SUPPLEMENTAL STUDIES
TO DETERMINE POTENTIAL IMPACTS
TO THE UPPER FLORIDAN AQUIFER
Tier II Environmental Impact Statement
Savannah Harbor Expansion Project
Georgia & South Carolina

The key question that needs to be answered in the Tier II EIS is what change would be expected to occur in chloride concentrations in the upper Floridan aquifer due to project dredging. The Savannah District therefore will require a well-considered evaluation of the risks involved in the project that address the following:

- Determine what, if any, impact removal of additional Miocene sediments (comprising the upper confining unit of the Floridan aquifer) within the dredging prism will have upon the water quality of the Upper Floridan aquifer in the Savannah area.
- Determine the change in rate and quantity of saltwater leakage through the upper Floridan (Miocene) confining unit that may result from harbor deepening.
- Determine if there are changes in chloride concentrations (salinity) with time in the upper Floridan aquifer that may be caused by harbor deepening alternatives.
- Determine the hydraulic properties, salinity, and hydraulic head (and the spatial variability of these parameters) of the upper Floridan confining unit in the project area.
- Determine the hydraulic properties and geometry of various paleochannels in sediments below the river channel.
- Better define the geologic framework in the channel area.

To that end, the Savannah District calls for the following supplemental studies to augment and build on the previous "Potential Ground-water Impacts" study, conducted in 1997-1998 by the US Army Corps of Engineers, Savannah District. The Savannah District has determined that the execution of this plan will provide sufficient information for the Tier II Environmental Impact Statement (EIS) currently under development for the Savannah Harbor Expansion Project.

- Develop 3-D coupled flow and transport model of the hydrologic system focused on the navigation channel. Various existing regional-scale flow models depict effects of heavy pumping in Savannah area on ground-water flow in Floridan aquifer; however, none are solute transport type needed to depict saltwater intrusion. An in-progress USGS Savannah SUTRA model will model solute transport; however, its scale is not suited to modeling harbor-specific simulations.

This task will focus on developing a model of the harbor and surrounding areas at an appropriate scale and then testing various combinations of properties and thicknesses to assess the significance of potential leakage. Use model to compare before and after dredging results as related to projected chloride changes in the Upper Floridan aquifer. Model various combinations of hydraulic properties, confining unit thickness, and future pumping rates from existing and anticipated data. Calibrated model will serve to estimate most likely impact scenario. Model parameters will then be assigned at limits of reasonable range of properties to assess a “worst case” scenario. Worst case defined as having relatively high vertical hydraulic conductivities and minimum likely thickness of upper confining unit with maximum upper Floridan aquifer pumping.

- Review data, reports and proposed studies for model considerations.
- Compile historical data and create model dataset.
- Develop and calibrate numerical model of hydrologic system including and underlying the navigation channel.
- Run simulations and report results to USGS, GAEPD, and SCDHEC.

- Supplemental Data Collection:
  - Conduct additional sub-bottom seismic surveying with particular emphasis in areas of paleochannels (approximate river stations 20+000 to –25+000). Initial phase of surveying will determine feasibility of acquiring high-resolution seismic data along the sides of the existing navigation channel. If initial surveying proves useful data can be obtained, a second phase of surveying will be implemented to better define paleochannel geometry and Upper Floridan confining unit thickness. All seismic data will be acquired in digital format to facilitate analysis and storage in the GIS.
    - Conduct initial test seismic survey (approx. 5 miles) to determine feasibility of acquiring useful data in paleochannel areas. Past experience has shown areas outside dredged channel to be difficult to obtain reliable seismic data. Attempt shall be made to obtain best data possible along navigation channel sides to correlate with existing data along navigation channel centerline.
    - Conduct second phase full seismic survey (approx. 25 miles) in paleochannel areas. Focus on following individual paleochannel alignments in area of concern (+25+000 to –25+000).
    - Analyze seismic data, incorporate into GIS, and correlate with previous survey data. Combine new data with existing data to obtain more detailed “view” of paleochannel relationship to confining unit and aquifer, which shall be used to improve the 3D model's representation of paleochannels and the thickness of the confining unit.

    - Based on survey data, determine need for any additional core holes in data gaps. Determine if detailed data indicates "critical" areas needing core boring confirmation and analyses.

- Conduct additional marine continuous core borings to further characterize in-filled sediments of paleochannels and Miocene confining unit below paleochannels. Cores to be drilled to top of Upper Floridan aquifer and analyzed to determine grain size, porosity, vertical hydraulic conductivity, pore-water geochemistry, and radioisotope composition. Geophysical logging shall also be performed. Four borings will be located in known deep paleochannels in principal area of concern between river stations 25+000 and – 30+000. Two additional borings should be reserved for locations to be determined after completion of additional seismic surveying.
    - Drill core hole (using fresh water) in paleochannel near SHE-4 and SHE-6 (Sta. –20+000) with pore water, K, grain-size, porosity analysis, and geophysical log. Continuous core hole will provide additional data on stratigraphy, K and pore water of in-filling sediment and confining unit in deep paleochannel area approximately 1 mile offshore Tybee. This additional data is important in assessing impact of the paleochannels on downward leakage.
    - Drill core hole (using fresh water) in paleochannel near SHE-327 (Sta. –03+000) with pore water, K, grain-size, porosity analysis, and geophysical log. As above in deep paleochannel area within jetties.
    - Drill core hole (using fresh water) in paleochannel near SHE-318 (Sta. 09+000) with pore water, K, grain-size, porosity analysis, and geophysical log. As above in deep paleochannel area just upriver from Coast Guard Station Tybee.
    - Drill core hole (using fresh water) in paleochannel near SHE-1 (Sta. –15+000) with pore water, K, grain-size, porosity analysis, and geophysical log. As above in deep paleochannel area.
    - (Optional) Two additional reserved borings if deemed necessary after seismic survey. As above in areas determined by new seismic data to be "critical".

- Conduct additional continuous core borings on land adjacent to navigation channel to top of Upper Floridan aquifer at three strategic locations where geologic or hydrogeologic data is sparse. Core holes will be geophysically logged, and core samples will be analyzed to determine grain size, porosity, vertical hydraulic conductivity, pore-water geochemistry, and radioisotope composition. Install multi-level wells within surficial aquifer and Miocene confining unit at three locations along the transect. Two locations will be near existing upper Floridan wells and one in the area of a known deep paleochannel. An additional well may be installed outside the immediate Harbor area (and saltwater influence) but within the Savannah drawdown cone as a control well if deemed necessary. The multi-level wells will be installed at various levels to allow data on hydraulic head and ground-water geochemistry of specific intervals to be obtained over time. Rotosonic drilling methods will be used to install multi-level wells.

- Drill core hole near SH-65 (Sta. 31+000) with pore water, K, grain-size, porosity analysis, and geophysical log. Continuous core hole will provide additional data on stratigraphy, K, and pore water in data gap.
- Drill core hole at sta. 60+000 (between DOT-1 and DOT-2) with pore water, K, grain-size, porosity analysis, and geophysical log. As above in data gap between DOT-1 and DOT-2.
- Install multi-level well (assume 5 zones) at DOT-2 to determine vertical head gradient and allow monitoring of conductivity/chloride. Test case of multi-level well installed with rotosonic drilling. Open ports set in 1 (lower) zone of 35' section of surficial sediments, 3 to 4 zones in 130' section of UF confining unit and 1 set in top of UF. Compare head data to existing VW transducers in DOT-2. Use multi-level well during trial aquitard test of DOT-2.
- Drill core hole at GAEPD UF well on Hutchinson Island (Sta. 86+000) with pore water, K, grain-size, porosity analysis, and geophysical log; also install multi-level well (assume 5 zones). If test case successful, install multilevel well as above to collect same data.
- Drill core hole at sta.10 (paleochannel area) with pore water, K, grain-size, porosity analysis and geophysical log; install multi-level well (assume 5 zones, including upper Floridan. Use seismic and Geoprobe conductivity data to locate landward extension of paleochannel onto narrow western end of Cockspur Island (Ft. Pulaski). Continuous core hole here will provide additional data on stratigraphy, K and pore water in area of least influence from fresh water. Install multi-level well as above to collect same data. This location may be suitable for additional aquitard testing, if deemed necessary.
- (Optional) Drill core hole at background location (no overlying saltwater) with pore water, K, grain-size, porosity analysis, and

geophysical log; install multi-level well (assume 5 zones, including upper Floridan). Continuous core hole to provide background data on stratigraphy, K, and pore water in area outside saltwater influence but on same drawdown contour as another core hole near river channel (in area of saltwater influence).

- Conduct Aquitard Testing
  - Conduct trial step-drawdown pumping test on two recently installed upper Floridan wells located adjacent to river channel to determine feasibility of hydraulic testing of confining unit. Continuous cores, pore-water data, grain size data, and lab vertical hydraulic conductivity data for confining unit exist for these wells. If results indicate hydraulic testing of confining unit is feasible, estimate design parameters and assumptions for full aquitard testing. The modeling, along with pore water and other data, may help determine the need for the additional testing; therefore a decision on aquitard testing should be delayed until at least the preliminary modeling is completed.
    - Temporarily install data collection system on disposal area wells DOT-1 and DOT-2 (Jasper Co. S.C.) to collect background data on multilevel transducers in confining unit prior to pumping. Determine if head data in confining unit and aquifer are affected by tides and/or ship traffic. Continuous direct tide data will be collected from river, and levels in wells and transducers will be taken for 3-5 days prior to test.
    - Temporarily install 6-inch, 15-hp pump in wells DOT-1 and DOT-2. Pump with 3" riser capable of flows in excess of 300 GPM.
    - Determine appropriate method of data analysis and perform step-drawdown tests on DOT-1 and DOT-2. Consult with USGS, GAEPD, and SCDHEC on test/analysis methodology. Trial test expected to last at least 3-5 days.
    - Review preliminary model results and trial test data to determine if additional full aquitard testing is needed. Consult with USGS, GAEPD, and SCDHEC on feasibility and necessity of additional aquitard testing.
  - If hydraulic testing of confining unit is deemed to be viable and if such data is determined to be critical, appropriate methodology will be used to conduct testing at up to 5 additional selected sites.

- The 1998 report shall be updated, via a new report, to include the information, data, findings, and/or conclusions of the supplemental studies.
    - Analyze all study findings and model results.
    - Prepare report for Environmental Impact Statement.

In addition to the scope of study identified above, the Savannah District will also be combining existing geologic, hydrogeologic, and engineering data from previous studies/projects in a comprehensive harbor-wide Geographic Information System (GIS). Included in the GIS will be available historic data from earlier dredging projects; total Upper Floridan withdrawals; and USGS, GAEPD, and SCDHEC water-level data, along with any new data (including any applicable data from on-going State of Georgia Sound Science initiatives). Future data will then be added to the GIS, when available, to facilitate enhanced analysis and visualization of potential aquifer impacts.

- Research existing boring/well data and input to GIS.
- Convert existing geologic/hydrogeologic data from previous investigations and input to GIS.
- Research historic dredging records for project geometry, depth, and material volume data for input into GIS.
- Convert existing seismic data into digital format and input into GIS.
- Collect all future seismic data in digital format and input into GIS.
- Obtain historic Savannah area Upper Floridan aquifer withdrawal data and input into GIS.
- Obtain historic Savannah area drawdown data from USGS, GAEPD, and SCDHEC and input into GIS.
- Input future harbor boring and geotechnical data into GIS.
- Use the GIS to analyze and visualize data for technical conclusions and report preparation.

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