PINEDALE ANTICLINE PROJECT AREA

Surface Water and Groundwater Monitoring Summary 2000 - 2012

Sublette County Conservation District

NATIONAL SYSTEM OF PUBLIC LANDS
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

November 2013

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BLMWY/PL-13/036+1010

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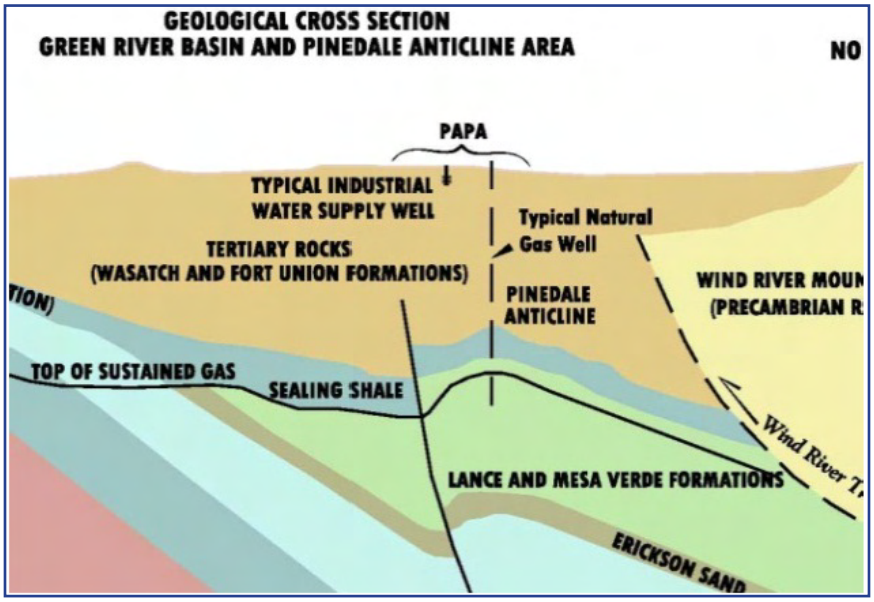
Introduction

In 2000, the SCCD began a surface-water monitoring program on the New Fork River. In 2001, due to increased natural-gas development in the PAPA, SCCD began monitoring dedicated Pinedale Anticline Surface (PAS) sites along the New Fork River in accordance with the 2000 BLM Record of Decision (ROD) which mandated the monitoring of water quality and quantity in the PAPA. Monitoring from 2000 to 2012 has not detected any hydrocarbons in the New Fork River.

SCCD began sampling water wells within the PAPA in 2004, in accordance with the 2000 BLM ROD. Where hydrocarbon detections were reported, subsequent sampling and investigations found there were rational explanations for the detections, including but not limited to: the use of hydrocarbon-based pipe dope and lubricants in water-well construction and pump installation; inadequate flushing of water-well production systems; and no backflow prevention devices when tanks were filled for natural gas well drilling and completions. To date, there is no evidence of aquifer contamination from natural gas development in the PAPA.



General Description

The PAPA is a 309-square-mile, 36-mile long, northwest-southeast trending anticline, currently being developed for natural gas. The primary perennial stream in the PAPA is the New Fork River, a Class 2, cold-water fishery, and popular fly-fishing stream. The New Fork River flows across the PAPA and joins the Green River, the largest tributary of the Colorado River, west of the PAPA (see map on p. 6).

Within the PAPA, groundwater is found in the shallow alluvium along the New Fork River and in the thin, discontinuous sandstones and siltstones in the Wasatch Formation. Between 2004 and 2012, SCCD has taken more than 2,300 groundwater samples from 385 domestic, stock, and miscellaneous water wells (which includes industrial use to provide water for oil/gas activities).

Domestic water wells range from 43 to 410 feet deep, stock water wells range from 4 to 600 feet deep, and miscellaneous water wells range in depth from 300 to 1,200 feet (SCCD). Domestic and stock water wells produce from both the shallow alluvium and Wasatch Formation and miscellaneous water wells generally produce only from the Wasatch Formation.

Natural-gas wells in the PAPA range in depth from 11,000 to 14,000 feet and produce from zones in the Lance Formation, which start at depths of approximately 8,000 feet. The Lance Formation lies below and is separated from the Wasatch Formation by the Fort Union Formation Shale.

	Surface Water	Ground Water
2000	SCCD began monitoring surface water quality on the New Fork River, which traverses the center of the anticline.	To meet the 2000, PAPA ROD requirements, Operators contracted SCCD to collect and manage water-quality data from domestic, stock, and miscellaneous (including industrial) water wells within one mile of existing or proposed natural gas wells.
2001	SCCD began by monitoring four dedicated Pinedale Anticline Surface (PAS) sites along the New Fork River.	SCCD began identifying water wells to be included in the program.
2004	SCCD continued monitoring four (PAS) sites.	Groundwater sampling using the 'Non-Polar' method to search for the presence of hydrocarbons began with approximately 150 water wells. A general water analysis was also done for all the wells sampled. There were no hydrocarbon detections during this first sampling.
2005	SCCD continued monitoring four (PAS) sites.	The 'Non-Polar' method was used in 10% of the water well samples with no hydrocarbon detections being reported.
2006	A fifth PAS site was added on the New Fork River in the PAPA.	The 'Non-Polar' method was used in 10% of the samples. Confirmation samples using BTEX method 8021B were collected from wells with Non-Polar occurrences. Hydrocarbon detections were reported in five miscellaneous water-wells; one had levels over WDEQ/EPA limits. This prompted a WDEQ study that included a one-time sampling of water wells in the PAPA and Jonah gas fields by third party contractors. Additional water wells were shown to have hydrocarbon detections.
2007	Three PAS sites were added to the New Fork River for a total of eight PAS monitoring sites.	SCCD groundwater sampling, using the 'Non-Polar' method in 10 percent of water wells with additional BTEX 8021B analysis as needed, reported hydrocarbon detections in eight miscellaneous water-wells; three contained hydrocarbons over the WDEQ/EPA limits.
2008	SCCD continued monitoring eight PAS sites.	The 'Non-Polar' method was replaced with testing for Gasoline Range Organics (GRO) and Diesel Range Organics (DRO) in 100% of the samples taken. BTEX 8021B would continue being used for additional analysis as needed. Hydrocarbon detections were reported in one domestic, one stock and 20 miscellaneous water-wells, four of which reported hydrocarbons over WDEQ/EPA limits.
2009	A ninth PAS monitoring site was added on New Fork River.	Hydrocarbon detections were reported in 19 miscellaneous and two domestic water-wells; four of the miscellaneous and one domestic water-well reported hydrocarbon detections over the WDEQ/EPA limits.
2010	SCCD continued monitoring nine PAS sites.	Hydrocarbon detections were reported in thirteen miscellaneous and one stock water-well with seven hydrocarbon detections in miscellaneous water wells over WDEQ/EPA limits.
2011	SCCD continued monitoring nine PAS sites.	Hydrocarbon detections were reported in nine miscellaneous, one domestic and one stock water-well with three hydrocarbon detections in miscellaneous water wells over WDEQ/EPA limits.
2012	SCCD continued monitoring nine PAS sites.	Hydrocarbon detections were reported in 13 miscellaneous and one domestic water-well with four hydrocarbon detections in miscellaneous water wells over WDEQ/EPA limits.

Water Quality Sampling

Water quality describes the chemical, physical, and biological characteristics of water, with respect to its suitability for a particular use. The U.S. Environmental Protection Agency (EPA) has established Primary and Secondary standards for drinking water (see links on back page). The WDEQ has adopted these drinking water standards and has established water-quality standards for surface waters (see links on back page), including Class 2 cold-water fisheries.

Water quality is affected by both the natural environment and human activities and can be used to indicate whether surface water and groundwater are connected, the possible sources of recharge to aquifers and baseflow in streams, the effects of over-pumping or drought, and potential contamination of surface and groundwater.

Because natural-gas development in the PAPA is a potential source of both surface water and groundwater contamination, the SCCD tested for hydrocarbons and other constituents using various, BLM approved methods to evaluate the general health of the streams and groundwater in water wells in the PAPA.

Macroinvertebrates

Aquatic insects tracked in this study are important indicators of stream health because they respond rapidly to changes in water quality and, because they have limited mobility, allow for pin-pointing disturbances.

Total Petroleum Hydrocarbon

The Water Resource Task Group (WRTG), a sub group of the Pinedale Anticline Working Group (PAWG), determined the sampling structure and ultimately recommended approving the Sampling and Analysis Plan (SAP) that was approved by the BLM. The WRTG was comprised of representatives from the oil/gas operators and WDEQ as well as other government and public sectors.

Beginning in 2004, hydrocarbon testing was included in all of the samples collected. From 2005 to 2007, the Non-Polar method was used, but only tested for in 10 percent of the samples. Any hydrocarbon-related detection would trigger confirmation sampling for Gasoline Range Organics (GRO) and BTEX (included analysis of specific hydrocarbon compounds such as benzene, toluene, ethylbenzene and xylene). In 2008, the Non-Polar was no longer used; instead, GRO and Diesel Range Organics (DRO) were used and included in all of the samples collected.

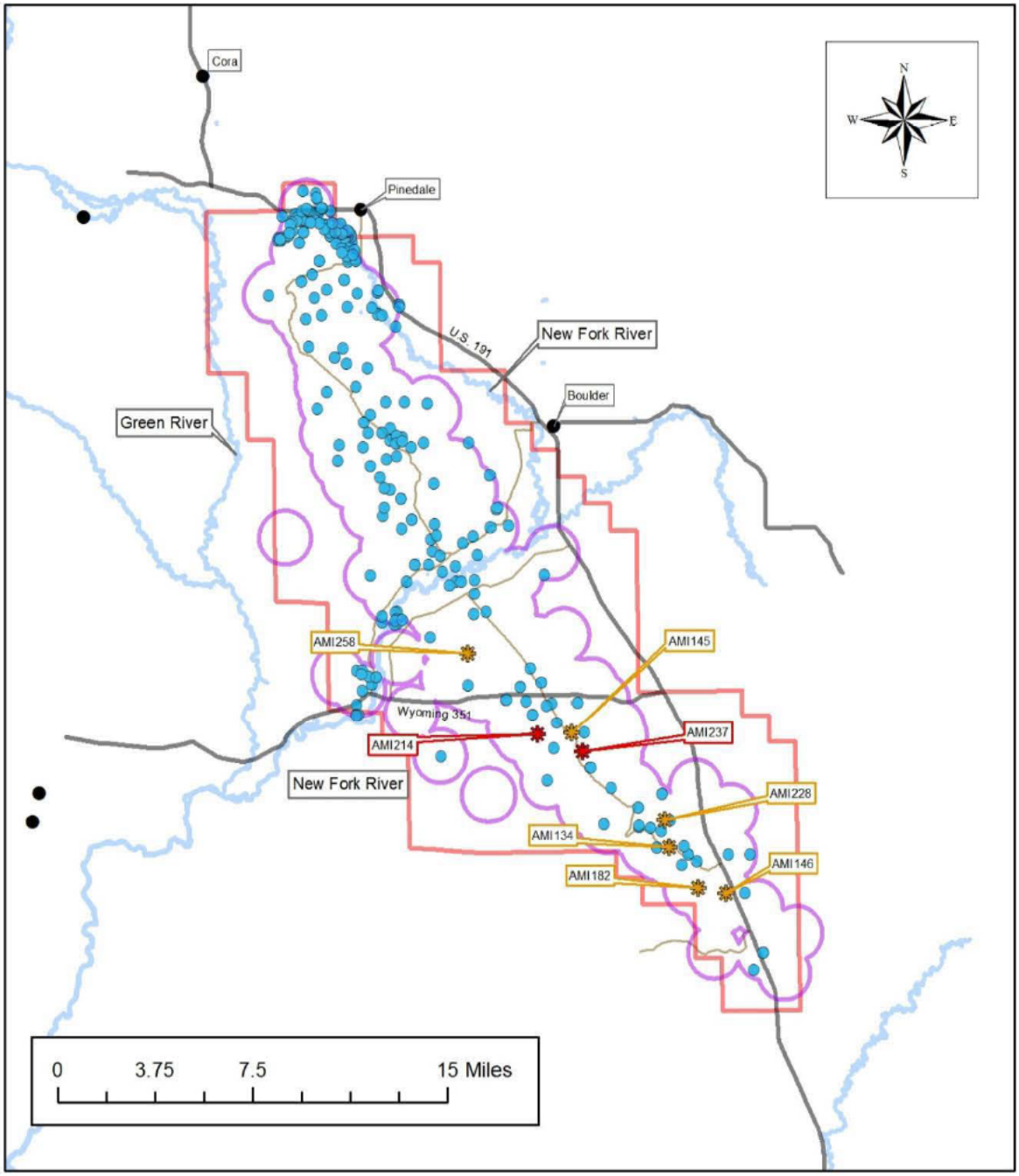
Other Water Quality Constituents

Other constituents are included in both surface and ground water sampling for comparative purposes.

Constituent	Standards	Remarks
Conductivity	No EPA/WDEQ limit	Changes over time can indicate the introduction of solids or organics.
DissolvedOxygen (DO*)	6 mg/L	
pH	6.5-8.5 drinking 6.5-9.0 streams	
Temperature	2ºF over 60ºF stream	
Total Dissolved Solids(TDS)	500 mg/L drinking 5,000 mg/L livestock	
Turbidity*	10 NTUs stream	Cannot cause an increase of more than 10 NTUs above ambient turbidity in stream.
TPH-DRO (screening)	1.1 or 10 mg/L	DRO detects larger carbon chain molecules, triggering BTEX testing.
TPH-GRO (screening)	7.3 mg/L	GRO detects smaller carbon chain molecules, triggering BTEX testing.
Benzene (as needed)	5 ug/L	Most toxic of BTEX chemicals and designated by EPA as a carcinoger
Toluene (as needed)	1,000 ug/L	Can cause liver, kidney, nervous system, and circulatory damage
Ethylbenzene (as needed)	700 ug/L	Can cause liver, kidney, and nervous system damage after long exposure
Xylene (as needed)	10,000 ug/L	Can cause liver, kidney, and nervous system damage after long exposure
Alkalinity	No EPA/WDEQ limit	
Bicarbonate*	No EPA/WDEQ limit	
Calcium	No EPA/WDEQ limit	
Carbonate*	No EPA/DEQ limit	
Chloride	250 mg/L drinking	
Fluoride º	4.0 mg/L drinking	
Hardness*	No EPA/WDEQ limit	
Magnesium	No EPA/WDEQ limit	
Nitrogen*	10 mg/L	
Phosphorus*		High levels can be from industrial or agricultural runoff.
Potassium	No EPA/WDEQ limit	
Sodium	No EPA/WDEQ limit	

*Surface water constituent only, ºGroundwater constituent only; otherwise both

	Detections under cleanup/ standards	Detections over cleanup/ standards	
GRO (mg/L)	>ND to 7.3	>7.3	WDEQ Clean-up Levels
DRO (mg/L)	>ND to 1.1 or 10*	>1.1 or 10*	
Benzene (ug/L)	>ND to 5	>5	WDEQ Clean-up Levels and/or EPA Drinking Water Standards (for domestic use wells only)
Ethylbenzene (ug/L)	>ND to 700	>700	
Xylene (ug/L)	>ND to 10,000	>10,000	
Toluene (ug/L)	>ND to 1,000	>1,000	



Main rivers
Main highways
Secondary roads within PAPA
Pinedale Anticline Project Area
One mile sampling area
Wells sampled in 2012

Status of wells (last time sampled by SCCD)

Hydrocarbon detections over WDEQ clean-up levels
Hydrocarbon detections under WDEQ clean-up levels

Surface Water Results

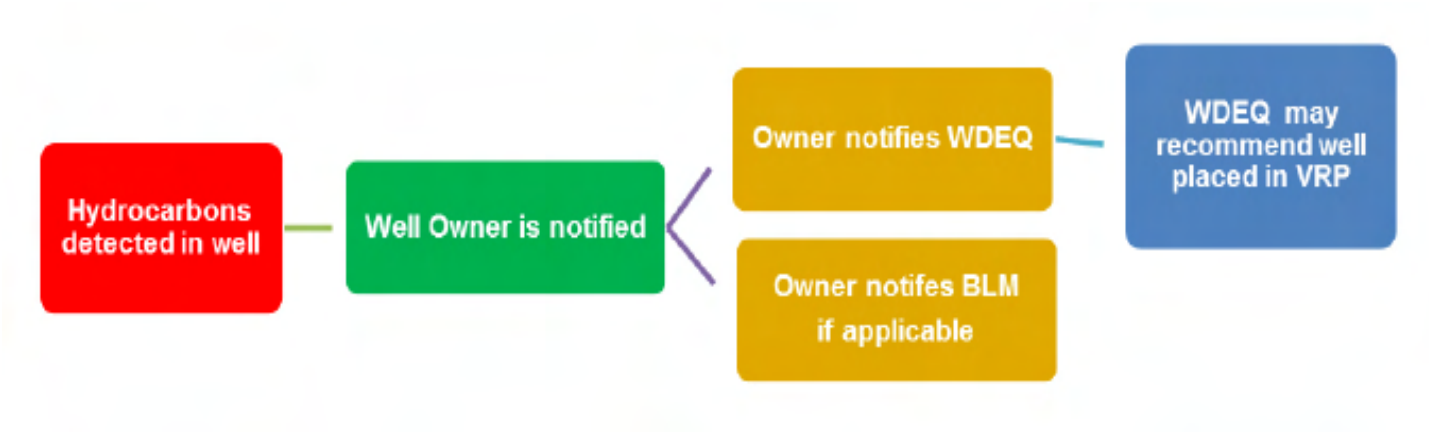
Surface water-quality sampling at the nine PAS sites along the New Fork River from 2000 through 2012 has shown no detections of hydrocarbons or exceedences of WDEQ surface-water quality standards. The biological condition of the New Fork River appears to have declined somewhat relative to 2009 (a good year for river flows), as a result of 'Didymo', a nuisance algae. Its presence may be due to naturally occurring processes. To date, there is no evidence of stream deterioration caused by hydrocarbon contamination or increased sedimentation from natural gas development in the PAPA.

Groundwater Results

Of the 385 water wells sampled by SCCD, 48 wells have had detectable hydrocarbons during one or more sample events from 2006 through 2012. In 2012, just eight wells had hydrocarbons present when last sampled (see figure on next page). In addition, hydrocarbons are naturally occurring in the Wasatch Formation in some areas (Clarey, p.2-14). Although eight water wells show some level of hydrocarbon detection 2012 to date, there is no evidence that either the alluvial or Wasatch formations have been contaminated by natural gas activities in the PAPA.

Voluntary Remediation Program

If hydrocarbons are detected in a water-well sample above the WDEQ and EPA standards, the Voluntary Remediation Program (VRP) may be initiated. The purpose of the VRP is to encourage site owners and/or operators to voluntarily address water-well contamination at sites with WDEQ concurrence and oversight. Any individual, business, or unit of government that conducts an environmental investigation and cleanup of a contaminated property, following WDEQ requirements, can receive a release from future environmental liability.



Units of Measurement

mg/L: Milligrams per liter-equivalent to parts per million (ppm)
ug/L: Micrograms per liter-equivalent to parts per billion (ppb)
NTU: Nephelometric Turbidity Unit

Definitions

Alluvium: Sediment deposited by flowing water (riverbed, flood plain, or delta)
Aquifer: Saturated geologic material capable of yielding water to wells and springs
Baseflow: Portion of stream flow resulting from groundwater seepage
Class 2 Fishery: Streams protected for trout, recreation, and drinking water
'Didymo': Didymosphenia geminate

References

- AMEC Environment & Infrastructure, Inc., Final Technical Report Hydrogeologic Data Gaps Investigation, Interim Plan, May 2012.
- Clarey, et al, Wyoming State Geological Survey, Green River Basin Water Plan II, Groundwater Study, Level I (2007-2009), August 2010.
- River Continuum Concepts, Summary of Biological Monitoring of the New Fork River in the PAPA, 2010.
- Sublette County Conservation District, Pinedale Anticline Groundwater Data Summary, Volume 1-4, February 2012.
- Sublette County Conservation District, Summary of Pinedale Anticline Chemical and Field Data, 2000-2011, February 2012.

Useful Links

- BLM Pinedale Anticline SEIS Implementation - Water Resources: www.blm.gov/wy/st/en/field_offices/Pinedale/anticline/resources/water.html
- SCCD Annual Reports can be found at www.sublettecd.com/index.html and www.blm.gov/wy/st/en/field_offices/Pinedale/pawg/DataResults.html
- Water Quality standards can be found at deq.state.wy.us/wqd, and
- water.epa.gov/drink/contaminants