Contract Report 521

Harmonic Mean Flows for Illinois Streams

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3.1.4 Determination of Q_{HM}: An Example

The Q_{HM} in the Kyte River near Flagg Center was calculated as 22 cfs under the 1990 effluent flow conditions. The 22 cfs flow comprised 16 cfs natural flow, 5 cfs effluent flow from Rochelle, and 1 cfs effluent from Ashton.

3.2 MAP 2 — NORTHEASTERN ILLINOIS REGION

The Northeastern Illinois region covers the area drained by the Chicago Sanitary and Ship Canal and the Chicago, Des Plaines, Du Page, and Fox Rivers.

3.2.1 Q_{HM} at Gaging Stations

USGS daily-flow records for 44 gaging stations were analyzed to determine the Q_{HM} for each year of record at these stations. The Q_{HM} values at each station were determined by following the procedures outlined in chapter 2. The USGS number, stream and gaging station, drainage area, period of record, percent of zero-flow days, and the Q_{HM} are given in table 3.2.

3.2.2 Wastewater Treatment Plants and Effluents

The Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) operates three major WTPs: Northside, West-Southwest, and Calumet. Since the mid-1970s the MWRDGC has put into operation three new medium-sized plants: Hanover Park, John Egan, and O'Hare. The North Shore Sanitary District (NSSD) also operates two new WTPs.

The monthly operation reports from various towns, cities, and industries were obtained from the IEPA. These reports contain information on the amount of water in gallons per day (gpd) leaving the plant after treatment and any wastewater bypassed during rains in the case of combined sewer systems. The effluent records were analyzed to derive the Q_{HM}s in the year 1990. Some municipal and industrial WTP managers were contacted by phone to verify the information collected from the files.

3.2.3 Fox Chain-of-Lakes

In-stream lakes and pools generally reduce the year low flow. Lakes and pools expose considerable water surface areas to evaporation, thus reducing the natural low flows. The upper part of the Fox River Basin in Illinois has a flat low-lying terrain abounding in lakes, swamps, marshes, and sloughs. Included in this area are the Fox Chain of Lakes with a combined water surface of 13 mi^2. The principal lakes in the chain are Pistakee, Nippersink, Fox, Petite, Channel, and Catherine. There are two dams in the area: the McHenry and Algonquin Dams. The McHenry Dam creates a pool extending upstream to the Pistakee Lake outlet. The surface area of the pool is 403 acres. The Algonquin Dam creates a 16.34-mile-long pool, with a surface area of 849 acres, extending upstream to the McHenry Dam. Gates at the McHenry Dam are operated to maintain the water level in the Chain of Lakes for recreational purposes.

The Q_{HM}S at Wilmot and Algonquin, adjusted for 1990 effluent discharge conditions, are 380 and 625 cfs, respectively.

3.2.4 Flow Regulation for Navigation

Flows in the MWRDGC waterways and in the Illinois River are regulated through a series of locks and dams for navigation purposes. The observed losses are attributed to evaporation, leakage, and storage because of regulation. Because all these losses are proportional to water surface area, the distribution of losses along the river is found by the use of the lake, river, and backwater surface areas at different points along the river.

Table 3.2: Map 2 - Gaging Stations and Harmonic Mean Flows

USGS Gage	*Stream and Gaging Station*	*Area (mi^2)*	*Period of Record*	*Zero-Flow Days (%)*	*Q_{HM} (cfs)*
05527500	Kankakee River near Wilmington	5150	72(1916-1987)	0.00	2240
05527800	Des Plaines River at Russell	123	20(1968-1987)	0.07	12
05528000	Des Plaines River near Gurnee	232	19(1969-1987)	0.00	100
05528500	Buffalo Creek near Wheeling	19.6	24(1964-1987)	0.28	2.0
05529000	Des Plaines River near Des Plaines	360	47(1941-1987)	0.36	150
05529500	McDonald Creek near Mount Prospect	7.90	35(1953-1987)	12.67	0.0
05530000	Weller Creek at Des Plaines	13.2	37(1951-1987)	4.58	1.2
05530500	Willow Creek near Park Ridge	19.7	8(1951-1958)	1.68	53
05530990	Salt Creek at Rolling Meadows	30.5	14(1974-1987)	0.59	3.8
05531500	Salt Creek at Western Springs	114	42(1946-1987)	0.00	81
05532000	Addison Creek at Bellwood	17.9	36(1952-1987)	0.01	8.0
05532500	Des Plaines River at Riverside	630	44(1944-1987)	0.01	370
05533000	Flag Creek near Willow Springs	16.5	36(1952-1987)	0.00	15
05534500	N. Br. Chicago River at Deerfield	19.7	35(1953-1987)	4.84	2.0
05535000	Skokie River at Lake Forest	13.0	36(1952-1987)	0.14	3.5
05535070	Skokie River near Highland Park	21.1	20(1968-1987)	0.00	6.4
05535500	W. F. of N. Br. Chicago River at Northbrook	11.5	35(1953-1987)	0.19	7.0
05536000	N. Br. Chicago River at Niles	100	37(1951-1987)	0.00	48
05536195	Little Calumet River at Munster, IN	90.0	30(1959-1988)	0.00	24
05536210	Thorn Creek near Chicago Heights	17.2	16(1965-1980)	6.21	1.5
05536215	Thorn Creek at Glenwood	24.7	38(1950-1987)	0.00	28
05536235	Deer Creek near Chicago Heights	23.1	39(1949-1987)	0.67	2.2
05536255	Butterfield Creek at Flossmoor	23.5	39(1949-1987)	2.11	0.0
05536265	Lansing Ditch near Lansing	8.80	39(1949-1987)	0.84	1.2
05536270	North Creek near Lansing	16.8	32(1949-1980)	3.09	2.7
05536275	Thorn Creek at Thornton	104	39(1949-1987)	0.00	48
05536290	Little Calumet River at South Holland	205	40(1948-1987)	0.00	85
05536340	Midlothian Creek at Oak Forest	12.6	37(1951-1987)	3.11	1.0
05536500	Tinley Creek near Palos Park	11.2	36(1952-1987)	5.95	0.0
05537000	Chicago Sanitary and Ship Canal at Lockport	739	36(1954-1989)	0.00	2900
05537500	Long Run near Lemont	20.9	36(1952-1987)	6.57	1.2
05539000	Hickory Creek at Joliet	107	43(1945-1987)	0.00	19
05539900	W. Br. Du Page River near West Chicago	28.5	26(1962-1987)	0.00	23
05540095	W. Br. Du Page River near Warrenville	90.4	19(1969-1987)	0.00	52
05540500	Du Page River at Shorewood	324	47(1941-1987)	0.00	185

Table 3.2: Map 2 - Continued

USGS Gage	Stream and Gaging Station	Area (mi^2)	Period of Record	Zero-Flow Days (%)	Q_{HM} (cfs)
05543500	Illinois River at Marseilles	8259	68(1920-1987)	0.00	7200
05546500	Fox River at Wilmot, WI	868	49(1940-1988)	0.00	380
05548280	Nippersink Creek near Spring Grove	192	21(1967-1987)	0.00	95
05549000	Boone Creek near McHenry	15.5	34(1949-1982)	0.00	10
05550000	Fox River at Algonquin	1403	72(1916-1987)	0.00	625
05550500	Poplar Creek at Elgin	35.2	36(1952-1987)	0.00	5.4
05551200	Ferson Creek near St. Charles	51.7	26(1962-1987)	0.00	12
05551700	Blackberry Creek near Yorkville	70.2	27(1961-1987)	0.00	27
05552500	Fox River at Dayton	2642	63(1925-1987)	0.00	1190

3.2.5 Streams in Urbanizing Basins

For streams with a rapidly urbanizing drainage area, the low flows each year exhibit a pronounced upward trend with time. As an example, consider the annual Q_{HM} flows for the Salt Creek at Western Springs (USGS gage 05531500) during the period 1946-1987. The five-year moving average of the Q_{HM}s is plotted in figure 3.1. The best-fit curve shows the trend and yields a Q_{HM} of 81 cfs for the 1990 conditions of inflows to Salt Creek above the gaging station. Various inflows above the gaging station for the years 1940, 1950, 1960, 1970, and 1980 are given below.

Inflows above Station 05531500
Salt Creek at Western Springs

Source	Inflows (cfs)				
	1940	1950	1960	1970	1980
John Egan Plant		.	.	.	19.5
Elk Grove Devon	-	-	-	-	0.1
Springbrook	-	0.03	0.42	0.80	1.5
Wood Dale	-	-	0.36	1.1	1.7
Addison	0.08	0.08	0.88	3.8	5.5
Salt Creek S. D.	1.1	1.4	3.4	4.6	2.8
Elmhurst	1.9	2.6	4.8	7.3	10.4
Oakbrook Terrace		.	.	0.12	
Oak Brook	-	-	0.09	1.6	
TOTAL	3.08	4.11	9.95	19.32	41.5

The total inflow in 1990 was about 60 cfs. Most of the communities in the basin depend on wells for their water supply. Water pumped from the ground or supplied from Lake Michigan is discharged as wastewater effluent. In the southern part of the basin, the glacial drift is thin, and the basal sand and gravel, though too thin to be used as an aquifer, do provide a hydraulic connection between the Salt Creek bed and the dolomite aquifer underlying the sand and gravel. This relationship is a critical factor in ground-water recharge in the southern part of the basin. The entire reach of the Salt Creek south