Memorandum

To: *South Carolina Department of Natural Resources (DNR)*
South Carolina Department of Health and Environmental Control (DHEC)

From: *CDM Smith*

Date: *March 19, 2015*

Subject: *SWAM Model Accessibility and Deployment Options*

The purpose of this memorandum is to summarize several alternatives for providing user access to the Simplified Water Allocation Model (SWAM) developed for each of the eight South Carolina river basins. Theses summaries are intended to facilitate a discussion between CDM Smith, DNR, and DHEC project and Information Technology, and allow selection of a preferred approach.

Presented below are descriptions of each alternative, as originally outlined in CDM Smith's Technical Proposal, plus some variations of the original alternatives. To the descriptions, we have added some additional points summarizing advantages and disadvantages of each approach.

Background

To allow for portability and support multiple users, CDM Smith designed SWAM to operate on a desktop environment, be freely distributable, and not rely on third-party software other than the universally-used Microsoft Excel. It can also be distributed online via a web interface to allow remote access to multiple users. SWAM was coded in Visual Basic, is compatible with Excel versions 2007, 2010, and 2013, and runs on Windows 7 and Windows 2000. SWAM includes built-in protections to ensure that users cannot manipulate the code. To date, SWAM has not been certified to operate on Apple computers.

Accessibility Options

There are several online options to provide access to SWAM for both internal users (DNR and DHEC) and external users (consultants, academia, utilities, etc.). CDM Smith's project cost detailed in the Business Proposal is based on a simple, but robust approach to SWAM deployment using a secure, remote access product from Citrix[1]. This approach, as well as several alternative approaches, are described below.

[1] http://www.citrix.com

Option 1: Citrix-SWAM Deployment

The existing SWAM tool is a self-contained, standalone application with all its modules included in a single Microsoft Excel file. As a ready-made tool, it may be deployed easily and securely via DHEC's existing Citrix infrastructure.

It uses the public internet to securely provide access to resources behind a firewall and emulates a desktop environment. The time to deploy is very fast as no further modifications to SWAM are needed. This approach is secure, nearly immediate and suitable for a number of concurrent users up to certain limits.

Deployment using Citrix will occur once the pilot model has been completed. Installation and testing would be conducted prior to deployment – and can occur at virtually anytime.

The advantages of this approach include:

- Reliable and proven
- No additional cost (this was the deployment approach assumed in the Business Proposal)

The disadvantages of this approach include:

- Supports limited number of users (up to 10). Performance may slow when multiple users are logged-in and running models at the same time.
- Performance is tied to the memory and processing speed of the DHEC machine where it resides

Option 2: Citrix-SWAM Deployment in the Cloud

One potential variation of the Citrix-SWAM deployment approach (not discussed in the Technical Proposal) includes the use of a cloud-based hosted virtual desktop for storing and running the models. Users would still log-in using the Citrix infrastructure; however, each basin model would reside on a cloud-based server, rather than on a DHEC machine.

The advantages of this approach include:

- Reliable and proven
- May supports more users with less decline in performance
- Scalable, based on demand
- Potential reduction in IT and hardware cost. Less time would be spent managing the infrastructure
- Less security concern, since the application is hosted remotely.

The disadvantages of this approach include:

- Recurring monthly cost. CDM Smith is using ICCGH[2] to host an application that allows 10 users. The cost for 10 users with a hosted application on a CPU with 2 GB RAM and 60 GB storage is $335/month. A hosted instance of SWAM might have a similar cost.

Option 3: Web-SWAM

The web-SWAM approach (Alternative 1 in the Technical Proposal) moves all elements of the SWAM modeling tool (data inputs, data calculations/processing and output reporting) to the web as a distributed application. This option is most suitable for many users who need simultaneous, secure access to the model. It presents greater access flexibility with a more complex architecture that meets web standards for security and compliance with standards.

Users of Web-SWAM will conduct data input via a series of web pages which resemble the current Microsoft Excel data-entry user interface. The input pages will also support creating multiple model scenarios, as well as administrative conveniences such as copying and reusing existing scenarios. Upon completion of a model scenario, the modeler will be able to run the data calculations/ processing component which will apply SWAM algorithms and generate the model output datasets, charts and reports. Output reporting will be in the form of a downloadable Excel Workbook or PDF file, which includes the contents of the scenario inputs and the resulting tables, charts and other SWAM reports. This approach is secure and suitable for a large number of concurrent users.

The advantages of this approach include:

- Suitable for many users who need simultaneous, secure access to the model.

The disadvantages of this approach include:

- This approach would result in significant additional cost to modify SWAM to run as a distributed application.
- Modification would take several months, including testing, and may result in schedule delays.

Option 4: Hybrid-SWAM

The hybrid approach (Alternative 2 in the Technical Proposal) combines both desktop and web technologies to provide secure user operation behind the network firewall, ease of use of the native Excel user interface, and secure deployment of the desktop application and shareable model results via the web. The learning curve and deployment effort is reduced by using familiar tools for users. There is no user interface on the web, which reduces security risk and compliance testing.

It utilizes modern web services to provide calculation and report generation services in a centrally managed, secure website running on Internet Information Services (IIS).

[2] http://www.iccgh.com

Similar to Web-SWAM, the three distinct modules are: 1) data inputs, 2) data calculations/ processing, and 3) output reporting. In the hybrid approach, the user enters data via a macro-enabled Excel Workbook template on their desktop which provides a flexible data- entry tool for modelers to configure the key inputs. The Excel input template will support creating multiple model scenarios, supporting administrative conveniences such as copying and reusing existing scenarios.

Upon completion of a model scenario, the macro-enabled Excel template will generate an XML data package to run through the data calculations/processing component via the web service. The modeler will upload the data via the web-based processing engine which, in turn, consume the scenario data using the SWAM rules and generates the model output datasets, charts and other reports. Output reporting will be in the form of an Excel Workbook files, which includes the contents of the scenario inputs and the resulting tables, charts and other SWAM reports. This approach is secure and suitable for a large number of concurrent users.

The advantages of this approach include:

- Suitable for many users who need simultaneous, secure access to the model.

The disadvantages of this approach include:

- This approach would result in significant additional cost to modify SWAM to run as a distributed application.
- Modification would take several months, including testing, and may result in schedule delays.

Option 5: Desktop SWAM

Unlike proprietary models or those which are tied to third-part solvers with licensing requirements, DHEC could freely distribute as many copies of each river basin SWAM model as there are requests. With this option, CDM Smith recommends that DHEC simply require that users register to download SWAM by providing basic contact information and an explanation of the proposed model use. By maintaining a list of users and including a web link for model updates within the interface, DHEC can be assured that users are informed of any subsequent model updates or revisions, and have access to the latest model versions.

The advantages of this approach include:

- It eliminates the need for operation in a virtual server environment with backend data storage. Accordingly, there is no IT time and expense associated with system maintenance and maintaining compatibility with new versions of software and drivers. There is also no “downtime” due to these issues.
- There are no web accessibility requirements to address and maintain.

- Security concerns are non-existent because users are not accessing a DHEC-hosted application.
- The effort involved in installation and testing is virtually eliminated, as are development and maintenance costs.

The disadvantages of this approach include:

- Microsoft Excel, VBA and or operating system updates may occur without warning. In some cases, these could prevent SWAM from loading or functioning correctly.
- The unique set-up of user's hardware and software may require troubleshooting and support, in the instance the program does not load or run as intended.
- DNR and DHEC no longer have control over the models, increasing the possibility of misuse or the unintended use of older versions when updates have been issued. Also, once a user registers for and downloads a model, they could feasibly distribute the model to others. In this case, DNR and DHEC no longer have control over who has the models and if updates are issued, older versions may still be in use by unknown users.

CDM Smith's Initial Recommendation

Based on the above advantages and disadvantages, CDM Smith's preliminary recommendation is for either Option 1 or 2 for the following reasons:

- Option 1 is proven, reliable and comes with no additional cost.
- Option 2 is recommended over Option 1 if DNR and DHEC are amenable to a monthly hosting fee (paid directly to a selected host).
- Options 3 and 4 are not recommended because of the additional significant cost and time requirements.
- Option 5 (Desktop SWAM) has some significant advantages; however, we have concerns regarding the ability to maintain control over the use of "current" models; the potential need to provide software support due to a user's unique hardware/software setup; and Microsoft OS or software updates that may prevent SWAM from loading or functioning correctly. Because of these factors, we are not recommending this as the first option.

CDM Smith recognizes that getting DHEC and DNR input is critical to selecting the preferred option. We welcome your thoughts, ideas, and questions and look forward to discussing these further.

Note to reader: It was tentatively agreed upon by DNR and DHEC that Option 2 (Citrix-SWAM Deployed in the Cloud) will be used.