USGS Water Use Data and Research (WUDR) Program
Draft Workplan
September 30, 2016
Kentucky Division of Water

SUMMARY

Kentucky has a long history of collecting water withdrawal data beginning with the first water withdrawal permit that was issued on June 01, 1966. The state's water use program is one of water withdrawal permitting and reporting on a daily basis, with reports submitted to the Division of Water by the 15th of each month. With the certain exemptions (agriculture, thermoelectric power, oil and gas injection) all withdrawals of 10,000 gallons per day or more are subject to the state's permitting program.

This work plan was developed in fulfillment of a cooperative agreement with the U.S. Geological Survey's (USGS) Water Use Data and Research Program (WUDR). The goal of this work plan is to lay the groundwork for developing projects or procedures that will improve the state's water use data reporting program in terms of the quality and usefulness of the data that is collected. It is intended to support the efforts of USGS to improve the understanding of water use as a nation, and to provide Kentucky with a plan to address areas that may need improvement or that have been overlooked during more than 50 years of water withdrawal data collection.

The priorities that were identified in this work plan were chosen with the objective of addressing all of the Tier I categories requested by USGS. Through collaborations with multiple partners and an assessment of the state's capabilities, both technical and regulatory, there were six categories that were selected for inclusion in the work plan as potential project areas for future grant proposals:

- Aquifer designation for all regulated groundwater withdrawals
- Interbasin transfers for all regulated groundwater withdrawals
- HUC-8 reporting and database alignment with USGS requirements
- Golf course irrigation reporting and consumptive use
- Non revenue water and PWS system losses
- Water purchases and sales to domestic, commercial, industrial, agricultural and other uses

One of the highest priority areas identified during the development of this plan is the designation of aquifers, more specifically the zones of production that supply over 200 regulated withdrawals across Kentucky. The techniques developed for this project will be applicable to a much larger number of wells that are not regulated, including those used for irrigation, livestock production, and domestic supply. The results of this project will provide additional water use data to USGS WUDR, but will also be a significant contribution to the

larger goal of characterizing our more heavily used aquifers and the demands that are being placed in them.

The remaining priority areas were chosen after considering the availability of data, resources, staff and potential partners that will be needed to develop the necessary processes or projects.

INTRODUCTION

Water use in Kentucky is monitored as part of Kentucky's water withdrawal permitting program according to the requirements found in KRS 151.140 and 410 KAR 4:010. With this authority the Kentucky Department for Environmental Protection/Division of Water requires that all withdrawals of at least 10,000 gallons per day be permitted and daily withdrawal data submitted each month. The statute does exempt water that is withdrawn for agricultural purposes, steam-generating power generation and water that is injected into the ground in conjunction with oil and gas operations. The first water withdrawal permit was issued on June 01, 1966 and since then the Division of Water has collected daily withdrawal data for all withdrawals of at least 10,000 gallons per day.

Prior to enacting a system of water withdrawal permitting and data collection under KRS 151 Kentucky, like most eastern states, observed the rules of common law riparianism. Riparian rights are rooted in the ownership of land that borders a watercourse and the use of water under this regime was restricted to riparian land. The first significant legislation that provided for the use of public water by non-riparians was enacted in 1966 under KRS chapter 151. This act created a system of water withdrawal permitting and water use data collection which departed substantially from the riparian system by allowing nonriparian owners to obtain permits. The act originally exempted many manufacturing and industrial users from the permit requirements as long as the water was returned in approximately the same quantity and quality as it was prior to its use. In 1972 this provision was removed leaving only steam-generating facilities still exempt, along with agricultural uses and oil/gas injection.

CURRENT STATE WATER USE PROGRAM

As described in the previous section, the state's water use program is one of water withdrawal permitting and reporting on a daily basis, with reports submitted to the Division of Water by the 15th of each month. With the noted exemptions, all withdrawals of 10,000 gallons per day or more are subject to the state's permitting program.

In 2002 the state adopted a new environmental database that facilitates all aspects of regulating Air, Water and Waste interests. Using this system, the state's water withdrawal data is stored and reports are developed to allow easy retrieval of water use data. More recently the state has developed an e-portal whereby permitted users submit water withdrawal data

online. This data is subjected to QaQc and then imported directly into the TEMPO database. To date, nearly 70 percent of our regulated users are now submitting data electronically.

Water withdrawal permits are issued to an applicant only after a thorough review of the potential impacts to the source and to other permitted users. There are various methods employed to evaluate a request for a withdrawal. Common to all analyses is the fundamental need for hydrologic data that is provided by USGS through the stream gage network. To that end, another function in the water withdrawal program is to manage and monitor the network of stream gages that the Division of Water supports through cooperative agreements with USGS. While many of the gages that the Division supports are multi-functional (water availability, TMDL development, ambient water quality monitoring, etc) all of them are located so that they provide needed information used to evaluate requests for water withdrawals.

Every five years the Division of Water provides this data to the United States Geological Survey for its use in publishing a report on water use in the United States. The data that we provide includes annual or monthly withdrawals for public supply, industrial, commercial (and golf courses), mining (coal and non-coal), and aquaculture. The data is also broken out by county and by source (stream, lake, pond, USACE impoundment, slurry impoundment, and groundwater, spring and underground mine). Our data provides a majority (by percent of total water use) of the needed data for the USGS publication in its current form. Estimates of water use by livestock, agricultural irrigation and domestic use must still be developed by the USGS. Data for water used in thermoelectric power generation can be obtained from monthly DMR reports submitted to the Division of Water as part of the NPDES permitting program. Overall, the monthly data submitted to the Division of Water as part of our water withdrawal and discharge permitting programs provides an accurate portrayal of raw water usage for 97 percent of the water that is withdrawn in Kentucky for all withdrawals over 10,000 gallons per day.

Water withdrawal data plays a significant role in managing water resources. This data is used to assess cumulative uses in watersheds, make determinations of usage patterns over time and in response to drought, identify areas of surplus supply, and create demand projections so that users can plan for future needs. It is in the best interest of the state to have a robust water use data program. Deficiencies that have been identified as priorities in the preparation of this document did not come to light as a result of this process. Rather, the process and the WUDR program have provided to the state a potential mechanism to address these long-known deficiencies and improve our water use program.

COLLABORATION AND TASKS ASSOCIATED WITH THE WORKPLAN

Most of the collaboration thus far has been with state agencies, a university and various specialists within the Division of Water. Two of the key priorities that have been identified as research-oriented (Table 2.) will involve collaboration with the Kentucky Geological Survey and the University of Kentucky Earth and Environmental Sciences (Aquifer Designation) and with the

University of Kentucky Turf grass Research Center (Golf Course Irrigation). Table 2 provides a more detailed description of the status of each priority based on our collaborative efforts thus far. Additional work will be done between now and September 30 at which time a final version of this workplan will be submitted.

A second set of collaborations are intended to address water use data that is already collected, estimated or stored by a state agency (Table 2: "Non-Revenue Water and System Losses" and "Water Purchases and Sales/PWS Deliveries to Residential, Commercial, Industrial and Agriculture Users"). Addressing these priorities has been a long and ongoing issue with our partners (Kentucky Infrastructure Authority, Public Service Commission (PSC), and Kentucky Rural Water Association (KRWA)) and we have attempted on a few occasions to work together in the past to find ways to improve and standardize our data related to "PWS Deliveries" and "NRW and Loss". Progress has been lacking thus far.

The Kentucky Infrastructure Authority (KIA) has the lead for the state Areawide Water Management Planning process in Kentucky. Most of their work lies in the administering of funding for water infrastructure projects. However KIA also has substantial expertise in GIS mapping and database development. Their database, Water Resources Information System (WRIS) houses PWS system data that includes all of the necessary data to determine NRW/System Losses and PWS Deliveries. Some of this data is derived from SDWIS/MOR submittals, a shared source between the KIA and state TEMPO database. In addition, KIA employs water service coordinators in 15 Area Development Districts who perform system audits each year and obtain independent, "real-time" estimates of the quantity of water that is produced, delivered to various use-sectors, and lost or not accounted for.

The WRIS is a rich source of data but there is a general lack of consistency between data from the state and data in the WRIS in the quantities of water not accounted for, quantities of water sold/purchased between system and other variables of interest to the WUDR program. These problems are mostly associated with a lack of quality control of data, and a lack of a consistent "period of record" used by the state and by KIA for identifying PWS production, deliveries, and losses.

However the more difficult aspects are the ability of individual systems to track the movement of water thorough metering and billing. The PSC and KRWA also have experience and data related to NRW and Loss and PWS deliveries. However, the PSC methods to compute NRW and Loss differ in some respects form those of the state. KRWA has direct experience in working with small systems in this area and are included as a key collaborator. The issues related to water tracking are not new, but the WUDR program will allow these agencies to address them and implement procedures for improvement of this data.

A third set of collaborations have taken place within the Division of Water related to the priorities of Interbasin Transfers and Reporting by HUC-8. Within the Watershed Management Branch is the GIS and Data Analysis Section (GDA). This section is staffed with experienced individuals who are a resource for the Division of Water for database management, GIS analysis

and mapping and statistical analysis. We intend to leverage our close working relationship with this section to accomplish the tasks associated with these priority areas.

During the development of this first draft of the workplan several preliminary activities were performed to evaluate the data at our disposal. These activities include:

- GIS determinations of the locations of IBTs within water transmission lines across HUC-6 boundaries
- GIS identification of all points of Sales and Purchases of wholesale water moving between systems, and
- Using WRIS and TEMPO to assign tiered sales and purchases between systems and the associated amounts and percents that wholesale purchases contribute to overall system demand
- QaQc of SDWIS/MOR Sales and Purchases to determine the level and types of errors within the database
- QaQc of the WRIS production and PWS Delivery data and comparison to SDWIS data
- QaQc of the state GIS layers associated with water withdrawal and water use reporting and corrections to 1) layers and attributes and 2) industrial codes
- Creation of GIS layers using areal photography to plot areas of high water use that are unregulated: irrigation systems, poultry houses, dairies, and cattle operations

These preliminary projects have provided a basis to begin the process of identifying the necessary steps needed to address each of the state priorities presented in Table 2.

It is perhaps useful for purposes of this workplan to address the WUDR goals that were not selected as priorities during this process. The most notable goals are agricultural withdrawals for irrigation and livestock, and data related to self-supplied individual use. We are in fact very interested in these categories but find that current methods of estimation by USGS are adequate for the use that they are intended. For example, the derivation of self-supplied domestic populations is often estimated as the difference between census-based county populations and estimated PWS-served populations. PWS-served populations are difficult to estimate largely due to errors found at the system level, related to PWS deliveries and metering and billing. Estimates of self-supplied populations will carry the same level of error. Thus, it seems more feasible and logical to focus on system tracking (PWS deliveries) because this is the variable that is more directly “measured”, and by difference can improve estimates of self-supplied populations.

Agricultural water use is a category that is the subject of intense interest for regulators, researchers, producers and citizens in general. However, the state lacks any mechanism to monitor agricultural water use and is in fact, prohibited from interfering with the withdrawal of the waters of the commonwealth for agricultural uses, except under extreme water shortage situations. The USDA census and irrigation surveys provide a reasonable estimate and are for

now the best information regarding irrigation in spite of the fact that it is not useful for estimating on an annual basis.

Recent developments in the state have begun to bring agriculture and the state together to address the issues related to agricultural water resources management. The Kentucky Farm Bureau established a Water Management Working group in 2014 to bring state, federal, and university interests together with the agricultural community to develop a better understanding of the issues facing agriculture, how they might be addressed and what mechanisms and resources are available to assist. Out of this collaboration came the legislative creation of a new Water Resources Board with members appointed by the Governor. The purpose of this board will be to advise the Cabinet in matters of agricultural water resources, and to be a mechanism for funding opportunities targeting a range of issues identified by the collaborative efforts of the Water Management Working Group. We believe that these new collaborative bodies will lead to a better understanding of agricultural water use and provide opportunities to invest in the types of research or creation of new mechanisms to quantify agricultural irrigation in Kentucky.

The data for thermoelectric power at our disposal originates from monthly discharge monitoring reports thorough our NPDES permitting program. These monthly withdrawals and returns are reported to USGS along with the other categories of water use, but we believe that net power generation is not a priority for us given the other more feasible priorities outlined in Table 2. For hydropower, until recently most facilities were located on Corps of Engineer dams or dams that predated Kentucky water law. These uses have never been permitted and it is unclear whether we will pursue permitting, partly due to the fact that it is a non-consumptive use and not a withdrawal or a diversion from the channel on which the plant is located. However, this does not preclude us from creating a process to capture hydropower water uses, it is simply not a priority for us given the more important priorities described in Table 2.

KENTUCKY WATER WITHDRAWAL DATA AND REPORTING

Categories of water withdrawal data collected by the Division of Water have been in place for as long as the program has been in existence with no modifications. These include the following:

- Aquaculture
- Commercial*
- Industrial
- Mining: coal
- Mining: non-coal
- Water supplier

*Commercial withdrawals include golf courses, geothermal, landscape, bottled water and other withdrawal types that do not fit into any of the other categories. As part of the WUDR work plan development a Qa/Qc was conducted to assess the accuracy of the assigned categories to all regulated water withdrawals. It was determined that there were an unacceptable number of wrongly categorized permits. To rectify this each permit will be categorized based upon NAICS Industrial codes as part of work plan implementation.

The locations that attend each water withdrawal are located at the point of withdrawal and assigned an X-Y coordinate based upon NAD83. In cases where a well field supplies a permitted water withdrawal, and provided the wells are located in close proximity and located within the same aquifer as determined by a hydrogeologist, the point of withdrawal is taken as an approximate centroid of the well field. Consequently, water withdrawal data at these sites is recorded as the cumulative withdrawal from the well field, and not from each individual well.

Water withdrawal data is recorded daily and reported monthly to the Division of Water. Nearly 70 percent of data is now submitted via an electronic e-portal with the remainder still using paper. QaQc of the data is performed manually prior to final submittal to the database. Paper submittals are manually keyed into the database while the e-portal submittals are received, reviewed for errors and then imported directly into the database. The e-portal itself is accessed by a permit holder through application and assignment of a logon name and password. E-portal access is limited to permit holders and their individual data. No mechanism exists for outside entities to access the e-portal since it is merely a mechanism to import electronic compliance data into TEMPO.

The current database that facilitates storage and retrieval of water withdrawal data serves the entire Department for Environmental Protection (Divisions of Water, Air and Waste). TEMPO (Tools for Environmental Management and Protection Organizations) is a robust database and process management program that a majority of the environmental data, permitting and technical information produced by the Department. TEMPO is not accessible to outside entities. Within TEMPO there are multiple avenues to access, view and export data using query functions that allow data to be retrieved and filtered by any of the fields associate with a particular dataset. For example water withdrawal data can be retrieved and filtered by basin, category of use, time period, water source, responsible party, county, X-Y coordinates, permit limits etc. TEMPO exports are in the form of an Excel spreadsheet that is then available to USGS for research or publications.

Table 1. Summary of Personnel, Data and Resources needed to meet Tier I standards

Category	Tier I Standards	Staff/Personnel	Data	Resources/Development	Collaborating Agencies
Public Supply	Monthly Withdrawals	KDOW	Compliance Reporting	Staff Time	
	Deliveries to Domestic Users	KDOW; KIA; ADD	Water Resources Information System (WRIS)	Improved system metering or billing	Kentucky Infrastructure Authority (KIA) Area Development Districts (ADD)
	Populations Served	KDOW; KIA; ADD	Water Resources Information System (WRIS) TEMPO database and SDWIS database	Improved coefficients for meter delivery to account for multi-family, commercial and other uses	KIA
	HUC-8	KDOW	GIS and TEMPO database	Staff Time	
	Aquifer Designation	KDOW; KGS;U.K.	KGS groundwater database; DOW withdrawal database	Methods to identify zones of production in geologic units	Kentucky Geological Survey; University of Kentucky (UK)
Industrial	Annual withdrawals	KDOW	Compliance Reporting	Staff Time	
	Aquifer Designation	KDOW; KGS;UK	KGS groundwater database; DOW withdrawal database	Methods to identify zones of production and formations	Kentucky Geological Survey; University of Kentucky
Crop Irrigation		**			
Thermoelectric	Annual and monthly withdrawals	KDOW	NPDES permit Monthly Op Reports		
	Return Flows	KDOW	NPDES permit Monthly Op Reports		
	Net Power Generation	**			

Self-supplied Domestic	Populations	KDOW; KIA; KRWA	Census Block data; GIS Roads, GIS water lines, County PVA data	Methods to estimate based on Proximity of households to water lines	KIA; Kentucky Rural Water Assn (KRWA)
	HUC-8	KDOW; KIA; KRWA	GIS HUC-8 layers	Spatial analysis after development of population layer	
	County	KDOW; KIA; KRWA	GIS County layers	Spatial analysis after development of population layer	
	Water Source	**			
Golf Course Irrigation	Annual and Monthly withdrawals	KDOW; U.K	DOW TEMPO database	DOW compliance initiative to permit golf courses not yet regulated	
	Aquifer Designation	KDOW; KGS;U.K.	KGS groundwater database; DOW withdrawal database	Methods to identify zones of production and formations	Kentucky Geological Survey; University of Kentucky
Livestock	Annual withdrawals for major facilities	KDOW; KFB; Various Ag Commodity Organizations; UK	GIS layers for locations at the county level of major facilities including Poultry, Dairy, Hog and Cattle; USDA and KY Ag Statistics for livestock production at the county level.	Methods to estimate withdrawals using published species-specific consumption coefficients; Method to locate/plot locations of major facilities.	Kentucky Farm Bureau (KFB); UK Ag Extension
Mining	Annual Withdrawals	KDOW	Compliance Reporting	Staff Time	
Aquaculture	Annual Withdrawals	KDOW	Compliance Reporting	Staff Time	
Commercial	Annual and monthly delivery from PWS	KDOW; KIA; ADD	Water Resources Information System (WRIS)	Improved system metering or billing	Kentucky Infrastructure Authority (KIA) Area Development Districts (ADD)
Hydroelectric Power	**				
Wastewater Treatment	**				

** This category either insufficient data or the best available data is readily available to USGS.

Table 2. Proposed Steps Needed to Address Identified WUDR Priorities

PRIORITY	STEPS	PARTNERS
AQUIFER DESIGNATION **Priority Ranking 1/7** Focus on Groundwater Withdrawals that are regulated by the Division of Water. Identify the geologic units that are zones of production for regulated withdrawals. Aquifer designation a Tier I goal for PWS, Industrial, Golf Course Irrigation. The goal of this Priority Research it to designate production zones for all regulated withdrawals for all categories of use, and to link water quantity and production zones. Such data is an important precursor to assessments of water availability and sustainability as well as future demand potential under various growth and climate scenarios	-Ongoing collaboration with respect to feasibility and scope of this expansive project -Preliminary Pilot study using well data from PWS locations from major geologic areas of Kentucky (July – Sep, 2016) -Assess feasibility develop methodology leveraging data from over 30,000 oil and gas well records (July – Sep, 2016) -Develop initial project objectives and determine the scope of study that can be managed in a two-year study timeline (can all regulated wells be characterized? Should this project focus on a subset of wells, like PWS as a pilot to develop methods and procedures?) (July-Sep, 2016) -Upon completion of preliminary assessment develop a working project proposal and attached to the work plan. (see Appendix A)	Kentucky Geological Survey University of Kentucky Kentucky Division of Water
INTERBASIN TRANSFERS **PRIORITY RANKING 2.5/7** IBT is a Tier III goal for PWS. However, IBT for all regulated categories will be the focus of this Priority Research. IBT as part of tracking of water is an important component of consumptive use.	-Continue ongoing collaboration with agency staff with expertise in GIS and water use database -Develop spatial coverages of water lines that map conveyance of PWS water across HUC-8 boundaries within transmission lines. -Develop methodology to estimate the quantity of water conveyed within transmission lines using data for line length, line volume, line density or their combination	Kentucky Division of Water

	-Leverage data from PWS sales and purchases across HUC-8 boundaries to compute estimated volume of water transferred across basin boundaries -Map specific withdrawal points that can be connected to specific point of discharge across HUC-8 boundaries using data from TEMPO database for withdrawals and NPDES discharges -Create maps of IBT locations and identify site specific IBT data suitable for use by USGS at the county and HUC-8 level for all regulated water use categories	
<u>HUC-8 Reporting/Database alignment with USGS requirements</u> **PRIORITY RANKING 2.5/7** HUC-8 reporting is a Tier I goal for PWS, Crop Irrigation, Self-Supplied Domestic, Mining, and Aquaculture. For this project, all regulated withdrawals from categories supplied to USGS will be reported at the HUC-8 level. A secondary objective of this project will be to enhance TEMPO database to include new fields of interest to USGS. HUC-8 will be one added feature, but additional fields will be addressed within this project. Staff will also create new standardized reports specifically tailored to the data needs of USGS. This work will be done in collaboration with USGS staff at the KY-IN Water Science Center in Louisville.	-Develop GIS coverages that identify the location of all regulated withdrawals with respect to HUC-8 -DOW staff will add HUC-8 to TEMPO database for all regulated withdrawals that are reported to USGS per the requirements of WUDR -DOW staff will coordinate with USGS to develop standard reports that are tailored to the requirements of USGS data needs. -NOTE: using land cover data it may be beneficial to consider mapping the most probable locations of agricultural withdrawals within each HUC-8	Kentucky Division of Water

Golf Course Irrigation (in-house tasks completed by the Division of Water) **PRIORITY RANKING 4/7**	-Continue to report on 80 golf courses that are currently permitted -Undertake a programmatic review to determine a more logical approach to reporting on uses such as golf courses that vary substantially by season and by year. -Undertake programmatic initiative to identify and permit the remainder of golf courses that are subject to regulation -This in-house work is a necessary precursor to providing to USGS a complete data set of golf course irrigation withdrawals	Kentucky Division of Water
Golf Course Irrigation (Tasks to meet Tier I and II Goals) **PRIORITY RANKING 7/7**	-Identify at least one pilot well used for golf course irrigation in an assessment of methodology for Aquifer Designation in collaboration with the Kentucky Geological Survey -Continue collaboration with the University of Kentucky Turfgrass Research Center. Scoping of potential research objectives to meet Tier II standard of Consumptive Use -Desired research objectives may include: 1) development of coefficients for consumptive use based on such as methods of irrigation or level of irrigation management 2) development of coefficients to address effective irrigation considering losses to drift, evaporation and runoff, and 3) survey of golf course utilization of PWS deliveries for irrigation -Based on observation, golf course irrigation in many areas is	Kentucky Division of Water University of Kentucky, Turfgrass Research Center

	a high water loss activity and this type of research will support opportunities for future efforts to increase water use efficiency and availability. -Develop a project proposal based on the above research objectives and attached to the work plan.	
<u>Non-Revenue Water and System Losses</u> **PRIORITY RANKING 6/7** NRW and Loss is a Tier III Goal for PWS. The issue of NRW and System Losses has been a recognized trouble area for many years. There is significant uncertainty in the accuracy of data that is used to estimate NRW and Loss, but it is clear that in many systems, apparent losses are substantial, approaching 50 percent or more in some cases. Lost water is inefficient, costly and a threat to public health and safety by increasing the likelihood of water deficits during drought.	-Continue collaboration with KIA and complete a QaQc assessment of data used to estimate NRW and Loss in the Water Resources Information System maintained by KIA. -Work with KIA, PSC and KRWA as well as Area Development Districts to improve PWS accounting of water deliveries to residential, commercial, industrial and agricultural users Kentucky Division of Water, Kentucky Infrastructure Authority and the Public Service Commission all have records of NRW and Loss in their database. These need to be compared and a standardized method agreed upon to bring the databases into agreement. The same general comment applies to Purchases and Sales as well. -Develop a more detailed assessment of data or other resources/policies needed to more accurately quantify NRW and Loss.	Kentucky Division of Water Kentucky Infrastructure Authority Kentucky Public Service Commission Kentucky Rural Water Association Area Development Districts
<u>Water Purchases and Sales/PWS Deliveries to Residential, Commercial,</u>	-Continue collaboration with KIA and complete a QaQc assessment of data used to	Kentucky Division of Water Kentucky Infrastructure Authority

<u>Industrial and Agriculture Users</u> **PRIORITY RANKING 5/7** Purchases and sales between PWS and water deliveries are Tier II goals for PWS. Depending on the outcomes of future discussions with collaborators, these may need to be broken out into separate priorities for project purposes. Purchases and sales of wholesale water have expanded substantially in Kentucky in the past two decades. Along with system mergers and regional systems these interconnections have brought water to unserved areas, decreased the vulnerability to drought and improved the safety and quality of drinking water in Kentucky. Purchases and sales are reported both to KIA via the WRIS and to the Division of Water via SDWIS/TEMPO. PWS deliveries to various categories of water use (residential, commercial, etc.) are similarly reported and suffer from the same inconsistencies between agencies. Data is not subjected to QaQc and there is some level of inaccuracy in our database that is carried over to the WRIS database. Accuracy in accounting for purchases and sales is important to the overall quality of tracking data as it is another "delivery" along with residential, commercial and industrial. PWS deliveries to various categories of user are not well	quantify Purchases and Sales in the Water Resources Information System maintained by KIA. -Identify the steps required to develop a standardized method to report and quantify Purchases and Sales so that data from KIA/Area Development District system audits more closely align with data captured on PWS monthly operating reports. -Engage collaborators in discussions to identify the resources or policies needed to more accurately track PWS deliveries to various water use categories. -Develop a more detailed assessment of the issues and possible strategies for improvement of PWS delivery tracking. -	Kentucky Public Service Commission Kentucky Rural Water Association Area Development Districts

tracked. Part of this is due to system accounting and billing practices.		

APPENDIX A

Aquifer Mapping and Designation for Permitted Groundwater Withdrawals

The state of Kentucky is topographically and geologically diverse. Many of the state's permitted groundwater users are withdrawing water from aquifers which are in effect reservoirs or zones of fresh water encased within larger, complex hydrogeologic systems consisting of interlayered clastic sediment deposits and fractured sedimentary bedrocks. Geological materials that serve as aquifers include unconsolidated sand and gravel deposits, fractured sandstones, shales, siltstones, and coals, and fractured and karstic limestones and dolostones. These types of aquifers are characterized by heterogeneities that include lateral and vertical changes in lithology, porosity, permeability, and saturated thickness. Groundwater availability and sustainability depends on what type of aquifer a water-supply well penetrates, its capture zone or contributing area, and the local and regional hydrogeologic factors that control groundwater recharge, storage, and flow within the larger groundwater flow system. All of these factors combine to make the objective of aquifer mapping and designation a technically challenging task, and create difficulties in properly managing and protecting the state's groundwater resources.

The Kentucky Division of Water, working in collaboration with the Kentucky Geological Survey, proposes to conduct a pilot project to develop data sets and data-analysis techniques needed to improve delineation of boundaries of the major aquifers used by permitted groundwater supplies and characterization (designation) of their present and potential uses as sustainable sources of fresh water. The project will involve the collection and synthesis of existing data from multiple sources including 1:24,000 scale digital geological mapping data (stratigraphy and structure), borehole geophysical logs, and well-construction logs obtained for public and private water wells, and permitted oil and gas exploration or production wells. These data sources will be processed to obtain hydrostratigraphic cross-sections that will delineate the boundaries, recharge areas, and discharge areas of the aquifers under consideration for study. New hydrogeologic data, including aquifer test data and water-level measurements, may be collected in selected locations where needed to fill critical informational gaps and quantify mapped aquifer hydraulic characteristics. The pilot project will include three major aquifer types in study areas where permitted public-supply wells are presently withdrawing groundwater: (1) the Mississippian Embayment—Jackson Purchase aquifers, (2) Western Coal Field Pennsylvanian aquifers, and (3) Mississippian Interior Low Plateaus karst aquifer.