FUTURE WATER RESOURCE DEVELOPMENT

As the population and economy of the St. Joseph River basin continue to grow, it will be necessary to develop additional ground-water and surface-water supplies, protect the quantity and quality of existing supplies, and increase water use efficiency. Although ground water will increase in overall importance as a source of supply, surface water is expected to remain a major supply source for industrial uses, agricultural irrigation, and waste assimilation.

SELECTION OF SIGNIFICANT SURFACE WATER SITES

One objective of this study is the identification of sites where there will be growth in demand for surface water or where surface water supply may be developed. Also important is the identification of sites where potential withdrawals may exceed statistical low flows. This basin report is not able to evaluate all locations throughout the St. Joseph River basin; therefore, only significant sites have been considered.

In general, a "significant" surface water site may be any one of the following types of locations:

1. A site where there is a large supply of water with little or no present demand.

2. A site where there is a large supply of water which meets a present substantial demand and where demand may increase.

3. A site where cumulative upstream withdrawal capability may exceed statistically-derived low flows.

4. A wastewater treatment facility where upstream withdrawals could adversely affect water quality downstream of the facility.

The above definition of significant sites includes sites where a reservoir could be constructed for supply. However, there are few locations in the St. Joseph River basin where a reservoir could be constructed due to topography and geology. Also, the construction of a reservoir is more costly than developing ground water in the St. Joseph basin. Therefore, significant sites will be limited, for the most part, to streams or rivers.

The significant sites that have been selected are listed in tables 31 and 32 and are shown in fig. 30. The types of significant sites shown in the tables correspond to the four location types discussed above. Also shown in fig. 30 are the stream gages that were not designated as significant but were included for information.

The major urban areas were selected as significant sites because both supply and demand are large and there is the likelihood of population or industrial growth. Sites were selected in the rural areas where increases in irrigation are anticipated.

Tables 31 and 32 list cumulative surface water withdrawal capabilities upstream of each site. These withdrawals are not actual usages but rather registered maximum capacities which are measures of demand. These withdrawal capabilities for the urban areas listed include not only demand from that particular urban area but also demand from upstream usage.

The significant sites in rural areas are points on streams or rivers where it is desired to compare supply and demand to determine if stream flow and potential withdrawals could be in conflict. A significant site, therefore, is not necessarily a point on a stream where water is needed but where the cumulative upstream withdrawal capability is large.

To characterize surface water supply in the St. Joseph basin, three types of flow have been selected. The 1-day, 30-year low flow (Q1-30), an indicator of dependable flow, is the annual lowest 1-day flow that can be expected to occur on the average of once every 30 years. The 7-day, 10-year low flow (Q7-10), used in the design of wastewater treatment facilities, is the annual lowest mean flow for seven days that can be expected to occur on the average of once every 10 years. The average flow for the period of record (Qave) represents the theoretical upper limit of supply. As tables 31 and 32 show, low flows far exceed cumulative upstream withdrawal capacities at most sites.

Except for Goshen, Indiana (table 31, site 37), all urban areas have been classified as type 2. There is little surface water withdrawal at Goshen, yet the cumulative upstream withdrawal capability is larger than the Q1-30. Therefore, Goshen has been classified as both types 1 and 3.

Where the withdrawal capability upstream of a site in table 31 is large relative to Q1-30, the site was classified as type 3. In most cases, the upstream withdrawals are for irrigation.

TABLE 31. Significant Sites

Stream	Site No.	Gage	Contributing Drainage Area Mi^2	1-Day, 30-Year Low Flow $(ft^3/s)^g$	7-Day, 10-Year Low Flow $(ft^3/s)^g$	Average Discharge $(ft^2/s)^g$	Registered Capacity Upstream $(ft^3/s)^g$	Type	Remarks
Christiana Ck.	18	No	128	18.2[a]	21.6[c]	125[a]	1.94[f]	2	Urban Area
Elkhart R.	29	No	309	16.7[a]	22.1[c]	301[a]	3.12	1	Potential Irrigation
Elkhart R.	37	Yes	594	11.5[b]	81[b]	514[d]	29.0	1,3	Irrigation Upstream
Fawn R.	3	No	157	22.7[c]	26.7[c]	153[a]	44.4[f]	3	Irrigation Upstream
Fly Ck.	9	No	41.7	5.35[a]	6.81[c]	40.7[a]	13.7	3	Irrigation Upsteam
Little Elkhart R.	13	Yes	91.7	9.2[a]	12[c]	100.4[d]	7.35	3	Irrigation Upstream
Pigeon Ck.	6	Yes	83.5	3.8[b]	5.8[b]	78.9[d]	7.13	3	Irrigation Upstream
Pigeon R.	11	Yes	307	24[b]	86[b]	361[d]	43.9	3	Irrigation Upstream
St. Joseph R.	15	Yes	1866	65[e]	366[e]	1580[e]	NA[f]	--	In Michigan
St. Joseph R.	39	Yes	3370	440[b]	818[b]	3176[d]	73.5[f]	2	Urban Area
St. Joseph R.	42	No	3506	442[a]	879[a]	3197[a]	76.1[f]	2	Urban Area
St. Joseph R.	45	No	3662	468[a]	945[a]	3348[a]	94.3[f]	2	Urban Area
Solomon Creek	32	No	42.3	5.44[a]	6.91[c]	41.2[a]	13.4	3	Irrigation Upstream
S. Br. Elkhart R.	27	No	114	5.62[a]	7.9[c]	111[a]	1.78	3	Potential Irrigation
Turkey Ck.	7	No	62.8	4.6[a]	6.3[c]	61.2[a]	0	1	Potential Irrigation
Turkey Ck.	36	No	183	14.7[a]	18.8[c]	178[a]	25.4	3	Irrigation Upstream
Turkey Ck.	33	Yes	43.8	0.3[b]	1.3[b]	36.8[d]	1.89	3	Upstream Lakes

NA Not Available

a. Division of Water, Indiana Department of Natural Resources.
b. Stewart, 1983.
c. Arihood, 1986.
d. Glatfelter, 1984.
e. U.S. Geological Survey, Lansing, Michigan.
f. Upstream withdrawal in Michigan unknown.
g. Multiply by 0.646317 to obtain million gallons per day.

TABLE 32. Wastewater Treatment Facilities

City	Site No.	Stream	Contributing Drainage Area Mi^2	1-Day 30-Year Low Flow (ft^3/s)[g]	7-Day 10-Year Low Flow (ft^3/s)[g]	Average Discharge (ft^3/s)[g]	Registered Capacity Upstream (ft^3/s)[g]	Type	Remarks
Albion	25	Croft D	24.7	0.88[a]	1.40[c]	24.1[a]	0	--	
Angola	4	Mudd Ck.	2.39	0	0	NA	0	--	Effluent may be a problem
Ashley	5	Johnson D.	0.72	0	0	NA	0	--	Effulent may be a problem
Bristol	16	St. Joseph R.	2445	243[a]	544[a]	2172[a]	12.9[f]	4	Irrigation
Cromwell	31	Solomon Ck.	12.0	1.38[a]	1.9[c]	11.7[c]	0	--	
Elkhart	40	St. Joseph R.	3375[e]	440[b]	818[b]	3176[d]	73.5[f]	4	Irrigation
Fremont	1	--	0.16	0	0	NA	0	--	Effluent may be a problem
Goshen	38	Elkhart R.	594[e]	11.5[b]	81[b]	514[d]	29.0	2,4	Goshen Pond Upstream
Kendallville	20	Henderson Lk. D.	7.49	0.24[a]	0.41[c]	7.3[a]	0	--	
LaGrange	8	Fly Ck.	13.8	1.6[a]	2.18[c]	13.3[a]	1.34	4	Irrigation
Ligonier	28	Elkhart R.	289	12.9[a]	17.6[c]	282[a]	3.12	4	Irrigation
Middlebury	14	Little Elkhart R.	91.7[e]	9.2[a]	12.0[c]	100.4[d]	7.35	4	Irrigation
Milford	34	Turkey Ck.	72.7	NA	2.0[g]	70.8[a]	9.36	4	Upstream Lakes
Millersburg	30	Stoney Ck.	15.9	0.54[a]	0.89[c]	15.5[a]	2.45	4	Irrigation
Mishawaka	43	St. Joseph R.	3547	449[a]	891[a]	3237[a]	91.2[f]	4	Irrigation
Nappanee	35	Berlin Court D.	5.73	0.18[a]	0.31[c]	5.6[a]	0	--	
Rome City	21	N. Br. Elkhart R.	35.8	1.32[a]	2.04[c]	34.9[a]	0.22	4	Upstream Lakes
Shipshewana	10	Page D.	1.21	0	0	NA	0	--	Effluent may be a problem
South Bend	44	St. Joseph R.	3610	461[a]	911[a]	3298[a]	91.2[f]	4	Irrigation
Syracuse	33	Turkey Ck.	43.8[e]	0.3[b]	1.3[b]	36.8[d]	1.89	4	Upstream Lakes
Topeka	19	Shrock D.	0.37	0	0	NA	0	--	Effluent may be a problem
Wakarusa	41	Werntz D.	0.61	0	0	NA	0	--	Effluent may be a problem
Wolcottville	22	Little Elkhart Ck.	31.6	1.2[a]	1.8[c]	30.8[a]	0	4	Upstream Lakes

NA: Not Available

a. Division of Water, Indiana Department of Natural Resources
b. Stewart, 1983.
c. Arihood, 1986.
d. Glatfelter, 1984.
e. Stream Gage.
f. Upstream withdrawal in Michigan unknown.
g. Indiana State Board of Health.
h. Multiply by 0.646317 to obtain million gallons per day.

It should be noted that at site 33 (Syracuse) there are two lakes immediately upstream. There is a control structure on Syracuse Lake which can be used to restrict releases downstream in order to maintain the lake level during low inflow to Lake Wawasee.

Wastewater treatment facilities where there were no registered upstream withdrawals were not classified as significant sites. It should also be noted that there are some sites where the Q7-10 low flow is zero, indicating there are times when the only flow in the stream at the site is the effluent from the facility.

Regression equations, which were developed from stream gage data on unregulated streams, were used to estimate the Q1-30, Q7-10, and Qave for drainage basins less than 1200 mi^2. However, many of the sites in Tables 31 and 32 are on regulated streams and there may therefore be discrepancies between estimated and actual values of discharges.

Also, these regression equations were developed from raw stream gaging data which do not necessarily represent natural conditions, but may include industrial, wastewater, or other discharges.

Considering the above comments, caution should be used when interpreting values of Q1-30 and Q7-10 in tables 31 and 32.

POTENTIAL IMPACTS OF GROUND-WATER DEVELOPMENT

Although ground-water supplies in the St. Joseph River basin should be adequate to satisfy most needs in the coming decades, local overdraft and contamination problems are expected to arise. The 1985 enactment of IC 13-2-2.5 (Water Rights: Emergency Regulation) has been a major step toward proper management of Indiana's ground-water resource, and the law will no doubt be a key factor both in developing and protecting ground water in the St. Joseph basin.

This law attempts to strike a balance between the interests of both small-capacity well owners and high-capacity users who plan to develop the ground-water resource. If small-capacity well failures (with respect to quantity or quality) are due to significant water-level drawdowns caused by high-capacity pumpage, and if certain statutory conditions are met, high-capacity well owners may be required to provide a replacement water supply for owners of impacted wells. Ground-water pumpage restrictions may also result if ground-water withdrawals exceed the aquifer's recharge capability or if the large-scale user refuses to provide an alternate supply[16]. The law does not apply to high-capacity users whose wells are impacted by other high-capacity withdrawals.

Although many types of high-capacity ground-water withdrawals can potentially create excessive water-level declines, irrigation, public supply, and industrial withdrawals have been identified as the most significant uses in the St. Joseph basin.

Ground-water Modeling

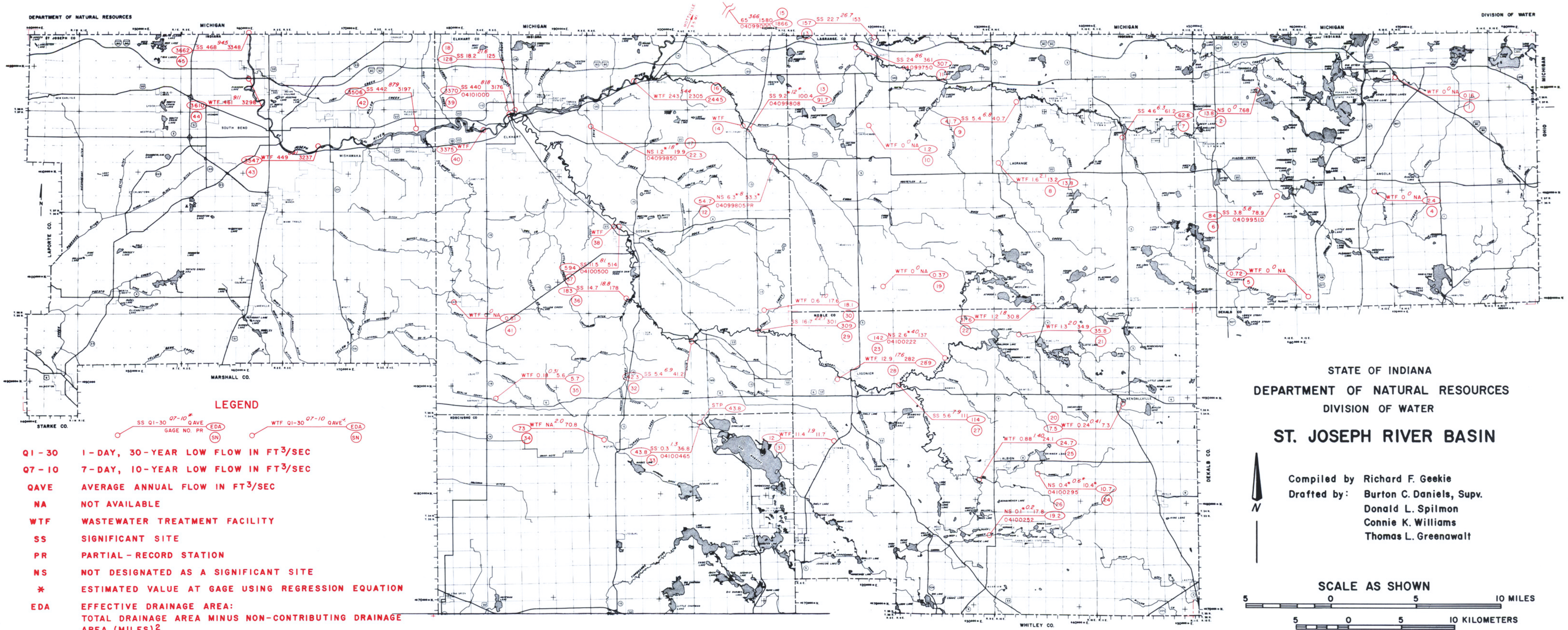
Agricultural irrigation is extensive in the St. Joseph River basin and is expected to increase in future decades. In an effort to study the potential effects of increased irrigation water usage, the Indiana Department of Natural Resources, Division of Water engaged in a cooperative study with the United States Geological Survey.

Two areas (near the towns of Milford and Howe, fig. 31) were chosen for intensive study. The Milford area is a 16.5-mi^2 area in northern Kosciusko and southern Elkhart Counties. The Howe area ia a 46.5-mi^2 area primarily in northern LaGrange County, with a small portion of the area extending into southern Michigan. In both investigations, the U.S. Geological Survey applied a three-dimensional digital ground-water flow model in order to predict the effects of hypothetical pumping plans (Lindgren and others, 1985; Bailey and others, 1985).

These two areas were chosen because they are representative of outwash areas where irrigation is extensive. The goal of both studies was to evaluate the effects of intensive pumping of surface and ground water on streams, wetlands, lakes, and aquifers.

In the Milford study, four pumping plans representing differences in the amount of land irrigated and in rainfall conditions were simulated. A fifth pumping plan simulated maximum year round water use. The Milford simulation representing the maximum amount of irrigated acreage and below normal precipitation computed a thirteen-fold increase in the volume of water pumped from wells and surface water intakes over the amount actually used in the study area during base year 1982. With this pumping scheme, the model predicts a water level decline of as much as 20.7 feet

16 Copies of IC 13-2-2.5 and other water-related laws referenced in this report can be obtained from the Division of Water.



LEGEND

SS Q1-30 Q7-10* QAVE EDA
GAGE NO. PR (SN)

WTF Q1-30 Q7-10 QAVE* EDA
(SN)

Q1-30	1-DAY, 30-YEAR LOW FLOW IN FT³/SEC
Q7-10	7-DAY, 10-YEAR LOW FLOW IN FT³/SEC
QAVE	AVERAGE ANNUAL FLOW IN FT³/SEC
NA	NOT AVAILABLE
WTF	WASTEWATER TREATMENT FACILITY
SS	SIGNIFICANT SITE
PR	PARTIAL-RECORD STATION
NS	NOT DESIGNATED AS A SIGNIFICANT SITE
*	ESTIMATED VALUE AT GAGE USING REGRESSION EQUATION
EDA	EFFECTIVE DRAINAGE AREA: TOTAL DRAINAGE AREA MINUS NON-CONTRIBUTING DRAINAGE AREA (MILES)²
(SN)	SITE NUMBER

STATE OF INDIANA

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF WATER

ST. JOSEPH RIVER BASIN

Compiled by Richard F. Geekie

Drafted by: Burton C. Daniels, Supv.
Donald L. Spilmon
Connie K. Williams
Thomas L. Greenawalt

SCALE AS SHOWN

5 0 5 10 MILES

5 0 5 10 KILOMETERS

DRAFTED 1986

Figure 30. Significant Sites

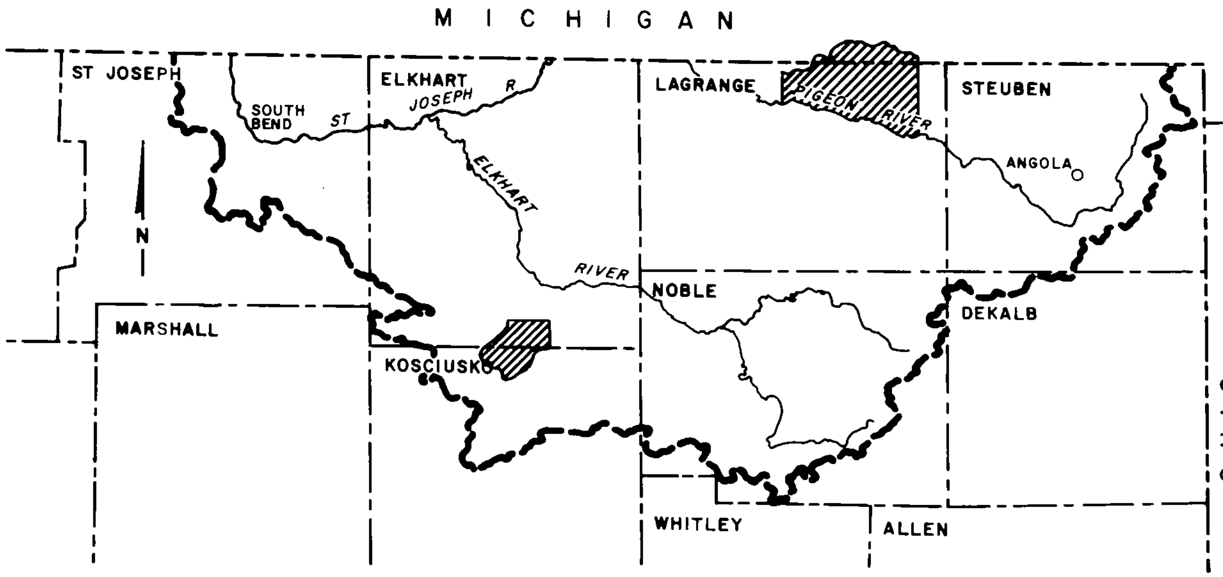


Figure 31. Howe and Milford Study Areas

over an 8-acre area of the aquifer. However, that much of a decline would only be about one-fourth of the available drawdown, so the source aquifer would not be dewatered.

Also, this pumping scheme predicts that stream flow in Turkey Creek would be reduced by 39 percent, but the remaining flow would still be equal to twice the 7-day, 10-year low flow. Flow in some smaller streams would cease.

The results of the Milford area study generally indicated that the outwash system can support substantial growth in irrigation. However, maximum irrigation development may cause temporary, local competition for water in some parts of the area (Lindgren and others, 1985).

The Howe modeling study simulated five pumping plans with varying amounts of irrigated acreage and precipitation. A sixth pumping plan simulated year-round pumping. The simulation representing maximum potential irrigation development and below normal rainfall calculated the greatest drawdowns.

Drawdowns over 30 feet were simulated with this pumping scheme. Stream flow under this pumping plan would be reduced to approximately 90 percent flow duration.

The Howe results indicate that pumping large amounts of water over short time periods (such as an irrigation season) generally will have a small effect on aquifer water levels, stream flow, lakes, and wetlands in the study area. The hydrologic system would probably recover to normal between irrigation seasons (Bailey and others, 1985).

Observation Well Hydrographs

Hydrographs which record fluctuations of water levels in observation wells within the basin can be used to monitor pumpage impacts. Five observation wells (Elkhart 4 and 7, Kosciusko 9, and LaGrange 2 and 3) are located in four areas of intensive irrigation. From three to eight registered high-capacity irrigation wells are within a 1-mile radius of each of the wells. Hydrographs of the five wells, examined by Crompton and others (1986), show no apparent impacts due to pumpage.

The hydrographs of the five observation wells with nearby irrigation pumpage closely resembled those of observation wells in similar outwash aquifers which have no irrigation pumpage. A comparison of hydrographs recorded during the 1983 growing season

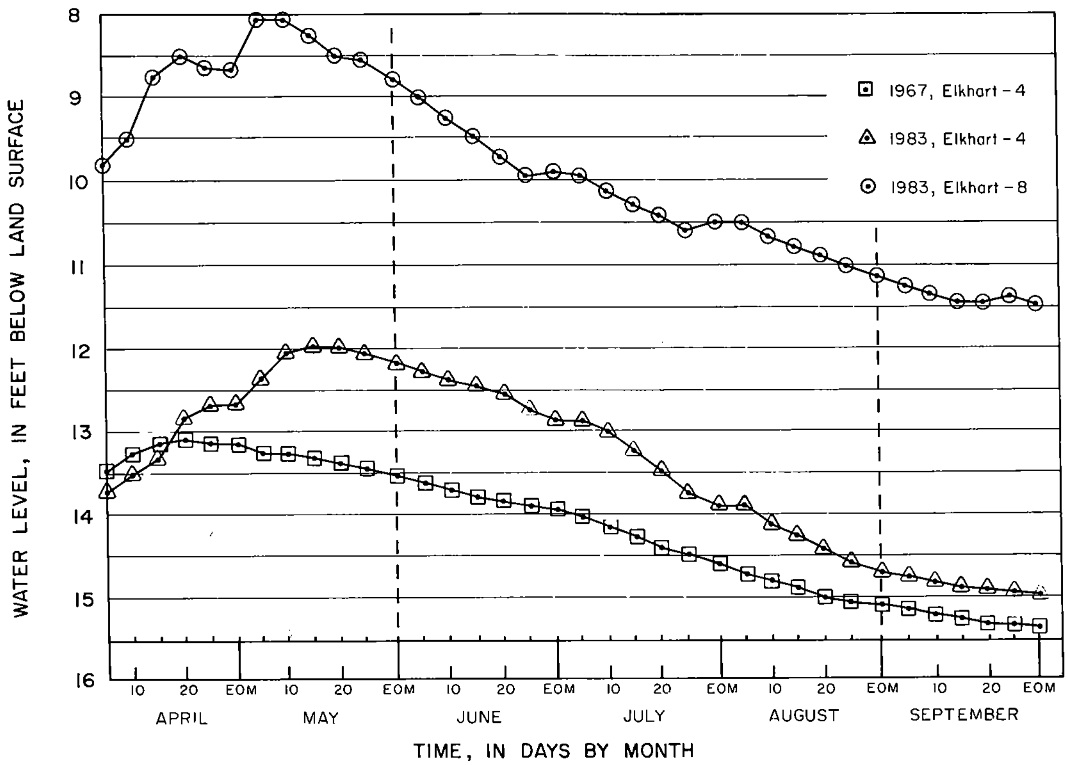


Figure 32. Maximum Daily Water Levels in Observation Wells Elkhart-4 (1967-1983) and Elkhart-8 (1983). From Crompton and others (1986).

for Elkhart 4 and Elkhart 8 (located away from irrigation pumpage) provide an example (fig. 32). The figure also shows the 1967 seasonal hydrograph for Elkhart 4, recorded before extensive irrigation commenced in the area. Based on the similarity of these and other hydrographs, Crompton and others (1986) concluded that any effects of irrigation pumping (June through August) on the water levels in observation wells Elkhart 4 and 7, Kosciusko 9, and LaGrange 2 and 3 are not apparent from water-level records collected to date.

They cite relatively high aquifer transmissivity, relatively high rates of recharge, and relatively small demand as reasons for the apparent lack of effect of irrigation on ground-water levels.

Water Quality Constraints[17]

As discussed in the ''Ground-Water Contamination'' section of this report, an abundant ground-water supply can be diminished by pollution due to man's activities. In the St. Joseph River basin, future constraints on ground-water development will probably result from the pollution of existing or potential supplies rather than shortages of available water. This is illustrated in Elkhart County where the activities of man have threatened the potability of a major portion of the ground-water supply for the city of Elkhart.

About 70 percent of the drinking water for the residents of Elkhart is provided at the North Main Street well field. In April 1981, 94 parts per billion of trichloroethylene (TCE) and other volatile organic chemicals (VOCs) were detected in this well field during a routine U.S. Environmental Protection Agency (USEPA) survey of VOCs in public water supplies. Because this level exceeded the one-in-one-million cancer risk concentration set by the USEPA, immediate action was taken by state, county and city officials to determine the extent of the VOC contamination.

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17 Information in this section was summarized from USEPA Fact Sheets and Layne-Western phase reports (see references).

A study of the area was completed in March 1982 which revealed the extent of the contamination on the east side of the well field. As a short-term remedial action, the city of Elkhart placed two interceptor wells on the east side of the well field to reduce the levels of contamination reaching the existing production wells. Between one and four million gallons of TCE-contaminated ground water is pumped daily into Christiana Creek to divert the contamination from the well field.

In December 1982, the USEPA added the Main Street well field to the National Priorities List, a roster of the most serious hazardous waste sites in the country, making it eligible for federal funds (Superfund) for investigation and possible cleanup. Continued monitoring of the contamination has been and will be an ongoing activity at the site.

In March 1985, the USEPA authorized planning for a short-term action to provide a safe and sufficient drinking water supply for the residents of Elkhart while the USEPA conducts its long-term remedial investigation. After several alternatives were studied, treatment of water from production and/or interceptor wells by air stripping (a process which separates the contaminants from the water and turns them into gases) was recommended and selected as the short-term action. After several delays in funding, design of the air stripper was completed and construction of the $2.7 million facility began in summer 1986. The State of Indiana is contributing 10 percent of the initial cost of $2.7 million for construction. The State will also contribute 10 percent of the first year's Operation and Maintenance (O & M) costs, which were estimated to be $166,000, and 100 percent of O & M costs after the first year of operation.

In addition to the short-term action, the USEPA began field activities associated with the remedial investigation (RI) of the site in late 1986. The RI will be completed in two phases. Phase I is designed to collect and analyze data in order to closely define the nature and extent of contamination. Phase II will evaluate Phase I data and all existing studies in order to develop a work plan for the Feasibility Study. This study will address and screen technologies until a recommended long-term alternative is identified. The short-term action is compatible with long-term action alternatives and may continue as part of the long-term plan. However, until the RI is complete, the final action can only be speculated.

One possible long-term action is development of an additional or replacement well field. In 1983, the City of Elkhart hired the Layne-Western Company to identify and evaluate a new uncontaminated well field with sufficient capacity to meet existing and future supply demands. Layne conducted a four-phase study which included reviewing available reports, test drilling, aquifer testing, and numerical modeling. Following test drilling, a proposed well field site was selected. In 1986, preliminary testing and modeling was completed on the proposed site.

The detection of VOCs in the St. Joseph Aquifer system in the Elkhart vicinity (at the North Main Street Well Field, in private residential wells on the east and south sides of the city, and on the west side north of US 33 near CR 1) has identified the need to carefully evaluate the potential for contamination of future well fields. To accomplish this, the city of Elkhart is currently scheduling further hydrologic and chemical testing to assess the potential for ground-water contamination with respect to projected withdrawal rates for the proposed new well field.

In addition to possible water quality problems, supply problems could develop if the proposed well field's production were to substantially lower ground-water levels and consequently affect water supplies for nearby residential housing. In their modeling study, Layne-Western considered what well field design alternatives could be used to limit the effect of the pumpage on nearby ground-water users. If substantial lowering of ground water were to occur, the city could be required to provide reasonable compensation as specified in IC 13-2-2.5 (discussed earlier in this section). Coordination between local and state government throughout planning stages may help to minimize the potential for such future conflicts.

DEVELOPMENT POTENTIAL

Extensive and productive aquifer systems in the St. Joseph River basin tend to facilitate a high degree of water usage by increasing both the area over which the water resource is distributed and the length of its residence time within the basin. Also, many streams exhibit well-sustained flows as a result of the high degree of interconnection between the aquifer and stream systems. Future water use choices must, therefore, be made in the context of a theoretical maximum supply of the total water resource.

A theoretical maximum water supply may be estimated using monthly discharges to derive average long-term (1924-85) total runoff. These figures give a general idea of the amount of precipitation which falls

TABLE 33. Mean Monthly Discharge (million gallons/month)

Month	Indiana portion of St. Joseph basin (1699 mi²)	Michigan portion of St. Joseph basin which drains into Indiana (1963 mi²)	Total at the state line (3662 mi²)
April	49925	54151	104076
May	40009	45360	85367
June	28365	33483	61848
July	23100	24482	47582
August	19914	19814	39728
September	17643	19039	36663
October	21156	21397	42553
November	22064	25069	47133
December	27567	30853	58420
January	28349	36583	64932
February	33922	34250	68172
March	49966	52470	102436

on the basin and is not used consumptively on a long-term basis. The discharges in table 33 were generated for the Indiana portion of the basin and the Michigan portion which contributes to Indiana.

Water in the basin is often used and reused many times before it is lost to evaporation or as outflow from the state. As long as the water is not used consumptively and the quality of the resource is not altered to the point that it becomes unsuitable for some purposes, there are very few limitations on total water use. However, constraints on water use in a particular location may result from its competing value for the maintenance of lake levels, for recreation, for support of aquatic life, for the availability of supply for downstream domestic and industrial water users, and for the provision of assimilative capacity for thermal loadings and wastewater treatment plant effluents. It is important to keep in mind that the listed potential monthly supplies represent long-term average values. During dry years when consumptive demands such as irrigation are at high levels, the available water supplies can be significantly less than average.