WRI-09-R015

ASSESSMENTS OF ENVIRONMENTAL IMPACTS AND BENEFICIAL USE OF COALBED METHANE PRODUCED WATER IN THE POWDER RIVER BASIN

TOPICAL REPORT

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By
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For
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Task 71

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ABSTRACT

Impact on water quality and the beneficial use of the coal bed methane (CBM) produced water are imminent questions to be answered due to the rapidly growing CBM exploration in the Powder River Basin (PRB). The practice of discharging large volumes of water into drainage channels or using it to irrigate rangeland areas has the potential of causing serious problems. The elevated salinity and sodicity in the CBM water may be detrimental to soils, plants and the associated microbial communities.

There are limited studies on CBM water characterization; however, a comprehensive understanding of CBM water influence on the local ecosystem is lacking. It is very important that the water applied to soils meets the favorable combination of salinity and sodicity that will allow the plants to grow at good production levels and that will maintain the structure of the soils.

The purpose of this study was to access various CBM water treatment technologies and the influence of the treated water on local biogeochemical settings in order to evaluate and identify the proper technologies to treat the CBM produced water from CBM operations, and use it in an environmentally safe manner. Unfortunately, a suitable field site was not identified and the funds for this effort were moved to a different project.

EXECUTIVE SUMMARY

Impact on water quality and the beneficial use of the coal bed methane (CBM) produced water are imminent questions to be answered due to the rapidly growing CBM exploration in the Powder River Basin (PRB). The practice of discharging large volumes of water into drainage channels or using it to irrigate rangeland areas has the potential of causing serious problems. The elevated salinity and sodicity in the CBM water may be detrimental to soils, plants and the associated microbial communities.

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INTRODUCTION

Water quality issues are at the forefront with regard to the development of coal bed methane (CBM) reserves in the Powder River Basin (PRB). The practice of discharging large volumes of water into drainage channels or using it to irrigate rangeland areas has the potential of causing serious problems. The elevated salinity and sodicity in the CBM water may be detrimental to soils, plants and the associated microbial communities. The primary problems associated with salinity are related to the ability of plants to take up water for photosynthesis and plant growth. As the electrolyte concentrations of the soil increase, the level of salt tolerance in plants will decrease and plants become less able to absorb the amounts of water needed. Consequently, plants will grow at slow rates or die.

It is very important that the water applied to soils meets the favorable combination of salinity and sodicity that will allow the plants to grow at good production levels and that will maintain the structure of the soils. This study will access the use of appropriate water treatment and/or soil amendments to prevent degradation of soils and the associated biomass. Each soil will react differently to the chemistry of the water applied and the method of application. Therefore, a study of the interactions of various parameters with the soil types found in the research areas should be conducted so that produced water from CBM operations can be used in an environmentally safe manner.

OBJECTIVES

The objective of this project was to evaluate the CBM produced waters generated at selected locations in the PRB with regard to salinity and sodicity and to determine how such waters will impact the physical, chemical, and biological nature of soils and vegetations in the vicinity of active production. This work was expected to evaluate several treatment and irrigation methods in an effort to maximize the beneficial use of the CBM produced water.

TECHNICAL APPROACH

The proposed work included infrastructure installation, monitoring of field plots and data evaluation at the selected sites in the PRB. Both site assessments and laboratory studies were to be conducted.

Subtask 1. Literature Review

A literature review will be completed to summarize the up-to-date studies on the beneficial use of CBM produced water. The information will be incorporated into this work. The objective is to identify the optimal applications of CBM produced water to minimize soil degradation and sustain plant growth. This information will be included in the final report.

Subtask 2. Site Assessments and Characterization

Site assessments will be conducted and existing data will be reviewed to select suitable locations for this study. Site visits will be conducted if deemed necessary. Soil and CBM produced water samples will be collected from the treatment plots located at the study sites and analyzed for alkalinity, cations, anions, metals, total microbial populations, total organic carbon, pH, EC, SAR, calcium carbonate, gypsum, and textural class with percent sand, silt, and clay. This parameter listed will be adjusted based on specific site characteristics.

Vegetation samples will be collected and analyzed for total biomass, major cations, nitrogen, phosphorus, sulfur, zinc, iron, manganese, and copper. Hydraulic properties will also be measured. Enumeration of total microbial populations will also be performed for soils, especially from the rhizospheric zone. Data from soil and water analysis will be used to determine gypsum and sulfur treatment rates. Data from soil, vegetation, and hydraulic analysis will also be used as the baseline for post treatment comparisons.

Subtask 3. Filed Applications

CBM produced water will be applied to the sites throughout the growing season. The CBM produced water and CBM produced water treated with (1) gypsum, (2) a bicarbonate reduction/removal system (sulfate), and (3) subsurface irrigation will be evaluated. Irrigation rates will be established based on evapotransporation models and required leaching fraction. The site will be divided into 4 plots for the 3 different treatments and a control plot (no treatment for the CBM water). The pivot irrigator will be programmed so that each plot receives water from a different treatment process. A total of 3 irrigation seasons are expected too be covered by this study.

Separate sites with similar soil and vegetation characteristics will be selected to conduct the subsurface irrigation approach as suggested by Huber. Treatments and monitoring parameters will be similar to what is described above.

Subtask 4. Monitoring and Analysis

Soil and vegetation chemistry, biology, and hydraulic properties, will be monitored prior to irrigation and at the end of each irrigation season. Proper samples will be collected and analyzed in the laboratory.

Subtask 5. Data Evaluation

The baseline and monitoring data will be evaluated to determine the impact that CBM produced water has on the soil and vegetation chemistry as well as the water infiltration and

hydraulic conductivity of the soils. Field determinations of infiltration capacity and hydraulic conductivity will be made using a tension infiltrometer and double-ring infiltrometer. This information will provide hydraulic characteristics of various soil types included in the study impacted with CBM-produced water.

The baseline and monitoring data will also be evaluated to assess treatment effects on soil and vegetation chemistry. This work will help to define the conditions and treatments that are required to minimize potential soil degradation and plant productivity.

Data from the field monitoring and laboratory analysis will be evaluated to determine the influence of CBM produced water on surface and subsurface soil structures, permeability, chemistry and biology.

Subtask 6. Project Management and Reporting

This task includes project management, cost management, and the development of reports. This task also includes attendance at meetings and presentations for industry and regulatory agencies.

Drs. Song Jin and Alan Bland will be the principal investigators of this project. Dr. Jin will manage the project on a day-to-day basis. WRI will serve as the project administrator and will direct any subcontract portions of the work to the collaborators and/or commercial entities, if applicable. Dr. Terry Brown at Poudre Valley Environmental Services and Dr. Renduo Zhang at the University of Wyoming may be included as the collaborators in this project. Dr. Brown has years of experience in CBM water research and mine reclamation. Dr. Zhang is a world-renowned expert in soil modeling, especially soils associated with surface and groundwater.

RESULTS AND DISCUSSION

Front-end work was conducted on this project to begin identifying field sites and treatment technologies. Unfortunately, a field site could never be secured for this research project and the remaining funding was used to support another project under WRI's cooperative agreement with DoE.