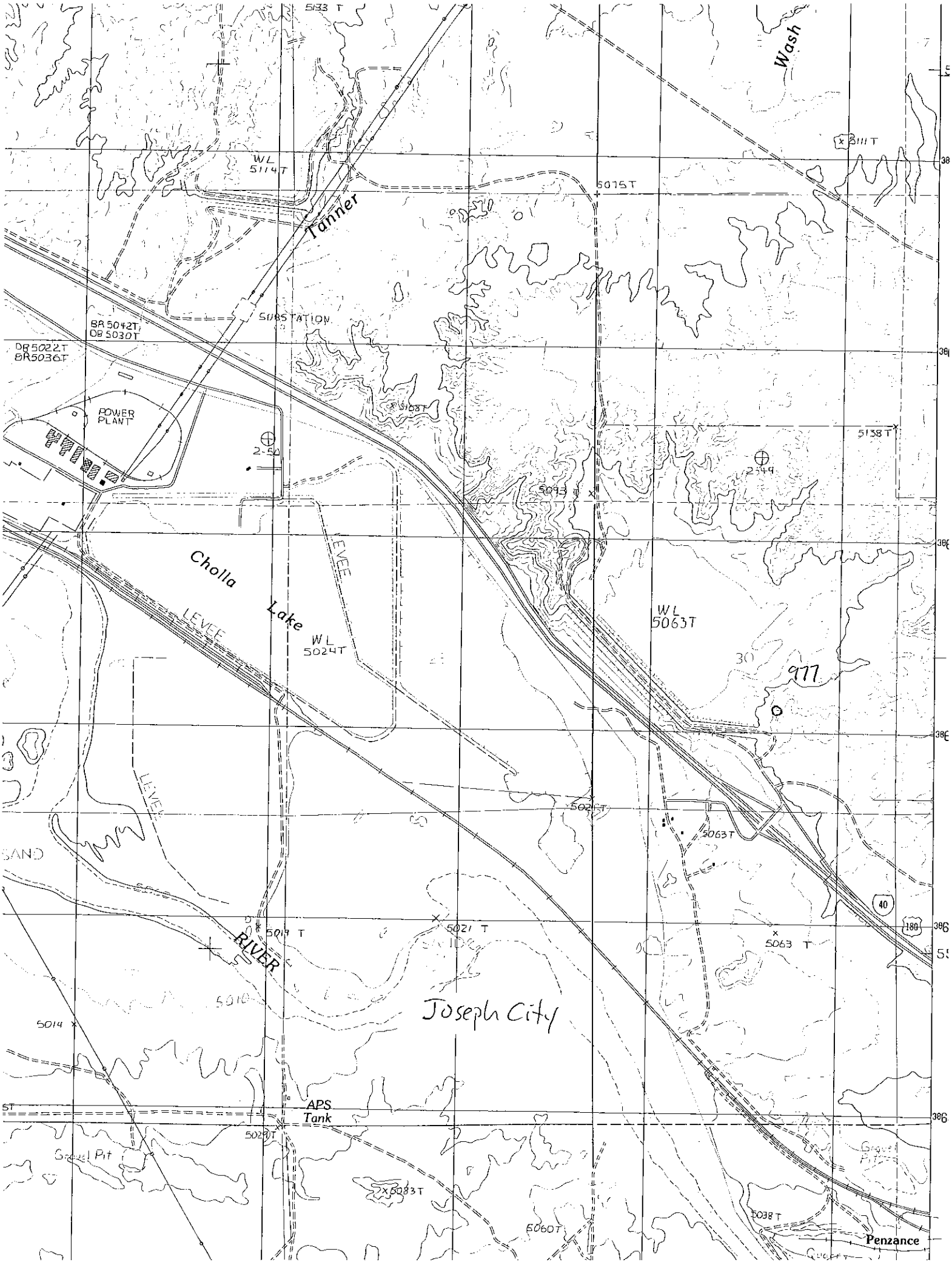

Wash
Tanner
WL 5114T
5075T
5111T
SUBSTATION
BR5042T
DB5030T
DB5022T
BR5036T
POWER PLANT
2-50
5108T
5138T
2-49
5093T
Cholla Lake
LEVEE
WL 5024T
WL 5063T
30
977
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180
5019T
5021T
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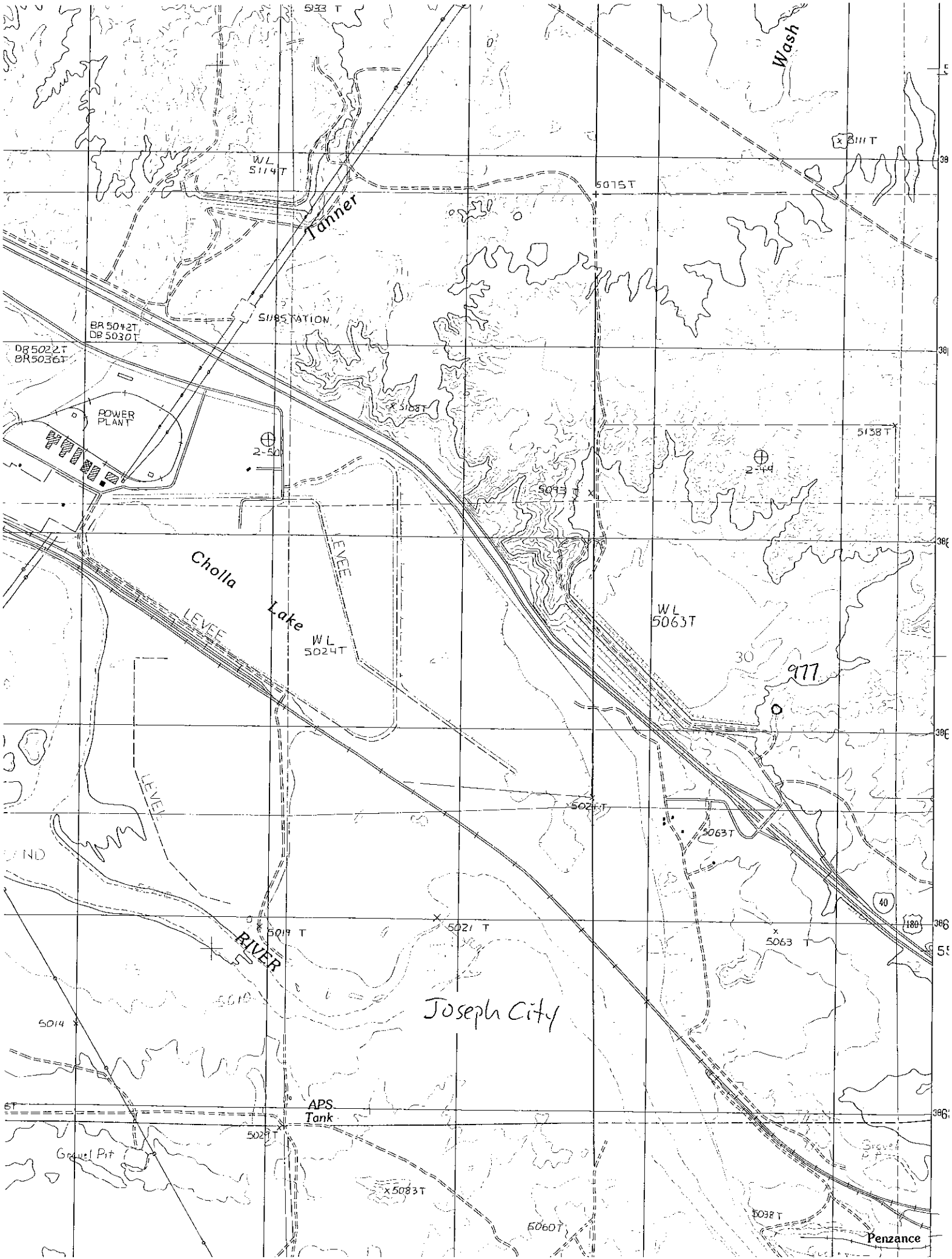
RIVER
5010
Joseph City
5014
APS Tank
5029T
Gravel Pit
5083T
5060T
5038T
Penzance



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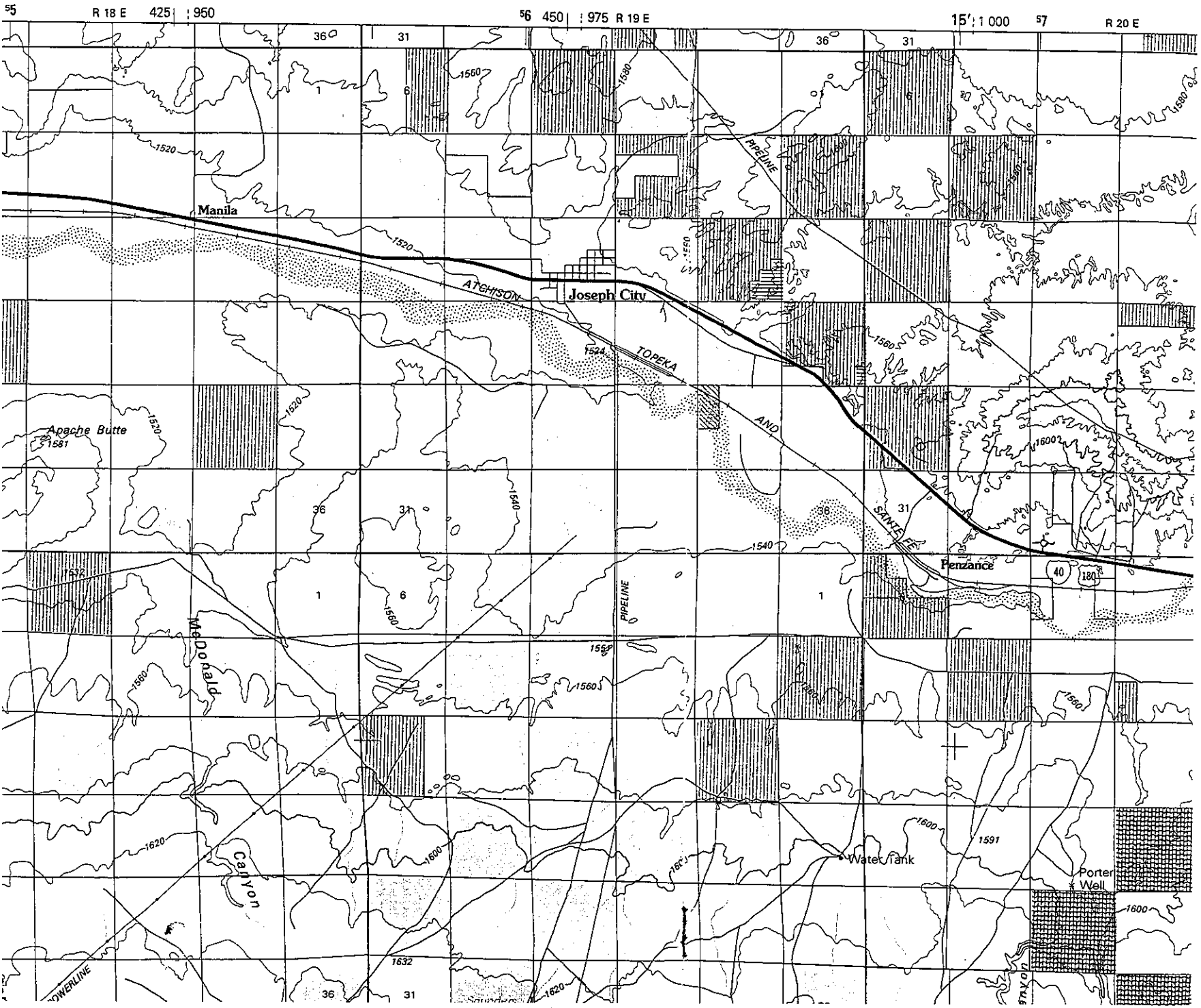
R 18 E
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Manila
Joseph City
ATCHISON
TOPEKA
AND
SANTA FE
PIPELINE
Penzance
Apache Butte
1581
McDonald
Canyon
Water Tank
Porter
Well
POWERLINE
40
180

Arizona Utilities CO_2 Sequestration Pilot Project
WELL CONSTRUCTION PLAN

Arizona Public Service Company (APS) is requesting a permit to drill one CO_2 Injection Well for a Pilot Test on Arizona Public Service Company property. The injection interval is anticipated to be a sedimentary formation containing highly saline waters. The primary target interval is the Martin Formation, with a backup interval being the shallower Naco Formation, should the Martin Formation be found to be unsuitable.

APS has partnered with Salt River Project (SRP), Tucson Electric Power (TEP), Arizona Electric Power Cooperative (AEPCO), Department of Energy (DOE), California Energy Commission (CEC), and the Electric Power Research Institute (EPRI) to conduct a pilot test to evaluate the geologic storage of carbon dioxide (CO_2). The overall goal of the Arizona Utilities CO_2 Sequestration Pilot Project is to gain practical experience with, and demonstrate the potential for, safe CO_2 storage in deep underground geologic formations in a location with large CO_2 sources and large CO_2 storage potential. In addition, new monitoring approaches will be tested and a two-way exchange of information will be established with governmental agencies and the public.

Well Construction Information
The following sections describe the procedures that will be followed to drill and complete the CO_2 Injection Well prior to initiating the Pilot Test experiment. Note that the expected surface elevation at the Test Site is approximately 5,120 feet above mean sea level and all depths in this attachment are referenced to the drilling rig kelly bushing (standard drilling reference location), which is anticipated to be located at 15 feet above ground elevation.

Total Well Depth
Proposed total drilling depth for the CO_2 Injection Well will be +/-4,000 feet below kelly bushing. At total depth, the CO_2 Injection Well is expected to be in the Pre-Cambrian basement. Protection casing will likely be set into the Pre-Cambrian basement to allow for sufficient rat hole below the Martin Formation for logging and testing (baseline and post-injection) purposes.

Well Casing Specifications
Following rig up of the drilling rig, a 17-1/2-inch conductor hole will be drilled to approximately 40 feet, and 13-3/8-inch conductor casing will be set and cemented from drilled depth to surface. A surface hole will be drilled using a 12-1/4-inch bit to +/-965 feet (just below the base of the Schnebly Hill Formation), and 9-5/8-inch surface casing will be cemented from total depth to surface. A 8-1/2-inch protection hole will drilled to +/-4,000 feet, where 5-1/2-inch protection casing will be set. The 5-1/2-inch protection casing will be cemented back to surface. Casing specifications for the proposed CO_2 Injection Well are shown in Table L1. The casing strings are more than adequately designed for the short life of the Arizona Utilities CO_2 Storage Pilot experiment.

Table L1. Proposed CO_2 Injection Well – Casing Specifications

TUBULAR	Depth (ft)	Size (in)	Weight (lb./ft)	Grade	Thread	Collapse/ Burst (psi)	Tensile Body/Joint (X 1000 lbs.)
Conductor	0 - 40	13-3/8	48	H-40	ST&C	770/1,730	541/322
Surface Casing	0 – 965	9-5/8	36	J-55	ST&C	2,020/3,520	564/394
Protection Casing	0 – 4,000	5-1/2	15.5	J-55	LT&C	4,040/4,810	248/217

Well Drilling Program

The following sections contain the proposed step-by-step program for drilling and completing the proposed CO_2 Injection Well. The CO_2 Injection Well will be used for baseline monitoring and characterization, injection of the CO_2 fluid during the active experiment, and post-injection monitoring of the intervals of interest.

DRILLING PROCEDURE

CONDUCTOR HOLE

1. Prepare surface pad location and install well cellar.
2. Mobilize drilling rig. Perform safety audit during rig-up to ensure that equipment setup complies with project requirements.
3. Notify Arizona Oil and Gas Conservation Commission at least 48 hours prior to spudding the well.
4. Drill mouse and rat holes.
5. Drill 17-1/2" conductor hole to +/-40 feet. Install 13-3/8" casing and grout annular space from set depth to surface with concrete.
6. Wait on concrete to cure for 12 hours.

SURFACE HOLE

7. Rig up mud logging unit and test equipment. Collect and save 10-foot samples from 40 feet to total depth. A set of samples is required to be submitted to the Oil and Gas Administrator, Arizona Geological Survey, within 30 days of completion of the well. Samples should be: 1) washed and dried, 2) place approximately 3 tablespoons of sample in an envelope identifying the well, the well location, the Arizona Oil and Gas Conservation Commission's Permit Number, and the depth of the sample. Samples to be shipped to:

   Oil and Gas Administrator
   Arizona Geological Survey
   416 West Congress, Suite 100
   Tucson, AZ 85701

8. Pick up 12-1/4 inch bit and the bottomhole assembly (BHA). Drill a 12-1/4 inch surface hole to +/-965 feet (below base of Schnebly Hill) using freshwater spud mud, as detailed in the Drilling Fluids Program section below. Take deviation surveys every 500 feet and at total depth. The recommended maximum allowable deviation from vertical is 3 degrees with a maximum recommended deviation of no more that 2 degrees per 100 feet (to minimize dogleg severity) at any point in the borehole. If the maximum recommended deviation is exceeded, an evaluation will be made to determine whether remedial action is necessary. After reaching surface casing setting depth, the drilling fluid will be circulated and conditioned to ensure correct fluid properties for the open hole logging and testing.

9. Run open-hole formation evaluation logs per the requirements of the Well Logging, Coring, and Testing Program (See Exhibit 1).

   If the logging procedure is extended and/or hole becomes sticky or unstable during logging, a conditioning/cleanup trip will be made with the drill string to circulate and condition the drilling fluid. The drilling string will be removed from the well and the logging program will be completed as planned.

10. Notify Arizona Oil and Gas Conservation Commission at least 48 hours prior to setting and cementing the surface casing.

11. Lower the 12-1/4" drilling assembly in the well to the total depth. The drilling fluid will be circulated and conditioned to ensure correct fluid properties for the casing installation and cementing. Remove the drilling assembly from the well.

12. Run 9-5/8 inch surface casing to +/-965 feet. See the Well Casing Specifications section above for a detailed description of the casing and casing equipment.

    Reduce mud levels in surface circulating system and have additional tanks on hand to recover any excess mud or cement that may be circulated to the surface.

    Designate a qualified person to observe the circulating system and monitor drilling fluid at all times during the cementing procedure. An accurate accounting of volumes will be critical information in the event that circulation is lost.

13. Rig up circulating equipment and perform a pressure test on the lines. Circulate and condition the drilling fluid to ensure correct fluid properties for the cementing procedure. Reciprocate the casing continuously during the circulation of the drilling fluid.

14. Cement the casing in place. Details of the cement blends proposed are located in the Well Construction Cementing Program section below.

    Be prepared to divert cement and cement-contaminated drilling fluid returns away from circulating system and into appropriate containment. Use sugar to retard the premature setting of the cement, if necessary.

15. If no cement returns are observed at surface, contact wireline service provider and schedule a temperature survey to determine the top of the cement.

16. Center the casing in the rotary table of the drilling rig after completing the cementing procedure and before the cement hardens.

17. Cement the annular space that does not contain cement, if required. Fill the annulus space by pumping cement through small tubing that has been run into the annulus to the top of cement.

18. After waiting on cement to harden for a minimum of 12 hours, cut off the surface and conductor pipe and install a 9-5/8 inch SOW (slip-on for welding) x 11-inch 3,000-psi casing head flange. Perform a pressure test on the casing head after installation. Digitally record the test and maintain a copy of the test results on location. Transfer the original test data to the Sandia Office for inclusion in the CO_2 Injection Well Report.

PROTECTION HOLE

19. Install 11-inch 3,000 psi double ram blow out preventer, 11-inch 3,000 psi annular preventer, and auxiliary well control equipment on the 11-inch, 3,000 psi casing head flange. Perform a pressure test on the equipment to the lesser of the manufacturer's full working pressure rating of the system, 70 percent of the minimum internal yield pressure of any casing subject to test, or one psi per foot of the last casing string depth. Annular or bag-type preventers shall be tested to the lesser of 1,000 psi or 50 percent of the full working pressure on installation. The blowout preventer and related equipment will be tested, as follows: a) after each string of casing is set in the well, b) not less than once every 14 days, and c) following any repairs that required the disconnection of any pressure seal assembly (note, only the repaired or replaced component need be tested unless alteration or repair occurs at a normal full blowout preventer test period).

20. Pick up an 8-1/2 inch bit, BHA, and trip in the hole to the top of cement with the drill pipe. Include drilling stabilizers above the second and third drill collars. Close pipe rams and perform a pressure test on the surface casing for at least 30 minutes. The surface casing will be pressure tested for at least 30 minutes to 70 percent of the internal yield pressure of the casing or one pound per square inch (psi) per foot of setting depth (whichever is less). A successful test is a drop of no more than 10 percent of the test pressure over the 30-minute time period. Digitally record the test and maintain a copy of the test results on location. Transfer the original test data to the Sandia Office for inclusion in the CO_2 Injection Well Report.

21. Convert the drilling fluid in the well to a salt-based drilling fluid. Details of the drilling fluid characteristics are located in the Drilling Fluids Program section below.

22. Drill out casing float equipment and 10 feet of new hole.

23. Perform a pressure test on the casing seat and formation to pressure leak-off point or to an 11.0 pounds per gallon equivalent drilling fluid density.

24. Drill an 8-1/2 inch hole from surface casing point to the core point in the Martin Formation. Alternatively, sidewall coring may be done as part of the wireline activities in Item #26. Take deviation surveys every 500 feet and at core point. The recommended maximum allowable deviation from vertical is 3 degrees with a maximum recommended deviation of no more that 2 degrees per 100 feet (to

minimize dogleg severity) at any point in the borehole. If the maximum recommended deviation is exceeded, an evaluation will be made to determine whether remedial action is necessary. Details of the coring program are described above in Exhibit 1. Monitor the well path as drilling proceeds.

25. Drill and retrieve the core (Martin proposed injection interval), unless sidewall coring is done instead.

26. Pick up the drilling assembly and lower into the well. Drill the cored interval (if taken) and continue drilling to the proposed total depth (+/-4,000 feet true vertical depth) into the Pre-Cambrian basement. Take deviation surveys every 500 feet and at total depth. The recommended maximum allowable deviation from vertical is 3 degrees with a maximum recommended deviation of no more that 2 degrees per 100 feet (to minimize dogleg severity) at any point in the borehole. If the maximum recommended deviation is exceeded, an evaluation will be made to determine whether remedial action is necessary.

27. After reaching total depth, circulate and condition the drilling fluid to ensure correct fluid properties for the wireline logging procedure. Make a short trip by pulling up into the 9-5/8-inch surface casing with the drill bit and BHA. Lower the drilling assembly back to bottom and check for solids fill. Resume circulating and conditioning drilling fluid and wellbore for open hole logging. Remove drilling assembly from well for open hole logging.

    Measure the drill string on the trip out to confirm well depth.

28. Rig up wireline equipment and run the open-hole logging and sampling suite. See Exhibit 1 for Well Logging, Coring and Testing details.

    If the logging procedure is extended and/or hole becomes sticky or unstable during logging, a conditioning/cleanup trip will be made with the drill string to circulate and condition the drilling fluid. The drilling string will be removed from the well and the logging program will be completed as planned.

29. After completing all wireline logging and sampling, go into the hole with bit, drill collars, and drill pipe to bottom. Check and note presence of any fill at the bottom of the hole. Circulate hole clean, condition the drilling fluid for running of the protection casing. Note, a high viscosity pill may be required to keep the bottom portion of the hole open.

30. Pull out of the hole with the drilling assembly. Lay down drill pipe and drilling assembly.

    Notify Arizona Oil and Gas Conservation Commission and USEPA of upcoming cement job at least 48 hours ahead of anticipated activities.

31. Rig up casing handling and make-up equipment. Run the 5-1/2 inch protection casing. Details of the casing program are described in the Well Casing Specifications section above. Set a differential shoe and a differential collar between the second and third joint.

    Ensure that all dimensions of cementing equipment and casing are visually inspected, measured, and drifted before running in the hole.

API Modified thread lubricant or equivalent will be used unless premium threads and/or corrosion resistant casing are used.

Have a casing swedge available, on the rig floor, with circulating hoses ready, in the event the casing must be washed to bottom or in the event that well control procedures are required.

32. Once the casing is on bottom, rig up and circulate the hole for a minimum of 150% of the open hole volume to clear the floats and cool the formation sufficiently for cementing. Add water and chemicals to the drilling fluid to adjust the characteristics of the fluid to improve drilling mud removal from the annulus during the cementing procedure.

    Reciprocate the pipe slowly, but continuously, in ±20-foot strokes during the circulating and cementing operations. If the movement of the pipe begins to indicate that sticking is occurring, lower the pipe to planned setting depth and discontinue pipe movement.

    Reduce mud levels in surface circulating system and have additional tanks on hand to recover any excess mud or cement that may be circulated to the surface.

    Designate a qualified person to observe the circulating system and monitor drilling fluid at all times during the cementing procedure. An accurate accounting of volumes will be critical information in the event that circulation is lost.

33. Mix and pump the cement. Details of the cementing program are described in the Well Construction Cementing Program section below. Displace the cement with drilling mud, 2% KCl, or fresh water.

34. Lift the BOP stack and hang off the 5-1/2" casing in tension (same hook load as when originally cemented in place). Nipple up the 7-1/16-inch 3,000 psi x 11-inch 3,000 psi tubing spool and perform a pressure test on the seals to the manufacturer's specifications. Isolate the well by installing a 7-1/16-inch 3,000 psi tapped flange with valve on the tubing spool.

35. Rig down the drilling rig and release rig from location. Remove and clean location of all drilling equipment.

COMPLETION PROCEDURE

PROTECTION CASING AND CEMENT EVALUATION

1. Mobilize a workover rig to location and rig up the equipment (note that the drilling rig may be used for completion operations, depending on availability and scheduling). Perform safety audit during rig-up to ensure that equipment setup complies with project requirements.

2. Install 7-1/16" 3,000 psi dual blow out preventer on well and pressure test.

3. Pick up a 4-3/4-inch cement bit and two casing scrapers, trip into the hole with a workstring to tag the top of cement in the casing.

4. Verify tagged depth and dress off cement as needed. Circulate the fluid in the wellbore to remove any solids. Displace the wellbore with filtered 2% KCl or other suitable completion fluid. Pull the workstring, scrapers, and bit.
5. Rig up wireline equipment and lubricator to the top of the annular BOP. Perform a 2,000-psig pressure test on the lubricator. Run cement evaluation/casing inspection/caliper logs, differential temperature survey, and gyroscopic survey as detailed in Exhibit 1, Well Logging, Coring and Testing. Run cement bond log initially under zero pressure. A repeat run at elevated pressure may be necessary to remove effects from potential micro-annulus. Run cement evaluation/casing inspection logs to surface or approximately 500 feet above the top of calculated annular cement. Rig down wireline equipment.
6. Perform a pressure test on the casing to 70 percent of the manufacturer's rated internal yield pressure or one psi per foot of casing depth, which ever is less, for at least 30 minutes. Note: Arizona Oil and Gas Conservation Commission and/or USEPA may witness casing pressure test. A successful test is a drop of no more than 10 percent of the test pressure over the 30-minute time period. Digitally record the test and maintain a copy of the test results on location. The original copy of the pressure test record **MUST** be sent in to the Sandia Office and made part of the CO_2 Injection Well report. Keep a copy of the pressure test record at the CO_2 Injection Well site with other important records.

WELL COMPLETION – CO_2 INJECTION PILOT

7. Run any pre-experiment baseline testing that requires the well to be clear of completion equipment (such as the baseline VSP).
8. Rig up wireline unit and set up perforating charges. Run in hole and correlate perforation gun(s) on depth. Perforate the Martin Formation (or alternate Naco Formation) injection interval as determined from the open-hole logs. It is recommended that the well be perforated **underbalanced**, to aid in perforation tunnel clean up.
9. Produce formation fluid from the Martin Formation by swabbing or backlift. This will also aid in developing the well. Monitor formation fluid properties at surface (chlorides, pH, temperature, specific gravity, etc.). Continue flowing the well until parameters stabilize, indicating that formation fluids are being recovered. Collect samples periodically for laboratory analysis. Once clean and stable formation brine is established, divert returns to a "fresh" frac tank(s). The stored formation fluids will be used for injection testing of the injection interval.
10. Pick up completion packer and tubing. Attach any downhole monitoring equipment and control lines. Run the completion assembly into the well. Once on bottom, circulate the well with clean formation brine.
11. Space out tubing string and set the packer +/-10 feet above the uppermost perforation in the Martin Formation injection interval.
12. Land the tubing into the wellhead.
13. Install wellhead equipment and control lines.

14. Allow well to equilibrate and perform annulus pressure test. The pressure test will be run at equal to the lesser of the maximum authorized injection pressure or 1,000 psi (no testing pressure will be less than 300 psi). A successful test is a drop of no more than 10 percent of the test pressure over the 30-minute time period. Digitally record the test and maintain a copy of the test results on location. *Note: Arizona Oil and Gas Conservation Commission & USEPA may witness annulus pressure test.* The original copy of the pressure test record **MUST** be sent in to the Sandia Office and made part of the well report. Keep a copy of the pressure test record at the well site with other important records.
15. Rig down the workover rig and move out associated equipment.

GENERAL NOTES

All depths referenced are approximate and are based on the expected log depth from rig Kelly bushing of 15 feet above ground level.

Actual depths may vary based on lithology and evaluation of local formations.

DRILLING FLUIDS PROGRAM

Surface Hole

Depth (Feet)	Mud Type	Weight (Lb./gal)	Viscosity (Funnel-sec.)	Fluid Loss (cc/30 min)
40-300	Freshwater Gel	8.4 – 9.0	40 - 60	control
300-965	Freshwater Gel	8.4 – 9.0	50 - 60	<10

Notes:

1. Should lost circulation and excessive drilling mud losses occur, materials designed for that problem will be used to remedy the problem on an "as needed" basis.
2. High-viscosity sweeps will be used as needed to assist in hole cleaning.

Protection Hole

Depth (Feet)	Mud Type	Weight (Lb./gal)	Viscosity (Funnel-sec.)	Fluid Loss (cc/30 min)
965-2,300	Saltwater Gel	9.5 - 10.5	35-42	<10
2,300-4,000	Saltwater Gel	9.5 - 10.5	35-42	≤5

Notes:

1. Should lost circulation and/or excessive drilling mud losses occur, materials designed for that problem will be used to remedy the problem on an "as needed" basis.
2. High-viscosity sweeps will be used as needed to assist in hole cleaning.

Completion Fluid
Potassium Chloride (KCl) brine is planned for use as the completion fluid. The fluid weight will be maintained to contain reservoir pressures at balance without inducing flow to the wellbore. Only during perforating will the well be in an underbalanced condition. This underbalance will aid in perforation tunnel clean up.

Annular Completion Fluid
The annular completion fluid for the well will be an inhibited KCl brine or native brine solution oxygen scavenger additives will be mixed with the annular completion fluid prior to pumping into the well.

WASTE FLUID AND SOLIDS MANAGEMENT PLANNING

Prior to mobilizing equipment to the CO_2 Injection Well location, the area beneath the drill rig footprint and surrounding area will be cleared and graded. The area will be constructed in a manner to divert any collected liquids to the well cellar or to a sump. The liquids collected in the cellar or sump will be periodically removed and recycled within the active fluid system or disposed of in an approved facility according to their classification.

Drilling mud that is circulated out of the hole will flow through solids control equipment consisting at a minimum of a shale shaker, desander, and/or desilter to remove drill cuttings and other solids from the circulating mud system. The surface system will be "closed loop" and contained at all times. Components of the closed-loop system will be bermed to allow for containment and collection. All drill cuttings and removed solids will be contained and characterized for proper disposal according to applicable state regulations.

Upon completion of the proposed CO_2 Injection Well, the drilling mud will be dewatered to separate the solids from the liquids. The solids will be characterized and disposed of according to all applicable state regulations. The liquids will be characterized and disposed of according to all applicable state regulations at another approved facility appropriate to receive the properly classified wastes.

WELL CONSTRUCTION CEMENTING PROGRAM

Conductor Casing
The following cementing program is proposed for installation of the conductor casing:

- 13-3/8" in 17-1/2" hole at +/-40 feet
- grouted to surface

Conductor casing will be grouted to the surface with approximately 2 cubic yards of concrete slurry. Wait on concrete a minimum of 12 hours before drilling out with the 12-1/4" surface hole bit.

Surface Casing
The following cementing program is proposed for installation of the surface casing string:

- 9-5/8" in 12-1/4" hole at +/-965 feet
- cement to surface
- actual volume to be calculated from open hole borehole caliper log plus 20% excess

Surface casing will be cemented to the surface with Lead Slurry of lightweight cement mixed at ~12.3 lb/gal with Class "G" cement and Tail Slurry of Class "G" cement mixed at ~15.6 lb/gal. Wait on cement a minimum of 12 hours before releasing and cutting casing.

> Note: Final surface hole cement slurries will be designed for the actual wellbore conditions and the cementing company's recommendations.

Protection Casing
The following cementing program is proposed for installation of the protection casing (longstring) string:

- 5-1/2" in 8-1/2" hole at +/- 4,000 feet
- cement to surface
- actual volume to be calculated from open hole borehole caliper log plus 20% excess

Cement protection casing from total depth to surface with Lead Slurry of lightweight cement mixed at ~11.50 lb/gal with Class "G" cement and Tail Slurry of 50-50 pozmix cement mixed at ~13.5 lb/gal. Displace the cement with clean 2 percent KCl water (or fresh water).

> Note: Final protection hole cement slurries will be designed for the actual wellbore conditions and the cementing company's recommendations. The final design may incorporate a two-stage cementing program with a cementing stage tool in the 5-1/2" casing string.

CEMENTING ACCESSORIES

Conductor Casing
13-3/8" Float Equipment and Casing Equipment

1. Guide Shoe - 8rd STC
2. Hinged Bow Spring Centralizers
    - Centralizer 10 feet above the guide shoe, straddling a stop collar
    - Centralizer 10 feet below the first casing collar, straddling a stop collar

Surface Casing
9-5/8" Float Equipment and Casing Equipment

1. Float Shoe - 8rd STC
2. Float Collar, installed 2 joints above the float shoe
3. Bottom Wiper Plug
4. Top Wiper Plug
5. Hinged Bow Spring Centralizers
   - 1 Centralizer 10 feet above the float shoe, straddling a stop collar
   - 1 Centralizer straddling the first casing collar above the float shoe
   - 1 Centralizer 10 feet above the float collar, straddling a stop collar
   - 1 Centralizer every other collar, up to the surface

Protection Casing ("Longstring")
5-1/2" Float Equipment and Casing Equipment

1. Float Shoe
2. Float Collar, 2 joints above the float shoe
3. Bottom Wiper Plug
4. Top Wiper Plug
5. Hinged Bow Spring Centralizers
   - Centralizer 10 feet above the float shoe, straddling a stop collar
   - Centralizer straddling the first casing collar above the float shoe
   - Centralizer 10 feet above the float collar, straddling a stop collar
   - 1 Centralizer every other collar, up to the surface

Well Tubing Specifications
The proposed injection well will be completed with 2-7/8-inch tubing set within a 5-1/2-inch protection casing string. The protection casing string will be set through the Martin Formation to approximately 4,000 feet. This will allow sufficient rat hole below the completion to run anticipated experiment monitoring and testing equipment. Injection tubing specifications for the proposed injection well are shown in Table L2. The tubing string is designed for the anticipated short duration of the CO_2 injection experiment.

Table L2. Proposed CO_2 Injection Well – Injection Tubing Specifications

TUBULAR	Depth (ft)	Size (in)	Weight (lb./ft)	Grade	Thread	Collapse/ Burst (psi)	Tensile Body/Joint (X 1000 lbs.)
Injection Tubing	0 -3,660	2-7/8	6.5	J-55	EUE 8rd	7,680/7,260	99.66/100

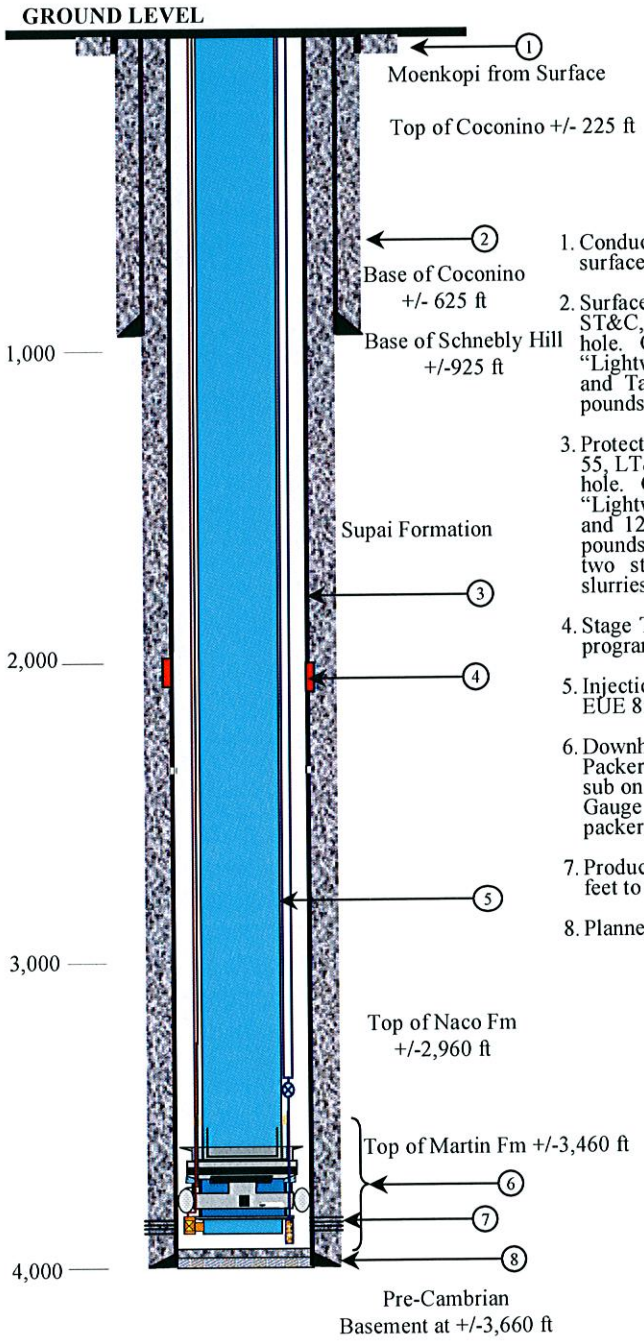
Well Packer Information

The completion packer will be set just above the perforated interval (approximately 10 feet above the top of perforations). Proposed packer is an inflatable 5-1/2-inch by 2-3/8-inch packer, or equivalent. The packer is designed for the life of the CO_2 injection experiment. For design of the CO_2 Injection Well, the packer setting depth is specified as approximately 3,660 feet (top of Martin Formation).

CONSTRUCTION DETAILS –

Arizona Utilities CO_2 Storage Pilot Injection Well

Proposed Completion Well Schematic



All depths reference Rig Kelly Bushing

Rig Kelly Bushing = 15' above Ground Level

Ground Level ~ 5,120'

COMPLETION DETAILS

1. Conductor Casing: 13-3/8-inch, 48 pounds per foot, surface to +/-40 feet, grouted to surface
2. Surface Casing: 9-5/8-inch, 36-pounds per foot. J-55, ST&C, Set from surface to +/-965 feet in a 12-1/4-inch hole. Cemented with Lead Slurry of 300 sacks of "Lightweight" cement mixed at ~12.3 pounds per gallon and Tail Slurry of Class "G" cement mixed at ~15.6 pounds per gallon.
3. Protection Casing: 5-1/2-inch 15.50 pounds per foot, J-55, LT&C. Set from surface to 4,000 feet in a 8-1/2-inch hole. Cemented with Lead Slurry of 380 sacks of "Lightweight" Cement mixed at ~11.5 pounds per gallon and 120 sacks of 50-50 Pozmix cement mixed at 13.5 pounds per gallon. Note: The final design may include a two stage cementing program and different cement slurries.
4. Stage Tool. Will only be used if a two-stage cementing program is required.
5. Injection Tubing: 2-7/8-inch, 6.5 pounds per foot, J-55, EUE 8rd. Surface to +/- 3,325 feet
6. Downhole completion consisting of: TAM Inflatable Packer (set at 3,460 feet) and inflate line, w/pass through sub on top of packer; Downhole Pressure & Temperature Gauge and LBL Stainless Steel U-Tube Sampler below packer.
7. Production Perforations: Martin Fm Test Interval: 3,460 feet to 3,660 feet w/ 4 shots per foot, 90 degree phasing.
8. Planned Total Depth; +/-4,000 feet

Notes

The Martin Formation is the Primary Target and the Naco is the Secondary Target

The Supai is expected to contain halite beds below +/-1,200 feet below ground

Sandia Technologies, LLC
6731 Theall Road, Houston, TX 77066
Tel: (832) 286-0471 Fax: (832) 286-0477

Drawn by: djc Date: May 2008 *Drawing not to scale*

Proposed injection well completion schematic.

EXHIBIT 1
Well Logging, Coring, and Testing Program

WELL LOGGING, CORING, AND TESTING PROGRAM

Proposed Well Logging Program
The following geophysical well logs will be run in the open-hole section of the surface casing hole of the CO_2 Injection Well:

- Platform Express (AITH Induction/Spontaneous Potential/Gamma Ray/ Compensated Neutron/Triple Litho Density/Borehole Caliper)
- Modular Formation Dynamics Tester (MDT)

The following geophysical well logs will be run in the open-hole section of the protection casing (long string) hole of the CO_2 Injection Well:

- Platform Express (AITH Induction (or laterolog)/Spontaneous Potential/Gamma Ray/Compensated Neutron/Triple Litho Density/Borehole Caliper)
- Combinable Magnetic Resonance (Naco and Martin Formations from 2,960 to 3,660 feet or minimum run)
- Formation Micro-Imager survey (lower Supai to base of Martin Formations from 1,800 to 3,660 feet)
- Dipole Shear Imager

Additional diagnostic logs and/or formation cores (whole core or sidewall cores) may be run at the discretion of the Arizona Utilities Project Team.

The following cased hole geophysical well logs will be run after cementing the protection casing in place:

- Cement evaluation and casing inspection log
- Gyroscopic survey
- Differential temperature survey

Additional diagnostic logs (such as a video log) may be run at the discretion of the Arizona Utilities Project Team.

INJECTION ZONE AND CONFINING ZONE TESTING

A whole core is proposed for the CO_2 Injection Well in the Martin Formation, based on anticipated funding. The core depth will be picked based on correlation from the offset wells and the mud log. The proposed conventional core may be supplemented or replaced with sidewall cores or horizontal rotary cores.

Conventional Coring

Core Size	Depth	Formation/Lithology
7-7/8" x 4" x 30 feet	+/-3,600 feet	Martin Formation

Supplemental conventional coring in the injection zone may be conducted to obtain additional reservoir data. The Arizona Utilities Project Team will select the actual core point during the drilling of the CO_2 Injection Well, in consultation with the mud logger's correlation to offset wells. If insufficient formation core is recovered in any core run, the core run may be repeated at the discretion of the team, or sidewall coring may be conducted in the interval. The core depth will be adjusted relative to actual drilling depths encountered.

Sidewall Coring/Horizontal Rotary Coring
Sidewall coring or horizontal rotary coring may be taken in the injection zone or the confining zone during the open-hole logging of the protection hole to supplement the conventional core data. The Arizona Utilities Project Team, based on the evaluation and percent recovery of the conventional core, will determine if sidewall coring is necessary and select actual core depths. If sufficient whole core is recovered, sidewall cores may not be taken in the CO_2 Injection Well.

Formation Fluid Sampling
The CO_2 Injection Well will be back flowed (pumping or via nitrogen) to obtain background native formation fluids from the Martin Formation. The decision to collect fluid samples in other intervals, via either wireline or drillstem testing, will be made based on open-hole logging and the condition of the borehole at the time of logging operations. Any fluid samples collected will be transported to a selected laboratory for detailed analysis.

Step Rate Injection Test
A step rate injection test using formation brine (recovered during well development operations) will be performed on the injection interval. An initial low rate, low injection pressure injectivity test will be performed to assess receptivity of the injection interval. From these data, a detailed step rate test will be designed and performed, so that test injection pressures span the range from the measured initial shut-in pressure to a maximum pressure determined by multiplying the top of the completed injection interval depth by a value of 0.622 psi/foot of depth. It is expected that the 0.622 psi/foot of depth pressure gradient is below the parting pressure of the injection interval. For example, assuming a native background initial pressure equal to a freshwater gradient (0.433 psi/foot of depth) and a below ground depth of 3,445 feet to the top of the Martin Formation, the step rate test would be planned to span the pressure range of 1,492 psi (initial pressure) to 2,143 psi (maximum test pressure) at 3,445 feet below ground surface, or 651 psi above the native background pressure.

The step rate test will be initiated following pressure recovery from the low rate, low pressure initial injectivity test. Injection will be initiated and stepped up in equal rate increments using equal time intervals (one or two hours). The equal time increments should be sufficient to allow for proper rate stabilization of the injection pump(s) and allow sufficient time to overcome wellbore storage effects between each rate change

(especially at the low rates when the well may be on a vacuum). General test procedure is as follows:

STEP-RATE TEST PROCEDURE:

1. The well will be shut in long enough prior to testing such that the bottom hole pressures approximate the initial shut-in formation pressure. Pressure gauges will be installed on the wellhead and downhole near the top of the perforated completion. The downhole gauge will include surface read-out, so that the test may be monitored.
2. A series of successively higher injection rates will be used. Both surface and downhole pressures will be read and recorded at the end of each rate and time step. Each rate step will last as long as the preceding rate (i.e., equal duration steps).
3. Injection rates will be controlled with a constant flow regulator that has been tested prior to use. Flow rates will be measured with a calibrated turbine flowmeter. Injection rates and surface and downhole pressures will be digitally recorded. Injection pressures will be measured and recorded for immediate evaluation and interpretation by recording and plotting each time step and corresponding pressure.
4. A plot of injection rates and the corresponding stabilized pressure values at the end of each step are expected to follow a constant slope straight line. If the slope reaches a point at which the formation fractures (i.e., "breakdown" pressure is exceeded), the slope of this plotted line will be observed to decrease. The injection pump(s) will be immediately stopped and the flow line valve will be quickly closed. Pressure will be allowed to bleed off into the injection interval.

The step rate test will be designed for either 5 steps (20 percent rate increase increments to 100 percent maximum rate) or 8 steps (15 percent rate increase increments to 100 percent maximum rate) to gather a sufficient number of points for valid test analysis. The step rate test results will be used to limit the maximum bottomhole injection pressure and surface injection pressure so that the reservoir and seal formations are not fractured.

Constant Rate Injection Test

After the step rate injection test, a constant rate hydraulic test may be performed to further define aquifer properties. This may directly follow the last step of the step rate test. Pressure will be adjusted to maintain a steady injection rate for 8-12 hours, or until the remaining stored formation water is injected. Then the well will be shut in. Bottom hole pressure will be measured throughout the injection and recovery periods.

WELL TESTING PROGRAM

Mechanical integrity tests will be performed during completion of the CO_2 Injection Well. The following tests will be performed:

- Pressure testing of the surface and protection casing to 70 percent of the manufacturer's rated internal yield pressure or one psi per foot of casing depth, which ever is less, for at least 30 minutes. A successful test is a drop of no more

than 10 percent of the test pressure over the 30-minute time period. Test data will be digitally recorded and a copy of the test results will be maintained on location. The original copy of the pressure test record **MUST** be sent in to the Sandia Office and made part of the CO_2 Injection Well report.

- Pressure testing of the 5-1/2-inch protection casing by tubing annulus to confirm the mechanical integrity of the completion. The pressure test will be run at equal to the lesser of the maximum authorized injection pressure or 1,000 psi, provided that no testing pressure will be less than 300 psi. A successful test is a drop of no more than 10 percent of the test pressure over the 30-minute time period. Test data will be digitally recorded and a copy of the test results will be maintained on location. The original copy of the pressure test record **MUST** be sent in to the Sandia Office and made part of the CO_2 Injection Well report.
- Casing inspection and cement bond evaluation of the 5-1/2-inch protection casing from total depth to surface. Interpretation report to be prepared by the vendor.
- Radioactive tracer survey of the completed CO_2 Injection Well following perforation to show the absence of fluid movement in vertical channels adjacent to the well.
- Baseline and repeat reservoir saturation logging (RST log) to show the distribution of CO_2 adjacent to the well.

STIMULATION PROGRAM

To obtain formation water for the step-rate injectivity test, well flow may be stimulated by scraper/swab, backlift, nitrogen lift, and/or bottom hole pump. Formation fluid properties will be monitored until parameters stabilize indicating that formation fluids are being recovered. Once clean and stable formation brine is established, divert returns to a "fresh" frac tank(s). The stored formation fluids will be filtered to remove particulates, then used for injection testing of the injection interval. All other fluids not reinjected will be disposed of at an appropriate disposal site in accordance with state regulations.

GENERAL SURETY RIDER

To be attached and form a part of

Type of Bond: Reclamation - Oil/Gas

Bond No. : 024016685

Dated effective: 8/31/2005
(MONTH, DAY, YEAR)

executed by: Arizona Public Service Company , as Principal,
(PRINCIPAL)

and by: Liberty Mutual Insurance Company , as Surety,
(SURETY)

and in favor of : The State of Arizona & The Oil & Gas Conservation Commission .
(OBLIGEE)

In consideration of the mutual agreements herein contained the Principal and the Surety hereby consent to changing

INFORMATION	FROM	TO
Principal Name	Arizona Public Service Company	Arizona Public Service Company & SunCor Development Company

Nothing herein contained shall vary, alter or extend any provision or condition of this bond except as herein expressly stated.

This rider is effective 3/12/2009
(MONTH, DAY, YEAR)

Signed and Sealed 3/12/2009
(MONTH, DAY, YEAR)

Arizona Public Service Company
PRINCIPAL

BY: [signature] Group Leader-Risk Insurance
TITLE

SunCor Development Company
PRINCIPAL

BY: [signature] V.P. Controller
TITLE

Liberty Mutual Insurance Company
SURETY

BY: [signature]
Ethan Baker, ATTORNEY-IN-FACT

2379650

THIS POWER OF ATTORNEY IS NOT VALID UNLESS IT IS PRINTED ON RED BACKGROUND.
This Power of Attorney limits the acts of those named herein, and they have no authority to bind the Company except in the manner and to the extent herein stated.

LIBERTY MUTUAL INSURANCE COMPANY
BOSTON, MASSACHUSETTS
POWER OF ATTORNEY

KNOW ALL PERSONS BY THESE PRESENTS: That Liberty Mutual Insurance Company (the "Company"), a Massachusetts stock insurance company, pursuant to and by authority of the By-law and Authorization hereinafter set forth, does hereby name, constitute and appoint

DAVID G. JENSEN, MARYANN CARAFELLO, BRANDY L. BAICH, TERRY CRULL, ETHAN BAKER, ALL OF THE CITY OF PHOENIX, STATE OF ARIZONA

, each individually if there be more than one named, its true and lawful attorney-in-fact to make, execute, seal, acknowledge and deliver, for and on its behalf as surety and as its act and deed, any and all undertakings, bonds, recognizances and other surety obligations in the penal sum not exceeding **SEVENTY FIVE MILLION AND 00/100**********DOLLARS ($ 75,000,000.00*****) each, and the execution of such undertakings, bonds, recognizances and other surety obligations, in pursuance of these presents, shall be as binding upon the Company as if they had been duly signed by the president and attested by the secretary of the Company in their own proper persons.

That this power is made and executed pursuant to and by authority of the following By-law and Authorization:

ARTICLE XIII - Execution of Contracts: Section 5. Surety Bonds and Undertakings.
Any officer of the Company authorized for that purpose in writing by the chairman or the president, and subject to such limitations as the chairman or the president may prescribe, shall appoint such attorneys-in-fact, as may be necessary to act in behalf of the Company to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations. Such attorneys-in-fact, subject to the limitations set forth in their respective powers of attorney, shall have full power to bind the Company by their signature and execution of any such instruments and to attach thereto the seal of the Company. When so executed such instruments shall be as binding as if signed by the president and attested by the secretary.

By the following instrument the chairman or the president has authorized the officer or other official named therein to appoint attorneys-in-fact:

Pursuant to Article XIII, Section 5 of the By-Laws, Garnet W. Elliott, Assistant Secretary of Liberty Mutual Insurance Company, is hereby authorized to appoint such attorneys-in-fact as may be necessary to act in behalf of the Company to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations.

That the By-law and the Authorization set forth above are true copies thereof and are now in full force and effect.

IN WITNESS WHEREOF, this Power of Attorney has been subscribed by an authorized officer or official of the Company and the corporate seal of Liberty Mutual Insurance Company has been affixed thereto in Plymouth Meeting, Pennsylvania this 15th day of July, 2008.

LIBERTY MUTUAL INSURANCE COMPANY

By Garnet W. Elliott
Garnet W. Elliott, Assistant Secretary

COMMONWEALTH OF PENNSYLVANIA ss
COUNTY OF MONTGOMERY

On this 15th day of July, 2008, before me, a Notary Public, personally came Garnet W. Elliott, to me known, and acknowledged that he is an Assistant Secretary of Liberty Mutual Insurance Company; that he knows the seal of said corporation; and that he executed the above Power of Attorney and affixed the corporate seal of Liberty Mutual Insurance Company thereto with the authority and at the direction of said corporation.

IN TESTIMONY WHEREOF, I have hereunto subscribed my name and affixed my notarial seal at Plymouth Meeting, Pennsylvania, on the day and year first above written.

TERESA PASTELLA COMMONWEALTH OF PENNSYLVANIA NOTARY PUBLIC

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Teresa Pastella, Notary Public
Plymouth Twp., Montgomery County
My Commission Expires Mar. 22, 2009
Member, Pennsylvania Association of Notaries

By Teresa Pastella
Teresa Pastella, Notary Public

CERTIFICATE

I, the undersigned, Assistant Secretary of Liberty Mutual Insurance Company, do hereby certify that the original power of attorney of which the foregoing is a full, true and correct copy, is in full force and effect on the date of this certificate; and I do further certify that the officer or official who executed the said power of attorney is an Assistant Secretary specially authorized by the chairman or the president to appoint attorneys-in-fact as provided in Article XIII, Section 5 of the By-laws of Liberty Mutual Insurance Company.

This certificate and the above power of attorney may be signed by facsimile or mechanically reproduced signatures under and by authority of the following vote of the board of directors of Liberty Mutual Insurance Company at a meeting duly called and held on the 12th day of March, 1980.

VOTED that the facsimile or mechanically reproduced signature of any assistant secretary of the company, wherever appearing upon a certified copy of any power of attorney issued by the company in connection with surety bonds, shall be valid and binding upon the company with the same force and effect as though manually affixed.

IN TESTIMONY WHEREOF, I have hereunto subscribed my name and affixed the corporate seal of the said company, this 12th day of March, 2009.

By David M. Carey
David M. Carey, Assistant Secretary

Not valid for mortgage, note, loan, letter of credit, bank deposit, currency rate, interest rate or residual value guarantees.

To confirm the validity of this Power of Attorney call 1-610-832-8240 between 9:00 am and 4:30 pm EST on any business day.

RIDER

To be attached and form part of Bond #024016685 issued by Liberty Mutual Insurance Company as Surety, on behalf of Arizona Public Service Company, as Principal and in favor of the State of Arizona and The Oil & gas Conservation Commission, the sum of Twenty Five Thousand and no/100ths Dollars ($25,000.00)

Land Description is amended:

FROM: Clifton Geothermal Energy Project, Clifton, AZ

TO: Blanket Locations

PROVIDED, however, that the attached bond shall be subject to all its agreements, limitations, and conditions except as herein expressly modified, and further that the liability of the Surety under the attached bond and the attached bond as amended by this rider shall not be cumulative.

SIGNED, AND SEALED THIS 21st day of August, 2008.

Liberty Mutual Insurance Company

Maryann Carafello

Maryann Carafello Attorney-in-Fact

2285699

THIS POWER OF ATTORNEY IS NOT VALID UNLESS IT IS PRINTED ON RED BACKGROUND.

This Power of Attorney limits the acts of those named herein, and they have no authority to bind the Company except in the manner and to the extent herein stated.

LIBERTY MUTUAL INSURANCE COMPANY
BOSTON, MASSACHUSETTS
POWER OF ATTORNEY

KNOW ALL PERSONS BY THESE PRESENTS: That Liberty Mutual Insurance Company (the "Company"), a Massachusetts stock insurance company, pursuant to and by authority of the By-law and Authorization hereinafter set forth, does hereby name, constitute and appoint

DAVID G. JENSEN, MARYANN CARAFELLO, BRANDY L. BAICH, TERRY CRULL, ETHAN BAKER, ALL OF THE CITY OF PHOENIX, STATE OF ARIZONA .....

, each individually if there be more than one named, its true and lawful attorney-in-fact to make, execute, seal, acknowledge and deliver, for and on its behalf as surety and as its act and deed, any and all undertakings, bonds, recognizances and other surety obligations in the penal sum not exceeding **SEVENTY FIVE MILLION AND 00/100**********_____ DOLLARS ($ **75,000,000.00*****_____) each, and the execution of such undertakings, bonds, recognizances and other surety obligations, in pursuance of these presents, shall be as binding upon the Company as if they had been duly signed by the president and attested by the secretary of the Company in their own proper persons.

That this power is made and executed pursuant to and by authority of the following By-law and Authorization:

ARTICLE XIII - Execution of Contracts: Section 5. Surety Bonds and Undertakings.
Any officer of the Company authorized for that purpose in writing by the chairman or the president, and subject to such limitations as the chairman or the president may prescribe, shall appoint such attorneys-in-fact, as may be necessary to act in behalf of the Company to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations. Such attorneys-in-fact, subject to the limitations set forth in their respective powers of attorney, shall have full power to bind the Company by their signature and execution of any such instruments and to attach thereto the seal of the Company. When so executed such instruments shall be as binding as if signed by the president and attested by the secretary.

By the following instrument the chairman or the president has authorized the officer or other official named therein to appoint attorneys-in-fact:

Pursuant to Article XIII, Section 5 of the By-Laws, Garnet W. Elliott, Assistant Secretary of Liberty Mutual Insurance Company, is hereby authorized to appoint such attorneys-in-fact as may be necessary to act in behalf of the Company to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations.

That the By-law and the Authorization set forth above are true copies thereof and are now in full force and effect.

IN WITNESS WHEREOF, this Power of Attorney has been subscribed by an authorized officer or official of the Company and the corporate seal of Liberty Mutual Insurance Company has been affixed thereto in Plymouth Meeting, Pennsylvania this 18th day of February, 2008.

LIBERTY MUTUAL INSURANCE COMPANY

By Garnet W. Elliott
Garnet W. Elliott, Assistant Secretary

COMMONWEALTH OF PENNSYLVANIA ss
COUNTY OF MONTGOMERY

On this 18th day of February, 2008, before me, a Notary Public, personally came Garnet W. Elliott, to me known, and acknowledged that he is an Assistant Secretary of Liberty Mutual Insurance Company; that he knows the seal of said corporation; and that he executed the above Power of Attorney and affixed the corporate seal of Liberty Mutual Insurance Company thereto with the authority and at the direction of said corporation.

IN TESTIMONY WHEREOF, I have hereunto subscribed my name and affixed my notarial seal at Plymouth Meeting, Pennsylvania, on the day and year first above written.

TERESA PASTELLA COMMONWEALTH OF PENNSYLVANIA NOTARY PUBLIC

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Teresa Pastella, Notary Public
Plymouth Twp., Montgomery County
My Commission Expires Mar. 28, 2009
Member, Pennsylvania Association of Notaries

By Teresa Pastella
Teresa Pastella, Notary Public

CERTIFICATE

I, the undersigned, Assistant Secretary of Liberty Mutual Insurance Company, do hereby certify that the original power of attorney of which the foregoing is a full, true and correct copy, is in full force and effect on the date of this certificate; and I do further certify that the officer or official who executed the said power of attorney is an Assistant Secretary specially authorized by the chairman or the president to appoint attorneys-in-fact as provided in Article XIII, Section 5 of the By-laws of Liberty Mutual Insurance Company.

This certificate and the above power of attorney may be signed by facsimile or mechanically reproduced signatures under and by authority of the following vote of the board of directors of Liberty Mutual Insurance Company at a meeting duly called and held on the 12th day of March, 1980.

VOTED that the facsimile or mechanically reproduced signature of any assistant secretary of the company, wherever appearing upon a certified copy of any power of attorney issued by the company in connection with surety bonds, shall be valid and binding upon the company with the same force and effect as though manually affixed.

IN TESTIMONY WHEREOF, I have hereunto subscribed my name and affixed the corporate seal of the said company, this 21st day of August, 2008

By David M. Carey
David M. Carey, Assistant Secretary

Not valid for mortgage, note, loan, letter of credit, bank deposit, currency rate, interest rate or residual value guarantees.

To confirm the validity of this Power of Attorney call 1-610-832-8240 between 9:00 am and 4:30 pm EST on any business day.

PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS

Bond Serial No. 024-016-685

That we: Arizona Public Service Company

of the County of Maricopa in the State of Arizona

as principal, and Liberty Mutual Insurance Company

of 175 Berkeley St., Boston, MA 02117

AUTHORIZED TO DO BUSINESS WITHIN THE STATE OF ARIZONA

as surety, are held and firmly bound unto the State of Arizona and the Oil and Gas Conservation Commission, hereinafter referred to as the "Commission", in the penal sum of Twenty-Five Thousand & NO/100 Dollars ($25,000.00) lawful money of the United States, for which payment, well and truly to be made, we bind ourselves, and each of us, and each of our heirs, executors, administrators or successors, and assigns jointly and severally, firmly by these presents.

The conditions of this obligation are that, whereas the above bounden principal proposes to drill a well or wells for oil, gas or stratigraphic purposes in and upon the following described land situated within the State, to-wit:

Clifton Geothermal Energy Project, Clifton, AZ.

(May be used as blanket bond or for single well)

NOW THEREFORE, if the above bounden principal shall comply with all the provisions of the Laws of this State and the rules, regulations and orders of the Commission, especially with reference to the requirements of A.R.S. § 27-516, providing for the proper drilling, casing and plugging of said well or wells, and filing with the Oil and Gas Conservation Commission all notices and records required by said Commission, then in the event said well or wells do not produce oil or gas in commercial quantites, or cease to produce oil or gas in commercial quantites, this obligation is void; otherwise it shall remain in full force and effect.

Whenever the principal shall be, and declared by the Oil and Gas Conservation Commission in violation of the Laws of this State and the rules, regulations and orders of the Commission, the surety shall promptly:

1. Remedy the violation by its own efforts, or
2. Obtain a bid or bids for submission to the Commission to remedy the violation, and upon determination by the Commission and the surety of the lowest responsible bidder, arrange for a contract between such bidder and the Commission, and make available as work progresses sufficient funds to pay the cost of remedying the violation; but not exceeding, including other costs and damages for which the surety may be liable hereunder, the amount set forth in the first paragraph hereof.

Liability under this bond may not be terminated without written permission of this Commission.

WITNESS our hands and seals, this 31st day of August, 20 05.

Arizona Public Service Company

By: [signature]

Principal

WITNESS our hands and seals, this 31st day of August, 20 05.

Liberty Mutual Insurance Company

By: [signature]

David G. Jensen
Attorney-in-Fact

Surety

N/A

(Surety, Resident Arizona Agent
If issued in a state other than Arizona)

(If the principal is a corporation, the bond should be executed by its duly authorized officers, with the seal of the corporation affixed. When principal or surety executes this bond by agent, power of attorney or other evidence of authority must accompany the bond.)

Approved Date 9-6-05

STATE OF ARIZONA
OIL & GAS CONSERVATION COMMISSION

By: SL Rowing

STATE OF ARIZONA
OIL & GAS CONSERVATION COMMISSION
Bond
File Two Copies

Form No. 2

Permit No. Blanket

Liberty Mutual Surety Bond Number 024-016-685

NOTICE FROM SURETY REQUIRED BY TERRORISM RISK INSURANCE ACT OF 2002

In accordance with the Terrorism Risk Insurance Act of 2002 (referred to hereinafter as the "Act"), this disclosure notice is provided for surety bonds on which one or more of the following companies is the issuing surety: Liberty Mutual Insurance Company; Liberty Mutual Fire Insurance Company; LM Insurance Corporation; The First Liberty Insurance Corporation; Liberty Insurance Corporation; Employers Insurance Company of Wausau (formerly "EMPLOYERS INSURANCE OF WAUSAU A Mutual Company"); Peerless Insurance Company; and any other company that is a part of or added to the Liberty Mutual Group for which surety business is underwritten by Liberty Mutual Surety (referred to collectively hereinafter as the "Issuing Sureties").

NOTICE FORMS PART OF BOND

This notice forms part of surety bonds issued by any one or more of the Issuing Sureties.

DISCLOSURE OF PREMIUM

The premium attributable to any bond coverage for "acts of terrorism" as defined in Section 102(1) of the Act is Zero Dollars ($0.00).

DISCLOSURE OF FEDERAL PARTICIPATION IN PAYMENT OF TERRORISM LOSSES

The United States will reimburse the Issuing Sureties for ninety percent (90%) of any covered losses from terrorist acts certified under the Act exceeding the applicable surety deductible.

THIS POWER OF ATTORNEY IS NOT VALID ..ESS IT IS PRINTED ON RED BACKGROUND.

1240420

This Power of Attorney limits the acts of those named herein, and they have no authority to bind the Company except in the manner and to the extent herein stated.

LIBERTY MUTUAL INSURANCE COMPANY
BOSTON, MASSACHUSETTS
POWER OF ATTORNEY

KNOW ALL PERSONS BY THESE PRESENTS: That Liberty Mutual Insurance Company (the "Company"), a Massachusetts stock insurance company, pursuant to and by authority of the By-law and Authorization hereinafter set forth, does hereby name, constitute and appoint

DAVID G. JENSEN, MARYANN CARAFELLO, BRANDY L. BAICH, MICHAEL C. METZGER, THOMAS O. WILDER, TERRY CRULL, ALL OF THE CITY OF PHOENIX, STATE OF ARIZONA

, each individually if there be more than one named, its true and lawful attorney-in-fact to make, execute, seal, acknowledge and deliver, for and on its behalf as surety and as its act and deed, any and all undertakings, bonds, recognizances and other surety obligations in the penal sum not exceeding **SEVENTY FIVE MILLION AND 00/100**********_____ DOLLARS ($ **$75,000,000.00*****_____) each, and the execution of such undertakings, bonds, recognizances and other surety obligations, in pursuance of these presents, shall be as binding upon the Company as if they had been duly signed by the president and attested by the secretary of the Company in their own proper persons.

That this power is made and executed pursuant to and by authority of the following By-law and Authorization:

ARTICLE XIII - Execution of Contracts: Section 5. Surety Bonds and Undertakings.
Any officer of the Company authorized for that purpose in writing by the chairman or the president, and subject to such limitations as the chairman or the president may prescribe, shall appoint such attorneys-in-fact, as may be necessary to act in behalf of the Company to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations. Such attorneys-in-fact, subject to the limitations set forth in their respective powers of attorney, shall have full power to bind the Company by their signature and execution of any such instruments and to attach thereto the seal of the Company. When so executed such instruments shall be as binding as if signed by the president and attested by the secretary.

By the following instrument the chairman or the president has authorized the officer or other official named therein to appoint attorneys-in-fact:

Pursuant to Article XIII, Section 5 of the By-Laws, Garnet W. Elliott, Assistant Secretary of Liberty Mutual Insurance Company, is hereby authorized to appoint such attorneys-in-fact as may be necessary to act in behalf of the Company to make, execute, seal, acknowledge and deliver as surety any and all undertakings, bonds, recognizances and other surety obligations.

That the By-law and the Authorization set forth above are true copies thereof and are now in full force and effect.

IN WITNESS WHEREOF, this Power of Attorney has been subscribed by an authorized officer or official of the Company and the corporate seal of Liberty Mutual Insurance Company has been affixed thereto in Plymouth Meeting, Pennsylvania this 28th day of March, 2003.

LIBERTY MUTUAL INSURANCE COMPANY

By Garnet W. Elliott
Garnet W. Elliott, Assistant Secretary

COMMONWEALTH OF PENNSYLVANIA ss
COUNTY OF MONTGOMERY

On this 28th day of March, 2003, before me, a Notary Public, personally came Garnet W. Elliott, to me known, and acknowledged that he is an Assistant Secretary of Liberty Mutual Insurance Company; that he knows the seal of said corporation; and that he executed the above Power of Attorney and affixed the corporate seal of Liberty Mutual Insurance Company thereto with the authority and at the direction of said corporation.

IN TESTIMONY WHEREOF, I have hereunto subscribed my name and affixed my notarial seal at Plymouth Meeting, Pennsylvania, on the day and year first above written.

TERESA PASTELLA COMMONWEALTH OF PENNSYLVANIA NOTARY PUBLIC

Notarial Seal
Teresa Pastella, Notary Public
Plymouth Twp., Montgomery County
My Commission Expires Mar. 28, 2005
Member, Pennsylvania Association of Notaries

By Teresa Pastella
Teresa Pastella, Notary Public

CERTIFICATE

I, the undersigned, Assistant Secretary of Liberty Mutual Insurance Company, do hereby certify that the original power of attorney of which the foregoing is a full, true and correct copy, is in full force and effect on the date of this certificate; and I do further certify that the officer or official who executed the said power of attorney is an Assistant Secretary specially authorized by the chairman or the president to appoint attorneys-in-fact as provided in Article XIII, Section 5 of the By-laws of Liberty Mutual Insurance Company.

This certificate and the above power of attorney may be signed by facsimile or mechanically reproduced signatures under and by authority of the following vote of the board of directors of Liberty Mutual Insurance Company at a meeting duly called and held on the 12th day of March, 1980.

VOTED that the facsimile or mechanically reproduced signature of any assistant secretary of the company, wherever appearing upon a certified copy of any power of attorney issued by the company in connection with surety bonds, shall be valid and binding upon the company with the same force and effect as though manually affixed.

IN TESTIMONY WHEREOF, I have hereunto subscribed my name and affixed the corporate seal of the said company, this 31st day of August, 2005.

By David M. Carey
David M. Carey, Assistant Secretary

Not valid for mortgage, note, loan, letter of credit, bank deposit, currency rate, interest rate or residual value guarantees.

To confirm the validity of this Power of Attorney call 1-610-832-8240 between 9:00 am and 4:30 pm EST on any business day.

ORGANIZATION REPORT

Full Name of the Company, Organization, or Individual
Arizona Public Service Company (APS)

Mailing Address and Phone Number
P.O. Box 188/Mail Station 4451, Joseph City, Arizona 86032

Plan of Organization (State whether organization is a corporation joint stock association, firm or partnership, or individual
Corporation

Purpose of Organization (State type of business in which engaged)
Generation of Electric Power

If a reorganiztion, give name and address of previous organization
N/A

If a foreign corporation give (1) State where incorporated	(2) Name and mailing address of state agent	(3) Date of permit to do business in state
N/A	C T Corporation 2394 E. Camelback Road Phoenix, Arizona 85016	Date of Incorporation: February 16, 1920

Principal Officers or Partners (if partnership) NAME	TITLE	MAILING ADDRESS
William J. Post	Chairman & CEO Pinnacle West Capital	P.O. Box 53999/Mail Station 9036 Phoenix, AZ 85072-3999
Donald E. Brandt	COO PNW/CEO APS President	P.O. Box 53999/Mail Station 9042 Phoenix, AZ 85072-3999
John Roy Denman	Senior VP APS Fossil Generation	P.O. Box 53999/Mail Station 4029 Phoenix, AZ 85072-3999

DIRECTORS NAME	MAILING ADDRESS
Conrad M. Spencer, Fossil Plant Manager APS Cholla Power Plant	P.O. Box 188/MS 4451, Joseph City, AZ 86032

CERTIFICATE I, the undersigned, under the penalty of perjury state that I am the Cholla Power Plant Manager of the Arizona Public Service Company (company), and that I am authorized by said company to make this report; and that this report was prepared under my supervision and direction and that the facts stated therein are true, correct and complete to the best of my knowledge.

Signature Conrad M. Spencer

3 Nov 2008

Date

STATE OF ARIZONA

OIL & GAS CONSERVATION COMMISSION

Organization Report

File One Copy

Form No. 1

Mail completed form to
Oil and Gas Program Administrator
Arizona Geological Survey
416 W Congress., #100
Tucson, AZ 85701

2/96

CH130-22J Rev. 5-98

PAYABLE THROUGH
WELLS FARGO BANK
100 W. WASHINGTON
PHOENIX, ARIZONA

Arizona Public Service Company
OPERATING AGENT
CHOLLA GENERATING STATION

WORKING FUND DRAFT

11-24
1210(8)

② 65003363

③ M ④ D ⑤ Y
DATE 110408

VOID 90 DAYS FROM DATE

NOT GOOD FOR MORE THAN $1,000.00

Twenty five and no/100 DOLLARS ⑥ $ 25.00

PAY TO THE ORDER OF:

INVOICE NO. AND DESCRIPTION	AMOUNT
Strategraphic Test Well	25 00

Arizona Oil & Gas Conservation Commission – Attn: Steve Rauzi
416 W. Congress, Suite 100
Tucson, AZ 85701

x Sheila Chaney
AUTHORIZED SIGNATURE

⑈65003363⑈ ⑆121000248⑆4159 540830⑈

RECEIPT Date 11-5-2008 No. 3160

Received From APS Cholla Generating Station

Address PO Box 188 / MS 4451, Joseph City AZ 86032

twenty five and no/100 Dollars $ 25.00

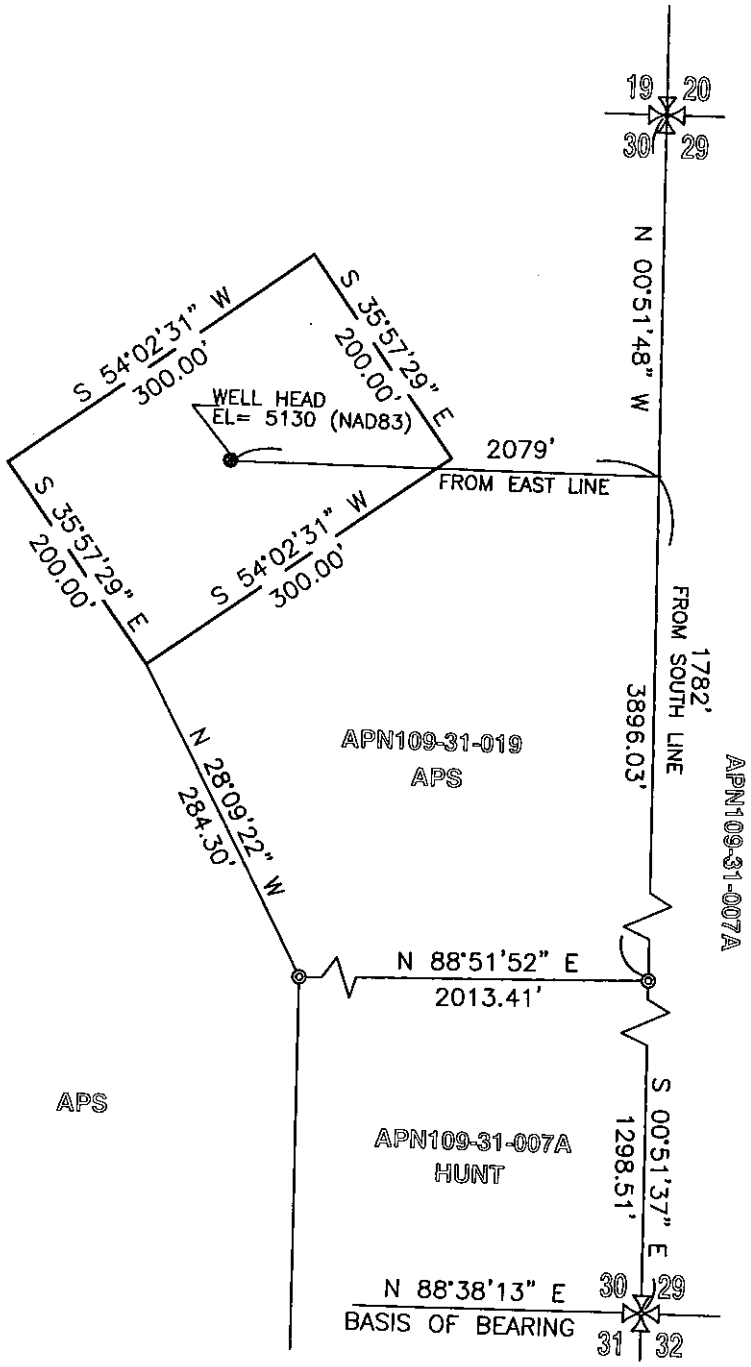
For filing fee Cholla CO_2 test #1, Permit 977

ACCOUNT			HOW PAID		
AMT. OF ACCOUNT			CASH		
AMT. PAID			CHECK	25	00
BALANCE DUE			MONEY ORDER		

By SL Rauzi

8K806 Rediform

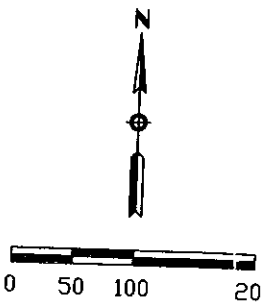
977



LEGAL DESCRIPT

WELL LOT

A PARCEL OF LAND SITUA
18 NORTH, RANGE 20 EA
NAVAJO COUNTY, ARIZONA
AS FOLLOWS:
COMMENCING AT THE S
30, THENCE N 00° 51' 3
LINE, A DISTANCE OF 129
THENCE S 88° 51' 52" W
APS REBAR & CAP; THEN
284.30 FEET TO
THE POINT OF BEGINNIN
THENCE N 35° 57' 29" W
THENCE N 54° 02' 31" E
THENCE S 35° 57' 29" E
THENCE S 54° 02' 31" W
TO THE **POINT OF BEGINN**
SAID PARCEL CONTAINS 1.3



BLANKET BOND COVER SHEET

Operator: Arizona Public Service Company

Bond Company: Liberty Mutual Insurance Company

Bond No.: 024-016-685

Amount of Bond: $25,000 (Covers up to 10 wells per to R12-7-103)

Date of Bond: 08/31/05

Date Approved: 09/06/05

Rider dated: 08/21/08 (P/N 977) and 03/12/09 (P/N 909, 911, 912)

Permits covered by this bond

909
911
912
929
~~930~~
931
977 P+A 6-4-2010

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

977

September 7, 2010

John L. Boyer
Principal Environmental Scientist
Arizona Public Service Company
Mail Station 8376
PO Box 53999
Phoenix, AZ 85072-3999

RE: Final Plugging and Abandonment Report of the Class V Experimental Injection Well under UIC Permit No. AZ50800004

Dear Mr. Boyer,

The United States Environmental Protection Agency ("EPA") has received Arizona Public Service Company's ("APS") final Well Plugging and Abandonment report dated August 5, 2010, for the Class V experimental injection well. Based on our review of the final report and the discussion with APS during the plugging activity, EPA has determined that APS has plugged the well as agreed to in the previously submitted plugging and abandonment plan and subsequent e-mails to EPA. Since APS has completed this final action required by the UIC Permit No. AZ50800004, the permit is now closed.

If you have any questions about this letter, or other UIC matters, please do not hesitate to call Nancy Rumrill of my staff at 415-972-3293 or me at 415-972-3971.

Sincerely,

David Albright, Manager
Ground Water Office

cc: Carrolette Winstead, APP & Reuse II Unit Manager, ADEQ
Steve Rauzi, Arizona Oil and Gas Conservation Commission

Printed on Recycled Paper

Subject: Re: Cholla CO2 Test Fee 1, Permit 977, Navajo County - Review of Plugging and Abandonment Report and Form 10
From: Steve Rauzi <steve.rauzi@azgs.az.gov>
Date: Mon, 23 Aug 2010 07:30:44 -0700
To: John.Boyer@aps.com

977

Records of the AZOGCC indicate that Arizona Public Service Company has complied with all AZOGCC rules applicable to the Cholla CO2 sequestration test well and has provided all the information necessary to close out the permit.

On 8/20/2010 5:02 PM, John.Boyer@aps.com wrote:

> Steve,
>
> I hope you have now had time to review the Plugging and Abandonment Report and the Form 10 information for CO2 Sequestration well at the Arizona Public Service Company Cholla Power Plant (see attached transmittal letter).
>
> Do you have any questions or concerns regarding the report?
>
> If the report is satisfactory, have we provided all the information necessary to close out the permit?
>
> Please let me know the status of your review.
>
> Thanks for your help in this matter.
>
> John L. Boyer
> Principal Environmental Scientist
> Environmental Health & Safety Department
> Arizona Public Service Company
> P.O. Box 53999/Mail Sta: 8376
> Phoenix, Arizona 85072-3999
> Telephone: 602-250-3196
> Cell Phone: 602-818-6721
> Fax: 602-250-3872
>
> Email Firewall made the following annotations
> ---
> --- NOTICE ---
> This message is for the designated recipient only and may contain confidential, privileged or proprietary information. If you have received it in error, please notify the sender immediately and delete the original and any copy or printout. Unintended recipients are prohibited from making any other use of this e-mail. Although we have taken reasonable precautions to ensure no viruses are present in this e-mail, we accept no liability for any loss or damage arising from the use of this e-mail or attachments, or for any delay or errors or omissions in the contents which result from e-mail transmission.
> ---

APS
A subsidiary of Pinnacle West Capital Corporation

John L. Boyer
Principal Environmental Scientist
Environmental Health & Safety
Department

Tel. 602-250-3196
Fax 602-250-3872
e-mail John.Boyer@aps.com

Mail Station 8376
PO Box 53999
Phoenix, Arizona 85072-3999

August 5, 2010

977

Mr. Steven L. Rauzi, Oil & Gas Administrator
Arizona Oil & Gas Conservation Commission
416 W. Congress, Suite 100
Tucson, Arizona 85701

Subject: **Plugging and Abandonment Report and Signed Form 10**
Reference: **Cholla CO_2 Test Fee 1, Permit 977, Navajo County**

Dear Mr. Rauzi:

As promised in my August 5, 2010 email transmitting the electronic version of the report, I am attaching the original signed copy of the Plugging Record Form No. 10 and a copy of the Plugging and Abandonment Report for the Cholla CO_2 Test Fee 1 well, located at the Arizona Public Service Company, Cholla Power Plant.

If you should have any questions about the attached information, please contact me at (602) 250-3196.

Sincerely,

John L Boyer

John L. Boyer

Attachments

CC: Douglas Lavarnway, APS Cholla Power Plant

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

977

4-22-2010

John L. Boyer
Principal Environmental Scientist
Arizona Public Service Company
Mail Station 8376
PO Box 53999
Phoenix, AZ 85072-3999

RE: Plugging and Abandonment of the Class V Experimental Injection Well under UIC Permit No. AZ50800004

Dear Mr. Boyer,

The United States Environmental Protection Agency ("EPA") has received Arizona Public Service Company's ("APS") Well Drilling and Completion report and the revised Plugging and Abandonment plan for the Class V experimental injection well. Based on our review, we have determined that the information is complete. EPA hereby approves the revised Plugging and Abandonment plan dated February 5, 2010.

APS shall plug the well as described in the plan and comply with all applicable Arizona Oil and Gas Conservation Commission requirements. While conducting the activities, APS should consult EPA and obtain prior approval from EPA if a change to the plan becomes necessary for any reason (e.g., change in well construction or loss of mechanical integrity of the well). EPA representatives are planning to witness part of the activity, and, therefore, EPA needs to be informed at least 30 days in advance of the scheduled start date. Because this 30-day notice may be approximate, please provide verbal updates on the actual schedule 72 hours in advance of the activity to allow EPA representatives to finalize travel plans.

As described in the general permit conditions of the UIC Permit No. AZ50800004, EPA prohibits plugging and abandonment of a well in a manner that allows the movement of fluid containing any contaminant into underground sources of drinking water, if the presence of that contaminant may cause a violation of any primary drinking water regulation under 40 CFR part 142 or may otherwise adversely affect the health of persons. After plugging the well, APS shall submit a Plugging and Abandonment report to EPA within sixty (60) days as specified in permit condition Part II.E.4.

Printed on Recycled Paper

If you have any questions about this letter, or other UIC matters, please do not hesitate to call Nancy Rumrill of my staff at 415-972-3293 or me at 415-972-3971.

(977)

Sincerely,

David Albright, Manager
Ground Water Office

April 22, 2010

cc: Michele Robertson, Groundwater Program Manager, ADEQ
Carrolette Winstead, APP & Reuse II Unit Manager, ADEQ
✓Steve Rauzi, Arizona Oil and Gas Conservation Commission

APS
A subsidiary of Pinnacle West Capital Corporation

John L. Boyer
Principal Environmental Scientist
Environmental Health & Safety Department

Tel. 602-250-3196
Fax 602-250-3872
e-mail John.Boyer@aps.com

Mail Station 8376
PO Box 53999
Phoenix, Arizona 85072-3999

March 31, 2010

Mr. Steven L. Rauzi, Oil & Gas Administrator
Arizona Oil & Gas Conservation Commission
416 W. Congress, Suite 100
Tucson, Arizona 85701

Subject: Drilling and Completion Report
Reference: Cholla CO_2 Test Fee 1, Permit 977, Navajo County

Dear Mr. Rauzi:

As we discussed during our telephone conversation on March 26, 2010, I am attaching the original signed copy of the Arizona Well Completion Report Form No. 04 and a copy of the Drilling and Completion Report for the Cholla CO_2 Test Fee 1 well, located at the Arizona Public Service Company Cholla Power Plant. I also told you that EPA requested modifications to the well abandonment plan you approved on December 8, 2009. EPA wants to review the Drilling and Completion Report before giving final approval to the revised plan. Once I receive EPA's approval, I will send the final abandonment plan to you. My understanding from our telephone conversation is that EPA's revisions should not change your previous approval as long as the plan retains the elements of the December 8, 2009 approved plan which met the Oil & Gas Conservation Commission well abandonment requirements.

If you should have any questions about the attached information, please contact me at (602) 250-3196.

Sincerely,

John L. Boyer

John L. Boyer

Attachments

CC: Douglas Lavarnway, APS Cholla Power Plant

APS
A subsidiary of Pinnacle West Capital Corporation

John L. Boyer
Principal Environmental Scientist
Environmental Health & Safety
Department

Tel. 602-250-3196
Fax 602-250-3872
e-mail John.Boyer@aps.com

Mail Station 8376
PO Box 53999
Phoenix, Arizona 85072-3999

December 4, 2009

977

Mr. Steven L. Rauzi, Oil & Gas Administrator
Arizona Oil & Gas Conservation Commission
416 W. Congress, Suite 100
Tucson, Arizona 85701

PLUGGING AND ABANDONMENT PLAN
Cholla CO_2 Test Fee 1, Permit 977, Navajo County

Dear Mr. Rauzi:

As required by A.A.C. R12-07-127.A, I am attaching the proposed Plugging and Abandonment Plan and signed Application to Plug and Abandon for the Cholla CO_2 Test Fee 1 well, located at the Arizona Public Service Company Cholla Power Plant.

If there should be a need for additional information, or if there are any questions, please contact me at (602) 250-3196.

Sincerely,

John L Boyer

John L. Boyer

Attachments

CC: Carrolette Winstead, Arizona Department of Environmental Quality
Nancy Rumrill. EPA Region IX
Douglas Lavarnway, APS Cholla Power Plant

APS
A subsidiary of Pinnacle West Capital Corporation

John L. Boyer
Principal Environmental Scientist
Environmental Health & Safety
Department

Tel. 602-250-3196
Fax 602-250-3872
e-mail John.Boyer@aps.com

Mail Station 8376
PO Box 53999
Phoenix, Arizona 85072-3999

December 4, 2009

977

Ms. Nancy Rumrill, Environmental Engineer
United States Environmental Protection Agency, Region IX
Water Division
Ground Water Office (Mail Code WTR-9)
75 Hawthorne Street
San Francisco, CA 94105-3901

PLUGGING AND ABANDONMENT PLAN
UIC PERMIT NO. AZ50800004

Dear Ms. Rumrill:

As required by the permit at Part II.E.1, I am attaching the proposed Plugging and Abandonment Plan for the Arizona Utilities Pilot Sequestration Project well at the Arizona Public Service Company Cholla Power Plant. The well will be abandoned in accordance with the requirements of the Arizona Oil & Gas Conservation Commission.

If there should be a need for additional information, or if there are any questions, please contact me at (602) 250-3196.

Sincerely,

John L Boyer

John L. Boyer

Attachments

CC: Carrolette Winstead, Arizona Department of Environmental Quality
Steven L. Rauzi, Arizona Oil and Gas Conservation Commission
Douglas Lavarnway, APS Cholla Power Plant

MONTGOMERY
& ASSOCIATES
Water Resource Consultants

www.elmontgomery.com

5010 East Shea Blvd.
Suite D110
Scottsdale, AZ 85254

TEL 480-948-7747
FAX 480-948-8737

TUCSON PHOENIX SANTIAGO DE CHILE

TRANSMITTAL FORM

TO: Steve Rauzi
ARIZONA GEOLOGICAL SURVEY
Tucson, AZ

PHONE:
DATE: October 15, 2009
PROJECT: 1263

We are transmitting to you via:

☐ Mail ☐ Federal Express ☐ Messenger ☒ Hand Delivery (Dale Nations)

The following items:

☐ draft report ☐ brochures ☐ sketches ☒ other: Drill cuttings

☐ final report ☐ data sheets ☐ prints ☐ other:

QUANTITY	DESCRIPTION
2 (sets)	Boxed drill cuttings stratigraphic well for OGCC #977 – 50 feet - TD of 3,853 feet bls

TRANSMITTED:

☐ As requested ☐ For review & comment ☐:

☐ For your use ☒ For your information ☐:

977

REMARKS:

rcd 10-16-09
SCR

Sincerely,
MONTGOMERY & ASSOCIATES

by: Dennis Shirley
Dennis Shirley, P.G.

cc:

Exploring Geologic CO_2 Storage in Arizona

Dennis H. Shirley – Montgomery & Associates Inc., Daniel J. Collins – Sandia Technologies LLC, and John L. Boyer – Arizona Public Service Company

Arizona power companies are in a predicament. On one front, population growth has led to substantial rise in demand for electric power. If recent trends continue, this demand will increase about 3.6 percent per year in Arizona and electricity consumption will double in about 20 years (Western Resource Advocates, 2007). With abundant coal resources in Arizona's Black Mesa Basin and elsewhere in the western interior, utilities have turned to coal-fired generating plants as the dominant power source. Yet coal is the largest anthropogenic emitter of carbon dioxide (CO_2) globally, and pending legislation would regulate carbon emissions by imposing significant limits on conventional coal-power generation. Consequently, reliance on coal power may be viable in the future only if conventional or next-generation, advanced-technology coal plants can achieve carbon capture and geologic storage. Moreover, from an industry perspective, investment in costly capture technology would be considered only under reasonable assurance that production-scale CO_2 emissions could be safely and reliably stored underground. Thus, a critical first step is testing geologic sequestration of CO_2 at a very small scale where the process can be carefully studied.

The Starting Point

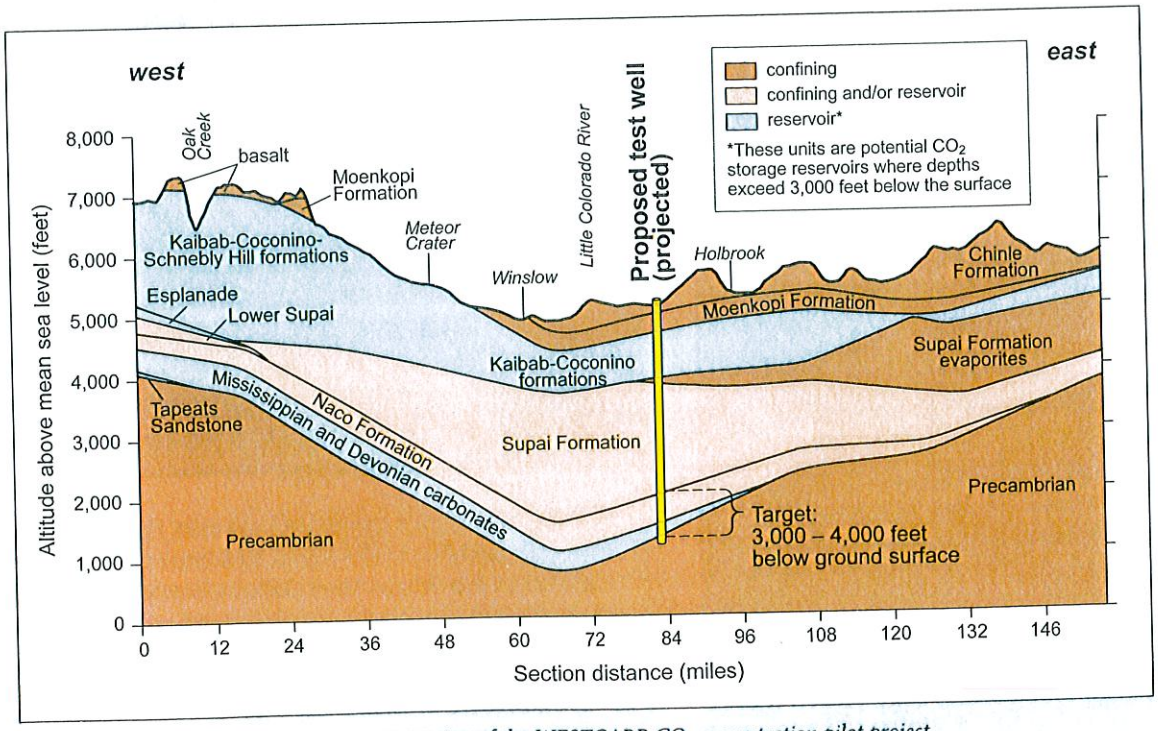
In Arizona, the Colorado Plateau Province is the obvious starting point to evaluate geologic storage of CO_2. According to the Department of Energy, six large coal-fired electrical generating stations operating in this region produce over 70 million tons of CO_2 annually, or roughly three percent of overall CO_2 emissions from the electric power sector. Over a billion tons of high-quality coal are found in shallow, mineable deposits in the Black Mesa area alone.

The Colorado Plateau in Arizona is underlain by a thick sequence of nearly flat-lying sedimentary strata with multiple potential reservoirs in the Paleozoic section that may be suitable for long-term CO_2 storage. The reservoirs range in depth from approximately 3,000 to 7,500 feet and are capped by thick and regionally extensive shale confining beds. However, hydrologic conditions and water quality in the plateau are poorly known in all but the uppermost aquifer.

To evaluate potential CO_2 storage in this area, Arizona industry partners have teamed with the West Coast Regional Carbon Sequestration Partnership (WESTCARB) to conduct the Arizona Utilities CO_2 Storage Pilot. The pilot project entails drilling, constructing, and testing one injection well for CO_2 storage. The proposed well is an experimental technology well to allow the WESTCARB consortium to gather information on the geology and suitability for CO_2 sequestration in the Holbrook Basin and in areas with similar geology in the southern Colorado Plateau. Sponsoring industry partners include Arizona Public Service Company (APS), Salt River Project, Tucson Electric Power, Arizona Electric Power Cooperative, and Peabody Investments. Project funding, in kind services, and/or technical contributions are provided by the California Energy Commission, U.S. Department of Energy, Lawrence Berkeley National Laboratory (LBNL), Electric Power Research Institute (EPRI), and the five industry partners. The total project budget is $5.5 million.

Site Selection

Based on regional geologic and hydrologic conditions (Montgomery & Associates, 2007), a site at the APS Cholla Power Plant near Joseph City, Arizona was selected for the pilot project. Two important factors were pivotal in selecting the site. First, of all land in the Colorado Plateau of northeastern Arizona outside the Navajo Nation and Hopi Indian Reservation, this area offers the best potential for CO_2 storage. Second, highly saline conditions present



East-west regional schematic geologic cross-section of the WESTCARB CO_2 sequestration pilot project.

in the uppermost aquifer suggest that underlying groundwater in potential CO_2 reservoirs will also be saline.

The well site selected for the demonstration project offers: 1) target reservoirs in the Pennsylvanian Naco Formation and the Devonian Martin Formation (a primary target; see diagram below left), which likely have saline groundwater conditions and possibly have permeability and porosity suitable for CO_2 storage; 2) sufficient depth of burial and hydrostatic head for CO_2 storage as a supercritical fluid; 3) extensive overlying fine-grained confining beds to prevent vertical leakage of CO_2; 4) access to or near the site on paved roads; and 5) an easement for land use and ease of permitting through the cooperation of APS.

A critical first step is testing geologic sequestration of CO_2 at a very small scale where the process can be carefully studied.

Drilling, Completion, and Testing

The test well will be drilled into Precambrian basement rock at a depth of approximately 4,000 feet using conventional mud-rotary drilling. LBNL and EPRI scientists have engaged Sandia Technologies of Houston, Texas, and Montgomery & Associates of Scottsdale, Arizona, to oversee and manage the well-drilling and testing program. As property owner, APS obtained a drilling permit from the Arizona Oil and Gas Conservation Commission (AOGCC), a temporary aquifer protection permit from the Arizona Department of Environmental Quality, and an underground injection control permit from the U.S. Environmental Protection Agency for the planned CO_2 injection pilot test. Well drilling began in July.

Well completion plans (Sandia Technologies and Montgomery & Associates, 2009) call for setting and cementing a conductor casing followed by drilling a 12¼-inch borehole into the upper Supai Formation to a depth of around 965 feet. A protective surface casing will be installed to isolate the wellbore and regional C-Aquifer from underlying saline groundwater. The surface casing will be equipped with a pressure-seal assembly for required pressure testing and subsequent blow-out prevention. The remaining borehole will be drilled with an 8½-inch drill bit using a salt-based mud.

Due to uncertainty regarding the adequacy of downhole conditions for CO_2 injection in the Naco and Martin formations, one or two drill-stem tests are planned to isolate each formation during drilling to obtain interval-specific information on formation pressures, water quality, and permeability. Upon reaching total depth, a full suite of geophysical logs will be obtained in the uncased borehole, and sidewall cores will be collected from selected intervals. If field data confirm adequacy of the injection intervals, a 5½-inch protective casing will be set and cemented in the borehole and zones will be selected for perforation of the casing.

And Finally, Injection

Field and laboratory data obtained from the test well, such as water quality and petrophysical properties, will be evaluated to determine if the pilot CO_2 injection test should proceed. If testing confirms saline groundwater exists in sufficiently permeable zones within the Martin and/or Naco formations, up to 2,000 metric tons of food-grade CO_2 will then be transported by truck to the site and injected into the completed well. Injection will occur in targeted zones between depths of 3,200 and 3,700 feet within the perforated casing. Vertical seismic profiling and formation fluid sampling of the injection well will be conducted prior to and for three to five months after the end of CO_2 injection.

The CO_2 used in this test is the amount generated by a typical 1,000-megawatt coal-fired power plant in approximately 2.2 hours. Although this amount is quite small, the pilot project will provide critical information about the injectivity of CO_2 into the geologic formation, test numerical modeling codes that estimate the extent and stabilization of the CO_2 plume, measure changes in water chemistry within the formation, test and demonstrate methods for monitoring the location of the CO_2 plume, and estimate the amount of the injected CO_2 that dissolves in the reservoir water or becomes immobilized in the formation. Upon completion of testing, the injection well will be plugged and abandoned, or preserved as a monitor well under APS ownership. ■

Contact Dennis Shirley at dshirley@elmontgomery.com.

References

Montgomery & Associates, 2007. Regional Geologic and Hydrologic Characterization, Northern Arizona Saline Formation CO_2 Storage Pilot, Colorado Plateau Region of Northern Arizona, report prepared for West Coast Regional Carbon Sequestration Partnership, May 7, 2008, 38 pp.

Sandia Technologies and Montgomery & Associates, 2009. WESTCARB Arizona Utilities Carbon Dioxide Storage Pilot Test, Pilot Well Installation Plan, prepared for EPRI, WESTCARB & APS Cholla Plant, May 2009.

Western Resource Advocates, 2007. A Clean Electric Energy Strategy for Arizona, 31 pp.

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Subject: NOTICE OF INTENT TO INSTALL SURFACE CASING-UIC PERMIT NO. AZ50800004UIC PERMIT NO. AZ50800004
From: "Kirk Delaune" <kdelaune@sbcglobal.net>
Date: Sat, 8 Aug 2009 13:43:39 -0700
To: <rumrill.nancy@epa.gov>, <robin.george@epa.gov>, <winstead.carrolette@azdeq.gov>, <steve.rauzi@azgs.az.gov>, <mb10@azdeq.gov>
CC: "Rob Trautz" <rtrautz@epri.com>, <John.Boyer@aps.com>, "'John Henry Beyer'" <JHBeyer@lbl.gov>, "'Daniel Collins'" <dan.collins@sandiatech.com>, <Douglas.Lavarnway@aps.com>, <John.Roznovak@aps.com>, "John. Roznovak" <jroznova1@yahoo.com>

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As required by the well permits, this memo serves as notification of intent to install surface casing in Arizona Utilities CO2 Sequestration Pilot Well located at the APS Cholla Power Plant, Joseph City, Arizona.

Current operations are drilling at approximately 905 ft. Estimated casing setting depth is 965 ft. Installation of the 9-5/8-inch surface casing is forecast to begin on Monday August 10, 2009, with cementing operations to follow immediately.

I am supervising operations at the wellsite and can be reached on my cell phone if an update on operations is needed.

Thank you,

Kirk F. Delaune
Sandia Technologies, LLC
6731 Theall Road; Houston, TX 77066
(O) 832.286.0471 x116 (M) 281.844.3135
kirk.delaune@sandiatech.com

If I diminish you, I diminish myself.

Subject: Arizona Utilities CO2 Sequestration Project, Cholla Power Plant, Joseph City, AZ. - Update regarding drilling activities
From: John.Boyer@aps.com
Date: Mon, 3 Aug 2009 16:32:07 -0700
To: rumrill.nancy@epa.gov, Bolitho.Mason@azdeq.gov, steve.rauzi@azgs.az.gov
CC: robin.george@epa.gov, Winstead.Carrolette@azdeq.gov

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To all:

For your information, the following activities are planned for later this week. If you are interested in viewing these activities please give me a call at least 12 to 24 hours in advance so I can make arrangements.

1) Open hole Logging of the Surface Hole (Wednesday/Thursday)
2) Zonal Isolation Water Sampling of the lower Coconino/Schnebly Hill (Thursday/Friday)
3) Setting & Cementing of the Surface Casing (Friday/Saturday)

John L. Boyer
Principal Environmental Scientist
Environmental Health & Safety Department
Arizona Public Service Company
P.O. Box 53999/Mail Sta: 8376
Phoenix, Arizona 85072-3999
Telephone: 602-250-3196
Cell Phone: 602-818-6721
Fax: 602-250-3872

Email Firewall made the following annotations

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APS
A subsidiary of Pinnacle West Capital Corporation

John L. Boyer
Principal Environmental Scientist
Environmental Health & Safety
Department

Tel. 602-250-3196
Fax 602-250-3872
e-mail John.Boyer@aps.com

Mail Station 8376
PO Box 53999
Phoenix, Arizona 85072-3999

July 27, 2009

977

Ms. Nancy Rumrill, Environmental Engineer
United States Environmental Protection Agency, Region IX
Water Division
Ground Water Office (Mail Code WTR-9)
75 Hawthorne Street
San Francisco, CA 94105-3901

REVISED NOTICE OF INTENT TO INITIATE DRILLING ACTIVITIES
UIC PERMIT NO. AZ50800004

Dear Ms. Rumrill:

Because of issues related to completing the drilling contracts, the drilling schedule previously submitted to you on June 4, 2009 has been revised. As a result and as required by UIC Permit No. AZ50800004, the Arizona Public Service Company (APS) is providing a revised notice of our intent to initiate drilling activities for the WestCarb Arizona Utilities Carbon Dioxide Storage Pilot Test Well on or about July 29, 2009. The revised schedule of events through setting and cementing of the protective casing and demobilization of the drilling rig off of location is as follows:

- Mobilize Supervisory Personnel and Support to the Project Site – July 28, 2009
- Mobilize Spud Rig, APS Orientation, and Set Conductor Casing – July29, 2009
- Mobilize Surface Casing Drilling Rig to the Project Site – July 29, 2009
- Initiate Drilling of the Surface Hole – August 1, 2009
- Run Open Hole Logs in the Surface Hole – August 6, 2009
- Obtain Open Hole Fluid Sample – August 7, 2009
- Run and Cement Surface Casing – August 8, 2009
- Demobilize Surface Casing Drilling Rig – August 9, 2009
- Mobilize Deep Drilling Rig – August 10, 2009
- Initiate Drilling of the Protection Hole – August 12, 2009
- Run Open Hole Logs in the Protection Hole – August 22, 2009
- Run and Cement Protection Casing – August 23, 2009

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- Demobilize Drilling Rig from the Project Site – August 25, 2009
- Secure Project Site Pending Completion Activities – July 14, 2009

If there should be a need for additional information, or if there are any questions, please contact me at (602) 250-3196.

Sincerely,

John L Boyer

John L. Boyer

Attachments

CC: Mason R. Bolitho, Arizona Department of Environmental Quality
Steven L. Rauzi, Arizona Oil and Gas Conservation Commission
Douglas Lavarnway, APS Cholla Power Plant

Subject: RE: CO2 Sequestration project schedule
From: "Bill Victor" <bvictor@elmontgomery.com>
Date: Tue, 21 Jul 2009 16:16:17 -0700
To: "Steve Rauzi" <steve.rauzi@azgs.az.gov>
CC: "jack dale nations" <daleaudrey@comcast.net>, "Jackie Murray" <jmurray@elmontgomery.com>, "Heather Gluski" <hgluski@elmontgomery.com>, "Dennis Shirley" <dshirley@elmontgomery.com>

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Hi Steve:

EPRI is still waiting for funding to be released from the California Governor's office so that they can give us the go ahead to mobilize the drilling rig. As I understand it, this is a day-to-day process and they can not predict when it will happen. We were told to be ready as it could happen any time. The funding was approved before the recent crisis in CA and is under a waiver from such freezes, but still needs to go through some additional red tape caused by the freeze.

When we get authorization, the rig for the surface borehole (upper 40 feet) will be mobed within 2-3 days. The rig for the intermediate borehole to 900+ feet will need 1-2 weeks to mobe.

I'll let you know when we get authorization and update you on the schedule from there.

Bill

Best Regards,

William R. Victor, P.G.
Principal / Hydrogeologist
MONTGOMERY & ASSOCIATES
5010 East Shea Boulevard, Suite D-110
Scottsdale, AZ 85254
(480) 948-7747 (office)
(480) 948-8737 (fax)
www.elmontgomery.com

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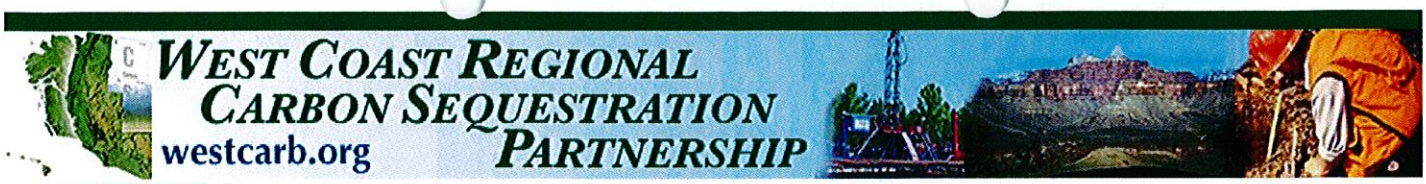
From: Steve Rauzi [mailto:steve.rauzi@azgs.az.gov]
Sent: Tuesday, July 21, 2009 2:12 PM
To: Bill Victor
Subject: Re: CO2 Sequestration project schedule

Have you started drilling yet?

On 7/10/2009 4:12 PM, Bill Victor wrote:



Arizona Utilities CO_2 Storage Pilot—Project Overview

WESTCARB's small-scale CO_2 storage test, the Arizona Utilities CO_2 Storage Pilot near Holbrook, Arizona, is part of a broad research effort taking place throughout North America to validate the capability of deep geologic formations to permanently store CO_2 produced from industrial sources, thereby preventing its emission into the atmosphere where it would contribute to global warming.

The goal of the WESTCARB Arizona Pilot is to field-test the feasibility of CO_2 injection and storage in the Colorado Plateau's saline formations—deep-lying porous rock formations filled with saltwater that cannot economically be made suitable for drinking water or agriculture. WESTCARB's regional characterization studies suggest that suitable CO_2 storage sites lie beneath or near many of the coal-fired power plants in northeastern Arizona. The Arizona Pilot will help validate this assessment and indicate the viability of using these geologic formations for larger CO_2 storage projects, which may play an important future role in lowering greenhouse gas emissions.

In preparation for the field test, WESTCARB researchers conducted numerous studies of the project site, which is adjacent to the ash pond for Arizona Public Service Company's Cholla Power Plant. This effort included a review of available rock cores and data from other deep wells in the area, water quality and compositional data from groundwater wells, outcrops of the target formations elsewhere in the state, and published literature on the area's geology. Computer models were used to predict the dispersion and immobilization of injected CO_2 and related subsurface effects, such as the dissipation of pressure in reservoir formation fluids.

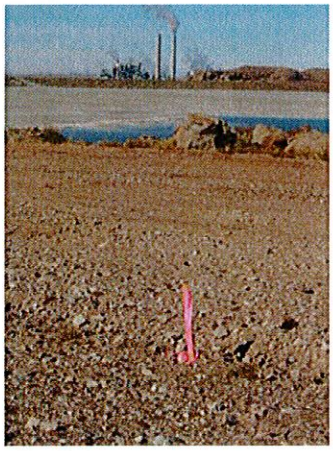
The next step in the project involves drilling an oil-industry type well that will be used for data and fluid sample collection, CO_2 injection, and at the end of the project, an attempt to produce CO_2 back out of the formation. During drilling, researchers will make a detailed record of the rock formations encountered and will extract core samples to ascertain formation porosity and permeability.

If geologic conditions at depth are appropriate, 2000 tons of CO_2 will be injected about three-quarters of a mile underground. Although this is a relatively small quantity of CO_2, it is sufficient to test monitoring techniques for tracking the location of the injected CO_2 and ensuring compliance with environmental and health and safety requirements.

The CO_2 injection is expected to take less than three weeks, while monitoring of the CO_2 plume in the formation will continue for three to five months after the end of injection.

Data collected in the field will be compared with the predictions from computer models, enabling researchers to fine-tune the models to better predict the behavior of CO_2 under similar circumstances in future projects. Findings will also provide insight into the CO_2 storage capacity of the region's saline formations relative to the quantities produced by the area's power plants and other industrial facilities.

For information on the latest Arizona Pilot activities, visit our Drilling Progress page. Overall project details can be found in the WESTCARB Fact Sheet. Permits issued for the field test include a Temporary Aquifer Protection permit from from the Arizona Department of Environmental Quality (ADEQ), and an Underground Injection Control permit from from Region 9 of the U.S. Environmental Protection Agency.



Proposed wellhead location for WESTCARB's Arizona CO2 Storage Pilot Test near the Cholla Power Plant

Attendees at a public meeting in Holbrook, Arizona, discuss the Arizona CO2 Storage Pilot with WESTCARB researchers (November 12, 2008)

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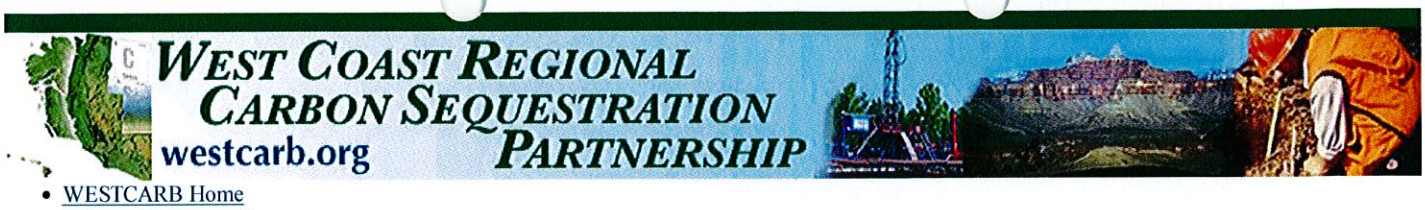
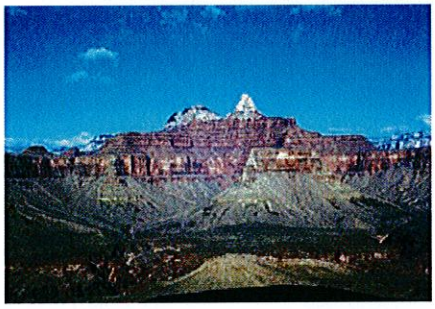


Geologic Formations—Records of the Past

Drilling into the earth is like a journey back in time. As the drill bit descends, it passes through rock formations that were deposited millions of years ago. For example, the formations at WESTCARB's Arizona Pilot location on the Colorado Plateau are composed of sediments that were deposited between 374 to 240 million years ago. As these sediments were buried by relatively younger sediments, they became compacted and cemented to form sedimentary rocks.



Geologic formations in Grand Canyon. An erosional remnant of Coconino Sandstone forms the white spire at the top of the ridge.

These formations contain fossils of plants and animals that existed during the time of deposition of the sediments. The fossils are all extinct species, but their environmental significance can be interpreted because the broad biological categories to which they belong are still living on the Earth, and are adapted to specific environments.

For example, brachiopods, crinoids, echinoids, and corals, which presently live only in marine environments, are common fossils in the Martin Formation and the Naco Formation. It is therefore logical to interpret the environment of deposition of these formations as marine.

Similarly, fossil plants with tissues and structures that are similar to those living on land today can logically be interpreted as having been buried in sediments that were deposited in terrestrial environments such as rivers and lakes. Such fossil plants have been found in the Supai Formation and the Moenkopi Formation, both of which also have abundant sedimentary structures as mud cracks and stream-formed ripple marks.

The characteristic cross-bedding in the Coconino Sandstone can be compared with similar features now forming in wind-blown sand dunes in modern desert environments. The Coconino Sandstone also has fossilized footprints of animals, which are similar to those formed by lizards today. Thus, over millions of years, the Colorado Plateau has experienced many climactic and environmental transitions to which the formations bear witness.

How are Geologic Formations Determined?

The fundamental unit used to classify and map layers of rock is the geologic formation, which consists of consecutive rock layers that share a particular set of characteristics. A formation must be distinctive enough in appearance that a geologic mapper can tell it apart from the surrounding rock layers; it must be thick enough and extensive enough to plot on a map.

If the formation consists of a single or dominant rock type, such as shale or sandstone, then the rock type is included in the name—Coconino Sandstone, for example. However, formations often contain a variety of related or interlayered rock types, in which case, the word 'formation' is used.

Formations sometimes contain "members," which are sub-units of rock with distinguishing characteristics within the formations. Formations may have only certain parts designated as members.

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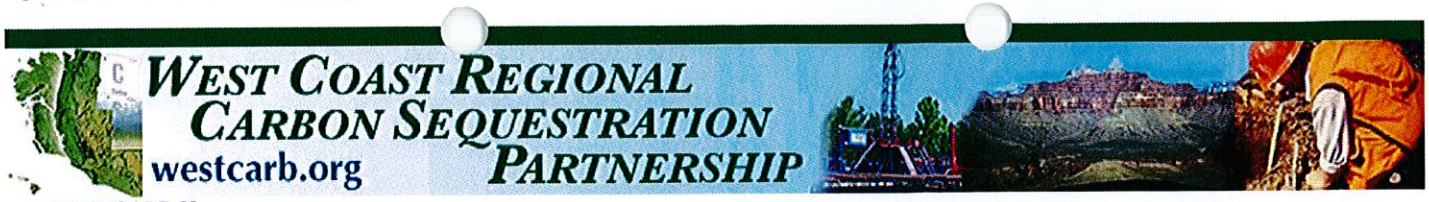
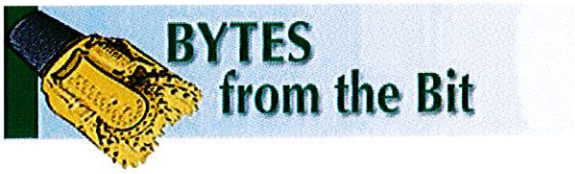


Arizona Utilities CO_2 Storage Pilot—Drilling Progress



Drilling Activity for June 27, 2009

SAMPLE TEXT FOR PLACEMENT ONLY

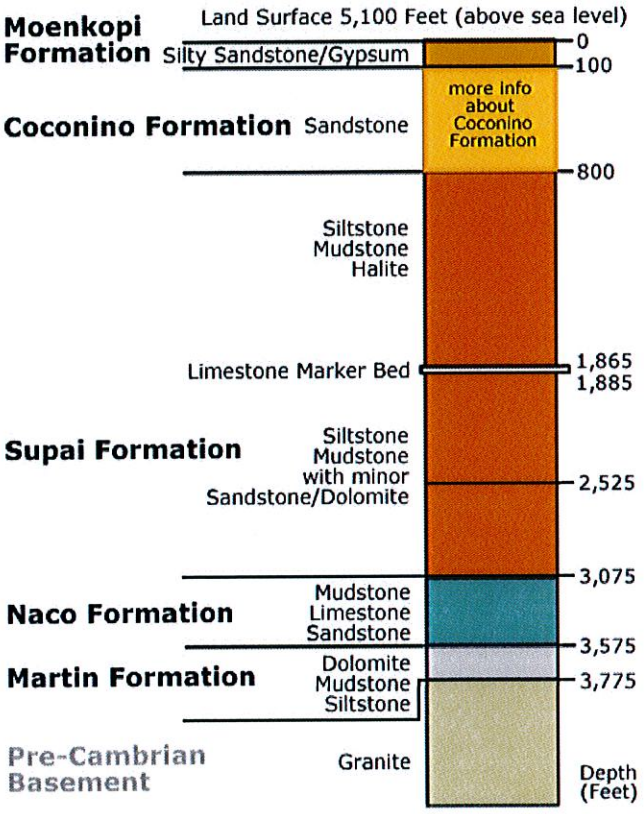
The [Coconino formation] was drilled from 5,403 feet to 5,581 feet. The drilling string stalled and locked up while drilling at 5,580.7 feet. The drill string was worked with an over pull of 30,000 lb over string weight without freeing the drill string.

6:00 AM Update:
The drilling string was worked free with a pull of 35,000 lb over string weight. An initial drilling fluid loss of 38 bbl was measured in the first 35 minutes. Drilling resumed at 00:30 hours. Drilling 7-7/8" hole at 5,645.0 feet with and average rate of penetration of 11.63 ft/hr over the past 6 hours.

Drilling Activity for:
June 26, 2009
June 24, 2009
June 22, 2009

For an introduction to Geologic Formations CLICK HERE

Select a specific formation (below) to learn more about its history and characteristics



Source: Errol L. Montgomery & Associates

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MOENKOPI FORMATION

EARLY-MIDDLE TRIASSIC
245 to 240
Million Years Ago

LITHOLOGY:
Mudstone, sandstone, shale, dark red to brown; gypsum

FOSSILS:
Amphibians, reptiles, freshwater clams, land plants

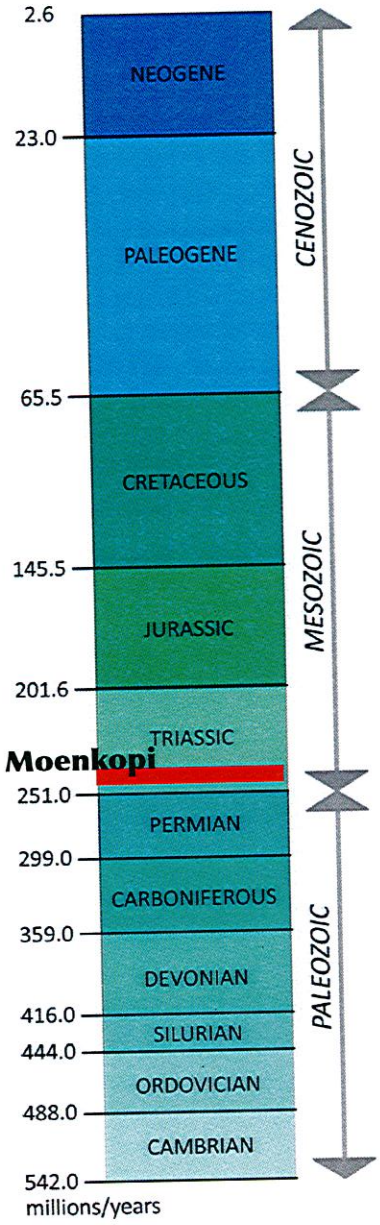
SEDIMENTARY STRUCTURES:
Mudcracks, salt crystal casts, ripple marks, cross-beds

DEPOSITIONAL ENVIRONMENT:
River channels, delta, tidal flat, arid coastal plain where evaporite minerals (salts) are deposited

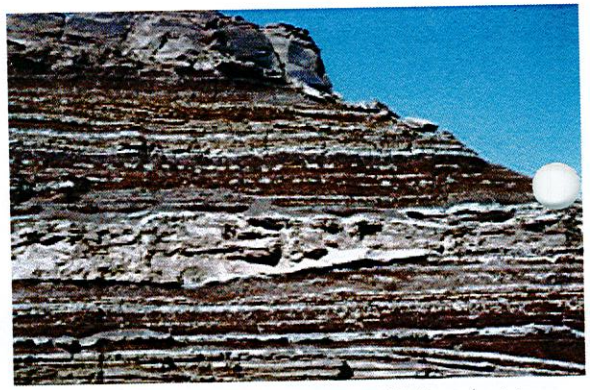
PALEOGEOGRAPHY/ TECTONIC SETTING:
Westward-sloping coastal plain of North America

MISCELLANEOUS:
The Moenkopi Formation thickens to west where it was partly deposited in shallow marine environments in southwestern Utah and Nevada

GEOLOGIC TIME SCALE



During the early Triassic, the supercontinent Pangaea showed signs of breaking apart, as the North American continent began to separate from Africa and Europe and move westward. The Colorado Plateau was located just above the equator and formed part of a large, flat coastal plain near the edge of the North American continent. Sediments were carried to this plain by rivers that started as far away as the Appalachians, which at that time, formed the continental divide. The sea also contributed sedimentary deposits through tidal flows and by overrunning the flat-lying plain during periods of sea-level rise. The Moenkopi formation contains many ripple marks and mudcracks, as well as tracks of reptiles and amphibians, however, few bones have been found. Both marine and terrestrial life forms were challenged during the early Triassic by the depleted biosphere that followed the Permian-Triassic extinction.



Outcrop of Moenkopi Formation near Holbrook, Arizona

Evidence of an Aqueous Environment in the Moenkopi Formation

Casts of mudcracks formed by drying of mud on river flood plains in the Moenkopi Formation

Wave-formed ripple marks formed on tidal flats in the Moenkopi Formation

Salt crystal (sodium chloride) casts in Moenkopi mudstone, the result of evaporation of sea water on tidal flats

Tracks of Cheirotherium, or "hand-beast," have been found in North America, Europe, and Africa, but no bones for this creature have ever been discovered. The name refers to the outermost toe, which extended to the side like a thumb, and may have provided a firmer grip in mud.

map?

Generalized map of environments across Arizona during the early Triassi period.

Skull of a Triassic metoposaur, a large amphibian (up to six feet long) that lived in streams of the coastal plain on which Moenkopi sediments were deposited. Metoposaur skulls have lines that run in front of each eye and curve around the nostrils. This is evidence of a tactile sense organ known as the lateral line system, which is found in many fishes and in some aquatic amphibians, and serves to detect movements and pressure changes in the surrounding water, allowing the animal to "read" and respond to its environment.

All images courtesy of Dale Nations.

Coconino Formation

EARLY PERMIAN (Leonardian) 280 to 275 Million Years Ago

LITHOLOGY: Quartz arenite sandstone, fine- to medium-grained, well-rounded, well-sorted, white to pink

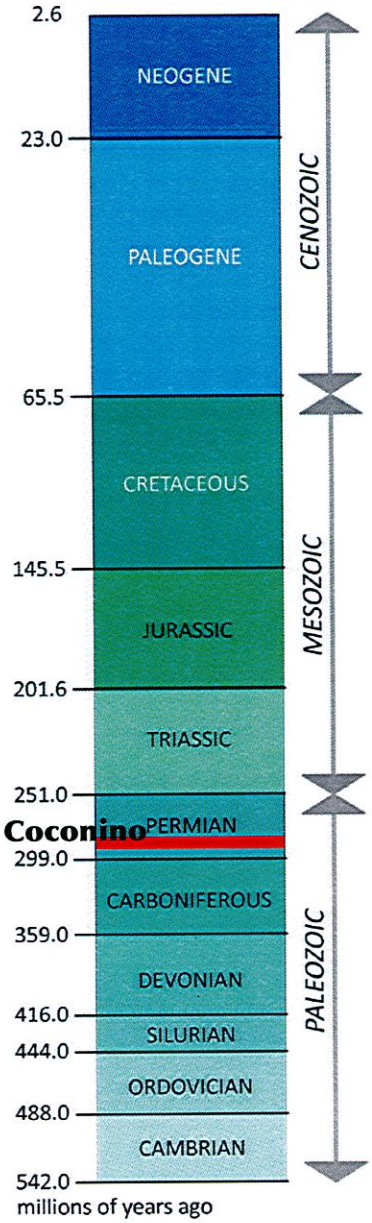
FOSSILS: Reptile tracks, insect burrows

SEDIMENTARY STRUCTURES: Large scale cross-bedding, ripple marks, slump structures

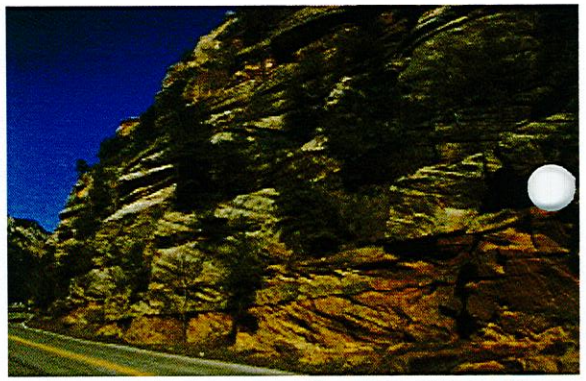
DEPOSITIONAL ENVIRONMENT: Wind-blown sand dunes in arid desert

PALEOGEOGRAPHY/ TECTONIC SETTING: Eolian sand sea (dunes) on a coastal plain along coastal shorelines

GEOLOGIC TIME SCALE



Sands carried by northerly winds were deposited across the Arizona landscape in the early Permian Period, creating vast dunes that today form the Coconino Sandstone and other similar contemporaneous formations. The only fossils found in the Coconino are footprints of extinct animals, for which no evidence of skeletal remains has been found. By the end of the Permian Period (251 million years ago), the greatest mass extinction of all time occurred, resulting in the disappearance of up to 50 percent of all marine invertebrate families, and 75 percent of terrestrial vertebrate families. Possible causes of the extinction include a worldwide loss of shallow marine environments during the convergence of continents into Pangaea and/or climatic changes triggered by volcanic eruptions, which released concentrations of CO_2 and SO_2 into the atmosphere. Multiple causes may have been at work.



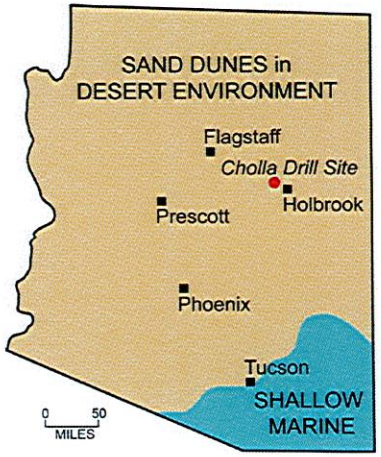
Coconino Sandstone outcrop along U.S. Highway 89, Oak Creek Canyon, near Sedona, Arizona. Note prominent large-scale cross-bedding that is typical of wind-blown sand dunes.

Reptile Tracks Provide Clues to Vanished Species

Referred to as the "Great Dying," the Permian mass extinction impacted both marine and land species and may have lasted a few thousand years (image courtesy of the Lunar and Planetary Institute)

Trackway of small reptile that was left on the sloping surface of a sand dune in the Coconino Sandstone

Tracks of the reptile Laoporus, *preserved on a bedding plane of ripple-marked Coconino Sandstone*



Generalized map of environments across Arizona during the early Permian, the time of deposition of the Coconino Sandstone (modified from Blakey and Ranney, 2008)

All images courtesy of Dale Nations, unless otherwise noted.

SUPAI FORMATION

EARLY PERMIAN
(Leonardian)
290 to 280
Million Years Ago

LITHOLOGY:
Sandstone, mudstone, shale, dark red to brown; limestone, medium gray. Evaporites including gypsum, anhydrite, halite, and potash

FOSSILS:
Land plants, amphibian/reptile tracks. Echinoids and other marine invertebrates in the Fort Apache Member

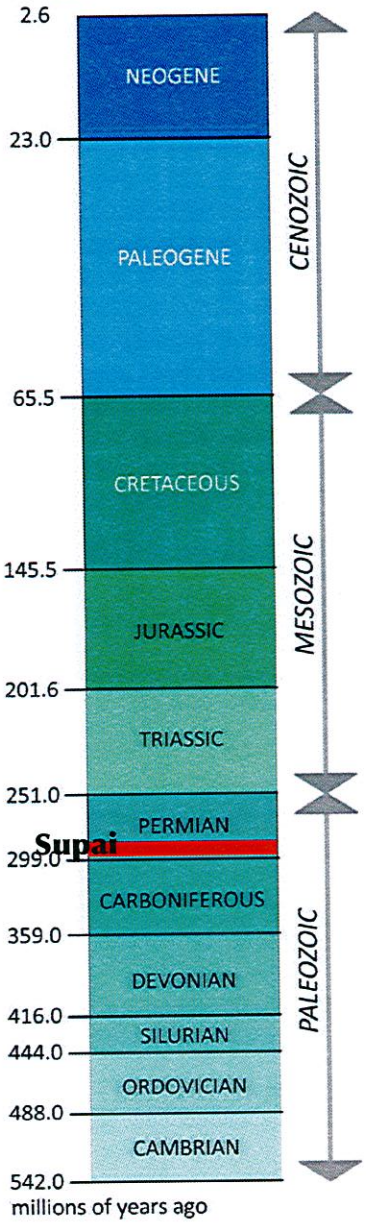
SEDIMENTARY STRUCTURES:
Horizontal bedding, cross-bedding, ripple marks

DEPOSITIONAL ENVIRONMENT:
River channels, flood plains, arid coastal plain where evaporate minerals (salts) are deposited; restricted marine carbonates

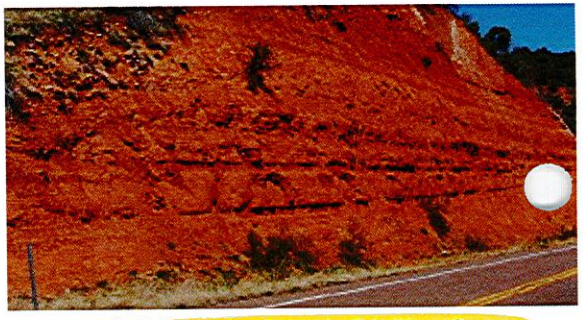
PALEOGEOGRAPHY/ TECTONIC SETTING:
Coastal plain with subsiding basin accommodating evaporate sediments; shallow marine, on a continental shelf

MISCELLANEOUS:
Thick evaporate deposits in Supai Formation below shallow marine Fort Apache Limestone

GEOLOGIC TIME SCALE



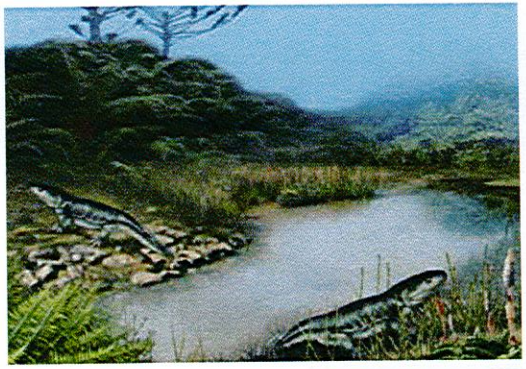
The Permian Period witnessed the convergence of the Earth's continents to form the supercontinent Pangaea, with the Colorado Plateau on the western edge, just above the equator. Although fossils in the Supai Formation indicate areas of forest, particularly toward the east, the overall climate on the Colorado Plateau was becoming arid or semi-arid. The area was also subsiding, which resulted in increased preservation of sediments. Major rivers traversed the land in a southwesterly direction from mountains that had arisen to the northeast (called the Ancestral Rocky Mountains and situated where the current Rocky Mountains are located in Colorado). These rivers left behind iron oxide-stained deposits of sand and mud, which formed the red mudstone and sandstone of the Supai Formation. The sea also continued to fluctuate in and out of the area, leaving behind shallow marine deposits such as the Fort Apache limestone, and evaporite minerals, such as halite, gypsum, and potash.



Outcrop of the Supai formation in Salt River Canyon, Arizona

Linking Sea and Land

The early Permian environment on the Colorado Plateau was conducive to amphibians and reptiles, many species of which had been in ascendance since the Devonian period.

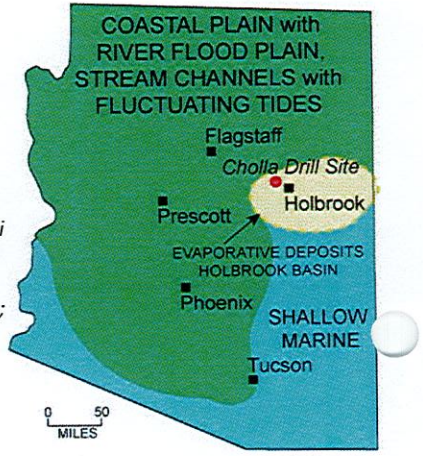


One of the evolutionary bridges between fish and amphibians can been found in transitional species of fish with lobed fins. These consisted of two pairs of fleshy projections with a rayed fin at the ends. The bones and muscles in each lobe allowed the fin to be moved in such a way that the fish could propel itself along a pond or river bottom.

Lobed fins were one of the many adaptations that enabled certain fish species to become the evolutionary ancestors of amphibians. (image courtesy of the Lunar and Planetary Institute)

Fossil leaves of ferns that lived in the forests of the Supai environment

Generalized map of environments across Arizona during the Permian Period, the time of deposition of the Supai Formation (modified from Blakey and Knepp, 1989; Rauzi, 2000, 2002, 2008)



Reconstruction of a late Paleozoic forest environment like that which existed in the Cholla area

All images courtesy of Dale Nations, unless otherwise noted.

MARTIN FORMATION

LATE DEVONIAN (Frasnian) 374 to 367 Million Years Ago

LITHOLOGY: Jerome Member: Dolomite mudstone, sandy dolomite; medium to dark gray, thin-bedded

FOSSILS: Corals, brachiopods, bryozoans, crinoids, conodonts, fish stromatolites

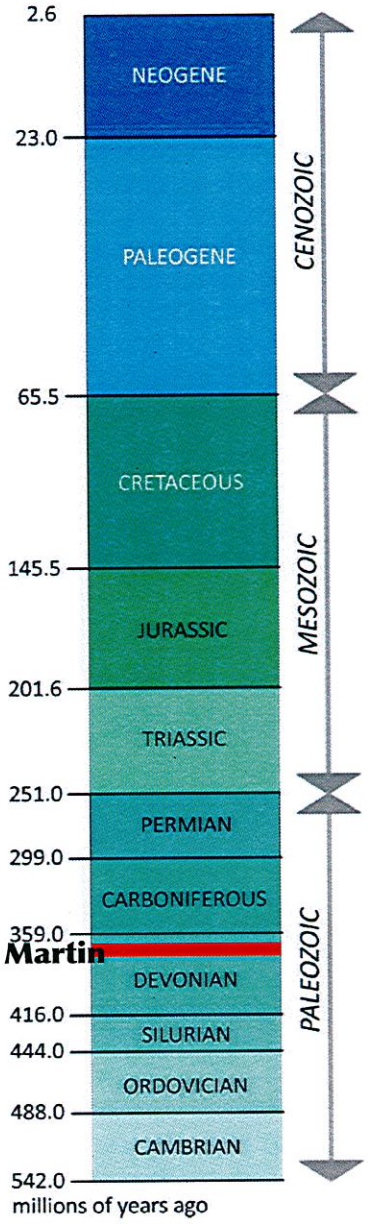
SEDIMENTARY STRUCTURES: Thin, horizontal bedding

DEPOSITIONAL ENVIRONMENT: Shallow marine

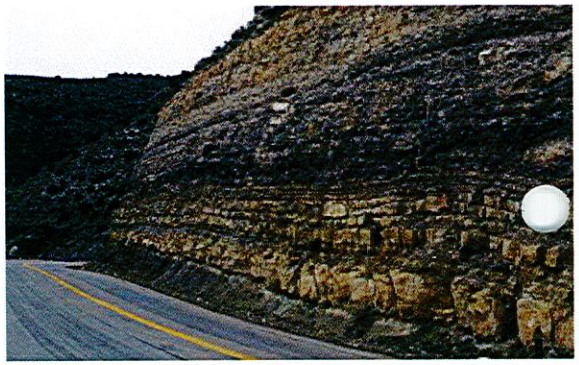
PALEOGEOGRAPHY/ TECTONIC SETTING: Continental shelf, platform; wedges out against Defiance-Zuni positive area to the east

MISCELLANEOUS: The Becker's Butte Member in Salt River Canyon has record of earliest land plants and defines a local shoreline

GEOLOGIC TIME SCALE



During the late Devonian Period, the western part of the North American continent was located south of the equator and was generally submerged beneath shallow tropical seas. The lower part of the Martin Formation, the Becker's Butte Member, contains sediments that were deposited in coastal plain environments as well as fossils of early land plants. At the Cholla Power Plant site, we find the upper part of the Martin Formation, the Jerome Member, which was deposited in a shallow marine shelf near the continental shoreline. It contains an abundance of shallow marine fossils, indicating that it was deposited after the sea encroached across the land surface.



Martin Formation in Salt River Canyon, Arizona

A variety of brachiopods from the Martin Formation

Brachiopods—Tenacious Survivors of Mass Extinctions

Brachiopods are shellfish that secrete a shell consisting of two parts called valves. These valves are bilaterally symmetrical—the right half is a mirror image of the left half. This bilateral symmetry differentiates brachiopods from clams and other bivalved mollusks, with which they are sometimes confused.

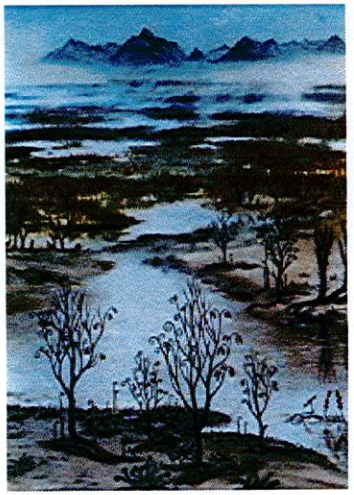
The fossil record for brachiopods dates back to the early part of the Cambrian Period. They were extremely abundant, but were decimated in the Permian mass extinction. This event was the largest of all extinction events (larger than the major extinction 65 million years ago that killed off the dinosaurs).

Still, some brachiopods survived the Permian extinction (as well as subsequent mass extinctions). Their descendants live in today's oceans, however, they have never achieved their former abundance and diversity.

Generalized map of environments across Arizona during the late Devonian, time of deposition of the Jerome Member of the Martin Formation (modified from Beus, Blakey, and Ranney, 2008)

Fossils of psilophytes, the first known land plants, found in the Becker's Butte Member of the Martin Formation

Fossil of Hexagonaria, *a coral that indicates Devonian age and a marine depositional environment*



Artist's reconstruction of the late Devonian environment of deposition for the Becker's Butte Member

All images courtesy of Dale Nations.

NACO FORMATION

LATE CARBONIFEROUS PENNSYLVANIAN EPOCH (Desmoinesian to Virgilian), 310 to 304 Million Years Ago

LITHOLOGY: Limestone, shale, sandstone; medium-gray

FOSSILS: Corals, brachiopods, bryozoans, crinoids, fusulinids

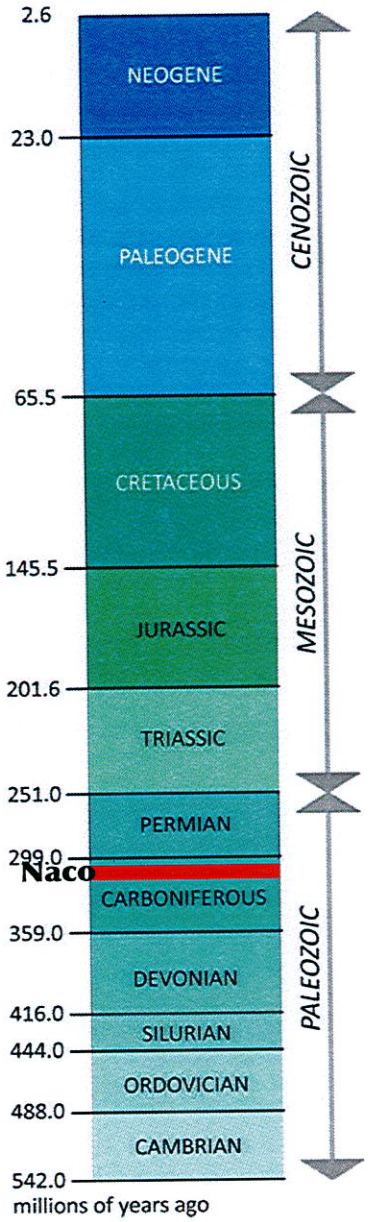
SEDIMENTARY STRUCTURES: Horizontal bedding

DEPOSITIONAL ENVIRONMENT: Shallow marine shelf, near shoreline to east against Defiance-Zuni positive area

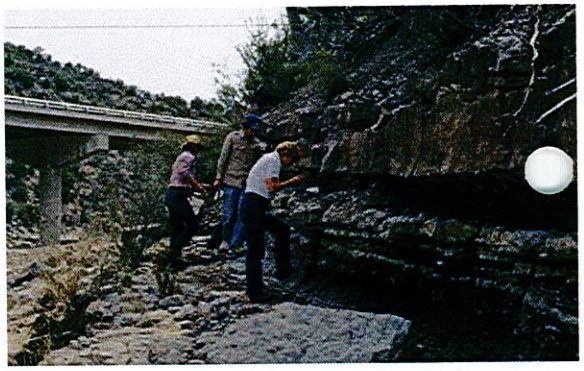
PALEOGEOGRAPHY/ TECTONIC SETTING: Continental shelf, platform; wedges out against Defiance-Zuni positive area to the east

MISCELLANEOUS: Correlated with the Horquilla Limestone by Ross, 1973

GEOLOGIC TIME SCALE



During the late Carboniferous Period (Pennsylvanian Epoch), the continents of the world began to collide into what would become the supercontinent, Pangaea. The period was marked by multiple cycles of rising and falling sea levels. These sea-level fluctuations were triggered, in turn, by glacial cycles in the Southern Hemisphere. The glaciers stored huge amounts of freshwater during periods of cooling—causing sea levels to drop—then released the water into the seas during warmer periods of melting, causing sea levels to rise. The shallow marine environments of this time, such as existed on the Colorado Plateau, featured an abundance of creatures such as crinoids, brachiopods, and fusilinids. At death, their calcium-rich shells were deposited in lime mud on the ocean floor, which eventually became limestone.



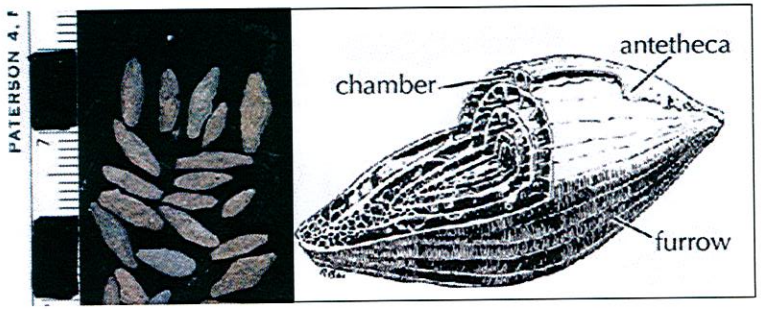
Geologists examine a Naco Formation outcrop at Carrizo Creek, Arizona

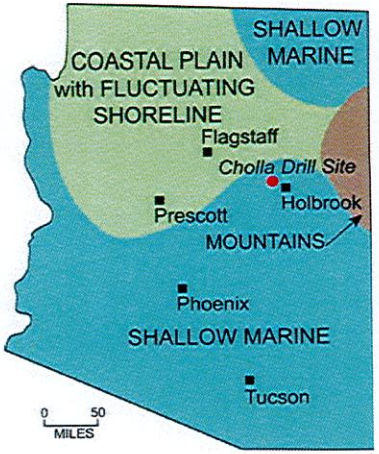
Fusulinids—Complexity at a Tiny Scale

Fusulinids were small single-celled marine organisms, typically about the size of a grain of wheat, although some forms were over two inches long. The earliest record of fusulinids occurs 320 million years ago. They evolved rapidly, changing into many forms, which make them excellent index fossils in Pennsylvanian rocks such as the Naco Formation. They became extinct during the mass extinction at the end of the Permian Period, about 251 million years ago.

Single-celled organisms rely on one cell to do all the essential life functions—movement, eating, digestion, reproduction, etc. In this way, they are different from multi-cellular life forms, which have various cells with specialized roles.

In order to accommodate all of these functions, the cell of organisms such as fusilinids is very complex. This can be seen in the hard calcium carbonate shells of fusilinids, which are internally divided into a series of chambers.





Generalized environments across Arizona during the Pennsylvanian Epoch, the time of deposition of the Naco Formation (modified from Ross, 1991, Blakey and Knepp, 1989)

Fusilinid drawing courtesy of the Kansas Geological Society, www.kgs.ku.edu
Photos courtesy of Dale Nations.

http://www.azjournal.com/

Carbon Capture Experiment Should Start Later This Month

July 3rd, 2009

(977)

By Tammy Gray-Searles

Drilling is set to begin soon to reach a deep underground rock formation into which carbon dioxide will be injected as part of a carbon capture experiment.

"We don't have an exact start date," Westcarb Outreach Coordinator Richard Myhre explained, but noted that if everything goes as planned, it will be within the next three weeks.

The carbon capture project is one of many across the nation designed to determine whether it is possible to safely and economically store carbon dioxide underground. If tests prove successful, output from various activities, including coal-based electric production, could be stored underground instead of being released into the atmosphere.

A number of partners are involved in the project, including Arizona Public Service Co. Westcarb includes a group of more than 80 private and public partners.

Work at the test site, which is located approximately one mile northeast of the APS Cholla Power Plant near the plant's ash pond, has already begun. Myhre explained that all of the preparations for drilling have been made, and partners in the project are ready as soon as a drilling rig arrives.

Since drilling will be much deeper than what is required for a water well, the rig will be the type that is used to drill for oil. According to Myhre, a private contractor will be providing the rig from Farmington, N.M., and is awaiting one last Arizona operating permit so that work can start. Permits to drill the well and conduct the test have already been obtained from the state and federal governments.

Myrhe explained that the drilling process should take a total of three weeks, if everything goes as planned.

"From the time the first bit hits the earth until the bottom of the hole is probably going to be about three weeks," he remarked.

Westcarb officials plan to provide regular updates about the depth of the drill and the layers of earth it will be cutting through on their Web site, www.westcarb.org, as work progresses.

"As we do the drilling, we will have daily or regular updates," Myrhe said. "It will show how deep, and as we're going through the layers for each formation we're in, how old the formation is, what was going on in Arizona at the time with it, what sort of reptiles, bony fishes, fossils, et cetera were there at the time."

Myhre explained that he hopes the Web site will be an educational tool both for adults and for school children learning about geology and new carbon capture techniques.

Because the hole will be so deep, reaching far below the Coconino aquifer (C-aquifer), it will be drilled in various tapering sizes. Myhre described the planned shape of the well as being similar to a telescope, with the wide part at the top, and the narrowest section at the bottom.

Once the drilling work is complete, scientists will test water and stone at the bottom to make sure that it is as expected. According to Myhre, preliminary research shows that the water at that depth and location should be extremely salty, and not suitable for any purpose, even with treatment.

"We actually want the good salty water. We don't want to be working in an area that could be someone else's resource," he explained.

Stone formations at that level are also expected to be porous sandstone, with sponge-like holes to absorb the carbon dioxide. Myrhe noted that a small water injection test will be performed to test the flow into the rock formation before the larger scale carbon dioxide test is completed.

"Carbon dioxide is liquid-like down at that pressure. We want to make sure it flows the way we expect," he said. "We inject the water and make sure it flows through the holes the way we want it to. We want to be sure we really can get it to flow into those holes, and that there are enough holes in the rock formation and they have enough connection."

If the early tests confirm what geologists believe about the formations at the location, carbon dioxide will then be injected and allowed to remain in the formation for a period of time. Then additional testing will take place to determine whether it has remained in the formation as expected and how far it has traveled.

Because the site is only being used for testing and not as a long-term carbon injection site, the hole will be

filled with cement and capped at the end of the experiment.

Myhre noted that prior to filling and abandoning the well, researchers may attempt a few additional experiments, including trying to retrieve some of the carbon dioxide from the site.

(977)

"Researchers actually question whether or not they can get it back out," Myrhe said.

He likened the absorption process to that of a sandstone coaster. Water from a glass is absorbed into the coaster, but cannot be extracted.

"It gets stuck in cracks between the pores due to capillary pressure," he noted. "There is some value to that. This is a small test, but if it were a bigger injection we might worry if it were able to come back out."

Drilling is set to begin soon to reach a deep underground rock formation into which carbon dioxide will be injected as part of a carbon capture experiment. "We don't have an exact start date," Westcarb Outreach Coordinator Richard Myhre explained, but noted that if everything goes as planned, it will be within the next three weeks

Local News

Subject: STATUS Re: START of DRILLING ACTIVITIES-UIC PERMIT NO. AZ50800004UIC PERMIT NO. AZ50800004
From: John.Boyer@aps.com
Date: Wed, 17 Jun 2009 10:50:49 -0700
To: rumrill.nancy@epa.gov
CC: robin.george@epa.gov, mb10@azdeq.gov, Winstead.Carrolette@azdeq.gov, dan.collins@sandiatech.com, JHBeyer@lbl.gov, steve.rauzi@azgs.az.gov, Douglas.Lavarnway@aps.com, John.Roznovak@aps.com

977

I am sending this note to let you know that due to some last minute contractual issues related to the driller, the start of drilling has been delayed. We are working to solve the problem and expect that we will begin drilling the week of July 6, 2009.

Once the contracts are final, I will send out a more definitive start schedule. Hopefully this revised schedule will be finalized by end of next week. If there is a delay, I will keep you informed.

John L. Boyer
Principal Environmental Scientist
Environmental Health & Safety Department
Arizona Public Service Company
P.O. Box 53999/Mail Sta: 8376
Phoenix, Arizona 85072-3999
Telephone: 602-250-3196
Cell Phone: 602-818-6721
Fax: 602-250-3872

From: Boyer, John L(K14729)
Sent: Thursday, June 04, 2009 3:53 PM
To: Nancy Rumrill
Cc: George Robin (robin.george@epa.gov); Mason Bolitho (mb10@azdeq.gov); Carrolette Winstead; dan.collins@sandiatech.com; John Henry Beyer; Steven L. Rauzi (steve.rauzi@azgs.az.gov); Lavarnway, Douglas R(Z52913); Roznovak, John M(Z80553)
Subject: NOTICE OF INTENT TO INITIATE DRILLING ACTIVITIES-UIC PERMIT NO. AZ50800004UIC PERMIT NO. AZ50800004

Nancy,

As required by our permit, I am attaching a letter that provides notice for initiating drilling at the Arizona Utilities CO2 Sequestration Pilot Well located at the APS Cholla Power Plant, Joseph City, Arizona. The letter provides the drilling schedule as it stands at this time and a copy of the surveyed well location plat.

A hard copy will be mailed to you today.

Please let me know if you have any questions.

John L. Boyer
Principal Environmental Scientist
Environmental Health & Safety Department
Arizona Public Service Company
P.O. Box 53999/Mail Sta: 8376
Phoenix, Arizona 85072-3999
Telephone: 602-250-3196

APS
A subsidiary of Pinnacle West Capital Corporation

John L. Boyer
Principal Environmental Scientist
Environmental Health & Safety Department

Tel. 602-250-3196
Fax 602-250-3872
e-mail John.Boyer@aps.com

Mail Station 8376
PO Box 53999
Phoenix, Arizona 85072-3999

June 4, , 2009

Ms Nancy Rumrill, Environmental Engineer
United States Environmental Protection Agency, Region IX
Water Division
Ground Water Office (Mail Code WTR-9)
75 Hawthorne Street
San Francisco, CA 94105-3901

977

NOTICE OF INTENT TO INITIATE DRILLING ACTIVITIES
UIC PERMIT NO. AZ50800004

Dear Ms Rumrill

Per UIC Permit No. AZ50800004, the Arizona Public Service Company (APS) is providing notice of our intent to initiate drilling activities for our WestCarb Arizona Utilities Carbon Dioxide Storage Pilot Test Well on or about June 25, 2009. A tentative schedule of events through setting and cementing of the protective casing and demobilization of the drilling rig off of location is as follows:

- Mobilize Supervisory Personnel and Support to the Project Site – June 15, 2009
- Mobilize Spud Rig and Set Conductor Casing – June 17, 2009
- Mobilize Drilling Rig to the Project Site – June 22, 2009
- Initiate Drilling of the Surface Hole – June 25, 2009
- Run Open Hole Logs in the Surface Hole – June 28, 2009
- Run and Cement Surface Casing – June 29, 2009
- Initiate Drilling of the Protection Hole – July 1, 2009
- Run Open Hole Logs in the Protection Hole – July 11, 2009
- Run and Cement Protection Casing – July 12, 2009
- Demobilize Drilling Rig from the Project Site – July 13, 2009
- Secure Project Site Pending Completion Activities – July 14, 2009

APS will keep you apprised of project progress and notify you as dates firm up.
Also, please find attached to this letter, per Permit Part II.A.2(a), a copy of the surveyor's plat for the well. This plat shows that the well will tentatively be located 2,079 feet west of the east line and 1,782 feet north of the south line in Section 30 of Township 18 North

and Range 20 East, Gila & Salt River Meridian in Navajo County, Arizona. A final well survey plat will be completed following well installation.

If there should be a need for additional information, or if there are any questions, please contact me at (602) 250-3196.

Sincerely,

John L Boyer

John L. Boyer

977

Attachments

CC: Mason R. Bolitho, Arizona Department of Environmental Quality
Steven L. Rauzi, Arizona Oil and Gas Conservation Commission
Douglas Lavarnway, APS Cholla Power Plant

Janice K. Brewer
Governor

State of Arizona
Oil and Gas Conservation Commission
416 W. Congress, Suite 100
Tucson, Arizona 85701
520-770-3500
www.azogcc.az.gov
Steven L. Rauzi, Oil and Gas Administrator

Commissioners:
J. Dale Nations, Ph.D. Chair
Robert L Jones, Vice Chair
Stephen R. Cooper
Michele P. Negley

May 28, 2009

Doug Lavarnway
Environmental Chemistry Manager
Arizona Public Service Company - Cholla
PO Box 188/STA 4451
Joseph City AZ 86032

977

Re: Extend Permit 977

Dear Mr. Lavarnway,

Your written request to extend Permit 977 for six months is approved. The extension is good through November 5, 2009.

Sincerely,

Steven L. Rauzi
Oil & Gas Administrator

c J. Dale Nations, Chairman

Subject: Re: Extension of Permit 977 for CO2 Injection Well
From: Steve Rauzi <steve.rauzi@azgs.az.gov>
Date: Thu, 28 May 2009 10:10:50 -0700
To: Douglas.Lavarnway@aps.com
CC: John.Boyer@aps.com, John.Roznovak@aps.com

977

Mr. Lavarnway,
Your request to extend Permit 977 for six months is approved (letter attached). The extension is good through November 5, 2009.
Steven L. Rauzi
Oil & Gas Administrator

On 5/28/2009 9:28 AM, Douglas.Lavarnway@aps.com wrote:

> Mr. Rauzi,
> Per our phone discussion earlier today, Arizona Public Service hereby requests a 6 month extension for the attached Drill permit #977 for Well #Cholla CO2-Test1.
>
> Doug Lavarnway
> Environmental Chemistry Manager
> Arizona Public Service Company - Cholla
> Work: (928) 288-1394
> Cell: (928) 587-0319
> Fax: (928) 288-1399
> e-mail: Douglas_Lavarnway@apsc.com
>
> Email Firewall made the following annotations
> ---
> --- NOTICE ---
> This message is for the designated recipient only and may contain confidential, privileged or proprietary information. If you have received it in error, please notify the sender immediately and delete the original and any copy or printout. Unintended recipients are prohibited from making any other use of this e-mail. Although we have taken reasonable precautions to ensure no viruses are present in this e-mail, we accept no liability for any loss or damage arising from the use of this e-mail or attachments, or for any delay or errors or omissions in the contents which result from e-mail transmission.
> ---

Permit 977 extension.pdf	**Content-Type:** application/pdf **Content-Encoding:** base64

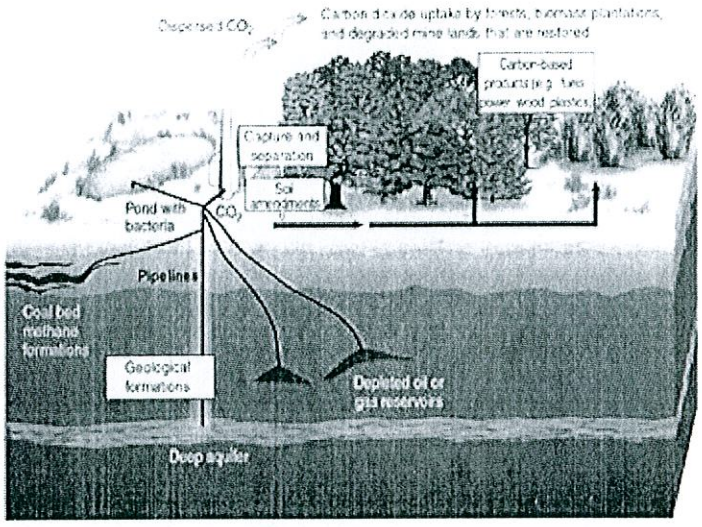
Arizona carbon sequestration project first of its kind in the Southwest

977

ADEQ SUNDAY, 12 APRIL 2009

COMMENT | BOOKMARK | + x - TEXT SIZE

The Arizona Department of Environmental Quality and U.S. Environmental Protection Agency have issued permits authorizing the West Coast Regional Carbon Sequestration Partnership (WESTCARB) to inject 2,000 tons of carbon dioxide into an underground saline formation in Joseph City, west of Holbrook.



The carbon dioxide injection will occur on Arizona Public Service Company's Cholla Power Plant property in Navajo County at a depth of about 3,500 feet. The WESTCARB injection project is sponsored by APS and Lawrence Berkeley National Laboratory, with funding from the Department of Energy.

"The short-term pilot project meets our national requirements to protect underground sources of drinking water," said Alexis Strauss, director of the Water Division for the EPA's Pacific Southwest region. "EPA and WESTCARB will evaluate this experiment to better understand how geologic sequestration can help the United States reduce atmospheric emissions of greenhouse gases."

In addition, ADEQ issued a temporary one-year Aquifer Protection Permit (APP), which requires the project to meet Arizona aquifer water-quality standards and to use the best available technology to protect the aquifer from pollutants. The below-surface formation will confine the carbon dioxide and keep it from permeating upward.

"We are pleased to join with the EPA and WESTCARB by issuing our temporary permit," said Patrick J. Cunningham, ADEQ's acting director. "This temporary permit is protective of groundwater in Northern Arizona."

Geologic carbon sequestration refers to the "capture" of carbon dioxide and its long-term storage in underground geologic formations, removing it from the atmosphere. Carbon dioxide can be captured by modifying industrial plants to remove the gas from process or exhaust emissions before their release.

In addition to being regulated under Arizona's Aquifer Protection Permit program, injection wells are regulated under the Safe Drinking Water Act's Underground Injection Control (UIC) program, which EPA administers in Arizona. The UIC program is responsible for regulating the permitting, construction, operation, and safe closure of injection wells that place fluids underground for storage, enhanced oil and gas

recovery, or disposal. The program ensures safe construction and operation of injection wells to prevent contamination of underground drinking water resources.

Arizona Range News
willcoxrangenews.com

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News

APS to bury C02, run experimental synthetic gas and algae-biofuel plants

Print Page

By Dick Kamp / Wick Communications Environmental Liaison

Published: Wednesday, April 1, 2009 3:28 PM CDT

3/26/09

Climate Change Experiment: Arizona's largest utility, Arizona Public Service, received a one-year aquifer protection permit March 25 from US EPA Region 9 and the Arizona Department of Environmental Quality (ADEQ) to experimentally pump 2,000 tons of carbon dioxide (also known as carbon sequestration) into a deep-aquifer saline formation of groundwater 3500 feet below their Cholla coal-fired power plant at Joseph City in northern Arizona.

Arizona does not differentiate between very deep aquifers that may be naturally saline or those closer to the surface that are normally a source of potable water.

Coal-fired plants are the largest single source of the estimated 1.7 billion tons of climate-changing carbon emissions generated by the U.S. as well as the largest source globally. Arizona is currently the fastest growing state in the country for carbon emissions according to ADEQ.

The CO2 being injected will not be climate changing carbon emitted by the1000 MW power plant itself. Rather it will be "food grade CO2" said ADEQ spokesman Mark Shaffer.

Actual carbon emissions from the Cholla plant, according to figures from the US Department of Energy and US Electric Power Institute, would be in the range of 6 million tons per year.

Carbon Sequestration unproven: There are no processes in place globally that capture over one million tons per year of CO2. The Massachusetts Institute of Technology in a report often cited by the utility industry estimates an approximate cost of 30 million dollars per year to capture CO2 from a pulverized coal power plant such as Cholla. This would be in addition to the actual costs of retrofitting a power plant to capture carbon which have been estimated in a range of costs from 400 million to one billion dollars. No similar coal fired power plant has been retrofitted to control carbon.

Environmental concerns accompany carbon sequestration. The first is the degree of certainty that CO2 injected into the ground will not migrate first to aquifers that could be contaminated and, ultimately back into the atmosphere. Shaffer said, "CO2 in water can form carbonic acid, which is a weak acid. Carbonic acid is present in carbonated drinks. There is also a slight possibility that sequestered CO2 or the resultant carbonic acid could mobilize naturally occurring contaminants such as metals from subsurface formations."

Shaffer was referring to the pure CO2, however CO2 separated from a power plant plume couldcont ain pollutants that otherwise might go out the stacks such as sulfur and nitrogen oxides, mercury and other heavy metals.

Another concern related to carbon sequestration is the increased amount of energy needed to power the coal sequestration process and toxic air emissions that accompany burning then coal needed for the extra power.

A September, 2008 study by Utrecht University in the Netherlands suggests that "a coal-fired power plant that sequesters its CO2 must burn about 30 percent more coal than conventional plants to cover these energy needs.....when the researchers factored in all thee pollution generated in order to sequester the carbon, "emissions of acid rain-causing gases like nitrogen oxides and sulfur oxides were up to 40 percent greater than the total cradle-to-grave emissions of a modern plant that doesn't capture its CO2.", reported Science News.

APS and Carbon alternatives: APS Vice President Edward Fox has been skeptical about carbon sequestration

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as a viable carbon strategy in the past. Fox said, "While I'm not overly optimistic about geologic sequestration, I need to be somewhat agnostic about available technology because if its works and is cost effective, we may have to do it."

Fox went on, "The test is one well, but will allow us to get a handle on how the material moves after its injected. We know the deep saline aquifer is wide spread in the area, but we need to gather additional data before making a decision to expand the project".

Denver-based climate change consultant and activist Nancy La Placa suggested that given economic and environmental costs and the lack of success of large-scale sequestration that APS should consider alternatives such as moving quickly to combine solar with the existing coal plant as one step on the road to permanent renewable energy source in the Joseph City area.

La Placa said, "We can look at coal plants and begin to "hybridize"

them with concentrated solar plants that use dry-cooling condensers instead of water-consuming cooling towers. Why put the money into sequestration? Concentrated solar is cheaper, emits no carbon and it works. You place the concentrated solar plant next to the coal plant and preheat the water and feed heated water into the coal boiler and burn less coal."

A concentrated solar plant about half the size of the Cholla coal plant would probably cost about a billion dollars to build-equivalent to the cost of a new natural gas plant but requiring no fuel.

La Placa added, "APS will need to look at where it has transmission lines and ensure that the solar resource at the site is adequate. Right now Salt River Project is experimenting with hybridizing their Kingman Griffith natural gas combined cycle power plant."

APS has also experimented with capturing carbon to grow algae at their Redhawk natural gas power plant near the Palo Verde nuclear plant. The algae then produced biofuel which fueled company vehicles, however a planned large-scale demonstration of algae capture at the Four-Corners Power Plant by the Greenfuels Corporation was halted. The hope was that either biofuel for external use or some form of algae based fuel could actually power one of the Four-Corners boilers in lieu of burning some coal.

Fox said that APS will be using their own algae creation technology to capture carbon emissions, "Our first bioreactor has been operating for a few weeks and shows great promise to be a design that can be commercialized. In fact, we are building a small operation at the Redhawk plant to prove its scalability. That should be operational later this year."

Fox said that the question of how long carbon capture of some sort could extend the life of the Cholla plant "is a very complicated question and the answer has a lot to do with the cost of carbon in a carbon-regulated program and the cost of sequestration versus other technologies, including algae. I will make the assumption that if CO2 can be successfully captured and managed (either geologic sequestration or algae or something else), there will be no reason to close the plants provide we are able to meet other environmental standards and I have little doubt that we can do that now and in the future"

APS, said Fox, will also be experimenting with a new technology to "gasify coal with hydrogen to make pipeline quality methane. The first hydrogasifier is being assembled at our facility here in Phoenix and we expect to (start it up) in the next 60 days." The technology would produce a relatively clean gas from coal although critics claim that the mining and overall carbon emissions do not justify coal hydrogasification as a step toward low-carbon fuels.

APS scientist Ray Hobbs has suggested that hydrogasification may be a plentiful and low polluting source of natural gas until renewable energy infrastructure can match existing natural gas pipeline infrastructure.

The company has invested in a 280 megawatt concentrated solar power plant, owns several hundred watts of wind turbine projects in eastern New Mexico, about 1.5 megawatts in photovoltaic projects, and intends to have invested in 1600 megawatts of renewable energy by 2025.

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[x] Close Window

(977)

3-25-09 Dennis Shirley, EL Montgomery

Received signed UIC application
Taking action to line up materials + equipment
Dan Collins, Sandia, is project leader
Running power line to site
Anticipate site to be ready by end of April
Looking at 2 drilling contractors
Estimate spud in early May

Subject: U.S. Environmental Protection Agency Region 9: Energy News Releases Update: ADEQ and EPA Issue Permits for Carbon Sequestration Injection Project Beneath APS Power Plant In Joseph City / Pilot project first of its kind in the Southwest
From: "U.S. EPA" <usaepa@govdelivery.com>
Date: Wed, 25 Mar 2009 12:32:06 -0500 (CDT)
To: steve.rauzi@azgs.az.gov

Media Contact: Margot Perez-Sullivan, perezsullivan.margot@epa.gov, 415.947.4149

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ADEQ and EPA Issue Permits for Carbon Sequestration Injection Project Beneath APS Power Plant In Joseph City

Pilot project first of its kind in the Southwest

PHOENIX (March 25, 2009) – The Arizona Department of Environmental Quality and U.S. Environmental Protection Agency have issued permits authorizing the West Coast Regional Carbon Sequestration Partnership (WESTCARB) to inject 2,000 tons of carbon dioxide into an underground saline formation in Joseph City, west of Holbrook.

The carbon dioxide injection will occur on Arizona Public Service Company's Cholla Power Plant property in Navajo County at a depth of about 3,500 feet. The WESTCARB injection project is sponsored by APS and Lawrence Berkeley National Laboratory, with funding from the Department of Energy.

"The short-term pilot project meets our national requirements to protect underground sources of drinking water," said Alexis Strauss, director of the Water Division for the EPA's Pacific Southwest region. "EPA and WESTCARB will evaluate this experiment to better understand how geologic sequestration can help the United States reduce atmospheric emissions of greenhouse gases."

In addition, ADEQ issued a temporary one-year Aquifer Protection Permit (APP), which requires the project to meet Arizona aquifer water-quality standards and to use the best available technology to protect the aquifer from pollutants. The below-surface formation will confine the carbon dioxide and keep it from permeating upward.

"We are pleased to join with the EPA and WESTCARB by issuing our temporary permit," said Patrick J. Cunningham, ADEQ's acting director. "This temporary permit is protective of groundwater in Northern Arizona."

Geologic carbon sequestration refers to the "capture" of carbon dioxide and its long-term storage in underground geologic formations, removing it from the atmosphere. Carbon dioxide can be captured by modifying industrial plants to remove the gas from process or exhaust emissions before their release.

In addition to being regulated under Arizona's Aquifer Protection Permit program, injection wells are regulated under the Safe Drinking Water Act's Underground Injection Control (UIC) program, which EPA administers in Arizona. The UIC program is responsible for regulating the permitting, construction, operation, and safe closure of injection wells that place fluids underground for storage, enhanced oil and gas recovery, or disposal. The program ensures safe construction and operation of injection wells to prevent contamination of underground drinking water resources.

For more information on the EPA's Office of Water, please visit:

www.epa.gov/region09/water

You are subscribed to Region 9: Energy News Releases for U.S. Environmental Protection Agency. This information has recently been updated, and is now available.

You can view or update your subscriptions or e-mail address at any time on your Subscriber Preferences Page. All you will

Fact Sheet

Aquifer Protection Permit P-106019
Place ID 509495-00, LTF 47849
Temporary Individual Permit
APS – Cholla Power Plant
(Carbon Sequestration Pilot Test)

977

The Arizona Department of Environmental Quality (ADEQ) proposes to issue a Temporary Aquifer Protection Permit for the subject facility that covers the life of the facility, including operational, closure, and post-closure periods, unless suspended or revoked pursuant to Arizona Administrative Code (A.A.C.) R18-9-A213. This temporary permit expires 1 year from the date of issuance and is eligible for renewal once. This document gives pertinent information concerning the issuance of the permit. The requirements contained in this permit will allow the permittee to comply with the two key requirements of the Aquifer Protection Program (1) meet Aquifer Water Quality Standards (AWQS) at the Point of Compliance (POC), and (2) demonstrate Best Available Demonstrated Control Technology (BADCT). BADCT's purpose is to employ engineering controls, processes, operating methods or other alternatives, including site-specific characteristics (i.e., the local subsurface geology), to protect drinking water aquifers from pollutants.

I. FACILITY INFORMATION

Name and Location

Permittee's Name:	APS – Cholla Power Plant
Mailing Address:	P.O. Box 188, MS 7668 Joseph City, Arizona 86032
Facility Name and Location:	APS – Cholla Power Plant (Carbon Sequestration Pilot Test) 4801 Frontage Road Joseph City, Arizona 86032

Regulatory Status

Although the location of this permitted facility is on the site currently operating under an existing current permit, this is a new permit. The work performed under this permit is for a pilot test, and is not planned to last longer than a few months. Therefore, there is no regulatory status associated with this permit.

Facility Description

This permit allows for the installation of an injection well for the purpose of conducting a pilot test to inject approximately 2,000 tons of food-grade, supercritical carbon dioxide into the Martin Formation. The injection will occur at approximately 4,000 feet below ground surface. The overall goal of the pilot test is to gain practical experience with, and demonstrate the potential for, safe carbon dioxide storage in

deep underground geologic formations in a location with large, surface carbon dioxide sources, such as the Cholla Power Plant, and large subsurface carbon dioxide storage potential. This injection test will incorporate food-grade, supercritical carbon dioxide to ascertain the maximum injection pressure and flow rate achievable, without causing fracturing in the geologic formation.

Closure Description

Upon completion of the pilot test, the injection well shall be plugged and abandoned in accordance with rules adopted by the Arizona Oil and Gas Conservation Commission.

II. BEST AVAILABLE DEMONSTRATED CONTROL TECHNOLOGY

Typical BADCT practices for aquifer protection cannot necessarily be implemented here, as BADCT applies to the quality of the media added to the aquifer through various pollution removal technologies and the quality of the discharged media will be food-grade. Instead, physical parameter monitoring shall be adopted to ensure safe practices and BADCT during operational periods, in addition to pre- and post-injection water quality sampling of the injection aquifer and shallower aquifer. The overall goals of the applied BADCT are to (1) protect the formation from fracturing, and (2) protect the shallower drinking water aquifers from exposure to the injected carbon dioxide. This pilot project is in essence a test that will provide information that may be relevant to potential future commercial scale carbon dioxide injection and sequestration projects.

The BADCT shall follow conservative, established procedures that minimize the risk of carbon dioxide leakage into shallow aquifers and fracturing of the target injection zone, the Jerome Member of the Martin Formation (with the shallower Naco Formation as the backup). Other possible outcomes of carbon dioxide injection include displacement of native fluids and chemical constituents, and potential leaching and mobilization of naturally occurring metals and minerals within the confining formation. Geological impacts to the nearby aquifer shall be considered with respect to site location, and shall be guarded against by the application of BADCT.

The BADCT shall be applied through well siting, construction, operation, and closure of the injection well, with the inclusion of monitoring parameters during the step-rate injection test (SRT), well integrity monitoring practices, and monitoring of carbon dioxide movement within the aquifer. Each of these methods is described in detail below.

Monitoring Step Test Parameters – The SRT, as it applies to BADCT, is the measured control of the injection flow rate and monitoring of the associated pressure for the duration of the pilot test. The step test shall begin at a lower flow rate and increase in equal intervals (at least five steps shall be planned) with continuous monitoring of associated pressures, until a slight pressure drop is observed. This first

pressure drop typically indicates fracture pressure, which is the amount of pressure required to initiate flow of formation water into the injection zone. This pressure is slightly higher than the required operational pressure for continued injection, due to the initial force required for the formation water injected to overcome, or displace, the head and capillary fringe that hold air and/or liquid within the formation pores and/or fractures.

This methodology guards against fracturing of the formation due to the step-controlled increase of the flow rate, which allows for some control over the associated pressure. A measured pressure drop of more than 10 percent at any point during the test will indicate a failure, which is a fracture of the formation, and contingency actions shall be implemented as described in the permit.

This step-rate test will aide in establishing the target flow rate and injection pressures for the carbon dioxide pilot test. The absolute maximum injection pressure during carbon dioxide injection at the injection formation shall not exceed 80 percent of the measured or estimated formation fracture (or parting) pressure at that depth. The permit includes the engineering design calculations and associated pressures for the step test.

The injection depth shall be selected based upon well logging results and formation testing. The target injection depth shall fall between the range of 3,600 to 4,500 ft bgs, due to the top of the Jerome Member of the Devonian Martin Formation estimated at approximately 3,600 ft bgs.

Carbon Dioxide Injection Test - The maximum flow rate for the carbon dioxide test shall be determined by the maximum allowable injection pressure as determined by the step-rate injection test using filtered formation water. An inline heater shall provide temperature regulation of the carbon dioxide and maintain the temperature between 40 and 70 degrees Fahrenheit.

Additionally, the injection well annulus pressurization and monitoring system shall maintain a positive pressure versus the tubing pressure for leak detection. Pressurization of the annulus shall be performed using high-pressure nitrogen. Alternatively, a small-volume, high-pressure pump connected to a low-pressure annulus fluid reserve tank may be used to maintain positive annulus pressure on the injection well. These parameters shall be monitored and recorded continuously.

Monitoring Carbon Dioxide Movement – Tracking the movement of carbon dioxide within the formation is critical for the purposes of the aquifer protection and permitting program. A representative sample of the target injection aquifer shall be collected prior to injection of carbon dioxide into the formation to reflect ambient conditions at the point of injection. In addition to sample collection, a vertical seismic profile (VSP) shall be performed to further characterize the carbon dioxide reservoir horizon and the adjunct formations.

III. COMPLIANCE WITH AQUIFER WATER QUALITY STANDARDS

Monitoring and Reporting Requirements

Discharge Monitoring
Discharge monitoring for selected parameters is required under the permit. Discharge monitoring is associated with flow rate, pressure, temperature, and volume with respect to the injection of formation fluid and food-grade carbon dioxide. The location of the injection well is as follows:

Facility	Latitude	Longitude
Injection Well	34° 55' 43" N	110° 15' 31" W

Ambient Groundwater Monitoring
Ambient groundwater monitoring shall be conducted in the injection well and in a monitoring well (W-125), which is located in the shallow drinking water aquifer (Coconino aquifer) between the injection well and nearest user of the drinking water aquifer. Ambient groundwater monitoring shall be performed before carbon dioxide injection to establish background water quality in the injection aquifer and shallower drinking water aquifer. Well W-125 is located as follows:

Monitoring Location	Latitude	Longitude
W-125 Located 1,800 feet cross-gradient of Injection Well (depth of 140 ft)	34° 55' 43" N	110° 16' 00" W

Operational Groundwater Monitoring
Operational groundwater monitoring shall be performed following the carbon dioxide injection test to compare water quality in the injection aquifer and shallower drinking water aquifer to that of ambient conditions. Operational monitoring includes the collection of water quality samples. One sample will be collected from the injection well and the other from the shallower aquifer monitoring well W-125.

As part of the final report, a discussion of pre- and post-test conditions in both aquifers shall be presented. All monitoring required in this permit shall continue for the duration of the permit, regardless of the status of the facility.

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Point(s) of Compliance

POC Location	Latitude	Longitude
Located 400 feet southwest of Injection Well	34° 55' 40" N	110° 15' 34" W

ADEQ may require installation and monitoring of the POC, if necessary, based upon the water quality results and/or the evaluation of test data.

IV. STORM WATER AND SURFACE WATER CONSIDERATIONS

Not applicable under this permit as there is no surface discharge and the injection well is isolated from any exposure to storm water runoff. The facility is located outside the 100-year flood plain of the Little Colorado River.

V. COMPLIANCE SCHEDULE

For each compliance schedule item listed below, the permittee shall submit the required information, including a cover letter that lists the compliance schedule items, to the Groundwater Section. A copy of the cover letter must also be submitted to the Water Quality Compliance Section.

Description	Due by
The permittee shall submit a well construction diagram, lithologic log and geophysical logs that confirm the well is constructed according to the Department-approved design report or plans and specifications, as applicable. Lithologic logging shall include 10-foot samples from 40 feet below ground surface to total injection well depth (samples to be provided to OGCC), and deviation survey information from every 500 feet of drilling.	Within 90 days of completion of construction
The permittee shall collect Coconino aquifer water samples from Monitoring Well W-125 and the injection well (during drilling). In addition, a sample of injection zone water shall be collected from the injection well (upon drilling completion) prior to any injection activities and report the results to the Department (Section 4.1, Tables I-B and I-C).	Within 30 days of receipt of the final laboratory report
The permittee shall collect a sample of injection zone water from the injection well at least 1 month following injection activities and report the results to the Department (Section 4.2, Table II-B).	Within 30 days of receipt of the final laboratory report

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The permittee shall collect a Coconino aquifer water sample from Monitoring Well W-125 following injection activities and report the results to the Department (Section 4.2, Table II-C).	Within 30 days of receipt of the final laboratory report
The permittee shall submit documentation of well abandonment activities.	Within 60 days of actual well abandonment
The permittee shall submit a report discussing the findings of the pilot test, including all supporting data.	September 30, 2009, or a subsequent date up to the end of this permit, if funding for this project is extended

VI. OTHER REQUIREMENTS FOR ISSUING THIS PERMIT

Technical Capability

APS has demonstrated the technical competence necessary to carry out the terms and conditions of the permit in accordance with A.R.S. § 49-243(N) and A.A.C. R18-9-A202(B). A detailed discussion of technical capability and a list of contractors and qualifications were included in the original application under Attachment 3.

ADEQ requires that appropriate documents be sealed by an Arizona registered geologist or professional engineer. This requirement is a part of an on-going demonstration of technical capability. The permittee is expected to maintain technical capability throughout the life of the facility.

Financial Capability

APS has demonstrated the financial responsibility necessary to carry out the terms and conditions of the permit in accordance with A.R.S. § 49-243(N) and A.A.C. R18-9-A203. The permittee is expected to maintain financial capability throughout the life of the facility. The estimated closure and post-closure costs are $121,275. The financial assurance mechanism was demonstrated through a performance surety bond for $121,275, pursuant to A.A.C. R18-9-A203(C)(2).

Zoning Requirements

APS has been properly zoned for the permitted use and the permittee has complied with all Navajo County zoning ordinances in accordance with A.R.S. § 49-243(O) and A.A.C. R18-9-A201(B)(3).

VII. ADMINISTRATIVE INFORMATION

Public Notice (A.A.C. R18-9-108(A))

The public notice is the vehicle for informing all interested parties and members of the general public of the contents of a draft permit or other significant action with respect to a permit or application. The basic intent of this requirement is to ensure that all interested parties have an opportunity to comment on significant actions of the permitting agency with respect to a permit application or permit. This permit will be public noticed in a local newspaper after a pre-notice review by the applicant and other affected agencies.

Public Comment Period (A.A.C. R18-9-109(A))

The aquifer protection program rules require that permits be public noticed in a newspaper of general circulation within the area affected by the facility or activity and provide a minimum of 30 calendar days for interested parties to respond in writing to ADEQ. After the closing of the public comment period, ADEQ is required to respond to all significant comments at the time a final permit decision is reached or at the same time a final permit is actually issued.

Public Hearing (A.A.C R18-9-109(B))

A public hearing may be requested in writing by any interested party. The request should state the nature of the issues proposed to be raised during the hearing. A public hearing will be held if the Director determines there is a significant amount of interest expressed during the 30-day public comment period, or if significant new issues arise that were not considered during the permitting process.

VIII. ADDITIONAL INFORMATION

Additional information relating to this proposed permit may be obtained from:

Arizona Department of Environmental Quality
Water Quality Division – Groundwater Section – Administration Unit
Attn: Mason Bolitho
1110 W. Washington St., Mail Code: 5415B-3
Phoenix, Arizona 85007
Phone: (602) 771- 4434

977

The Power To Make It Happen
Cholla Steam Electric Station
P.O. Box 188/STA 4451 • Joseph City, Arizona 86032 - 0188
Phone: (928) 288-1541
Fax: (928) 288-1399

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Nov 7, 2008

977

Mr. Steven L. Rauzi
Arizona Oil & Gas Program Administrator
Arizona Oil & Gas Conservation Commission
416 W. Congress, Suite 100
Tucson, Arizona 85701
502-770-3500

Re: APS Cholla Power Plant Revised Survey Map

Dear Mr. Rauzi,

Arizona Public Service Company (APS), Cholla Power Plant (Cholla) has attached a revised Survey Map as per our conversation.

Thank you for your departments prompt review and consideration, if any other questions arise, please call Dan Gradle at 928-288-1541 or Mr. John Boyer at 602-250- 3196.

c 602-818-6721

Dan D. Gradle
Environmental & Chemicals Manager
Cholla Power Plant

Hlb Trib-News Friday Nov 7 2008

Public Meeting Is Slated On Underground Storage Of CO_2

A public meeting will be held on Wednesday, Nov. 12, in Holbrook to present information and progress on the planned research project near Joseph City to test and demonstrate technology for the underground storage of carbon dioxide (CO_2). The project is part of large scale research to control CO_2 emissions. The meeting will be held from 3:30 to 6 p.m. at the Catholic Family Center, located at 212 E. Arizona St.

CO_2 is released into the atmosphere when fossil fuels are burned to generate electricity, refine oil, power vehicles, make asphalt and heat buildings.

The meeting is being presented by Arizona Public Service Co. (APS), Salt River Project (SRP), Tucson Electric Power (TEP), Arizona Electric Power Cooperative and Peabody Energy Co., and other members of the West Coast Regional Carbon Sequestration Partnership (WESTCARB). Other WESTCARB presenters at the meeting will include representatives of the Lawrence Berkeley National Laboratory and the Electric Power Research Institute.

The WESTCARB partners are participating in the Arizona Utilities CO_2 Storage Pilot project to validate the feasibility, safety and efficacy of carbon sequestration techniques. Scheduled to begin in January and continue for about one year, the project is co-funded by the U.S. Department of Energy and the California Energy Commission.

The research site is located approximately one mile east of Joseph City in Navajo County on land owned by APS. The site was selected by geologists because of its deep geologic formations containing water so salty that is unsuitable for drinking, livestock or irrigation.

A small amount (2,000 tons) of commercial CO_2 will be transported by truck to the site and pumped about three-fourths of a mile deep into the reservoir formation. Sensitive instruments will monitor the location and stabilization of the CO_2 plume. The land surface will remain undisturbed except for a small area required for the injection well. Upon completion of the project, the test well will be properly abandoned as required by Arizona laws.

Regulatory permitting and oversight of the project will be provided by the Arizona Department of Environmental Quality and the U.S. Environmental Protection Agency. The agencies will review geologic information, the well design, test plan and procedures to ensure that drinking water aquifers are not endangered. Application has been made to the Arizona Oil and Gas Conservation Commission for a well drilling permit.

Successful testing in Arizona and some 20 other locations in the U.S. and Canada may lead to large commercial underground storage projects that could reduce the impacts of CO_2 emissions on climate change and global warming. With large-scale commercial sequestration, CO_2 would be captured from the exhaust stacks of power plants, oil refineries and other industrial facilities and stored underground for centuries or longer. While WESTCARB and its Arizona utility partners are testing underground storage techniques, the technology needed to capture CO_2 emissions at industrial sites is being developed through other programs by the U.S. Department of Energy.

West Coast Regional Carbon Sequestration Partnership
westcarb.org

SRP NEWS

Tucson Electric Power
A UniSource Energy Company

APS
THE POWER TO MAKE IT HAPPEN

For Immediate Release
November 5, 2008

Contact: Steven Gotfried (APS) (602) 250-3040
Patty Garcia-Likens (SRP) (602) 236-2500
Joe Salkowski (TEP) (520) 884-3625

Public Meeting Announced for Wednesday (Nov. 12) in Holbrook to Discuss Research Project for Underground Storage of CO_2 Near Joseph City to Reduce Greenhouse Gases

A public meeting will be held in Holbrook on Wednesday (Nov. 12) to present information and progress on the planned research project near Joseph City to test and demonstrate technology for the underground storage of carbon dioxide (CO_2). The project is part of large scale research to control CO_2 emissions. The meeting will be held from 3:30 to 6 p.m. at the Catholic Family Center at 212 E. Arizona St.

CO_2 is released into the atmosphere when fossil fuels are burned to generate electricity, refine oil, power vehicles, make asphalt and heat buildings.

The meeting is being presented by Arizona Public Service Co. (APS), Salt River Project (SRP), Tucson Electric Power (TEP), Arizona Electric Power Cooperative and Peabody Energy Co. and other members of the West Coast Regional Carbon Sequestration Partnership (WESTCARB). Other WESTCARB presenters at the meeting will include representatives of the Lawrence Berkeley National Laboratory and the Electric Power Research Institute.

The WESTCARB partners are participating in the Arizona Utilities CO_2 Storage Pilot project to validate the feasibility, safety and efficacy of carbon sequestration techniques. Scheduled to begin in January and continue for about one year, the project is co-funded by the U.S. Department of Energy and the California Energy Commission.

The research site is located approximately one mile east of Joseph City in Navajo County on land owned by APS. The site was selected by geologists because of its deep geologic formations containing water so salty that is unsuitable for drinking, livestock or irrigation.

A small amount (2,000 tons) of commercial CO_2 will be transported by truck to the site and pumped about three-fourths of a mile deep into the reservoir formation. Sensitive instruments will monitor the location and stabilization of the CO_2 plume. The land surface will remain undisturbed except for a small area required for the injection well. Upon completion of the project, the test well will be properly abandoned as required by Arizona laws.

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Successful testing in Arizona and some 20 other locations in the U.S. and Canada may lead to large commercial underground storage projects that could reduce the impacts of CO_2 emissions on climate change and global warming. With large-scale commercial sequestration, CO_2 would be captured from the exhaust stacks of power plants, oil refineries and other industrial facilities and stored underground for centuries or longer. While WESTCARB and its Arizona utility partners are testing underground storage techniques, the technology needed to capture CO_2 emissions at industrial sites is being developed through other programs by the U.S. Department of Energy.

WESTCARB is one of seven research partnerships co-funded by the U.S. Department of Energy to conduct technology validation tests. The WESTCARB region consists of seven states – Arizona, Alaska, California, Hawaii, Nevada, Oregon and Washington – and the Canadian province of British Columbia. The team is managed by the California Energy Commission with the Lawrence Berkeley National Laboratory providing technical oversight and leadership for the field tests. A complete list of WESTCARB partners, including other Arizona companies and agencies, is available at www.westcarb.org.

# # #

APS, Arizona's largest and longest-serving electricity utility, serves more than 1 million customers in 11 of the state's 15 counties. With headquarters in Phoenix, APS is the largest subsidiary of Pinnacle West Capital Corp. (NYSE: PNW)

Tucson Electric Power, a subsidiary of UniSource Energy (NYSE: UNS), provides safe, reliable electric service to nearly 395,000 customers in southern Arizona. For more information, visit TEP.com. For more information about UniSource Energy, visit uns.com.

SRP, the largest provider of power to the greater Phoenix metropolitan area, serves more than 930,000 electricity customers and is the nation's third largest public power utility provider. **For more information, visit** www.srpnet.com.

Janet Napolitano
Governor

State of Arizona
Oil and Gas Conservation Commission
416 W. Congress, Suite 100
Tucson, Arizona 85701
520-770-3500
www.azogcc.az.gov
Steven L. Rauzi, Oil and Gas Administrator

Commissioners:
J. Dale Nations, Ph.D. Chair
Robert L Jones, Vice Chair
Stephen R. Cooper
Michele P. Negley
Katosha Nakai

November 5, 2008

Mr. James Jayne
P O Box 668
Holbrook AZ 86025

Re: APS Cholla CO_2 Test 1 (Permit 977) Navajo County

Dear Mr. Jayne:

It is a policy of the Arizona Oil and Gas Conservation Commission to inform county government about proposed exploration and drilling activity. The referenced well is being drilled as a stratigraphic test to obtain subsurface geologic information. The Commission posts approved applications for permit to drill on its website at www.azogcc.az.gov.

The Commission issues a permit to drill under A.R.S. § 27-513. The permit is issued for wells that are in compliance with applicable statutes (A.R.S. § 27-516) and rules (12 A.A.C. 7), which were promulgated to safeguard the public health and safety and protect the environment and natural resources.

Sincerely,

S L Rauzi

Steven L. Rauzi
Oil and Gas Administrator

Janet Napolitano
Governor

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November 5, 2008

Mr. Dan D. Gradle
Cholla Power Plant
PO Box 188/STA 4451
Joseph City AZ 86032-0188

Re: APS Cholla CO_2 Test 1 (Permit 977) Navajo County

Dear Mr. Gradle:

I have enclosed a duplicate original copy of the approved Application to Drill the referenced stratigraphic test well, Permit to Drill 977, and filing fee receipt 3160.

The referenced application is approved on the condition that APS conduct its operations in compliance with all applicable statutes and rules of the State of Arizona and that APS or its designated representative notify me at least 48 hours before you move in drilling equipment and commence operations and that APS or its designated representative:

- Submits samples and other data pursuant to A.A.C. R12-7-121 and,
- Submits Sundry Notices summarizing daily progress and activity on at least a weekly basis through the completion of operations.

Forms are available for download at the Commission's web site at www.azogcc.az.gov.

Sincerely,

S L Rauzi

Steven L. Rauzi
Oil & Gas Administrator

Enclosures

Subject: Re: Arizona Utilities CO2 Sequestration Pilot Test Well - Corrections to Drilling Prognosis and to elevation of drill site.
From: Steve Rauzi <steve.rauzi@azgs.az.gov>
Date: Wed, 05 Nov 2008 13:36:13 -0700
To: John.Boyer@aps.com
CC: Danny.Gradle@aps.com

Thank you. No need for a new signature page. I'll make the corrections on the approved application that I return to you. I'll mail the approved application to Dan Gradle this afternoon. Steve

On 11/5/2008 1:13 PM, John.Boyer@aps.com wrote:

> Steve, I received your telephone call this morning confirming that you had received the signed original copies of the application in the mail.
>
> You asked about the reference to Attachment I in the text describing the drilling program.
>
> I apologize that I did not catch this reference when I assembled the document. It was pulled from the documentation sent to EPA for the UIC permit and the Attachment reference was to the section in that permit.
>
> I am attaching a revised document with the references corrected. In the original document, there is a reference to Attachment I on page 3, paragraph 9 and page 7, paragraph 5. On page 5, paragraphs 24 and 28 there is a reference to Appendix I. All of those references apply to the same document.
>
> The change I made was to change all four references to Exhibit 1. I then added Exhibit 1 that contains the language on the Well Logging, Coring and Testing Program that each of these references described.
>
> The revised document is attached.
>
> Also, we discovered that the surveyor incorrectly listed the surface elevation on the map. He listed it as 5,113 ft when in fact it should have been 5,130 ft. I am attaching the revised map. An original certified and stamped drawing will be mailed to you today.
>
> This change also impacts page 1 of the application under the Description of Well and Lease section. The elevation should be changed from 5,113 ft to 5,130 ft.
>
> Should we send a new signature page for this correction?
>
> John L. Boyer
> Principal Environmental Scientist
> Environmental Health & Safety Department
> Arizona Public Service Company
> P.O. Box 53999/Mail Sta: 8376
> Phoenix, Arizona 85072-3999
> Telephone: 602-250-3196
> Cell Phone: 602-818-6721
> Fax: 602-250-3872
>
> <<ArizonaUtilitiesCO2SequestrationPilot_DrillingPrognosis_Rev1_5Nov08.pdf>> <<Revised plat.pdf>>

The Power To Make It Happen
Cholla Steam Electric Station
P.O. Box 188/STA 4451 • Joseph City, Arizona 86032 - 0188
Phone: ~~(928) 288-1541~~ 928-288-1394 Doug Lavrnway
Fax: (928) 288-1399

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Nov 4, 2008

Mr. Steven L. Rauzi
Arizona Oil & Gas Program Administrator
Arizona Oil & Gas Conservation Commission
416 W. Congress, Suite 100
Tucson, Arizona 85701
502-770-3500

977

Re: APS Cholla Power Plant Strategraphic Test Well Application

Dear Mr. Rauzi,

Arizona Public Service Company (APS), Cholla Power Plant (Cholla) sends with this letter one original signature Application to Drill a CO_2 Strategraphic Test injection well, a Check number 65003363 in the amount required of $25.00 and an identical copy of the application for your review and consideration. This application is exact replica of the electronic version sent to your attention for early review on November 3, 2008 by Mr. John Boyer of APS.

Thank you for your departments prompt review and consideration, if questions arise, please call Dan Gradle at 928-288-1541 or Mr. John Boyer at 602-250- 3196.

Sincerely,

Dan D. Gradle
Environmental & Chemicals Manager
Cholla Power Plant

Dan retired + replaced by
Doug Lavrnway
928-288-1394

Subject: Application for the Arizona Utilities CO2 Sequestration Well at Cholla Power Plant - Joseph City,AZ
From: John.Boyer@aps.com
Date: Mon, 3 Nov 2008 16:24:50 -0700
To: steve.rauzi@azgs.az.gov
CC: Danny.Gradle@aps.com

Steve,
As promised, here is an electronic version of the application that will be mailed this afternoon via overnight mail.

The mailed version will include two copies of the application package plus the $25 application fee. One copy will include all signed originals, certified original survey map.

Please let me know if you have any questions about the application.

Thanks for your help.

John L. Boyer
Principal Environmental Scientist
Environmental Health & Safety Department
Arizona Public Service Company
P.O. Box 53999/Mail Sta: 8376
Phoenix, Arizona 85072-3999
Telephone: 602-250-3196
Cell Phone: 602-818-6721
Fax: 602-250-3872
<<AOGC-ApplicationPkg_ChollaCO2Well-3Nov08.pdf>>

Email Firewall made the following annotations

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AOGC-ApplicationPkg_ChollaCO2Well-3Nov08.pdf	**Content-Description:**	AOGC-ApplicationPkg_ChollaCO2Well-3Nov08.pdf
	Content-Type:	application/octet-stream
	Content-Encoding:	base64

Holbrook (Ariz.) Tribune-News, December 19, 2007-Page 9

Carbon Sequestration Test Planned In Area

By Tammy Gray-Searles

Plans are moving forward for a carbon sequestration test project near the Arizona Public Service (APS) Cholla Power Plant.

Work to obtain the necessary state and federal permits has started, which is the first step in the project.

The project includes injection of carbon dioxide into underground formations. It will serve as a test site to determine whether injecting carbon dioxide into the earth is a safe and reliable way to dispose of the carbon dioxide produced by power plants and other industries. Although the site is within a mile of the Cholla plant, the carbon dioxide used in the study will come from other plants.

According to APS, which has partnered with Tucson Electric Power and Salt River Project (SRP) for the testing, the site near Joseph City was selected "because of its deep, impervious geologic formations containing salty water that is unsuitable for drinking or irrigation."

Carbon sequestering has been in use in other countries for several years, but its uses are just beginning to be explored in the United States. Carbon dioxide emissions are believed to be part of the cause of global warming. The testing site near Joseph City will help researchers determine whether carbon sequestration is a viable method of containing the gasses so that they aren't released into the atmosphere. The testing is expected to last about two years.

According to APS and the researchers, there is no danger to nearby residents. Officials noted that the only danger will be to work crews who are actually injecting the carbon dioxide into the earth. The materials are explosive if not properly handled and monitored.

The injection site will be monitored for escaping gasses, and to ensure that the carbon dioxide remains in the formation where it is placed.

Several other test sites around the country will also be monitored so that data can be collected regarding different types of geological formations and to determine the most suitable locations for a permanent large-scale injection site.

Carbon dioxide injection has been used in Texas for many years to enhance recovery of oil, but it has not been tested to determine whether it is a long-term solution for storing the gas.