10.195

Department of Environmental Quality

To protect, conserve and enhance the quality of Wyoming's environment for the benefit of current and future generations.

Dave Freudenthal, Governor

John Corra, Director

RECEIVED
FEB 09 2005
Solid & Hazardous Waste Div.
Lander, Wyoming

February 2, 2005

Mr. Jim Hedges, Chairman
Fremont County Solid Waste Disposal District
P.O. Box 1400 Lander, WY 82520

Re: September 13, 2004, Fremont County Solid Waste Disposal District Questions
Sand Draw Landfill (SHWD File #10.195)

Dear Mr. Hedges:

First, let me apologize for the delay in responding to the questions in your September 13, 2004, letter. I'll respond to your questions in the order they were presented.

Question 1. "If an isolated confined pocket of groundwater is determined to be present in an area of either new landfill construction or expansion, would that preclude construction/expansion of an unlined landfill? If yes, then what are the restricting limits of the size of the isolate groundwater pocket?"

I assume that your question deals with the situation encountered at R-8, at the Sand Draw landfill expansion area. Before I answer your question generally, I need to speak to the situation at R-8.

The groundwater depth at R-8 has been monitored since 1995. During the beginning of that interval, groundwater elevations were measured around 5510'. They gradually declined to 5485' during the period 1996 to 1999. In 2000, the groundwater elevation increased to 5495', remained at that level for several months, and then declined gradually to levels consistent with the pre-2000 levels.

Careful examination of groundwater level measurements made during the same time period indicate that R-7 and R-10 exhibited similar, albeit much less pronounced, trends in groundwater elevation as did R-8. R-11 and R-12 did not, but it is not uncommon for an unconfined aquifer to behave in this manner. All of these groundwater elevation data follow the general trend in annual precipitation levels in Wyoming, which have generally declined by about 2.5 inches per year over the past decade (National Climatic Data Center). There were precipitation increases in our state in the 1998-1999 time period, as shown by statewide average precipitation data from NCDC. These increases could account for rises in the water table at R-7, R-8, and R-10 in 2000.

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So, I do not believe that the groundwater in the vicinity of R-8 is an 'isolated' pocket of groundwater, as you have characterized it. The groundwater at R-8 is certainly not confined, according to well records submitted by Inberg-Miller. Groundwater at R-8 is part of the local groundwater system that underlies much or all of the expansion area at the Sand Draw landfill.

As to your general question, if an 'isolated' pocket of groundwater was encountered in an area proposed for an unlined landfill, it is probable that the landfill would need to be lined. (You also asked if the isolated pocket was also confined, but by definition an 'isolated' pocket cannot be confined. A confined aquifer is under greater than atmospheric pressure, because it is connected to other groundwater at higher elevations.) There are two reasons why the landfill would need to be lined. First, in DEQ's experience it is difficult, or at least very expensive, to document that an aquifer is not connected to other groundwater. Second, the statute protecting Wyoming's groundwater does not have any provision to allow pollution of groundwater that is believed to be limited to some predetermined lateral extent or depth.

Question 2. "If an unexplained water table rise is observed only in one well with no adjacent wells exhibiting a similar rise, does that comprise a global rise in the water table, that is a rising water table in surrounding areas away from the well exhibiting the rise?"

Again I presume that your question deals with groundwater conditions at R-8, at the Sand Draw landfill expansion area. As discussed above, we do not believe that the rise that occurred in 2000 at R-8 was an 'unexplained' rise that didn't occur in surrounding wells. Groundwater elevations at R-8 over the past decade vary from a high of about 5512' to a low of about 5485'. That is a variation of about 27 feet during the decade. The 'unexplained' rise in R-8 that occurred in 2000 put the elevation of groundwater at about 5495', well within the range of the decade's elevation variation.

I want to acknowledge that the FCSWDD installed additional wells to see if the 'unexplained' rise at R-8 was limited to the immediate area around R-8, or if it affected a broader area. The District's conclusion was that since it couldn't document similar rises with other wells, that the elevations measured in R-8 must be an anomaly, or that the rise in R-8 wasn't reflective of an overall water table rise throughout the expansion area. I've already mentioned my evaluation of R-7 and R-10 and my conclusion that these wells exhibited a similar trend as measured in R-8. The additional wells that were installed around R-8 (wells R-14, R-16, and R-18) did not show a similar rise as occurred in R-8--but that is to be expected since these additional wells were installed in 2002, two years after R-8 had returned to pre-2000 water levels. I would also note that the additional wells installed encountered groundwater, resulting in a considerable expansion of the area known to be underlain by groundwater. This offers further evidence that R-8 is part of a local groundwater system and not an "isolated pocket" of groundwater.

I do not agree that there was an 'unexplained water table rise in only one well' at the Sand Draw expansion area. But in answer to your question, in an unconfined aquifer, a rise in one well indicates a rise in the groundwater level at the location of that single well.

Question 3. "If seasonal or perched groundwater is impacted, does that constitute a violation of WDEQ/SHWD regulations?"

Chapter 2, Section 5(x), is the operating standard governing groundwater impacts from solid waste disposal facilities. It says: "Solid waste disposal facilities shall not be allowed to alter groundwater quality, as determined by groundwater monitoring." Groundwater is defined in Chapter 1 as "water below the land surface in a saturated zone of soil or rock." Thus, seasonal or perched groundwater is considered groundwater requiring protection from contamination under the state's solid waste rules.

These rules are consistent with the groundwater protection requirements of the Environmental Quality Act in Article 3, and with the Water Quality Division's groundwater protection rules. As an example, Chapter 8, Sections 3(a) and (c) of the Water Quality Rules and Regulations states:

"(a) All waters, including groundwaters of the State, within the boundaries of the State of Wyoming are the property of the State; and control of the beneficial use of waters of the State resides with the Wyoming State Engineer.

(c) Protection shall be afforded all underground water bodies (including water in the vadose zone). Water being used for a purpose identified in W.S. 35-11-102 and 103(c)(i) shall be protected for its intended use and uses for which it is suitable. Water not being put to use shall be protected for all uses for which it is suitable."

"Underground water" is defined in Section 2(t) as "...subsurface water, which is any body of water under the surface of the earth, including water in the vadose zone and groundwater."

"Vadose zone" is defined in Section 2(u) as "...the unsaturated zone in the earth, between the land surface and the top of the first saturated aquifer which is not a perched water aquifer. The vadose zone characteristically contains liquid water under less than atmospheric pressure. Perched water bodies exist within the vadose zone."

I note that Chapter 8 of the Water Quality Division's rules governing protection of groundwater extends to water in the vadose, or unsaturated zone, as well as to groundwater in a saturated zone. The state's landfill rules do not specifically prohibit contamination of water in the vadose zone beneath a landfill. I believe that the reason for this is the technical difficulty of measuring impacts to water in the vadose zone beneath a landfill. The landfill rules do, however, prohibit contamination of groundwater beneath a landfill. This is entirely appropriate, in my view, since groundwater moves and can impact other users of the resource.

Since the solid waste rules contain requirements that must be followed in the event that groundwater monitoring shows that a landfill is contaminating groundwater, DEQ has chosen not to cite owners when contamination occurs. DEQ would cite an owner for failure to follow the requirements that are triggered when contamination is documented at a landfill. For a Type II landfill, confirmation that the landfill is contaminating groundwater means that the landfill is reclassified as a Type I landfill. This is because Type II landfills include only those landfills which have "....no evidence of existing groundwater contamination from the landfill" (Chapter 1, Section 1(e)). For both Type I landfills, and leaking Type II landfills that have been reclassified as Type I landfills, evidence that the landfill is leaking also means that future disposal areas at the landfill must be lined. This is because evidence that the landfill is leaking means that it is not possible for an owner to meet the conditions which must be demonstrated to allow DEQ to waive liner requirements, as specified in Chapter 2, Section 4(j).

The landfill rules contain other requirements that must be followed by an owner when groundwater pollution is confirmed, including requirements to increase the frequency and number of constituents that are monitored; and if contaminant levels are high enough, requirements to install additional wells to map the extent of contamination and requirements to assess potential corrective measures and carry out the selected measure(s). These are the other requirements that have been held in abeyance at the Lander landfill, and which I've agreed to lay out for you, in accord with my conversations with Dr.Groutage and Don Connell during our meeting in Cheyenne about two weeks ago.

I hope this letter answers the questions in your September 13, 2004 letter. As I mentioned to Dr. Groutage, the Department has been working for several years to balance the need to protect human health and the environment with the waste management needs and financial limitations of the Fremont County SWDD. I am hopeful that, in spite of some lingering differences, we will be able to reach responsible solutions. The Department will provide a detailed discussion of outstanding issues at the Lander and Sand Draw landfills as requested by Dr. Groutage. I look forward to meeting with you in February to discuss these issues in more detail. If you have any questions before then, don't hesitate to contact Patrick Troxel or me.

Sincerely,

David Finley
Administrator
Solid and Hazardous Waste Division

cc: Patrick Troxel >>> Lander SHWD File #10.195
Cheyenne SHWD File #10.195
Bob Doctor >>> Casper SHWD File #10.195
John Corra

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April 15, 2005

Don Connell
Fremont County Solid Waste Disposal District
P.O. Box 1400
Lander, WY 82520

Re: AquaTrack Geophysical Groundwater Characterization Investigation
Sub: Riverton, WY – Sand Draw Landfill

Dear Don:

Introduction

Willowstick Technologies, LLC has carefully reviewed the information provided by the Fremont County Solid Waste Disposal District (FCSWDD) regarding groundwater levels beneath the Sand Draw Landfill - Riverton, Wyoming. Although the groundwater levels appear confusing and inconsistent in comparison to one another, we believe the historic and recorded groundwater measurements are most likely accurate and consistent with what one would expect to find given the information provided. As a result of our findings, we believe that an AquaTrack geophysical investigation "**may not**" be warranted or necessary to resolve the apparent inconsistencies with groundwater levels; however, the AquaTrack technology "**may**" be of benefit in further characterizing groundwater by delineating areas of greater saturation and/or preferential flow paths beneath the site.

Review of Existing Data

After careful review of the hydro-geology of the site, recorded groundwater levels and precipitation records of the area, we don't believe that there are inconsistencies or abnormalities with the data. However, we do believe that the measured and recorded data may have been misinterpreted.

It is our understanding that monitoring well R-8 has fluctuated as much as 35 feet between high and low potentiometric levels. It is also our understanding that adjacent wells R-7, R-10, R-11, and R-12, which have been monitored along with R-8, have also experienced some fluctuation during the same periods of time although not as much as R-8. The high and low water levels in the wells correspond very closely with the high and low levels of well R-8.

The geology of the area suggests that the shallow groundwater encountered in the monitoring wells is meteoric generated (created from precipitation falling on or near the landfill). The geology of the area is on a high plateau and regional groundwater is at significant depth. We believe the groundwater found in the monitoring wells is from meteoric origin. The shallow groundwater table below the landfill mirrors the surface topography by forming a dome like shape beneath the plateau and landfill. When groundwater was observed at high levels in well R-8, the surrounding wells also recorded higher than normal water levels. In most cases these high water levels were proceeded by higher than normal periods of precipitation. We do not know the exact location of the precipitation measuring station but have assumed that it is not measured at the landfill. Thus, the precipitation records may not correspond exactly

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with groundwater fluctuations at the landfill. Also, we don't know the characteristics of the precipitation at the landfill. For example, a storm that drops a lot of water in a short period of time most likely will flow off the plateau before it can be absorbed into the ground. Whereas, a long slow but steady storm may allow water to be absorbed by the ground and not run off the plateau. Varying conditions of storms can have varying impacts to the groundwater, especially over a small targeted area like the landfill.

Wells 15D and 16D were drilled after a significant history with wells R-7, R-8, R10, R-11 and R-12. At the completion of wells 15D and 16D, water levels in all wells surrounding R-8 have been consistent with the expected potentiometric surface of the groundwater. Well R-8, which is located at the highest point on the plateau and centered over the groundwater dome, has the highest water level. The surrounding wells all have lower water levels because they are located away from the center of the groundwater dome.

Well 15D has never had measurable water in the well. We believe the reason for this is because the well has been drilled and developed slightly above the groundwater table (potentiometric surface). Historic records in all monitoring wells (after well 15D was constructed) show that the groundwater beneath well 15D comes within a few inches of the bottom of well. The potentiometric contour map and cross-sections indicate that the groundwater is very closely located at the bottom of the well. We believe the water table is at the termination depth of the well borehole. Thus, the reason no groundwater has been encountered or measured in well 15D since its construction.

The well log for 15D also shows cuttings consistent with the other wells present on site. It is not likely or physically probable that there is an impermeable or dry zone around well 15D. It is our preliminary opinion, based upon the data provided, that well 15D was just not drilled deep enough to intercept the existing groundwater level. At some future date, when the groundwater levels rise (after periods of above normal precipitation), it is highly probable that groundwater will be found in the well corresponding with the potentiometric levels of adjacent wells forming a dome beneath the landfill and mirroring the topography of the plateau.

It should also be noted that the reason the monitoring wells located east of the existing 80 acre landfill facility are dry is due to the fact that they also are not drilled deep enough to encounter groundwater. The monitoring wells lie on the edge of the dome where depth to groundwater is slightly greater than in the center of the dome.

Overall, the landfill appears to be located on a very good site, specifically because water bearing wells have never shown any measurable contaminants migrating through landfill refuge carried by meteoric water seeping into the subsurface. The soils appear to act as an aquatard filtering and minimizing any harmful substances from reaching groundwater.

Possible Need for AquaTrack Geophysical Investigation

One reason the District may want to pursue an AquaTrack geophysical investigation of the groundwater located beneath the landfill is to better characterize and delineate areas of greater groundwater concentrations and probable preferential flow paths that shallow groundwater (influenced by meteoric sources) takes as it concentrates and flows beneath the landfill. Monitoring wells can then be located in these preferential or concentrated areas of groundwater to better understand the impact the landfill may or may not be having on the regional groundwater system.

The information obtained from an AquaTrack geophysical investigation can be used by the Fremont County Solid Waste Disposal District to assist in monitoring and preventing contaminants from impacting the regional groundwater aqueous system and will prove invaluable in reducing costs associated with regulatory compliance.

Background

AquaTrack is a patented geophysical technology (patents 5,825,188, 6,445,187 and other patents pending) with exclusive rights currently held by Willowstick Technologies, LLC. AquaTrack uses Controlled Source – Frequency Domain Magnetics (CS-FDM) to map existing groundwater. The groundwater body to be investigated and mapped is energized with a low-amperage alternating current introduced to the groundwater through source electrodes placed in wells, ponds or springs that have contact with the groundwater of interest. Return electrodes are placed strategically away from the source electrodes to allow injected electricity to flow through the groundwater of interest. The electricity will follow the path of least resistance and because the groundwater is a conductor, the electrical current follows it between the electrodes. As the electrical current flows through the groundwater, the current creates a magnetic field characteristic of the injected electrical current. This preferential flow of electrical current creates an induced magnetic field that is measured at multiple points on the ground surface, typically in a grid pattern. The magnetic field measurements are recorded using a data logger and the locations of the field measurements stations are determined and recorded using a Global Positioning System (GPS). The measured magnetic field data are processed, contoured, and correlated to other hydrogeologic data, resulting in enhanced definition of the extent of saturation associated with the groundwater body being investigated.

It's important to note that the AquaTrack technology identifies areas of highest conductance which is interpreted as the areas of highest water concentration through the area being energized. The technology will identify the contrast between areas of high conductance and low conductance. If no anomalies are found between high and low areas of conductance/water concentration, then it must be considered that the water content in the ground is uniform. On the other hand, if there are contrasts between high and low areas of conductance, water saturation, then these areas can be identified and mapped.

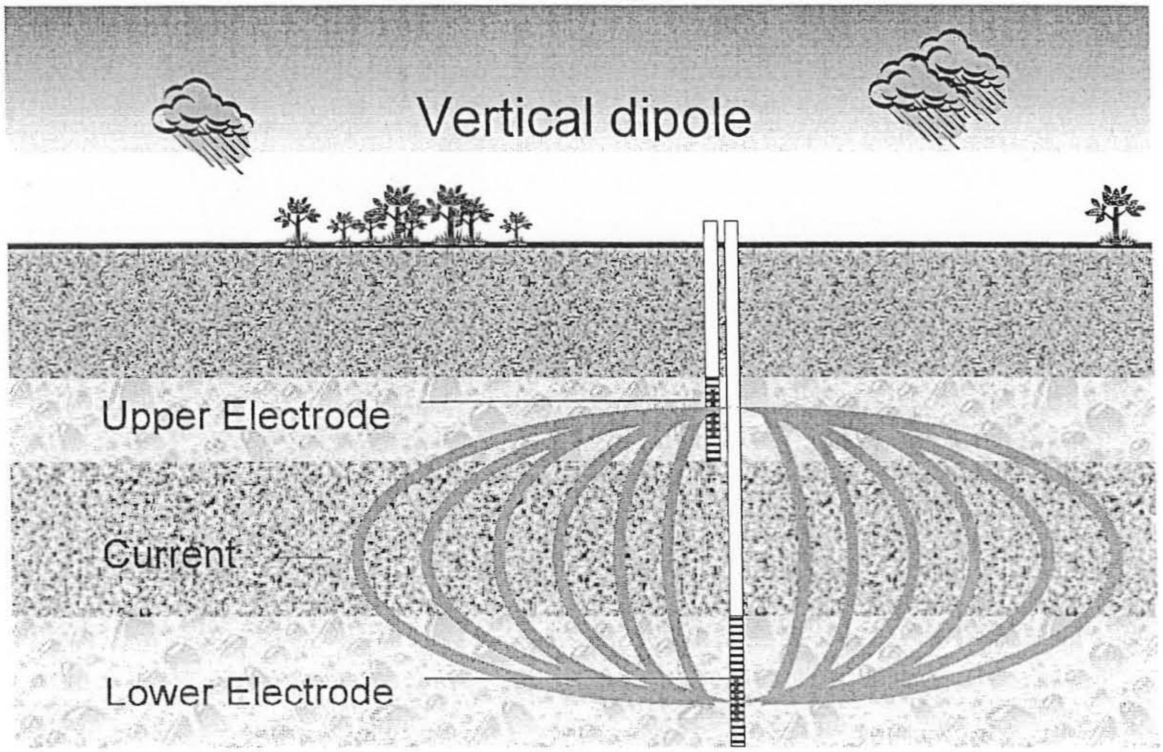
Objective

The objective of an AquaTrack geophysical investigation for the Sand Draw Landfill is to better characterize and delineate areas of greatest groundwater saturation and preferential flow paths beneath the landfill refuge in the local shallow groundwater system. The AquaTrack technology is a very accurate and cost effective tool that can identify areas of highest electrical concentration, which in turn is interpreted as identifying the areas of greatest saturation and/or areas of highest conductance or a combination of both. These highly conductive areas in the groundwater are most probably the preferential flow paths that the water is occupying as it flows beneath and away from the landfill site.

Approach to the Work

It is proposed that a vertical dipole antenna / electrode configuration be employed for this investigation to characterize and delineate the shallow groundwater immediately beneath the landfill. This will require the use of monitoring well R-8 and a new monitoring well to be located in very close proximity to R-8 (within 10 feet) but drilled to regional groundwater or at significant depth in comparison to well R-8 (350 to 500 feet deep). This new monitoring well will be of benefit to the District not only for the AquaTrack investigation but possibly for long term monitoring and background information on the deeper regional groundwater quality and depth. We will refer to this new monitoring well as R-21. The District would be required to drill this new monitoring well. **The cost to construct the well is not included in this proposal.**

Electrodes would be placed in well R-8 in contact with the shallow groundwater and in R21 in contact with the regional or significantly deeper groundwater (see figure below). The two electrodes would be charged with a 400 Hz, 110 volt potential electrical current. As the electrical current flows down from the upper electrode to the lower electrode, the current will flow out in the shallow groundwater and then bleed off down to the lower electrode.



This flow pattern of electrical current will allow the upper or shallower groundwater, associated with R-8 well, to be identified and delineated. Because the electrical current concentrates in the upper water zone before bleeding off to the deeper electrode the effects of the magnetic signal near the surface of the ground can be detected and used to determine where electrical current is most present, thus identifying areas of high and low conductance in the shallow groundwater system.

A vertical dipole configuration is limited to how far the electrical current will flow out from well R-8 until it bleeds off down to the deeper return electrode located in R-21. The radial distance the current will flow out from R-8 is not unknown at this time and cannot be determined until the AquaTrack geophysical work is actually setup and tested; however, we estimate that the signal will carry out as far as 1500 feet from well R-8. We have assumed a radial coverage area of 1500 feet around well R-8 (3000 ft diameter circle). This study area covers much of the expanded site and located directly over the domed groundwater and adjacent monitoring wells. Approximately **264 measurements stations** will be recorded to map the characteristics of the magnetic field within the targeted study area.

The magnetic signature emanating from the groundwater, as explained above, will allow for the interpretation and delineation of groundwater concentrations and probable preferential flow paths beneath the landfill. This information will then be compared and calibrated with well log data and geologic information and other hydro-geologic data available from the area of investigation.

The information gathered from the investigation will yield comprehensive information about the shallow groundwater located immediately below the landfill. The final AquaTrack magnetic contour map will show the magnitude of the processed magnetic field data and the inferred extent of saturation and/or preferential flow paths that meteoric water takes as it flows beneath the landfill and possibly off from the plateau.

Deliverables

1. *Interpretation and Report for AquaTrack Surveys* – Willowstick will submit copies of the report identifying site conditions, constraints, geologic understanding, project background, methodology, survey data, data reduction procedures, interpretations, maps, findings, summary and conclusions.

2. *Electronic Survey Results* – Willowstick will submit the tabulated data and visualization of interpretation in Excel and AutoCAD format respectively for inclusion in the final report, files, and modeling needs of the District and their consulting engineers.

Cost Estimate

The cost to perform the AquaTrack geophysical investigation, as described herein, is **$39,202 plus direct expenses** billed at no markup. It is expected that the direct expenses will be around **$2,122**. Therefore, the total cost of the proposed work is estimated to be **$41,324**. Not included in this cost is the cost to drill a "deep" new monitoring well (R-21).

Schedule

Upon the District's approval of the proposed work plan, we could begin work late May early June 2005 and complete the work within 45 days.

Conclusion

Willowstick feels confident that our AquaTrack geophysical technology will produce information that will greatly help in the characterization of the groundwater in question. We look forward to your consideration of this proposal.

Please contact me by phone (801-858-3012) or by email (prollins@willowstick.com) with any questions you may have regarding this proposal. We look forward to hearing from you in the near future.

Sincerely,

Paul R Rollins

Paul Rollins
Business Development Manager
Willlowstick Technologies, LLC