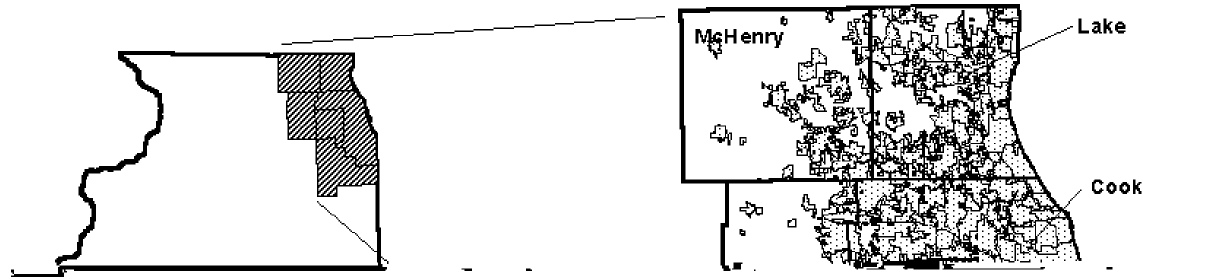
Walton R. Kelly and Steven D. Wilson
Groundwater Section
Illinois State Water Survey
Champaign, IL 61820

The rapid increase in population and developed land in the Chicago metropolitan area has placed a heavy demand on water resources. Owing to legal restrictions and natural limitations on the availability of additional water from Lake Michigan and the region's deep aquifer system, the most cost-effective option for future water development in the region is likely to be the shallow aquifer system. The shallow aquifers of the region are vulnerable to surface-derived contaminants, and the increase in developed land may be increasing the rate at which groundwater quality is being degraded. Historical shallow groundwater chloride (Cl^-) concentrations from the Chicago metropolitan area have been evaluated for data quality and temporal trends. Chloride concentrations are increasing in municipal wells in the outermost counties of the Chicago metropolitan area, with road salt runoff likely the largest source of contamination. In the vast majority of municipal wells in DuPage, Kane, McHenry, and Will Counties, Cl^- concentrations have been increasing. More than half of the wells in these four counties have rate increases greater than 1 mg L^{-1} yr^{-1} and approximately 13% have increases greater than 4 mg L^{-1} yr^{-1}. On the other hand, Cl^- concentrations have not been increasing in most municipal wells in Cook and Lake Counties. Approximately 16% of the samples collected from municipal wells in northeastern Illinois in the 1990s had Cl^- concentrations greater than 100 mg L^{-1}; median values were less than 10 mg L^{-1} prior to 1960, before extensive road salting.

Population and infrastructure have grown rapidly in the Chicago metropolitan area in recent decades. The population has increased from about 5 million to greater than 7.7 million from 1950 to the present, and is projected to increase by 25% by 2020 (NIPC, 1999). Most of the growth is occurring in the outer "collar" counties of Kane, McHenry, and Will, where the projected population increase is 70 to 100% by 2020 (NIPC, 1999). The amount of developed land also has been expanding; residential acreage increased by 46% between 1970 and 1990 (NIPC, 1996). The growth in population and development has placed a heavy demand on water resources. Water use increased about 27% from 1980 to 1992 and demand is expected to continue to grow as the population of the region increases (Kirk et al., 1982; Avery, 1999). Owing to legal restrictions and natural limitations on the availability of water from Lake Michigan and the region's deep aquifer system, the most cost-effective option for future water development in the region is likely to be the shallow aquifer system. This aquifer system consists of unconsolidated sand and gravel aquifers contained within the glacial drift together with the upper portion of the underlying bedrock. A considerable amount of water (500 million gallons day^{-1}) is estimated to be available in these shallow aquifers (Schicht et al., 1976).

Shallow unconfined aquifers, however, are vulnerable to surface contamination, and there are a large number of potential sources of contamination in urban and suburban areas. Some common sources include landfills, sewage treatment plants, industrial effluents, atmospheric deposition, septic fields, gasoline storage tanks, and road runoff. The list of potential contaminants is long, Because of this, the literature on temporal variations in groundwater quality is limited, especially in urban areas (Long and Saleem, 1974; Gibb



. Study area. Dotted regions are incorporated areas.

Complete analyses (i.e., having data for all major ions) from the ISWS and IEPA databases were evaluated using the cation-anion balance:

$$\%E = (\Sigma cations - \Sigma anions / \Sigma cations + \Sigma anions) * 100$$

where %E is percent error and the ion sums are calculated in milliequivalents per liter. Major cations include calcium, magnesium, sodium,

Table 1. Trends in Cl^- concentrations in selected municipal wells in Kane County. n is number of samples. Rate of change and r^2 values determined by linear regression for post-1960 samples only. Final Cl^- is concentration at final date.

Municipality	Well #	Depth (ft)	Rate ($mg\ L^{-1}\ yr^{-1}$)	r^2	n	initial date	final date	final Cl^- ($mg\ L^{-1}$)
Burlington	1	108	<-0.01	<0.001	4	1941	1985	2
Carpentersville	3	72	2.33	0.756	8	1971	1986	44
Carpentersville	5	183	1.12	0.538	11	1966	1998	37
Carpentersville	6	179	1.88	0.861	23	1973	1998	61
Citizens River Grange Div	1	180	0.70	0.779	6	1972	1986	13
East Dundee	2	69	2.08	0.963	5	1958	1991	78
East Dundee	3	128	1.59	0.818	10	1968	1991	64
Elburn	2	153	-0.01	0.083	6	1937	1985	1
Fox Riv Wtr Rclm Dist-Skyline	1	131	1.50	0.738	5	1973	1991	31
Fox Riv Wtr Rclm Dist-Skyline	2	135	2.42	0.864	4	1980	1991	31
Glenwood	3	113	0.37	0.522	23	1962	1983	25
Glenwood	4	100	8.76	0.998	3	1977	1982	54
Highland Subdivision	1	152	3.06	0.749	7	1975	1986	47
Maple Park	2	134	0.06	0.530	6	1946	1985	5
Maple Park	3	185	0.06	0.306	6	1971	1980	1
Ogden Gardens Subdivision	1	185	0.22	0.829	6	1973	1986	4
Ogden Gardens Subdivision	2	176	0.10	0.350	6	1973	1986	2
Ogden Gardens Subdivision	3	185	<0.01	<0.001	7	1972	1986	1
Patterson Mobile Home Park	1	80	3.27	0.824	5	1986	1998	87
Subdivision Water Trust No 1	1	147	0.22	0.766	6	1972	1988	6
Subdivision Water Trust No 1	2	180	0.30	0.826	7	1973	1988	9
Subdivision Water Trust No 1	3	196	0.38	0.849	9	1976	1998	14
South Elgin	4	109	3.10	0.952	3	1982	1997	98
South Elgin	5	68	2.1	855s[8-.3(29)-2674.4(6)-.w2Trust No 113				

Table 2. Trends in Cl^- [illegible] well[illegible] Lake County. n is nu[illegible] of [illegible]

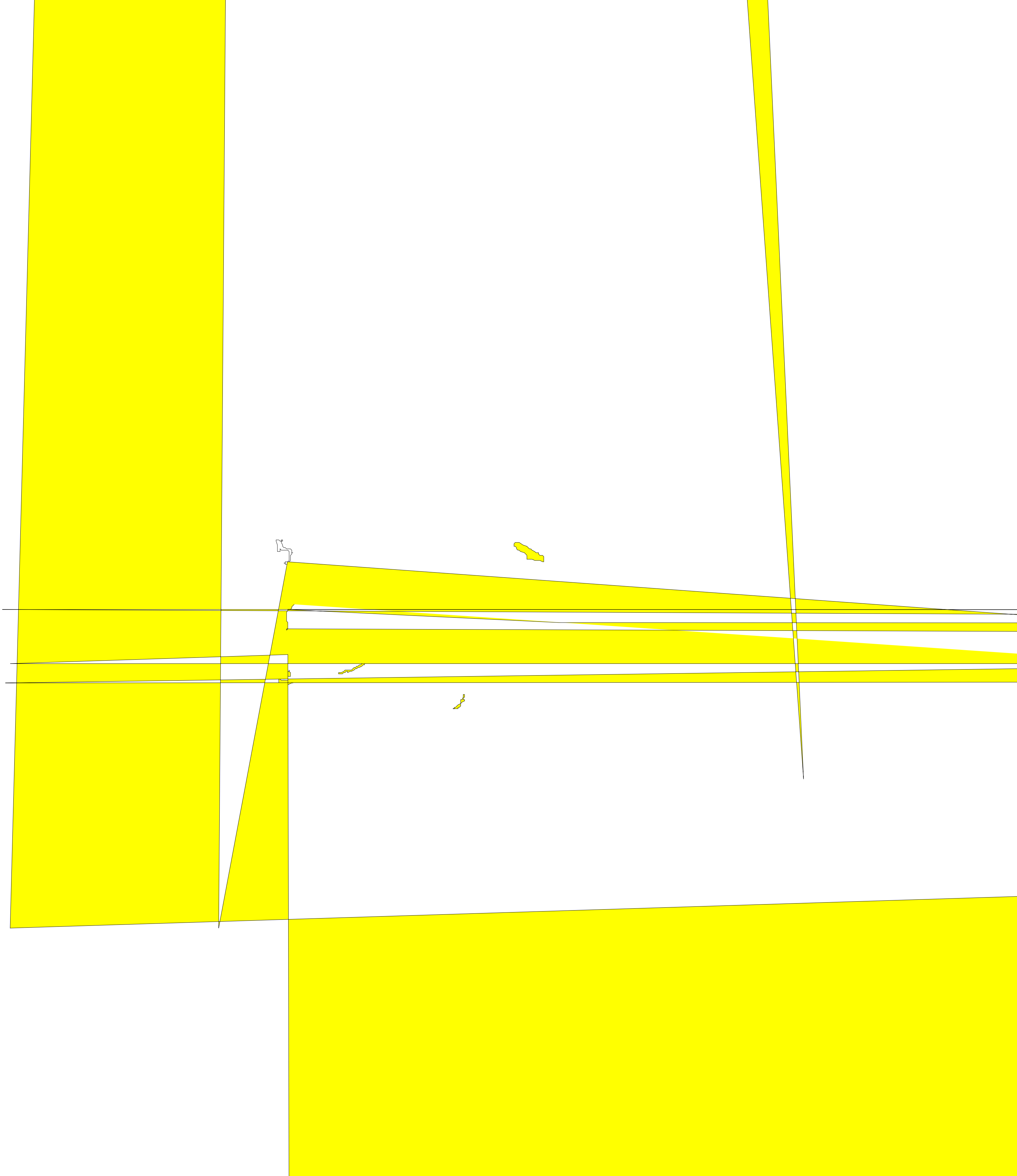
Table 3. Trends in Cl^- concentrations in selected municipal wells in McHenry County. n is number of samples. Rate of change and r^2 values determined by linear regression for post-1960 samples only. Final Cl^- is concentration at final date.

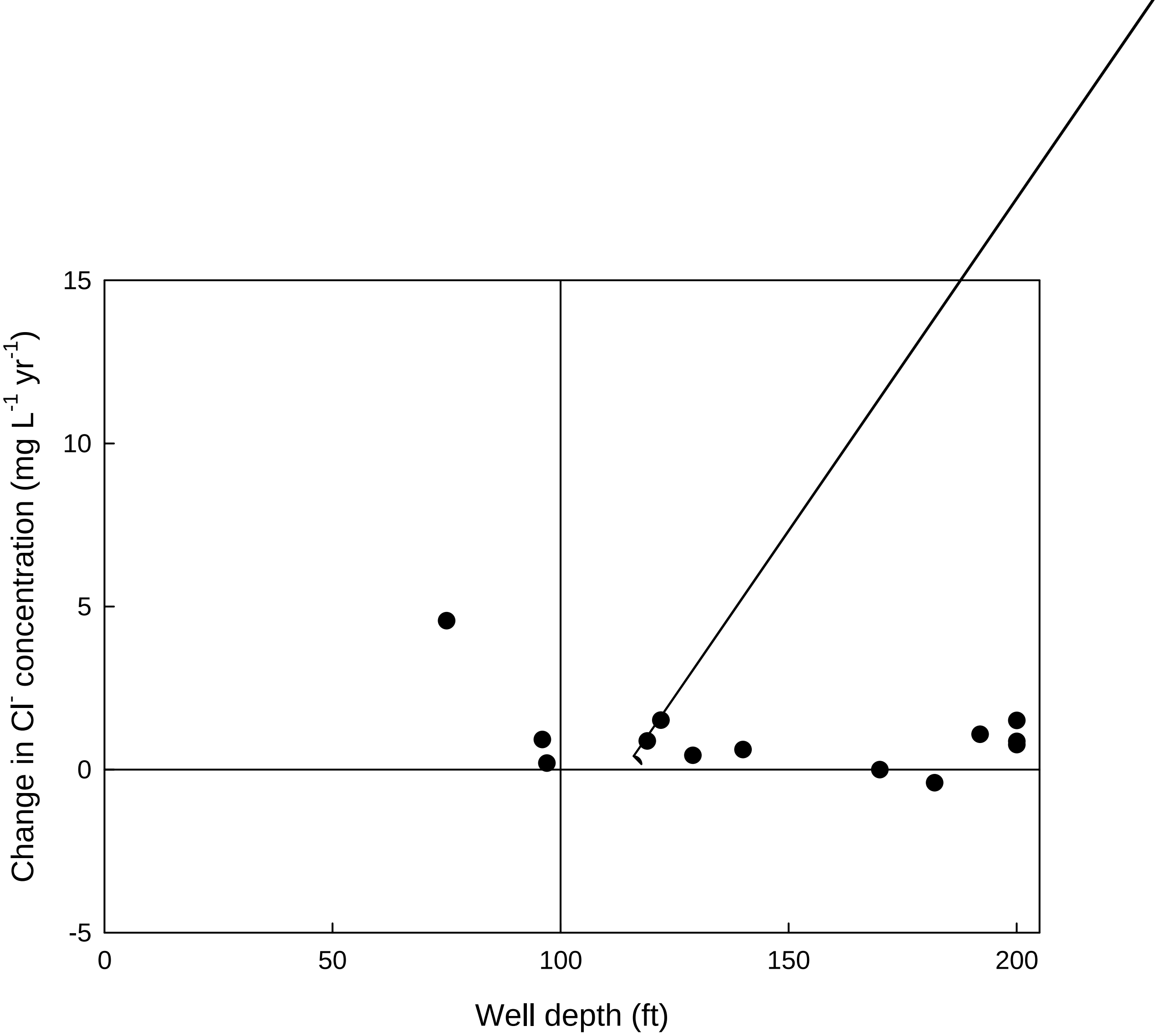
Municipality	Well #	Depth (ft)	Rate ($mg\ L^{-1}\ yr^{-1}$)	r^2	n	initial date	final date	final Cl^- ($mg\ L^{-1}$)
Algonquin	6	152	2.12	0.261	4	1993	1998	23
Algonquin	spring	0	0.73	0.928	4	1953	1987	46
Algonquin	1	165	0.51	0.826	14	1980	1992	12
Algonquin	5	131	0.84	0.696	4	1978	1986	13
Cary	3	155	0.71	0.776	8	1961	1986	25
Cary	8	105	5.29	0.963	5	1982	1997	101
Community Service Corp	2	108	0.71	0.758	6	1972	1986	24
Deering Oaks Sbdv	2	178	0.22	0.693	6	1953	1986	17
Fox River Grove	1	140	1.39	0.333	9	1947	1997	113
Fox River Grove	2	120	1.37	0.440	11	1956	1997	105
Harvard	3	71	5.18	0.668	8	1938	1985	101
Harvard	4	69	2.79	0.673	7	1963	1985	57
Harvard	5	68	2.65	0.846	11	1958	1985	84
Harvard	6	197	0.63	0.850	21	1965	1998	24
Hebron	4	125	4.27	0.661	6	1986	1998	100
Huntley	4	63	1.83	0.856	7	1918	1986	62

Table 4. Trends in Cl^- concentrations in selected municipal wells in Will County. n is number of samples. Rate of change and r^2 values determined by linear regression for post-1960 samples

Table 6. Percentage of Cl^- concentrations greater than various values for municipal wells from northeastern Illinois counties by decade.

Time period	> 10 mg L^{-1}	> 20 mg L^{-1}	> 40 mg L^{-1}	> 100 mg L^{-1}
< 1960	32%	15%	8%	< 1%
1960s	41%	22%	7%	1%




15
10
5
0
-5
0
50
100
150
200
Change in Cl⁻ concentration (mg L⁻¹ yr⁻¹)
Well depth (ft)

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