



DRAFT

City of Madison Master

Item 17-1
City of Madison
Madison, WI 53703
www.cityofmadison.com

File Number: 07290

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Requester: BOARD OF WATER COMMISSIONERS

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Introduced: 08/14/2007

File Name: Authorizing the Mayor and the City Clerk to execute Amendment No. 2 to the Professional Services Agreement with Montgomery Associates Resource Solutions LLC for the completion of continued assessment of Manganese in Madison Water Utility Wells.

Final Action:

Title: Authorizing the Mayor and the City Clerk to execute Amendment No. 2 to the Professional Services Agreement with Montgomery Associates Resource Solutions LLC for the completion of continued assessment of Manganese in Madison Water Utility Wells (City Wide).

Notes:

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Agenda Date: 08/21/2007

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Sponsors: Lauren Cnare

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Attachments:

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History of Legislative File

Ver- sion:	Acting Body:	Date:	Action:	Sent To:	Due Date:	Return Date:	Result:
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Text of Legislative File 07290

..Fiscal Note

The proposed amendment to the Professional Services Agreement with Montgomery Associates Resource Solutions LLC for the completion of continued assessment of Manganese in Madison Water Utility Wells is estimated at \$111,000. Funds are included in the 2007 Water Utility Capital Budget.

..Title

Authorizing the Mayor and the City Clerk to execute Amendment No. 2 to the Professional Services Agreement with Montgomery Associates Resource Solutions LLC for the completion of continued assessment of Manganese in Madison Water Utility Wells (City Wide).

..Body

WHEREAS, Madison Water Utility recognizes the need to study and more fully understand the manganese water quality issues at city wells; and

WHEREAS, Madison Water Utility wishes to plan for, design and construct additional wells around the City into the future in accordance with the Utility's approved Master Plan to provide high quality water in sufficient

quantities to area residents; and

WHEREAS, Montgomery Associates Resource Solutions LLC has completed a study on manganese in the Utility's Well 29 and has recommended additional testing at other system wells to evaluate groundwater chemistry and water quality in conjunction with aquifer and well construction conditions; and

WHEREAS, Madison Water Utility feels that it is in the Utility's best interest to proceed with this recommendation to further develop data and knowledge on the area aquifer and groundwater resource and to protect the long term drinking water quality; and

WHEREAS, it is in the best interests of the Water Utility for efficiency and continuity of knowledge to continue this project with Montgomery Associates Resource Solutions LLC; therefore it is prudent to seek Council approval of this amendment and extension of services as a "sole source" per MGO 4.26(4)(a) and 4.26(4)(b).

WHEREAS, Madison Water Utility has budgeted funds in the 2007 Operating Budget for well work.

NOW THEREFORE BE IT RESOLVED that the Mayor and the City Clerk are authorized to execute Amendment No. 2 to the Professional Services Agreement with Montgomery Associates Resource Solutions LLC for the completion of continued assessment of Manganese in Madison Water Utility Wells.

Quality and Reliability since 1882

**Madison
Water
Utility**



Madison Water Utility

David Denig-Chakroff, General Manager
Alan L. Larson – Principal Engineer

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Madison, Wisconsin 53713
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Item 17-3

MEMORANDUM

Date: Tuesday, August 14, 2007

To: Board of Water Commissioners

From: Al Larson
Principal Engineer

Draft Resolution 07290

Subject: Montgomery Mn Assessment Study
Continuation and Expansion of the Well Sampling and Analysis

Description: Continue the work of investigation of the sources and causes of elevated iron and manganese in Madison wells. It is the objective of the Utility to investigate and understand why some wells have elevated levels of iron and manganese and others do not. This knowledge will help the Utility make better scientific based decisions on the location of future high capacity wells. This study will use vertical sampling at selected wells to investigate variations in water yield and water quality within the open borehole portion of the well. The study will investigate wells 8, 10, 12, 29, and 30. See attached proposal for a detailed description of the proposed scope of services.

Estimated Cost: \$110,400 – Funds are currently not available in the 2007 budget. To start this study this fall would require a budget amendment.

Benefit: The knowledge gained through this study would be used to site future high quality municipal wells and potentially help the Utility manage water quality in those wells with respect to iron and manganese concentrations. This would be a long-term benefit to the Utility.

Recommendation: Approval of the study.

Let me know if you have questions or concerns about this.

July 24, 2007

Mr. Alan Larson
City of Madison Water Utility
119 E. Olin Avenue
Madison, Wisconsin 53713

VIA EMAIL, MAIL COPY TO FOLLOW

Re: Proposal for Professional Services
Continued Assessment of Manganese in City of Madison Wells

Dear Al:

Montgomery Associates, Resource Solutions, LLC (MARS) in collaboration with RMT, Inc. (RMT) is pleased to submit this proposal for continued assessment of the manganese issue at the City of Madison wells as you requested in our May 4, 2007 meeting and refined in subsequent discussions. The services described in this proposal will be performed according to the terms and conditions of our existing agreement.

An important long term objective of the Water Utility is to understand the sources and causes of dissolved manganese (Mn) in the City's aquifers in order to better manage the quality of our water supply. As you know, the presence of Mn and several other water quality parameters varies substantially among the City's wells. Our investigation of UW 29 indicated that Mn concentrations in groundwater was likely due to several factors including near-well disturbance, and variations in permeability, aquifer mineralogy and water chemistry with depth in the borehole. The UW 29 study drew conclusions relevant to decision-making on wellhead treatment for Mn removal, but we did not have sufficient data to draw more general conclusions on the cause of Mn dissolution through the vertical depth of wells of different construction or at different locations.

This proposed scope of services will provide an assessment of aquifer water quality at wells that draw their supply from different combinations of the upper and lower sandstone aquifers at different locations, and which have produced water with different Mn concentrations. We propose to use vertical sampling at these selected wells to determine the variation in water yield and water quality within the open borehole portion of each selected well.

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Mr. Alan Larson
City of Madison Water Utility
June 8, 2007
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The various situations and wells to be assessed are shown below:

	Wells open to both aquifers	Wells open to only the lower aquifer	Wells near surface water and in an area without the Eau Claire shale
Wells with moderate to high Mn	UW 10	UW 29	UW 8
Wells with low Mn	UW 12	UW 30	

Our proposed Scope of Services is described in detail in the attachment to this letter. The cost of this proposed scope of services is \$110,400.

This project will provide the Utility with hard data on the vertical variation in water quality and water yield of these wells. The data will allow us to draw conclusions that should help reduce costs and improve reliability in assessing and developing new well sites and managing existing wells to manage or avoid locations or conditions that may produce high Mn concentrations. The results of this study has the potential to avoid additional treatment systems or to reliably modify existing wells to produce lower manganese concentrations, which could result in savings of several million dollars, even if the utility can avoid Mn treatment at one new well or reconstruct one existing well to avoid high Mn concentrations.

Please review the enclosed Scope of Services and cost estimate, which provides the details of our proposal. Should you have any questions, please contact us.

Sincerely,

Montgomery Associates: *Resource Solutions, LLC*

Robert J. Montgomery P.E.
Principal



Scope of Services Continued Assessment of Manganese in City of Madison Wells

INTRODUCTION

Our initial investigation summarized in our March 2007 *Summary Report, Unit Well 29 Manganese Assessment*, identified that manganese concentrations in groundwater was likely due to several factors including near-well disturbance, and variations in permeability, aquifer mineralogy and water chemistry with depth in the borehole. This was based on well head samples, which are a vertical composite of the water coming from the entire open interval of the well. The initial scope of work was extended to include analysis of field parameters (pH, dissolved oxygen, temperature, conductivity and redox) at UW 30 and UW 12. Based on the results of the composite water quality sampling at UW 29, the deep aquifer is relatively isolated from the surface as there was no indication of shallow groundwater being present in water being produced from UW 29.

The preliminary evaluation at UW 30, UW 12 and at UW 10 resulted in the following observations:

- The thickness of the Eau Claire shale at wells UW 29, UW 30, UW 12 and UW 10 is approximately 5, 7, 15 and 16 feet, respectively
- Iron and manganese groundwater concentrations tend to correlate at UW 10, UW 12 and UW 30. However, groundwater iron concentrations at UW 29 are much lower than would be predicted at UW 10 for the same Mn concentrations indicating a different cause of manganese dissolution at these wells.
- Rock cuttings analysis suggests that significant Mn and Fe concentrations are found throughout the sandstone. Analyses from UW 10 (12 samples), UW 12 (8 samples) and UW 30 (8 samples) indicate that Mn concentrations in the rock solids range from 58 ppm to 1,230 ppm and Fe concentrations in the rock solids range from 5,700 ppm to 43,000 ppm. Rock cuttings analysis from UW 29 (23 samples) indicates that Mn concentrations range from 31 ppm to 1,440 ppm and Fe concentrations range from 4,800 ppm to 74,500 ppm.
- Dissolved oxygen (DO) levels at UW 29 and UW 30 were essentially zero but were approximately 3.42 mg/L at UW 12 which likely represents the mixing of more oxygen-rich shallow groundwater with deep groundwater having very little DO. DO levels weren't monitored at UW 10.

OBJECTIVES

A long term objective of the Water Utility is to gain an understanding of the sources and causes of dissolved manganese in the City's aquifers in order to manage water quality of the water supply, including operation and management of existing wells and planning/implementation for future wells.

The objectives of this scope of services are to extend the understanding gained in our UW 29 study, specifically to:

1. Determine in various situations whether the source and cause of Mn dissolution is associated with variations in rock mineral assemblages in the deep aquifer where there is evidence of no surficial



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sources of reducing conditions (e.g., at UW 29). This will be very useful in assessing new well sites and well drilling and construction methods to predict and avoid locations or conditions that may produce moderate to high Mn concentrations with the least cost.

2. Evaluate the possibility that surficial sources of reducing conditions may contribute to the dissolution of iron and manganese naturally present in the rock. Knowledge of how these conditions affect a well's water quality will be very useful in managing wells that are subject to surficial conditions. This would include many of the existing, older wells that are open to both the upper and lower aquifer. It may also apply to wells cased into the lower aquifer in areas where the Eau Claire shale is not effectively continuous (i.e., thin or not present in a large area around the well). It may also apply to both the shallow and deep aquifers in the long term when recharge to the lower aquifer will become more representative of the water recharging our aquifers (recharge from infiltration, infiltration from the lakes, etc.).

PROPOSED APPROACH

The proposed approach to satisfy both objectives is to compare two sets of wells, including three older wells, which are typically multi-aquifer wells (i.e., UWs 8, 10, and 12), and two new wells which are cased into the lower aquifer (UWs 29 & 30). This analysis will consist of evaluating the following characteristics:

- Geology and well construction
- Hydraulic parameters
- Mineral assemblage
- Zone of influence, recharge area, connectivity of aquifers
- Land use and potential local contaminant sources
- Vertical distribution of water quality and flow rates.

The general approach includes review of existing data and collection of additional field sampling and laboratory analysis at each well (i.e., UWs 8, 10, 12, 29, and 30) and evaluation of the data against several working hypotheses that could explain the composite manganese concentrations observed. The primary focus of this analysis is to extend our understanding of water quality in the aquifer from composite samples of the entire 400 ft to 800 ft of rock aquifer(s) contributing flow and water quality to a well to collection of vertically distributed flow and water quality data to understand the vertical distribution of water quality coming from the entire open interval of each well.

A primary limitation on the evaluation of the source and cause of dissolved Mn in the production wells is the fact that the well head water quality is a composite of water coming from 400 ft to 800 ft of the rock aquifer and, in many wells, from multiple aquifers. Therefore, our recommendation is to continue the assessment of the source and cause of Mn in the wells by determining the vertical variations in flow and water quality from wells representative of the various conditions in the City's aquifers. The various conditions include wells open to both aquifers, wells open to only the lower aquifer, wells near the lakes, and comparing wells with low Mn vs. wells with moderate to high Mn. Recommended wells to assess these various conditions are:



	Wells open to both aquifers	Wells open to only the lower aquifer	Wells near surface water and near the lake
Wells with moderate to high Mn	UW 10	UW 29	UW 8
Wells with low Mn	UW 12	UW 30	

UW 29 and UW 30 were constructed recently and designed to draw water from the deep sandstone aquifer beneath the Eau Claire shale confining unit. Water quality monitoring has identified the presence of dissolved Mn at concentrations above the secondary maximum contaminant level (MCL) of 0.05 mg/L at UW 29 but below the secondary MCL at UW 30.

UW 10 and UW 12 were constructed over 40 years ago and are open to both the upper and lower bedrock aquifers. Water quality monitoring has shown that dissolved Mn is present in UW 10 at concentrations above the secondary MCL when pumping commences and decreases to concentrations below the secondary MCL with continued pumping. At UW 12, dissolved Mn concentrations are below the secondary MCL and are not dependent upon the timing of pumping cycles. Presently, UW 10 is held in active reserve (being operational, but not pumping into the system) because of the concentrations of dissolved Mn at UW 10. Inclusion of UW 8 in this study will provide data on a well with potential influence from recharge from Lake Monona.

PROPOSED SCOPE OF WORK

Task 1 – Accessibility Survey

Prior to attempting to conduct the vertical profiling of each well, a relatively expensive part of this project, a low cost accessibility survey will be completed. This will consist of review of the well head construction at each well will be conducted to determine accessibility for the vertical profiling tools and providing recommendations for minor modifications to provide the needed access. We will review the plumbness and alignment survey, where available, to determine the best position for access to the well to avoid pinch points between the casing and the pump/pump riser. Each well site will be visited and the access ports to the well will be explored to determine whether a suitable access exists or whether minor modifications could be made to provide the needed access. The project team will work with the Water Utility to determine the best method of conducting the accessibility survey for vertical profiling. One method would be to insert a 20 ft length of chain on a steel cable to the bottom of the well to determine whether the vertical profiling survey is feasible prior to mobilization of the vertical profile survey firm.

If the accessibility survey indicates that most or all of the wells are not accessible for the vertical profile survey, then the methods to be used for this assessment need to be reconsidered.



Task 2 – Existing Data Review and Rock Solids Analysis

- a. Hydraulic Data: Review driller's pumping test and consultant's pumping test data, field observations, well construction information, and flow meter data for each well site. Aquifer hydraulic parameters will be evaluated for each site and compared.
- b. Collaboration with WGNHS: Coordinate core and cuttings review and analysis to be conducted by the WGNHS to further determine the distribution of Mn and other elements in the rock. Ten to twelve samples will be collected from each well site, except UW29 where sufficient detail is already available. A total of 36 samples will be selected and analyzed using whole rock analysis (including Fe, Mn and S) at the Bondar-Clegg Laboratory in Canada. These samples will supplement the rock cuttings analyses done during the UW29 manganese assessment.
- c. Existing Water Quality Data Assessment – The existing water quality data will be assessed to help identify potential sources and to help select parameters and sampling strategies for collection of additional water quality data.
- d. Sand samples for reservoirs receiving discharge from other wells known to produce sand will also be collected (by utility personnel) and analyzed under this task, to provide additional data on the correlation (if any) between sand production and Mn content of water produced

Task 3 – Groundwater Modeling

Groundwater Flow Model: The existing Dane County Regional Groundwater Model, which includes the City well field, will be used to assess the potential source areas of water to UWs 8, 10, 12 and 30 (UW 29's capture zone analysis has already been completed)

- a. The model will be refined to reduce the node spacing in the vicinity of UW 8, UW 10, UW 12 and UW 30 and run to establish a baseline condition with steady state pumping at all the wells at a long term average pumping rate (e.g. annual volume/1 year) to estimate the capture zone for each well.
- b. Potential contaminant sources of organic compounds for each well will be identified and particle tracking will be used in the model to evaluate whether water from these potential sources is captured by the wells and over what time period. Where available, Wellhead Protection Plans will be reviewed to assist in the identification of potential sources of organic compounds.
- c. The USGS Multinode Package will be run with MODFLOW-2000 to simulate open boreholes at UW 10 and UW 12 and evaluate the potential impact on flow from the shallow aquifer to the deep aquifer (i.e. short circuiting near source).



Task 4 – Composite Sampling and Analysis

Sampling of wells UW 8, UW 10, UW 12, and UW 30 will be conducted from the well head (i.e., a composite sample) to evaluate and compare the water chemistry for these wells to UW 29 for which composite sampling has already been conducted. The sampling program outlined below may be revised based on the available water quality data for each well.

Sampling and analysis will include the following:

- a. A flow through cell will be used to collect field parameters (pH, dissolved oxygen (DO), redox, and conductivity) on a recording data logger. This flow through cell would ideally be connected to a flowing tap as close to the well head as practical. Water samples would then be collected from a sample tap near the well head. Samples would be collected after stabilization of the field parameters, except at UW 10 where it is known that water quality changes through time. At UW 10, two samples would be collected. The first sample would be collected after pumping for a period long enough to clear water from the well casing and then one after stabilization of the field parameters.
- b. Analysis of water quality samples will generally include the following parameters:
 - i. Field parameters will be collected with a recording flow through cell including DO, Redox, pH, and Conductivity.
 - ii. General Water Chemistry
 1. Major ions – Ca, Mg, Na, K, Cl, Alkalinity, SO₄
 2. Total Organic Carbon (TOC) – to assess potential man made and natural sources of carbon
 3. TDS – general character and to help in ion balance
 4. Redox parameters – Mn, Fe, NO₃, Nitrate-N, Total Kjeldahl-N, and ammonia-N.
 - iii. Others – Bromide and Iodide to assist in source characterization,
 - iv. VOCs – Low level 8260B. Low detection limits to look for very low concentrations of man made or petroleum sources not detected in routine analyses,
 - v. Age Dating – Tritium to date the age of the water,
 - vi. Isotope Characterization – δD and δO^{18} to characterize the source of the water.

Task 5 – Vertical Profiling

Wells which are shown to be feasible for a vertical profile (i.e., Task 1 Accessibility Survey indicates they are free and clear to approximately the bottom of the well) will be profiled for flow and quality. This will consist of the following:



- Mobilization of Besst, Inc. to conduct their Hydrobooster/Dye Tracing service on 5 wells. More detail on Besst, Inc. methods is available on http://www.besstinc.com/dye_tracer.html.
- Conducting a vertical profile at up to five wells with 10 vertical flow meter measurements and 5 water quality samples (for 1 liter of water/sample).
- The vertical profile will be conducted while pumping the well to waste.
- The 5 water quality sample intervals will be based on the geology at the well (i.e., the position of the Eau Claire shale), the rock solids analysis, and the results of the flow meter log showing the vertical distribution of flow coming into the well. Samples will be selected to indicate the water quality coming from zones with high Mn content in the rock, the water quality from the upper aquifer (if open in the well), and zones indicating high flow rates. Analysis of each water sample will consist of field parameters (pH, specific conductance, and redox), iron, manganese and chloride. If sample volume is available, two selected samples will also include bromide, iodide, VOCs, tritium, and the stable isotopes deuterium and oxygen 18 to characterize the upper and lower portion of the well's open interval. For wells UW 10 and UW 12, this will characterize the zones above and below the Eau Claire shale. For wells UW 8, UW 29, and UW 30, this will characterize the top and bottom of the aquifer below the Eau Claire shale.
- Presentation of the results will include graphics of the contribution to flow from the 10 intervals measured, water quality from the five intervals sampled to indicate how the various zones within the well contribute to the composite flow and quality produced by the well.

Task 6 - Analysis and Reporting

The project report will consist of tables, graphics, analytical data, and text describing the methods and results of the composite sampling, vertical profiling, rock solids analysis and modeling to assess differences in manganese concentrations in the aquifer(s) and present recommendations for evaluating proposed well sites.

Task 7 - Project Meetings and Project Management

It is our intent to keep the City and the WGNHS involved at each stage of the project. Therefore, the data and interpretation of the data will be reviewed by the City and WGNHS throughout the duration of the project. This will include discussions after completion of the existing data review and upon receipt and preliminary analysis of the water quality sampling data. This interactive approach will share data compilations and draft graphics with the City and the WGNHS for their consideration prior to moving into the next task. Recommendations for refining subsequent tasks will be provided at this time.

The following meetings are included:

- Project kickoff meeting to discuss the accessibility survey, project schedule and coordination between the project team and the Water Utility



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Continued Assessment of Manganese in City of Madison Wells

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- Site meetings at UW 8, UW 12, UW 10, UW 29 and UW 30 to coordinate the accessibility survey, composite sampling and vertical profiling
- Vertical profiling logistics meeting with the Water Utility to review procedures (with Besst, Inc.)
- Three meetings with the Water Utility to present project findings to-date
- One meeting with the Water Board to present the results of the project

ASSUMPTIONS AND CONDITIONS

We have assumed the following regarding the scope of our work:

- An estimate of \$5,000 has been included for the rock solids analysis and consultation with WGNHS.
- Available water quality data from all the wells and pumping records will be provided in electronic format by the City.
- Coordination with the City to conduct sampling at the wells is minimal and that a sample tap is available to use with both a flow through cell and for collecting samples.
- Three briefing meetings will be attended to discuss interim results, conclusions and sampling plan with the City.
- The Water Utility will provide construction details, the plumbness and alignment survey (where available), and other assistance, as needed for review of the well construction and access to the well.
- The project team will work with the Water Utility to select access ports into the unit wells where needed to complete the accessibility survey and the vertical profiling equipment. The Water Utility will provide access ports where needed.
- The accessibility survey and vertical profiling methods will be reviewed by the Water Utility prior to conducting the surveys and the Water Utility will be involved in the survey. Each piece of equipment will be disinfected prior to insertion into the well, so that if the equipment is stuck in the well it can then be left in the well with no adverse effects on the well. It is assumed that if a piece of equipment is stuck in the well, that the Water Utility will allow it to remain in the well until the pump is pulled at the next regular date of service.
- The accessibility survey will be conducted using logging cable available from the WGNHS at little cost to the project (i.e., it is not necessary to purchase 1,000 ft of cable for this survey).
- The accessibility and vertical profiling methods will be reviewed by WDNR for their agreement that this approach is consistent with best management practices for municipal supply wells.



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Continued Assessment of Manganese in City of Madison Wells

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FEES

The services described in this proposal will be performed according to the terms and conditions of the attached Services Agreement. MARS and RMT propose to perform the Scope of Services on a time-and-expenses basis. The estimated total fees will be approximately \$ 110,400, as described below. Should the City request MARS or RMT to make changes in the services or to perform additional services, MARS will prepare a Change Order for the City's acceptance.

TASK		FEE
TASK 1:	ACCESSIBILITY SURVEY	\$3,500
TASK 2:	EXISTING DATA REVIEW AND ROCK SOLIDS ANALYSIS	\$10,600
TASK 3:	GROUNDWATER MODELING	\$9,000
TASK 4	COMPOSITE SAMPLING AND ANALYSIS	\$3,500
TASK5:	VERTICAL PROFILING AND LABORATORY ANALYSIS	\$51,300
TASK 6:	ANALYSIS AND REPORT	\$14,300
TASK7:	PROJECT MEETINGS AND PROJECT MANAGEMENT	\$17,500
	SUPPLIES, EQUIPMENT, MILEAGE, MISC.	\$700
TOTAL		\$110,400

SCHEDULE

The following schedule of activities is proposed based on a start date of August 27th. The completion date of groundwater sampling will be dependent on the results of the accessibility survey and scheduling for the vertical profiling.

	Begin	Complete
Project Kickoff Meeting	August 27	
Task 1 – Accessibility Survey	September 6	September 14
Task 2 – Existing Data Review	September 4	September 28
WGNHS Rock Solids Review and Lab Analysis	September 4	October 5
Task 3 - Groundwater Modeling	September 17	October 19
Task 4 – Composite Sampling and Lab Analysis Receipt	September 7	October 24
Task 5 – Vertical Profiling	October 15	October 19
Laboratory Analysis	October 19	November 30
Task 6 – Analysis and Completion of Draft Report	October 24	December 14
Final Report	December 14	TBD



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CONTRACT

The contract will be the existing agreement between the City of Madison and Montgomery Associates.