WATER SUPPLY ALTERNATIVES AND ASSESSMENTS

Introduction

The Water Resources Planning Act requires that this State Water Plan include **"**an identification and assessment of practical alternatives for an adequate supply of water to satisfy existing and future reasonable and beneficial uses, including improved storage, groundwater recharge and surface/groundwater conjunctive management programs." Identifying alternatives involves an investigation of methods and practices that either increase water supply or decrease water demand. In turn, their practical application depends on their resource protection capacity, natural conditions, existing infrastructure, and financial feasibility. Some alternatives, consumer conservation for example, can be easily undertaken while providing side benefits such as environmental enhancement and lower treatment, delivery, chemical and energy costs. Other means of assuring sufficient water to satisfy all reasonable and beneficial uses can be complex, expensive, or politically challenging.

The Act further requires "an assessment of both structural and nonstructural alternatives to address identified water availability problems, adverse impacts on water uses or conflicts between water users, including potential action to develop additional sources or alternative supplies, conservation measures, and management techniques". In this edition of the State Water Plan, an assessment of broadly functional options and their applicability to a specific set of parameters was generically conducted through the use of a decision matrix presented in Appendix S. The identified and assessed alternatives ranged from straightforward and inexpensive management techniques to costly and highly invasive construction projects. When choosing any remedy to a defined problem, water resource protection should play a central role in the selection process and options having a reduced potential for altering the environment should be given primary consideration. These alternatives are normally less invasive and typically less costly. If the assessment points toward new construction, or to a project that would directly influence stream flow or water quality, careful planning and design must be employed to ensure the continued viability and protection of the affected water resources.

The identified and assessed alternatives are not exhaustive nor are they exclusive. The decision matrix was created to provide a convenient method of evaluating the array of options and to generate a range of possible solutions. The list of described alternatives and their assessments are intended to provide only general direction and do not represent State Water Plan recommendations.

Definitions

It is important to define several key terms that are used to frame this discussion. An "adequate supply of water" refers to the quantity of water necessary to sustain reasonable and beneficial uses over the planning horizon. A planning horizon of 15 years has been selected because the State Water Plan will be updated at five-year intervals, and the accuracy of water resource need projections beyond 15 years leads to considerable uncertainty. "Reasonable and beneficial uses" is a multifaceted term that refers to using water for a useful and productive purpose, while considering the rights of other users and remaining consistent with the public interest. It also includes using water in an efficient manner. The assessment considered both withdrawal and non-withdrawal water uses. "Withdrawal uses" references any use of water that is taken from a surface or underground source and includes traditional uses such as domestic, municipal, public, commercial, industrial, energy development and production, and agricultural water supply. "Non-withdrawal uses" are activities that utilize water while it is in place. Examples of non-withdrawal uses are navigation, in-stream hydropower production, recreation, fish and wildlife habitat protection, and sustaining the aquatic environment. Finally, "consumptive use" means the loss of water from a groundwater or surface water source through an artificial conveyance system (including water that is delivered through a public water supply system), due to transpiration by vegetation, from incorporation into manufactured products, evaporation, diversion out of the basin, or by any other process that withdraws water from a basin without returning it.

Practical Alternatives for an Adequate Supply of Water

Employ Consumer Conservation Measures

Water conservation relieves stress on water supply sources; saves industrial, agricultural and residential customers money; and produces a number of related benefits. Consumer conservation reduces energy cost and chemical use, can eliminate the need for inter-basin water transfers, and can delay or avert expansion of existing drinking water and wastewater infrastructure. Water conservation educational programs, installing water saving plumbing fixtures, and using water meters all effectively reduce residential and institutional water consumption. Minimizing leakage and loss, recycling wastewater, or making fundamental process changes can also significantly reduce industrial water use and consumption. Industrial and commercial water conservation measures are often implemented in conjunction with more general pollution prevention efforts. Farmers can employ conservation techniques to effectively manage water use at their livestock operations, and can minimize crop irrigation water use by relying on irrigation systems designed specifically for existing soil, topography and vegetation.

Although water use reduction and water conservation are largely presented in the Water Resources Planning Act as voluntary actions, water conservation is also prominently addressed in several regulatory contexts. Projects that implement water conservation practices are to be given special funding consideration by the Pennsylvania Infrastructure Investment Authority (PENNVEST) under the Act. The Act also directs the Environmental Quality Board to adopt regulations that, in part, describe "a process under which users may document and register practices or projects that they have implemented to reduce water withdrawals or consumptive use, promote groundwater recharge or otherwise conserve or enhance water supplies for consideration and use in providing appropriate recognition and credit during the implementation of existing or future water supply programs."

Other legislation identifies water conservation as a mandatory activity. Permits issued under the Water Rights Act of 1939 are typically conditioned to require adoption and implementation of a water conservation program. In addition, drought emergency regulations require public water supply agencies, and major industrial and commercial water users, to develop drought contingency plans that match water use reduction scenarios to various levels of drought conditions. Water users in the Susquehanna and Delaware River basins must also comply with Susquehanna River Basin Commission (SRBC) and Delaware River Basin Commission (DRBC) water conservation regulatory requirements.

Public Water System Metering

Nearly 98% of public water suppliers in Pennsylvania meter their customers' use of water. Metering water use has several advantages. It can provide an accurate picture of water use differences among customers, identify seasonal use variation, monitor conservation efforts, and help identify structural problems. Metering customer water use also establishes an incentive to reduce consumption and forms the basis for a volumetric rate structure. DEP and DRBC have adopted policies and regulations that enable them to require public water suppliers to meter all new customers on un-metered systems. In addition, Public Utility Commission regulations require customer metering by all water utilities under its jurisdiction. DEP also requires public water suppliers to meter individual surface water sources as a condition of issuing a surface water allocation permit. SRBC and DRBC have source metering requirements as well that apply to ground and surface water withdrawals of 100,000 gallons per day or more. The trigger point for source metering drops to 10,000 gallons per day in the Southeast Pennsylvania Groundwater Protected Area, and to 20,000 gallons per day of consumed water in the Susquehanna River basin.

Apply Appropriate Pricing Strategies

Clean water has a cost. How that cost is determined and how it is recovered can be important components to promoting water conservation. Consumer water rates should be set to recover the full cost of managing a water system by accounting for debt service, administration, operation, maintenance, capital improvements, and environmental protection. Full cost pricing promotes system sustainability, financial stability, and economic efficiency. Because water rates can prompt customers to use water more efficiently, billing should be clear and logical so that consumers can easily link their water use to cost and make appropriate adjustments.

There are several types of rate structures in use. A flat rate system assesses the customer an equivalent amount each billing cycle regardless of the quantity of water used. A tiered rate structure is based on paying a specific amount for each predetermined block or unit of water used. Decreasing block rates result in lower unit cost as water use escalates, while increasing block rates require the customer to pay higher rates for each volumetric tier encountered. In setting increasing block rates, it may be appropriate to establish different usage block ranges based on customer class so that large volume, conservation-conscious, users are not unduly charged merely because of their size. Volumetric pricing simply charges the customer based on the volume of water used – the more water used, the more the customer is charged. Seasonal rates and surcharges are variations of block and volumetric pricing. Seasonal rates increase during the warmer months when water use is at its peak, and should be based on the full cost of capacity needed to meet summer demand. A surcharge rate component assesses premium rates to customers for excessive water use beyond a predetermined threshold. Volumetric and tiered rate structures require that individual water use be metered.

An efficient pricing strategy can be a strong incentive to reduce water use and can lead to multiple environmental benefits, deferred capital costs, and decreased use of power and chemicals. To effectively encourage informed water resource use, pricing and rate structures must be directly linked to the amount of water used and capacity needed, and produce sufficient revenue to cover the full long-term cost of supplying water.

DRBC encourages appropriate pricing stratgies by requiring water purveyors in the Delaware River basin seeking new or expanded water withdrawals of more than one million gallons per day to evaluate the feasibility of implementing a water conservation pricing structure and billing program.

Water Loss Control

Water loss control can be viewed as water conservation by water suppliers. Water systems can waste or lose significant amounts of water through distribution system leaks and storage overflows. Water that is treated and lost translates to reduced revenue and overuse of the water source. Responding only to erupted water mains and customer complaints increases the frequency of public health threats and will not solve or contain system leakage problems.

Effectively controlling leakage requires a management program that includes periodic water audits, prompt response to identified losses, and planned rehabilitation or replacement of system piping prior to the end of its useful life. Many effective strategies currently enable water utilities to identify, measure, reduce or eliminate leaks in a manner that is consistent with their cost of doing business. The Water Resources Planning Act recognizes the value of leakage and loss reduction by directing PENNVEST to give special funding consideration to projects that "address unaccounted for water loss".

Revise Operational Protocols

Revising operational protocols entails changing operation and management procedures on water supply systems and water resource management projects to maximize yield, system flexibility, and beneficial uses. It is fundamentally a risk-based decision making approach used to efficiently balance supply with multiple demands. If a system has more than one reservoir, coordinated water routing and use among reservoirs based on specific needs and timing could increase overall water delivery and enhance multiple water uses. Operational changes to the timing or volume of reservoir storage and releases can also be made to match various priorities, to increase system efficiency, or to focus on a specific use. Unless new construction or facility demolition is necessary, revising operational protocols can be a relatively inexpensive means of maximizing beneficial use potential and minimizing water use conflicts.

Employ Conjunctive Management Techniques

Conjunctive management programs maximize water availability and minimize resource damage by optimizing the combined use of water supply sources, including ground and surface sources, and interconnections. Conjunctive water management is applied to increase water supply reliability through the planned, coordinated management and use of multiple sources. Successful conjunctive water resource management results in cumulative benefits beyond those achieved through separate management of the sources. Conjunctive water resource management does not create new sources of water, but uses available water in the most efficient manner possible. It extends the use of existing sources based upon their individual seasonal and long-term yields or availability, their storage characteristics, operational costs, and contractual arrangements with other suppliers. For example, run-of-stream sources with little or no storage would generally be used first to preserve stored ground or surface water for periods when stream flows are insufficient or at critical stages. Contracts with other water suppliers for supplemental supplies through interconnections may be used either early or late after cost, seasonal capability, and contractual arrangements with the interconnecting system are considered. While operating costs are a consideration, a conjunctive management operating plan that attains full overall system yield will not, in many cases, align with the most cost-efficient operating plan. Conjunctive water management must be tailored to local conditions, and be administered with an understanding of the unique environmental, economic, and operational characteristics of the system involved. In areas of Pennsylvania where demand is approaching the safe yield of available water resources, conjunctive management could extend water availability, improve reliability and prolong beneficial uses by coordinating all available surface and groundwater assets.

Restore Watershed Integrity

Watershed restoration is an efficient way to expand the scope of beneficial water use. Restoring and protecting Pennsylvania's water resources begins with home management of local watersheds. Effective watershed protection and restoration tools include stabilizing stream banks, establishing forested riparian buffers, reclaiming abandoned mine discharges and mine sites, recharging groundwater through effective stormwater management, re-using treated wastewater, applying best management practices to farmland, and minimizing the footprint of development. Removing legacy sediment is also emerging as a means of reclaiming streams' carrying capacities to minimize flooding. Additionally, protecting public water supply sources provides significant benefits to overall watershed quality.

Local watersheds serve as sources of clean drinking water, filter and purify groundwater, provide industrial process water, supply water for irrigation, and offer natural flood control and protection. Small watersheds and their riparian areas are also the single most important habitat for land and aquatic wildlife. Local watersheds present outstanding recreational opportunities, and confer a sense of place and history to the surrounding area. Local watersheds also make up larger watersheds and major river basins that progressively influence the condition of downstream creeks, rivers, lakes and estuaries. In fact, Pennsylvania is accountable to downstream states for the health of the Chesapeake Bay, the Delaware Bay, the Gulf of Mexico, and the Great Lakes system; and to 38% of the nation's population who drink water originating from or passing through Pennsylvania watersheds.

Replace Potable Water Use

Treated drinking water is routinely used for a variety of purposes that do not require water of potable quality. Using non-potable water to irrigate crops and gardens, water golf courses, make snow, and flush toilets can effectively conserve potable water while saving money and chemical use. Stormwater capture or infiltration systems such as rain gardens, rain barrels, cisterns, infiltration beds, and pervious pavement are all capable of supplementing and moderating reliance on potable water sources. Recycling and reusing wastewater also reduces overall fresh water use and extends potable water sources at individual locations. DEP's Southeast Regional Office in Norristown, where a 5000-gallon cistern captures precipitation for use by restroom facilities, provides an example of local precipitation harvesting. While these individual practices do not generate substantial new sources of water, they combine to reduce demands on and prolong traditional potable water supplies.

<u>Mitigate Consumptive Water Use</u>

Consumptive water use removes ground or surface water from a watershed or river basin and does not return it. Water can be consumed by evaporation through cooling towers, evapotranspiration through irrigated crops, incorporation into manufactured products, or diversion to another river basin. A huge amount of water is lost from Pennsylvania's major river systems every day. This continuous water consumption under drought conditions can become critical as streams approach dangerously low flows. SRBC and DRBC have both established regulations to mitigate the potential consequences of extreme drought by banking water that can be released to augment basin flows as needed.

SRBC regulates consumptive ground and surface water use exceeding 20,000 gallons of water per day to compensate for the lost water during periods of low flow in the Susquehanna River basin. Acceptable compensation measures include, among others, replacing consumed water at or above the intake point and making monetary payments to SRBC. The rate through 2008 for water consumption in the Susquehanna River basin is $0.14 per thousand gallons. This rate will increase to $0.21 per thousand gallons consumed during 2009, and will further increase in 2010 to $0.28 per thousand gallons consumed. SRBC uses the funds collected to purchase stored water from the U.S. Army Corps of Engineers (USACE) at Cowanesque Lake in Tioga County and Curwensville Lake in Clearfield County. Currently, about 30,000 acre-feet of such storage have been procured. The stored water is released during drought conditions to maintain aquatic habitat, and otherwise minimize the effects of excessive low flow on downstream water users. Construction to provide additional storage is currently ongoing at the Whitney Point Lake Reservoir in Broome County, New York as well. The Whitney Point project is scheduled for completion in late spring of 2009.

SRBC is also actively engaged in replacing the estimated 15.7 million gallons per day of water needed to compensate for agricultural consumptive use during low flow conditions. By partnering with the Commonwealth in a project to restore 10 million gallons of treated abandoned mine water to the Susquehanna Basin, agricultural consumptive use will be partially compensated during the growing season. Additional methods such as using abandoned quarry water and developing underground mine storage are being considered to acquire the remaining 5.7 million gallons per day needed for full compensation.

DRBC Basin Regulations adopted in 1974 codified "Water Supply Charges" that apply to all water users in the Delaware River basin. The regulations require payment for surface water use in the basin, with appropriate exceptions, consistent with a schedule of water charges. In March of 2006 the payment schedule was revised to $60 per million gallons for consumptive use of water, and $0.60 per million gallons for non-consumptive use. DRBC uses the revenue generated to purchase storage from USACE in the Blue Marsh Reservoir on the Schuylkill River and the Beltzville Reservoir on the Lehigh River. Releases can be made from these facilities to supplement low river flows. The Merrill Creek Reservoir is also used to augment flow in the Delaware River. It is a 650 acre pump and storage reservoir in New Jersey built and operated by regulated power generators. Water is pumped to the reservoir from the Delaware River during high flows and released during low river flows to make up for the evaporative water consumption at contributing electric generating units. This source of water ensures that the generating units can continue to produce power under drought conditions.

Expand Treated Water Storage

There are nearly 3800 tanks and other containment vessels that store treated water on public water distribution systems throughout Pennsylvania. Expanding treated water storage capacity is a straightforward approach to improving short-term water supply availability and reliability. It is particularly effective as a way to mitigate water shortages caused by natural disasters, temporary power disruptions or pollution incidents. The previous State Water Plan recommended that all public water supplies have the capability to keep at least one day's worth of treated water in reserve. Although some small water systems may still lack that capability, most public water suppliers have fulfilled the recommendation.

Regionalize Water Systems

In densely populated urbanized centers and in high growth areas expanding from an urban core, regionalizing water systems may be appropriate. Regionalizing separate water supply systems can lead to cost savings, better service, improved reliability and enhanced flexibility. Regionalization is not based solely on economy of scale, but also on superior technical and financial resources. Instituting arrangements to operate multiple systems more efficiently through common management, procurement, and other shared resources, without physically connecting them, may also appreciably improve their reliability and service. Although many benefits of regionalization can be realized whether or not systems are physically integrated, increased yields would usually require interconnection of regional systems.

There are some areas where regionalization through physical connection of scattered small water systems is not appropriate and could be counterproductive. This condition is typical where there is no single growth center and where growth patterns are spread among suburban and exurban areas near small communities. Pursuing large scale regionalization in these locations, if not closely linked to local land use planning efforts, could undermine sustainable development efforts and contribute to expansion of growth patterns in areas where dense development is undesired. Large regional systems in these settings may also deter the use of local water resources where they are available, and could promote inter-basin transfers of wastewater out of the watersheds where the source water supplies were originally drawn.

Recharge Groundwater

The importance of groundwater cannot be overstated. Groundwater supplies approximately 4.5 million Pennsylvanians with drinking water, contributes a stable base flow to streams and rivers, and provides nearly all stream flow under drought conditions. In many rural areas, groundwater may be the single practical source of water available, partially accounting for Pennsylvania having the second highest number of domestic water wells in the nation. To manage groundwater on a sustainable basis, withdrawals and recharge must be balanced and linked closely with land use planning efforts.

Of the 42 inches of precipitation that Pennsylvania averages annually, about thirteen inches contribute to replenishing groundwater reserves under natural conditions. Groundwater levels throughout the state vary seasonally, and are generally at their peak during the early spring and at their lowest levels during mid-autumn. These normal seasonal fluctuations can range up to 50 feet. Precipitation, groundwater levels, soil types, geologic formations and recharge rates differ significantly throughout Pennsylvania. This variability influences local groundwater movement, storage capacity and accessibility. Groundwater can be recharged both naturally and artificially. Natural recharge takes place most efficiently in undisturbed areas as precipitation percolates to the groundwater table. Natural groundwater recharge can be maintained in developing areas by managing runoff through preservation of native hydrologic watershed features. Artificial groundwater recharge can be achieved by using reclaimed wastewater to supplement natural aquifer regeneration. Using reclaimed wastewater for irrigation and other practices may also incidentally contribute to groundwater recharge. The Water Resources Planning Act directly encourages groundwater recharge through provisions that enable water users to document and register projects or practices with DEP that “promote groundwater recharge”.

Expand Treatment Capacity

Expanding treatment capacity is a straightforward approach for meeting a treated water demand deficit or satisfying new needs. Treatment capacity expansion would require a new water allocation permit, or approvals from the DRBC or SRBC if withdrawals were to be increased beyond current allocations or authorizations. Adding treatment capacity could involve upgrading existing facilities or constructing an entirely new treatment plant.

Increase Withdrawals from Existing Sources

Increasing water availability could be as simple as withdrawing more water from an existing source or obtaining an increased allocation amount. Optimizing the volume of withdrawals on a watershed among water users could also be an economical and environmentally neutral means of ensuring adequate water availability. Any anticipated withdrawal increase must be measured against its projected influence on other existing and competing uses. The potential harm to riparian surface water and groundwater users must be assessed, along with the potential impairment to the aquatic community. Boosting surface or groundwater withdrawals or increasing their allocations may require SRBC or DRBC approval. Public water suppliers seeking to add to their surface water allocation would need to obtain a new Water Allocation Permit from DEP.

Increase Raw Water Storage

Increasing raw water storage is among alternatives that may be considered for ensuring a reliable and adequate supply of water. This option could involve improving capacity at existing facilities or building new structures. Reservoirs collect and detain water for later release or use. With nearly 8 million Pennsylvanians obtaining water for daily use from surface water sources, improved water storage is usually associated with enhancing public and industrial water supplies. Reservoir storage can also be critical to sustaining adequate stream flow for a number of other beneficial water uses such as recreation, and aquatic and riparian habitat protection. New reservoirs may have a substantial environmental cost as well. Their invasiveness can potentially modify the native stream and wetland ecology, influence local groundwater levels, and alter water temperatures.

Most reservoirs were created for a specific purpose; for example, flood control, recreation, or as water supply sources. Many existing reservoirs have untapped multiple use capability that could be integral to drought management, navigation, resource protection and hydropower production. Additionally, local storage can improve water quality, upgrade water system reliability and flexibility, and provide drought resistance. Release of stored water plays a critical role in maintaining acceptable flow in the Ohio, Susquehanna and Delaware River systems to support navigation, maintain fisheries, ensure adequate drinking water supplies, and provide cooling water for power generation and industrial facilities.

There are 3368 permitted dams and approximately 7500 additional smaller dams in Pennsylvania creating pools, impoundments and lakes on waterways and watersheds of all sizes. The large majority of dams are privately owned, with only 906 of the 3368 dams being held in public ownership. At maximum pool levels, the permitted dams are capable of holding back over 10 million acre-feet, or in excess of 3 trillion gallons, of water. Numerous existing dams in Pennsylvania were built decades ago and were not designed to meet modern safety standards. Many are now showing signs of structural aging and numerous outdated dams have been demolished over the past several years. Since 1997, DEP has issued only 43 permits authorizing the construction of new dams in Pennsylvania.

New, strategically located water storage facilities could provide real-time flow management capabilities, facilitate multiple source blending to improve water quality, augment conjunctive management capability, and provide added protection from catastrophic events. The cost of new surface storage capacity varies greatly, but most projects face the financial challenge of raising a large amount of capital over a short period of time. Many beneficiaries typically share the cost of multipurpose storage projects. Storage capacity can usually be expanded more economically at existing facilities by raising reservoir levels, dredging accumulated silt, modifying reservoir outlets or changing operating procedures.

Off-stream surface storage also provides valuable benefits. With few exceptions, these storage facilities are not designed to provide additional benefits such as flood control, power generation or primary recreation. Their principal functions are to improve water system reliability and flexibility, to satisfy water supply needs at small industrial sites, and to supply recreational sites such as ski areas and golf courses.

In some areas it may be possible to inject or infiltrate, and store, water in a local aquifer for future use. Underground storage can be a reliable means of providing clean water during a drought or pollution incident emergency. It also eliminates evaporative loss, reduces vulnerability to contamination and tampering, and may improve water quality and supplement stream base flow during dry periods. Aquifer storage is less expensive than constructing new surface reservoirs, and usually is less disruptive to the native environment. Excess treated water may also be stockpiled underground in a suitable aquifer to be recovered and used during periods of peak water use or low stream flow.

Developing additional storage capacity by constructing new dams and creating new reservoirs may generate significant environmental costs, or require local economic and social adjustments. The potential harm to the water body and surrounding wetland ecology, including loss of habitat and changes to water temperature, must be closely studied and avoided or mitigated. Potential hydrogeological changes must be assessed, and the risk of dam failure and its consequences must also be considered. New reservoirs may reduce tax revenue to local government, and could change the social fabric of an area. All of these matters must be explored and compared to the intended benefits when planning new projects.

Develop Additional Sources

Developing additional sources of raw water is an obvious means of addressing a need deficiency. Decisions related to new source development depend on the specific conditions encountered, the quantity required, and the relative availability, quality and abundance of suitable water. New sources can be attained from direct stream withdrawals, or groundwater development of wells and springs. In some regions of Pennsylvania, large volumes of water are being held in limestone quarries and abandoned surface and deep coal mines, creating a mostly untapped, potential supply of confined water.

Interconnecting water systems can also provide an inexpensive temporary or permanent solution to potable water deficits. This alternative involves two or more separate water supply systems being physically connected and the purchase of treated water by the utility experiencing need. Interconnections are most applicable where a water surplus is located near a water deficient area. Interconnections are encouraged by the Water Resources Planning Act, which requires PENNVEST to give such projects special consideration for funding.

In rare instances, transfers or diversions can economically redistribute water to satisfy water supply needs in a neighboring basin or watershed. All proposed water transfers and diversions must be closely evaluated because they could alter the character of both the source and destination watersheds. Care must be taken to ensure that the hydrologic and biologic integrity of the donor and receiving watersheds are not harmed by the diversion, and that unsustainable development is not artificially encouraged in the receiving basin. SRBC and DRBC both have formal regulatory standards that address proposals to divert water from the Susquehanna and Delaware River basins. The Great Lakes - St. Lawrence River Basin Water Resources Compact calls for a prohibition on diversion of Great Lakes basin water with limited exceptions for certain uses within the eight Great Lakes states, some of which will be subject to a 10-jurisdiction Regional Body review and interstate Compact Council approval.
In addition, DEP implements a statewide policy discouraging inter-basin water transfers unless the importing basin has made reasonable efforts to develop its own sources, the transfer will not prevent the exporting basin from meeting its own needs, and compensation through augmentation is provided to the exporting basin during low periods.

Locating and developing additional water sources for domestic, commercial or industrial use is a complicated process. Relative cost, permit requirements, social concerns and environmental consequences must all be part of the appraisal leading to a final choice.