FLORIDA DEPARTMENT OF HEALTH

Rick Scott
Governor

H. Frank Farmer, Jr., M.D., Ph.D.
State Surgeon General

April 4, 2011

Mr. Damann Anderson
Hazen and Sawyer
10002 Princess Palm Avenue
Registry One Building, Suite 200
Tampa, Florida 33619

Dear Mr. Anderson:

This letter authorizes you to proceed with the following tasks in accordance with the current executed contract CORCL for Florida Onsite Sewage Nitrogen Reduction Strategies Study: Task A.31 change-order allowance in the amount of $19,000 to perform a simulation of bioreactor filtration treatment of onsite wastewater. The work will be performed per the attached task scope and budget.

If you have questions, please contact me at (850) 245-4070 x2708 or by email at Elke_Ursin@doh.state.fl.us.

Sincerely,

Elke Ursin
Environmental Health Program Consultant

Attachment (1)
EU/ contract file

DIVISION OF
Environmental Public Health

Bureau of Onsite Sewage Programs
4052 Bald Cypress Way, Bin A08 • Tallahassee, Florida 32399-1701
Phone: (850) 245-4070 • Fax: (850) 922-6969 • http://www.floridashealth.com

Simulation of Bioreactor Filtration Treatment of Onsite Wastewater

The Provider will develop a process design and simulation tool for passive bioreactor treatment for nitrogen removal from onsite wastewater using biofiltration. The design tool will be used for interpretation of demonstration results and to design and scale-up treatment systems. The scope includes the following tasks:

- Literature review and specification of modeling tools, approach, and potential calibration data;
- Unsaturated bioreactor modeling; and
- Coupled two stage modeling.

Tasks

1. Literature Review and Data Set Specification

Provider will conduct a brief literature review and confer with practitioners to determine current and state of the art practice for modeling biochemical reactions and nitrogen transformations in onsite wastewater biological treatment filters. Of particular interest are features of high pertinence to passive nitrogen reduction systems including biochemical reactions in saturated and unsaturated flow, water retention and oxygen transfer, ion exchange, and oxidative dissolution of electron donor media. Provider will specify potential calibration data that has been or will be generated from Passive Nitrogen Removal studies (PNRS I & PNRS II) and other sources if available. This task will determine the specific modeling and design tool approach, the anticipated multi-component reactive solute transport models, and specific data sets to be used. The manner of continuation of Tasks 2 and 3 will be decided at the conclusion of Task 1 after a process forward conference call.

2. Unsaturated Bioreactor Modeling

Provider will develop a tool for unsaturated biofilter process analysis and design. The design tool will be spreadsheet based and enable the user to specify bioreactor designs that achieve nitrogen reduction or conversion objectives for given wastewater flowrates and quality characteristics. The tool will provide salient bioreactor design features of media type, depth of media layer(s), average areal hydraulic loading rate, and dosing frequency. The design tool will be based on matrix simulations of biofiltration process results identified in Task 1 and will be targeted to upsizing these results to the design of nitrogen reducing biofiltration systems at the single family residence scale. To support the design tool, simulations will be performed of multi-component reactive solute transport within a variable-saturated water flow framework. The biochemical reaction model will describe domestic wastewater constituents (organics (i.e. BOD), nitrogen species, alkalinity) interconnected by multiple microbially mediated biochemical reactions. The reaction matrix will include hydrolysis and oxidation of organic components, nitrogen cycle reactions, and multiple microbial populations. Model calibration and verification will be performed using data identified in Task 1. Sensitivity analyses will elucidate the degree to which specific bioreactor design features affect nitrogen reduction.

Simulations will be performed for multiple bioreactors with different designs of type of media (water retention and sorptive characteristics), media particle size, and depth. For any given bioreactor design, simulations will be performed for varying areal hydraulic loading rates, dose magnitude and cycle times, and wastewater composition (organic oxygen demanding materials, nitrogen, and alkalinity). Simulation outputs will feature non-steady response patterns to successive repeating dose cycles. Simulations of longer term non steady operation (e.g. 2 months of no flow from non-occupied household) will also be conducted.

3. Coupled Bioreactor Modeling

The provider will expand the unsaturated design tool to passive two-stage biofilters for nitrogen removal. The design tool will enable the user to specify bioreactor designs that achieve nitrogen reduction objectives for given wastewater flowrates and quality characteristics. The tool will provide salient design features of media type, depth of media layer(s), average areal hydraulic loading rate, and dosing frequency. The design tool will be based on matrix simulations of biofiltration process results identified in Task 1 and will be targeted to upsizing these results to the design of nitrogen reducing biofiltration systems at the single family residence scale. To support the design tool, simulations will be performed of multi-component reactive solute transport within a variable-saturated or fully saturated water flow framework. The coupled simulations will employ results from Task 2 as a starting point for simulations of reactive transport in saturated media. The biochemical reaction model will describe domestic wastewater constituents (organics (i.e. BOD), nitrogen species, alkalinity) interconnected by multiple microbially mediated biochemical reactions. The saturated bioreactor simulation will describe advective solute transport, utilization of molecular oxygen and nitrate, reductive dissolution of electron donor, and heterotrophic and autotrophic biochemical reactions. Model calibration and verification will be performed using data identified in Task 1. Sensitivity analyses will elucidate the degree to which specific bioreactor design features affect nitrogen reduction.

Simulations will be performed for multiple bioreactors with different designs of type of media (water retention and sorptive characteristics), media particle size, and depth. For any given bioreactor design, matrix simulations will be performed for varying areal hydraulic loading rates, dose magnitude and cycle times, and wastewater composition (organic oxygen demanding materials, nitrogen species, and alkalinity). Simulation outputs will feature non-steady response patterns to successive repeating dose cycles. Simulations of longer term non-steady operation (e.g. 2 months of no flow from non-occupied household) will also be conducted.

Schedule

The table below outlines the schedule for the work described in the scope. The Provider will initiate work upon receipt of a letter of authorization from the Department.

Tasks	Month							
	1	2	3	4	5	6	7	8
1. Literature Review and Data Specification	X							
2. Bioreactor Design Tool and Unsaturated Bioreactor Model		X	X	X	X			
3. Bioreactor Design Tool and Coupled Bioreactor Model					X	X	X	X

Deliverables

The provider will produce technical memoranda with description of methods, results, conclusions, and recommendations.
Task 1: After month 1, a workplan will be presented (Task 1a) and discussed at a process forward conference call (Task 1b), that includes a summary of the results, such as the specific modeling and design tool approach and process models to be used, and anticipated data sets.
Task 2: After month 5, description of model development process, verification, modeling calibration, sensitivity analysis, and simulation results, and the functioning spreadsheet model described in Task 2 will be provided.
Task 3: After month 8, description of model development process, verification, modeling calibration, sensitivity analysis, and simulation results (Task 3), the functioning spreadsheet model described in Tasks 2 and 3 and guidance on its use will be provided.

Budget

The table below outlines the budget for each task described in the scope.

Task	Cost
1a. Literature Review and Data Specification Workplan	$ 4,000.00
1b. Process Forward Conference Call Minutes	$ 3,000.00
2. Design Tool and Unsaturated Bioreactor Modeling	$6,000.00
3. Design Tool and Coupled Bioreactor Modeling	$6,000.00
Total Estimated Cost	$ 19,000.00