

Date 12/13/2001

Facility Name _____

Receiving Water LINCOLN CREEK

Evaluated by WAWRZYN, WILLIAM 1984, 1989

This stream classification is not included in the revised code because (select one):

___ The discharger is no longer at this location.

___ A new classification has resulted in a full fish and aquatic life designation.
New survey date _____ Please provide copy of new classification report.

___ This receiving water should be added to the database and to the code. Specify information, as it should be included in code.

___ Other (please explain)

WATER RESOURCE APPRAISAL AND STANDARDS REVIEW FOR THE
MILWAUKEE RIVER SOUTH BRANCH WATERSHED
1989

LINCOLN CREEK SUBWATERSHED

I. Description of the Subwatershed

The Lincoln Creek subwatershed is located in north west Milwaukee County. Lincoln Creek is the principal perennial stream located in the subwatershed.

Lincoln Creek is a continuous tributary of the Milwaukee River and is located entirely within Milwaukee county. The stream is approximately 9 miles in length and drains 19.3 square miles of the civil divisions of Milwaukee (96%), Glendale and Brown Deer. The stream gradient ranges from 9.0 ft/mile downstream of Silver Spring Drive to 17.3 ft/mile upstream of Silver Spring Drive. The reported $Q_{7,10}$ of Lincoln Creek is 0.84 cfs (USGS).

Approximately 50% of the upper watershed (upstream of Silver Spring Dr.) is comprised of more "rural-like" and less pervious land uses such as golf courses, cemeteries, fallow fields, parks and agriculture. The lower watershed area is comprised almost entirely of urban land uses. Most of the watershed is drained by a curb, gutter and storm sewer conveyance system (SEWRPC, 1982).

Lincoln Creek discharges to the Milwaukee River and Estabrook-Lincoln Park impoundment at T8N, R22E, S.31, SE 1/4, NE 1/4. The pool formed by the Estabrook Park dam extends upstream into Lincoln Creek to approximately 1,300 ft below Teutonia Ave.

A stormwater drainage and flood plan prepared for the Milwaukee Metropolitan Sewerage District (MMSD) by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) has recommended that the remainder of free flowing stream between Hampton Ave. and Teutonia Ave. be "improved" or channelized in concrete. The MMSD is currently taking this recommendation under advisement only and is developing a system level plan which will consider channelization in an earthen channel with instream and riparian habitat, and aesthetic mitigation as an important objective.

II. Water Resource Conditions

A. Perennial Streams

Lincoln Creek

Water resource conditions and biological and recreational use objectives for Lincoln Creek were identified in a report titled

Stream Classification and Water Quality Standards Review for Lincoln Creek (Wawrzyn, 1985 and WDNR, 1983). Conclusions in this report were that existing and potential biological and recreational use potentials for Lincoln Creek were variable, therefore they were assigned on a segment-by-segment basis as follows:

Segment

- #1 Downstream of Teutonia Ave. to its confluence with the Milwaukee River
Full fish and aquatic life stream (FAL-B).

Segments

- #3 32nd St. to 35th St.
#4 35th St. to a concrete dropstructure located near 47th St.
#5 Concrete drop structure located near 47th St. to Hampton Ave.
#7 Drop structure at Silver Spring Dr. to Mill Road
#8 Mill Rd. to a series of private ponds located on the Brynwood Country Club property upstream of 60th St.
Intermediate fish and aquatic life (INT-D).

Segments

- #2 Upstream of Teutonia Ave. to 32nd St. drop structure and from Hampton Ave. to drop structure located upstream of Silver Spring Dr. (concrete)
#6 A short reach downstream of headwaters at 76th St. (concrete)
Marginal fish and aquatic life (MAR-E)

The entire length of Lincoln Creek should be classified for partial body contact (PBC). Children are frequently observed wading in Lincoln Creek.

At present, Lincoln Creek is not meeting its full biological and recreational use potential for all stream segments which still existing in an earthen channel. Observed or potential problems or threats limiting its full use potential include loss of instream and riparian fish and other aquatic life habitat, low dissolved oxygen, bacteria and toxics. Pollutants or other factors responsible for these problems include concrete channelization, sediment, fish migration barriers, hydraulic scour, bank erosion, spills, urban runoff, combined sewer overflows, sanitary sewer overflows, leachate from landfills, potentially toxic sediments (including PCBs and metals), and unidentified point sources (Table 1).

Water Quality

The most recent Lincoln Creek chemical and physical water quality information was collected at three stations on a monthly basis from 1975-1976 (WDNR, 1976) and at one monitoring station during a three month period between 1976-1977 (SEWRPC, 1984). Dissolved oxygen, temperature, pH and un-ionized

ammonia levels did not violate Wisconsin State full fish and aquatic life standards. Samples were collected at random and less than 15% of the samples were collected during low-flow and warmwater periods. Nutrient, heavy metal, BOD5 and chloride concentrations generally increased downstream as a result of increasing urban land use runoff, municipal and industrial point source contributions. One whole water sample contained 3.2 ug/l of PCB as Archlor 1248 and 0.1 ug/l of the pesticide Lindane. DDT and its isomers DDD and DDE were also detected. Maximum observed concentrations of lead, zinc, copper, chromium and mercury were 112, 100, 17, 24, and 0.2 ug/l, respectively. Maximum observed lead and zinc concentrations exceeded or approximated the recommended instream chronic toxicity water quality standard. Maximum heavy metal concentrations routinely occur during precipitation induced nonpoint source runoff events. The majority of random water quality samples were collected during base flow conditions or after nonpoint source runoff related events. As such, mean concentrations are somewhat skewed toward base flow conditions and do not entirely depict all of the potential water quality impacts associated with urban nonpoint sources of pollution.

Overall, chemical water quality is characteristic of urbanized watersheds impacted by sanitary and combined sewer overflows and urban runoff (Bannerman, et al., 1979, 1984 and Chesters et al., 1979).

The City of Milwaukee and the Milwaukee Metropolitan Sewerage District reported dissolved oxygen levels less than Wisconsin State water quality standards between 1964-1968 (SEWRPC, 1978).

Sediment

Two sediment samples were collected from Lincoln Creek and analyzed for a limited number of heavy metals and/or PCBs (WDNR, 1975). Based on EPA Region V Sediment Classification for Great Lakes Harbor Sediments, bottom sediments from Lincoln Creek could be classified as "heavily polluted" by lead and zinc and "moderately polluted" by chromium, copper and nickel (USEPA, 1977). Municipal and industrial point sources, spills, illegal discharges, and urban nonpoint source runoff are known sources of heavy metal contamination in the watershed (WDNR, 1976). Sediments contained PCB concentrations ranging from 3.2-7.5 mg/kg. The source of PCBs in Lincoln Creek bottom sediments is unknown.

More recently, sediment samples were collected by the MMSD and analyzed by Triad Engineering as part of the MMSD flood control and channelization project for the lowermost reaches of Lincoln Creek near the mouth of the Milwaukee River. Heavy metal and PCB concentrations were similar to those observed in the WDNR sampling program discussed above. Overall, sediments were routinely classified as "heavily polluted" by lead and

occasionally by oil and grease, chromium and zinc. Sediments were classified as "moderately polluted" by copper, and zinc.

Additional sediment samples have also been collected by the MMSD, but have yet to be reported.

Bacteriological Quality

Fecal coliform samples were collected from Lincoln Creek during 1975-76 and again during 1986. During both sample periods, fecal coliform levels routinely exceed Wisconsin State recreational use standards for full and partial body contact.

City of Milwaukee Health Department (1977) bacterial water quality samples show higher bacteria levels at sample stations proceeding downstream. High fecal coliform levels occur throughout the year but especially during precipitation related events when urban runoff and sanitary and combined sewer overflow events occur. Fecal coliform levels routinely exceed Wisconsin State recreational use standards for full and partial body contact.

Fish

Prior to 1984, historical fish distribution data for Lincoln Creek was limited to data collected by Fago (1973) at two sample sites. Samples collected at segment 1 were representative of species indigenous to the Milwaukee River. A total of eleven species of fish were collected representing all four fish classifications: sport, intolerant, tolerant and very tolerant forage species. Most species were poorly represented except for the tolerant bluntnose minnow and white sucker. Fish collected from segment 5 were represented by only three species, one sport and two very tolerant species. Green sunfish were the dominant species collected at this site.

More recently, qualitative fish collections were made from Lincoln Creek during July and August of 1984. A total of 17 species were collected at segment 1. As in earlier collections, species represented those indigenous to the Milwaukee River and all four fish tolerance classifications (Sport through Very Tolerant Forage). Sport fish species were the dominant group of fish collected in terms of taxa and numbers. Many more redhorse, carp and large suckers were observed but were difficult to collect.

Fish samples were collected from segments 3 & 4. A total of nine species of fish were collected representing sport, tolerant and very tolerant forage fish classifications. Most fish were collected from a deep pool (3 ft) located at the base of a concrete drop structure near 27th St. Although warmwater sport fish species were the dominant group collected, they were present in less than fishable size and numbers. Young-of-the-year largemouth bass were collected at this site

and assumed to originate from the ponds located in the headwaters area.

Ponds located on the Brynwood Country Club are not being managed for any particular fishery. However, naturally reproducing populations of sunfish, largemouth bass and carp exist in these ponds (Blendell, 1984).

Sport fish, redhorse, carp and sucker species are present in fishable numbers and size, however, the consumption of these fish is not recommended due to the potentially high concentrations of PCB in their tissue. Common carp were collected and their tissue analyzed for PCBs from Lincoln Creek segment 1. The sample consisted of a three whole fish composite. PCBs were reported at 11 mg/kg. Although the sample was whole fish and not just the edible portions, PCBs may have been in excess of the Federal Food and Drug Administration recommended human consumption level of 2 mg/kg (Sheffy et al., 1981). This limited fish tissue data may indicate that Lincoln Creek resident fish and/or transit fish populations from the Milwaukee River are unacceptable for human consumption. At present, a fish consumption advisory exists for the Milwaukee River in all of Milwaukee and portions of Ozaukee counties.

Benthos

Quantitative benthic macroinvertebrate samples were collected at one site during the fall of 1975. Out of twenty-two taxa collected, 5 and 14 taxa were classified as being tolerant to very tolerant of pollution, respectively. The very tolerant taxa of were the dominant organisms. Approximately 60% of the total number of organisms collected were comprised of the very tolerant taxa Oligochaeta and Physa spp. The Hilsenhoff Biotic Index (HBI) value indicated "very poor" water quality with respect to conventional forms of organic pollution (Hilsenhoff, 1982).

Semi-qualitative HBI benthic macroinvertebrate samples were collected at three Lincoln Creek sites during the spring of 1984. The sample sites located in segments 1, 4 and 7, had HBI values which indicated "poor" water quality. The two furthest-downstream sample sites were represented by only two taxa and no more than 17 organisms could be collected from the two sites despite an extensive sampling effort. Toxic conditions or some other catastrophic event may be responsible for the poor condition of the benthic community at these sites.

Further upstream in segment 7, seven taxa were collected and HBI values still indicated "poor" water quality. But, unlike sample stations further downstream, diversity increased and organisms were relatively common and easily collected.

public water distribution system. Cooling water discharges using chlorinated public water supplies have been shown to contain residual chlorine concentrations in excess of acute and chronic toxicity levels to fish in other watersheds (CH2M Hill, 1982).

Prior to 1983, an unknown source of iron sulfate and other heavy metals was randomly being discharged to Lincoln Creek via the 35th storm sewer system. Abandoned acid pits ("pickle liquor") on the A.O. Smith property were eventually identified as the source of this contaminated discharge. Remedial control measures have been implemented. However, the events continue. Therefore, other discharges tributary to this system maybe responsible for this material.

The impacts of numerous sanitary and combined sewer discharges on Lincoln Creek water quality undoubtedly contribute to the poor water quality documented in Lincoln Creek and the Milwaukee River. The responsible communities and the Milwaukee Metropolitan Sewerage District are under orders to abate these sanitary sewer discharges.

Other Pollutant Sources

Industrial spills (intentional or accidental) are a chronic problem limiting Lincoln Creek water quality. Thirty-seven spill incidents were reported for Lincoln Creek between 1975-1977 (WDNR, 1976). Intermittent discharges of solvents, paint, cutting and lubricating oils, fuel oils and "pickling" liquor (Fe_2SO_4) are a few of the materials that have been verified or suspected of being discharged to the stream. During this period, 78% of the spill incidents were due to industry, 14% a result of "dry weather" sanitary sewer by-passes and 7% by commercial activities. Illegal plumbing connections (eg. facility floor drains to storm sewers), lack of oil storage and disposal facilities, and deliberate dumping were the most frequently reported reasons for these spills. Late reporting of incidents, cessation of the spill before locating the source, and the complexity of the storm and sanitary sewer systems are some of the reasons that only 45% of the spill incidents result in a source identification.

Three major storm sewer systems continue to experience the most frequent spill incidents in the watershed. This is only a partial list of reported problem sources:

- the 35th St. and Congress St. twin box system
- the 32nd St. and Hampton Ave. system
- the 58th St. and Silver Spring Dr. system.

Leachate seepage from an abandoned municipal and U.S. Army Reserve landfill located on the State's Havenwood Park property and U.S. Army Reserve training facility was identified as a source of ammonia-nitrogen and iron to Lincoln Creek. Ammonia-nitrogen concentrations have been reported at 7.2 mg/l

and 9.3 mg/l and iron at 2.3 mg/l. Flow rate from the only identified seep was estimated at 1 gal/min. Additional sample analyses for a limited number of heavy metals and organics indicate that these parameters do not occur in the leachate. The location of additional contaminated groundwater discharges from the abandoned landfill to the creek have not been determined.

Other landfills possibly discharging groundwater of questionable quality include the Village of Whitefish Bay landfill located south of Good Hope Rd., the City of Milwaukee landfill near Havenwood and the City of Milwaukee incinerator ash fill at Green Bay Ave.

III. Water Resource Management Objectives

The recommended water resource management objectives for streams contained in the Lincoln Creek subwatershed are provided below. They include objectives to be addressed by both NPS and IRM planning processes.

Lincoln Creek

1. Protect, and to the fullest extent practical, enhance instream and riparian fish and aquatic life habitat in the remaining segments of stream enclosed in an earthen channel.

a. Reduce nonpoint sources of sediment, including upland sites and stream banks by 50% (NPS).

b. Reduce hydraulic loadings associated with existing and planned land use conditions. Encourage the City of Milwaukee to require infiltration and /or detention facilities for all new developments and retrofit critical developments whenever practical (NPS, CITY).

c. Encourage and assist in identifying technologies using "soft" engineering practices for stormwater and flood management instead of concrete channelization. These practices should be extended to include the preservation and enhancement of aesthetic green space areas and urban wildlife habitat needs (WRZ and WR).

d. Remove deteriorating reaches of concrete lined channel inlieu of repair or replacement (MMSD).

2. Protect human health and recreational uses of Lincoln Creek and the Milwaukee River.

a. Abate or eliminate sources of fecal bacteria including urban nonpoint sources, sanitary and combined sewer overflows (NPS and WW).

3. Identify and abate point and nonpoint sources of toxics.

a. Reduce urban nonpoint sources of toxics by 50% (NPS).

b. Identify and abate chronic spill and illegal dumping sources through public education activities (IRM). Sanitary sewer surveys should be conducted to identify and eliminate illegally connected floor drains and facilities practicing poor site

Stream Classification for Lincoln Creek
Milwaukee River Basin
Milwaukee County
December, 1984
By Will Wawrzyn

INTRODUCTION

Objective

The objective of this stream classification is to determine the appropriate use designation for Lincoln Creek based on the Stream Classification Guidelines for Wisconsin (Ball, 1982). The final designation is determined by evaluating the physical, chemical and biological factors which influence the potential resource value of this body of water.

DESCRIPTION OF THE WATER RESOURCE

Lincoln Creek is a continuous tributary of the Milwaukee River and is located entirely within Milwaukee County. The stream is approximately 9 miles in length and drains 19.3 square miles of the civil divisions of Milwaukee (96%), Glendale, and Brown Deer. The stream gradient ranges from 9.0 ft./mile downstream of Silver Spring Drive to 17.3 ft./mile upstream of Silver Spring Drive. Approximately 50% of the upper watershed (upstream of Silver Spring Drive) is comprised of more "rural-like" and less pervious land uses such as golf courses, cemeteries, fallow fields, parks, and agriculture. The lower watershed area is comprised almost entirely of urban land uses. Most of the watershed is drained by curb, gutter, and storm sewer conveyance system (SEWRPC, 1982). No continuous tributaries discharge to Lincoln Creek which would not be classified as a storm sewer. The stream discharges to the Milwaukee River at T8N, R22E, Sec. 31, SE 1/4, NE 1/4.

Two stream classifications have previously been conducted for Lincoln Creek. The most recent report recommended a stream classification of intermediate fish and aquatic life (INT-D) for the segment of Lincoln Creek which lies within the Havenwoods park boundaries (WDNR, 1983). An earlier report recommended that Lincoln Creek be classified as a noncontinuous urban stream (WDNR, 1975). Subject to the provisions of NR 104.04, Lincoln Creek shall meet the criteria for fish and aquatic life standards with the exceptions as stated under 102.02(3)(a): Dissolved oxygen not to be less than 2 mg/l at any time, nor shall the membrane filter fecal coliform count exceed 1,000 per 100 mls as a monthly geometric mean based on not less than 5 samples per month nor exceed 2,000 per 100 mls in more than 10% of all samples during any month.

STREAM EVALUATION

Water Quality

The most recent Lincoln Creek chemical and physical water quality information was collected from three stations on a monthly basis from 1975-1976 (WDNR, 1976) and at one monitoring station during a three month period from 1976-1977 (SEWRPC, 1984) (Appendix 1). Dissolved oxygen, temperature, pH, and un-ionized ammonia levels did not exceed Wisconsin State full fish and aquatic life standards. Samples were generally collected at random and less than 14% of the samples were collected during low-flow and warmwater periods when dissolved oxygen levels would most likely violate standards especially during runoff and sanitary sewer bypass events. Nutrient, heavy metal, BOD₅, and chloride concentrations generally increased downstream as a result of increasing urban nonpoint source and municipal and industrial point source contributions. One whole water sample contained 3.2 ug/l of PCB 1248. Overall, chemical water quality is expected to be characteristic of urbanized watersheds impacted by sanitary and combined sewer overflows and urban runoff in southeastern Wisconsin (Bannerman et al., 1979 and 1984, and Chesters et al., 1979).

The City of Milwaukee and the Milwaukee Metropolitan Sewerage District reported dissolved oxygen levels less than Wisconsin State water quality standards between 1964-1968 (SEWRPC, 1978).

Bacteriological Quality

Fecal coliform levels frequently exceed Wisconsin State recreational use standards. During one 30-day summer sample period, fecal coliform bacteria exceeded the Wisconsin State recreational use standard for Lincoln Creek (2,000/100 ml) 82% of the time (WDNR, 1976) (Appendix 2). City of Milwaukee Health Department (1977) and the WDNR monthly bacterial water quality samples show an increasing trend as sample stations progress downstream. High fecal coliform levels occur throughout the year but especially during runoff and sanitary and combined sewer overflow events.

Two sediment samples have been collected from Lincoln Creek and analyzed for a limited number of heavy metals and/or PCB's (WDNR, 1975) (Table 1). Based on EPA Region V Sediment Classification for Great Lakes Harbor Sediments, bottom sediments from Lincoln Creek at mile 1.3 are heavily polluted by lead and zinc and moderately polluted by chromium, copper, and nickel (USEPA, 1977). Municipal and industrial point sources, spills, illegal discharges, and urban nonpoint source runoff are known sources of heavy metal contamination in the watershed (WDNR, 1976). Sediments had PCB concentrations ranging from 3.2-7.5 mg/kg. The source of PCB's in Lincoln Creek bottom sediments is unknown. Additional sampling will be needed to determine if PCB's are continuing to be discharged to Lincoln Creek at unacceptable levels.

Fish

Prior to 1984, historical fish distribution data for Lincoln Creek was limited to data collected by Fago (1973) at two sample sites (Table 2). Samples collected at river mile 0.8 were representative of species indigenous to the Milwaukee River. A total of 11 species of fish were collected representing

all 4 fish classifications: sport, intolerant, tolerant, and very tolerant forage species. Most species were poorly represented except for the tolerant bluntnose minnow and white sucker. Fish collected at river mile 4.3 were represented by only 3 species, a sport and 2 very tolerant species. Green sunfish was the dominant species collected at this site. No indication is given regarding the fishability of these sunfish populations relative to size.

More recently, qualitative fish collections were made from Lincoln Creek during July and August of 1984 using a DC pulse stream shocker or DC pulse stream back-pack shocker (Table 2). A total of 17 species were collected at river mile 1.0. As in earlier collections, species were representative of species indigenous to the Milwaukee River and all 4 fish classifications. Sport fish were the dominant group of fish in terms of taxa and numbers. Many more redhorse, carp, and largesuckers were observed but were difficult to collect. Sport fish, redhorse, carp, and sucker species are present in fishable numbers and size. However, the consumption of these species may be limited due to the potentially high concentrations of PCB in their tissue.

Fish samples were collected at stream miles 2.7 and 3.3 on 2 separate sample dates. A total of 9 species of fish were collected representing sport, tolerant, and very tolerant forage fish classifications. Most fish were collected from a deep pool (>3.0 ft.) located at the base of a concrete drop structure near 27th Street. Sport fish were the dominant species collected from this site but were present in less than fishable sizes and numbers. Young-of-the-year largemouth bass were collected at this site and may have originated from the ponds located in the headwaters area.

Toxics in Fish Tissue

Common carp were collected and tissue analyzed for PCB's at Lincoln Creek mile 0.4. The sample consisted of a three whole fish composite, and PCB's were reported at 11 mg/kg. Although the sample was whole fish and not just the edible portions, PCB's may well have been in excess of the Federal Food and Drug Administration recommended human consumption level of 2 mg/kg (Sheffy et al., 1981). This limited fish tissue data may indicate that Lincoln Creek resident fish and/or transit fish populations from the Milwaukee River are unacceptable for human consumption. At present, a fish consumption advisory exists for the Milwaukee River in all of Milwaukee and portions of Ozaukee Counties.

Benthos

Quantitative benthic macroinvertebrate samples were collected at one site during the fall of 1975 (Appendix 3). Twenty-two taxa were collected of which 5 and 14 taxa were classified as being tolerant to very tolerant of pollution, respectively. The very tolerant taxa of Oligochaeta and Physa spp. were the dominant organisms comprising 60% of the total number of organisms collected. The Hilsenhoff Biotic Index (HBI) value indicated poor water quality.

Qualitative benthic macroinvertebrate samples were collected at 3 Lincoln Creek sites during the spring of 1984. Benthos were collected and HBI values calculated using the standard HBI technique developed by Hilsenhoff (1982).

All 3 of the sample sites (river mile 0.9, 2.6, and 6.8) had HBI values which indicated poor water quality. The two furthest downstream sample sites were represented by only 2 taxa and no more than 17 organisms could be collected from the 2 sites despite an extensive sampling effort. Toxic conditions or some other catastrophic event may be responsible for the poor condition of the benthic community at these sites.

Further upstream at river mile 6.8, 7 taxa were collected, and HBI values still indicated poor water quality. But unlike sample stations further downstream, diversity increased, organisms were relatively abundant and easily collected.

Habitat

Low-flow characteristics ($Q_{7,10}$) for Lincoln Creek have been estimated to be 0.84 ft.³/sec. Low-flow characteristics for Lincoln Creek are not entirely limiting to the biological use of Lincoln Creek. Numerous cooling water discharges and minimal water depths needed to sustain fish and aquatic life appear to be maintained throughout much of the stream during brief low-flow periods.

Habitat evaluations were conducted during August and November of 1984. These surveys were conducted during base flow periods when flows were estimated at approximately 5 ft.³/sec. Based on unique habitat characteristics, the stream was broken down into 8 segments for ease of discussion. (See Table 3 for Habitat Rating Forms)

Segment 1 (WWSF)

Segment 1 is located between the confluence with the Milwaukee River (R.M.=0.0) and Teutonia Ave. (R.M.=1.3). Almost the entire segment lies within the Milwaukee County parkway system.

Lower banks are steep and vegetative cover is generally absent due to severe erosion and the inundation of the banks during the summer growing season. Bankside vegetation is limited to a mixture of grasses, shrubs, trees. Boulder size rip-rap is located near the top of this segment along the right bank.

Stream channel widths and depths are variable and change dramatically as a result of a seasonally regulated impoundment located 1.3 miles downstream on the Milwaukee River at Estabrook Park. The pool is maintained during the summer months (June-September) and lowered during the remainder of the year. When impounded, depths within the pool increase by approximately 3 feet at Green Bay Avenue (R.M.=0.8) to less than 0.5 feet downstream of Teutonia Avenue.

When the pool levels are maintained, the channel width ranges from 50-90 feet. Habitat is characteristic of an extensive pool with the only riffle/run complex occurring near the top of this segment. Depths range from 0.5 feet in the few riffle areas while depths in some pools and holes exceed 7 feet. Average depth in this segment is 3 feet. Despite the large channel, over bankflows are frequently based on historical flood records and highwater marks observed during these surveys.

During drawdown, channel widths decrease significantly, ranging from 30-75 feet. In some reaches, sedimentation has resulted in a number of shallow and diffuse channels being formed. At drawdown, this segment is a series of pool/run/riffle complexes. Riffles occur at a frequency of every 300-600 feet, and depths in riffles range from 0.2-0.4 feet. At least 4 large pool areas are located in this segment which provide habitat for larger fish species throughout the year. Pool sizes are approximately 65' x 60', 200' x 70', 500' x 50', and 150' x 70'. Depths within these pools range from 2-7 feet and average at least 3 feet during drawdown. Pools were found to be relatively free of siltation due to frequent scouring.

Substrate types are quite variable ranging from a well sorted mixture of silt, sand, and gravel along the inside of bends, to honeycombed scoured clay, gravel and rubble along the outside of the channel. Massive deposits of fine sediment are present at the Milwaukee R.-Lincoln Cr. confluence where large silt bars are scoured and redeposited annually. Additional deposits are found throughout much of this segment following pool drawdown.

The most diverse and unique habitat in this stream segment is found at the top of this reach (R.M.=1.0) where a series of large, deep pool, run and riffle complexes occur. Boulder rip-rap material along the right bank provides important habitat for fish. Substrate in this area is a mixture of sand, gravel, rubble, and concrete slabs.

Habitat in this segment is fair and capable of sustaining a fishable sport and forage fishery including sucker and redhorse species. Bottom scour, bank erosion, and sedimentation are the most limiting habitat factors in this segment.

Segment 2 (MARG)

Segment 2 of Lincoln Creek is a 0.6 mile concrete channel which extends from Teutonia Ave. (R.M.=1.3) to a steel drop structure at 32nd St. (R.M.=1.9). Channel characteristics are uniform throughout this segment. Stream depths at base flow average <0.5 feet and instream structures such as pools, riffles, and runs do not exist. Bottom scour during runoff events is severe. No fish or significant macroinvertebrates were observed in this segment during all of the stream habitat surveys. Habitat in this segment is very poor and incapable of sustaining any significant or diverse biological community.

Segment 3 (INT)

Segment 3 extends for 0.6 miles from 32nd St. to 35th St. (R.M.=2.5). Land uses adjacent to the stream include wooded and grass parkway and some commercial development.

Lower banks are perpendicular and are usually constructed of masonry rock or natural dolomite bedrock. Banks are generally stable except where sediment bars have formed along the lower banks. Bank heights range from 6-10 feet, and high water marks indicate that overbank flows occur frequently in this segment.

Downstream of Glendale Ave., habitat is characteristic of a fast flowing run and shallow riffle complex. Stream depth in this reach ranges from 0.2 feet in riffles to an average of 2.0 feet in run areas. Substrate consists of bedrock, clay, and coarse sand. Riffles are located approximately 300 feet apart. Fish movement is not restricted by the shallow riffle depths since deeper runs are located along alternating sides of the channel. A drop structure with a head of 1 foot and cut from the bedrock is located in this reach.

Channel widths are fairly uniform averaging 35-40 feet. At some cross sections, channel widths are narrower due to the formation of massive sediment bars. These deposits are formed along the inside of bends and extend into the channel as much as 15 feet and are up to or in excess of the man-made bank heights. Judging from the age of shrubs and trees growing on top of these deposits, these bars have been present for at least 5 years.

Upstream of Glendale St., habitat is characteristic of a riffle and pool complex. Stream depths in the upper reach of this segment range from 0.2 feet in riffle areas to >3 feet in a pool. Average depth in this segment is approximately 2.0 feet. Substrate is similar to that noted for the lower reach. There are 3 riffle/pool complexes located in this reach with the riffles located 100-200 feet apart. Bottom scour is extensive throughout this segment.

Channel widths range from 25-40 feet and, like the downstream reach, have massive silt bars along the inside of bends. These deposits are larger than deposits found immediately downstream, extending as much as 25 feet from the channel wall and are up to 4 feet in height. Large trees located on top of these deposits indicate that they have been present for at least 20 years. These deposits contribute to flooding in the area by constricting flow in the channel.

Habitat in this stream segment is fair to poor and is capable of sustaining a tolerant to very tolerant fish and macroinvertebrate community. Bottom scour, and to a lesser extent bank erosion, are the most limiting habitat factors in this stream segment.

Segment 4 (INT.)

Segment 4 extends for 0.8 miles from 35th St. to a concrete drop structure located near 47th St. (R.M.=3.3). A small 1 foot head concrete weir (the "Hansen Dam") is located just upstream of Sherman Blvd. The Milwaukee County parkway borders both banks of this stream segment.

Lower bank heights average 4 feet and stream widths are fairly uniform averaging 30-35 feet. Stream flows frequently exceed the lower bank. Banks are almost perpendicular and in most areas are badly eroded. Upper and lower banks are covered with a mixture of grasses, shrubs, and trees.

This segment of stream can be characterized as a shallow run and riffle complex. Bends are absent, and it is essentially a straight channel. Depths average 1 foot downstream of Sherman Blvd. to 0.5-0.8 feet upstream of Sherman Blvd. (R.M.=3.0). Riffles are shallow, averaging 0.2 feet, and occur at a frequency of every 300-400 feet. Pools are nonexistent in this reach except below storm sewer outfalls and a larger pool located immediately downstream of the concrete drop structure near 47th Street. Maximum depth within this pool is approximately 5 feet. Additional habitat is provided by a few deadfalls and exposed tree roots.

Substrate is of a mixture of well sorted coarse sand, gravel, and lesser amounts of clay and rubble. Bottom scour is extensive throughout the segment.

Habitat in this segment is poor and capable of sustaining a limited tolerant to very tolerant fish and macroinvertebrate community. Bottom scour, bank erosion, and a general lack of protective habitat are the most limiting habitat factors in this segment.

Segment 5

Segment 5 extends for 1.1 miles from the concrete drop structure located near 47th St. (R.M.=3.3) to Hampton Ave. (R.M.=4.4). Another concrete drop structure is located between 49th and 51st Street. The entire segment is bordered by the Milwaukee County parkway system.

Upper banks are covered with a mixture of grasses and shrubs and lesser amounts of trees. Lower bank heights range from 4-15 feet but average 5 feet. Lower banks are steep and less eroded when compared to previous stream segments. High water marks indicate that the banks are frequently exceeded during runoff events.

In the lower stream reach between 47th St. and 55th St., stream widths range from 30-40 feet, and cross sectional depths are fairly uniform across any given cross section ranging from 1.5-3.0 feet. Substrate is quite variable ranging from well scoured clay to well sorted silt, sand, gravel, and much lesser amounts of rubble. Additional habitat is limited to deadfalls, exposed tree roots, and small pools formed by storm sewer outfalls.

In the upper reach between 55th St. and 60th St., stream depths are also uniform across the entire cross section ranging from 1-2 feet in depth. Substrate is similar to what was noted for the lower reach.

Both reaches are dominated by run-like habitat with few riffle or deep pool areas. Maximum depths in riffles range from 0.2-0.4 feet. Bottom scour may not be as severe or as extensive as in previous stream segments. Macrophytes in Lincoln Creek are first encountered in this segment. Though far from common *Elodea* spp., filamentous algae and diatom growths were observed along the inside of the stream channel where stream scour is not as severe.

The best habitat in this segment is featured at two areas. A large scoured pool is located just downstream of the pedestrian bridge near 49th Street. Depths within this pool average 3 feet. This pool is approximately 200 feet in length and is formed by the constriction and scour of the creek bottom

channel. In addition, a short reach upstream and downstream of the 60th St. bridge has a honeycombed clay substrate which provides a variety of unique habitats for fish and other aquatic life. Depths within these honeycombed areas range from 1.5-4.0 feet and the diameter of the holes range from a few feet to over 20 feet.

Habitat in this segment ranges from fair to poor and is capable of sustaining a tolerant to very tolerant fish and macroinvertebrate community. Lack of larger and more protective substrates, bottom scour, and bank erosion are the most limiting habitat factors in this segment.

Segment 6 (MARG)

Segment 6 is a 1.25 mile concrete channel which extends from Hampton Ave. (R.M.=4.4) to a 5.5 foot iron drop structure upstream of Silver Spring Drive. Channel characteristics are uniform throughout this segment and are very similar to those noted for the concrete channel segment 2 discussed earlier. Habitat in this segment is incapable of sustaining any significant biological community.

Segment 7 (INT.)

Segment 7 extends for 1.1 miles from the iron drop structure at Silver Spring Dr. to Mill Road (R.M.=6.9). Land uses immediately adjacent to the stream include woodlands and meadows located within the Havenwoods park and the U.S. Army Reserve property.

Lower banks are steep and heights range from 5-10 feet. Overbank flows are frequent and vegetative bank cover is poor due to the extensive bank erosion.

Most of the lower half of this stream segment is characteristic of a shallow run with an average depth of 1.5 feet. Widths range from 12-15 feet. Substrate in this reach is dominated by clay and lesser amounts of coarse sand, gravel, and rubble. The most diverse habitat is found just downstream of the railroad crossing near the center of the park. Here a series of 8 riffle/pool complexes occur between 75-100 feet apart. Depths in the pools average 2 feet, and riffle depths average 0.2 feet. The presence of rubble size substrate provides more protection for maintaining filamentous algae and macroinvertebrate populations. A noticeable increase in the numbers and diversity of macroinvertebrate populations were found in this segment compared to previous stream segments. Asellus spp. are abundant and Heptageniidae, Hydropsychidae, and midge larvae are present. Filamentous algae was also more abundant in this stream reach.

The upper half of this stream segment is characteristic of a fast flowing, shallow riffle area. Depths range from 0.1-0.4 feet and stream widths range from 9-12 feet. Substrate is dominated by a mixture of clay, coarse sand, and gravel. Bottom scour, overbank flow, and bank erosion are extensive throughout this segment.

Habitat in this segment is fair to poor and is capable of sustaining a tolerant to very tolerant fish and macroinvertebrate community. Bottom scour and bank erosion are the most limiting habitat factors in this segment.

Segment 8 (INT)

Segment 8 extends for 1.7 miles from Mill Rd. to a series of private ponds located on the Brynwood Country Club property upstream of 60th St. (R.M.=8.6). Land uses adjacent to this segment include mowed grass parkway, cattail marsh, meadow, railroad right-of-way, a cemetery, and the Brynwood Country Club golf course.

Between Mill Rd. and Green Tree Rd., lower banks slope gently and heights average 1.5 feet. Banks are generally stable and are covered by grasses and lesser amounts of shrubs. Bank erosion is most severe along the downstream side of the Green Tree Rd. culverts.

In surveyed areas, stream widths range from 4-10 feet and depths range from 0.5-1.0 feet. Overbank flow is common. Substrate is dominated by well sorted deposits of silt, coarse sand, and gravel. Filamentous algae growth was abundant and *Elodea* spp. and *Sagittaria* spp. were found.

Upstream of Green Tree Rd., the stream channel is more characteristic of a cattail marsh and flow is reportedly intermittent. Stream widths range from 10-25 feet, and stream depths average 0.5 feet. Habitat was not extensively surveyed in the reach which runs along the railroad right-of-way.

The most important stream habitat in this segment occurs within the Brynwood Country Club ponds. Their total area is approximately 10 acres with depths ranging between 1-9 feet. The water in the ponds is maintained by urban stormwater flows. Although these ponds are not managed for any fishery, naturally reproducing populations of sunfish, largemouth bass, and carp exist in these ponds (Blendell, 1984).

With the exception of the series of ponds located in the headwaters area, habitat in this stream segment is poor and is capable of sustaining a very limited tolerant to very tolerant fish and macroinvertebrate community. Habitat is most limited by low-flow conditions.

Water and Riparian Recreation

The stream is bordered almost entirely within the publicly owned Milwaukee County park system or the Wisconsin Department of Natural Resources 238 acre Havenwoods urban natural and wildlife preserve. These "green spaces" include a mixture of mowed grass areas, meadows and woodlands which provide unique water-based wildlife habitat, outdoor recreational and educational uses in an otherwise heavily urbanized area. A variety of wildlife have been documented along the length of Lincoln Creek. During the fall habitat evaluations, numerous flocks of mallard ducks were observed in all but the concrete lined segments. A variety of song birds and raptors were also observed including chickadees, cardinals, bluejays, warblers, ruby-crowned kinglets and red-tailed hawk and kestrel.

Water borne recreational uses of Lincoln Creek which involves contact with the stream are limited by its size and depth. While some pools provide sufficient depth for full body contact. These are the exception. Overall, human contact would be limited to incidental types such as wading and fishing. Children have routinely been observed wading, fishing and catching "polywogs" in the stream during the summer months. (See Appendix 4)

Public access to Lincoln Creek is extensive throughout this urban watershed. As discussed in previous sections of this report, there are a variety of point and nonpoint source discharges which contribute to elevated and unsafe levels of in-stream bacteria. While most point sources are abateable, nonpoint source contributions are more difficult to abate.

Navigability

No active recreational boating was observed along Lincoln Creek during any of the stream surveys. However, there is no doubt that by definition, Lincoln Creek is a navigable water of the State. Lower bank heights in excess of two feet were observed throughout the entire length of stream surveyed. High water marks were routinely observed along the lower limit of the upper bank. Most stream reaches are navigable even during low-flow periods.

Channel Modifications

Construction of the concrete channel has eliminated most of the fish and aquatic life habitat necessary to sustain fish and aquatic life populations. Concrete channelization results in the loss of suitable substrate for fish cover and food production, elimination of overhead bank and vegetative cover, loss of riparian vegetation needed for substrate and shading, increased rates of bottom scour to channelized and downstream natural segments, increased potential for bank scour and failure in natural downstream reaches, etc. Fish migrations are eliminated by the addition of high drop structures.

Most of the water-borne and riparian related recreational uses associated with natural channel reaches of Lincoln Creek have been lost in the concrete channelized reaches of stream. Riparian vegetation needed to sustain wildlife, fish and aquatic life communities have been removed or greatly reduced. Avenues for wildlife migration have also been eliminated. Many of the aesthetic qualities with the natural channel have also been reduced. Hiking trails along vegetated banks have been destroyed. Removing riparian vegetation has reduced the sound damping properties along the creek and reduced scenic variety in a heavily urbanized area.

Navigability has also been impaired. Upstream and downstream travel is inhibited and in some situations dangerous by the addition of high drop structures. Increasing the width and shallowness of the wetted perimeter also inhibits navigation.

The entire length of stream has, at one time or another, been modified in order to accommodate urban development and reduce flooding. A 0.3 mile segment of stream between Teutonia Avenue and 32nd Street and a 1.25 mile segment between Hampton Avenue and Silver Spring Drive has been channelized in concrete. A recently completed flood control plan for the Lincoln Creek watershed has been completed by the Southeastern Wisconsin Planning Commission (SEWRPC, 1982). The report recommended that the remaining 2.5 miles of "natural" stream channel, lower and upper banks, between 32nd Street and Hampton Avenue be channelized in concrete. An additional 1.8 miles of stream channel in the upper watershed will be modified through deepening and widening.

Controllable Limiting Factors

Water quality in Lincoln Creek is limited by a variety of pollutant sources including urban nonpoint sources, municipal and industrial point sources, spills or unpermitted discharges, and an abandoned landfill.

Watershed Erosion and Nonpoint Sources

Based on a limited number of field observations, active erosion is not believed to be extensive in the Lincoln Creek watershed. Active erosion is somewhat limited by the fact that the watershed is already extensively developed. Erosion problems may arise as future urban development occurs in the remaining open areas of the upper watershed and stream channelization progresses throughout the watershed. The potential impacts of sedimentation as a result of stream channelization was evidenced during the construction of a bridge and small section of concrete channel at 32nd Street. Total suspended solids concentrations were 3,590 mg/l downstream of the construction site during a base flow sample period. A sample obtained upstream of the construction site contained a suspended solid concentration of 8 mg/l. Erosion potential in the watershed will be influenced by the Hydrologic Group C Soils which are dominate throughout the watershed.

Nonpoint source pollution from urban land uses limits the water quality of Lincoln Creek. Specific studies to evaluate the impacts and relative contributions of urban nonpoint sources of pollution compared to other sources have not been conducted. SEWRPC (1983) predicted the effectiveness of stormwater management alternatives needed (street sweeping and settling basins only) to reduce the amounts of pollutants discharged to Lincoln Creek from urban nonpoint sources of pollution. A cost-effective program of intensified street sweeping and development of two detention or retention basins in the watershed was projected to reduce the level of annual pollutant loadings (lead, total phosphorus, total nitrogen, vol. suspended solids, and total solids) to the stream by 6-18%.

Point Sources

Municipal and industrial point sources of pollution limit Lincoln Creek and Milwaukee River water quality. There are 18 known industrial and at least 55 municipal sanitary sewer relief devices or combined sewers which discharge to Lincoln Creek (Table 4).

Of the 18 industrial dischargers, 15 are noncontact cooling water discharges. Two of the noncontact cooling water discharges include water treatment or biocide additives. Industrial discharges may add from 2-3 ft.³/sec. to the base flow of Lincoln Creek or more than 3 times the $Q_{7,10}$ of 0.84 ft.³/sec. Although the majority of these dischargers do not add any pollutants to their effluent, concerns have been raised over the potential of chlorine toxicity. All industrial cooling water dischargers use the City of Milwaukee public water supply which maintains a total residual chlorine concentration of 0.5-1.0 mg/l in the public water distribution system. Cooling water discharges which use chlorinated public water supplies have been shown to contain residual chlorine concentrations in excess of fish acute and chronic toxicity levels in other watersheds (CH2M Hill, 1982).

Prior to 1983, an unknown source of iron sulfate and other heavy metals was randomly being discharged to Lincoln Creek via the 35th storm sewer system. Abandoned acid pits ("pickle liquor") on the A.O. Smith property were eventually identified as the source of this contaminated discharge. Remedial control measures have been implemented resulting in a decrease in the frequency and magnitude of such incidents. The effects of the iron and associated heavy metals on the biological community of Lincoln Creek is not known.

The impacts of numerous sanitary and combined sewer discharges on Lincoln Creek water quality undoubtedly contribute to the poor water quality documented in Lincoln Creek and the Milwaukee River. The responsible communities and the Milwaukee Metropolitan Sewerage District are under orders to abate these sanitary sewer discharges.

Other Pollutant Sources

Industrial spills (intentional or accidental) are a chronic problem which limits the water quality of Lincoln Creek. Thirty-seven spill incidents were reported for Lincoln Creek between 1975-1977 (WDNR, 1976). Intermittent or continuous discharges of solvents, paint, cutting and lubricating oils, fuel oils and "pickling" liquor (Fe_2SO_4) are just a few of the materials which have been verified or suspected of being discharged to the stream. During this period, 78% of the spill incidents were due to industry, 14% a result of "dry weather" sanitary sewer bypasses and 7% by commercial activities. Illegal plumbing connections (i.e., facility floor drains), lack of oil storage and disposal facilities, and deliberate dumping of the material were the most frequently reported reasons for these spill incidents. Late reporting of incidents, cessation of the spill before locating the source and the complexity of the storm and sanitary sewer systems are some of the reasons that only 45% of the spill incidents ever result in identifying the source. More recent inventories have not been completed to update the frequency of these incidents. Three storm sewer systems continue to experience the most frequent spill incidents in the watershed: the 35th St.-Congress St. system, the 32nd St.-Hampton Ave. system, and the 58th St.-Silver Spring system.

Leachate seepage from an abandoned municipal and U.S. Army Reserve landfill located on the State's Havenwood Park property and U.S. Army Reserve training facility has been identified as a source of ammonia-nitrogen and iron to Lincoln Creek. Ammonia-nitrogen concentrations have been reported at 7.2 mg/l and 9.3 mg/l, and iron at 2.3 mg/l. Flow rate from the only identified seep was estimated at 1 gal/min. Additional sample analysis for a limited number of heavy metals and organics indicate that these parameters do not occur in the leachate. The location of additional contaminated groundwater discharges from the abandoned landfill to the creek have not been determined.

MANAGEMENT ALTERNATIVES FOR CONTROLLABLE AND PARTIALLY CONTROLLABLE LIMITING FACTORS

Controllable and partially controllable factors and management alternatives which may cause a direct benefit to Lincoln Creek water quality and habitat and help sustain or improve its present and future biological and recreational use potential include:

(1) Recognizing that flooding problems and urban nonpoint sources of pollution exist throughout much of the watershed, it is recommended that a more comprehensive stormwater management plan be developed for the watershed. This plan should include more innovative and up-to-date flood, stormwater and urban nonpoint source pollution management alternatives which take into account those portions of the upper watershed which are presently undeveloped. Previous nonpoint source pollution management alternatives included only street sweeping and limited use of detention/retention basins.

The hydrologic-hydraulic model should be recalibrated to include the effects of massive bank constrictions deposited in segment 3 of Lincoln Creek as well as the effects of various innovative stormwater management alternatives in the lower and especially less developed upper watersheds. For example, alternatives to curb, gutter and storm sewer conveyance systems, additional pond storage and alternative land uses should be seriously considered for the upper watershed.

The present flood control plan recommends extensive concrete channelization and channel realignment for the remaining natural stream segments. If this portion of the plan is implemented, the present and future biological and recreational use potential will be permanently destroyed. Alternatives to concrete channelization should be reviewed which are compatible with the recommended use objectives contained within this report. If alternatives are not considered which are compatible with biological and recreational use objectives, than regulatory action should be implemented.

(2) Continue the scheduled abatement of sanitary and combined sewer overflows throughout the watershed.

(3) Strict enforcement of state and local regulatory agency codes which prohibit the connection of interior floor drains to the storm water sewer system. Outside storage facilities should be inspected to determine if pollution potential exists as a result of storm sewer drainage to the stream. A cooperative strategy between state and local agencies will be needed to identify and control these sources of pollution. This plan should be implemented for the three storm sewer systems previously identified as chronic spill areas.

(4) Extensive bottom scour, bank erosion and the lack of extensive protective in-stream habitat such as pools, undercut banks and large substrate such as rubble, are currently limiting the establishment and maintenance of a more balanced fish, macroinvertebrates and primary producer community. Sedimentation is extensive in the lower reaches of segment one. Placement of bank protection devices which are compatible with fish and aquatic life habitat requirements should be constructed in areas which experience severe stream bank erosion. In addition, the placement of large substrates onto the bed of Lincoln Creek would greatly improve upon the streams biological use potential by providing pool features and protection against high stream velocities and bottom scour.

(5) Monitor point sources and stream water quality for chlorine to determine if the potential for chlorine toxicity exists in the watershed during low-flow periods.

(6) Responsible parties should continue to monitor groundwater quality in the vicinity of the abandoned municipal and U.S. Army landfill to insure that groundwater will not impact Lincoln Creek water quality during low-flow periods.

(7) Based on percent biological data, toxic or other catastrophic events are limiting the fish and/or macroinvertebrate samples should be collected from Lincoln Creek segments 5, 7 and 8. These samples are needed to better define spatial water quality and habitat trends throughout the watershed. Fish tissue samples should be collected from Lincoln Creek to define the furthest upstream extent and potential sources of PCB's and other toxic substances.

UNCONTROLLABLE LIMITING FACTORS

Uncontrollable factors which limit the existing the potential biological and recreational use of Lincoln Creek include the effects of past concrete channelization and drop structures.

SUMMARY AND RECOMMENDATIONS

A stream classification was completed for Lincoln Creek to determine an appropriate biological use designation based on physical, chemical, and biological criteria which effect the potential use of this resource.

Extreme physical and chemical water quality conditions have been observed for Lincoln Creek, especially during wet weather induced nonpoint source runoff and point source events. Water quality during these events is probably typical of previously monitored urban streams in southeastern Wisconsin which receive substantial pollutant loadings from urban nonpoint sources and sanitary point sources. Despite these highly variable water quality conditions, dissolved oxygen, pH, temperature, and un-ionized did not routinely violate Wisconsin State full fish and aquatic life water quality standards. However, based on these results, it should not be concluded that violations of water quality standards do not occur. Previous water quality sampling programs were randomized and did not attempt to document the frequency of water quality standard violations during critical instream conditions.

Fecal coliform bacteria frequently exceed Wisconsin State recreational use standards as a result of urban nonpoint source runoff but especially sanitary sewer overflows. Sediments in Lincoln Creek have been classified as being heavily polluted by a variety of heavy metals and are enriched with PCB's. Whole fish samples from Lincoln Creek were analyzed for PCB's and a variety of organic pesticides and are most likely unsuitable for human consumption as a result of having high PCB levels. A fish consumption advisory is presently in effect for the Milwaukee River in all of Milwaukee and portions of Ozaukee Counties.

Fish populations are segregated into 2 distinct areas of the watershed. Fish populations in segment one are similar to the sport and forage species indigenous to the Milwaukee River. Sport and large forage species such as suckers and redhorse are of fishable sizes and numbers. Remaining upstream segments are dominated by lesser numbers of sunfish, tolerant, and very tolerant forage species. Migration of fish populations from lower stream segments is limited or prohibited by concrete channels and high drop structures.

The benthic macroinvertebrate community is indicative of poor water quality throughout the watershed. The macroinvertebrate community is especially stressed in the lower watershed where very low numbers of organisms and poor diversity may indicate that toxic instream conditions or some other catastrophic event is impacting water quality.

Controllable or partially controllable factors which are most limiting to Lincoln Creek's water quality and its existing or potential use include urban nonpoint sources, sanitary and combined sewer overflows, spills, and unpermitted "dumping." A recent analysis of nonpoint source management alternatives concluded that a 6-20% reduction of pollutants loading to the stream could be anticipated upon implementation of street sweeping practices and construction of settling basins in the watershed. If implemented, it remains to be seen if these or other storm water management alternatives will

result in pollutant loading reductions which would maintain or raise the potential use of the stream. Pollution abatement controls are currently being implemented for the 55 or more sanitary sewer and combined sewer overflows in the watershed. Substantial improvements in water quality is anticipated once sanitary sewer discharges are abated.

Bank erosion, sedimentation and bottom scour are partially controllable factors which presently limit the biological and recreational use of Lincoln Creek. Bank protection devices should be constructed which are compatible with the biological and recreational use objectives. Implementation of stormwater and nonpoint source pollution control practices may reduce the impacts associated with sedimentation and bottom scour.

An important factor which may someday limit the existing and potential biological and recreational use of Lincoln Creek will be the concrete channelization of the remaining 2.5 miles of lower Lincoln Creek. The present concrete segments of Lincoln Creek typically have base flow depths of 0.5 feet or less and are severely impacted by bottom scour. The lack of larger substrate, diverse instream structure such as riffle/pool complexes, undercut banks and bankside vegetation severely limits the concrete channel ability to sustain any significant and diverse fish and aquatic life community. Additional channel modifications have been recommended for much of the remaining upper Lincoln Creek watershed through channel widening and deepening. The potential biological and recreational use of these stream segments will ultimately depend on the final channel configuration, average water depth at base flow, and the amount of other stream habitat the channelization project will provide.

Lincoln Creek is bordered by publicly owned packlands. These "green spaces" provide unique recreational use activities for the residents who reside near the stream. Hiking, outdoor education, observing wildlife, fishing and wading were some of the water-borne activities observed during this assessment.

The current use classification for Lincoln Creek is a noncontinuous urban stream. After evaluating the use classification criteria, it is recommended that the segment of Lincoln Creek (#1) downstream of Teutonia Ave. be classified as a full fish and aquatic life stream (FAC-B). Stream segments upstream of Teutonia Ave. (#2-5 and 7-8) should be classified as intermediate fish and aquatic life (FAC-D). Recognizing that two short segments of Lincoln Creek (#2 and 6) are concrete channels and incapable of supporting any significant biological community, it is recommended that they be classified as marginal fish and aquatic life (MAR-E). Water quality standards for these concrete segments should be applied which guarantees the protection of downstream use classes. (See Appendix 5 for pictorial presentation.)

Waterborne recreational uses of Lincoln Creek are limited by its small size and shallow depth. While many of the point source discharges which contribute to high bacterial levels are controllable, the controllability of high bacteria levels in-stream as a result of nonpoint source discharges may be difficult. Despite these limitations, field observations have shown that Lincoln Creek is frequently used for partial body contact uses such as wading and fishing. Therefore, it is recommended that Lincoln Creek's recreational uses standard be supportive of partial body contact.



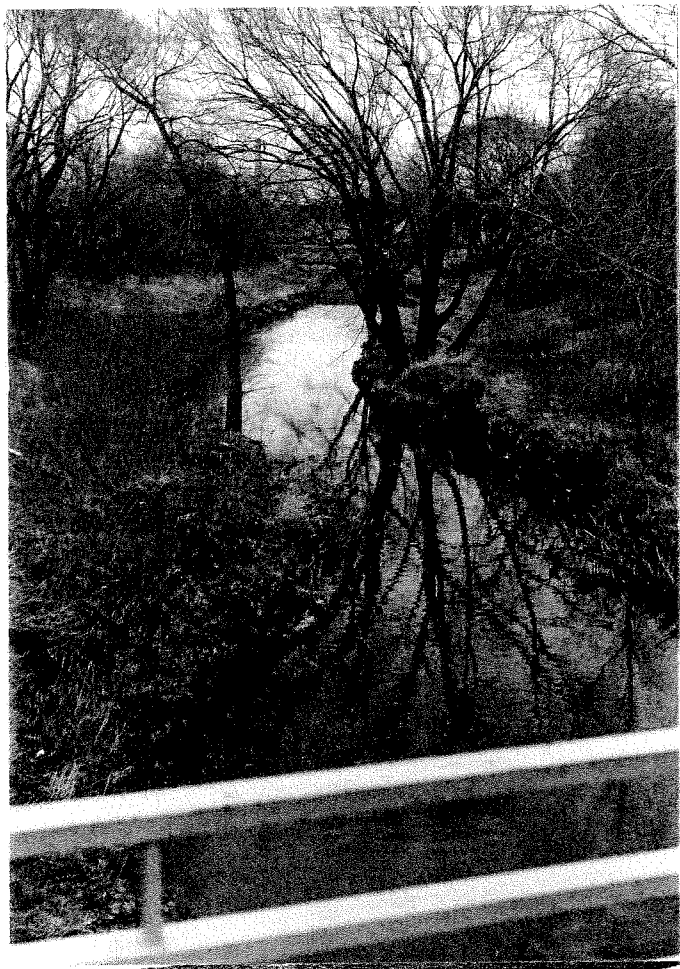
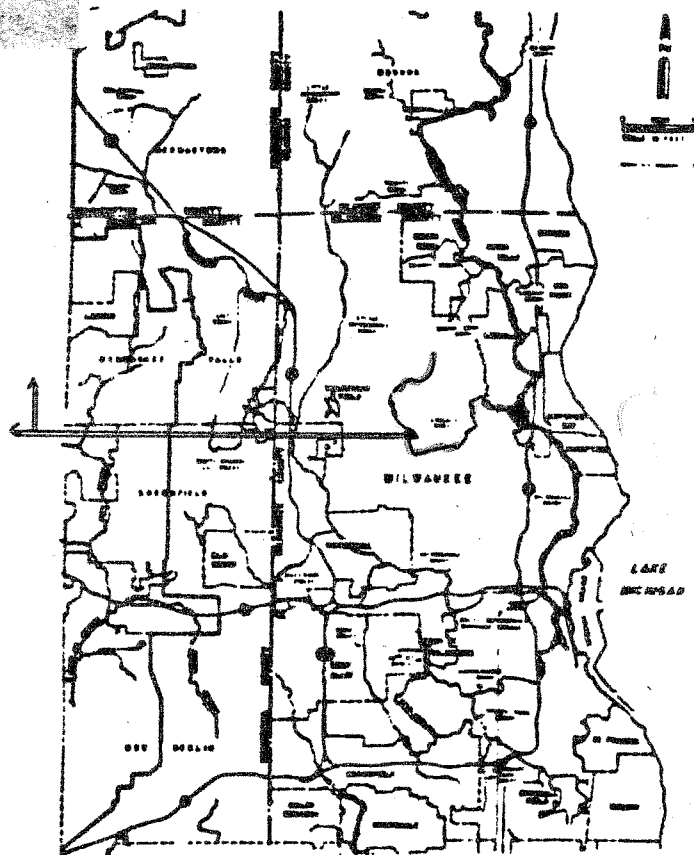
Looking upstream of the concrete structure located near 47th St. Typical of this run/shallow pool reach. Depths fairly uniform across entire cross-section ranging from 1'-2'. Deep pools located near 49th St. and 60th St.

Milwaukee Co.

Date: 8/ /84

Lincoln Creek

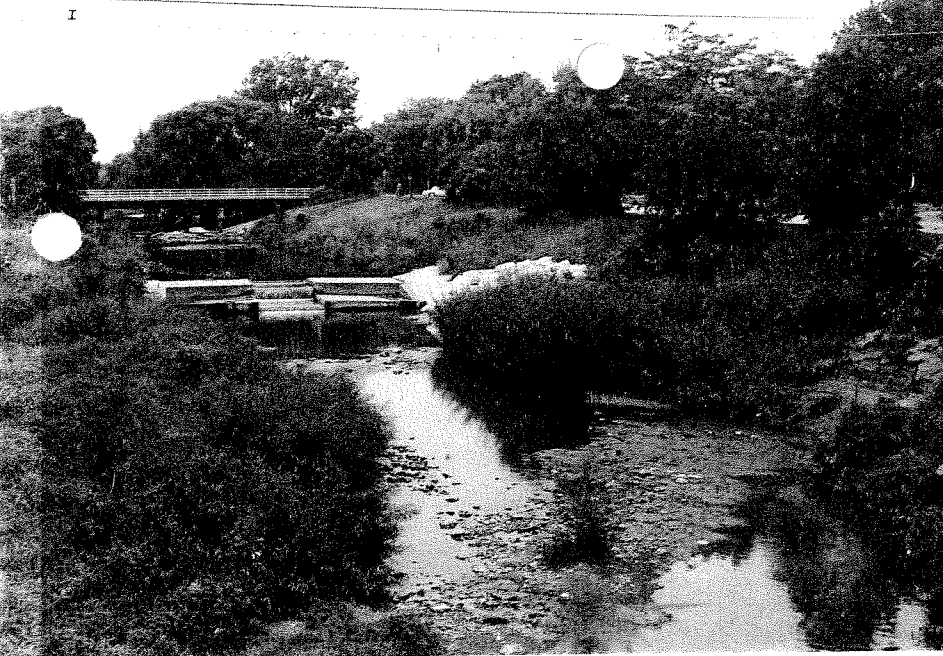
Segment 5



Looking downstream from pedestrian bridge located near 49th St. Photo shows one of two pool reaches in this stream segment.

Milwaukee Co.

Date: 11/ / 84

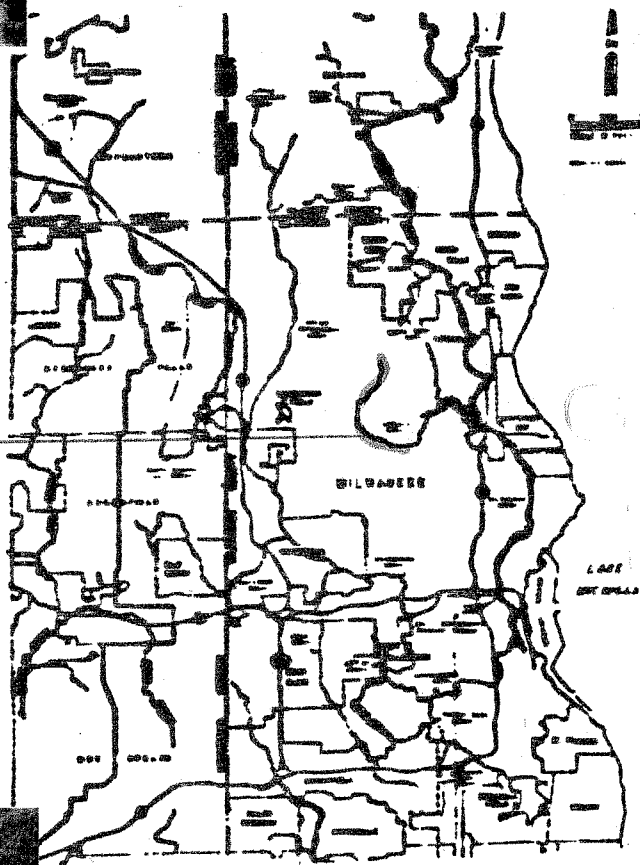


Looking upstream from pedestrian bridge at 49th St. toward concrete drop structure and 51st Street bridge. Only significant riffle area found in this segment.

Milwaukee Co.

Date: 8/ /84

Lincoln Creek
Segment 5



Looking upstream from 51st street bridge. Typical of run/shallow pool characteristics of this segment. Bank erosion noticeably less in most of this segment compared to segments downstream.

Milwaukee Co.

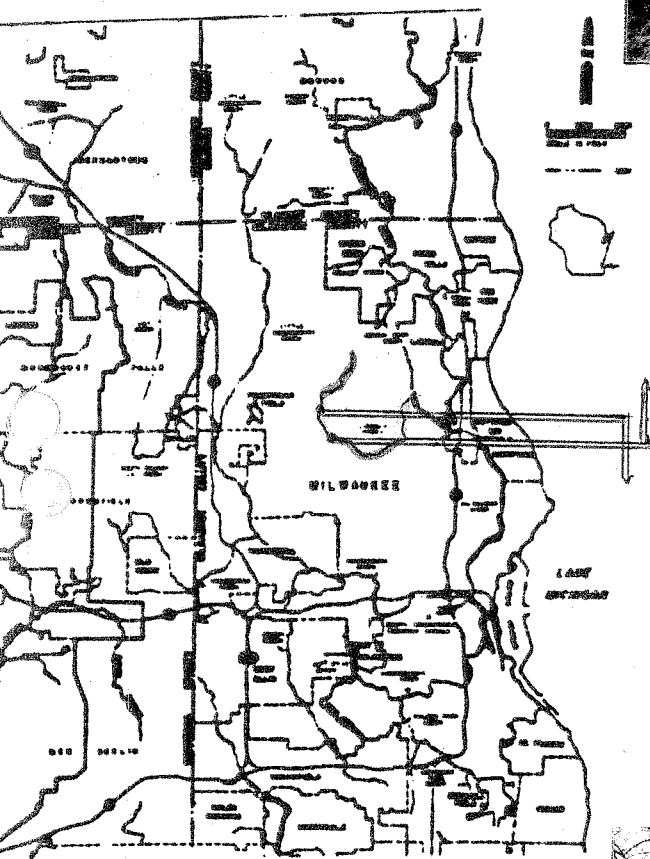
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Same location as previous photo looking upstream of 51st St. bridge except in the fall. Extensive grass cover along bank appears to contribute to better stream bank protection. Bank erosion in other segments appears magnified where stream flows are channeled around and over trees and their roots.

Milwaukee Co.

Date: 11/ /84

Segment 5



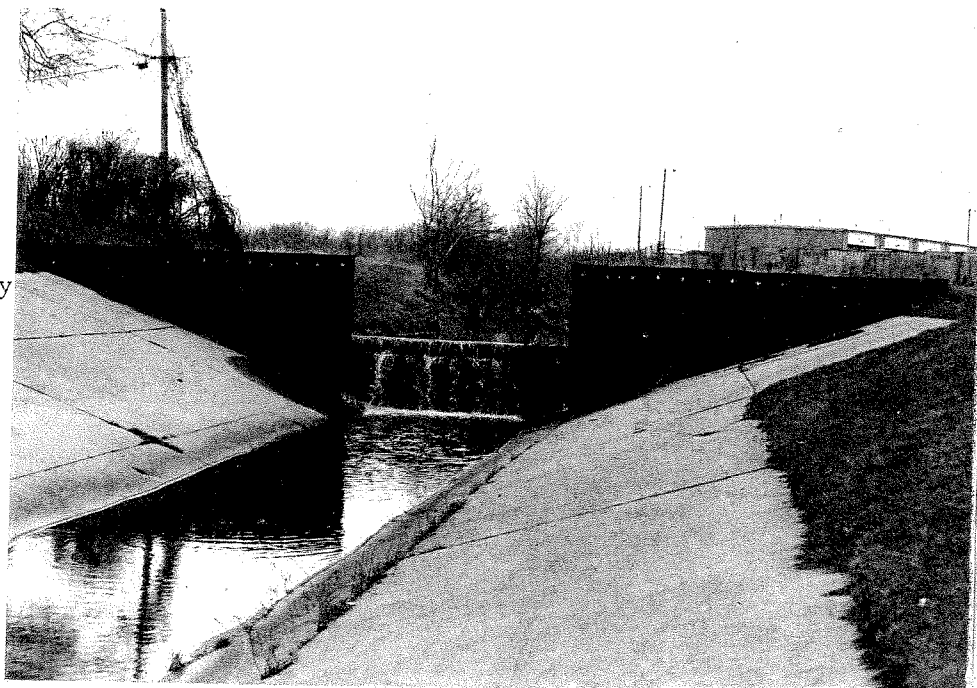
Lincoln Creek

Looking upstream from Thurston Ct. toward the drop structure which starts segment 7 and the Havenswoods State Forest property

Milwaukee Co.

Date: 11/ /84

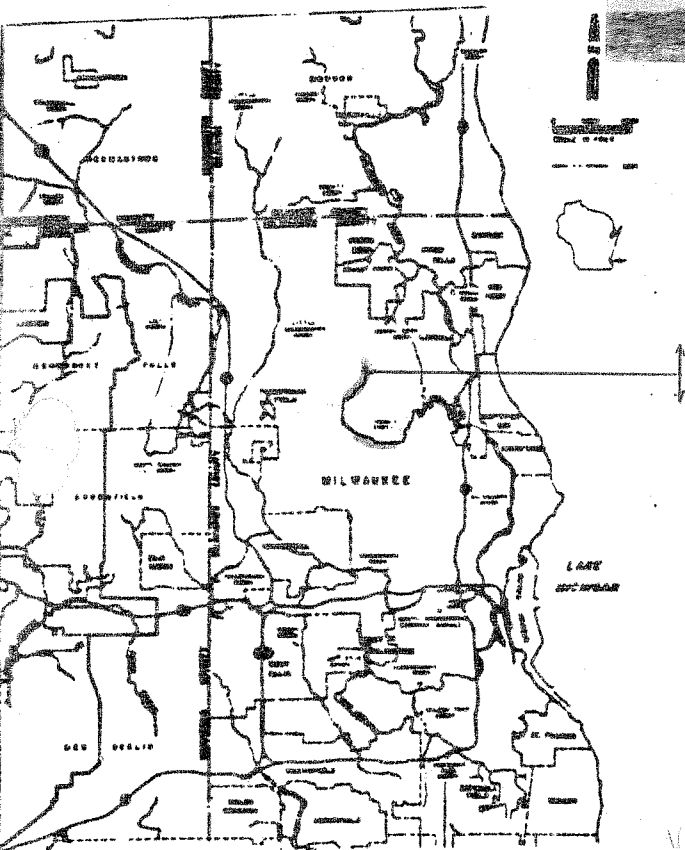
Segment 6



Looking upstream from Green Tree Road. Habitat is shallow and marsh. Flow may be intermittent.

Milwaukee Co.

Date: 11/ /84



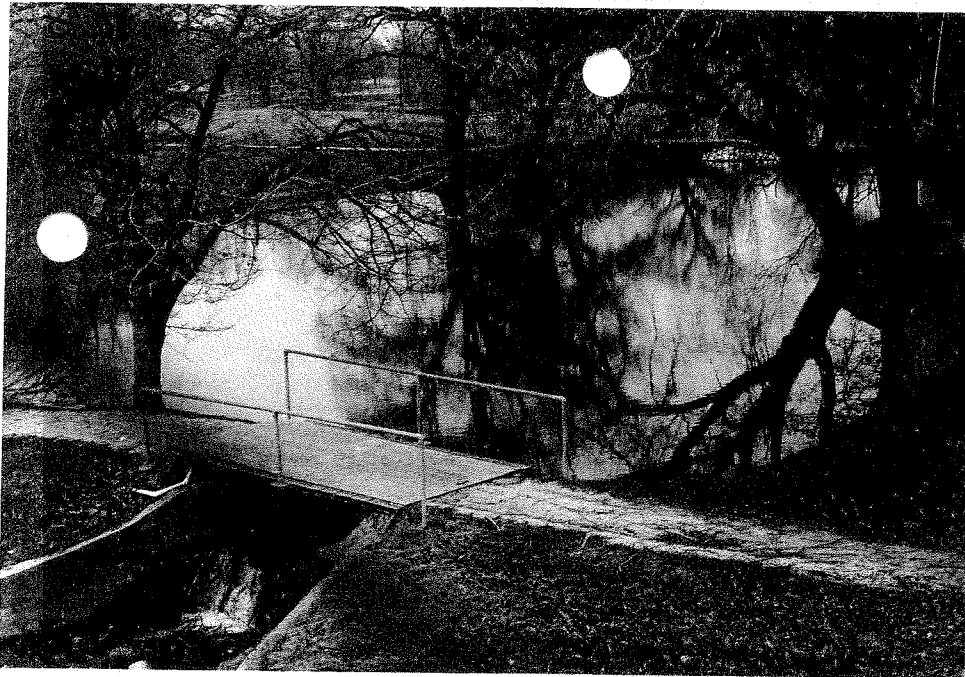
Lincoln Creek

Looking downstream of road culverts at Green Tree Road towards Mill Road. The only bank erosion found in this reach is below these culverts.

Milwaukee Co.

Date: 11/ /84
Segment 8



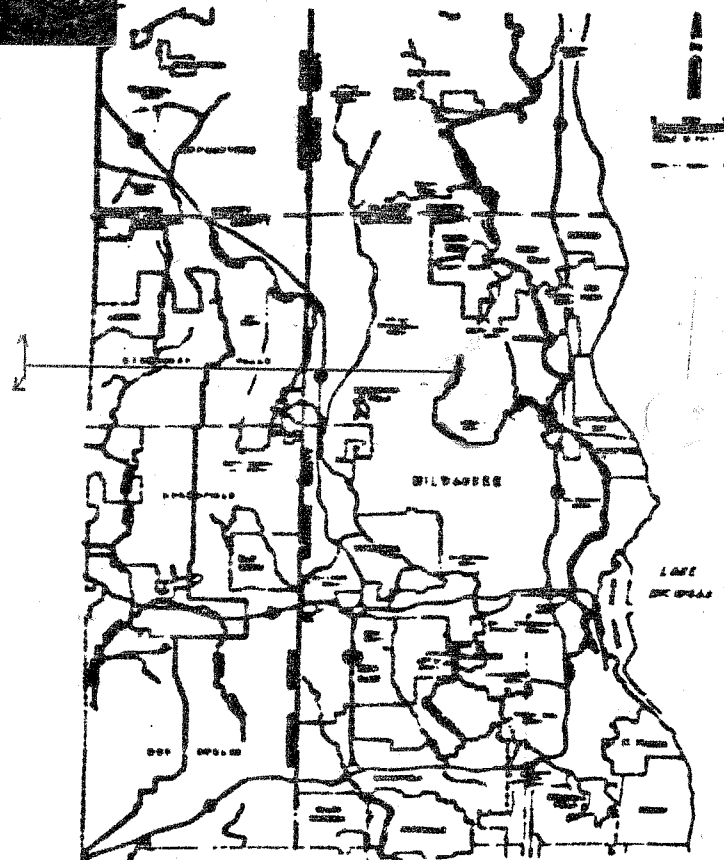


Looking upstream onto to the
Brynwood Country Club grounds
and the last of a series of
ponds.

Milwaukee Co.

Date: 11/ /84
Segment 8

Lincoln Creek



Looking upstream from Mill Road
bridge. *Sagittaria* spp. and *Elo-*
dea spp. present in this reach.
Banks are stable with dense growth
of grasses.

Milwaukee Co.

Date: 8/ /84
Segment 8