Oil & Natural Gas Technology

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Quarterly Report

July 2011 - September 2011

Water-related Issues Affecting Conventional Oil and Gas Recovery and Potential Oil-Shale Development in the Uinta Basin, Utah

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Office of Fossil Energy

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EXECUTIVE SUMMARY

Various data collection activities for all areas of the Utah Geological Survey's (UGS) Uinta Basin water project are mostly complete. The focus has now shifted towards synthesizing all the collected data, creating a wide variety of maps and figures, and forming final conclusions. In order to provide more time for compiling the final reports, a one quarter no-cost extension was granted changing the final project completion date to December 31, 2011.

The Task 2 team recently completed the exhausting task of reconciling the over 2600 water chemistry analyses collected throughout the basin with the preliminary map of the base of the moderately saline aquifer (BMSA), making appropriate changes to resolve data conflicts. The Task 3 team has finalized all core logs and regional cross sections examining the Birds Nest aquifer at depth and is currently revising the isopach maps after several new data points were added on the northern and western boundaries. The Task 4 team has completed all water sampling, obtained all water chemistry analyses, and is in the process of synthesizing all the data and writing the final report.

PROGRESS, RESULTS, AND DISCUSSION

Task 1.0: Project Management Plan

During the month of July, the PI wrote and submitted the project's eleventh quarterly report for the period April through June 2011. This report was subsequently sent via email to all interested parties and posted on the UGS project website.

Task 2.0: Moderately Saline Aquifer Study

The Task 2 team leader has spent the past several months vetting the first draft of the BMSA map, making sure that the log-based salinity interpretations agree with the 2661 ground-truth water chemistry analyses collected from 1469 different wells (figure 1). The ground-truth water chemistry data were obtained from a variety of sources including oil and gas operators or service companies (820 analyses); Utah Division of Oil, Gas, and Mining (DOGM) well files (405 analyses); UGS databases (1248 analyses); U.S. Geological Survey databases (106 analyses); and other publications (82 analyses). An Access database has been populated with all data, facilitating its manipulation and retrieval.

In order to add a third dimension to the mapping effort, five regional cross sections, two north-south sections and three east-west sections, will be constructed (figure 1). When finished, these cross sections will highlight the general geology, water-bearing formations, formations that act as seals, and the level of the BMSA.

Task 2 is on target to be completed by the end of December 2011. The final report will be submitted to NETL within 90 days of the project's completion, after an extensive UGS review.

Task 3.0: Geologic Examination of the Birds Nest Aquifer

The Task 3 team is on schedule to complete this portion of the project by December 31, 2011. Over the past few months, the Task 3 team leader has finalized all 21 core logs and all five regional cross sections. However, the isopach maps presented in the last quarterly report will be changed slightly. The PI has examined additional geophysical data from several more wells on the northern and western edges of the aquifer in order to better constrain those boundaries. These maps will be finalized by the end of November.

In addition to examining additional well data, the PI spent several days in the field exploring the northeastern outcrop boundary of the Birds Nest aquifer and completed one additional measured section in the area (Cowboy Canyon section) (figure 2). The PI also examined the Saline zone near Buck Canyon on the southwestern side of the study area. Only very minor saline minerals were found, confirming that the saline zone pinches out to the southwest.

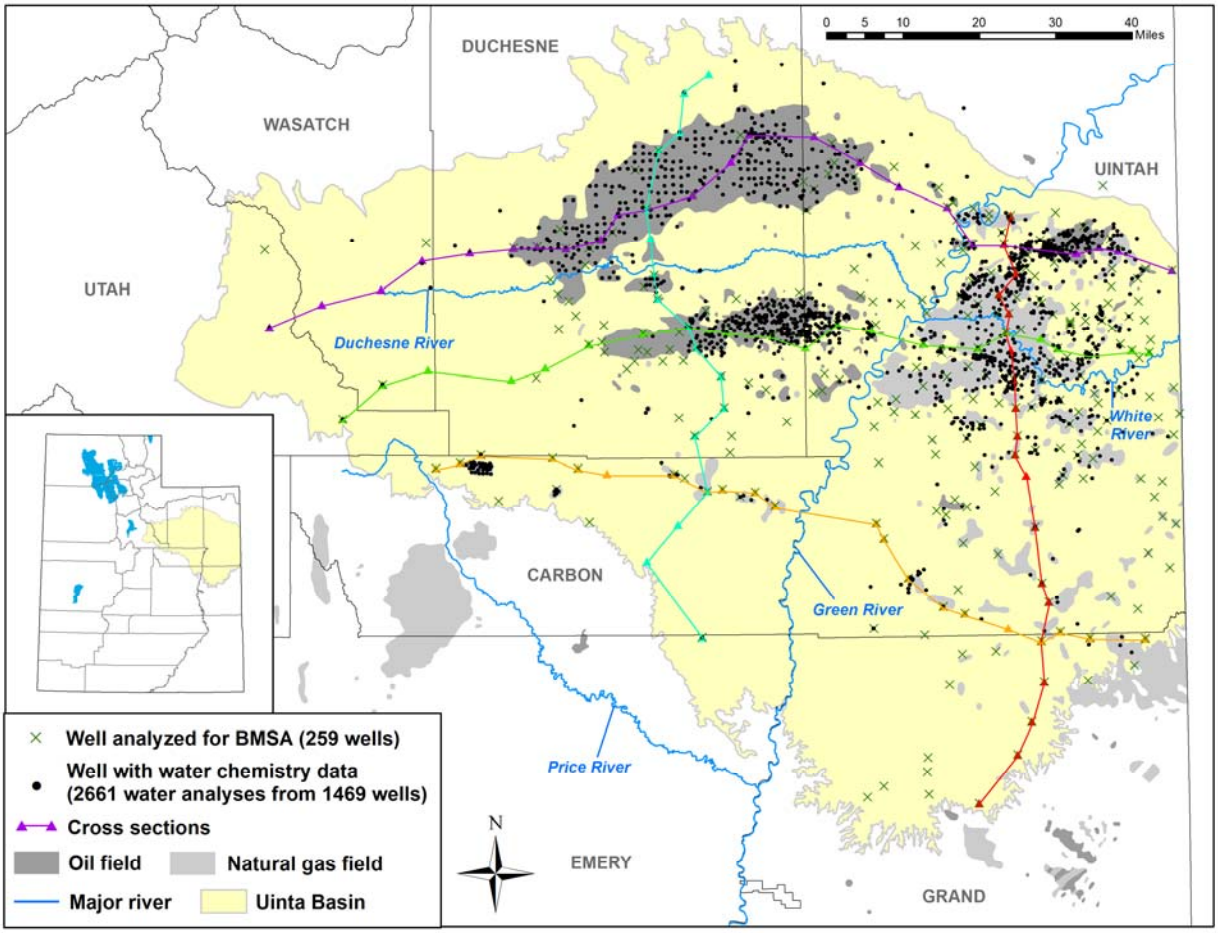

Figure 1. *Location of wells in the Uinta Basin with available water chemistry data and wells analyzed for the BMSA.*

Task 4.0: Baseline Water Quality and Quantity GIS Database

The Task 4 team leader collected the final round of water samples from 18 of the previously sampled sites and one new site, Willow Spring (table 1, figure 3). All water samples have been analyzed and data delivered to UGS. Total-dissolved-solids concentrations for samples collected in spring 2011 range from 220 to 2154 mg/L, with lower than average concentrations in the flowing streams most likely due to high runoff from record snow accumulations, but slightly higher than average concentrations in springs and wells (table 1, figure 3 and 4). Nitrate concentrations were also slightly elevated in wells this past spring (table 1, figure 5). The Task 4 team leader is currently in the process of preparing the final report, which should be completed in December 2011 and turned into NETL after an extensive UGS review.

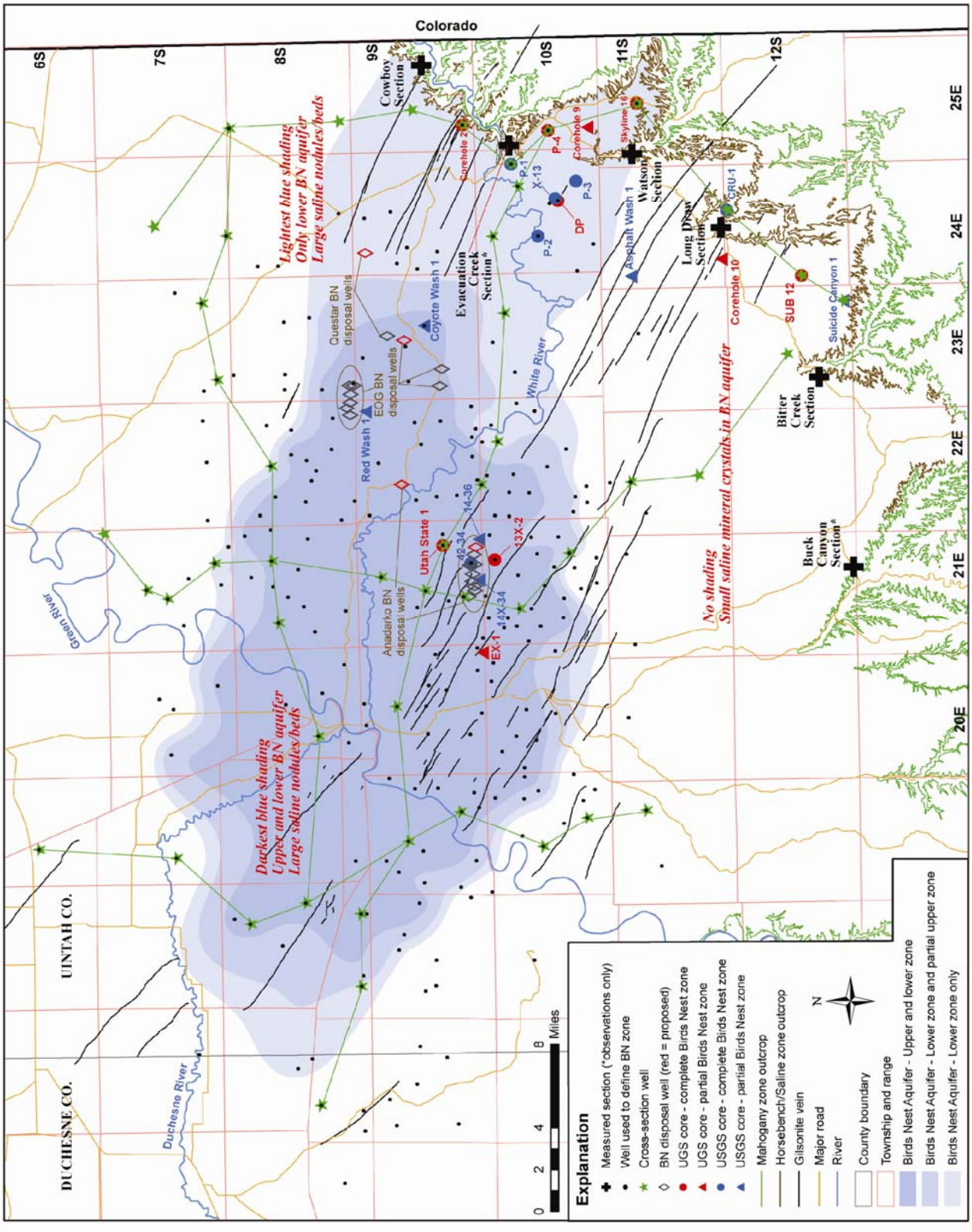

Figure 2. *Areal extent of the Birds Nest aquifer with potential for saline water disposal (location of large saline nodules or beds) as determined using geophysical logs (these boundaries are preliminary and might change in the final report). Dark blue represents the area where both an upper and lower Birds Nest zone exist, medium blue represents an area with the lower zone but only a partial upper zone, and the lightest blue represents an area where only the lower zone exists. Five cross sections have been constructed to illustrate the aquifer's spatial and stratigraphic extent.*

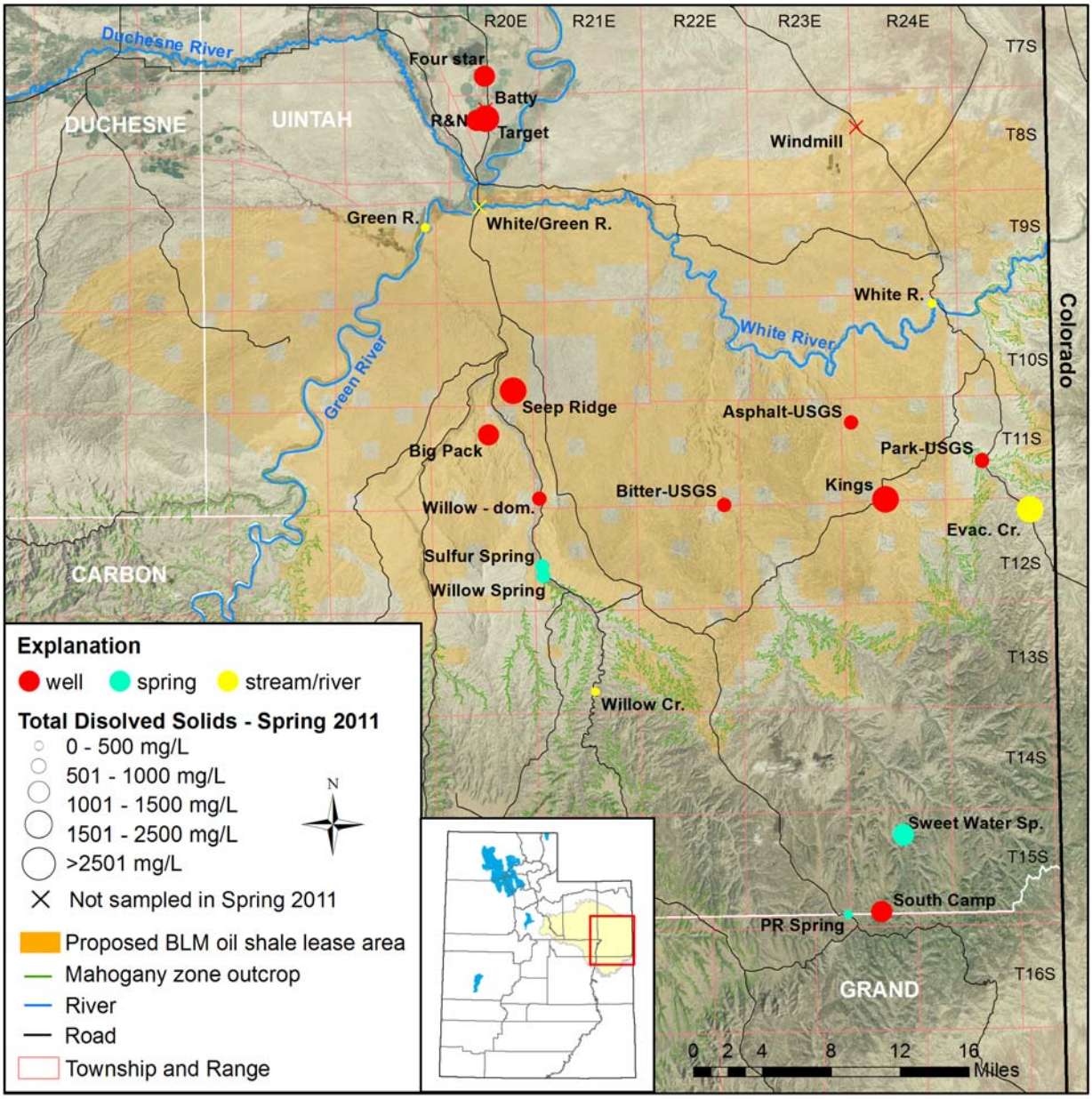

Figure 3. *Sampling sites related to Task 4, with TDS data from spring 2011 samples.*

Table 1. *Overview of water sampling sites.*

Well ID	Depth (ft)	Level (ft)	NO_3 (mg/L)					TDS (mg/L)					Formation
			Summer 2009	Fall 2009	Spring 2010	Fall 2010	Spring 2011	Summer 2009	Fall 2009	Spring 2010	Fall 2010	Spring 2011	
Park-USGS	193+	flowing	<0.1	<0.1	<0.1	<0.1	<0.1	796	854	786	782	778	Green River
Big Pack	6900	flowing	<0.1	<0.1	<0.1	<0.1	<0.1	1298	1308	1320	1246	1266	Wasatch
Willow – dom.	711	flowing	<0.1	<0.1	<0.1	<0.1	<0.1	936	956	924	888	892	Green River?
Willow Creek	surface	surface	<0.1	<0.1	0.1	<0.1	0.1	562	648	506	592	412	Alluvial
Sulfur Spring	spring	flowing	<0.1	<0.1	<0.1	<0.1	<0.1	578	584	586	572	630	Green River?
Evacuation Cr.	surface	surface	<0.1	<0.1	<0.1	<0.1	<0.1	2832	2724	2708	2632	2154	Alluvial
4-star	172	70	12.6	13.5	12.7	12.7	13.7	1260	1280	1332	1232	1318	Alluvial
Kings[1]	?	67?	9.5	--	8.2	8.3	9.8	2114	--	1988	1886	1862	?
Windmill[4]	1382+?	flowing?	<0.1	<0.1	--	<0.1	--	2394	2236	--	2106	--	Green River?
Target[2]	53	23	10	--	8.5	9.4	13.3	1442	--	1496	1446	1858	Alluvial
R&N[5]	60 & 80	23 & 49	7.7	7.7	--	7.6	8.3	1016	978	--	1058	1110	Alluvial
Batty[2,6]	83	28	18.8	--	--	--	--	1908	--	--	--	--	Alluvial
Seep Ridge	>2510	flowing	<0.1	<0.1	<0.1	<0.1	--	3056	1462	1486	1516	1640	Green River
PR Spring[1]	spring	flowing	0.4	--	0.6	0.3	0.5	420	--	356	378	338	Green River?
South camp[3]	98	61	--	5.8	<0.1	<0.1	<0.1	--	1204	1352	1172	1202	Green River?
White River[3]	surface	surface	--	<0.1	<0.1	<0.1	0.1	--	400	300	400	220	Alluvial
White/Green R.[3,7]	surface	surface	--	<0.1	--	--	--	--	412	--	--	--	Alluvial
Green River[8]	surface	surface	--	--	<0.1	<0.1	<0.1	--	--	172	410	242	Alluvial
Sweet Water Spr.[8]	spring	flowing	--	--	0.6	0.6	0.5	--	--	994	996	1044	?
Bitter Cr –USGS[8]	1497	?	--	--	<0.1	<0.1	<0.1	--	--	950	886	892	Green River
Asphalt 1–USGS[8]	2650	?	--	--	<0.1	<0.1	<0.1	--	--	1012	958	966	Green River
Willow Spring[9]	spring	surface	--	--	--	--	<0.1	--	--	--	--	764	?

[1]No access to site in fall 2009 due to weather conditions
[2]Not sampled in fall 2009 due to time constraints
[3]New sites sampled in fall 2009
[4]Well not operational in spring 2010 or spring 2011
[5]Unable to sample in spring 2010
[6]Well no longer in use starting spring 2010
[7]Not sampled after spring 2010
[8]New sites sampled in spring 2010
[9]New site sampled in spring 2011

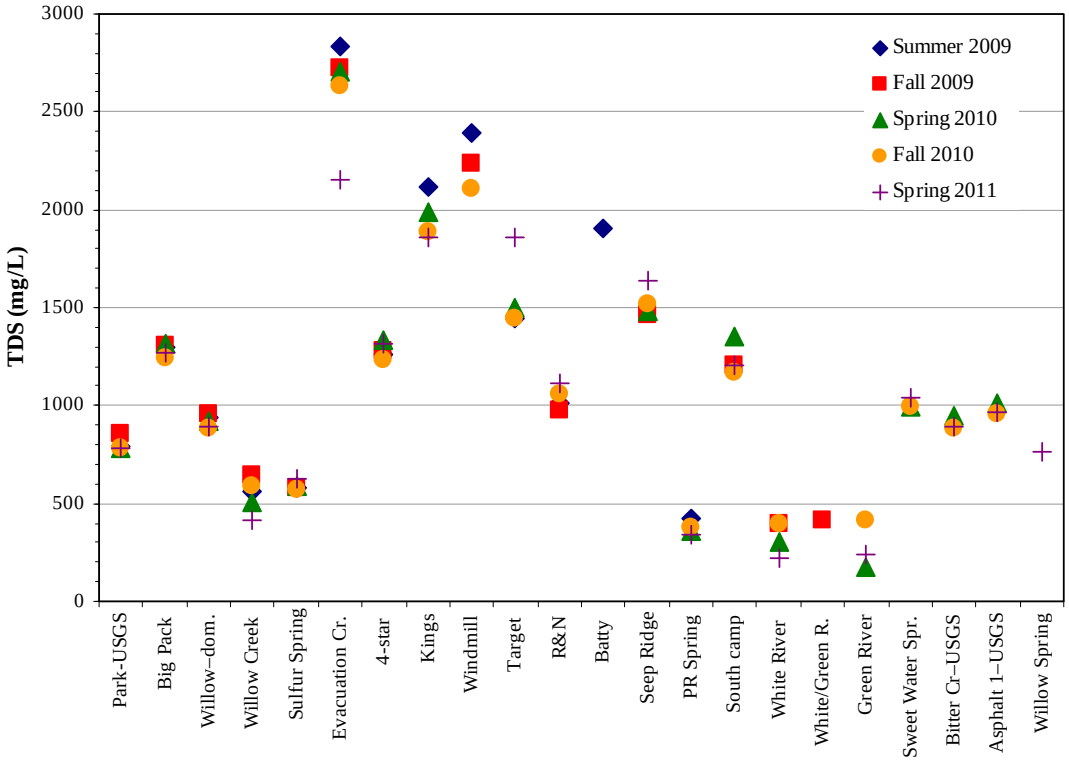

Figure 4. *Total dissolved solids concentrations from sites sampled as part of Task 4.*

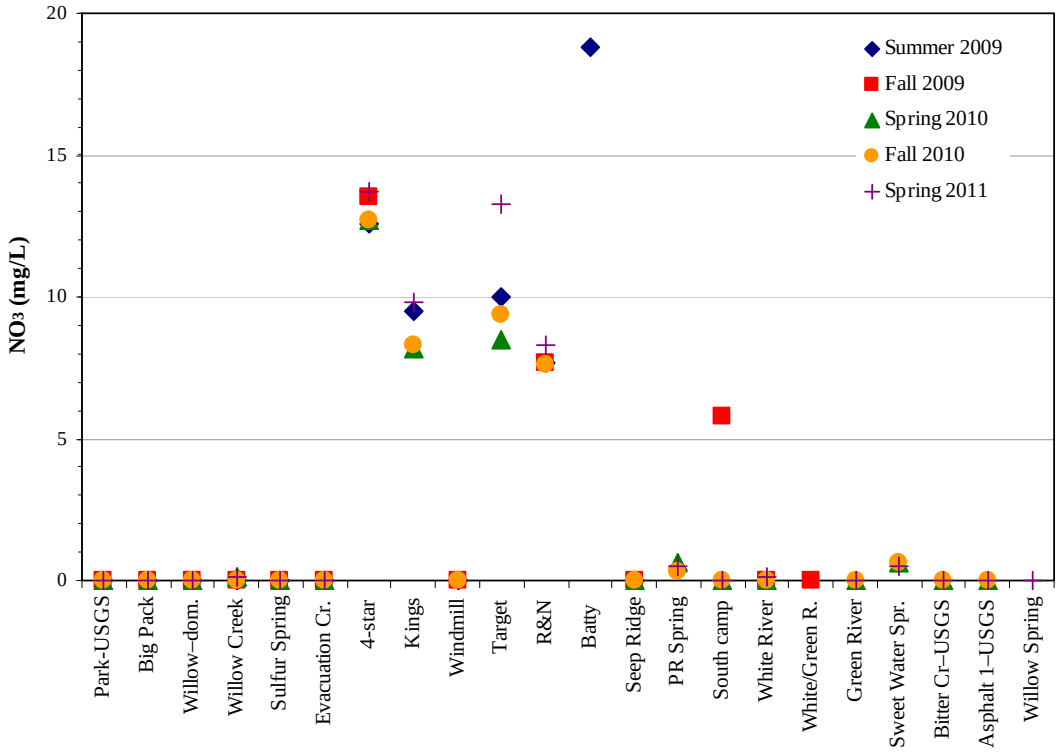

Figure 5. *Nitrate concentrations from sites sampled as part of Task 4.*

Task 5.0: Integration of Analysis of Produced Water from Simulated In-situ Oil Shale Extraction Technologies

As stated in the previous quarterly report, researchers in the Department of Chemical Engineering at the University of Utah have completed laboratory experiments simulating in-situ oil shale extraction with two overall objectives in mind: (1) determine the presence and species of dissolved organics in the water phase post-pyrolysis, and (2) determine the effect of the presence of water on retorting and its products. A detailed report/paper is currently being prepared by Dr. Milind Deo and his graduate students.

Task 6.0: Technology Transfer

- The PI submitted an abstract to the 2012 American Association of Petroleum Geologists (AAPG) annual meeting which will be held in Long Beach, CA. This abstract details the final results related to Task 3, a geologic characterization of the Birds Nest aquifer.
- The Task 2 team leader submitted an abstract to the 2012 AAPG annual meeting. This abstract details the final results of the new BMSA mapping.
- The project website (http://geology.utah.gov/emp/UBwater_study) was updated with new quarterly reports, abstracts, and presentations prepared by project team members.

CONCLUSION

A one-quarter no-cost extension was granted in August 2011, moving the project's final completion date to December 31, 2011. The project will also use the allowable 90-days post-completion-date time period to finalize and review the reports before they are submitted to NETL.

The majority of the data collection and research activities are now finished and the project team has begun to synthesize the data and formulate conclusions. The Task 2 team has completed a preliminary BMSA map and has spent the past few months refining the contours to match all existing data. The Task 3 team has created many preliminary maps and cross sections and will now focus on finalizing the products and formulating conclusions/recommendations. The Task 4 team has finished with the water sampling, received the final water chemistry dataset, and has started preparing the final report.

COST STATUS

Costs incurred during the past quarter were significantly under budget due to the team leader's obligations to other projects (table 1 and figure 7). A one-quarter no-cost extension was granted in August 2011, changing the project's official completion date to December 31, 2011. After three years, the project has billed 90.9% of projected costs; the remaining funds ($78,043) will be used during the one-quarter extension and during the allowed 90-days post-completion-date time period to finish the final reports.

Table 2. *Project costing profile for Budget Period 3 (fourth quarter).*

	Jul 2011		Aug 2011		Sep 2011	
	Plan	Actual	Plan	Actual	Plan	Actual
UGS-personnel	$13,286	$2,492	$15,839	$4,568	$17,803	$4,641
Travel Expenses[1]		$1,095	$1,136	$932	$106	$178
Water Chemistry	$9,359					
Miscellaneous[2]		$2				
SUBTOTALS	$22,645	$3,590	$16,975	$5,500	$17,909	$4,820
UGS OVERHEAD (32.40%)	$7,337	$1,163	$5,500	$1,782	$5,802	$1,562
SUBCONTRACTS						
P. Anderson[3]	$6,777	$3,780	$6,777	$6,180	$6,777	$2,940
GRAND TOTALS	$36,759	$8,533	$29,252	$13,462	$30,488	$9,321

[1]July – AAPG-RMS annual meeting in Cheyenne, WY (held in June 2011); August – Trips to Vernal for Birds Nest outcrop work and water sampling, registration for the 31st Oil Shale Symposium (held in October 2011); September – trips to Vernal for water sampling

[2]July – field supplies

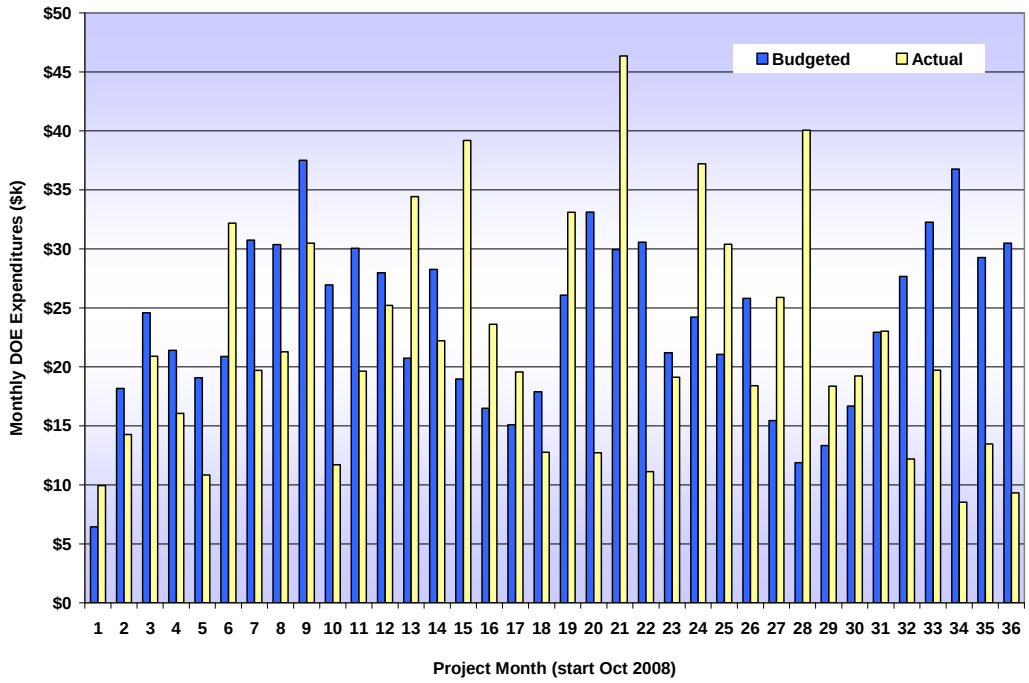

Figure 6. *Project costing profile.*

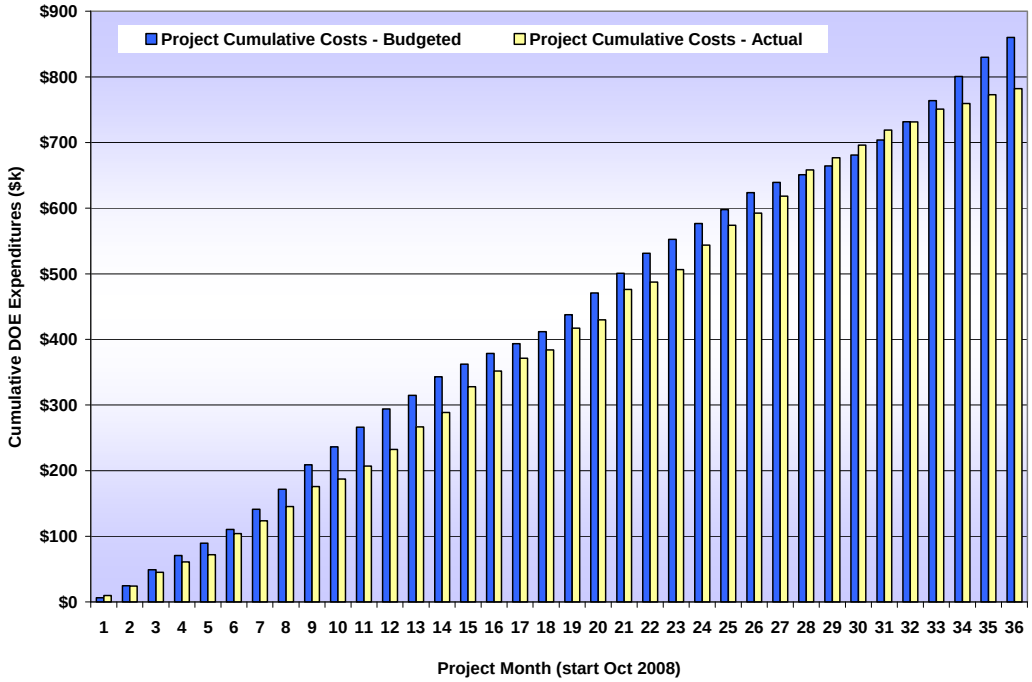

Figure 7. *Project cumulative costs.*

MILESTONE STATUS

Table 3. *Milestone log for Budget Period 3.*

	Title	Description	Related task or subtask	Completion Date	Update/comments
Milestone 3.1	Map the base of the moderately saline aquifer	Re-map the base of the moderately saline aquifer, including cross-sections, based on data collected during the previous two years	Subtask 2.2	3/31/2011	Currently have 2661 individual water analyses from 1469 wells; determined the BMSA using geophysical logs in all 259 wells, first draft of map completed, several months spent vetting first draft map and all data, final map will be finished in November 2011
Milestone 3.2	Creation of Birds Nest aquifer maps	Map the thickness, extent, and water chemistry of the Birds Nest aquifer	Subtask 3.5	6/30/2011	Preliminary maps are now completed, more data gathered in August which will be incorporated into final maps
Milestone 3.3	Water quality and quantity analysis	Combine all collected water data and combine into a final report	Subtask 4.4	9/30/20011	Final round of water sample collection is completed and final water chemistry results obtained, final report in progress
Milestone 3.4	Integration analysis	Model transfer of oil and water to adjacent aquifers and beyond	Task 5	6/30/2011	Researchers at the University of Utah have completed this part of the project and are in the process of preparing a final report/journal article

ACCOMPLISHMENTS

- Submitted two abstracts to AAPG Annual meeting to be held in April 2012.
- Finalized 21 core logs and five regional cross sections showing the Birds Nest aquifer in the subsurface.
- Completed one additional measured section through the Birds Nest aquifer on the northernmost outcrop area and examined the Buck Canyon exposure area in the southwest.

PROBLEMS OR DELAYS

A three-month no-cost extension was granted in August 2011, pushing the project's final ending date to December 31, 2011. NETL allows 90-days post-completion-date time period for submission of the final report; the project team will use this time to complete all project requirements.

PRODUCTS AND TECHNOLOGY TRANSFER ACTIVITIES

- Completed eleventh quarterly report
    - April 2011 through June 2011 – available on the UGS project website

- Updated project website
    - Posted various new reports, abstracts, and presentations prepared by project team members
    - http://geology.utah.gov/emp/UBwater_study
- Abstracts – AAPG Annual meeting – Long Beach, CA – April 22-25, 2012
    - Submitted two abstracts, one detailing the final results of Task 2 (re-mapping the BMSA) and one detailing the final results of Task 3 (Birds Nest aquifer study)
    - The abstracts are available on the UGS project website

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