2. FINDINGS

Findings are important facts, issues and challenges related to water supply planning and management in East-Central Illinois identified by the Committee. Findings subsequently provide a basis for recommending a regional water supply plan (Chapter 3).

This chapter begins with the Committee's findings related to the flow of water through and the storage of water in the environment. This is followed by findings related to climate variability and change, present and future water demands and withdrawals, impacts of groundwater withdrawals, future water availability, the costs and benefits of water withdrawals, and the balance among water availability, demand and supply. Findings related to current laws, regulations and property rights, institutional organization and governance, and technical assistance then are presented. A summary of key findings is provided at the end of the chapter, followed by conclusions.

The water cycle

Nature's plumbing system consists of water storage vessels and conduits – aquifers and river basins. Water moves through the environment continuously at varying rates dependent upon climatic, soil and geological conditions (Figure 2 and Appendix 1). Variations and changes in climate cause the amount of water available in surface waters and shallow aquifers to vary over time. Spatial variations in soil and geology strongly influence the flow of water through the environment – including groundwater recharge, discharge and water storage, and create spatial differences in the impacts of withdrawing water from aquifers and streams. Knowledge of the water [hydrologic] cycle and intertwined water supply issues provides a sound basis for water supply planning and management[1].

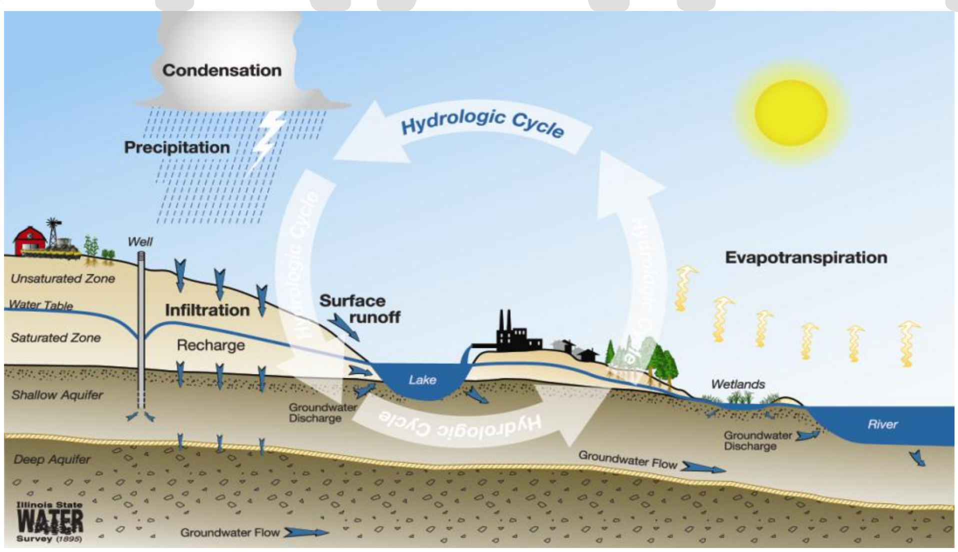

Figure 2. The water [hydrologic] cycle (from the Illinois State Water Survey).

Healthy aquatic and riparian ecosystems are essential components of the natural water infrastructure and it is important to maintain their integrity and diversity. However, knowledge and understanding of the impacts of water withdrawals on aquatic and riparian ecosystems in the region is rudimentary. More is known about the impacts of waste water discharges on streamflow and aquatic and riparian ecosystems. Such discharges are regulated to meet water quality standards.

Climate

Precipitation and temperature are the most important climatic variables affecting water availability and water demand: water demand generally increases with higher temperature and lower precipitation; the availability of surface water and shallow groundwater generally decreases with higher temperature and lower precipitation. In general, hot and dry weather conditions stress water resources.

Historical climate records indicate a high degree of variability from year-to-year and decade-to-decade in precipitation, streamflow and groundwater elevation in shallow aquifers (Appendix 1). Figure 3 shows the smoothed record over the past century of precipitation in the Illinois River watershed, streamflow in the lower Illinois River, and groundwater elevation in a shallow well at Snicarte in Mason County. Streamflow and groundwater elevation are strongly influenced by precipitation: typically, a 20 percent decrease in precipitation results in more than 50 percent decrease in runoff. Flow in many small streams and recharge to reservoirs and shallow aquifers is reduced in periods of drought[1].

In selecting the magnitude and frequency of droughts to plan for, precipitation return periods often are considered. For example, precipitation with a 1-in-50 year return period (a 50-year drought) has a 2 percent chance of occurring each year; precipitation with a 1-in-100 year return period (a 100-year drought) has a 1 percent chance of occurring each year. In Illinois, summer (May-September) precipitation with a 50-year drought is about 38 percent below normal (1971-2000), and with a 100-year drought it is about 42 percent below normal[1]. Specified precipitation amounts can be transformed into streamflow amounts in each river basin, thus allowing the hydrological impacts of climate variability and change to be evaluated.

The availability of surface water supplies to meet demand typically is limited most during severe droughts. The past 30 years generally have been wet and favorable for water supplies, although periodic droughts and floods have created problems. A two year drought occurred in 1988-1989 and 2005 was a drought year in many parts of the state. State-wide precipitation in 1988 averaged only 29.6 inches – 25 percent below normal (1971-2000) – but 1988 was only the eigth driest year on record[1]. More severe 12-month droughts and severe multi-year droughts have occurred in the past, especially in the first 60 years of the 20th Century. Drought conditions persisted from April 1952 through March 1957, the longest recorded drought in Illinois history[1]. In 1953-1954, the worst drought on record for Springfield, runoff into Lake Springfield averaged only 0.1 inches, compared to 9.0 inches in an average year and 1.1 inches in the 1988-1989 drought[2]. For Decatur, the worst drought on record occurred in 1930-1931 and for Bloomington in 1939-1940[2]. Tree-ring analysis indicates a 10-year drought in the region from 1565 through 1574[1]. It is multi-year droughts that have the greatest, long-reaching, persistent impacts on water availability. Generally high precipitation over the past few decades may have led to a false perception and acceptance of low risk in water supply planning and management.

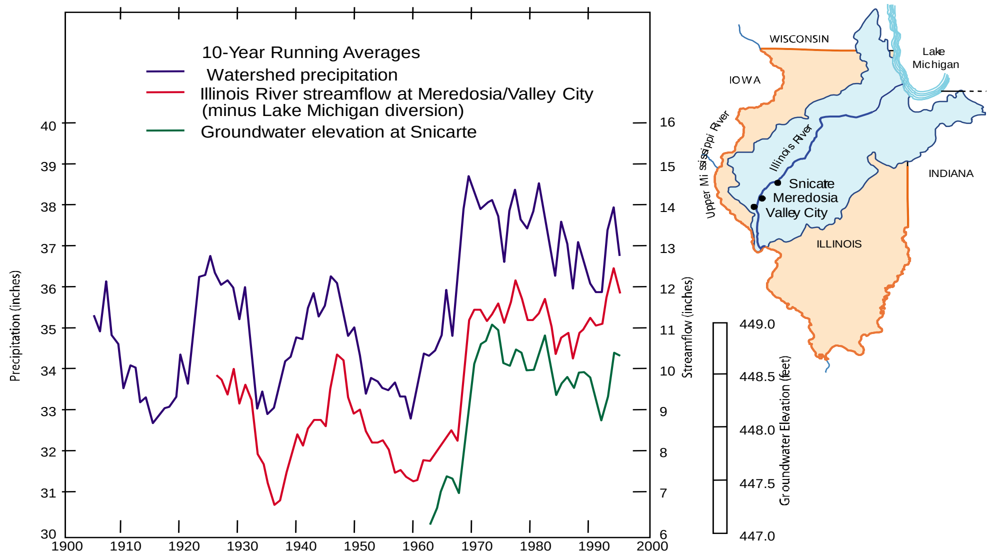

Figure 3. Precipitation in the Illinois River watershed (top), streamflow in the lower Illinois River (middle) and groundwater elevation at Snicarte (bottom) are closely correlated[1]. The Snicarte well is completed in the unconfined Mahomet Aquifer some 4 miles east of the Illinois River.

Although guidelines by the Illinois Environmental Protection Agency are for six months water storage for a 40-year drought, there are no state requirements for water storage or drought preparedness. Since the 1960s, Illinois State Water Survey scientists and engineers have focused on estimating yields associated with specific drought frequencies, such as a 50-year drought. Best estimates of water yields with 50 percent confidence limits traditionally have been considered to be firm numbers. Recognizing that these best estimates may overestimate available water, the Illinois State Water Survey now gives emphasis to estimating yields for specific drought frequencies, analyzing uncertainty in data and methods, and providing confidence limits on yield estimates[2]. Acceptance of a 90 percent confidence limit provides a higher degree of confidence and less risk in water supply planning and management than a 50 percent confidence limit.

High temperature also reduces water availability, but much less than a reduction in precipitation: it has been calculated that an increase in temperature of 7 degrees Fahrenheit (°F) results in only a few percent decrease in runoff[1]. In 1952-56, average annual precipitation across Illinois was 18 percent below normal and temperature was 2.1°F above normal; average annual runoff was 48 percent below normal[1].

Global annual average temperature has increased over the past 150 years such that the current global average temperature is higher than at any time since the mid-19th Century. However, annual average temperature in Illinois in recent decades has increased much less than the global average, and it is no warmer today in Illinois than it was in the 1930s and 1940s. Annual precipitation in Illinois has increased markedly since the early 20th Century, but precipitation also was high in the 19th Century before decreasing near the end of the century. Climate records indicate that the global temperature trend has not been a consistent indicator of regional climate conditions in Illinois[1].

Geology and hydrology

Geologic and hydrologic conditions vary throughout the region and, together with climate variations, have major implications for water supply (Appendix 1).

In the eastern half of the region, surface water supplies are limited by low flow in headwaters and few valleys suitable for reservoirs: east of Decatur, only Danville has a surface water supply; elsewhere, there is great dependence on groundwater. In the western half of the region, streamflow generally is higher and Decatur, Bloomington and Springfield have reservoirs. Reservoirs are designed to yield specified amounts of water during specified drought periods. Reservoir yield can fall short of meeting required water demand, if a drought occurs that is more severe than the drought planned for. In all reservoirs, sedimentation causes loss of storage capacity over time and environmentalists are concerned about the ecological impacts of constructing and operating reservoirs.

Groundwater exists essentially everywhere, but nearly all groundwater withdrawals in the region are from sand and gravel aquifers that have capability to transmit substantial quantities of water.

Throughout the region, discontinuous shallow aquifers are the source of some community and most self-supplied domestic water supplies. Water levels in these aquifers respond quickly to climate variations: water levels drop during periods of drought and rebound quickly when precipitation increases. Aquifers, streams, lakes, reservoirs and wetlands are like bathtubs – the amount of water in a bathtub decreases as water is withdrawn, unless the faucet is turned on. Across Illinois, some 82 community groundwater supplies are at risk of water shortages under moderate to severe drought conditions, including about a dozen in East-Central Illinois[1].

The withdrawal of groundwater always causes head (water level) in a production well and surrounding wells to decline and a cone of depression to form (Figure 4). The decline in head is called drawdown. Where aquifers are physically connected, pumping water from a deeper confined aquifer can affect an overlying shallow aquifer. For example, a well in Champaign finished in the Glasford Aquifer is reported by the Illinois State Water Survey to no longer yield water, probably due mainly to extensive pumping from nearby wells in the deeper Mahomet Aquifer (Appendix 1).

Well interference occurs when one well competes and interferes with the groundwater available to another well drawing from the same or connected aquifer. A single high capacity well or a group of wells pumping large amounts of water from a limited aquifer may stress the system. The cones of depression associated with individual wells can merge to form a large sub-regional cone of depression: withdrawals in and around Champaign County have formed a large cone of depression tens of miles across, extending into neighboring counties. It is important to consider the cumulative impacts of pumping groundwater from many wells in multiple jurisdictions.

Groundwater recharge occurs in all parts of the region, but at varying rates. Groundwater recharge to the confined Mahomet Aquifer is impeded more by thick, relatively impermeable layers of silt and clay (till) than by changes in land cover, such as urbanization[3]. In the Illinois State Water Survey groundwater flow model, soils developed on the fine-grained till are assigned a recharge rate of 1.75 inches per year, although much of that water drains off to surface waters and does not recharge the confined Mahomet Aquifer[3]. There is evidence that recharge to the confined Mahomet Aquifer is greatest in areas where relatively impermeable layers of silt and clay are absent and leakage from streams provides a large amount of water to the aquifer system. East of the Havana Lowlands in Mason and Tazewell Counties, the Mahomet Aquifer is completely covered by till, except in the narrow alluvial valleys of some major streams. With the exception of four critical stream segments, the alluvial sand deposits do not appear to be connected to the Mahomet Aquifer. The following four key segments appear to provide a large amount of water to the aquifer system by direct leakage from the stream[3]:

- The Middle Fork of the Vermilion River in northeastern Champaign County and eastern Ford County;
- The Sangamon River between Mahomet and Fisher;
- The Sangamon River south of Monticello through Allerton Park; and
- Sugar Creek near McLean.

Statewide maps of aquifer sensitivity to contamination[4,5] and potential for aquifer recharge[6] in Illinois have been published. The map of potential aquifer recharge is based principally on surficial textural classifications, so is qualitative.

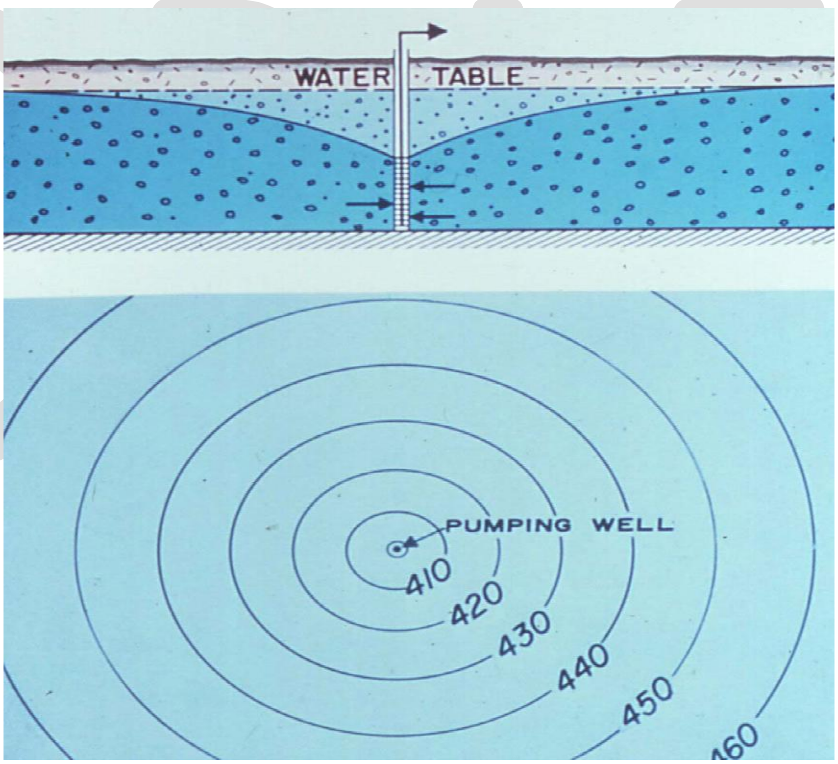

Figure 4. Diagram to illustrate head elevations and creation of a cone of depression when groundwater is pumped from an unconfined aquifer. An unpumped water table elevation of 460 feet is shown (from the Illinois State Water Survey).

In the Havana Lowlands, the geology and hydrology of the Mahomet Aquifer are different than in the central and eastern parts of the aquifer. Here, overlying relatively impermeable tills are absent and the aquifer is unconfined and behaves like a quick-response shallow aquifer: droughts and large groundwater withdrawals for crop irrigation in summer lower groundwater levels and create cones of depression, but water levels typically rebound after the growing season and with a return to higher precipitation (Appendix 1). In the Illinois State Water Survey groundwater flow model, soils in the dunal areas are assigned a recharge rate of 15.0 inches per year, and 8.8 inches per year where there are thin, fine-grained lake-bed deposits covering them[3]. Due to sub-regional variations in geological and hydrological conditions, drawdown (lowering of the water table) in the unconfined aquifer in the Havana Lowlands is much less than, for example, drawdown (lowering of head) in the confined Mahomet Aquifer in Champaign County, even though withdrawals in the Havana Lowlands are much greater[3].

As noted above, surface waters and groundwater are connected through the water cycle. Over time, groundwater withdrawals are balanced by a reduction in groundwater storage, a reduction in natural groundwater discharge to surface waters, and/or an increase in groundwater recharge. In general, an aquifer is more able to support a large amount of water withdrawn from widely distributed wells rather than from wells that are close together, although the economics of withdrawing, treating and distributing water may favor the latter.

Water withdrawal and use

Water withdrawn and used in East-Central Illinois meets domestic, commercial and industrial needs in the region and the needs of people outside the region for some goods and services produced in the region, such as agricultural products and electricity. Past, present and possible future water withdrawals and uses have been described in detail and are summarized in Appendix 1. Key findings from the water demand report[7] are presented here.

The average amount of water withdrawn per person each day in the region in 2005 for residential, commercial, industrial and recreational uses and agriculture and irrigation (adjusted to normal weather and excluding electric power generation) was about 312 gallons. High water withdrawals for irrigation in Mason and Tazewell counties are a main reason why regionally-averaged per capita water withdrawals are so high. Average per capita water withdrawal for public water supplies in 2005 was 147 gallons. Average per capita domestic water withdrawal was estimated to be about 82 gallons per day. The commercial and industrial sector also has its own water supplies, much of which is not for potable water use. Withdrawals in this self-supplied sector averaged 160 gallons per employee per day in 2005.

Once water is withdrawn it is distributed and used. Two types of water use are recognized – consumptive use and non-consumptive use. Water consumption represents that part of water withdrawn that is evaporated, transpired by plants, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment and is not available for immediate or economical reuse. Almost all withdrawals for once-through, electric power generating systems represent non-consumptive use, because nearly all the water withdrawn is returned to the source after passing through the condensers. Furthermore, some of the water withdrawn for commercial, industrial and public uses also is non-consumptive, as treated waste water discharged to surface waters is available for reuse. A large but undetermined portion of the smaller withdrawals for three closed-loop, electric power generating plants and water withdrawn for agricultural irrigation is evaporated (consumed). Groundwater that is withdrawn, used, treated and discharged to surface waters is removed from aquifers, but is available for reuse in surface waters.

In 2205, population in the 15-county region was just over one million. Total surface water and groundwater withdrawals were modeled to be 339 millions of gallons per day (mgd). In fact, 2005 was a drought year, especially in western parts of the region, and water withdrawals were reported and estimated to be about 120 mgd higher than modeled withdrawals adjusted to normal weather.

Adjusted to normal weather, public water supply sector withdrawals in 2005 were modeled to be 127 mgd, self-supplied domestic 9 mgd, self-supplied commerce and industry 64 mgd, agriculture and irrigation 139 mgd, and 1,315 mgd were withdrawn for electric power generation. The electric power generation sector withdraws the most water, but, as noted above, most withdrawals are for non-consumptive use.

For all sectors combined, groundwater withdrawals from the Mahomet Aquifer in 2005 (adjusted to normal weather conditions) are simulated to have been about 220 mgd[9].

The above figures are for average day withdrawals throughout the year, but withdrawals generally are higher in summer than in other seasons. Peak day withdrawals for public water supplies typically are 50 to 100 percent higher than annual average day withdrawals and up to a factor of 7 higher for irrigation. In 2005, a drought summer, peak day water withdrawals for irrigation in the Havana Lowlands in Mason and Tazewell Counties were reported to be almost one billion gallons.

Peak day demand plays a key role in water demand planning and management and most operators have drought response plans. Title IV of the Illinois Environmental Protection Act indicates that there should be continuous operation and maintenance of public water supply installations in order to protect the public from disease and to assure an adequate supply of pure water for all beneficial uses. This concept is carried forward in the Illinois Pollution Control Board Rules, in particular 601.101 (Appendix 2). This could be interpreted as a 100 percent dependability standard for public water supplies. In general, continuous water supplies are planned for by developing capacity to supply water with a high probability of meeting peak day demand; contingency or emergency response plans are implemented to address unusual situations. Perfect water supply dependability, meaning no chance of future shortfall, generally is not optimal where water development costs are high.

The historical record of water conservation in the region is reported to show a slight declining trend in regional per capita water withdrawals in the public supply sector, although per capita water withdrawals in 2005 were slightly higher than in 1990. In the self-supplied commercial and industrial sector, a conservation trend is reported to reflect gains in the efficiency in production processes and technologies.

A comprehensive, consistent, reasonably accurate and regularly updated inventory of water withdrawals is necessary for water supply planning and management. The Illinois State Water Survey operates a voluntary water withdrawal reporting system – the Illinois Water Inventory Program. Much progress has been made and, even though some important data gaps remain and funding for the program is unstable, the Illinois Water Inventory Program remains the best source of Illinois water withdrawal data.

Future water demand and withdrawal scenarios

Many factors interact to determine how much water will be needed and will be withdrawn. A plausible range of water withdrawal scenarios has been produced, including consideration of drought and climate change[7], and are summarized in Appendix 1. Key findings from the water demand report are presented here.

Major drivers determining water withdrawals are the number of people living and working in the region, the demand for products produced in the region, and the average amount of water withdrawn per person.

Population in the 15-county region of East-Central Illinois is expected to increase from 1.03 million in 2000 to 1.34 million in 2050 – a 30 percent increase.

If the average amount of water withdrawn per person remains constant and population increases by 30 percent, total water withdrawals also will increase by 30 percent.

If population increases or decreases by more or less than the official 30 percent and the average amount of water withdrawn per person remains constant, water withdrawals will change by the percentage change in population.

If population increases by 30 percent and the average amount of water withdrawn per person increases or decreases, total water withdrawals will increase by 30 percent plus or minus the percentage change in the average amount of water withdrawn per person.

The major variables that could result in a change in the average amount of water withdrawn per person and, hence, total water withdrawals are reported to be household income, the price of water, drought, an increase in temperature, employment and productivity, new industrial facilities, the number of irrigated acres, and water conservation. Water conservation and water prices probably are more amenable to control than the other factors influencing water demand.

Demand for water and water withdrawals will increase. Using different combinations of assumptions, a plausible range of increases in total surface water and groundwater withdrawals in the region by 2050 (excluding electric power generation) is about 220 to 420 mgd more than 2005 modeled normal-weather withdrawals of about 340 mgd. This range of increase would be about 100 to 300 mgd above 2005 reported and estimated withdrawals of about 460 mgd, which was a drought year in parts of the region. Withdrawals for electric power generation (the large majority of which are non-consumptive) could decrease by 7 percent to about 1,218 mgd, or increase by 2 percent to about 1,342 mgd.

Under normal weather conditions, groundwater withdrawals from the Mahomet Aquifer are reported to increase from about 220 mgd in 2005 to 260 mgd in the Less Resource Intensive (LRI) scenario in 2050, 280 mgd in the Baseline (BL) scenario, and 300 mgd in the More Resource Intensive (MRI) scenario[8]. Withdrawals would be much higher in a drought year, especially for irrigation, and would increase with some climate change scenarios.

Impacts of groundwater withdrawal

The Illinois State Water Survey, using data and a geological model provided by the Illinois State Geological Survey, created a groundwater flow model to simulate the impacts of withdrawing water to meet the three water demand scenarios[9]. All increases in pumpage were assigned to existing high capacity wells. A 95 percent confidence level for simulating heads is reported to be about +/- 5 feet. Simulations have not been conducted for domestic self-supplied withdrawals or pumping from possible new wellfields in the Mahomet Aquifer to serve Bloomington, Springfield, and/or other communities[9]. Recharge rates were adjusted up and down by 2 percent per decade to simulate the impacts of potential future climate changes[9]. The modeling results are preliminary.

Pumping from the confined Mahomet Aquifer is greatest in Champaign County and drawdown (decline in head) is and will continue to be greatest in and around Illinois American Water's production wells (Figures 5 and 6). The bull's eye of concern is in Champaign County, but in all cases head in the Petro North observation (non-pumping) well on Rising Road west of Champaign remains above the top of the Mahomet Aquifer, i.e., the aquifer is not dewatered locally (Figure 7). However, in a model cell in northern Champaign, near the boundary of the aquifer, head in the MRI scenario is modeled to drop to less than 25 feet above the top of the aquifer. Available head above the top of the aquifer is greatest in the LRI scenario and least in the MRI scenario.

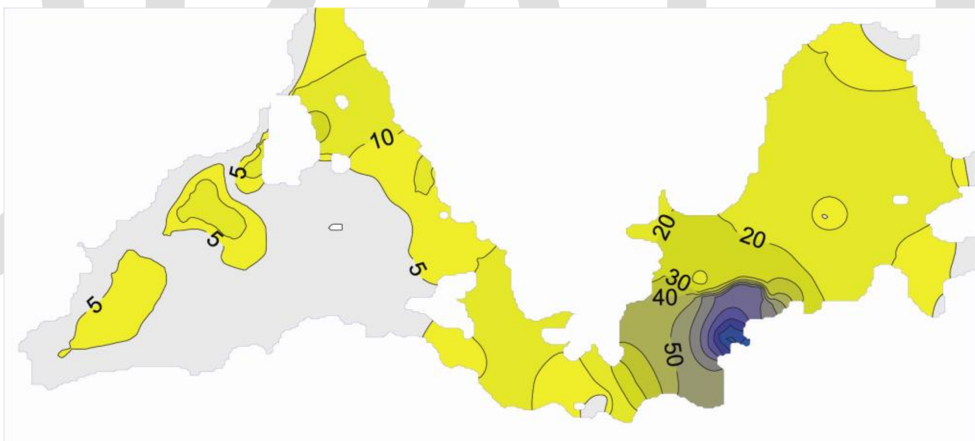

Figure 5. Simulated drawdown (feet) from 1930 to 2005 based on estimated historical withdrawals that increased over time[9].

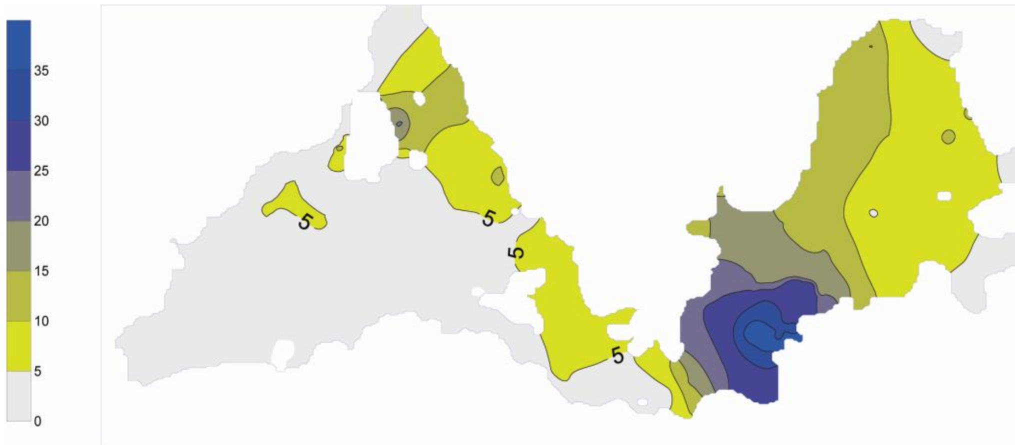

Figure 6. Simulated drawdown (feet) from 2005-2050 for the MRI demand scenario[9].

When simulating a 2040 pumping scenario of 51.1 mgd by Illinois American Water, Wittman Hydro Planning Associates, Inc. concluded that such pumping would be sustainable west of Champaign[10]. Conditions were considered to be sustainable as long as water levels were predicted to remain above the top of the Mahomet Aquifer, i.e., the Mahomet Aquifer remains saturated. However, in this simulation, heads about three miles to the east of the Petro North well drop to the top of the aquifer and drop below the top of the aquifer in a worst-case scenario, i.e., the aquifer starts to become unsaturated, or partially dewatered. This analysis did not include additional withdrawals from the Mahomet Aquifer by other communities or industries out to 2040, or withdrawals from the Glasford Aquifer. It was recognized that increased pumping by other users would add to the drawdown caused by increased pumping of 16 mgd by Illinois American Water and “reduce the capacity of the aquifer system to yield water in the Champaign area and will exacerbate the effects of expansion of the ILAW source of supply”. Also, it was concluded that “dewatering of shallow water-bearing zones will affect some local wells and will ultimately reduce the capacity of the Mahomet Aquifer due to decreased vertical leakage”[10]. Illinois American Water concluded that this level of pumping by Illinois American Water and the resulting impacts would be sustainable in Champaign County[11] [see also Appendix 1].

Figure 7 shows past, present and possible future head above the top of the Mahomet Aquifer (elevation 515 feet) in the Petro North well. Head has declined about 83 feet since predevelopment (1930) and is projected to continue to decline under all scenarios considered: the LRI, BL and MRI scenarios to 2050, linear extrapolation of the 1935-2007 trend in head to 2050, and a scenario of Illinois American Water pumping 51.1 mgd in 2040. Head in this observation well some distance away from the main production wells is expected to remain above the top of the aquifer. Also, heads in Illinois American Water’s production wells typically drop an additional 20-30 feet during pumping[3]. A further consideration is that data from the Illinois State Water Survey groundwater flow model are for transient simulations of average day withdrawals. Heads are expected to be somewhat lower under equilibrium conditions and in summer, especially during drought periods when water demand is higher. In some wells, head at some locations could drop close to or below the top of the aquifer in some pumping scenarios.

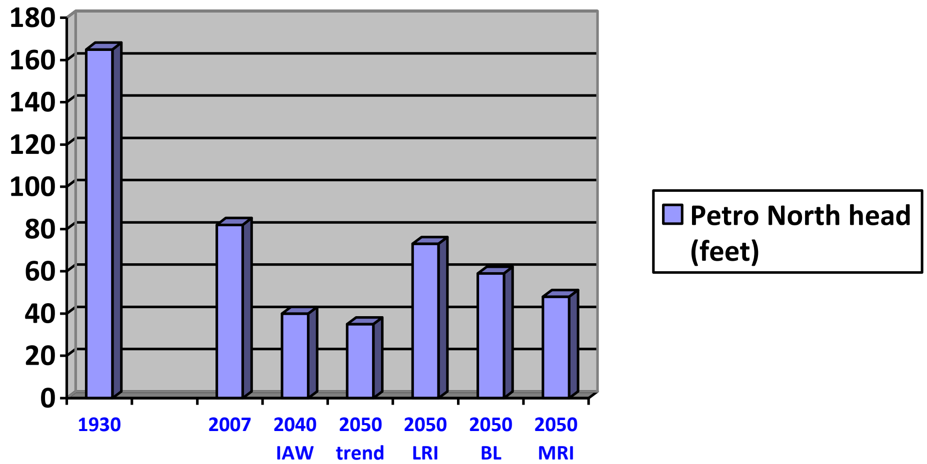

Figure 7. Head (feet) above the top of the Mahomet Aquifer in the Petro North observation well on Rising Road, west of Champaign. The 1930 head is a best estimate[3,8]. The 2007 head is from observations[3,8]. The 2040 IAW head (Illinois American Water pumping 51.1 mgd) is from visual interpretation of Figure 34 in reference[10]. The 2050 trend head is a linear extrapolation of 1930-2007 head data[3,8]. The 2050 LRI, BL and MRI heads are from groundwater flow model simulations of the three water demand scenarios[9].

Withdrawing water from the aquifers also has other hydrologic and groundwater flow impacts: in the confined aquifer, recharge is increased by increasing infiltration from the shallow aquifers. Water levels in the shallow unconfined aquifers also are lowered and parts of the shallow aquifers in Champaign County are dewatered locally[10].

Furthermore, Mahomet Aquifer groundwater flow from Champaign County to Piatt County, estimated to have been 10 mgd in predevelopment times, already has been reversed and Champaign County now “imports” an estimated 3 mgd from Piatt County[3]. By 2050, water from even further west will be pulled into the expanding cone of depression centered in Champaign County[9]. Possible implications of this groundwater flow reversal for water availability in Piatt County have not been evaluated.

The above simulations are for average day demand, but withdrawals for irrigation occur only in summer. When withdrawals for the summer season are simulated, and periodic withdrawals for the large industrial wellfield in Champaign County are included, the greatest impacts still are in the confined part of the aquifer east of the Havana Lowlands, even though hundreds of millions of gallons of water per day are pumped for irrigation in the Havana Lowlands[9].

In the Havana Lowlands, groundwater elevation in the vicinity of pumping wells varies by up to 15 feet or more between wet and dry years, and in dry years some small streams may go dry (Appendix 1). Both drought and irrigation pumping reduce groundwater elevation and saturated thickness in the unconfined aquifer (Figure 8). However, there are huge amounts of water in storage in the unconfined aquifer and saturated thickness was reduced by only about seven percent in the drought year of 2005, and has since recovered[3]. This is due to the fact that the unconfined aquifer in the Havana Lowlands is able to release about 1,000 times more water out of storage per foot of drawdown than in the confined aquifer[9]. Withdrawals in the Havana Lowlands are projected to continue to increase and groundwater elevation and saturated thickness to decrease in the growing season in all three water demand scenarios[9]. There is a limit to the increase, however, as a point is reached where all irrigable farmland acreage is assumed to be irrigated. However, even with higher withdrawals, groundwater elevation and saturated thickness can recover quickly after the growing season and/or drought.

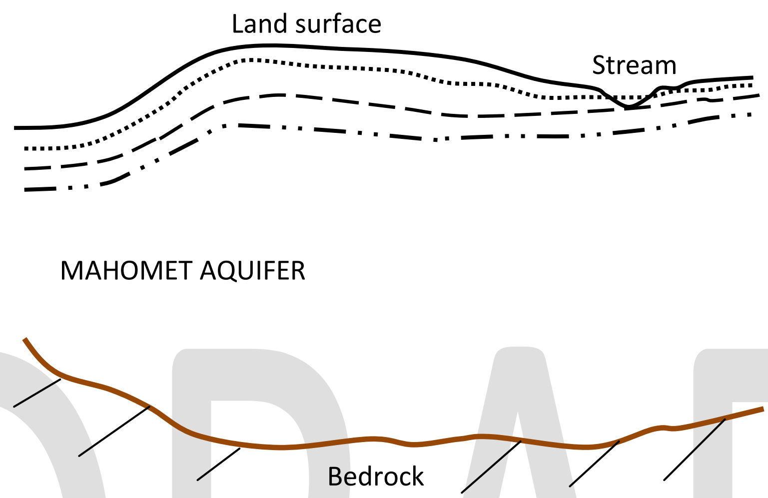

Figure 8. Simplified diagram of groundwater elevations in the unconfined Mahomet Aquifer in the Havana Lowlands. The zone between the land surface and the water table is unsaturated. The top dashed line (······) represents the water table – the highest groundwater elevation and the top of the saturated zone. All the material between the water table and bedrock is saturated. In a drought period, groundwater elevation drops (▬▬ ▬▬). Large groundwater withdrawals for irrigation cause groundwater elevation to decline further (▬▬ · · ·). Lowering of groundwater elevation caused by drought and pumping can cause some headwater streams to go dry and reduce flow in larger streams.

It was concluded from simulations of the Illinois State Water Survey groundwater flow model that groundwater development has caused a significant decrease in the amount of baseflow discharge to streams in the region, although a confidence level for calculated changes in streamflow is not presented[9]. Baseflow discharge to the Upper Sangamon River and Quiver Creek watersheds is modeled to have decreased by about 35-40 percent since 1930, due to reduced groundwater discharge, increased leakage out of the rivers, and increased capture of recharge at the surface. Future reductions in groundwater discharge to streams are greatest in the MRI scenario and with an assumed decrease in recharge due to climate change. Groundwater discharge to streams increases in the LRI scenario and in a climate change scenario in which recharge is assumed to increase. Under normal weather conditions in all the demand scenario, streams do not dry out; but streams do go dry during drought periods[9]. Analyses have not been completed that describe changes in the frequency with which streams go dry, or remain dry, in groundwater development scenarios.

It has been calculated that, in the BL scenario, a reduction of 8 inches (40 percent) from normal (1971-2000) summer precipitation of about 20 inches would result in an increase in total regional water demand (excluding electric power plants) of 106 mgd above 2005 normal weather withdrawals[7].

Again in the BL scenario, an increase in temperature of 3 $^{\circ}$F – the mid-point in the temperature scenarios – would result in an increase in total regional water demand (excluding electric power plants) of about 39 mgd. An increase in temperature of 6 $^{\circ}$F – top of the range of temperature scenarios – would result in an increase in total regional water demand (excluding electric power plants) of about 78 mgd[7].

An extreme climate scenario for water supplies would be a decrease in mean annual precipitation, a recurrence of severe multi-year droughts, and an increase in temperature. All these factors would combine to increase water demand and decrease water availability. However, the probability of occurrence of various climate scenarios is unknown, and changes in drawdown due to changes in water demand under conditions of potential climate change have not been simulated.

All the above simulations are for transient runs, i.e., they simulate drawdown in 2050 associated with pumping in 2050. However, a further factor to consider is the response time for the aquifer system to adjust to specified pumping levels. Even if pumping is held constant at 2050 pumping rates, there can be a delayed response as the aquifer system adjusts to a new equilibrium, or steady state, among discharge, recharge and water storage. The Illinois State Water Survey has not reported on steady-state drawdowns[9], but they could be an additional few feet[8]. And, of course, if pumping continues to increase beyond 2050, the transient and steady-state impacts will continue to increase.

The Committee finds that allowing water levels in wells to drop below the top of the confined Mahomet Aquifer and for the aquifer to become partially dewatered (dry), even locally, would represent a stressed situation. Similarly, the Committee finds that loss of too much saturated thickness in unconfined aquifers would represent a stressed situation, especially if streams go dry, or remain dry for a longer period as a result of groundwater development.

The main reason to use a range of scenarios is to demonstrate that determining future water demands depends on the choice of assumptions about uncertain future conditions. Different assumptions can lead to the identification of different futures and different management strategies. A regional water supply plan, therefore, can be developed only in the context of considerable uncertainty about future conditions – uncertainty that poses challenges, risks and opportunities.

Future water availability

The amount of surface water and groundwater available in the future will depend on climate conditions, groundwater recharge and discharge rates, streamflow, reservoir capacities, and the amount of water that is withdrawn from storage.

Precipitation and water availability will continue to vary from year-to-year and decade-to-decade (Appendix 1). Even without considering human-induced climate change or using climate models, it is reasonable to assume that severe multi-year droughts are likely to recur in the future. With recurrence of droughts that occurred in the 1930s and 1950s, water levels in many streams, lakes, reservoirs, wetlands and shallow aquifers will drop to low levels and stress many water supplies and aquatic ecosystems.

Global climate models indicate that annual average temperature in Illinois could increase between 0 and 6 ^{o}F by the year 2050 and continue to increase beyond that date (Appendix 1). However, there is considerable range in climate model projections and it is not possible to attach a probability to future temperature changes in the state. If temperature does increase, evapotranspiration will increase and diminish water levels in streams, lakes, reservoirs, wetlands and shallow aquifers, but much less than during a severe drought.

Scenarios of future precipitation amounts in Illinois produced from global climate model simulations range from a substantial increase in precipitation to a substantial decrease (Appendix 1). As with temperature, it is not possible to attach a probability to future precipitation changes in Illinois. If average annual precipitation decreases by several inches, water levels in streams, lakes, reservoirs, wetlands and shallow aquifers will decrease, but not as much as during a severe drought. Conversely, if mean annual precipitation increases, water levels in streams, lakes, reservoirs, wetlands and shallow aquifers will increase.

The susceptibility of the confined Mahomet Aquifer to long-term changes in temperature and precipitation is unknown, but it is expected to be much more protected from the potential impacts of climate change than shallow aquifers and surface waters. Groundwater flow model simulations indicate that water levels in the unconfined Mahomet Aquifer in the Havana Lowlands could go up or down by several feet with possible climate change, but head in the confined aquifer is little impacted by climate change[9].

Trying to determine how many gallons of water are available, or will be available in the region is subject to many assumptions and is unlikely to produce meaningful management information. The approach that many scientists and engineers have adopted is to evaluate the benefits and costs of storing and withdrawing water to meet demand, rather than focusing on how many gallons of water will be available.

Benefits and costs of water withdrawals

Providing water to meet demand involves considerations of benefits and costs. Many benefits arise from using water. However, withdrawing water from an aquifer, stream, lake, reservoir or wetland, or building a reservoir also has financial and environmental costs: storing or withdrawing a small amount of water has small costs; storing or withdrawing a large amount of water can have large costs. Perhaps the largest social and economic costs occur when insufficient water is supplied to meet demand and water shortages occur.

A key challenge is to determine the economic and environmental costs of water supply management that are socially acceptable. A more comprehensive analysis requires balancing the social and economic benefits of providing water to meet demand against the economic, social and environmental costs of providing, or failing to provide water to meet demand. It also requires comparing the costs and benefits of providing water to meet demand against the costs and benefits of reducing water demand. Such comprehensive cost-benefit analyses have not been conducted for East-Central Illinois; hence, the

Committee is not in a position to evaluate alternatives or recommend water supply plans based on full cost-benefit analysis.

Balancing water availability, demand and supply

Water demand scenarios combined with data and information on water availability lead the Committee to conclude that there is sufficient water available in East-Central Illinois to meet water demands to 2050, provided that i) economic and environmental costs can be tolerated, and ii) drought preparedness plans are developed and implemented.

The Committee does not have data on the capacity of all existing water supply facilities to meet existing and future water demands; the capacity of supply facilities was beyond the scope of this planning effort. However, providing dependable and adequate supplies of clean water to meet increased demand undoubtedly will require costly expansion of many water facilities, construction of new facilities, and/or reduction in demand. Funding for new infrastructure and operations may raise problems, but facility managers have authority and responsibility to resolve these problems. The Committee will not make recommendations in support of or in opposition to specific water supply development or conservation projects.

The Committee does view one of its roles to be the gathering and posting of data and information on water supply issues for deliberation by the public and diverse interest groups. The water demand scenarios and climate change sensitivity studies for the region are two examples; revealing what the Committee views as a possible early indication of an emerging issue – dewatering at least one well finished in the Glasford Aquifer in Champaign – is another.

Reservoirs are the prime sources of water supply for Decatur, Danville, Springfield and Bloomington. Bloomington's current use is about 12 mgd and the 90 percent estimate of yield in a drought of record is 11.0 mgd. Decatur currently uses about 37 mgd and the 90 percent yield estimate is 34.6 mgd. Springfield uses about 32 mgd and its 90 percent yield estimate is 23.4 mgd[2]. All three cities will have increasing water supply deficits in the future unless additional sources of supply are developed[2]. Increasing deficits are due to increasing demand, and for Bloomington and Springfield to declining yields due to sedimentation. Droughts of record – or worse – could occur at any time. The 90 percent yield estimate for Bloomington in 2050 decreases to 10.1 mgd and for Springfield to 21.8 mgd. Decatur has a dredging program that removes sediment from their lake at about the same rate as sediment is being deposited from the Sangamon River. It is assumed that they will maintain this program, and thus the capacity of the reservoir will not change substantially over time[2]. Water demand in 2050 in the BL scenario increases to 16 mgd for Bloomington, 56 mgd for Decatur and 37 mgd for Springfield[2]. Water demands increase in the MRI scenario[7]. Danville will have a water supply deficit with the BL scenario by 2050[2], and a greater deficit with the MRI scenario[7]. In the absence of measures to augment water supply or reduce water use, it is expected that the Springfield power plant will need to shut down, should a 40- to 50-year drought occur in the next decade, although sufficient water would still be available for potable water use[1]. Ashland is expected to become part of Cass County Rural Water District, thus receiving a more dependable supply of water.

If limits on water storage and withdrawals are identified to protect the environment and ensure sustainable water supplies, these could pose additional challenges to balancing water withdrawals with water demand in some parts of the region, and result in higher water prices.

A regional perspective can bring to water supply planning greater unity in identifying future water demands and risks of drought and climate change, an analytical framework for evaluating the long-term, area-wide impacts of water withdrawals, and guidance on the sustainability of water supplies. In short, regional planning focuses on shared responsibilities and opportunities. The Committee believes that meaningful participation by all water facility managers in a regional planning process with their review, acceptance and implementation of regional guidance can lead to sustainable water supply management throughout the region, without diminishing the authorities and responsibilities of local water supply managers.

Water prices are reported to significantly influence water demand in the region[7] – the higher the price the lower the demand. Water rate structures and water prices vary across the region due to the number of local historical and current management strategies and policies. In this pilot study, the Committee has not discussed water rates in detail.

Current laws, regulations and property rights

Appendix 2 provides a summary of relevant water laws, regulations, and property rights. Key findings are presented here.

Water currently is stored, withdrawn, treated and distributed and waste water is discharged by public and private water system operators for beneficial use in accordance with existing laws, regulations and property rights. Complaints can be addressed through the courts.

Water withdrawals in the state are subject to the riparian doctrine of reasonable use. In the case of a complaint, the legal system allows for adjudication by the courts of the relative needs of landowners. The lowering of the water table or reduction in water pressure by a groundwater user that reduces or eliminates the use of a neighbor’s well is not necessarily unreasonable. Also, the law does not specify that it is unreasonable *per se* to dewater an aquifer, does not treat groundwater and surface water as a linked resource, and does not define the sustainability of water supplies.

Permits to withdraw water are required only for the public navigable waters of the Illinois River, the lower Sangamon River and lower Sangamon River South Fork, where maintenance of minimum instream flows is regarded as a benefit to the public. The construction of all water withdrawal and storage facilities is regulated, as are discharges of waste water.

An important component of the Water Use Act relating to groundwater is to establish a means of reviewing potential water conflicts before damage to any person is incurred and to establish a rule for mitigating water shortage conflicts (Appendix 2). Some counties are exempt. In the event that a land occupier or person proposes to develop a new point of withdrawal, and withdrawals from the new point can reasonably be expected to occur in excess of 100,000 gallons on any day, the land occupier or person is required to notify the Soil and Water Conservation District before construction of the well begins. The District in turn is required to notify other local units of government that have water systems that may be impacted by the proposed withdrawal. The District then is required to review, with assistance of the Illinois State Water Survey and the Illinois State Geological Survey the proposed point of withdrawal's effect upon other users of the water. The findings of such reviews are to be made public. However, this is an unfunded mandate for the Soil and Water Conservation Districts and the Scientific Surveys and the reviews are not conducted. Individual utilities and water authorities develop and implement their own plans with varying degrees of public participation and review.

The riparian doctrine of reasonable use states that wasteful and malicious use of water is unreasonable. The Committee is unaware of malicious uses of water in the region, but there is no doubt that some uses are inefficient and wasteful. There are varying degrees of unavoidable leakage and unaccounted for flow in water treatment and distribution systems, perhaps up to 15 percent or more. The efficiency of water used for all purposes could be improved.

Institutional organization and governance

Appendix 2 provides information on institutional organization and governance relevant to water supply planning and management. Key findings are presented here.

Individual local, county, state and federal governments, non-governmental organizations, rural water districts, and private entities have individual roles, authorities and responsibilities to plan and manage water supplies. State-level activities for water supply planning and management in Illinois are conducted by various agencies, consistent with a variety of statutory authorities and responsibilities. However, there is no general statute in Illinois that allows comprehensive water resources management at the state level.

Thirteen Water Authorities in the region have roles in the planning and management of water supplies in the region, mainly to protect local interests. Their current authorities, geographical coverage and management strategies are insufficient to provide a framework for comprehensive management of water supplies across the region.

The Illinois Department of Natural Resources and the Illinois Environmental Protection Agency co-chair the Governor’s Drought Response Task Force. The Task Force meets to coordinate state response to drought situations. The Committee is pleased that the co-chairs are revising the state’s drought response plan to include drought preparedness. Being prepared for drought is an important component of providing dependable and sustainable water supplies.

Water supplies in East-Central Illinois, however, are planned and managed largely in piecemeal manner by individual managers and local and sub-regional authorities. Time horizons for planning vary from years to decades. Assumptions about future conditions that affect water demand and methods of water availability and impact analysis vary. No uniform dependability standard is implemented, resulting in varying risks of water shortages. The concept of the sustainability of water supplies is not uniformly or comprehensively defined or integrated in water supply management plans. Communication and cooperation among stakeholders are limited. Technical expertise at the local level often is limited. The public and many local officials have limited understanding of water supply issues and often are misinformed. Although there is an increasing tendency for managers to be aware of and take into consideration conservation and area-wide impacts of withdrawals, there is no planning and management process or structure for comprehensive water supply planning and management across the region. Existing laws and regulations do not provide explicit authorities and responsibilities for providing dependable supplies of water for future generations in a sustainable manner. Yet, despite all this, there have been relatively few conflicts or water shortages.

Regional, or area-wide, planning has become increasingly accepted in many states and other countries. This acceptance is based, in part, on awareness that issues of physical and economic development and of environmental deterioration transcend the geographic limits of local units of government. It has also been recognized that sound resolution of area-wide problems requires cooperation and coordination among all units and agencies of government concerned and private interests.

In Texas, for example, the Texas Water Development Board (the Board) has under Texas Water Code authority and responsibility for conservation and development of water across all 16 regions of the state[12]. The Board's main responsibilities are threefold: collecting and disseminating water-related data; assisting with regional water planning and preparing the state water plan for the development of the state's water resources; and administering cost-effective financial programs for the construction of water supply, wastewater treatment, flood control and agricultural water conservation projects. The Board has a strategic plan, rules for regional and state water planning, and has produced a State Water Plan.

The way that Texas engages all water supply managers in each water supply planning region is for the Board to provide an opportunity for them to evaluate the Board's water demand projections and suggested management strategies and to submit to the Board for approval a portfolio of water management strategies tailored to meet each region's water supply needs. The Board's suggested management strategies include conservation, reuse of waste water, and new supply development to meet water demands under worst-case drought conditions. The regions' plans can include modifications to the Board's projections and suggested management strategies, but environmental and economic impacts must be assessed and guidelines established by the Board must be adhered to. However, it is the stakeholders in each region who decide how water supplies and demands are balanced. The Board provides technical assistance to the regions to enable county-by-county review of the Board's projections and the counties engage municipalities, utilities and other entities.

Membership in the Texas planning process is voluntary, but state support for financing water supply and treatment projects is tied to participation in the State Water Plan. The Texas loan program is similar to the existing Water Pollution Control Loan Program and the Public Water Supply Loan Program administered by the Illinois Environmental Protection Agency[13].

The Board[12] identifies the following five benefits of its model that has well established authorities, responsibilities, incentives and oversight:

- Broad-based growth of public knowledge of water resource issues;
- Fostering a direct link between water planning and implementation;
- Enhanced cooperation among different interest groups;
- Improved relationships between environmental and development interests; and
- Implementation of water management strategies.

To the list of benefits could be added regional self-sufficiency.

The sustainability of water resources is addressed in different ways in different states. In Texas, for example, the sustainable development of surface waters is based on safe yield during a drought of record, which already is well regulated and considered in reservoir management. Sustainability of groundwater resources is not required by state law, but most planning groups have adopted a policy of sustainability for their aquifers. In most cases, sustainability is intended to maintain groundwater availability at current levels through perpetuity. All but five of the state's aquifers have what are described as sustainable values of water availability, and three of these will meet sustainable values in 2060. Several planning groups recommended temporarily overdrawing from their aquifers. In Texas and other states, it is recognized that some environmental costs of providing adequate supplies of water to meet demand must be acknowledged; but the balance between environmental and economic values is variable.

In a regional water supply plan for Southeastern Wisconsin[14], the sustained ability of supplies to meet probable future needs is addressed by establishing objectives, principles and standards. Some examples of the standards are provided below.

- The use of the deep sandstone aquifer should be managed so that the potentiometric surface in that aquifer is sustained or raised under use and recharge conditions within the Southeastern Wisconsin Region.
- The use of groundwater and surface water for water supply purposes should be carried out in a manner which minimizes adverse impacts to the water resources system, including lakes, streams, springs, wetlands and aquatic ecosystems.
- Important groundwater recharge and discharge areas should be identified for preservation or application of land development plans and practices which maintain the natural surface and groundwater hydrology, while protecting the groundwater quality. The use of groundwater and surface water for water supply purposes should be carried out in a manner which minimizes adverse impacts to the water resources system, including lakes, streams, springs, and wetlands.
- Residential per capita water usages should be reduced to the extent practicable.
- Both indoor and outdoor water uses should be optimized through conservation practices that do not adversely affect public health.
- Water uses for commercial, industrial, and institutional land uses should be reduced to the extent practicable.
- Unaccounted-for water in utility systems should be minimized.
- The regional water supply plan should consider the possibility of long-term climate cycles that can affect recharge rates and water demand.
- The recommended regional water supply plan components should be adaptable to change in scope, capacity, and effectiveness to the extent practicable.

The Southeastern Wisconsin Regional Planning Commission (the Commission) defined unacceptable damage as "a change in an important physical property of the ground or surface water system – such as water level, water quality, water temperature, recharge rate, or discharge rate – that approaches a significant percentage of the normal range of variability in that property. Impacts that are 10 percent or less of the range in annual or other historic period of record for any property are considered acceptable, unless it can be shown that the cumulative effect of the change may cause a permanent change in an aquatic system by virtue of increasing the extremes of that property to levels known to be harmful. In the specific case of the deep sandstone aquifer, the term sustainability is interpreted to mean that the potentiometric surface in that aquifer is maintained at current levels or raised based upon use and recharge conditions within Southeastern Wisconsin”[15].

Technical information for developing alternative and recommended water supply plans is provided in a comprehensive report on state of the art of water supply practices (best management practices) prepared by Ruekert and Mielke, Inc. [16].

The Commission is the official area wide planning agency for the seven-county Southeastern Wisconsin Region. The permissible scope and content of that plan, as outlined in the enabling legislation, extends to all phases of regional development, implicitly emphasizing the preparation of plans for the use of land and for supporting transportation, utility, and other public infrastructure facilities. The work of the Commission emphasizes close cooperation among various levels, units, and agencies of government, with oversight. Water supply system planning recommendations initially are advanced at the regional systems level of planning and are followed by implementation actions in the form of local project planning.

The Southeastern Wisconsin regional water supply plan includes the following major components:

- Development of water supply service areas and water demand forecasts;
- Documentation of existing and potential water supply problems and issues as revealed by inventories, analyses, and forecasts to be prepared under the planning program;
- Development of recommendations for water conservation efforts to reduce water demand;
- Development and evaluation of alternative means of addressing the identified water supply problems and issues, culminating in the identification of recommended sources of supply and in recommendations for development of the basic infrastructure required to deliver that supply;
- Identification of groundwater recharge areas to be considered for protection from incompatible development;
- Specification of any new institutional structures found necessary to carry out the plan recommendations; and
- Identification of any constraints to development levels in subareas of the region that may emanate from water supply sustainability concerns.

Unlike many states, Illinois does not have statutory mandates for developing and implementing regional water supply plans, permitting of water withdrawals and allocations, or mandatory water withdrawal reporting.

Technical assistance

The University of Illinois at Urbana-Champaign, through the Illinois State Water Survey, Illinois State Geological Survey and other departments, provides valuable technical assistance for water supply planning and management utilizing resources made available through the state budget and fees-for-service. The planning process in East-Central Illinois is dependent upon the technical support of the Scientific Surveys and the Committee wishes to maintain and strengthen this relationship.

Summary of key findings

- A fundamental fact remains valid: withdrawing and using water is necessary for sustaining life and for domestic, commercial, industrial, agricultural and recreational uses.

- Water is stored, withdrawn, treated and distributed and waste water is discharged by public and private water supply operators for beneficial use in accordance with existing laws, regulations and property rights.

- Climate, surface waters, groundwater and aquatic and riparian ecosystems are physically interconnected and associated resource management issues are intertwined.

- Demand for water and water withdrawals will increase. Using different combinations of assumptions, a plausible range of increases in total surface water and groundwater withdrawals in the region by 2050 (excluding electric power generation) is about 220 to 420 mgd more than 2005 (normal weather) modeled withdrawals of about 340 mgd. This range of increase would be about 100 to 300 mgd above 2005 reported and estimated withdrawals of about 460 mgd, which was a drought year in parts of the region. Withdrawals for electric power generation (the large majority of which are non-consumptive) could decrease by 7 percent to about 1,218 mgd or increase by 2 percent to about 1,342 mgd.

- Under normal weather conditions, groundwater withdrawals from the Mahomet Aquifer are reported to increase from about 220 mgd in 2005 to 260 mgd in the Less Resource Intensive (LRI) scenario in 2050, 280 mgd in the Baseline (BL) scenario, and 300 mgd in the More Resource Intensive (MRI) scenario[8]. Withdrawals would be much higher in a drought year, especially for irrigation, and would increase with some climate change scenarios.

- An extreme climate scenario for water supplies would be a decrease in mean annual precipitation, a recurrence of severe multi-year droughts, and an increase in temperature. All these factors would combine to increase water demand and decrease water availability, especially in surface waters and shallow aquifers. The probability of such a scenario occurring is unknown. However, severe multi-year droughts are likely to recur in the future and pose a great threat to water availability and some water supplies in the region, especially those from surface waters and shallow aquifers. This is a bigger threat than a possible decrease in precipitation and increase in temperature with climate change. Some water supply facilities are not adequately prepared for severe multi-year droughts. Building capacity to be prepared for severe multi-year droughts also would provide protection against the adverse impacts of possible climate change.
- Surface water and shallow groundwater supplies typically are and will continue to be limited during periods of drought.

- Even during periods of drought and with possible climate change, there is sufficient water in the region to meet the future water demand scenarios considered, <u>provided that adequate infrastructure and drought preparedness plans are developed and implemented and economic and environmental costs can be tolerated.</u>

- Withdrawing water from rivers and aquifers, storing, treating, distributing water, and discharging waste water have social and economic benefits and economic and environmental costs. Determining how much water is to be withdrawn from different sources necessitates balancing and weighing benefits against costs and risks.

- Reservoirs are the prime sources of water supply for Decatur, Danville, Springfield and Bloomington. Bloomington's current use is about 12 mgd and the 90 percent estimate of yield in a drought-of-record is 11.0 mgd. Decatur currently uses about 37 mgd and the 90 percent yield estimate is 34.6 mgd. Springfield uses about 32 mgd and its 90 percent yield estimate is 23.4 mgd. Due to increasing water demand and increasing sedimentation, all three cities will have increasing water supply deficits in the future unless additional sources of supply are developed and/or demand is reduced. In a drought-of-record, Danville will have a water supply deficit with the BL scenario by 2050 and a greater deficit with the MRI scenario.

- Withdrawing sufficient water from aquifers to meet demands to 2050 results in increasing drawdown in wells finished in the aquifers, expanding cones of depression, a reversal of groundwater flow in some areas, and reduced baseflow in streams. The impacts increase in proportion to the amount of water withdrawn: they are greatest with the MRI scenario and in summer when demand is highest, especially in periods of drought and with an assumed increase in temperature. The bull's eye of concern is in Champaign County, where drawdown could lower head in some wells to less than 50 feet above the top of the Mahomet Aquifer in some scenarios. Some shallow aquifers increasingly are dewatered locally, some wells finished in these aquifers go dry, and water levels in other wells drop below the pumps and will require pumps to be lowered to sustain yields.

- The Committee finds that allowing water levels (heads) in wells finished in the Mahomet Aquifer to drop below the top of the confined aquifer and for the aquifer to become partially dewatered (dry), even locally, would represent a stressed situation. Similarly, the Committee finds that allowing water levels in unconfined aquifers to drop to low levels represents a stressed situation. Similarly, the Committee finds that loss of too much saturated thickness in unconfined aquifers would represent a stressed situation, especially if streams go dry, or remain dry for a longer period as a result of groundwater development.

- Groundwater flow model simulations indicate that groundwater development and the creation of a large cone of depression have reversed groundwater flow from Champaign County to Piatt County and caused a significant decrease in the amount of baseflow discharged to streams. Groundwater withdrawals in other parts of the region also have reduced groundwater discharge to streams.

- The possibility of a slight increase in water withdrawals for electric power generation does not appear to create a problem, although projections of future electricity demand and associated water withdrawals are highly uncertain.

- The efficiency of water use can be improved and water demand reduced. Many factors influencing water demand, e.g., population, income and drought, are impossible or difficult to control. The price of water and water conservation are two factors influencing water demand that perhaps are most amenable to control.

- The varied physical, demographic and economic characteristics of the region result in distinct sub-regional variations in water availability, water storage ability and water demand that need to be factored into the development of a regional plan.

- There are uncertainties, errors and data gaps in all aspects of water supply planning and management, especially climate, water availability, water withdrawals, uses and losses, and estimates of the impacts of water withdrawals. Research and monitoring can reduce the uncertainties and errors and fill some of the data gaps, but available data and a range of plausible scenarios provide a solid basis for assessing and managing risks and identifying regional guidelines.

- Activities for water supply planning and management in Illinois are conducted by various agencies, consistent with a variety of statutory authorities and responsibilities.

- Common law provides users of water with only limited guidance to answering many issues that will likely arise in the future: for example, common law does not define the sustainability of water supplies. The planning concept of the sustainability of water supplies, which does not have a uniform, agreed upon definition, is not uniformly or comprehensively integrated in water supply management plans in the region.

- Water supplies in East-Central Illinois are planned and managed largely in piecemeal manner by individual managers and local and sub-regional authorities. There is no planning and management process or structure for comprehensive water supply planning and management across the region.

- Lack of funding prevents the mandatory review of the potential impacts of new high capacity groundwater withdrawals and realization of the full potential of the voluntary Illinois Water Inventory Program to provide a comprehensive and consistent data base of water withdrawals .

- There is no central authority for collecting, analyzing, archiving and disseminating water-related data for the region and insufficient input by stakeholders in setting priorities.

- The public and many local decision makers have limited understanding of water supply issues and often are misinformed.

- Regional water supply planning increasingly has become accepted in many states and other countries. This acceptance is based, in part, on awareness that problems of physical and economic development and of environmental deterioration transcend the geographic limits of local units of government. It also has been recognized that resolution of regional problems requires enhanced cooperation and coordination among all stakeholders.

Conclusions

In examining the issues and challenges of water supply planning and management in East-Central Illinois and recognizing the efforts of other states, the Committee was faced with three key issues: (i) identifying whether changes to water supply planning and management need to be made in the region; (ii) if so, identifying the changes that need to be made, and (iii) determining whether such changes can be achieved within existing laws, regulations and property rights.

Based on the above findings, the Committee concludes that improvements in regional water supply planning and management are needed to continue to provide benefits and to reduce costs and risks for current and future residents of East-Central Illinois, those outside the region who depend on goods and services produced in the region, and the environment. The above findings facilitate identification of improvements that need to be made. A recommended regional water supply plan is presented in Chapter 3.

References

1. Winstanley, D., J.R. Angel, S.A. Changnon, H.V. Knapp, K.E. Kunkel, M.A. Palecki, R.W. Scott, and H.A. Wehrmann, 2006. *The Water Cycle and Water Budgets in Illinois: A Framework for Drought and Water Supply Planning.* Illinois State Water Survey Information and Educational Material 2006-01, Champaign, IL (http://www.sws.uiuc.edu/pubdoc/IEM/ISWSIEM2006-01.pdf, accessed December 29, 2008).
2. Knapp, H. Vernon, 2007. *Yield Analysis for East-Central Illinois' Surface Water Supply Systems.* Illinois State Water Survey. Presentation to the East-Central Illinois Regional Water Supply Planning Committee, February 2009 (http://isws.illinois.edu/iswsdocs/wsp/ppt/EC_IL_Reservoir_Yields.pdf, accessed April 6, 2009).
3. Personal communication, George Roadcap and Allen Wehrmann, Illinois State Water Survey, March 30 and April 14, 2009.
4. Keefer, D., 1995. *Potential for Agricultural Chemical Contamination of Aquifers in Illinois.* Illinois State Geological Survey, Environmental Geology 148, Champaign, IL.
5. Berg, R.C. and J.P. Kempton with contributions by Robert C. Vaiden and Amy N. Stecyk, 1984. *Potential for contamination of shallow aquifers from land burial of municipal wastes*. Illinois State Geological Survey Miscellaneous maps, MIL Potential for contamination Statewide map, Champaign, IL.
6. Keefer, D.A. and R. C. Berg with contributions by William S. Dey, 1990. *Potential for aquifer recharge in Illinois.* Illinois State Geological Survey, Miscellaneous maps, MIL Recharge Statewide map, Champaign, IL.
7. Wittman Hydro Planning Associates, Inc., 2008. *Water Demand Scenarios for the East-Central* Illinois *Planning Region: 2005-2050.* Wittman Hydro Planning Associates Inc., Bloomington, IN (http://www.mahometaquiferconsortium.org/, accessed December 20, 2008).
8. Personal communication, George Roadcap, Illinois State Water Survey, April 7, 2008.
9. Roadcap, G.S. and H.A. Wehrmann, 2009. *Impact of Future Water Demand on the Mahomet Aquifer: Preliminary Summary of Groundwater Flow Modeling Results*, Illinois State Water Survey, Institute of Natural Resource Sustainability, University of Illinois, Champaign, March 2009.
10. Wittman Hydro Planning Associates, Inc., 2006. *Modeling a New Well Field for Champaign-Urbana*. Wittman Hydro Planning Associates, Inc., Bloomington, IN (http://www.sws.uiuc.edu/iswsdocs/wsp/champaign_sos_rpt112706.pdf , accessed March 12, 2009).
11. Illinois American Water Company, 2007. *A Sustainable Water Supply for Champaign County.* Illinois American Water Company, Champaign-Urbana, IL.

12. Texas Water Development Board (http://www.twdb.state.tx.us/home/index.asp, accessed January 16, 2009).
13. Illinois Environmental Protection Agency (http://www.epa.state.il.us/water/financial-assistance/, accessed January 21, 2009).
14. Southeastern Wisconsin Regional Planning Commission, *A Regional Water Supply Plan for Southeastern Wisconsin*, Southeastern Wisconsin Regional Planning Commission Planning Report No.52 ,Waukesha, WI (http://www.sewrpc.org/watersupplystudy/chapters.asp, accessed January 24, 2009).
15. Personal communication, Philip C. Evenson, Executive Director, Southeastern Wisconsin Regional Planning Commission, letter to Derek Winstanley, Chief, Illinois State Water Survey, March 13, 2008.
16. Ruekert and Mielke, Inc., 2007. *State of the Art of Water Supply Practices*. Ruekert and Mielke, Inc., Waukesha, WI, published as Technical Report No. 43 of the Southeastern Wisconsin Regional Water Supply Planning Commission, Waukesha, WI (http://www.sewrpc.org/publications/techrep/tr-043_water_supply_practices.pdf, accessed January 25, 2009). `