Technical Memorandum

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

From: *CDM Smith*

Date: *August 2015*

Subject: *Methodology for Unimpaired Flow Development*
Edisto River Basin, South Carolina (Prepared as part of the South Carolina Surface Water Quantity Modeling Program)

1.0 Background and Objectives for Unimpaired Flows

Unimpaired Flow (UIF) describes the natural hydrology of a river basin. UIFs quantify streamflows throughout a river basin in the absence of human intervention in the river channel, such as storage, withdrawals, discharges, and return flows. From this basis, modeling and decision making can be compared with pristine conditions. This memorandum explains the methods that will be employed to develop UIFs for South Carolina's Edisto River Basin. It describes data needs, methods for filling data gaps, and issues specific to the Edisto River basin. Once developed, UIFs will be input to the Simplified Water Allocation Model (SWAM) to evaluate surface water hydrology and operations throughout the basin. The UIFs for the Edisto River Basin will extend from 1931-2013.

UIFs will serve two purposes:

- UIFs will be the **fundamental input** to the model at headwater nodes and tributary nodes upstream of historic management activity, representing naturally occurring water in the riverways. Current and future management practices such as storage, withdrawals, and discharges will be superimposed on the UIFs.
- UIFs will provide a **comparative basis** for model results. The impacts of current and future management practices on flow throughout the river network can be compared to the natural conditions represented by the UIFs, and decisions about relative impacts can be well informed.

UIFs are defined as the addition and subtraction of management impacts on measured, impacted flows. UIFs will be calculated on a daily timestep using Equation 1:

Unimpaired Flow *= Measured Gage Flow + River Withdrawals + Reservoir Withdrawals – Reservoir Discharge – Return Flow + Reservoir Surface Evaporation – Reservoir Surface Precipitation + Upstream change in Reservoir Storage + Runoff from previously unsubmerged area* **(Equation 1)**

2.0 Overview of the Edisto Basin

The Edisto River basin covers 3,120 square miles, 10 percent of the land area of the State, lying within Coastal Plain physiographic province (**Figure 2-1**). The basin's major watercourses include the North and South Fork of the Edisto River; the Edisto River below their confluence near Branchville; and Four Hole Swamp which feeds into the Edisto River (**Figure 2-2**). Near the coast, the North and South branches of the Edisto River drain separately to the Atlantic Ocean.

Eight active Unites States Geological Survey (USGS) gaging stations monitor streamflow in the basin, including four on the South Fork, one on the North Fork, on the Edisto, and two on tributary streams. The North Fork station at Orangeburg (USGS 0217350) offers the earliest period of record, beginning in 1931 (but with a gap between 1971 and 1980). The Edisto River station near Givhans (USGS 0217500) offers the longest, uninterrupted period of record, beginning in 1938. Average annual streamflow in the South Fork Edisto River is 892 cubic feet per second (cfs) near Bamberg. Average annual streamflow in the North Fork Edisto River is 753 cfs near Orangeburg. Average annual streamflow in the Edisto River is 1,991 cfs near Branchville and 2,522 cfs near Ghivans.

In the upper Coastal Plain portion, tributary flows are generally steady, with well-sustained low flows. Comparatively, in the middle and lower Coastal Plain, sustained flow is more dependent on rainfall and direct runoff. Flows in the Edisto River are substantial and fairly consistent as a result of discharge from groundwater reserves in the upper Coastal Plain.

Chapter 7 of The South Carolina State Water Assessment (SCDNR, 2009) describes the basin's surface water and groundwater hydrology and hydrogeology, water development and use, and water quality. A summary is also provided in An Overview of the Eight Major River Basins of South Carolina (SCDNR, 2013).

3.0 Water Users and Dischargers in the Edisto Basin

The South Carolina DHEC has provided information and data regarding current (active) and former (inactive) water users and dischargers throughout the state. Currently permitted or registered water users in the Edisto basin are listed in **Table 3-1**. Former users are listed in **Table 3-2**. Withdrawal locations of current and former water users are shown in **Figure 3-1** (municipal water supply; industrial and mining; thermoelectric, and golf courses) and **Figure 3-2** (agriculture). Individual withdrawals less than 3 million gallons per month (mg/m) will generally not be included in UIF calculations or in water quantity modeling; however, some aggregation of withdrawals that are less than 3 mg/m on a particular reach may occur, and the combined amount included. In other instances, withdrawals that average less than 3 mg/m annually, but are seasonally higher than 3 mg/m may be included.

Current and former wastewater dischargers are listed in **Tables 3-3 and 3-4**, respectively, based on National Pollution Discharge Elimination System (NPDES) permit information. Discharge locations of current and former discharges are shown in **Figure 3-3**. Only active discharges that typically average over 3 mg/m are listed in the tables and shown on Figure 3-3. Discharges that averaged less than 3 mg/m will generally not be considered when performing UIF calculations, except when the cumulative discharge amount from facilities located on the same tributary or portion of the mainstem are deemed significant.

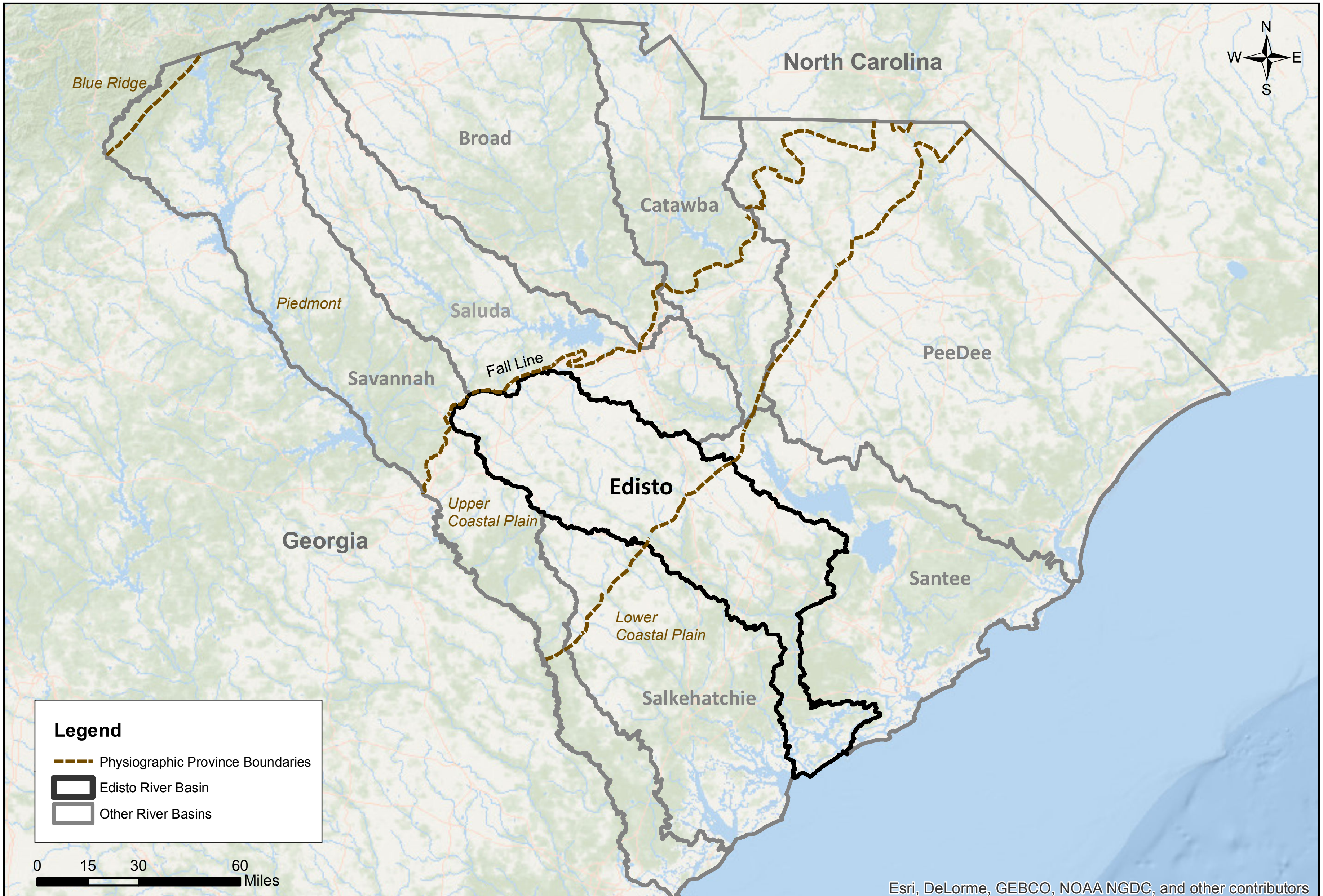

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Figure 2-1
South Carolina's Edisto River Basin and Other Major River Basins

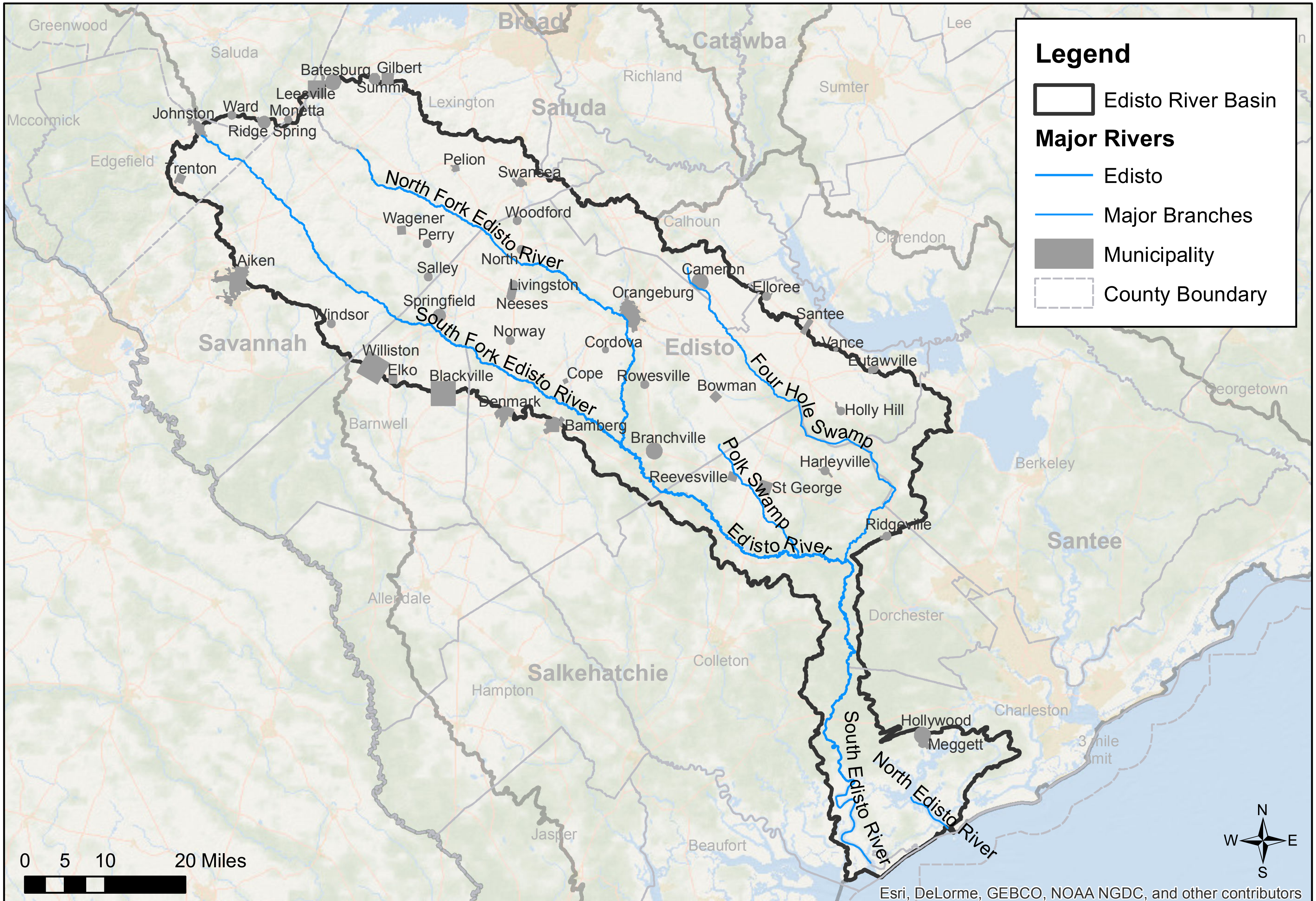

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Figure 2-2
Edisto River Basin

Table 3-1. Currently permitted and registered surface water users in the Edisto Basin

Intake ID	Facility Name	Withdrawal Tributary
Golf Course Users		
32GC011S01	INDIAN TRAIL GOLF CLUB	Duncan Creek
38GC004S01	ORANGEBURG COUNTRY CLUB	North Fork Edisto River
Industrial and Mining Users		
38IN002S01	ALBEMARLE CORP	North Fork Edisto River
Thermoelectric Users		
38PT001S01	SCE&G - COPE STATION	South Fork Edisto River
Drinking Water Users		
02WS002S01	CITY OF AIKEN	Shaw Creek
10WS004S03	CHARLESTON CPW - HANAHAN WTP	Edisto River
38WS002S03	CITY OF ORANGEBURG WTP	North Fork Edisto River
38WS002S01	CITY OF ORANGEBURG WTP	North Fork Edisto River
38WS002S02	CITY OF ORANGEBURG WTP	North Fork Edisto River
32WS003S01	BATESBURG WATER PLANT	Lightwood Knots Creek
32WS003S02	BATESBURG WATER PLANT	Duncan Creek
Agricultural Users		
09IR003S01	COTTON LANE FARMS	Goodby's Swamp
09IR003S02	COTTON LANE FARMS	Goodby's Swamp
09IR003S03	COTTON LANE FARMS	Goodby's Swamp
38IR020S01	BACKMAN FARMS	Willow Swamp
38IR081S01	BOLAND FARM	Dean Swamp Creek
38IR081S02	BOLAND FARM	Dean Swamp Creek
38IR015S01	BROWN FARMS	Willow Swamp
38IR015S02	BROWN FARMS	South Fork Edisto River
38IR014S03	BULL SWAMP PLANTATION	Bull Swamp Creek
38IR014S01	BULL SWAMP PLANTATION	Bull Swamp Creek
38IR014S02	BULL SWAMP PLANTATION	Bull Swamp Creek
09IR004S02	CALHOUN TRADING CO	Limestone Creek
09IR004S01	CALHOUN TRADING CO	Caw Caw Swamp
38IR042S01	GRAY FARM	Cooper Swamp
09IR009S01	HAIGLER FARMS INC	Four Hole Swamp
09IR009S02	HAIGLER FARMS INC	Four Hole Swamp
09IR009S03	HAIGLER FARMS INC	Four Hole Swamp
09IR009S04	HAIGLER FARMS INC	Four Hole Swamp
19IR002S01	HOLMES & SON LEWIS FARM	Shaw Creek
19IR002S02	HOLMES & SON LEWIS FARM	Shaw Creek
32IR004S01	KYZER FARMS	Black Creek
02IR028S01	MAURY FURTICK FARM	Dean Swamp Creek
38IR004S01	MILLWOOD FARM	Limestone Creek
38IR004S02	MILLWOOD FARM	Limestone Creek
38IR004S03	MILLWOOD FARM	Limestone Creek
38IR067S01	NORWAY FARM	Willow Swamp
09IR011S01	OAK LANE FARM HALFWAY SWAMP	Caw Caw Swamp
02IR027S01	PEBBLE CREEK ENTERPRISES	North Fork Edisto River
05IR012S01	PHIL SANDIFER & SONS, LLC	South Fork Edisto River
05IR054S01	RIDDLE DAIRY FARM	Hayes Mill Creek
38IR077S01	RIVER BLUFF SOD FARM	South Fork Edisto River
06IR020S01	ROB BATES FARM	Windy Hill Creek

Table 3-1 (continued). Currently permitted and registered surface water users in the Edisto Basin

Intake ID	Facility Name	Withdrawal Tributary
38IR040S01	SHADY GROVE PLANTATION & NURSERY INC	Cow Castle Creek
05IR005S01	SHIVERS TRADING AND OPERATING COMPANY	Sykes Swamp
19IR012S02	SMITH W G III	Shaw Creek
19IR012S03	SMITH W G III	Shaw Creek
19IR012S04	SMITH W G III	Shaw Creek
38IR066S01	SPRINGFIELD FARM	Goodland Creek
38IR026S02	SPRINGFIELD GRAIN CO BROWN KIRBY & SONS	South Fork Edisto River
38IR026S01	SPRINGFIELD GRAIN CO BROWN KIRBY & SONS	Goodland Creek
38IR026S03	SPRINGFIELD GRAIN CO BROWN KIRBY & SONS	Goodland Creek
32IR050S01	THOMAS C. FINK FARM	Black Creek
41IR014S07	TITAN FARMS	Beech Creek
41IR014S09	TITAN FARMS	Beech Creek
19IR004S03	TITAN FARMS	Beech Creek
19IR004S08	TITAN FARMS	Beech Creek
41IR014S02	TITAN FARMS	Bog Branch
41IR014S06	TITAN FARMS	Bog Branch
19IR004S01	TITAN FARMS	Bog Branch
19IR004S05	TITAN FARMS	Bog Branch
19IR004S06	TITAN FARMS	Bog Branch
19IR004S07	TITAN FARMS	Bog Branch
19IR004S15	TITAN FARMS	Bog Branch
41IR010S01	TITAN FARMS	Chinquapin Creek
41IR014S05	TITAN FARMS	Mill Creek
41IR014S10	TITAN FARMS	Shaw Creek
19IR004S12	TITAN FARMS	Shaw Creek
19IR004S09	TITAN FARMS	South Fork Edisto River
19IR004S13	TITAN FARMS	South Fork Edisto River
19IR004S14	TITAN FARMS	South Fork Edisto River
02IR024S02	TITAN FARMS	South Fork Edisto River
19IR004S02	TITAN FARMS	Temples Creek
19IR004S04	TITAN FARMS	Temples Creek
19IR004S10	TITAN FARMS	Temples Creek
19IR004S11	TITAN FARMS	Temples Creek
19IR004S16	TITAN FARMS	Temples Creek
38IR078S01	TURF CONNECTIONS	Goodland Creek
32IR013S08	WALTER P. RAWL & SONS/WP FARL FARM	Black Creek
02IR025S01	WALTHERS FARMS	South Fork Edisto River
38IR021S01	WILLIAMS & SONS FARMS	South Fork Edisto River
38IR021S02	WILLIAMS & SONS FARMS	South Fork Edisto River
38IR043S01	WILLSHIRE FARMS INC	Providence Swamp
38IR043S02	WILLSHIRE FARMS INC	Providence Swamp
10IR014S01	YELLOW HOUSE FARMS	Wadmalaw River

Table 3-2. Formerly permitted or registered surface water users in the Edisto Basin

Intake ID	Facility Name	Withdrawal Tributary
Industrial and Mining Users		
02IN005S01	J M HUBER CORP EDISTO PLANT	South Fork Edisto River
Thermoelectric Users		
15PT001SO1	SCE&G - CANADAYS STATION	Edisto River

Table 3-3. Currently Permitted NPDES Discharges in the Edisto Basin(Average Discharge ≥3 mg/m)

NPDES Pipe ID	Facility Name	Discharge Tributary	Associated Surface Water Permit	Associated Groundwater Withdrawal ID
SCG641003-001	AIKEN/SHAW CREEK WTP	Shaw Creek	02WS002	02WS002G
SC0024465-001	BATESBURG-LEESVILLE WWTF	Duncan Creek	32WS003	32WS002G
SC0001180-001	ALBEMARLE CORP/ORANGEBURG	North Fork Edisto River	38IN002	*none*
SC0045772-001	SCE&G/COPE POWER PLANT	Roberts Swamp	38PT001	38PT001G
SC0045772-002	SCE&G/COPE POWER PLANT	Roberts Swamp	38PT001	38PT001G
SC0045772-003	SCE&G/COPE POWER PLANT	Roberts Swamp	38PT001	38PT001G
SC0045772-005	SCE&G/COPE POWER PLANT	Roberts Swamp	38PT001	38PT001G
SC0045772-006	SCE&G/COPE POWER PLANT	Roberts Swamp	38PT001	38PT001G
SC0024481-001	ORANGEBURG WWTF	North Fork Edisto River	38WS002	*none*
SC0001147-001	ROSEBURG FOREST PRODUCTS S/HOLLY HILL MDF	Four Hole Swamp	*none*	38IN005G
SC0001147-002	ROSEBURG FOREST PRODUCTS S/HOLLY HILL MDF	Four Hole Swamp	*none*	38IN005G
SC0001147-003	ROSEBURG FOREST PRODUCTS S/HOLLY HILL MDF	Four Hole Swamp	*none*	38IN005G
SC0002992-001	HOLCIM (US) INC/HOLLY HILL PLT	Four Hole Swamp	*none*	38IN001G
SC0002992-002	HOLCIM (US) INC/HOLLY HILL PLT	Four Hole Swamp	*none*	38IN001G
SC0002992-003	HOLCIM (US) INC/HOLLY HILL PLT	Four Hole Swamp	*none*	38IN001G
SC0002992-02A	HOLCIM (US) INC/HOLLY HILL PLT	Four Hole Swamp	*none*	38IN001G
SC0022667-001	GIANT CEMENT COMPANY INC	Four Hole Swamp	*none*	18WS014G/18IN001G
SC0022667-002	GIANT CEMENT COMPANY INC	Four Hole Swamp	*none*	18WS014G/18IN001G
SC0022667-003	GIANT CEMENT COMPANY INC	Four Hole Swamp	*none*	18WS014G/18IN001G
SC0022667-004	GIANT CEMENT COMPANY INC	Four Hole Swamp	*none*	18WS014G/18IN001G
SC0022667-004	GIANT CEMENT COMPANY INC	Four Hole Swamp	*none*	18WS014G/18IN001G
SC0022667-005	GIANT CEMENT COMPANY INC	Four Hole Swamp	*none*	18WS014G/18IN001G
SC0022586-001	LAFARGE BUILDING MATERIALS INC	Indian Field Swamp	*none*	18IN0040G
SC0022586-002	LAFARGE BUILDING MATERIALS INC	Indian Field Swamp	*none*	18IN0040G
SC0038504-001	TOWN OF HARLEYVILLE	Indian Field Swamp	*none*	18WS003G
SC0043419-001	ACO DISTRIBUTION & WAREHOUSE INC	North Fork Edisto River	*none*	38IN004G

Table 3-3 (continued). Currently Permitted NPDES Discharges in the Edisto Basin(Average Discharge ≥3 mg/m

NPDES Pipe ID	Facility Name	Discharge Tributary	Associated Surface Water Permit	Associated Groundwater Withdrawal ID
SC0026417-001	BLACKVILLE WWTF	Windy Hill Creek	*none*	06WS002G
SC0047333-001	TOWN OF BRANCHVILLE	Edisto River	*none*	38WS007G
SC0047333-001	TOWN OF BRANCHVILLE	Edisto River	*none*	38WS007G
SC0034541-001	GASTON COPPER RECYCLING CORP	Bull Swamp Creek	*none*	32IN002G
SC0047821-001	TOWN OF NORTH	North Fork Edisto River	*none*	38WS003G
SC0047821-002	TOWN OF NORTH	North Fork Edisto River	*none*	38WS003G
SC0038555-001	SHOWA DENKO CARBON	Four Hole Swamp	*none*	18IN002G
SC0038555-01A	SHOWA DENKO CARBON	Four Hole Swamp	*none*	18IN002G
SC0023272-001	SPRINGFIELD/PLANT #1	South Fork Edisto River	*none*	38WS009G
SC0023281-001	SPRINGFIELD/PLANT #2	Goodland Creek	*none*	38WS009G
SC0025844-001	TOWN OF ST. GEORGE, TOWN	Polk Swamp	*none*	18WS002G
SC0026204-001	TOWN OF WAGENER	Dean Swamp Creek	*none*	02WS001G
SC0045993-001	TOWN OF NORWAY	Willow Swamp	*none*	38WS006G
SC0046388-001	KENTUCKY-TENN CLAY/GENTRY PIT	South Fork Edisto River	*none*	*none*
SC0046388-002	KENTUCKY-TENN CLAY/GENTRY PIT	South Fork Edisto River	*none*	*none*
SC0047023-001	ORANGEBURG NTL FISH HATCHERY	North Fork Edisto River	*none*	*none*
SC0047023-002	ORANGEBURG NTL FISH HATCHERY	North Fork Edisto River	*none*	*none*
SC0047848-001	BEARS BLUFF NATL FISH HATCHERY	Wadmalaw River	*none*	*none*
SC0047848-002	BEARS BLUFF NATL FISH HATCHERY	Wadmalaw River	*none*	*none*
SC0047848-003	BEARS BLUFF NATL FISH HATCHERY	Wadmalaw River	*none*	*none*

Table 3-4. Formerly Permitted NPDES Discharges in the Edisto Basin (Average Discharge ≥3 mg/m)

NPDES Pipe ID	Facility Name	Discharge Tributary
SC0002020-001	SCE&G - CANADAYS STATION	Edisto River
SC0002020-002	SCE&G - CANADAYS STATION	Edisto River
SC0002020-003	SCE&G - CANADAYS STATION	Edisto River
SC0002020-005	SCE&G - CANADAYS STATION	Edisto River
SC0002020-04A	SCE&G - CANADAYS STATION	Edisto River
SC0021113-001	BRANCHVILLE, TOWN OF	Pen Branch
SC0022268-001	RIDGE SPRING/S. LAGOON #1	Flat Rock Creek
SC0024341-001	J M HUBER CORP/EDISTO PLANT	South Fork Edisto River
SC0040401-001	PARADISE SHRIMP FARMS OF SC	North Creek
SC0040401-002	PARADISE SHRIMP FARMS OF SC	North Creek
SC0044270-001	YOUMANS GAS AND OIL CO, INC	Wadmalaw River Trib.

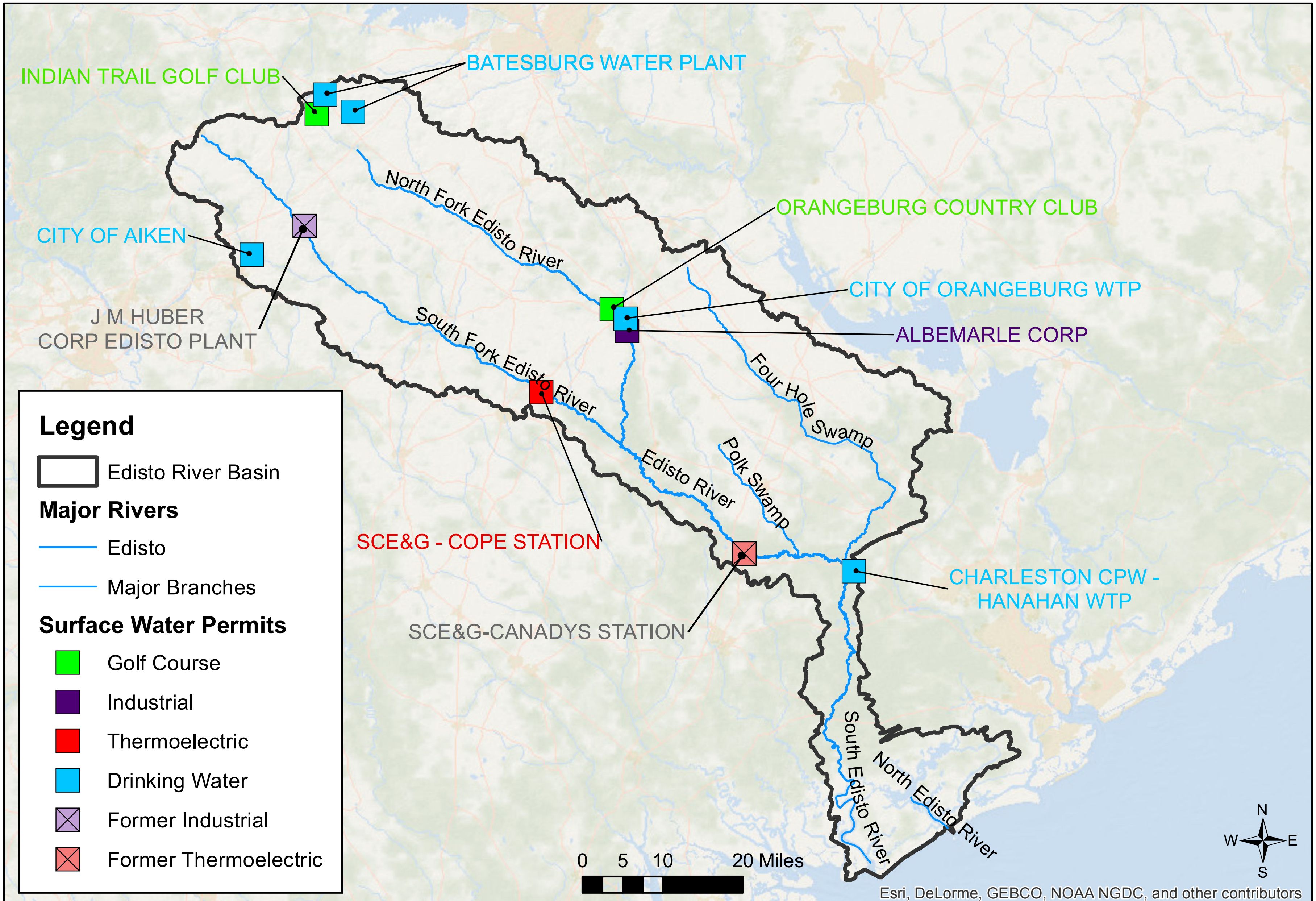

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Figure 3-1
Current and Former Municipal, Industrial, Thermoelectric, and Golf Course Surface Water Users

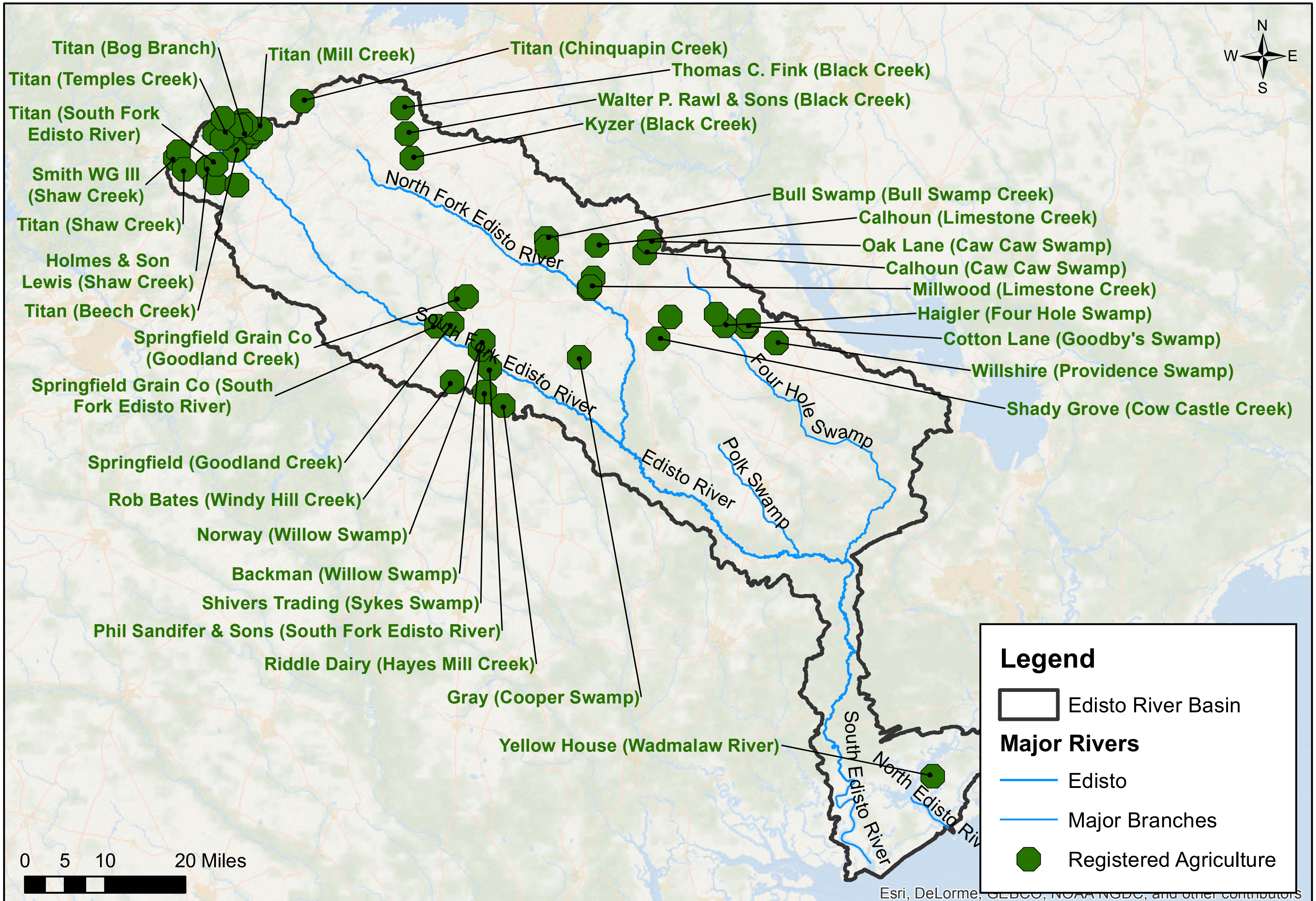

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Figure 3-2
Current Agriculture Surface Water Users

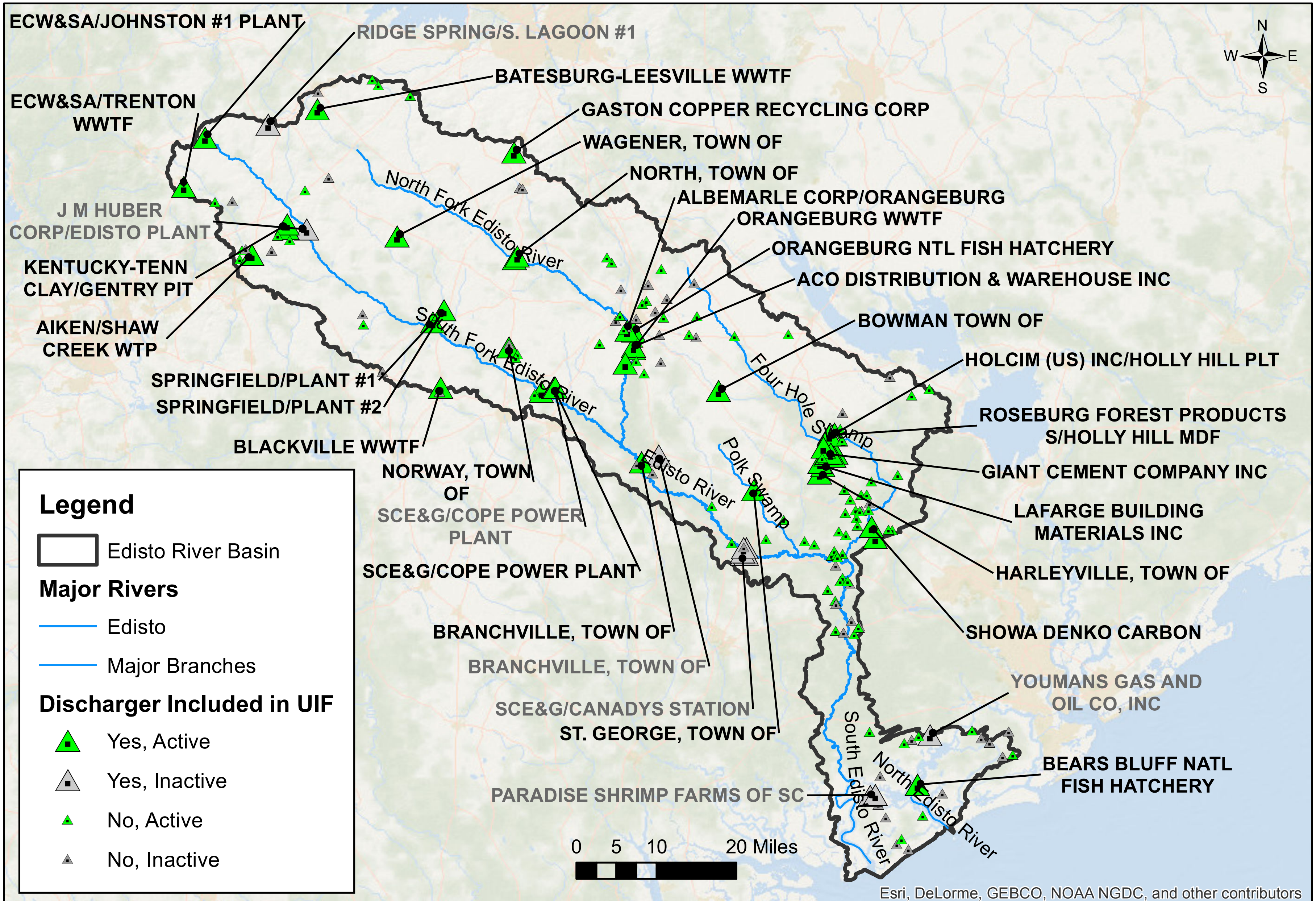

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Figure 3-3
Active and Inactive NPDES Discharges

4.0 Overview of Methodology

4.1 UIF Process Diagram

Figure 4-1 illustrates the general UIF development process, not as a step-by-step procedure, but as a guiding approach. The process involves adding and subtracting known historical management practices from measured streamflow records. In doing so, the impacts of human intervention on the flow in the river can be removed from the historical flow records. Water is added to existing streamflow estimates to account for historic withdrawals and subtracted out to account for historic discharges, and the timing of flows is adjusted to account for impoundment of rivers.

The overarching process can be described in four steps. Each is summarized below and presented in detail in **Section 5.**

Step 1: Data Collection. This step includes collection of available streamflow records, withdrawal records, discharge records, operational records at dams, impoundment features, etc. The duration of the longest available, reliable streamflow record determines the period of record for the basin. Records from other gages are extended to match this duration (described in **Section 5.4**).

Step 2: Unregulated Flow. The distinction between "Unregulated Flow" and "Unimpaired Flow" is helpful in understanding the different ways in which water management affects streamflow, but in the calculations of the UIFs, the two terms are not disaggregated. Unregulated flows represent flow in which the effects of timing due to impoundment are removed, and are, effectively, a subset of Unimpaired Flows. Equation 1 in Section 1 includes the effects of streamflow regulation in the UIF calculation.

As noted, Unregulated Flow refers to flow in which the timing of flow has not been altered by impoundment. In the Edisto, there are no impoundments of significant size, and no impoundments are being included in the SWAM model. Therefore, no adjustments need to be considered to account for the timing of flows from impoundments.

There is an important difference between the alteration to flow timing associated with impounding a river (corrected with unregulated flows), and the timing of flow due to its traverse through the river channel (hydraulic time lags). Currently, it is not expected that hydraulic time lags (also referred to as "travel time") will be necessary for these UIF data sets for the following reasons:

a. At a monthly timestep, the time lags would be inconsequential.
b. At a daily timestep, for long-term simulation, the key metric is frequency of various flow levels and water availability, which would be preserved over time even if shifted by several days.

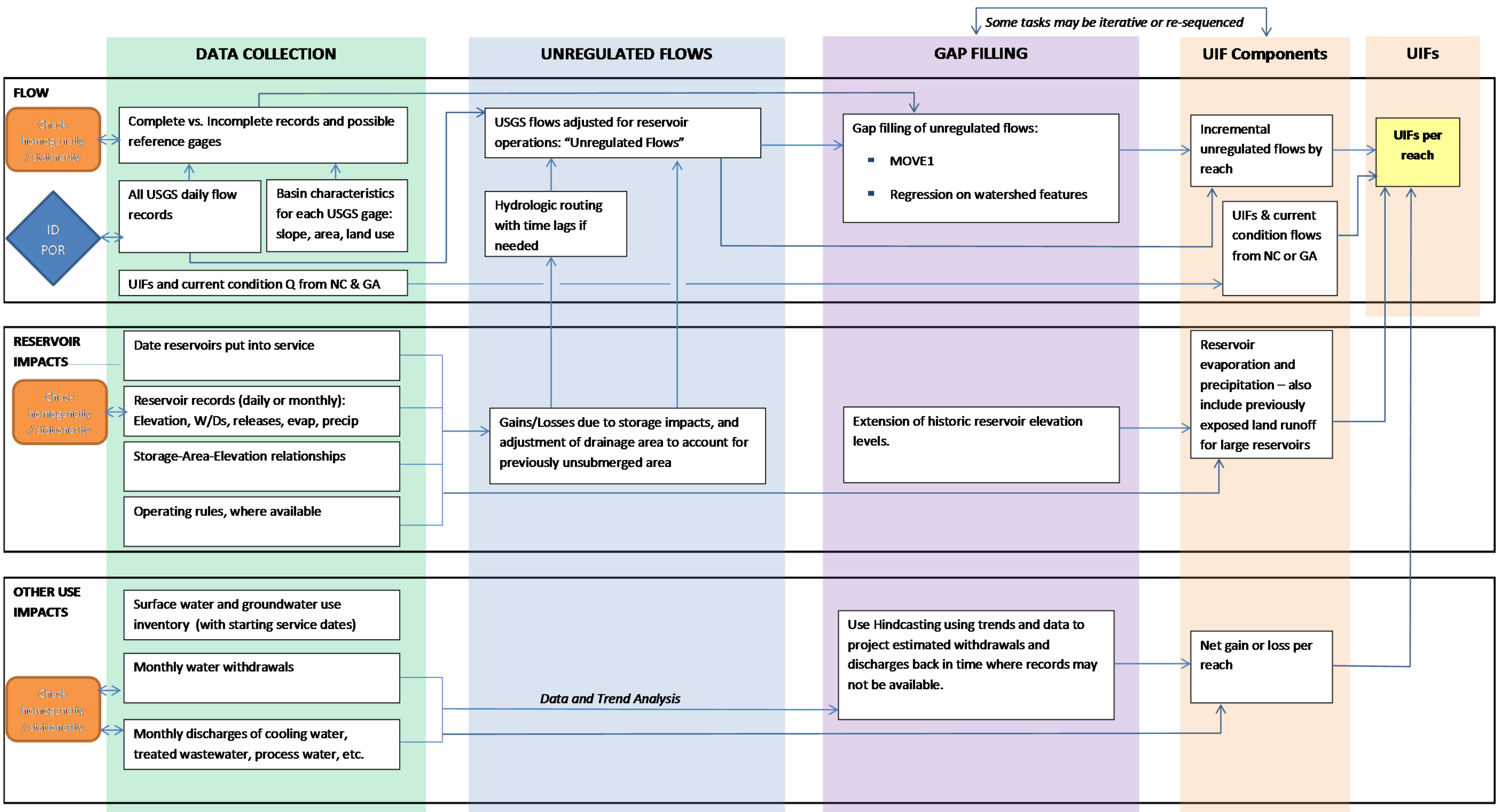


Figure 4-1. Unimpaired Flow Process Diagram

c. Accurate prediction of hydraulic time lags requires channel bathymetry and iterative hydraulic routing equations (HEC-RAS, for example).
d. For UIFs, the observed lags (albeit for impaired flows) are already resident within the USGS streamflow records, so the UIFs will have some of the lag already built in.

If special circumstances warrant rough estimation of hydraulic time lags, flow-based lag equations from USGS could be considered. Note that time lags associated specifically with return flows, e.g. via groundwater, are able to be simulated in SWAM.

*Steps 3 and 4 are presented sequentially in **Figure 4-1**, but may be conducted in either order, and possibly with iteration. It may be preferable to compute UIFs to the greatest extent possible and then fill data gaps using trends observed in documentable UIFs, or it may be preferable to first fill gaps in historic data and then compute uninterrupted UIFs. These decisions will be made on a case-by-case basis, and will likely depend primarily on data availability (see additional detail in **Step 3: Gap Filling**, below).*

Step 3: Gap Filling. As stated under Step 1, the period of record for the basin will begin with the first date that any USGS gage began recording streamflow. All other records will be synthetically extended back to this date if measurements are not available. Likewise, measurement gaps will be filled in synthetically. Two types of synthetic data will be developed: First, the operational data used to compute a UIF over a given period of record for a specific gage will be extended or filled over that period (this includes withdrawals, discharges, and effects of storage). Second, the UIFs for each USGS gage will be extended statistically over the period corresponding with the most complete gage in the basin. Hydrologic flows will be computed using one of a variety of alternative statistical approaches described in **Section 5.4**. Historical management practices, such as withdrawals and discharges, will be filled in to the greatest extent possible with anecdotal information from relevant utilities, supplemented with statistical hindcasting based largely on population.

Where practical, gap filling of the hydrologic flow should occur after UIFs are developed as fully as they can be. This will help preserve the statistical integrity of natural hydrologic relationships. However, the approach is illustrated as flexible for two reasons:

- **Regional Consistency:** It appears that Georgia may have applied some level of gap filling on unregulated flows prior to developing unimpaired flows (see Figure 4-1 of *REVIEW DRAFT: Synopsis of Surface Water Availability Assessment, Georgia Statewide Water Management Plan, Section 4, March 2010*), and we will be using those data sets for the Savannah River Basin.

- **Case-by-Case Decisions:** For basins in which UIFs will be newly developed as part of this study, some flexibility may be important because the timing of when gap filling can be most effective may depend on the type of data sets being filled.

There may be some operational flows that require hind-casting to characterize their impacts over time. It may be beneficial to do this prior to developing the UIFs. In other cases, it may simply be advantageous to extend USGS records synthetically if they can be shown to correlate well with other data so that UIFs can be developed from data sets that are as comprehensive as possible. Not all of the reasons for these decisions are foreseeable at this time, and some will be case-by-case decisions made in collaboration with DNR/DHEC.

For the pure hydrologic timeseries, however, the project team will endeavor to compute UIFs to the greatest extent possible and then fill in gaps *in the UIFs* using statistical techniques. The flexible approach outlined above facilitates the filling in of some operational gaps along the way if the project team (collectively with DNR/DHEC) deems it to be necessary or advantageous to create the most comprehensive datasets with which to compute the UIFs.

Step 4 – Unimpaired Flow Calculation: UIFs will be computed following Equation 1. Once they are complete for each gage record, two additional steps are needed:

> Step 4a: Extend each UIF record over the period corresponding to the most complete (longest) gage record in the basin,
>
> Step 4b: Using basin area proration, estimate the UIFs in ungaged basins that are deemed necessary for subsequent model input.

4.2 Locations of UIFs

UIFs will be computed at two types of locations throughout the basin:

- Any site where a USGS gage station has recorded streamflow measurements will have calculated UIFs (See **Figure 4-2**). This is because the USGS records provide a necessary "footing" with which to begin the calculation per Equation 1. It will allow model development to proceed with UIFs at upstream sites as input, and at downstream sites for comparative use, or as input of incremental hydrologic flows:
  - Where a gage is located upstream of historical management activity, it will be included in the model as direct input.
  - Where a gage is located on a tributary downstream of a management activity, the management activity will be removed in the calculations and, if necessary, the record can be scaled according to drainage area to estimate an upstream boundary condition UIF for that tributary.
  - Where a gage is located downstream of a management activity on a river mainstem, it will available for comparative purposes, and also used to calibrate reach gains and losses (see Section 4.3 below) or explicit incremental unimpaired flows. Simulated flow at these locations will be computed by the model itself based on upstream UIFs and subsequent river management.

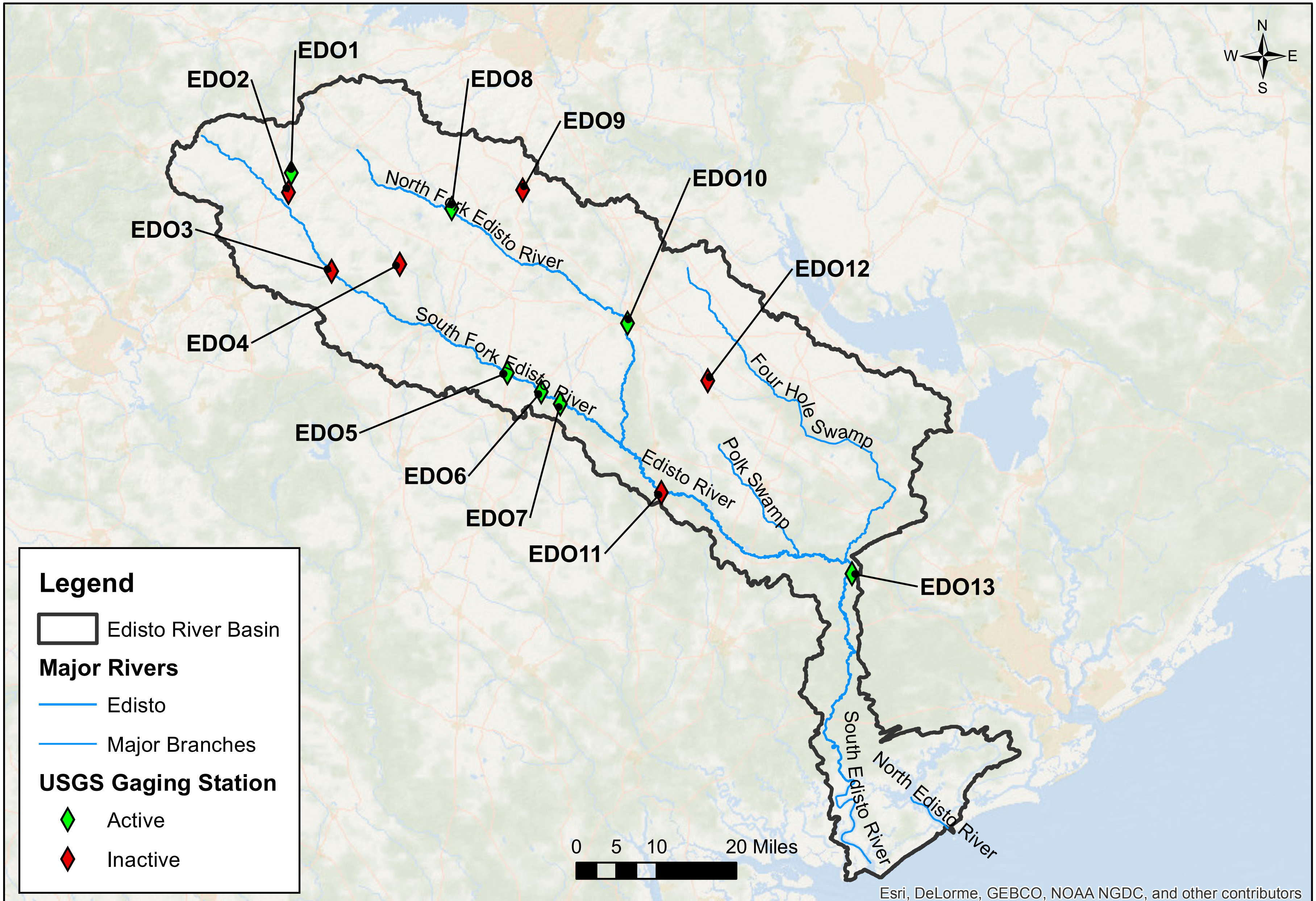


Figure 4-2
Active and Inactive USGS Streamflow Gaging Stations

- Any tributary that will be explicitly included in the model will require input of unimpaired headwater boundary flow (Sections 4 and 8 of the *November 2014 South Carolina Surface Water Quantity Models Modeling Plan* discuss explicit and implicit tributaries). If USGS gage data is unavailable for an explicitly modeled tributary, a synthetic UIF will be developed using reference gages and statistical methods discussed in **Section 5.4**.

4.3 Gains and Losses Between UIF Nodes

UIFs will be computed for each USGS streamgage in the basin but, as discussed, not all UIFs will be used for model input. UIFs will be used for model inputs at headwater locations, and available in the river network to compare against computed flows as they are affected by storage, withdrawals, and discharges, and to use for model calibration.

During the subsequent model development and calibration process (after the UIFs are input into the model as headwater inputs), there will be reaches in which hydrologic gains or losses are computed. Gains or losses can be simulated in SWAM in one of two ways. As a first option, the gain/loss function available in SWAM for each tributary object could be used and parameterized according to user-specified percent increases (or decreases) per unit length of stream reach. Alternatively, a timeseries calculated in a similar way to the UIFs themselves (using the difference between two UIFs, and simulated as an inflow or withdrawal) could be specified in SWAM using separate tributary or user objects. Note that for losing streams, the modeled losses would not return elsewhere in the model network, and would be assumed to be lost from the river system.

It is understood that losing streams are likely present in the Edisto Basin and so a general methodology for losses is discussed here. If a downstream gage indicates lower flow than an upstream gage (both unimpaired), this would indicate that the reach in between loses water to the ground, and the REACH GAIN/LOSS function in SWAM would be calibrated accordingly. Alternatively, the difference between the daily flows could be added as a withdrawal from the river using a user object (and not returned elsewhere).

Another possibility that may arise is that an upstream flood may not result in downstream flow immediately (due to travel time). In a normally gaining river, simply subtracting the higher upstream flow from the lower downstream flow that hasn't received the flood waters yet could result in negative values. If this is observed, we will apply discretionary correction factors or time shifts to reduce the impact of the perceived time lag and help ensure that the reach does not lose water simply because of the hydraulic routing of floods.

5.0 Unimpaired Flow Methodology

The UIF methodology follows the diagram previously shown in Figure 4-1. In addition to discussion of the period of record, each block (from left to right) is discussed in detail below.

5.1 Period of Record

While UIF estimates will begin in 1931 for the Edisto Basin, more than half of the streamgages began operation in the 1980s or later. The records for all gages that started tracking flow after 1931 will be extended using gap filling techniques. Although much of the UIFs will thus be based on estimated flows, the value of a lengthy record, even if approximate, is that DNR, DHEC, and other users can evaluate results over a large range of hydrologic and climate conditions. **Figure 5-1** depicts the length and timing of records available for all USGS gages in the Edisto basin. **Table 5-1** lists each gage.

Figure 5-1. Period of record for USGS gages in the Edisto Basin

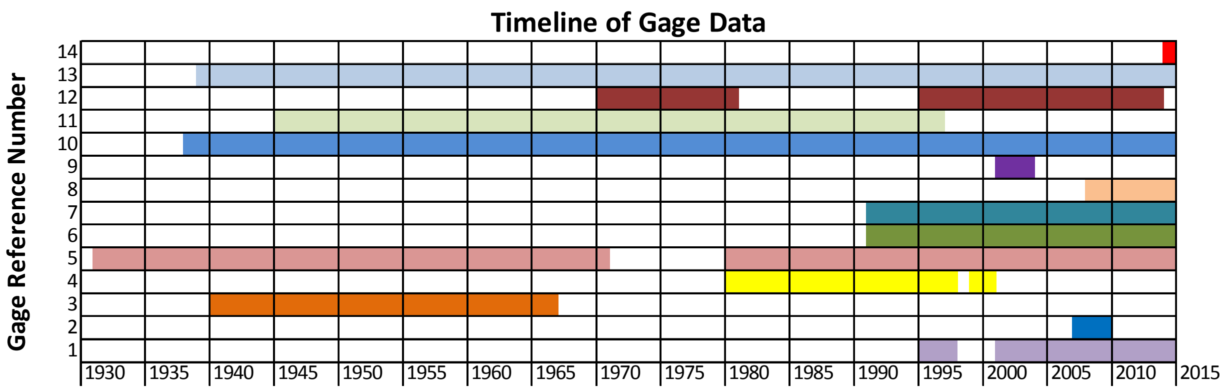


Table 5-1. USGS gages in the Edisto Basin

USGS Number	Description	Period of Record				Gage ID
		From:	To:	From:	To:	
02172300	MCTIER CREEK (RD 209) NEAR MONETTA, SC	10/1/1995	10/1/1997	2/7/2001	12/31/2014	1
02172305	MCTIER CREEK NEAR NEW HOLLAND, SC	6/13/2007	11/30/2009			2
02172500	SOUTH FORK EDISTO RIVER NR MONTMORENCI, S. C.	4/1/1940	9/30/1966			3
02172640	DEAN SWAMP CREEK NR SALLEY, SC	10/1/1980	3/25/1987	3/1/1988	9/30/2000	4
02173000	SOUTH FORK EDISTO RIVER NEAR DENMARK, SC	8/4/1931	9/2/1971	10/1/1980	12/31/2014	5
02173030	SOUTH FORK EDISTO RIVER NEAR COPE, SC	6/29/1991	current			6
02173051	SOUTH FORK EDISTO RIVER NEAR BAMBERG, SC	4/9/1991	current			7
02173212	CEDAR CREEK NEAR THOR, SC	4/8/2008	current			8
02173351	BULL SWAMP CREEK BELOW SWANSEA, SC	2/6/2001	9/30/2003			9
02173500	NORTH FORK EDISTO RIVER AT ORANGEBURG, SC	12/1/1938	current			10
02174000	EDISTO RIVER NEAR BRANCHVILLE, SC	10/1/1945	9/30/1996			11

USGS Number	Description	Period of Record				Gage ID
		From:	To:	From:	To:	
02174250	COW CASTLE CREEK NEAR BOWMAN, SC	10/1/1970	9/30/1981	10/1/1995	2/24/2013	12
02175000	EDISTO RIVER NR GIVHANS, SC	1/1/1939	current			13
02172558	SOUTH FORK EDISTO RIVER ABOVE SPRINGFIELD, SC	10/10/2014	current			14

5.2 Data Needs and Collection

Data needs, discussion of how the data will be used, and potential sources of the data are presented in **Table 5-2**. The majority of data needed are historic records. The categories of data needed include flow, reservoir impacts, and other use impacts. These categories partially overlap. Additional information that needs to be collected as part of developing the SWAM model may also be used to assist with gap filling. Each main category is briefly discussed below.

<u>Flow</u>: All available records of streamflow in the basin need to be gathered, whether they are complete or not. Incomplete records will be filled using the gap filling techniques discussed in **Section 5.4**. The gap filling technique includes correlation with other stream gage records, precipitation data, and evaporation data, which may include gages from outside the basin. As UIF estimates are being prepared across South Carolina, flow data will be gathered from stations statewide to determine the nearest gages from which to correlate flows.

<u>Other Use Impacts:</u> Other impacts include water users, water dischargers, and groundwater withdrawals. Current and historical water users and dischargers are listed in **Section 3**. While daily withdrawal and discharge data would be ideal, such data is unlikely to be available in most cases. Monthly data should be available for most, but the period of record for such data is limited as such data was not required to be maintained before 2000. Water users and dischargers have been contacted by phone to collect additional information on historic usage/discharge patterns to extend the records. Details on the information that was requested is presented in **Attachment A**.

Table 5-2. Data Needs

Data Category	Data	Use(s)	Potential Sources	Comments
Flow	USGS Stream gage Records	UIFs for every available gage	USGS	Provides opportunity to calculate incremental flows between gages.
	Slope, contributing area, and land use for each USGS gage	Correlation for flow estimation	USGS, GIS	USGS provides contributing area, GIS tools and data used to determine slope and land use.
Other Use Impacts	Historical M&I Water Withdrawals	Compute net gain or loss per reach	DHEC databases, Records and anecdotal information from individual users/ permittees	Overlap with UIF data collection and development, but useful in confirming models' ability to recreate historic flows as measured by USGS stream gages.
	Historic Ag Water Withdrawals			
	Historic Industrial / Energy Water Withdrawals			
	Historic Discharges			
	Historic Groundwater Use			
	Historic Interbasin Transfers		DNR/DHEC	
	Historic Population	Estimate historical withdrawals absent data	US Census	Surrogate for actual withdrawal data
Potential Use for Gap Filling	Drought Management Requirements	Estimate changes in water user withdrawals given hydrologic conditions	DNR/DHEC	All data gathered as part of model development, but may be utilized for gap filling of UIFs
	Contingency Plan Requirements	Estimate changes in water user withdrawals given hydrologic conditions		
	Spatially distributed acreage of crop types	Estimate historical agricultural water demand and return flows		

5.3 Unregulated Flow Estimation

Unregulated flows are flows with the timing impacts from reservoirs removed. Unregulated flows are estimated by computing stream flow from changes in reservoir storage. No reservoirs of significant size are present in the Edisto; therefore, unregulated flow estimation is not necessary. Furthermore, the process of UIF calculation has been compressed into a single equation that accounts for flow regulation as one of several types of impairment.

5.4 Gap Filling Techniques

As stated in **Section 4**, the period of record for the basin will begin with the first date that any USGS gage began recording streamflow. Hydrologic records will be extended, filled, or created for sites in the model that meet one or more of the following criteria:

- Sites with USGS gages that began recording after the earliest start date in the basin
- Sites with USGS gages that have gaps in their records

- Ungaged tributaries that will be modeled explicitly in SWAM (Sections 4 and 8 of the November 2014 *South Carolina Surface Water Quantity Models Modeling Plan* discuss explicit and implicit tributaries)

As noted, management practices that have been recorded (withdrawals, discharges, etc.) will likely require record extension using hindcasting approaches. The various techniques to fill in data gaps are described below in **Sections 5.4.1** through **5.4.5**. Decisions on which method to use will be made on a case-by-case basis, based on available data, confidence in the data, and the nature of the incomplete data. In some cases, it may be best to combine methods, or apply more than one for validation purposes.

5.4.1 Streamflow Transposition by Area Ratios *(For extension, gap filling, or full synthesis of historical flows in ungaged or partially gaged basins)*
Where good correlation exists between overlapping periods of streamflow records, or where hydrologic and physical features (drainage area, land use, slope) of an ungaged or incompletely gaged basin correlate well with a nearby gaged reference basin, the correlated reference gage will be used to generate a new synthetic timeseries of flows, or to fill gaps in an existing dataset. Basin area ratios will be applied, and possibly adjusted by correction factors from empirical observations of overlapping periods of record, or literature values related to the magnitude of difference in the area (which may have more of an influence on daily flows than on monthly flows). Reference gages will selected based on proximity to the ungaged or incompletely gaged basin, as well as similarities (to the greatest extent practical based on data availability) in drainage basin land use, size, and slope. For the Edisto, references gages from the Saluda basin may be considered for use in addition to those in the Edisto.

5.4.2 MOVE.1 Technique *(For basins with partial streamflow records)*
Periods of missing streamflow data can be filled based on flow in nearby measured streams using the Maintenance of Variance Extension (MOVE.1) technique (Hirsch, 1982)[1] MOVE.1 is a statistical flow record extension technique that fills missing data in a streamflow record (y) based on flow in a nearby reference stream gage (x) while preserving the statistics in basin *y*. The method, and variations of it, have been employed in other U.S. statewide water plans, such as for the Oklahoma Comprehensive Water Plan 2011 Update. The technique shown in the equation below uses the mean (m) and standard deviation (s) of the two streams (the index 'i' is the daily timestep).

$$y_i = m_y + \frac{s_y}{s_x} \cdot (x_i - m_x) \qquad \textbf{(Equation 2)}$$

The selection of an appropriate reference gage will be an important aspect of applying MOVE.1. It is preferred that only nearby reference gages be used for any given basin. Additionally, reference

[1] R.M. Hirsch, 1982: *A Comparison of Four Streamflow Record Extension Techniques.* Water Resources Research, Volume 18, Issue 4, pages 1081–1088, August 1982.

basins will be selected so that basin size, land use, and slope are similar to the characteristics of the basin whose record is to be extended as closely and as practically as possible, based in large part on data availability. Any overlapping data will be checked for reasonable correlation before final selection of reference gages.

Also, if statistics for the reference basin differ substantially between the periods for which the basin with data gaps has data and is missing data, a determination will be made as to whether to apply statistics for the entire record or just periods over which the statistics are relatively stable, and which include the gaps to fill.

As part of the UIF dataset development for the Saluda River Basin, CDM Smith conducted testing of the MOVE.1 method for record extension, as well as a variation of it which did not include log transformations. Based on the results of the testing, the log transformations generally gave better results; therefore, the MOVE.1 method as described by Hirsch will be followed in most cases, though because of known bias that the log transformation can produce, correlation tests (and subsequent record extension) can also be conducted with the raw flow data if the overlapping period is sufficiently long and broad enough across the hydrologic spectrum to distinguish one method as clearly preferable.

When deciding between using Area Ratio or MOVE.1, if one method is clearly preferred over the other for different hydrologic regimes, and can produce a good fit to observed data, CDM Smith will apply a "hybrid" approach that uses both methods, and define the flow threshold at which to switch from one method to the other. If neither method can reproduce high flows well, CDM Smith will consider MOVE.1 with the entire period of record and straight flows (i.e., without the log transform) for high flows only. Tests confirm that this method may sometimes be best for high flows.

CDM Smith will also endeavor to manually smooth daily flows where run-of-river operations or other stream impairments have produced unnatural "noise". Moving averages will be applied in instances where it appears that run-of-river operations are creating unrealistic, single day spikes in the record. The smoothing of the data, where appropriate, will eliminate much of the noise that is transferred to downstream UIFs. Generally, smoothing techniques will be applied where it's possible to identify a likely cause of the sudden spike or dip in UIF estimates, which are not a result of the natural hydrology.

5.4.3 Regression on Overlapping Flow Periods, Precipitation, Temperature, and Watershed Features *(for basins with partial records)*

In some cases, area transposition is not robust enough to cover the full range of hydrologic conditions in a basin, especially on a daily basis. In these cases, regression equations can be developed based on overlapping periods of streamflow record with a longer reference gage, provided there is good correlation between the two. Features such as basin size, level of development, and basin slope may be useful as additional predictive variables for streamflow. It is unlikely that precipitation or temperature will be highly correlated with streamflow on a daily basis, but these records can also be checked for correlation and included in multivariate regression analysis if statistically valid correlation can be demonstrated.

5.4.4 Hindcasting Historical Operations (For basins with undocumented operations that affect streamflow)

This method refers to the operational components of UIFs, as opposed to the hydrologic components discussed above. Generally, the operational gaps are filled FIRST in order to calculate UIFs for the period of record corresponding to each individual gage. The project team has contacted water users throughout the Edisto basin to augment historical information on operating practices (withdrawals, discharges, impoundment management, etc.) that may not be recorded in databases extending back as far as the USGS gage records. Based on information collected, historical undocumented operations can be estimated using start dates, trend analysis for hindcasting, relationships to population, etc. These synthetic operating records can then be used in UIF calculation.

5.5 Unimpaired Flow Calculations

Once data gaps are filled, UIFs can be developed by removing the impacts of changes in volume. This includes withdrawals and/or discharges from water users along a river reach. Discharges and withdrawals come from one or more of the water users and dischargers listed in **Section 3**.

Using unregulated flow as a variable, UIFs in the Edisto basin will be computed using the following general equation:

UIF = Measured Gage Flow + River Withdrawals - River Discharges - Irrigation Return Flow – Septic/Other Return Flow

(**Equation 3)**

UIFs will be developed for every stream gage and every major tributary and/or tributary that has managed flows. These particular tributaries will be modeled explicitly. If gage data is not available for such tributaries, synthetic UIFs will be developed to represent these reaches. Smaller tributaries without a gage and without managed flows will be modeled implicitly and do not require development of synthetic UIFs.

Rather than compute UIFs for individual additive reaches from upstream to downstream (a process by which error can accumulate), CDM Smith will compute UIFs for the entire upstream area of each gage, and subtract upstream UIFs to determine incremental UIFs between gages. This avoids accumulation or error or uncertainty by adding calculated UIFs together into a network.

A subsequent report will be issued with the completed UIF datasets to help explain how they were computed, and what assumptions were made. This report will include:

- Data sources
- Specific gap filling measures and where they were applied (and why)
- Examples of each step in the process of computing different types of UIFs, including direct computations from data, operational gap filling, and hydrologic record extension/filling techniques.

6.0 Issues Specific to the Edisto Basin

6.1 Groundwater

Registered and permitted (both active and inactive) groundwater withdrawal locations are shown in **Figure 6-1**. Between 2002 and 2013, total reported groundwater withdrawals for municipal, industrial, mining, golf course, and agricultural purposes in the Edisto basin averaged between 33 and 53 mgd.

Groundwater withdrawals may lower streamflow to a point that they potentially influence UIF estimates in a significant manner if the following conditions are met:

- The withdrawal occurs in an aquifer that contributes baseflow to a stream via direct groundwater discharge.
- The withdrawals are greater than 100,000 gpd.
- A significant portion of the withdrawal is not returned to the stream as a wastewater discharge or to the surficial aquifer via onsite wastewater treatment systems (septic tanks). For example, groundwater withdrawals for irrigation of golf courses or agriculture are expected to be mostly lost to evapotranspiration. Very little is returned to the stream via direct or indirect runoff.

In much of the Edisto basin, registered groundwater withdrawals will likely not meet these conditions, and can therefore be ignored when calculating UIFs; however, larger groundwater withdrawal will be reviewed for consideration.

The combined net amount of groundwater withdrawals from private wells (individual wells not permitted or registered) that is not returned to the surficial aquifer system via onsite wastewater systems is not expected to significantly lower stream baseflow in any area of the basin, such that consideration of these withdrawals is necessary in calculating UIFs.

6.2 Agriculture

Registered agriculture surface withdrawal locations in the Edisto basin were shown in **Figure 3-2. The Edisto basin has the largest number of registered agricultural withdraws of any basin in the state.** Of the 31 registered agricultural surface water users, all six had reported water withdrawals greater than 3 mg/m in any one month over the last 5 years (2009-2013).

Withdrawals for agricultural irrigation are currently assumed to be 100 consumptive. For the UIF calculations, no return flows are assumed.

6.3 Losses of River Flow to Groundwater

Certain reaches of the Edisto River may exhibit hydrologic losses to groundwater as water flows downstream. In such cases, these losses can be included in the SWAM model either as a LOSS function for a particular reach, or as a time history of losses (difference between upstream and downstream UIFs) represented as a withdrawal by a non-user, with no return flow.

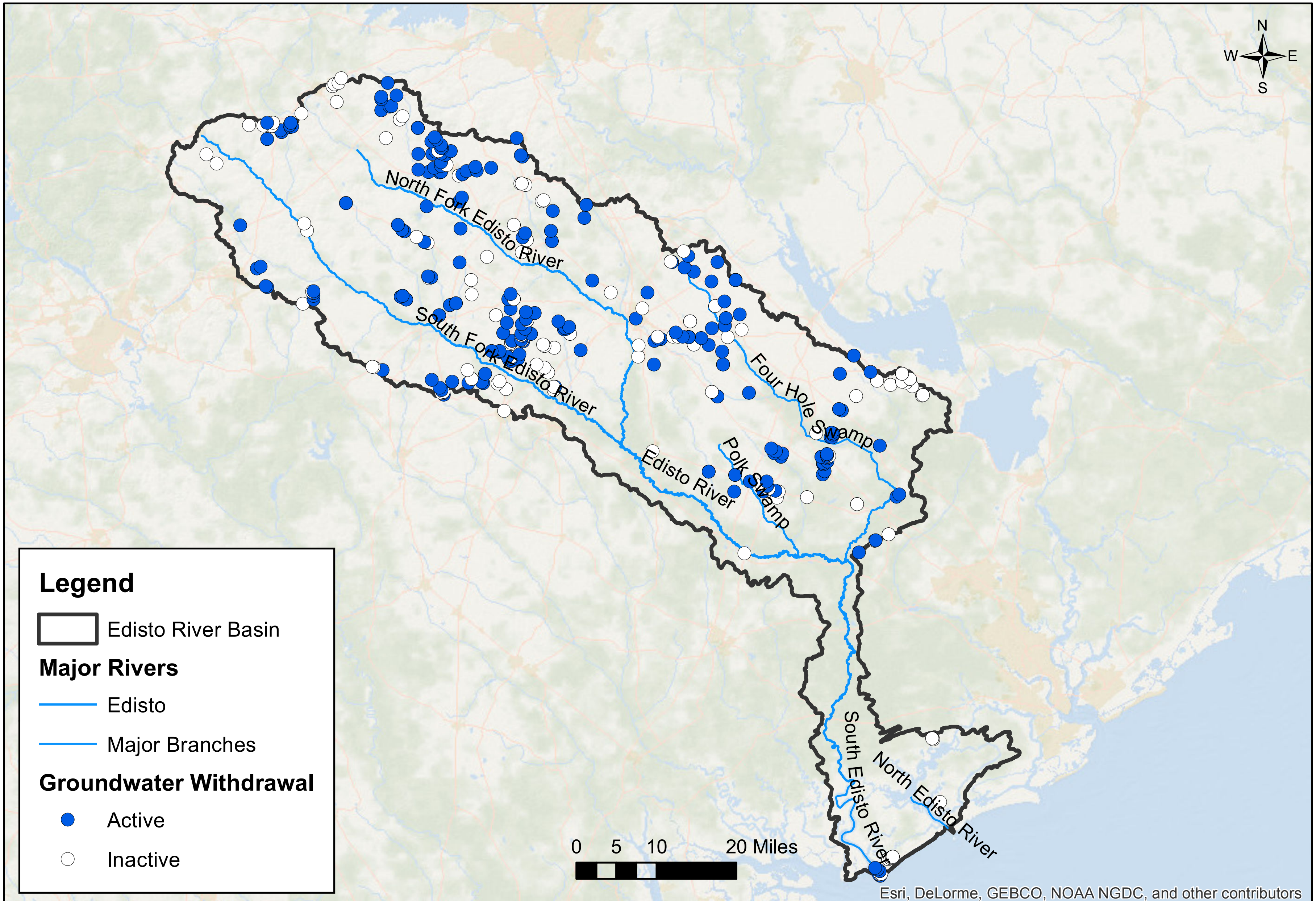
7.0 Validation of UIFs

Independent checks on final calculated unimpaired flows will occur as part of the surface water model calibration and validation task. Basin-specific surface water allocation models constructed using SWAM will include all the same major withdrawals, return flows, storage reservoirs, and tributaries used to calculate the UIFs described above. In contrast to the UIF calculations, however, SWAM will include spatially continuous flow balance calculations that originate with UIF inputs upstream and incorporate the impacts of reach gains/losses and management activity, rather than calculations for specific downstream nodes.

Flow regimes are constructed in the model from the top of a simulated reach to the bottom based on headwater flows, tributary inputs, and calibrated reach gains or losses. Unimpaired flows are used directly in the models in upstream headwater locations, or areas that are not affected by upstream management activity. However, as the stream network develops and management activity is simulated, UIFs at downstream nodes are *not* used directly as inputs to the models, but will be available for comparative purposes to managed flows. Downstream gaged flows, which include existing development and flow impairment, will be used as calibration targets in the modeling.

Reach gains or losses and ungaged tributary flows will serve as the primary calibration parameters. Following calibration, UIFs at downstream nodes can be easily extracted from SWAM by "turning off" upstream water uses and storage and simulating historical periods. The resulting modeled downstream flows essentially represent simulated unimpaired flows for the given historical period. These downstream flows, calculated by removing upstream water users and storage in the model, can be used to confirm and validate the previously calculated UIFs – That is, we will check the comparability between a UIF at a downstream node (calculated per the procedures outlined in previous sections) and the simulated Unimpaired Flow at that location by removing the management objects from the calibrated model. When upstream management activity is removed from the model, the resulting flow at a given node *should* match the calculated UIF for that node. The model and downstream UIF calculations, therefore, can corroborate each other.

It is likely that the SWAM calibration period will not extend as far as the UIF calculation period. The SWAM models will be calibrated using only periods well supported by data and where there is high confidence in the model input data. These periods may or may not exactly coincide with the full UIF calculation periods. Model development (programming and data entry) and calibration are two separate tasks, and it is not possible to predetermine the model calibration periods until all available data has been collected and reviewed. However, once calibrated, “baseline” historical models will be constructed with simulation periods that match the UIF periods.



CDM Smith

Figure 6-1
Active and Inactive Groundwater Withdrawal Locations

ATTACHMENT A

Telephone Questionnaires for Water Users
To Supplement Information on Historical Flow Management

Script for <u>Water Supply (WS)</u> Water User

Contact the water user, following the suggested script below.

Hello, my name is __________ with CDM Smith. As you may be aware, South Carolina DNR and DHEC have begun a two-year project to conduct surface water availability assessment modeling for each of the State's eight major river basins. CDM Smith has partnered with DNR and DHEC to assist with this process.

One of our first responsibilities is to characterize the natural hydrologic conditions in each basin, and we'll do this by blending historic streamflow measurements with historic records of water usage. I'm calling you today to solicit your help in confirming our understanding of the history of your water source(s) and operation, and to collect additional data that may be useful to characterize and quantify your utility's historical water use. You may have recently received a letter from DHEC indicating that we would be contacting you. This should only take about 5 to 10 minutes of your time.

You will hear more about the project in the coming months. DNR is in the process of procuring a facilitator to help engage stakeholders in each basin. The facilitator will be organizing meetings to provide additional information regarding the water quantity modeling and subsequent phases of the state water planning effort.

Do you mind if I ask you a few questions about your utilities water withdrawals, both current and historical, or is there someone else that I should speak with?

As I mentioned, one of the first steps in the process is the development of naturalized flows, which are basically estimates of past river flows without any man-made influences such as withdrawals discharges, and dams. These are based in-part on historical records of withdrawal and discharges.

You have provided DHEC with monthly withdrawal data dating from _________ to _____________.

- *Did your utility withdraw surface water prior to ________?*
- **[if Yes]** *Do you have data quantifying the withdrawal amounts prior to ___________, or if not, can you provide estimated average monthly or annual water use prior to ___________?*
- *Has your water source(s) ever changed?*
- *Have multiple sources ever been used?*
- **[Only if multiple sources are used]** *What are your priorities/rules for withdrawing water if multiple sources are used?*

- *Do you have offline storage reservoirs (*not tanks*)? If yes, is storage/area/elevation data available?*

- *Do you have interconnections with other systems?*

- *Do you purchase water from or sell water to other utilities? Have you historically purchased or sold water (but no longer do so)?*

- **[Only if they do not have a Drought Contingency Plan]** *Have you prepared a Drought Contingency Plan and have you used it?*

- **[If they have a Drought Contingency Plan]** *Have you had to use your Drought Contingency Plan in the past?*

- **[If they have an NPDES permit]** *We have your reported NPDES discharge amounts for your utility dating from _________ to _________. Do you have any records of discharge prior to __________?* **[May not need to ask this depending on the situation. Also, we may need to contact some on the wastewater side of their utility, instead].**

- **[For some utilities which also operate WWTPs, their wastewater is stored in holding ponds when the stream's flow and assimilative capacity are low. Water may be withdrawn from the stream but not returned as wastewater while instream flow remains low. This is a "controlled discharge". Ask them the following question:]** *Does your WWTP ever use controlled discharges?*

- **[Only if they have an interbasin transfer permit]** *Can you describe your interbasin transfer* (e.g. is it a constant transfer, or used only in emergency such as through an interconnection to another utility?*) Do you have records quantifying your historical interbasin transfers?*

Thank you very much for your time. To follow-up, I am going to e-mail to you a memorandum documenting my understanding of the information we have discussed today and listing any additional data needs. If you could review the letter, provide corrections or clarifications, and include any additional withdrawal or other data we discussed within the next 30 days, I would appreciate it. I can be reached by phone at ________________ or e-mail at ________________________.

I have your e-mail address as ____________________________. **[Or if we don't have their e-mail address, ask for it]**

Thanks again for your time.

Script for <u>Golf Course (GC)</u> Water User

Contact the water user, following the suggested script below.

Hello, my name is __________ with CDM Smith. As you may be aware, South Carolina DNR and DHEC have begun a two-year project to conduct surface water availability assessment modeling for each of the State's eight major river basins. CDM Smith has partnered with DNR and DHEC to assist with this process.

One of our first responsibilities is to characterize the natural hydrologic conditions in each basin, and we'll do this by blending historic streamflow measurements with historic records of water usage. I'm calling you today to solicit your help in confirming our understanding of the history of your water source(s) and operation, and to collect additional data that may be useful to characterize and quantify your utility's historical water use. You may have recently received a letter from DHEC indicating that we would be contacting you. This should only take about 5 to 10 minutes of your time.

You will hear more about the project in the coming months. DNR is in the process of procuring a facilitator to help engage stakeholders in each basin. The facilitator will be organizing meetings to provide additional information regarding the water quantity modeling and subsequent phases of the state water planning effort.

Do you mind if I ask you a few questions about your water withdrawals, both current and historical, or is there someone else that I should speak with?

As I mentioned, one of the first steps in the process is the development of naturalized flows, which are basically estimates of past river flows without any man-made influences such as withdrawals discharges, and dams. These are based in-part on historical records of withdrawal and discharges.

You have provided DHEC with monthly withdrawal data dating from _________ to _____________.

- *Did your golf course withdraw <u>surface water</u> prior to ________?*
- **[if Yes]** *Do you have data quantifying the withdrawal amounts prior to ____________, or if not, can you provide estimated average monthly water use prior to ___________?* **[Many golf courses may only irrigate April-October]**
- *Has your water source(s) ever changed?* **[Make sure you develop an understanding of groundwater use vs. surface water use, if both have been used. Often, they may pump groundwater to a pond, then withdraw from the pond to irrigate – which is not considered surface water use.**
- *Have multiple surface water sources ever been used?* **[Not likely]**

Thank you very much for your time. To follow-up, I am going to e-mail to you a memorandum documenting my understanding of the information we have discussed today and listing any additional data needs. If you could review the letter, provide corrections or clarifications, and *include any additional withdrawal or other data we discussed within the next 30 days, I would appreciate it. I can be reached by phone at ___________________ or e-mail at ____________________________.*

I have your e-mail address as _________________________________. **[Or if we don't have their e-mail address, ask for it]**

Thanks again for your time.

Script for <u>Industrial (IN)</u> and <u>Mining (MI)</u> Water User

Contact the water user, following the suggested script below.

Hello, my name is __________ with CDM Smith. As you may be aware, South Carolina DNR and DHEC have begun a two-year project to conduct surface water availability assessment modeling for each of the State's eight major river basins. CDM Smith has partnered with DNR and DHEC to assist with this process.

One of our first responsibilities is to characterize the natural hydrologic conditions in each basin, and we'll do this by blending historic streamflow measurements with historic records of water usage. I'm calling you today to solicit your help in confirming our understanding of the history of your water source(s) and operation, and to collect additional data that may be useful to characterize and quantify your utility's historical water use. You may have recently received a letter from DHEC indicating that we would be contacting you. This should only take about 5 to 10 minutes of your time.

You will hear more about the project in the coming months. DNR is in the process of procuring a facilitator to help engage stakeholders in each basin. The facilitator will be organizing meetings to provide additional information regarding the water quantity modeling and subsequent phases of the state water planning effort.

Do you mind if I ask you a few questions about your utilities water withdrawals, both current and historical, or is there someone else that I should speak with?

As I mentioned, one of the first steps in the process is the development of naturalized flows, which are basically estimates of past river flows without any man-made influences such as withdrawals discharges, and dams. These are based in-part on historical records of withdrawal and discharges.

You have provided DHEC with monthly withdrawal data dating from _________ to _____________.

- *Did your plant withdraw surface water prior to ________?*
- **[if Yes]** *Do you have data quantifying the withdrawal amounts prior to ____________, or if not, can you provide estimated average monthly or annual water use prior to ___________?*
- *Has your water source(s) ever changed?*
- *Have multiple sources ever been used?*
- *Do you have offline storage reservoirs (*not tanks*)? If yes, is storage/area/elevation data available?*
- *Do you have interconnections with other systems?*

- *Do you also purchase water from a nearby utility? Have you historically purchased or water (but no longer do so)?*

- **[If they have an NPDES permit]** *We have your reported NPDES discharge amounts for your utility dating from _________ to __________. Do you have any records of discharge prior to ___________?* **[May not need to ask this depending on the situation.]**

- **[Only if they have an interbasin transfer permit]** *Can you describe your interbasin transfer* (e.g. is it a constant transfer, or used only in emergency such as through an interconnection a utility?*) Do you have records quantifying your historical interbasin transfers?*

Thank you very much for your time. To follow-up, I am going to e-mail to you a memorandum documenting my understanding of the information we have discussed today and listing any additional data needs. If you could review the letter, provide corrections or clarifications, and include any additional withdrawal or other data we discussed within the next 30 days, I would appreciate it. I can be reached by phone at _________________ or e-mail at _________________________.

I have your e-mail address as _____________________________. **[Or if we don't have their e-mail address, ask for it]**

Thanks again for your time.

Script for Power/Thermal (PT) and Nuclear (PN) Water User

Hello, my name is __________ with CDM Smith. As you may be aware, South Carolina DNR and DHEC have begun a two-year project to conduct surface water availability assessment modeling for each of the State's eight major river basins. CDM Smith has partnered with DNR and DHEC to assist with this process.

One of our first responsibilities is to characterize the natural hydrologic conditions in each basin, and we'll do this by blending historic streamflow measurements with historic records of water usage. I'm calling you today to solicit your help in confirming our understanding of the history of your water source(s) and operation, and to collect additional data that may be useful to characterize and quantify your utility's historical water use. You may have recently received a letter from DHEC indicating that we would be contacting you. This should only take about 5 to 10 minutes of your time.

You will hear more about the project in the coming months. DNR is in the process of procuring a facilitator to help engage stakeholders in each basin. The facilitator will be organizing meetings to provide additional information regarding the water quantity modeling and subsequent phases of the state water planning effort. Do you mind if I ask you a few questions about your facilities water withdrawals, both current and historical, or is there someone else that I should speak with?

As I mentioned, one of the first steps in the process is the development of naturalized flows, which are basically estimates of past river flows without any man-made influences such as withdrawals discharges, and dams. These are based in-part on historical records of withdrawal and discharges.

You have provided DHEC with monthly withdrawal data dating from _________ to _____________.

- *Did your facility withdraw surface water prior to ________?*
- **[if Yes]** *Do you have data quantifying the withdrawal amounts prior to ____________, or if not, can you provide estimated average monthly or annual water use prior to ___________?*
- *We have your reported NPDES discharge amounts for your utility dating from _________ to __________. Do you have any records of discharge prior to ___________?*

Thank you very much for your time. To follow-up, I am going to e-mail to you a memorandum documenting my understanding of the information we have discussed today and listing any additional data needs. If you could review the letter, provide corrections or clarifications, and include any additional withdrawal or other data we discussed within the next 30 days, I would appreciate it. I can be reached by phone at _________________ or e-mail at _________________________.

I have your e-mail address as _____________________________. **[Or if we don't have their e-mail address, ask for it]**

Thanks again for your time.