

WORK ORDER FORM

PURSUANT TO AGREEMENT No. 7575 (AGREEMENT) BETWEEN
THE CITY OF FORT COLLINS
AND
CH2M HILL Engineers, Inc.

Per RFP #7575 Consulting Engineering Services for WTF Design and Construction Services

DATED: February 24, 2014

Work Order Number: CH-2017-ASR-II

Purchase Order Number: _____

Project Title: Aquifer Storage and Recovery (ASR) Assistance – Phase II Fatal Flaw

Commencement Date: September 25, 2017

Completion Date: December 31, 2017

Maximum Fee: (time and reimbursable direct costs): \$ 45,778 refer to Exhibit C – Compensation

Project Description: Professional Engineering Services to perform a fatal flaw analysis and fill in gaps in the feasibility analysis (performed by others) to confirm the feasibility of Aquifer Storage and Recovery (ASR)

Scope of Services: Refer to Exhibit B – Scope of Services

Professional agrees to perform the services identified above and on the attached forms in accordance with the terms and conditions contained herein and in the Professional Services Agreement between the parties. In the event of a conflict between or ambiguity in the terms of the Professional Services Agreement and this work order (including the attached forms) the Professional Services Agreement shall control.

The attached forms consisting of Exhibits B and C are hereby accepted and incorporated herein, by this reference, and Notice to Proceed is hereby given.

Professional: CH2M HILL Engineers, Inc.

By: Albert Paquet
Date: 10/5/2017

City of Fort Collins: DocuSigned by:
Submitted by: Adam Jakerst
Project Manager
Date: 10/5/2017

Reviewed by: Pat Johnson
Date: 10/4/2017

Approved by: Mark Kempton
Water Production Manager
Date: 10/5/2017

Approved by: Carol West
WR&T Manager
Date: 10/10/2017

Approved by: _____
Director of Purchasing & Risk Management
(if over \$60,000.)
Date: _____

Exhibit B - Scope of Services

Exhibit B to the AGREEMENT between the City of Fort Collins, Colorado, a Municipal Corporation, hereinafter referred to as the City, and CH2M HILL Engineers, Inc., hereinafter referred to as the Professional, for a project generally described as:

Professional Engineering Services to perform a fatal flaw analysis and fill in gaps in the feasibility analysis (performed by others) to confirm the feasibility of Aquifer Storage and Recovery (ASR).

The Professional's services for the project are detailed hereinafter.

Project Objective: To further investigate and advise the City on the feasibility of ASR based on Professional's independent review of the Assessment of Fort Collins' ASR Opportunities Report dated April 19, 2017. The ASR project is proposed to provide additional water supply, increase drought resiliency, and provide emergency treated water storage.

It is understood the City will designate Mr. Adam Jokerst and Eileen Dornfest as the City Project Managers (PMs) and primary points of contact with respect to the work performed under this AGREEMENT, with authority to transmit instructions, receive information, and interpret and define City policies and decisions relative to elements pertinent to the work covered by this AGREEMENT.

Task 1 – Storage Zone Characterization

Professional will further research and review available existing data to fill in the data gaps and further characterize the hydrogeologic nature of the Dakota Formation including the type of porosity exhibited by these rocks (primary, secondary, fracture, etc.), static water levels, local pumpage, degree of confinement, effective thickness, and native groundwater quality. With this information, Professional will evaluate the injection levels at differing rates, pressures, groundwater migration rates, and the degree of mixing between source water and native groundwater.

Professional will coordinate with Colorado State University (CSU) staff via in person meetings and teleconference to understand what data has already been reviewed and gathered. In the same meeting, professional will coordinate with CSU local geology and dam experts to assist with Task 3 (see Task 5 below).

If necessary, Professional will gather additional data from online resources such as United States Geological Society (USGS), Colorado Division of Water Resources (DWR), Colorado Oil and Gas Conservation (COGCC), Colorado Division of Water Resources (DWR) and the Environmental Protection Agency (EPA). Existing data review will be performed to:

- Identify recent water quality of the source water,
- Identify water quality of the potential injection zones sampled by personnel from Colorado State University (CSU) from supply wells in area screening or open in the Dakota Formation,
- Confirm static water levels and identify groundwater gradient and groundwater flow directions,
- Confirm porosity and permeability for the Dakota Formation,
- Review existing injection tests, pressure buildup, injection capacity from existing UIC permits in the area completed into the Dakota Formation.

Professional will identify data gaps and the risks associated with the missing data.

A status meeting will be held between the Professional and City to review the results of Task 1 and identify whether additional scope tasks should be completed as a part of this fatal flaw analysis, such as the tributary/nontributary determination, based on the results of Task 1.

Assumptions:

- No field work will be performed to complete this task.
- Recent water quality data collected by CSU from existing wells in the area will be provided by the City.
- If static water levels were measured by CSU at the time of water quality sampling, that data will be provided by the City.
- If additional water quality sampling is required, it will be identified and scoped later.
- The City will provide source water quality analyses.
- Up to one, three-hour meeting will be held with Professional and CSU at CSU office. Up to three members of the Professional team will attend (two in person and one via teleconference).
- Up to four hours of additional coordination will be performed with CSU via email and teleconference.

Deliverables:

- Meeting agenda and meeting minutes
- Data gaps will be identified in the final technical memorandum, Task 7

Task 2 – Geochemical Model

Professional will perform a preliminary geochemical evaluation to determine if the source water quality (recharge water) is compatible with the native groundwater quality and the mineralogy of the storage aquifer. During Task 2 the Professional will employ a geochemical equilibrium model to investigate mineralogy of the Dakota Formation based on water quality analyses, mixing between the source water and groundwater, and reactions between the source water and aquifer minerals. Based on the preliminary model results, Professional will identify treatment requirements and potential issues that may arise like as leaching of undesirable metals, precipitation of metals and plugging, clay dispersion and swelling, and scaling.

Based on the available water quality data, Professional will identify critical missing water quality parameters which could affect the results of the geochemical modeling and risks associated.

The water quality parameters recommended for this evaluation are included as Exhibit D.

Assumptions:

- No field work will be performed to complete this task.
- If additional water quality sampling is required, it will be identified and scoped at a later date.
- Source water quality will be provided by the City.
- Storage zone water quality and mineralogy data will be provided by the City and based on recent water quality sampling performed by CSU.

Deliverables:

- Results of the preliminary geochemical evaluation will be documented in a final technical memorandum, Task 7.

Task 3 – Induced Seismicity Risk

Professional will summarize the potential risks associated with induced seismicity resulting from operation of the proposed ASR wellfield, particularly recharging water into confined aquifers under positive pressure. The evaluation will include researching the following items using online sources and input from CSU:

- Characterizing local structural geology using online resources, CSU resources, and field mapping as needed (see Task 4),
- Identifying active or inactive faults in the area and other mesoscopic fabrics including joints, cleavage, etc. that can influence seismicity during injection operations using online resources, CSU resources and field mapping as needed (see Task 4),
- Identification of documented seismic occurrences in the area,
- Research and review of case histories of injection or withdrawal activities linked to induced seismicity,
- Research and review of case histories of injection or withdrawal activities linked to dam failure or damage, and
- A qualitative assessment of the potential for induced seismicity due to ASR activities.

Assumptions:

- All information used in the analysis will be readily available from public resources, and expert knowledge.

Deliverables:

- Results of the induced seismicity evaluation will be documented in a final technical memorandum, Task 7.

Task 4 Field Mapping (removed)

Task 5 Colorado State University Services

Professional will coordinate with CSU to complete Tasks 1 and 3 above. CSU will provide the following scope of services to Professional:

Existing Data Reviewed and Gathered

- CSU shall host up to one meeting at CSU offices between Professional and CSU staff who performed work on the feasibility analysis and report, Assessment of Fort Collins' ASR Opportunities Report dated April 19, 2017, CSU geology experts and CSU dam experts. Meeting shall last approximately 3 hours with the purpose of the meeting to provide an understanding to Professional on what data has been reviewed and gathered to characterize the hydraulic nature of the formations proposed for ASR wellfield development including Providing available information regarding the hydrogeologic units of interest. This will include:
 - A recent report on the Fountain Formation (Colorado Water Conservation Board), two recent Masters Theses, and our report to the City of Fort Collins on groundwater quality (Drs. Sale and Sutton).
 - Visiting key geologic and water supply infrastructure features in the area of the proposed wellfield (Dr. Sale).

- Meeting with Dr. Joe Scalia and to share his insights regarding issues with the Horsetooth Reservoir Dams including a 2017 Senior Design project. Dr. Sale will also support this effort through brief documentation of ASR operation under and an existing Reservoir in Colorado (Consolidated Mutual) and induced seismicity in Greeley.
- Demonstrating CSU's novel well field simulation model and ASR costing tools
- Existing data reviewed and gathered by CSU will be provided to Professional upon request in electronic format (PDF for reports, excel for water quality data).
- Additional coordination with Professional will be performed via email and teleconference as needed, assume up to 4 additional hours of coordination time will be required.

Consulting and Reviews

- CSU will support Professional's evaluations through responses to questions and review of documents as requested.

Assumptions:

- Proposal from CSU is based on 32 hours of faculty support and 20 hours of student support

Task 6 Project Meetings

Professional will meet with the City to conduct a project Kickoff meeting and Professional will meet with the City's Project Managers and Staff to discuss the results of Task 1 and any additional tasks recommended to be completed as a part of the fatal flaw analysis, and a third meeting to discuss the results of the scope above. It is assumed that the meetings will be at the City's Water Treatment Facility or Service Center. The Professionals Project Manager and Groundwater Engineer will attend. Professional's Senior Technical Consultant will attend by phone conference. Two (2) meetings are assumed. CSU will also attend the meetings to coordinate their scope items.

Deliverables:

- Meeting Agenda
- Meeting Summary

Task 7 Technical Memorandum

Professional will prepare a brief draft technical memorandum (TM) to document the results of the above tasks findings and provide an opinion of the project feasibility. A TM outline will be issued for review by the City. The TM will include: a list of potential fatal flaws, list of unknowns and a go/no go flow chart.

Professional will issue the draft TM for CSU and the City's review. Draft TM for City's review will include CSU comments. Professional will finalize the TM within two weeks after receipt of the City's comments and incorporate both CSU and the City's comments in one round of revisions. If necessary, Professional will conduct phone conference call to discuss the City's comments prior to finalizing the TM.

Deliverables:

- Draft TM
- Final TM

Task 8 Project Management

Professional’s Project Manager (PM) shall prepare, implement, monitor, and update the project execution plan throughout the project. Professional’s PM will prepare and submit to the City’s PM, on a monthly basis, a brief cost and schedule status report. The report will include a narrative description of progress to-date, actual costs for each Task, estimates of percent complete, and potential cost variances.

Deliverables:

- Monthly project cost and schedule status reports and Invoices.

Schedule

The professional will work expeditiously to support the City’s schedule. An anticipated schedule is shown below in Table 1.

Table 1, Project Schedule

Activity	Anticipated Milestone Dates
Notice To Proceed (NTP)	TBD
Project Meetings	Kickoff and 6 weeks from NTP
Issue Draft TM to CSU for Review	8 to10 weeks from NTP
Issue Draft TM for City Review	10 to 12 weeks from NTP
Issue Final TM	12 to 14 weeks from NTP

Assumptions Used in Developing this Scope of Services

The Professional’s estimate of engineering costs for the project is based on the elements included in task descriptions above, and the following assumptions:

1. City will examine information submitted by Professional and render in writing or otherwise provide decisions within one week.
2. City will give prompt notice to Professional whenever City observes or becomes aware of any development that affects the scope or timing of Professional’s services, or of any defect in the work of Professional.
3. Professional will provide the City with deliverables as defined respectively in this scope of work.
4. All deliverables will be distributed electronically via email (pdf format).
5. Meetings with the City will be held at the City’s service center office or water treatment facility.
6. In providing opinions of cost, financial analyses, economic feasibility projections, and schedules for the project, Professional has no control over cost or price of labor and materials; unknown or latent conditions of existing equipment or structures that may affect operation or maintenance costs; competitive bidding procedures and market conditions; time or quality of performance by operating personnel or third parties; and other economic and operational factors that may materially affect the ultimate project cost or schedule. Therefore, Professional makes no warranty that City’s actual project costs, financial aspects, economic feasibility, or schedules will not vary from Professional’s opinions, analyses, projections, or estimates. If City wishes greater assurance as to any element of project cost, feasibility, or schedule, City will employ an independent cost estimator, contractor, or other appropriate advisor.
7. If it is determined that CSU can assist with groundwater flow, rock water interactions, and/or other topics, CSU will propose additional tasks and fees on an as needed basis. Professional

coordinate with the City to incorporate additional services to the agreement through change order or new scope of work, if authorized by the City.

Exhibit C Compensation Schedule

		Al Paquet Principal Project Manager	Lindsay Atkinson Groundwater Engineer	Andrea Dumont Project Engineer	Mark Lucas ASR STC/Geochemist	Dario Rosidi Induced Seismicity STC	Gretchen Sage Contracts	Administration/ Accounting	Labor Hours	Labor	CSU ⁽²⁾ (Subconsultant)	Expense	Total Cost
	Per Diem Code/Classification	03	05	7	04	3	4	19					
	2017 Labor Rates ⁽¹⁾	\$235	\$185	\$142	\$205	\$235	\$205	\$90					
1.0	Storage Zone Characterization	7	11		11				29	\$5,935			\$5,935
2.0	Geochemical Model				32			8	40	\$7,280			\$7,280
3.0	Induced Seismicity Risk	2	4	40	4	8			58	\$9,590			\$9,590
4.0	Field Mapping (as needed)	0	0		0			0	0	\$0		\$0	\$0
5.0	CSU								0	\$0	\$5,775		\$5,775
6.0	Project Meeting	6	6	2	2				16	\$3,214		\$200	\$3,414
7.0	Technical Memorandum	8	16	22	8				54	\$9,604			\$9,604
8.0	Project Management	6	0				8	12	26	\$4,130		\$50	\$4,180
	Total	29	37	64	57		8	20	223	\$39,753	\$5,775	\$250	\$45,778

Exhibit D – Water Quality Parameters

TABLE 1*Recommended Analytes for Projects*

Constituent	Units	Federal Drinking Water Standards	Method Detection Limits or Threshold Accuracy
pH	standard units	6.5 - 8.5	0.1
Eh (corrected)	mv		
Specific Conductivity	emhos		
Dissolved Oxygen	mg/L		0.1
Temperature	°C		0.1
Field Carbon Dioxide	mg/L		1
Turbidity	NTU		0.01
Field Sulfate	mg/L	250	1
Field Iron (ferrous)	mg/L	0.3	0.01
Field Iron (total)	mg/L	0.3	0.01
Field Manganese	mg/L	0.05	0.01
Field Alkalinity	mg/L		10
Aluminum dissolved	mg/L	0.2	0.01
Aluminum total	mg/L	0.2	0.01
Arsenic dissolved	mg/L	0.005	0.001
Arsenic total	mg/L	0.005	0.001
Iron dissolved	mg/L	0.3	0.05
Iron total	mg/L	0.3	0.05
Manganese dissolved	mg/L	0.05	0.01
Manganese total	mg/L	0.05	0.01
Magnesium total	mg/L		1.0
Potassium total	mg/L		1.0
Sodium total	mg/L	20	1.0
Calcium total	mg/L		1.0
Sulfate	mg/L	250	1.0
Chloride	mg/L	250	1.0
Alkalinity	mg/L		1.0
Nitrate as N	mg/L	10	0.1
Total Kjeldahl Nitrogen	mg/L		0.1
Fluoride	mg/L	2.0	0.1
Silica	mg/L		0.1
Total organic carbon	mg/L		0.5

TABLE 1*Recommended Analytes for Projects*

Constituent	Units	Federal Drinking Water Standards	Method Detection Limits or Threshold Accuracy
Total phosphorus	mg/L		0.1
Ortho-phosphate	mg/L		0.1
Total dissolved solids	mg/L	500	10
Total suspended solids	mg/L		0.5
Hardness	mg/L		10
Ammonia	mg/L		0.2
Chloroform	ug/L		0.5
Bromoform	ug/L		0.5
Bromodichloromethane	ug/L		0.5
Dibromochloromethane	ug/L		0.5
Total HAA	ug/L		0.5
Bromochloroacetic	ug/L		0.5
Dibromoacetic	ug/L		0.5
Dichloroacetic	ug/L		0.5
Monobromoacetic	ug/L		0.5
Monochloroacetic	ug/L		0.5
Trichloroacetic	ug/L		0.5
Gross Alpha	pCi/L	15	1.0
Gross Beta	pCi/L		1.0
Rad-226	pCi/L		1.0
Rad-228	pCi/L		1.0
Combinded Radium	pCi/L	5	1.0
Uranium	pCi/L	20.1	1.0

Requisition Form

Vendor: CH2M
 Attn: Al Paquet
 200 East 7th St., Suite 314
 Loveland, CO 80537

Today's Date: October 4, 2017
Ship To: _____
Vendor #: _____
Special Instructions: _____

Requisition No.: _____
Date Entered: _____
Date Approved: _____
Date Denied: _____

Item #	Quantity	Unit	Description	Unit Price	Total	Charge Number
1	0.5	ls	Aquifer Stoarge and Recovery (ASR) Assessment Report Review	\$45,778.00	\$22,889.00	5020850302.521210.1
2	0.5	ls	Aquifer Stoarge and Recovery (ASR) Assessment Report Review	\$45,778.00	\$22,889.00	502.234201.521130

Requested By: Adam Jokerst DocuSigned by: Adam Jokerst 10/5/2017
CBD381575202481...

Authorized By: Carol Webb DocuSigned by: Carol Webb 10/10/2017
8B61B104A714A9...

Mark Kempton DocuSigned by: Mark Kempton 10/5/2017
0713A418D4C84B9...