Assessment of Osmotic Mechanisms Pairing Desalination Concentrate and Wastewater Treatment

PREPARED FOR: Dr. Saqib Shirazi, Texas Water Development Board

PREPARED BY: Juan Gomez, Ph.D., P.E, CH2M HILL

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Robert Huehmer/WDC

DATE: March 3, 2010

TWDB CONTRACT NUMBER: 0804830852

Dear Dr. Shirazi,

Please find attached the project update for activities up to January 31, 2010.

We have substantially completed Task 1, Task 2 and Task 4 of our scope of work, while maintaining a small allowance for revision work. CH2M HILL's project manager and senior technical consultant reviewed the progress report submitted by Colorado School of Mines. CH2M HILL summarized most relevant findings from that report. CH2M HILL received water quality and production data from several utilities in Texas. We summarized the data provided and drew important conclusions. We performed a desktop exercise based on data provided by utilities to determine the best path forward for the piloting phase of the project. Results of the exercise were presented to TWDB staff (Jorge Arroyo and Saqib Shirazi) in a meeting held on 1/4/10. CH2M HILL is well underway with development of the FO process sizing and costing models part of Task 4 and Task 5. An invoice and supporting information summarizing the project financials through 1/31/10 was submitted by our project accountant last week. To date, no expenses have been occurred on travel. Please contact me if you have any questions regarding this progress report.

Sincerely,

Juan Gomez, Ph.D., P.E. - Project Manager
CH2M HILL
Direct Phone: (210) 321-6241
Cell Phone: (210) 240-0084
Fax: (972) 385-5153

Section A – Summary of Total Expenses

(1)	CONTRACTOR's Vendor Identification Number:	
(2)	TWDB Contract Number:	0804830852
(3)	Total expenses for the billing period:	$20,603.49
(4)	Total Inkind Services:	
(5)	Total Services for this period:	$18,469.08
(6)	Less LOCAL SHARE OF THE TOTAL STUDY COSTS for the billing period:	$9,852.23*
(7)	Total BOARD's SHARE OF THE TOTAL STUDY COST for the billing period:	$8,616.85
(8)	Amount of Retainage to be withheld for the billing period:	$2,922.03
(9)	Total Costs to be Reimbursed by the BOARD for the billing period:	$26,298.31

* Local share represents indirect overhead and profit based on CH2M HILL's rate structure.

An invoice for the value in Line (9) is appended to this project update.

I hereby certify that the expenses submitted for the billing period are a true and correct representation of amounts paid for work performed directly related to this contract.

Juan Gomez, Ph.D., P.E.
Project Manager
CH2M HILL

Section B – Direct Costs

EXHIBIT 1.
Direct Cost Summary Spent this billing period.

TASK Budget	Total Budget	Expenses This Period	Previous Total Expenses	Total Expenses Incurred	Balance Remaining
Task 1	$ 10,039.00		$ 10,239.21	$ 10,239.21	$ (200.21)
Task 2	$ 9,120.00		$ 10,714.27	$ 10,714.27	$ (1,594.27)
Task 3	$ 52,507.00	$ 21,256.50	$ 2,426.16	$ 23,682.66	$ 28,824.34
Task 4	$ 17,920.00	$ 8,846.07	$ 10,246.54	$ 19,092.61	$ (1,172.61)
Task 5	$ 17,769.00	$ 8,970.00	$ 3,703.36	$ 12,673.36	$ 5,095.64
Task 6	$ 28,228.00		$ 357.60	$ 357.60	$ 27,870.40
Total	$ 135,583.00	$ 39,072.57	$ 37,687.14	$ 76,759.71	$ 58,823.29

EXPENSE Budget	Total Budget	Expenses This Period	Previous Total Expenses	Total Expenses Incurred	Balance Remaining
Salaries & Wages	$ 28,579.00	$ 8,616.85	$ 9,233.84	$ 9,233.84	$ 19,345.16
Fringe	$ 11,289.00	$ 7,443.22	$ 3,648.84	$ 3,648.84	$ 7,640.16
Travel	$ 3,591.00		$ -	$ -	$ 3,591.00
Subcontractor Services	$ 45,000.00	$ 20,603.49	$ -	$ -	$ 45,000.00
Reproduction	$ 1,540.00		$ -	$ -	$ 1,540.00
Overhead	$ 34,438.00		$ 11,126.77	$ 11,126.77	$ 23,311.23
Profit	$ 11,146.00	$ 2,409.01	$ 3,601.41	$ 3,601.41	$ 7,544.59
Total	$ 135,583.00	$ 39,072.57	$ 17,312.60	$ 27,610.86	$ 107,972.14

See attached invoice for additional information.

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Section C – Outside Contractors

A subcontract with Colorado School of Mines was signed and approved by all parties. Two amendments to the contract were also approved by TWDB staff. Amendment #2 is of particular importance because it extends the contract schedule through August of 2010.

Colorado School of Mines staff submitted a draft report for their work. CH2M HILL's project manager and senior technical consultant reviewed the report to summarize most relevant findings. Those findings were presented to TWDB staff during the meeting held on 1/4/10.

Currently, they are preparing equipment and pilot test plan to conduct pilot testing at a facility in Colorado using laboratory prepared seawater RO concentrate as the draw solution.

Section D – Travel and Subsistence

Nothing to Report.

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Agenda

1. Invoicing and Contract Language
2. Subcontracting
3. Project Status
    a. Draft Table of Contents – Report

PROGRESS REPORT

1. Invoicing and Contract Language

CH2M HILL received payment for all invoices submitted to TWDB with the exception of April's invoice. Additional information for Invoice dated 5/29/09 covering project charges through 5/1/09 was requested by Phyllis Thomas and submitted by CH2M HILL for her review and approval.

An invoice for project charges through 12/25/09 was submitted to TWDB. TWDB staff requested additional information and clarification on charges per task. That information was provided in January. No additional information has been requested.

2. Subcontracting

A subcontract with Colorado School of Mines was signed and approved by all parties. This issue was finally resolved.

3. Project Status

3.1 Draft Table of Contents.

CH2M HILL submits the following Table of Contents for the final report.

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We are currently working on Section 1, 2, 3 and 4which correspond to Task 1, Task 2 and Task 3 of our contract.

Progress by Task

Task 1. Survey of Water Categories and Quality

An initial review of desalination facilities in the State of Texas was conducted. This task is substantially complete. A small budget reserve is being maintained.

CH2M HILL staff received water quality information from the following utilities and/or water systems:

- El Paso Water Utilities
- City of Laredo
- Brownsville PUB
- City of Seadrift
- Holiday Beach Water Supply Corporation
- City of Fort Stockton

The largest desalination facility in the state is located in El Paso, TX. Water quality for that facility indicates that RO concentrate has a TDS concentration ranging from 5,000 to as high as 12,500 mg/L (based on a permeated water recovery of 80% with influent water quality ranging from 1,500 to 2,500 mg/L of TDS).

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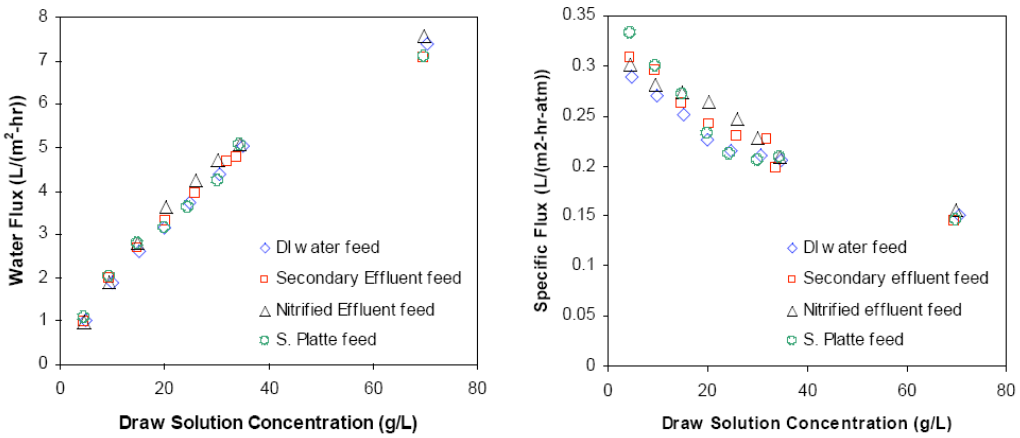

FIGURE 1. Results of Bench-Scale experiments for FO Technology

The figure above indicates that at a draw solution concentration of 10 g/L, the expected water flux through the membrane will be 2 L/m²-hr, which is equivalent to 1.2 gallon per square foot per day (gfd). Common flux rates for brackish groundwater applications are around 15 gfd (25.5 L/m²-hr). At this low flux, membrane area required for a given forward osmosis application is very large, resulting in high capital costs that make this technology economically unfeasible.

A more economically attractive flux rate of 7 L/m²-hr (4.1 gfd) for a forward osmosis system can be observed at a draw solution concentration of 70 g/L, which is representative of the TDS concentration of the RO concentrate from a seawater desalination application. Common flux rates for seawater RO applications range between 8-10 gfd (13.6 to 17 L/m²-hr).

Texas has very limited experience with seawater desalination. To date, the state's experience with this technology is limited to a handful of pilot projects. One of the most recent RO seawater desalination piloting efforts was conducted in Brownsville, TX. Brownsville PUB is planning on designing and constructing a 2.5 mgd SWRO demonstration facility with an ultimate capacity of 25 mgd.

Task 2. Screening and Selection of Hybrid Forward Osmosis System Configurations

This task is substantially complete. A small budget reserve is being maintained.

Task 3. Testing of the Novel Forward Osmosis Spiral Wound Membrane Element

CSM contract is finally in place. to conduct their portion of the work. CSM is ready to start testing the required water qualities identified under Task 1 and Task 2.

CH2M HILL staff performed a desktop exercise based on water quality data provided by utilities to determine the best path forward for the piloting phase of the project. The objective of the exercise was to calculate the membrane area required for FO systems with varying capacity from 1 to 40 mgd based on data presented in Figure 1, above. Results of the exercise were presented to TWDB staff in a meeting held on 1/4/10.

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Important decisions made during the meeting include:

- Nature and source of draw solution. It was agreed based on existing information and data from utilities that RO concentrate from brackish groundwater could not be utilized as a cost-effective draw solution for this study. Instead, it became evident that using RO concentrate from a seawater application would be more cost-effective and applicable to the conditions found in the State of Texas.
- The objective of the project was confirmed as it relates to the feasibility of using FO for recovering water from wastewater streams.

Task 4. System and Process Modeling

This is substantially complete now. A small budget reserve is being maintained.

CH2M HILL staff developed a FO process sizing model that looks at total dissolved solids concentration and the effects of staging, hydraulics through the membrane elements and solute transport on both directions (from the draw solution to the feed solution and vice versa).

We are currently reviewing and finalizing the model as we develop the cost model. Some of the decisions made in the process sizing model may affect the cost model. So, they will have to be completely integrated as we complete the cost model.

Task 5. Cost Modeling

We have started and made substantial progress on our cost model based on the work performed under Task 4 during the months of December and January. We are also preparing/refining cost curves for the non-forward osmosis system components. Additional work will be required as Colorado School of Mines conducts the pilot testing phase of the project and the FO sizing module is refined.

Task 6. Final Report Preparation

We have prepared a draft Table of Contents for TWDB review. TWDB has submitted guidelines for reports prepared under this type of contract. Those guidelines will be followed for the preparation of the final report.

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