Submission No 875

INQUIRY INTO COAL SEAM GAS

Organisation: Geo9 Pty Ltd

Date received: 14/09/2011

The Hon Robert Brown MLC
Chair, General Purpose Standing Committee No. 5
Parliament of NSW
6 Macquarie St
Sydney NSW 2000

14 September 2011

Dear Mr Brown,

- **Recommendations for Improved Environmental Risk Assessments of CSG Mining**
- **Using Geophysics and Advanced Modelling to Improve Risk Assessments**

Geo9 is an independent geological consulting company that specialises in using ground-based geophysics for groundwater exploration. We are concerned about the impacts to groundwater resources from coal seam gas mining.

On behalf of our Chief Scientist Paul Ferguson and our team of exploration geologists, I present our views of the potential structural impacts of coal seam gas mining and the scientific solutions we propose for minimisation of these risks.

Geo9 has developed a methodology to use best practice geophysical techniques in combination with advanced modelling to improve environmental risk assessments of coal seam gas mining activities. The working title for Geo9's approach is 'The DIVINE Method' which stands for Deep Identification of Vertical Interconnectivity and New Element Method.

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Our approach is known to parties that include the Principal Scientist at the Federal Department of Sustainability, Water, Environment, Population and Communities (SEWPAC), the NSW Farmers Association, the Lock the Gate Alliance, the Great Artesian Basin Coordinating Committee and the Queensland Water Commission. We believe these organisations would be willing to provide a written endorsement of our approach if of interest to the Committee.

We feel Geo9 is uniquely positioned in our ability to contribute highly specialised scientific assessments to improve understanding of the environmental impacts of CSG mining.

We are the only authorised surveyor of US-based Willowstick technology, a ground-based geophysical technique has been used successfully by water authorities, the oil and gas industry, and environmental consulting companies to map connected groundwater and contamination flowpaths. Introduced to Australia by Geo9 this year, this technology has been used internationally for over a decade and its' use is being increasingly mandated by the US Environmental Protection Authority for independent evaluation of contentious contaminated sites. A case study on Chevron's use of the technology for tracking subsurface routes of steam is attached.

By using Willowstick to map aquifer connectivity in combination with other geophysical techniques and traditional hydrogeological datasets, Geo9's approach will contribute high resolution data to reduce uncertainty in existing hydrogeological models that assess the impacts of CSG mining on overlying aquifers.

Further, in collaboration with Canadian-based Professor James Craig of the Environmental Modelling and Analysis Group at the University of Waterloo, Geo9's DIVINE project intends to improve the science of environmental modelling by incorporating geophysical data into cutting-edge environmental models.

We are encouraged by the interest we've received in our approach to date. We believe in the longer term, there is potential for this methodology to become a standard part of the environmental risk assessment process for coal seam gas mining activities.

We recognise that some of the detail of our submission may not be relevant to the Committee's scope of interest. However, we trust our papers will be helpful input for policy considerations and would welcome the opportunity to present to the Committee on the scientific detail if of interest.

Yours sincerely,

Maya Sydney

Maya Sydney
Managing Director

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Recommendations for Improved Environmental Risk Assessments of CSG Mining

Presented to: General Purpose Standing Committee No. 5
NSW Legislative Council
Date: 14 September 2011

Author: Paul Ferguson, Chief Scientist, Geo9 Pty Ltd
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Overview

Geo9 is an independent geological consulting company that specialises in using ground-based geophysics for groundwater exploration. We are concerned about the impacts to groundwater resources from coal seam gas mining. It is our view that key risks exist due to the absence of detailed knowledge of the potential interconnectivity of aquifers and the geomechanics of the gas reservoir.

Risks

Our preliminary research indicates there are multiple risks to the integrity of the overlying aquifers. Risks often mentioned in the current public debate which we agree are significant include –

1) Potential of contamination of overlying aquifers from the saline water and other chemicals that may exist in the coal seam
2) A depletion of aquifers
3) Lowering of the water table, and
4) A reduction of groundwater pressure.

Beyond these well publicised risks, Geo9 is of the view that the most severe long term risk associated with CSG mining is the likelihood of interconnecting fractures developing due to compaction of the reservoirs and land subsidence. We have not found any evidence to date that either the CSG companies or government agencies approving mining activities have requested or sought the inclusion of compaction geomechanical models. Geomechanical models are customarily created by oil and gas engineers to determine the production capacity and longevity of an oil or gas reservoir.

Understanding geomechnical compaction is a fundamental part of understanding the impact of net stress increases to a gas reservoir. Large stress redistributions can cause micro-seismicity or the creation of new fractures and faulting, that ultimately result in interconnections between aquifers at different layers. These effects occur without warning once production has been underway and pressure in the coal seam is reduced over time.

Recommendations for Improved Environmental Risk Assessment

Geo9 believes that the environmental risk assessment process for CSG mining can be improved by the inclusion of ground-based geophysical surveys and geomechanical models to fill current knowledge gaps on the potential impacts of CSG mining.

Ground-based geophysical surveys would input high resolution subsurface data into hydrogeological models and improve the understanding of the likely impacts of CSG mining on overlying aquifers. Geo9 has an outline for a pilot study using geophysics and advanced modelling for which we are seeking funding. More detail is attached.

Geomechanical models will indicate the potential for subsidence over the reservoir, and the collapse and shearing of well casing around the borehole.

Using Geophysics and Advanced Modelling to Improve Environmental Risk Assessments of CSG Mining

Geo9's DIVINE Method

Deep Identification of Vertical Interconnectivity and New Element Model

Proposal for Pilot Study, Version 5, Updated 12 September 2011.

Presented to: General Purpose Standing Committee No. 5

NSW Legislative Council

Date: 14 September 2011

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Overview

Geo9 is an independent geological consulting company specialising in ground-based geophysics for groundwater exploration. Based in Sydney, Geo9 has introduced and applied a number of US-based geophysical techniques to the study of groundwater here in Australia.

This document outlines the scope of a pilot study proposed by Geo9 to prove the interconnectivity of aquifers and the impact of CSG extraction on the overlying aquifers to the highest standards of scientific rigour. The working name for Geo9's unique approach is 'The DIVINE Method', which stands for Deep Identification of Vertical Interconnectivity and New Element Method.

Geo9's approach combines a number of state-of-the-art ground-based geophysical techniques with traditional data collection methods including geological mapping, geochemical sampling and borehole analysis. Together with conventional hydrogeological investigations, Geo9's proposed approach to study the impact of CSG mining on connected groundwater resources using geophysics will provide an unprecedented level of information to inform the mapping and characterisation of aquifers.

Further, in collaboration with Canadian-based Professor James Craig of the Environmental Modelling and Analysis Group at the University of Waterloo, Geo9 intends to improve the science of environmental modelling by incorporating geophysical data and applying cutting-edge environmental models.

Pilot Study Partners

Geo9 is the only Australian representative of three state-of-the-art ground-based geophysical techniques, who would collaborate with us on the study.

The first is AquaTrack™ from Utah based Willowstick Technologies. Geo9 is the only company worldwide to be authorised as an independent user of the Willowstick AquaTrack equipment which has been used by water authorities, oil and gas mining companies, geothermal energy companies and consulting companies for environmental assessments in Northern America and Europe over the past decade. This technology uses the preferential flow of a current induced into the groundwater of interest to map flowpaths that interconnect aquifers at depths of up to 3km. In 2011, Geo9 brought Willowstick to Australia for the first time to conduct dam seepage studies for Melbourne Water and Hunter Water Corporation.

The second technology is the Electro-Kinetic –Sounding (EKS) technique formerly known as Groundflow from the UK. This technology identifies permeability in water filled strata, enabling accurate determination of depth to the water table and groundwater flow rates without the need for drilling boreholes and pump testing from them. The EKS system provides an effective and cost-efficient alternative to standard methods used to assess the impact of groundwater extraction on the water table and aquifer system.

The third technology is the Petro-Sonde electrotelluric survey method from Texan-based Geophysics International. This technique detects the electromagnetic effects of telluric currents generated in the earth and has been used for many years both in the oil and gas industry and groundwater exploration field to evaluate the presence and relative quantity of water bearing zones in the subsurface.

Further, for this study Geo9 has secured the cooperation of Dr James Craig, Assistant Professor at the Environmental Modelling and Analysis Group, Department of Civil and Environmental Engineering, University of Waterloo, Canada. Prof. Craig has developed and applied new modelling approaches to address difficult water resources problems in groundwater and surface water systems. His analytical approaches are used for complex local and regional problems in unsaturated and saturated flow systems and multilayer aquifer systems. His intention is to make these tools and techniques accessible and useful to consultants, educators and regulators.

In 2009, Prof. Craig supervised students work on the prioritisation of borehole capping measures in the Great Artesian Basin, where they focused on the Cadna-Owie-Hooray aquifer. He is currently working on integrating the analytic element method (AEM) which is advantageous at large scales, and the finite element method (FEM), more appropriate for complex local-scale phenomena. He is also working with his Department's Computational Mechanics Laboratory on the extension of the extended finite element method (XFEM) to mixed-scale problems of carbon sequestration and reservoir leakage in multilayer aquifer systems.

Geo9 also has the cooperation of Swiss Masters student Ms Stephanie Muff who is studying at the Institute of Geochmistry and Petrology at the Swiss Federal Institute of Technology in Zurich, Switzerland.

Lastly, Geo9 aims to obtain the participation of an Australian academic partner to collaborate with us on this important study, including for independent review of the work and peer review of the results for publication in scientific journals and presentations to the International Association of Hydrogeologists and other professional bodies.

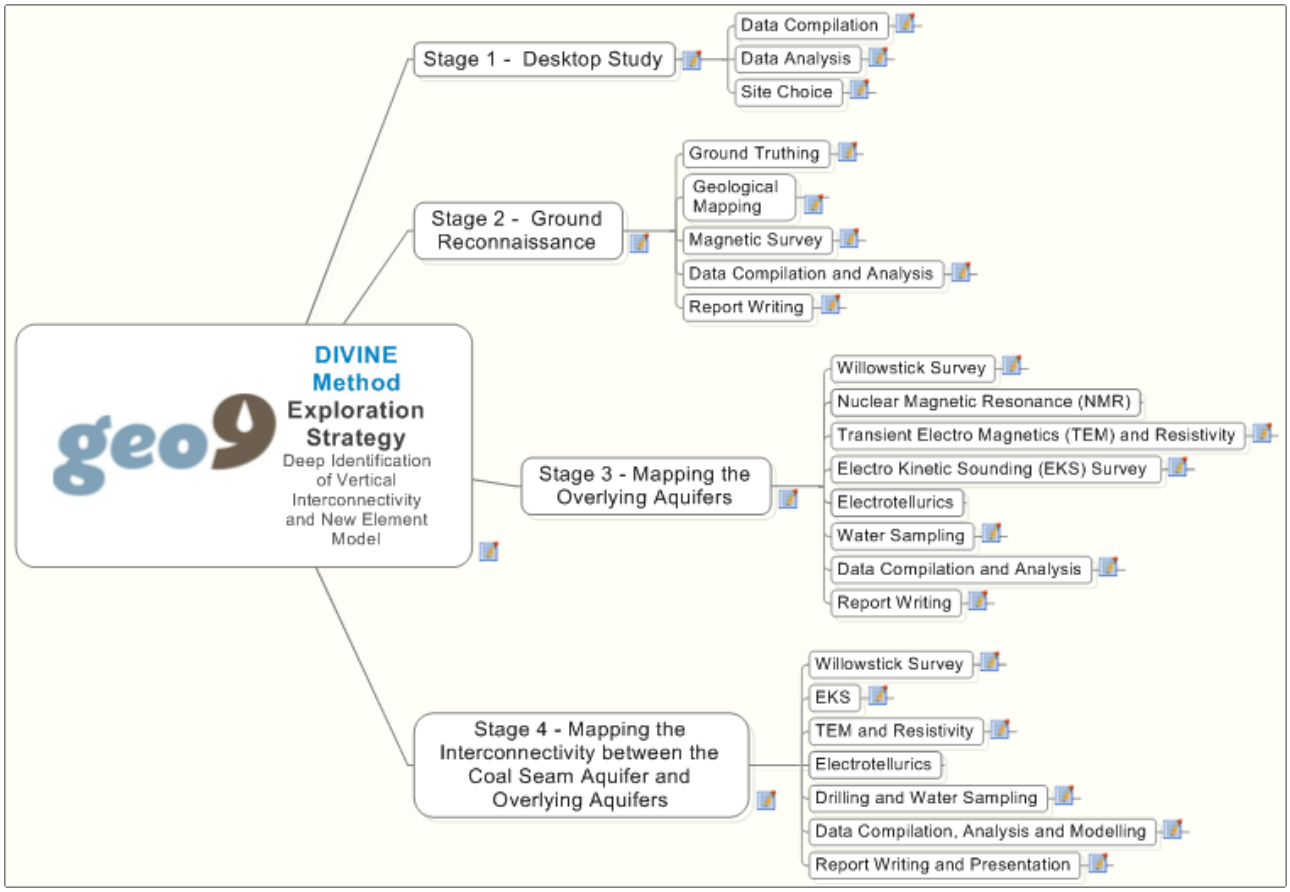
Aim and Objectives

The aim of the DIVINE Method pilot study is to identify and assess both qualitatively and quantitatively the degree of interconnection between coal seam aquifers currently being utilised for coal seam gas extraction, and overlying aquifers in areas perceived by the community as being threatened either by contamination or depletion from such activities.

Geo9's objective is to provide an independent scientific assessment of the risk to groundwater supplies co-existing with CSG production by using geological mapping, geophysics and groundwater geochemistry to create a DIVINE model.

Further Geo9's seeks to prove and establish the DIVINE model methodology as a recognised means to improve the precision and accuracy of hydrogeological models used for environmental impact assessment of CSG extraction.

Exploration Strategy



Stage 1 - Desktop Study

The first stage is identifying a location with the geological characteristics deemed most likely to provide evidence of seepage between the aquifers in question. The areas need to be chosen through geological considerations. This research needs to take an initial broad scale view to find areas most relevant to the study. The choice of location for the pilot study will also depend on the proximity of active CSG wells and overlying bores used for agricultural production and human use. Further, it will be important to identify locations where there is negligible interference from surrounding metal sources to the proposed ground based geophysical techniques.

Data Compilation

Geo9 will analyse areas where CSG exploration and production activity is occurring and review previous geological reports and surveys that are on the public record. This will include an analysis of agricultural and domestic bore logs from State Government records. Geo9 will then source a wide range of publicly available data on geology, geomorphology, geography, hydrology and groundwater chemistry in those areas. We will also research satellite imagery and airborne geophysics which includes magnetic, gravity and radiometric data. The data will be compiled as separate overlays in a Geographical Information System (GIS) software package for analysis.

Data Analysis

The purpose of this step is to identify geological features most likely to host seepage between aquifers in areas where active CSG and agricultural and domestic bores exist. For the purposes of this study, the bores must be located within 3 km of each other to be within the limitations of the geophysical surveying method. The data analysis will identify the location of regional scaled fault zones, fracture zones, intrusive dykes and pipes that intersect rock layers. These geological features would act as seepage zones interconnecting the aquifers of interest and Geo9 is seeking to find them for closer investigation.

Site Choice

Once the data analysis is complete, target areas for exploration would be identified at sites judged most suitable for geophysical surveying. During this step, Geo9 will also conduct an initial assessment of potential survey interference factors such as power lines and fences, roads and railways.

Stage 2 - Ground Reconnaissance

Geo9 commences fieldwork in order to rank the suitability of target areas for geophysical surveys based on site conditions. Geo9 will conduct an initial assessment of built infrastructure including communication cables, irrigation pipes and fences that could interfere with surveying.

Ground Truthing

Ground truthing verifies that the data collected in the office faithfully represents features expressed on the ground. This includes checking that geological mapping is correct and that features identified from aerial geophysical maps correlate to a certain rock type or landscape.The effectiveness of ground truthing the geological data will be dependent on the degree of rock outcrop and the geomorphology on site. Geo9 will also verify the location and condition of the agricultural and domestic bores and the location of CSG wells. Further detail including the types of well head design, pipelines, fences, roads and the location of evaporative dams that may be used, will be collected to confirm the suitability of the site for later geophysical surveying.

Geological Mapping

Geo9 will need to gather detailed geological evidence to prove the existence of faults, fractures and dykes. In order to achieve this, Geo9 will make observations on rock outcrops, the landscape and the processes that control drainage and recharge in the areas of interest. Geological maps available in the public domain are based on a large scale of 1:250 000 and do not include fine structural details. Observations will lead to a higher level of mapping detail and a better understanding of the controlling influence the lithologies and structure have on the groundwater flow paths. It will also be useful in assessing hydrogeological characteristics of the subsurface such as porosity and hydraulic conductivity. The areas of interest for the next step of ground based magnetic surveying are determined from this step.

Magnetic Survey

The first ground-based geophysical data Geo9 would collect is a ground based magnetic survey. This is needed to identify the locations of faults, fracture zones, dykes and intrusive pipes with precision.

Data Compilation and Analysis

The last step is to compile and analyse the field data. In this step, Geo9 incorporates new data into the existing GIS database from Stage 1.

Stage 2 Report

The report will present key data, analysis and conclusions from Stage 1 and 2 and identify the most suitable target areas for the next phases of ground-based geophysical surveying.

Stage 3 - Mapping the Overlying Aquifers

The objective of this stage is to use ground based geophysics to provide a high resolution map of the aquifer(s) used in agricultural production overlying the coal seam, and to determine the connectivity between bores drawing from these aquifer(s). Geo9 would use and calibrate multiple geophysical techniques and geochemistry to develop a detailed understanding of the groundwater systems.

Willowstick Aquatrack™ Survey

The Willowstick AquaTrack groundwater mapping technology will map the connection between bores in high resolution. This technique requires electrodes to be placed in two productive bores that intersect the aquifer or aquifers of interest and are no greater than 3 km apart. An alternating current is produced in the groundwater and induces a magnetic field that is measured at multiple points on the surface. Data would initially be collected in a grid of 50m spacing that can upgraded to a higher resolution grids over specific points of interest. .This technique is also useful for establishing the presence of salinity fronts in aquifers.

Nuclear Magnetic Resonance (NMR)

NMR is another non-invasive and direct method of determining water content and permeability of aquifers. Both the upper and lower boundaries of the subsurface water-saturated layers can be determined. The depth the NMR technology can detect is up to 150m. This technique detects the reaction of hydrogen atoms in water molecules to the variability of the earth's magnetic field. The results from this survey will be compared with pump test data and be used to calibrate the electro kinetic sounding (EKS) system (below).

Transient Electro Magnetics (TEM) and Resistivity

Transient Electromagnetics (TEM) and Resistivity are two further ground-based geophysical techniques that can map the conductivity, and its inverse, resistivity, of the subsurface. The choice of technique will depend on the individual circumstances of a site. These techniques provide a way to identify stratigraphy and structure to depths of 250 m. These techniques are especially useful for detecting the depths to boundaries and remotely estimating the presence of groundwater, interconnections and relative salinity. The results from these surveys are useful for the calibration of depth in the EKS and electrotelluric surveys (below). The results would also be correlated with the AquaTrack results to elucidate the geological controls on groundwater flow paths, identify recharge zones and establish the connection between groundwater, surface run off and groundwater dependant ecosystems.

Electro Kinetic Sounding (EKS)

An important part of Geo9's geophysical toolkit is an electro-kinetic sounding technique (EKS) that identifies permeability in water filled strata at selected locations commonly up to 500m depth. The EKS uses a sonic pulse to establish a vibration between water molecules and the surface of mineral grains, resulting in an electromagnetic field that can be measured. This method enables the accurate determination of depth to the water table and groundwater flow rates in specific aquifers without the need for drilling and pump testing. The EKS system can be used in locations where no wells or bores exist, or in close proximity to existing ones.

Electrotellurics

This technique can determine true vertical depth of a given formation down to 12 kilometres and provide data on relative porosity. It also identifies lateral/vertical lithological variations, small-scale structures, structural displacements and the depth and thickness of aquifers.

This technique detects the telluric currents generated in the earth as a result of the the interaction of solar radiation with the Earth's ionosphere. When the currents flow downward, a change in conductivity occurs due to changes in lithological composition, porosity or mineral content. This induces a secondary electromagnetic pulse which radiates to, and is detected at, the surface.

By taking a number of readings, descriptive structural and stratigraphic cross sections and structural maps can be produced. The resulting data can be used for stratigraphic correlation, porosity geometries, and reserve estimation. Field checking the accuracy of electrotelluric surveying is easily done by selected readings taken at well sites for which electric logs (downhole resistivity profiles) are available.

After calibration models have been established, multiple data points are correlated to define the presence, depth, thickness and lateral limits of an aquifer or coal seam. Oil, saltwater, fresh water, gasses associated with chemical precipitates, coal and certain minerals all have recognisable and repeatable patterns which can be used to determine their presence or absence in a formation.

Water Sampling

In selected locations, the collection of water samples for chemical analysis would determine the water's ionic composition and age. Geo9 will calibrate the EKS based on ionic composition of the water. Further samples could be collected for the analysis of methane, fraccing fluids and other organic contaminants derived from coal and other hydrocarbons. These geochemical analyses establish the baseline chemical characteristics of the groundwater water to provide another indication of the connection between CSG aquifers and the overlying aquifers independently of the geophysical studies.

Data Compilation and Analysis

Once the fieldwork is completed, survey results from all of the different geophysical techniques and geochemical analysis will be correlated and added to the GIS database.

A groundwater model would be created to present the results of work to date. Geo9's inclusion of the Canadian academic modelling team is designed to provide the benefits of world-leading input into the large and local scale model design and a high level of objectivity as the University of Waterloo is geographically remote and has no vested or other interest in the outcome of the work.

Stage 3 Report

The findings from Stage 3 will be presented with extensive use of graphics to illustrate the interaction between the aquifers and the geological controls therein. The results of the groundwater modelling would be submitted for peer review.

Stage 4 - Mapping the Interconnectivity between the Coal Seam Aquifer and Overlying Aquifers

This goal of this stage is to explore for, and map any interconnectivity between the coal seam aquifer(s) and the overlying aquifers mapped in Stage 3. This stage requires access to CSG wells and will depend on the cooperation of several landholders and access to CSG wells.

Willowstick AquaTrack ™ Survey

For the Willowstick AquaTrack survey in this stage, access to a CSG well, on or near the property will be required. Geo9 seeks the close cooperation of the CSG company regarding logistical survey issues in relation to the CSG well.

The AquaTrack system will map any flow paths between the aquifers and identify the salinity or freshwater plumes around these structures. This will indicate whether water of one aquifer is flowing into another and the direction of that flow. The AquaTrack survey can also determine the integrity of any leaking CSG wells. If there is puddling around the well head, the interconnectivity of the coal seam to the surface can be mapped by locating one electrode in the CSG well and another in the wet area around the CSG well.

The surveying programme would likely commence with broad measurements located at estimated 50m spacings, with high density measurement at 5m spacings in areas of greatest interest. These measurement points map the position and orientation of the connection path and any cross contamination plumes. Modelling of Willowstick AquaTrack results from this stage are required in 3D to inform the next stages of the study.

Electro Kinetic Sounding (EKS)

The EKS measurements will enable the permeability and groundwater flowrates to be determined both within the coal seam and along any interconnection found between the coal seam and the overlying aquifers. The locations and depths of the EKS survey will be determined by the 3D model based on the preceeding Willowstick AquaTrack results. The results of this step and the AquaTrack survey data will provide inputs for modelling of the aquifer systems at an unprecedented high level of resolution.

Transient Electro Magnetics (TEM) and Resistivity

TEM and resistivity would be useful in mapping the upper parts of the interconnecting groundwater conduits if they are within 250m of the surface. These additional sources of subsurface data would add rigour to the groundwater model as they would provide an additional image of the connection between aquifers. Survey results from this step would be correlated with AquaTrack and EKS survey data.

Electrotellurics

These surveys can determine the true vertical depth of a formation. The resulting data is used for stratigraphic correlation, porosity geometries and reserve estimation. Oil, saltwater, fresh water, gases associated with chemical precipitates, coal and certain minerals have recognisable and repeatable patterns which can be referenced to determine their presence or absence in a formation. The electrotellurics system would map the stratigraphy at a much higher resolution and would be able to resolve groundwater models for the entire depth of the basin with correlation to drill logs.

Drilling and Water Sampling

Drilling of test holes for geophysical surveying using Willowstick AquaTrack could be required if a site is selected where the CSG aquifer under review does not have a nearby agricultural bore drawing from the overlying aquifers within a 3km radius.The option for drilling test holes will also be required for the chemical analysis of water samples to establish the interconnection between the aquifers independently of geophysics. The analysis would determine water composition, age, and establish the degree of contamination of methane, fraccing fluids and other organics derived from the coal seams. Drilling would intercept seepage structures at various depths to provide information on the dilution of organic contaminants, salts and isotopic chemical species. Since the chemical characteristic of groundwater is unique to each aquifer, the chemical analysis of water within the seepage conduits would characterise the degree of the interconnection.

Data Compilation, Analysis and Modelling

The results from the AquaTrack survey are processed in Utah, USA. All information from the study would be combined into a model that includes high resolution data to identify and predict the impact of CSG extraction on the surrounding aquifers.

Stage 4 Report

The findings from the pilot study will be presented with extensive use of graphics to illustrate the interaction between the aquifers, the geological controls therein, aquifer reaction and predictions of CSG extraction. The results of the groundwater modelling would be submitted for publication and presented in talks to the Australian chapter of the International Association of Hydrogeologists and other professional bodies.

Budget and Timeframes

The budget for the pilot study will depend on the specifics of the site chosen. Indicative costings and timelines are available for review with interested parties.

Contact Information

To register for future updates to Geo9's DIVINE Method project or for any enquiry in relation to the information presented in this document, please contact:

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willowstick

CASE STUDY

Chevron Discovers What's Below With Willowstick

INTRODUCTION

CHEVRON DIDN'T BECOME ONE OF THE world's largest and most respected energy companies by following others, they got there by blazing their own trail. With their corporate commitment to being a responsible and environmentally friendly company, Chevron stands apart from their competitors by being open to new ideas.

In 2006 the company brought in Willowstick, a Utah-based company whose AquaTrack™ Technology creates accurate, contoured maps of subsurface water paths. Willowstick was charged with helping Chevron engineers discover what was occurring beneath the ground.

Willowstick was able to provide Chevron a better understanding of the complex underground water systems that were creating difficult problems. In the end the company was able to save potentially millions of dollars and countless hours of work, thanks in large part to AquaTrack.

The AquaTrack on site.

THE PROBLEM

"Chevron needed something that could provide a more concrete reading with accurate data."

CHEVRON DEVELOPED A NEW TECHNIQUE for revitalizing oil production wells using steam. In order to safely and efficiently utilize the steam, Chevron's Bakersfield, California-area engineers needed a clearer understanding of the subsurface, most specifically the potential routes through which the steam could travel.

While there were research methods that could give them an educated guess as to subsurface routes, Chevron needed something that could provide a more concrete reading with accurate data.

Pete Dillett, an Earth Scientist at Chevron, needed the method to be inexpensive and justifiable to management. Beyond that, the data pulled needed to be able to be plugged into earth models for the engineers and scientists, but also into presentation formats for executives.

"My boss was basically charged with bringing in technologies that could possibly benefit the company," Dillett said. Willowstick,'s AquaTrack technology had been referred to Dillett's group by other Chevron engineers who felt that their technology and services could benefit the projects Dillett had been charged to address.

AquaTrack works by measuring magnetic fields generated by an AC current, which is applied using strategically placed electrodes that are in direct contact with groundwater flow. After multiple unobtrusive readings taken by a Willowstick surveyor, the data is applied to mathematical algorithms and used to create maps and three-dimensional models of the subsurface pathways. There is no requisite well drilling involved, no large equipment and no extra personnel to manage.

PROBLEM

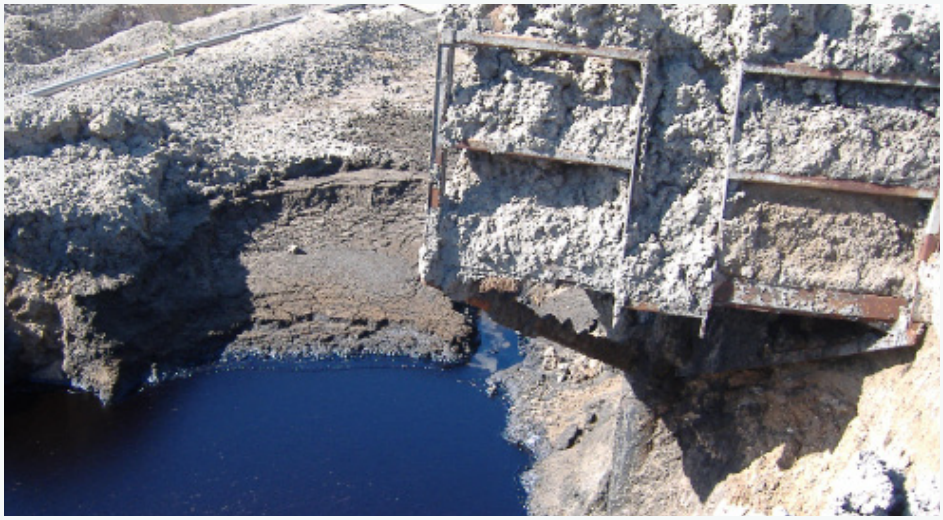
$6-9 million

SOLUTION

$140,000

"We felt like Willowstick would be able to give us digital insight that would integrate with data pulled from all our other monitoring sources, to better understand the subsurface"

PETE DILLETTE, EARTH SCIENTIST—CHEVERON



Willowstick uses electrodes placed in direct contact with groundwater flow

"We felt like Willowstick would be able to give us digital insight that would integrate with data pulled from all our other monitoring sources, to better understand the subsurface," Dillett said. "We wanted it to be supplemental, as opposed to a standalone operation."

Going from the idea to actual deployment was a cinch. "We worked with Paul Rollins (Willowstick Vice President of Business Development) and two technicians, beginning with a field tour. We showed them the site and exactly what we wanted to do," Dillett said. "We gave them a glimpse of our data and in turn they drafted a proposal. I was able to go to my bosses and make a recommendation."

After the proposal was approved and the final logistics and safety measures were planned, Willowstick deployed a team of engineers to gather readings of the field. They began with a wider, 100 square-foot pattern, to get a general sense of the area. After examining the data with Chevron's team, a more detailed reading was taken every 25 square-feet in areas of interest.

From initial talks to completed maps, the entire project took six months. But it only took about a month from the beginning of measurement to finalized maps. Dillett said that, "Willowstick's turnaround was extremely quick and efficient."

"The maps are well laid out and easy to understand," Dillett noted. "We could take the image files and view them in earth models, integrate it with other data we had pulled and get an understanding of what was happening at depth.

"Willowstick did everything we wanted them to do, such as following our safety procedures and checking in on a daily basis," said Dillett. "They did a great job.

"They were very professional, and we're really pleased with how they helped us plan and execute the project."

"We were attacking a $6-to-$9 million problem with a $140,000 solution," Dillett said. "Willowstick wasn't able to give us answers to every issue we've faced, but the data we received has proven to be accurate and reliable. It helped us see things we hadn't seen before."

Dillett took the data Willowstick provided him and was able to plug it into multiple formats, including PowerPoint™, which made it easier to present to management. "Even mid-project, I had information to take to management on the wells we sought to take action on and why."

Dillett noted that the field has not yet been returned to production but they plan on it in the very near future. Armed with the information Willowstick provided, the process has been simplified greatly, and at a low price.

"Willowstick worked with us on measurements, which helped save on costs," Dillett said. "Instead of doing an intensive 25x25 survey from the outset, we took less readings over a wider area, then focused in on a few spots. We were able to take less time as well.

"The existing survey technology on the market wouldn't be able to give us the same information at all," Dillett said. "Willowstick really runs a tight business. They have people that manage the project with you, collaborate with you and turn things around quickly.

"All across the board, Willowstick was very professional, very competent and very responsive. They're growing, but we never felt the effects of that; we always received personal attention from them. You don't always get that from vendors in this industry."

"Willowstick really runs a tight business. They have people that manage the project with you, collaborate with you and turn things around quickly."

PETE DILLETTE, EARTH SCIENTIST—CHEVERON

For more information on Willowstick and AquaTrack™, visit willowstick.com

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