Broad River Basin Water-Demand Projections

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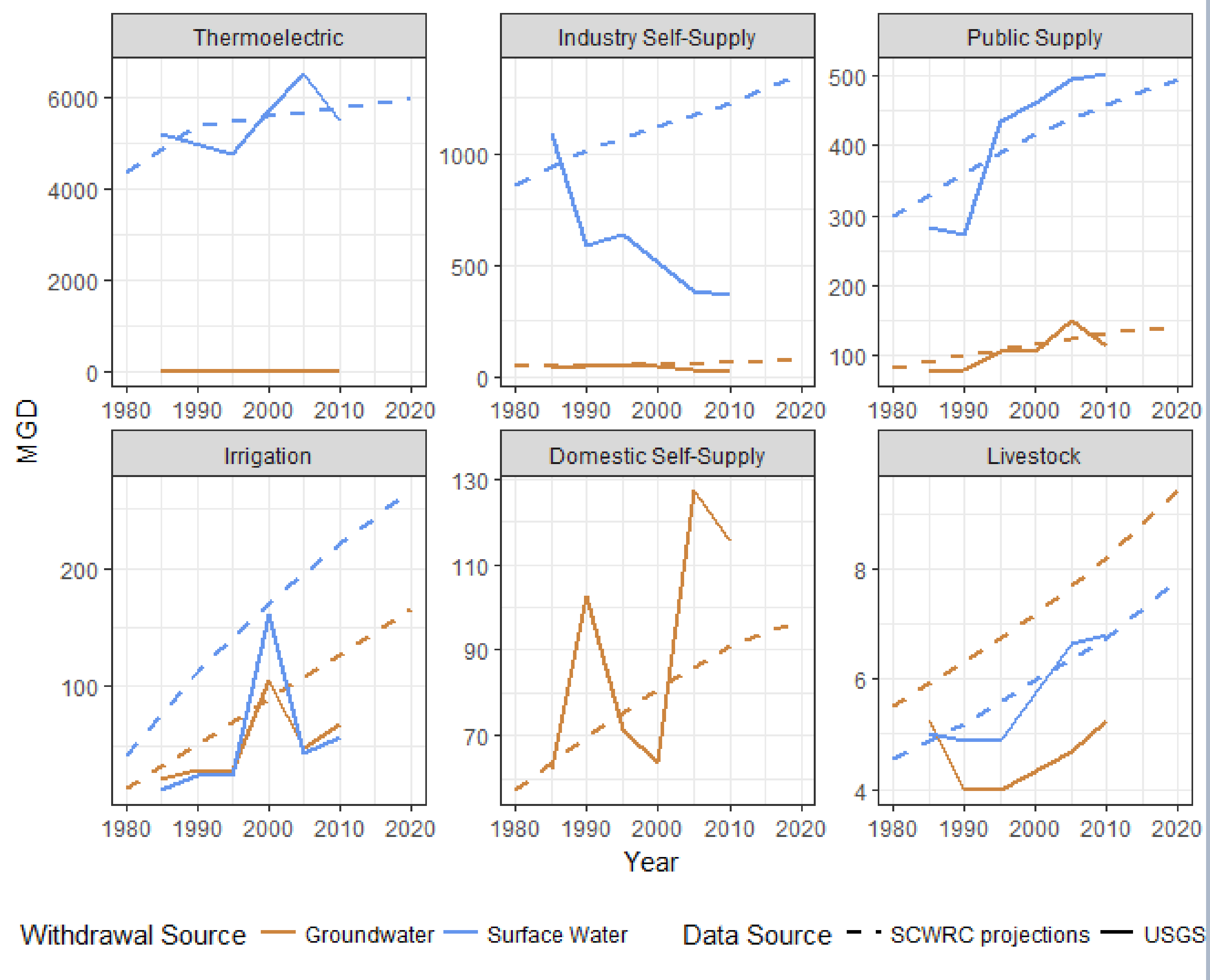
Is It Possible to Predict the Future?



Projections are not forecasts

Forecast

- Educated guess.
- Based on expected conditions and actions.
- Timeframe limited by predictability of future conditions.
- Aim to be accurate.

Projection

- Extrapolation of trend.
- Based on hypothetical scenarios.
- Timeframe can extend beyond the limits of effective forecasting.
- Aim to be informative.

Stakeholder Input Throughout the Process

Development of the Methods

2016 -2017 - meetings with stakeholder interest groups for input on water-demand projection methods and data sources.

- SCAWWA Water Utility Council
- SC Water Quality Association
- SC Farm Bureau Water Committee
- Chamber of Commerce Environmental Technical Committee
- SC Water Planning Process Advisory Committee (PPAC)

Stakeholder Feedback

- Water Works Association, Utility Council
  - Use weather and demographic variables for long term forecasts.
  - Consider impacts of outdoor use restrictions.
- Chamber of Commerce, Environmental Committee
  - Provide information on a reach scale for real-world application.
  - Guarantee privacy of survey responses.
- Farm Bureau, Water Committee
  - Agricultural return flows can be significant.
  - Not all cropland can be profitably irrigated.
  - Vegetables and hemp production could increase.
- Water Quality Association
  - Some systems are highly interconnected.
  - Inflow and Infiltration can be significant.

Development of the Methods

2018 - technical advisory conference calls with representation from a variety of fields of experience.

- Public water supply (17)
- Thermo-electric power (5)
- Manufacturing (5)
- Government (22)
- Consultants (4)
- Legal (2)
- Golf (2)
- Agriculture (5)
- Environment (4)
- Research & education (11)

Acknowledgements to Chrissa Waite and Stuart Norvell of USACE and Dr. Jeff Allen and Dr. Tom Walker of the SCWRC for their collaboration on developing the water demand projection methods.

Technical Advisory Committee Feedback

- General recommendations:
  - provide draft projections to local stakeholders.
  - provide an opportunity for feedback.
  - do not rely on overly complex methods.
- Sector specific recommendations:
  - **Thermo-electric**: Contact the utilities directly
  - **Public supply**: Do not rely on complex statistical methods which may underestimate demand.
  - **Industry**: Use economic output, not employment as the driver variable.
  - **Agricultural Irrigation**: A more technical method may be appropriate for projecting irrigated acreage.
  - **Golf**: A simpler projection method was recommended due to the relatively low volume of water use.

Development of the Methods

2018 – Publication of "Water Users' Perspectives: Summary of Withdrawal Survey Responses and Commentary" in *Journal of South Carolina Water Resources.*

2019 – Projection Methods for Off-stream Water Demand in South Carolina published online by SCDNR following reviews by an editorial board, the PPAC, and technical advisory conference call participants.

Pellett, C. Alex (2020) "Mapping Center Pivot Irrigation Fields in South Carolina with Google Earth Engine and the National Agricultural Imagery Program," *Journal of South Carolina Water Resources*: Vol. 7 : Iss. 1 , Article 4. Available at: https://tigerprints.clemson.edu/jscwr/vol7/iss1/4

Equations to Define the Terms

Equation 1: Water Demand Mass Balance

$$Demand = Withdrawal + Purchase + Reuse - Sales - Loss - \Delta Storage + Shortage$$

Where:

Demand	:	Off-stream water demand
Withdrawal	:	Total water withdrawal from source water bodies
Purchase	:	Total purchases of water from distributors
Reuse	:	Total reuse of water previously used for another purpose
Sales	:	Total wholesale transfers of water to another user or distributor
Loss	:	Total losses of water preventing it from being put to use
ΔStorage	:	Net change in off-stream storage
Shortage	:	Water not available to meet the objectives of water users

Equation 2: Return Flow Mass Balance

$$Return\ Flow = Discharge - Inflow\ \&\ Infiltration$$

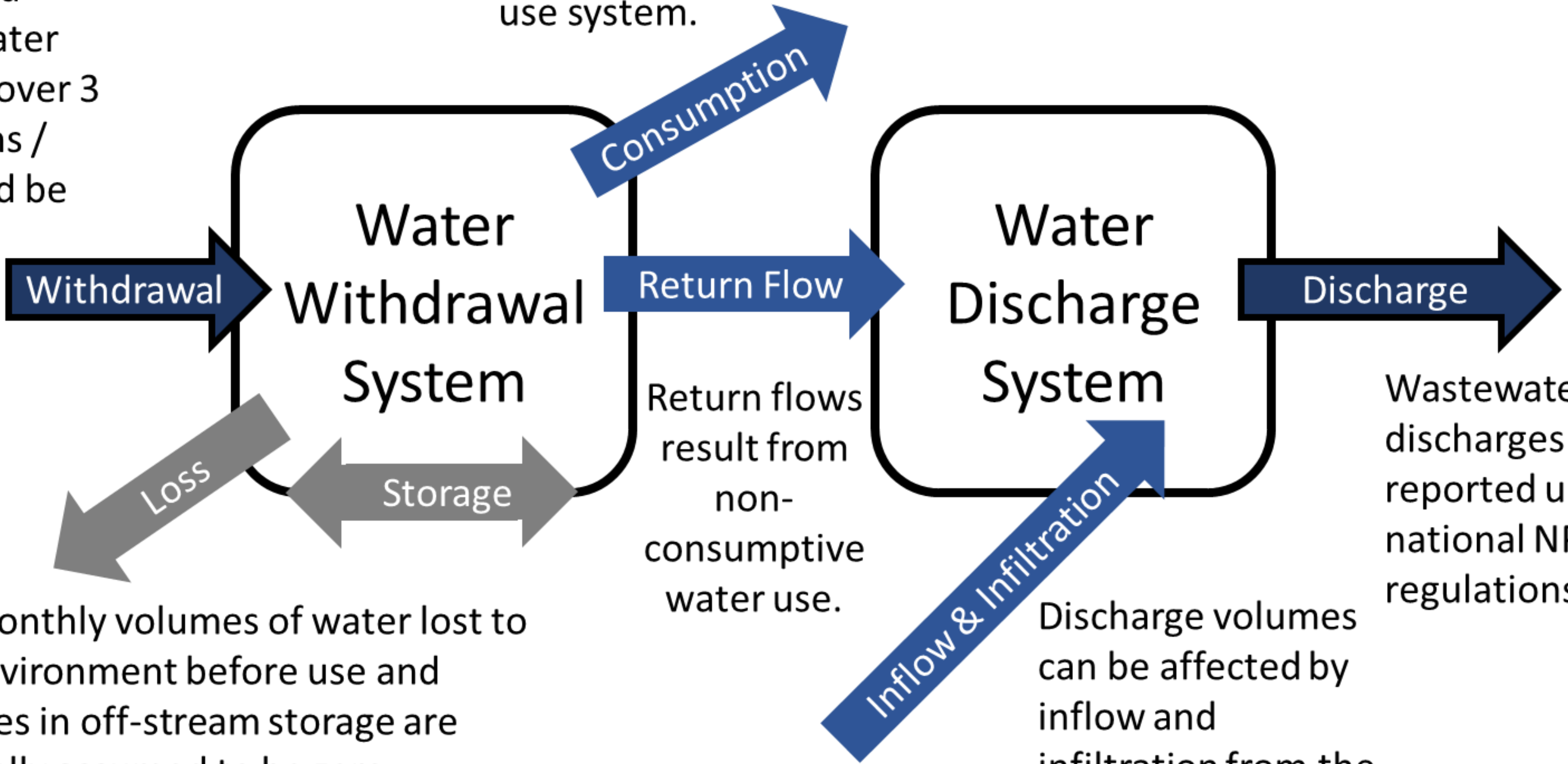
Where:

Return Flow	:	Water returned to the environment after non-consumptive uses
Discharge	:	Concentrated discharges to surface water bodies (NPDES data)
Inflow & Infiltration	:	Waste-water resulting from inflow and infiltration (I/I)

Mass Balance Illustration

Permitted and registered water withdrawals over 3 million gallons / month should be reported to SCDHEC.

Water that is used and evaporates or transpires to the atmosphere is *consumed* from the water use system.



Return flows result from non-consumptive water use.

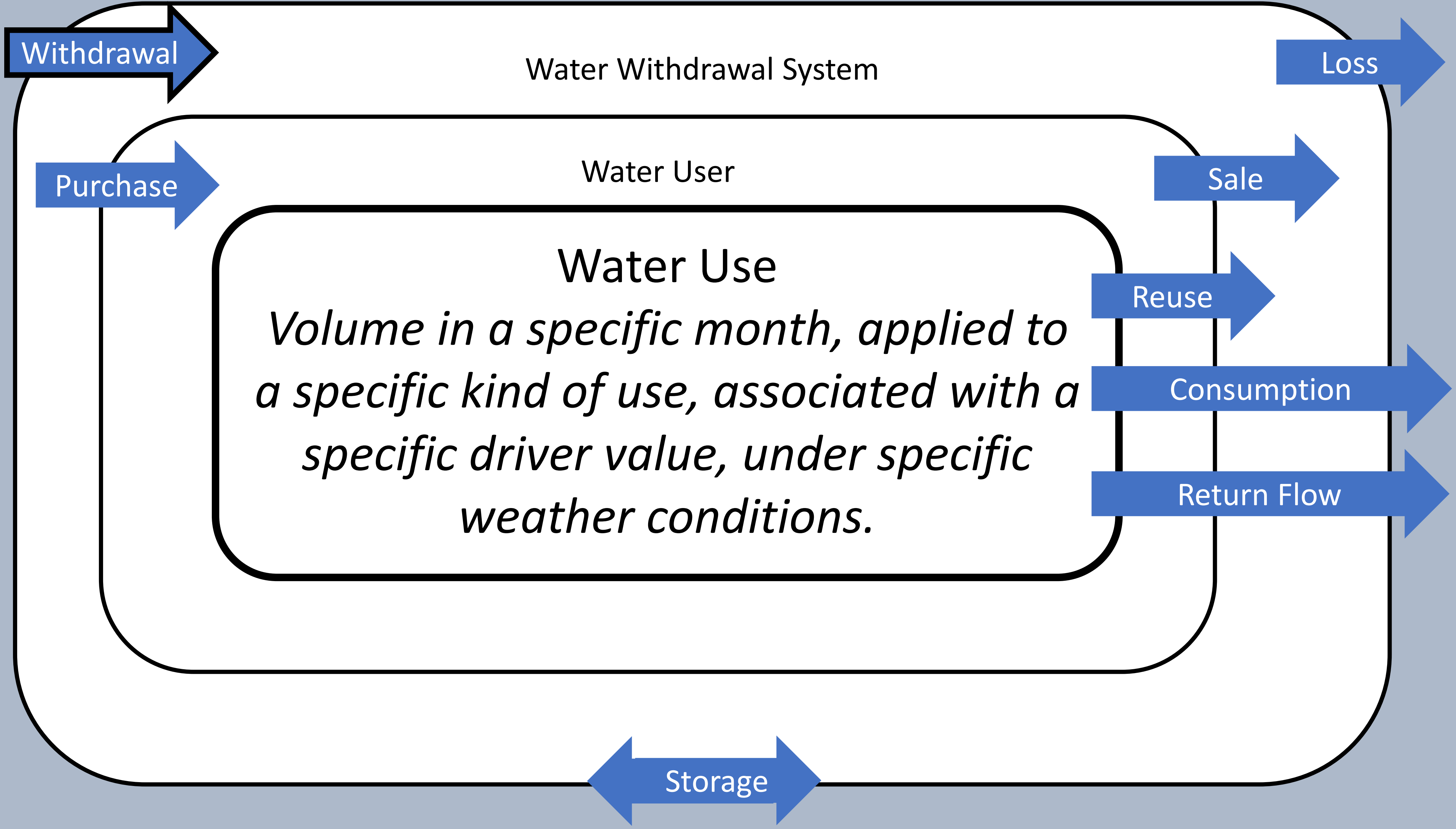
Wastewater discharges are reported under the national NPDES regulations.

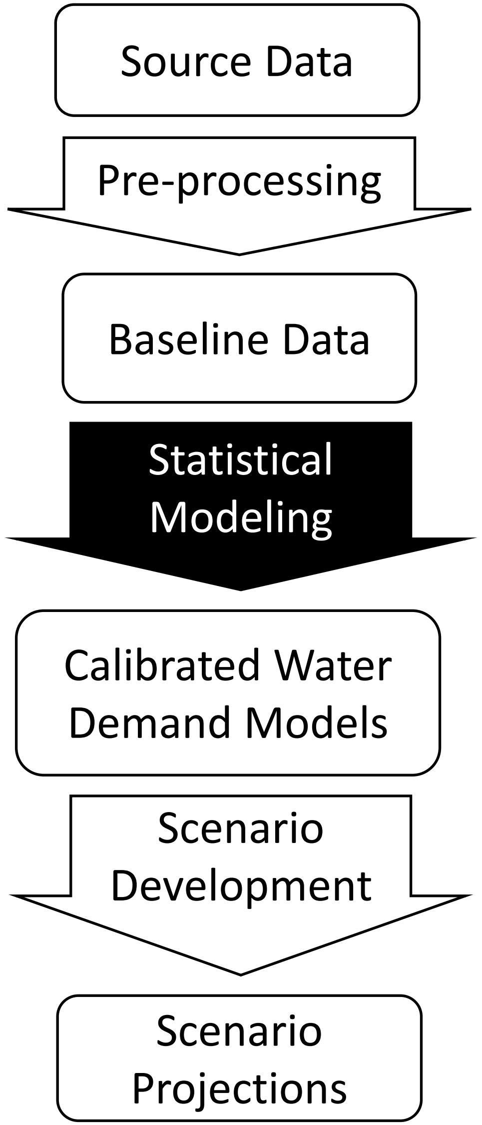
The monthly volumes of water lost to the environment before use and changes in off-stream storage are generally assumed to be zero.

Discharge volumes can be affected by inflow and infiltration from the environment.

Consumption, return flow, and inflow & infiltration are estimated over the baseline period to project future non-consumptive use.

A More Detailed Model





Equation 3 – General Model of Water Demand

$$Demand_{u,t} = \frac{Driver_{u,t} * Rate_k * Seasonality_{k,m} * \cancel{Weather_{u,t}}}{Efficiency_u}$$

Where:

Demand$_u$	:	Modeled water demand for use *u*, expressed in terms of volume per month.
Driver$_u$	:	Primary driver value for use *u*, units vary by category.
Rate$_k$	:	Median rate for kind *k* of water demand, expressed per unit of primary driver.
Seasonality$_{k,m}$	:	Median seasonality coefficient for kind *k* and calendar month *m*, unitless.
Efficiency$_u$	:	Average efficiency coefficient for use *u*, unitless.
~~*Weather*$_{u,t}$~~	~~:~~	~~Weather coefficient for use *u* at time *t*, unitless.~~

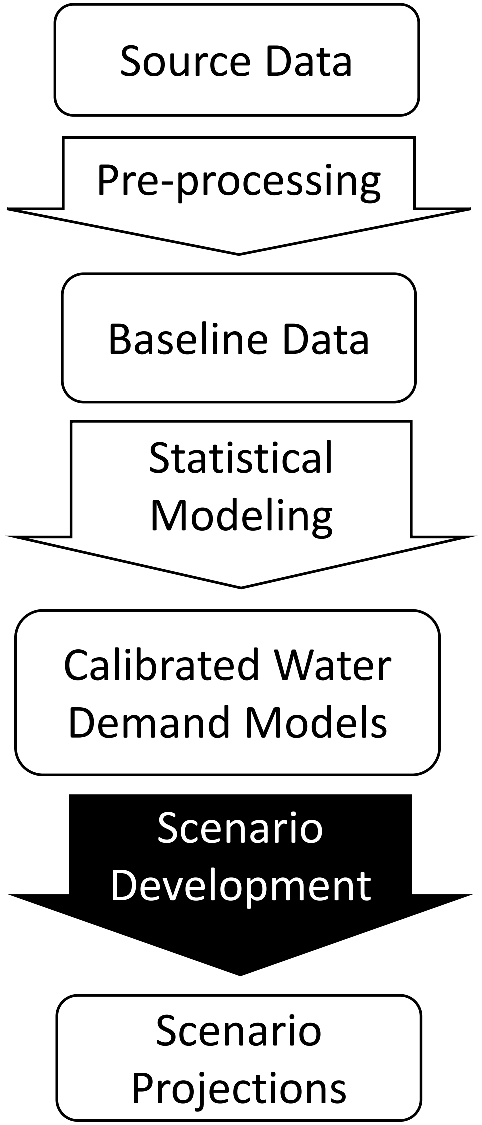
Equation 4 –Simplified Model of Water Demand

$$Demand_{u,t} = Driver_{u,t} * Rate_u * Seasonality_{u,m} + Deviation_{u,t}$$

Where:

Demand$_u$	:	Modeled water demand for use *u*, expressed in terms of volume per month.
Driver$_u$	:	Primary driver value for use *u*, units vary by category.
Rate$_u$	:	Median rate for kind *k* of water demand, expressed per unit of primary driver.
Seasonality$_{u,m}$	:	Median seasonality coefficient for kind *k* and calendar month *m*, unitless.
Deviation$_{u,t}$	:	Deviation for use *u* at time *t*, volume per month.

Business-as-usual Projections



- Water demand models derived from 2012-2017 input data will be applied to projected datasets including population, employment, and irrigated acres.
- ‘Business as Usual’ projections assume stable trends in dynamic factors, and no change in underlying relationships.
- **High-demand scenario assumes high growth and high withdrawals.**

Business-as-usual & High-demand projections will be presented to basin specific stakeholder groups.

Drivers of Water Demand

Table 1.1: Drivers of Water Demand

Category	Primary driver
Thermo-electric power	Electricity production
Public and domestic supply	Population
Manufacturing	Economic production
Agriculture and Golf Courses	Irrigated acres

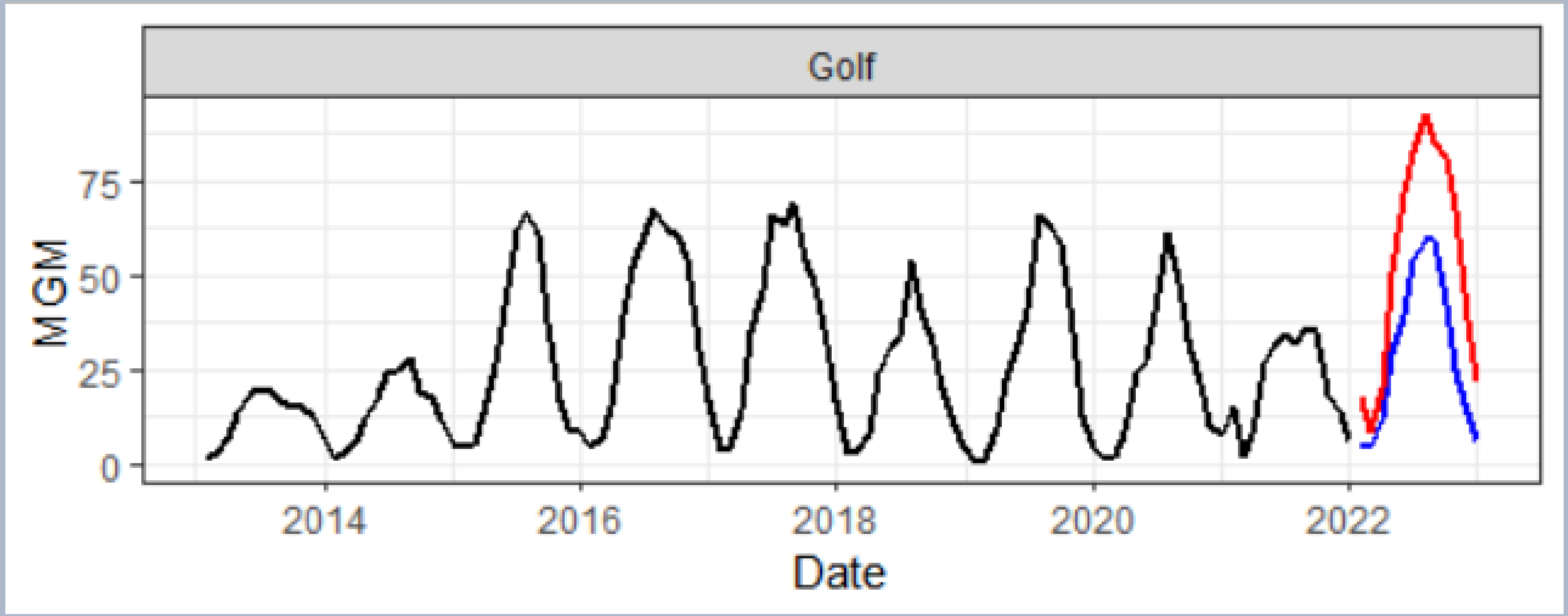
Draft Water Demand Projections

- Preliminary draft results, not yet vetted.
- For demonstration purposes only.
- Only includes users of surface water in the Broad basin.
- There will be modifications to these draft projections based on continued stakeholder feedback.
- All values are plotted as Million Gallons per Month

Mining

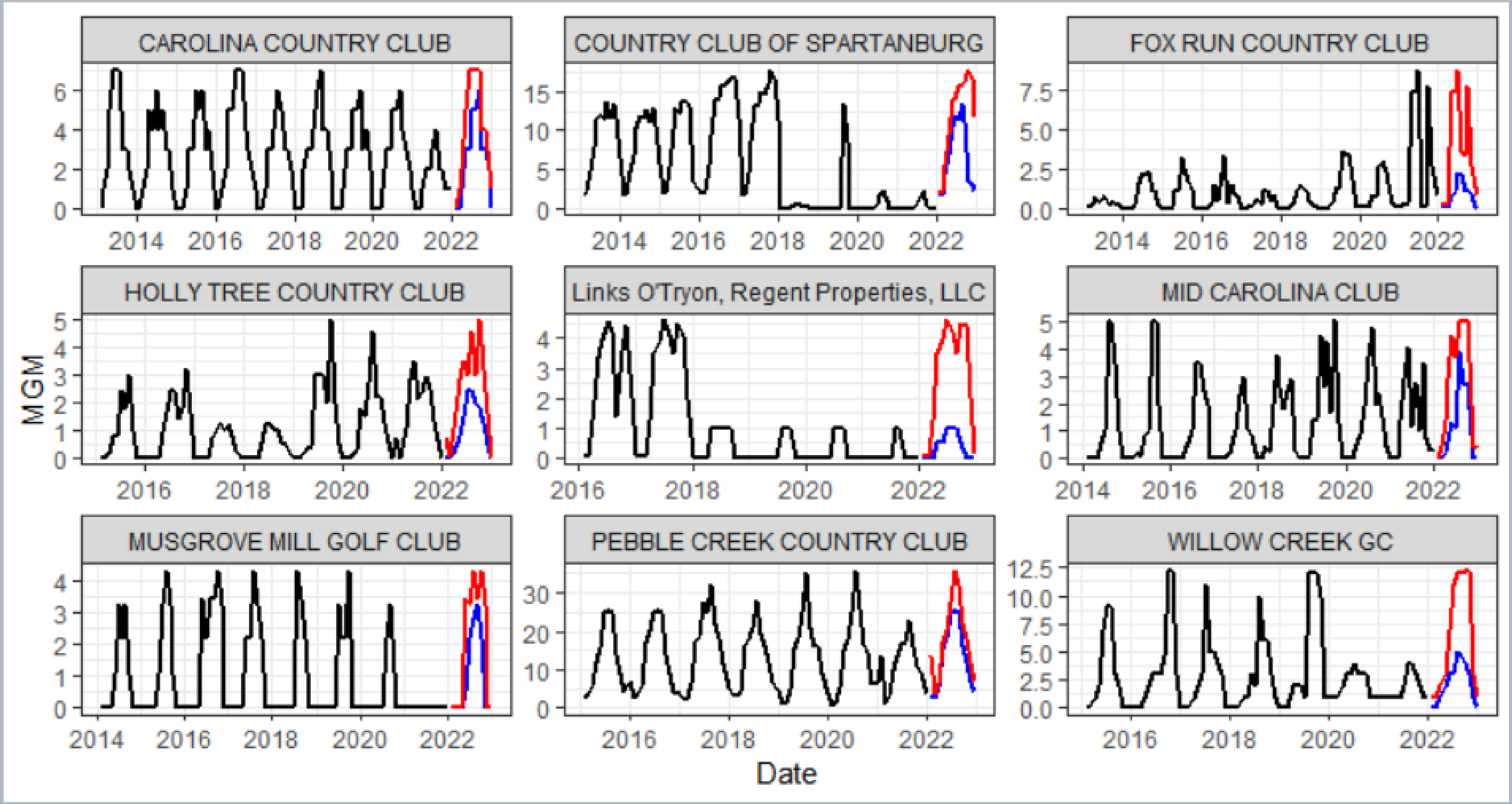
- Only one mine uses surface water in the Broad basin, a granite quarry.
- Mining water demand is not projected to change over time.

Golf Courses



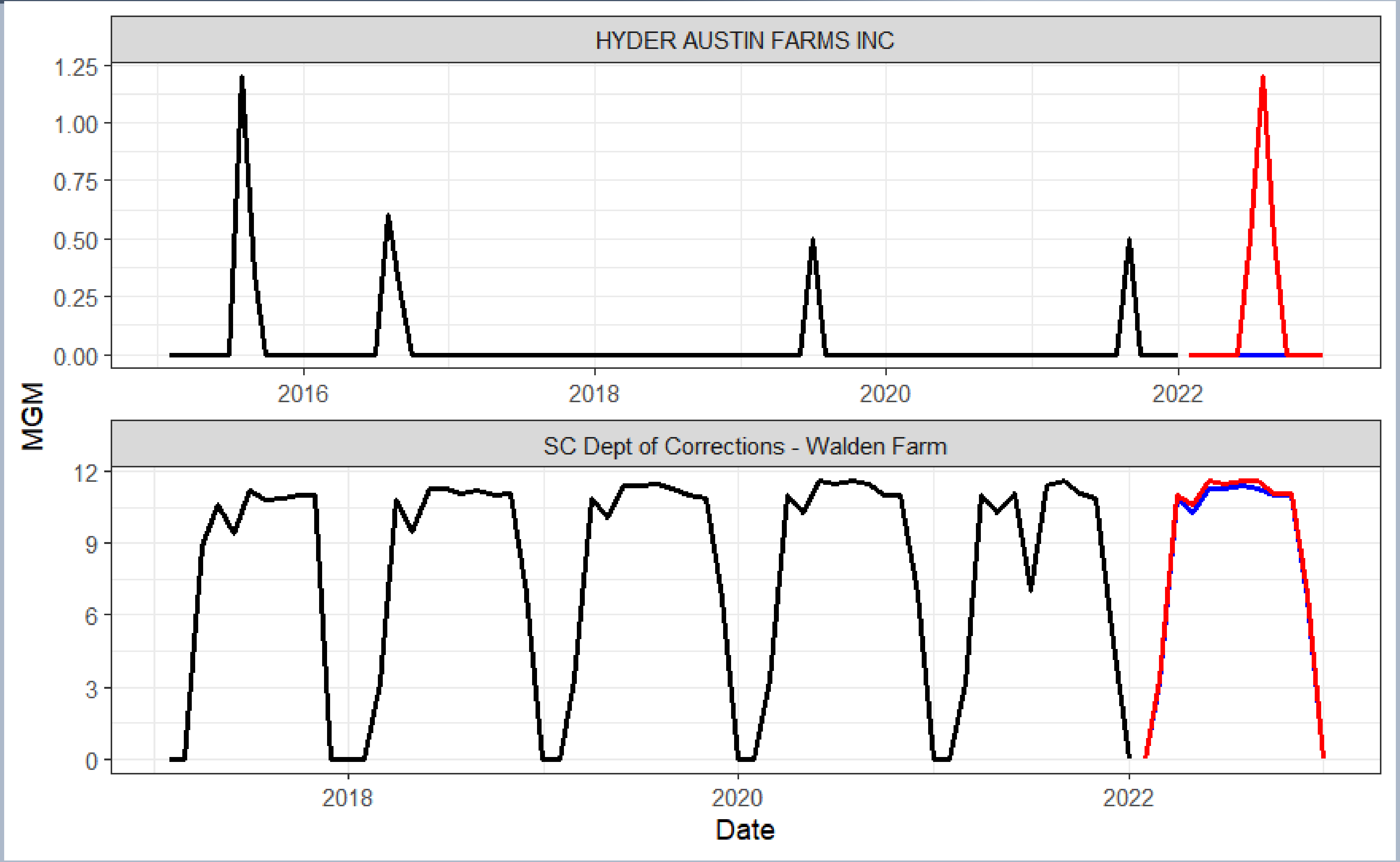
- 9 golf courses use surface water in the Broad basin.
- Golf course irrigation is not projected to change over time.

Golf Detail



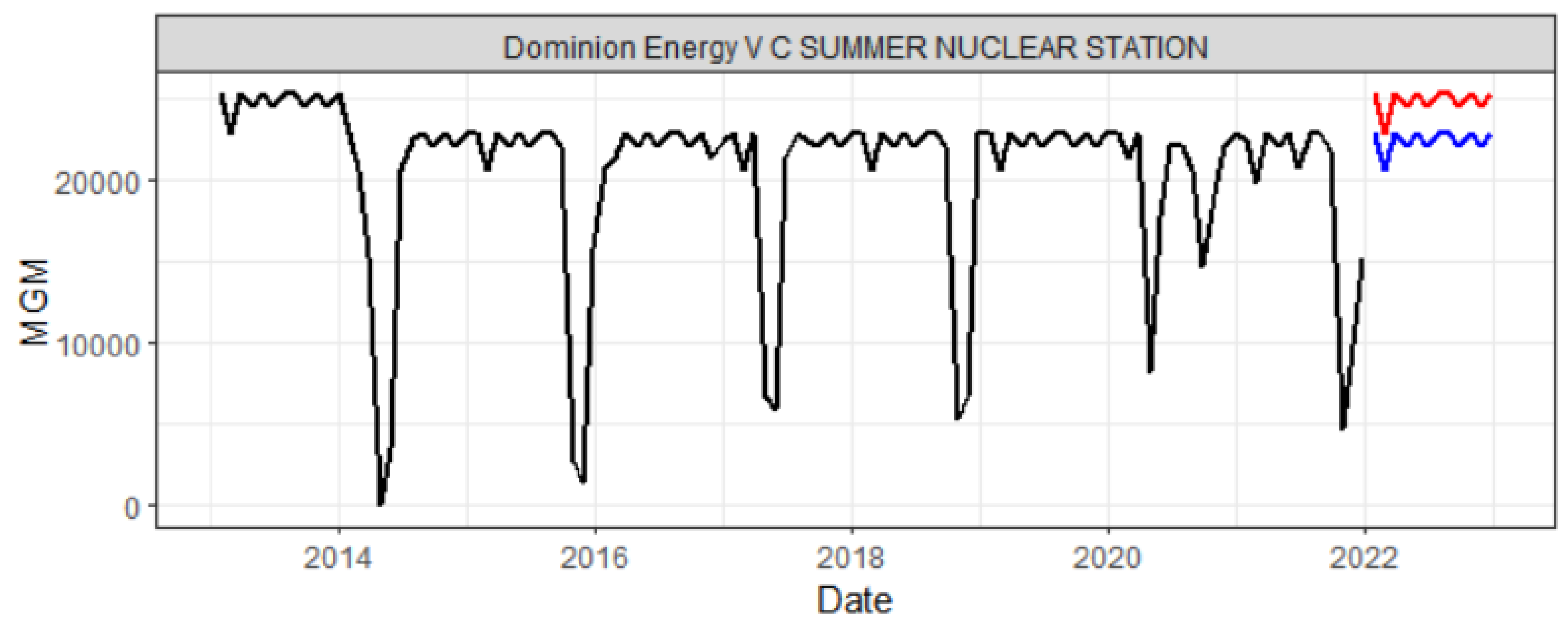
CAROLINA COUNTRY CLUB
COUNTRY CLUB OF SPARTANBURG
FOX RUN COUNTRY CLUB
HOLLY TREE COUNTRY CLUB
Links O'Tryon, Regent Properties, LLC
MID CAROLINA CLUB
MUSGROVE MILL GOLF CLUB
PEBBLE CREEK COUNTRY CLUB
WILLOW CREEK GC
MGM
Date

Agricultural Irrigation



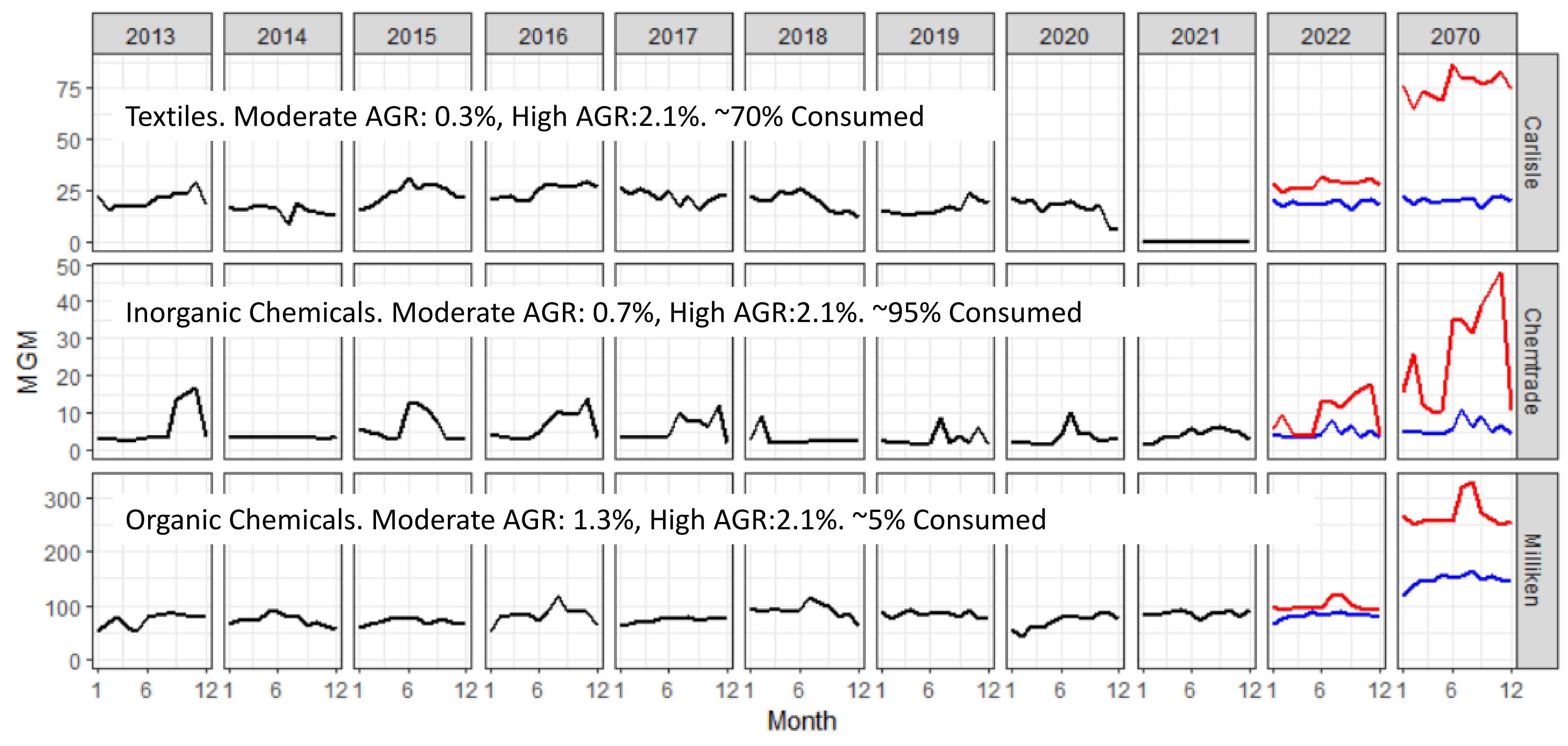
I propose projecting no growth in agricultural irrigation in the Broad basin.

Thermoelectric Water Demand

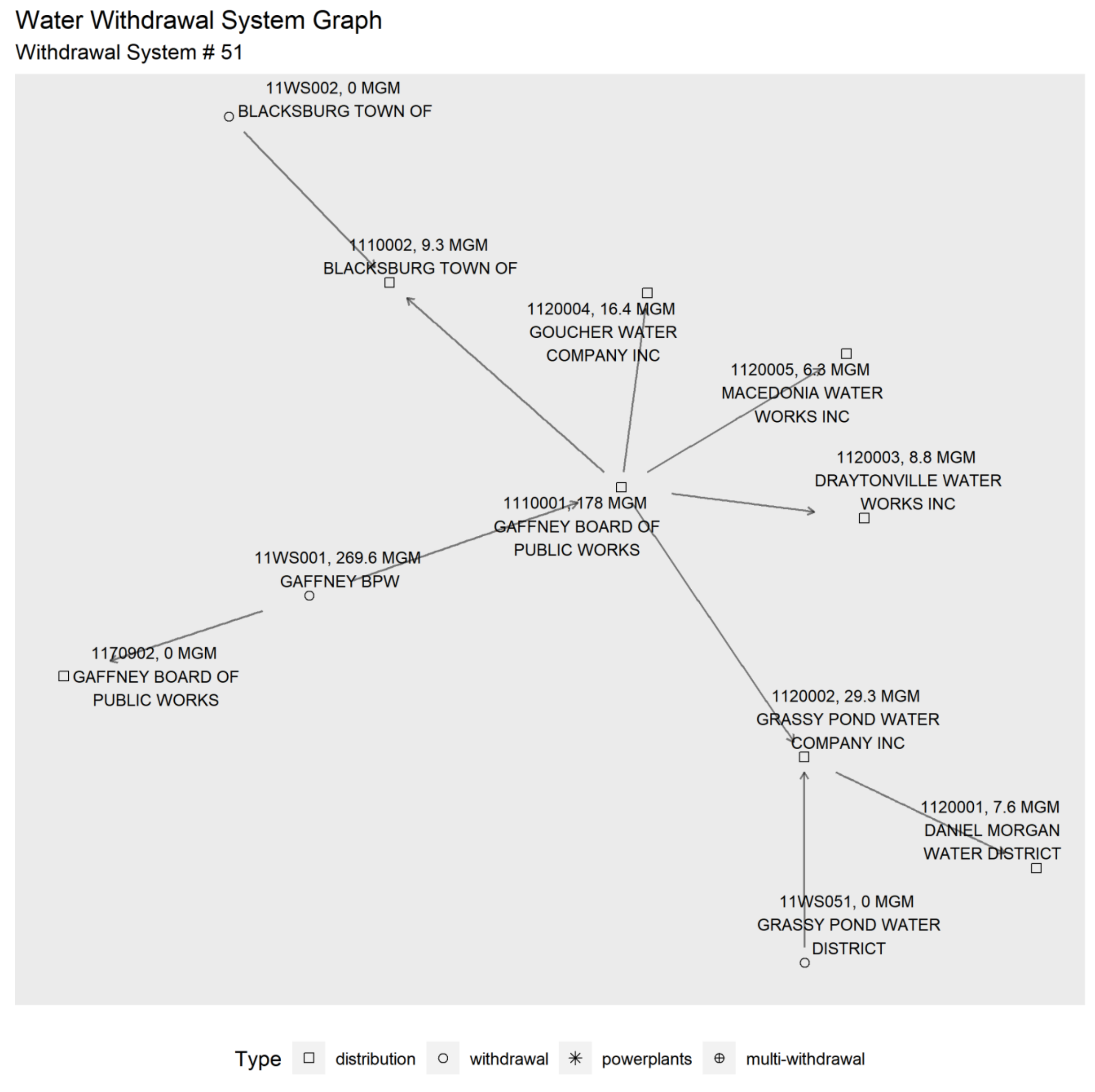


- No planned expansions have been reported for VC Summer. Filed for extension of license to 2062. No change is water demand is projected.
- Prior to 2014, water demand (and consumption) was greater than in recent years.
- Apparently, maintenance/refueling is carried out in alternative spring and fall seasons.
- Will there be a new nuclear plant in the future? Cherokee or William States Lee…

Manufacturing

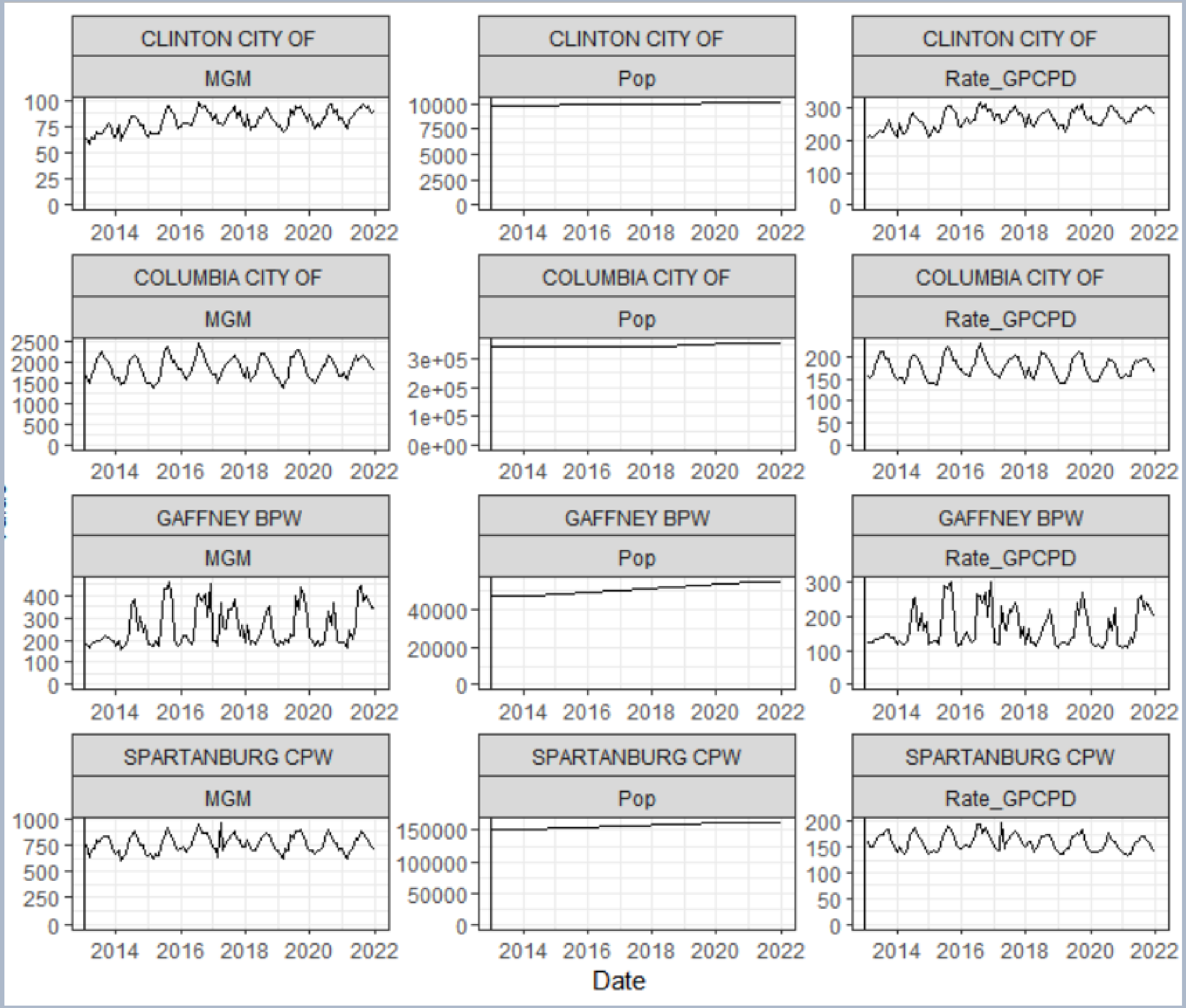


Public Supply



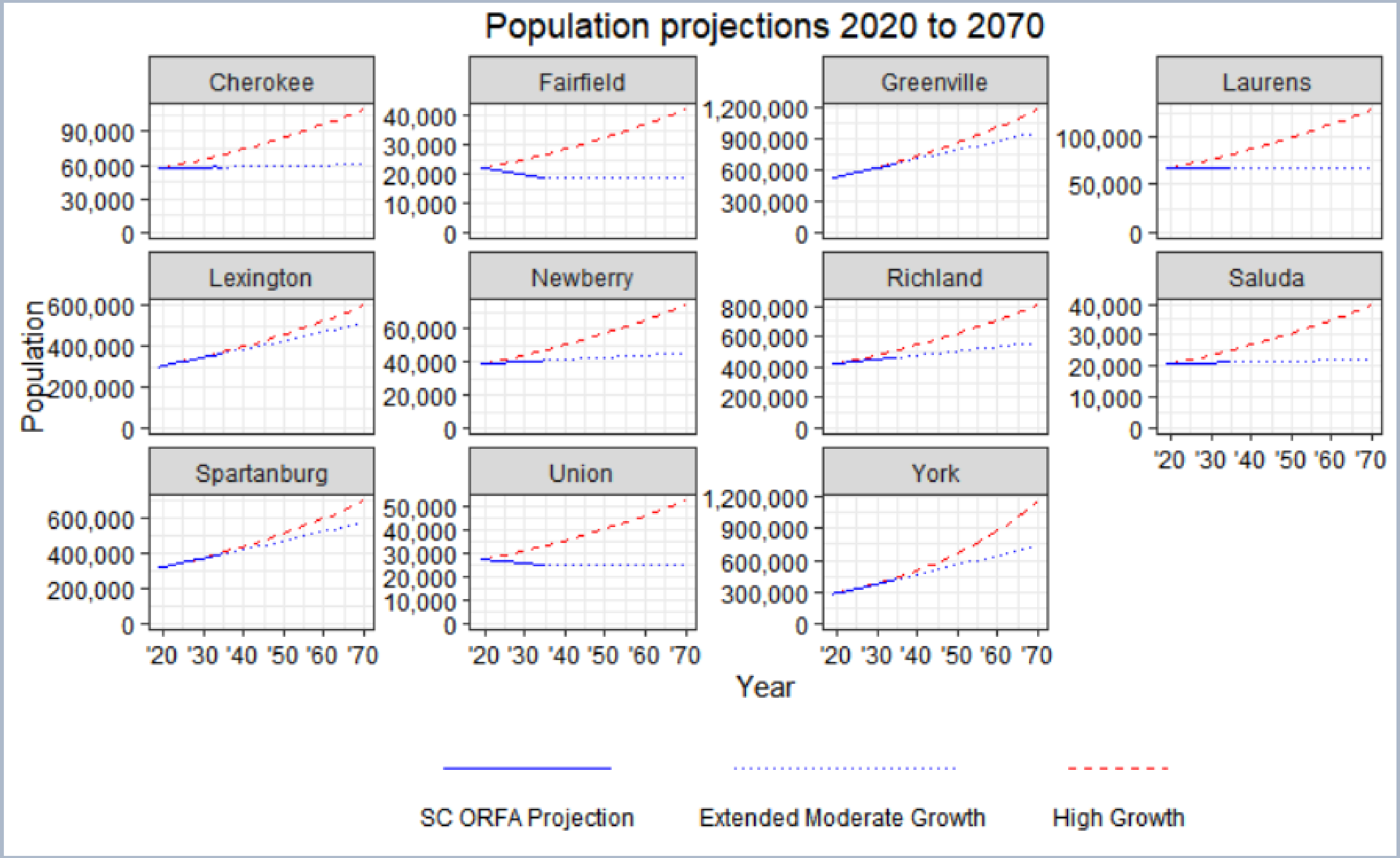
- Many Drinking Water Distributors are interconnected by wholesale purchases and sales.
- Public Supply Systems are represented as the total of all interconnected withdrawal and distribution permits.
- Population served by each distributor is projected based on the county listed on the distribution permit.

Public Supply



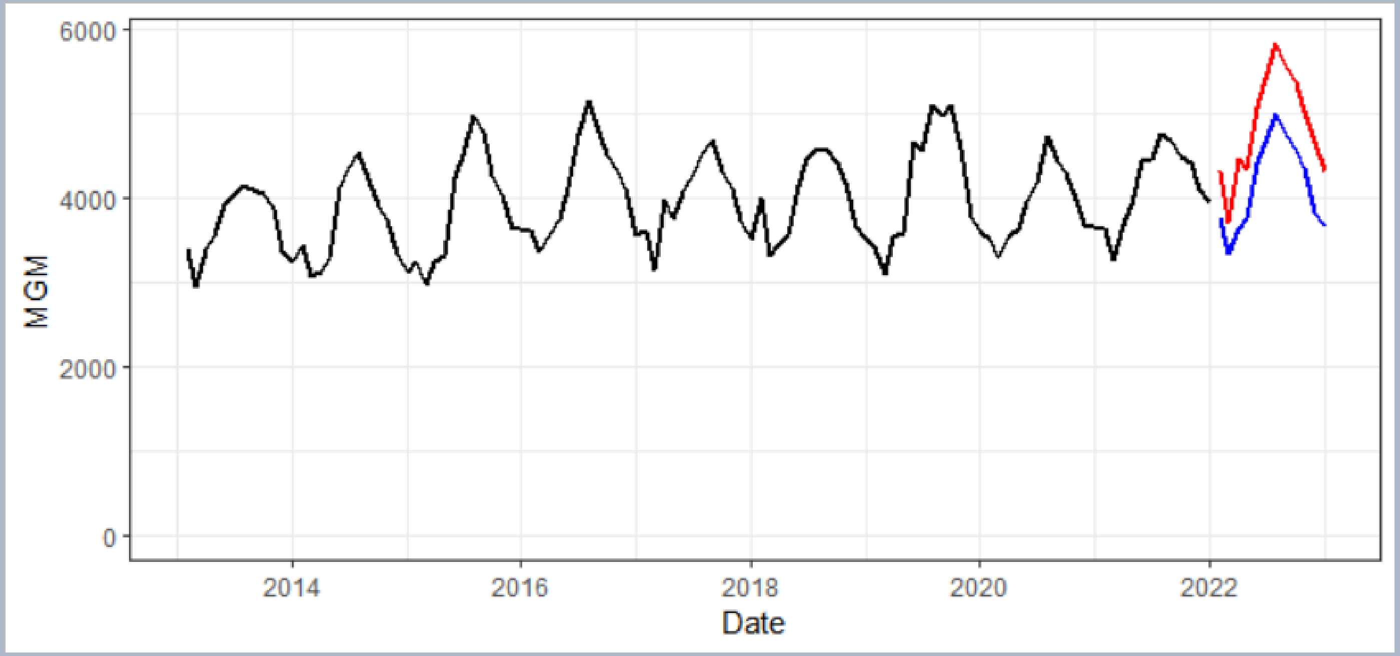
- Calibration of selected water supply systems.
- The populations are calculated as the sum of the populations of each associated drinking water distribution permit.
- The rate of use is expressed in terms of Gallons per Capita per Day (GPCPD), which generally ranges from 100-200.

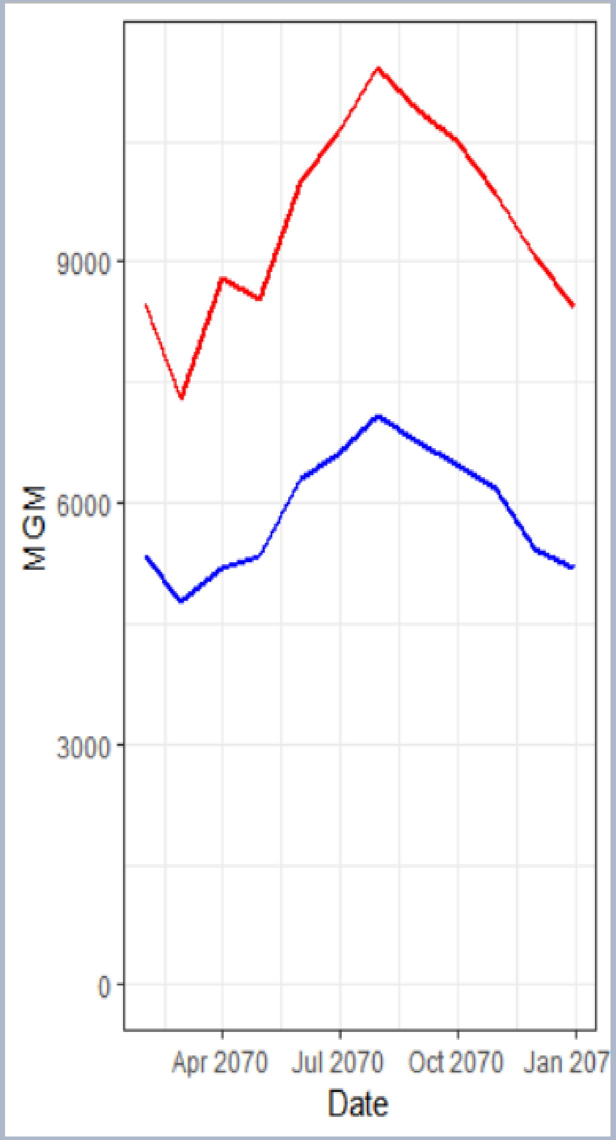
Population Drives Water Demand for Public Supply



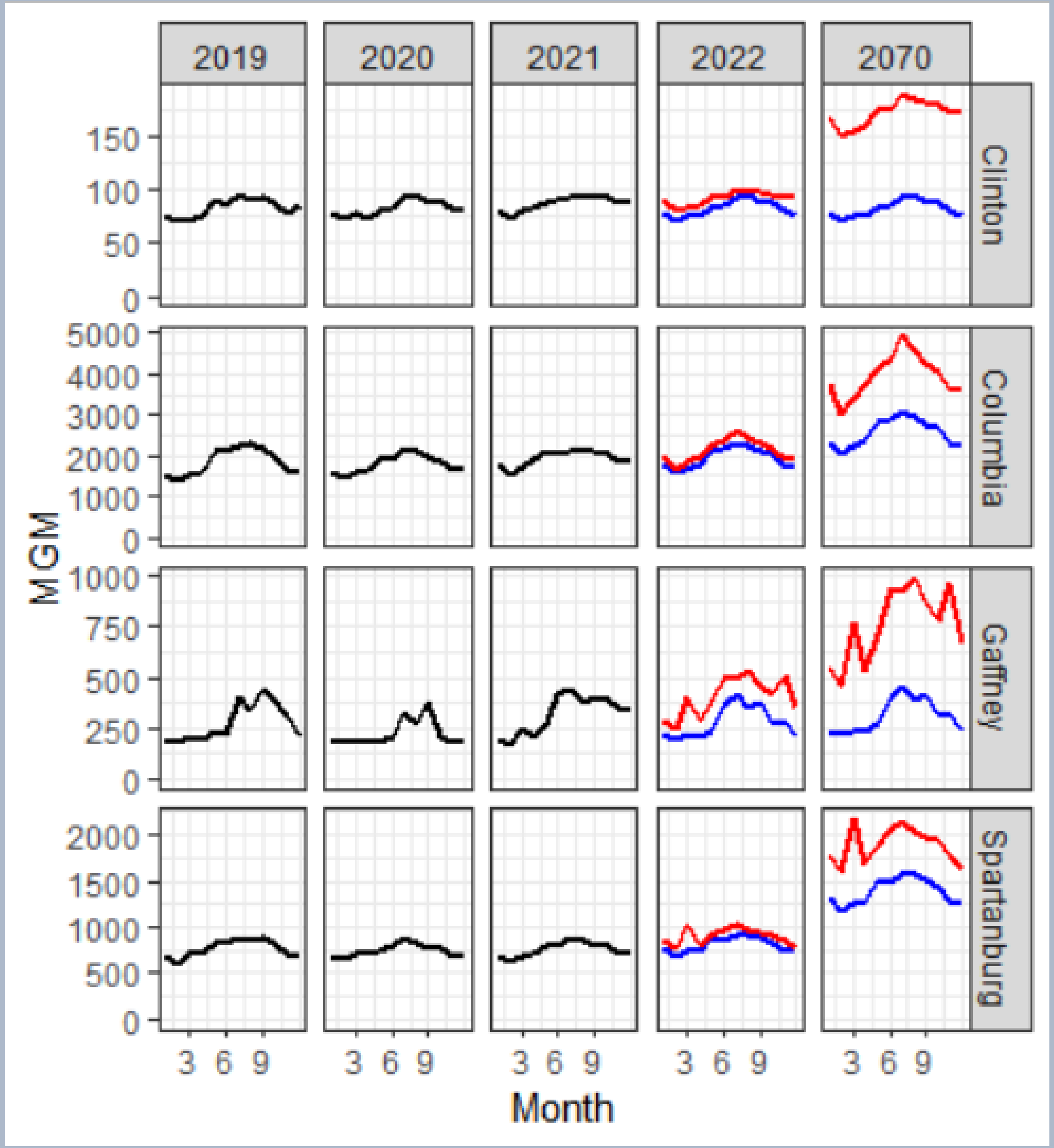
Public Supply Projection Summary

Total water demand of public suppliers that withdraw surface water in the Broad Basin.



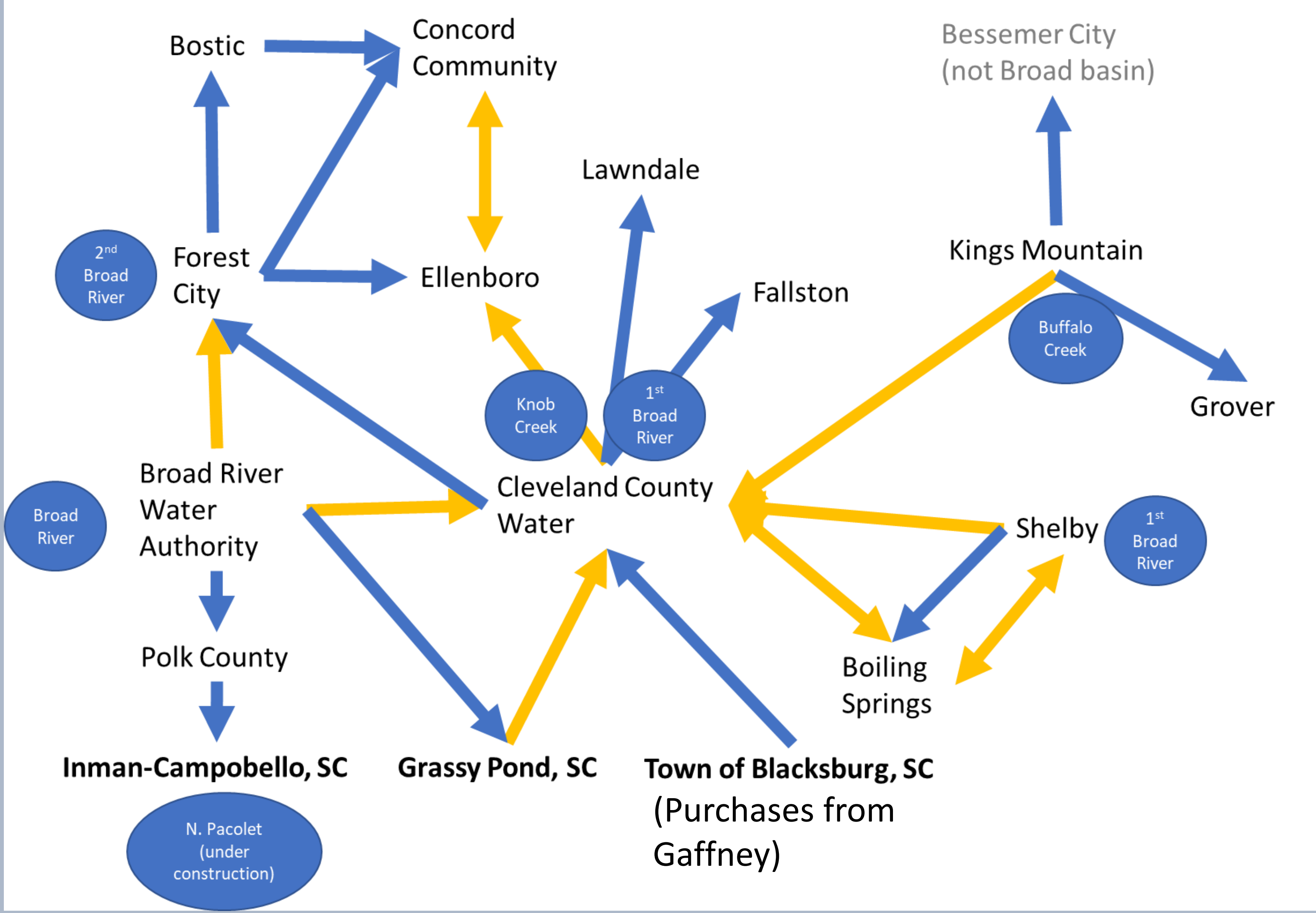


Selected Public Supply Projections

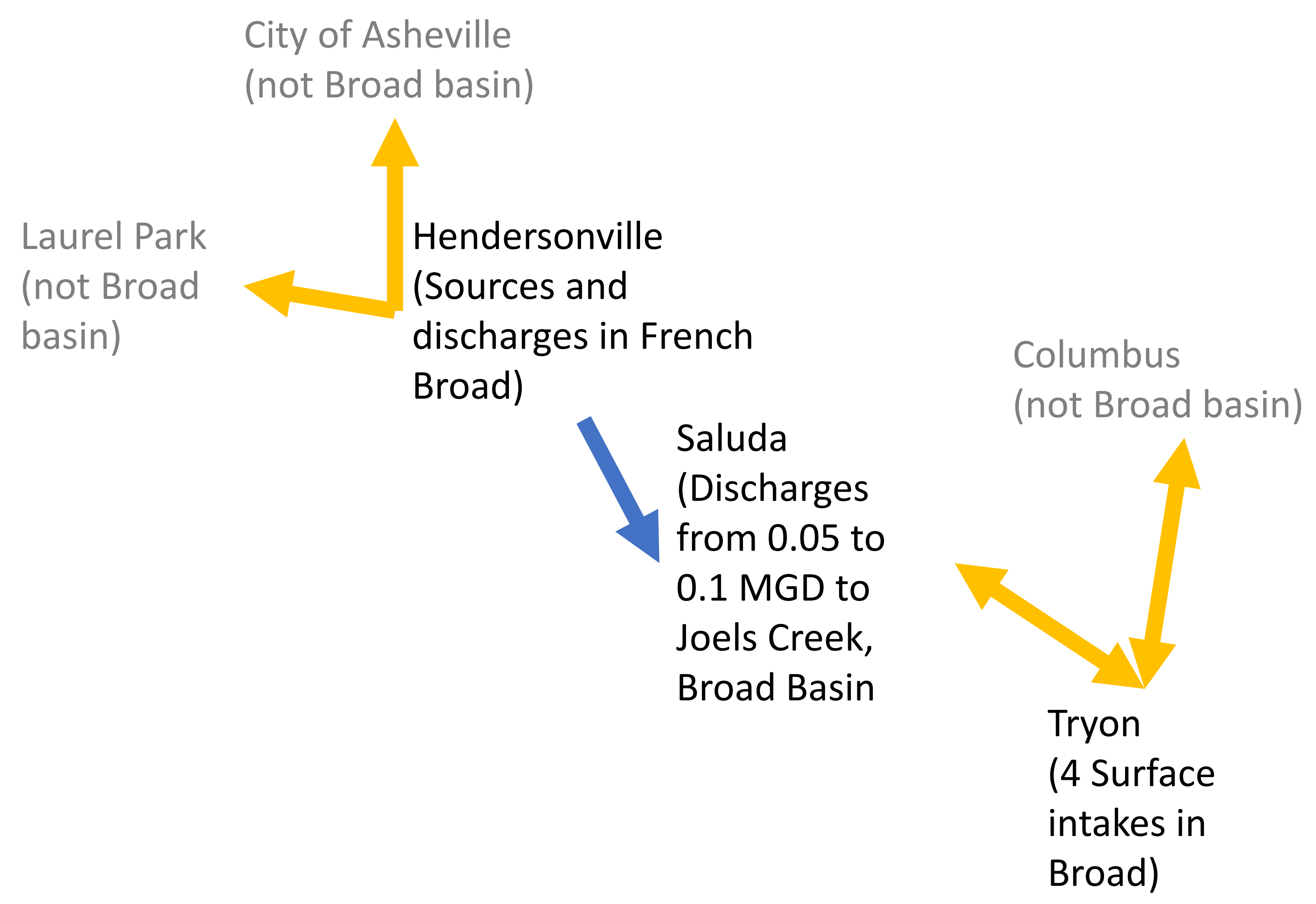


- Clinton consumes ~50% and returns to Saluda basin.
- Columbia gets about half of its water from Lake Murray. All returns go to Saluda basin.
- Gaffney consumes ~45%
- Spartanburg consumes ~75%

Public Supply in North Carolina



Public Supply in North Carolina



Questions?