Contract Report 654

An Assessment of the Hydrology and Water Quality of Indian

An Assessment of the Hydrology and Water Quality of Indian Ridge Marsh and the Potential Effects of Wetland Rehabilitation on the Diversity of Wetland Plant Communities

by
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ABSTRACT

Indian Ridge Marsh is a remnant of a once larger wetland

INTRODUCTION

The history of Indian Ridge Marsh and the Calumet region of Chicago produced an ecological system that is quite different from the one that existed before development. The extensive wetlands that comprised the area have been reduced to smaller pockets isolated from each other by industrial, commercial, and residential areas and by transportation routes. Hydrologic flow patterns have been

HYDROLOGY

Physical Description

The Indian Ridge Marsh consists of several wetland pools connected to the Calumet River (figures 1 and 2). The marsh sits on a rectangular site that is 1 mile long north to south and a quarter mile wide east to west. It is bounded by the SEPA station of the MWRDGC and the Calumet River to the south, Torrence Avenue to the east, 116th Street to the north, and the Norfolk Southern Railroad line to the west. East 122nd Street sits on a causeway that divides the marsh into north and south pools connected by a culvert at the west end of the causeway. Six smaller pools along Torrence Avenue are isolated from the north and south pools by undeveloped causeways.

rthht Railr057TTi0.2000 Tc (h)mode 0.g8.92ee north (e)17s

Figure 2. Bathymetric elevation map and sampling locations.

Table 1.

Flow Characteristics

Flow occurs generally from north to south. Water enters the wetland system at the north pool with flow from both the east and the west. Smaller flows enter from the north. Three culverts are located beneath the railroad tracks approximately one block south of 116th Street. These culverts carry runoff from a drainage area estimated to be approximately 13 acres on the Lake Calumet Cluster Site. Flow from this culvert exceeds ~ 5 cubic feet per second (cfs) during large storm events. A culvert under 116th Street conveys runoff from an estimated one-acre drainage area along the railroad tracks to the north, although no measurable discharge was observed in this culvert during storm events. There does not appear to be any overland flow from the adjacent coke plant into the north pool.

Between the north pool and Torrence Avenue there are an estimated 26 acres of upland dry area that drain into the north pool; the remaining upland dry areas drain into the east pools or onto Torrence Avenue where flow is collected by a storm drainage system. Assessing runoff patterns in the upland area was difficult due to the flat, but erratic, surface of the anthropogenic fill. The many wet spots and undulations in the topography would indicate that the site was not properly graded after the infilling. The inefficiency of the storm drains along Torrence Avenue caused constant flooding problems on the street, which made determining the amount of runoff to the drains impossible.

Water from the north pool flows through the culvert under the 122nd Street causeway and into the south pool. This connecting culvert is often blocked by sediment or debris, which can cause the water level in the north pool to rise by several feet. After flowing through the south pool, the water flows through a

surface elevations of today, historic water surface elevations were more variable. During this historic time, the mouth of the river possibly was blocked periodically by sandbars and spits during low flows. In addition, none of the causeways or filled-in areas surrounding the marsh existed, allowing natural hydrologic retention functions to operate in the presettlement wetlands. Historical flow dynamics probably produced water levels that were both higher and more responsive to precipitation, even though there was a good connection with Lake Michigan to remove water from this area.

Today the Calumet River is a deep navigation channel from Lake Michigan to the Thomas J. O'Brien Lock and Dam 1.5 miles south of the marsh outlet. The river has a very low discharge for its channel cross section, with flow reversals common due to the lock and dam operation and storms on Lake Michigan. A hydrograph of the Calumet River near the Indian Ridge Marsh outlet (figure 3) was developed by combining two sets of stage data. Daily stage data for the Calumet River on the lake side of the lock were available for 1986-1997 from the U.S. Army Corps of Engineers, Rock Island District Office. Missing data not exceeding three consecutive days were interpolated linearly. Lake Michigan elevation data at the Calumet Harbor were obtained from the National Oceanic and Atmospheric Administration (NOAA) for 1978-1997. Using the data from both sets, the slope between the stations was computed. The elevation adjacent to the wetland for each day was then calculated as the slope multiplied by the distance from Lake Michigan to Indian Ridge Marsh and added to or subtracted from the lake elevation.

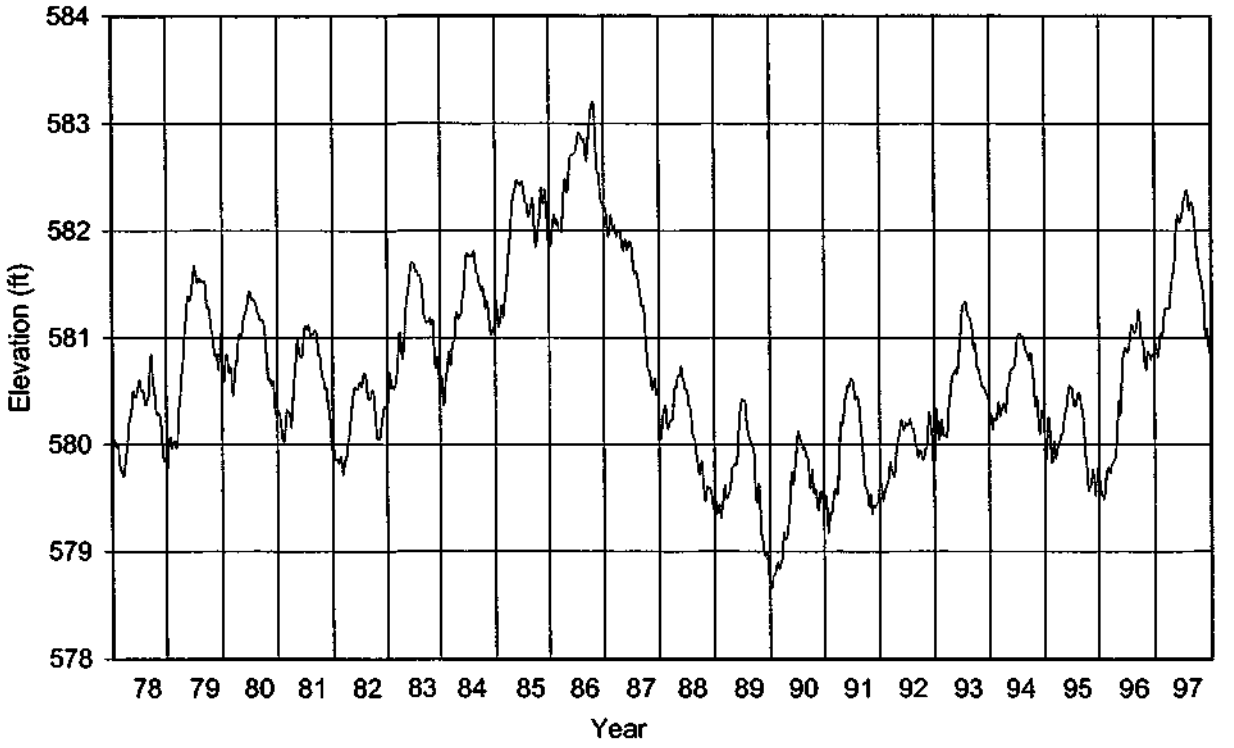

Figure 3. Hydrograph of the Calumet River at the Indian Ridge Marsh outlet.

During normal and low-stage conditions, when the water level in the river is lower than the level in the wetland-9 0.20 Tc (,)Tj-0.063 Tc 0.411 7where

Much of the large upland area in the north-central portion was filled

WATER QUALITY

Existing Water Quality Data

Surface water and ground-water samples were collected from Indian Ridge Marsh as a part of other past and existing ground-water a 0 Tc (R)rl and

Table 2. Indian Ridge Marsh Sampling Stations

Station	*Description*
1	Second east pool north of 122nd Street and next to Torrence Avenue, near center of the pool next to a 10-inch diameter post
2	North pool, 500 feet north of 122nd Street (4th electric pole) and in center of main channel east of railroad
3	South pool, 400 feet south of 122nd Street (5th electric pole) and in center of main channel east of railroad
4	Near south pool outlet, approximately midway between Station 3 and the confluence with the Calumet River
5	Northeast corner of uppermost SEPA station pool

the SEPA station was chosen because the water has already undergone some aeration and it has the highest hydraulic head to best gravity feed water into the marsh. When the SEPA station was not operating, water samples also were collected from the Calumet River (April 15 and August 20, 1997).

In situ observations were made for water temperature, DO, and Secchi disc transparency in conjunction with each sample. A Yellow Springs Instrument model 58, with a 50-foot cable and probe, was used for DO measurements. The meter was calibrated at the site using the saturated air chamber standardization procedure. Temperature and DO profiles were measured when possible. The profile interval was 1 foot. Secchi disc transparency was determined using an 8-inch diameter Secchi disc, which was lowered until it disappeared from view, and the depth was noted. The disc was lowered further, then slowly raised until it reappeared. This depth was also noted, and the average of the two depths was recorded.

Water Chemistry

Grab samples for water chemistry analyses were taken near the surface (at a depth of 6 inches) using 1000-milliliter (mL) pTw (L)Tj-0.022 Tc -0.w (an)Tc (g)Tj-0.0Tc (e)Tjc (r)Tj580.029(

Table 3. Analytes, Method Detection Limits, and Analysis Methods

Analyte	*MDL*[1]	*Standard methods*[2]	*USEPA method*[3]	*USEPA method*[4]
Nutrients (mg/L)				
Nitrite and Nitrate, NO_2-N+NO_3-N	0.06	4500-NO_3-F		
Ammonia + Ammonium, NH_3-N + NH_4-N	0.02	4500-NH_3-N		
Total and Dissolved Phosphate-P	0.01	4500-P-B&E		
Total Kjeldahl Nitrogen, TKN	0.15			351.1
Dissolved Cations/Metals (ug/L)			6010B	
Aluminum, Al	0.3			
Antimony, Sb	0.3			
Arsenic, As	0.2			
Barium, Ba	0.2			
Beryllium, Be	0.2			
Boron, B	5			
Cadmium, Cd	0.05			
Chromium, Cr	0.4			
Cobalt, Cb	0.05			
Copper, Cu	0.1			
Iron, Fe	10			
Lead, Pb	0.05			

certified laboratory. Organic analyses were performed according to U.S. Environmental Protection Agency (USEPA, 1996a) method SW846 in the 8000 series, i.e., 8260 and 8270. The USEPA (1996a) methods of SW 846-6010 were used for metal analyses.

Quality Assurance and Control Summary

A quality assurance project plan or QAPP (R.A. Locke II, 1997, unpublished) was developed for this project and submitted to the USEPA - Region 5 Office. The overall quality assurance objective for this study was to develop and implement field sampling and laboratory analysis procedures that would help accomplish the following study

where:
S = original sample value.
D = duplicate sample value.

For concentrations (in the original sample) at or above ten times the MDL, an RPD of up to 20 percent between a duplicate and original sample analysis was acceptable. For concentrations

Table 4. Water Quality Characteristics of Field Blanks

4/15/97	5.76	2	1.2	4	2	2	2	0	0	<0.05	<0.02	<0.15
5/13/97	5.89	2	1.8	0	0	0	0	<0.01	<0.01	<0.05	<0.02	0.38
6/16/97	5.75	2	1.2	0	1	1	1	0	0	<0.06	<0.02	<0.15
6/29/97	5.77	1.6	1.0	0	0	0	0	0.03	<0.01	<0.06	<0.02	<0.15
7/20/97	5.61	0.8	1.8	0	0	0	0	0.01	<0.01	<0.06	<0.02	<0.15
8/20/97	5.77	0	1.1	0	0	0	0	0	0	<0.06	<0.02	<0.15
9/23/97	5.60	0	1.6	0	0	0	0	0	0	<0.06	<0.02	<0.15
10/15/97	5.71	0	1.7	0	0	0	0	0	0	<0.06	<0.02	<0.15

Note: Values are in mg/L unless otherwise indicated.

field blank, limited validations of the accuracy of metals data can be made. Caution should be exercised when using data for aluminum,

under normal conditions. Data completeness of 90 percent was

unique characteristics of the marsh are produced by infilling with waste materials and by disruptions in the natural flow patterns. Although Indian Ridge Marsh is unique, it is still possible to use water-quality characteristics from a natural marsh and general-use standards to evaluate monitoring data collected in this study.

Temperature

Water temperature is one of the most important factors affecting the rate of chemical reaction and biological activities (growth) in an aquatic environment. In general, the reaction rate and/or the growth increases with increasing temperature. In a lake or reservoir, thermal stratification occurs during the summer period when the upper layer (epilimnion) is isolated from the lower layer of water (hypolimnion) by a temperature gradient (thermocline). Lakes will experience spring and fall turnovers. However, these are not significant for shallow wetland areas. In Indian Ridge Marsh the water depths in the three pools were less than 3 feet (tables 5-7), mostly between 1.5 and 2 feet in depth, which allows wind mixing to overcome any thermal

Percent DO saturation values were determined from DO and temperature measurements using a conversion table (ASCE, 1960). The calculated values are included in tables 5-9. As shown in table 5, during the summer period from June 29-August 20, 1997, DO was undersaturated in the east pool; but for the rest of the monitoring period (70% of the time), it was supersaturated. This lower DO concentration was likely due to the influence of bottom sediment respiration, which is expected to peak during high summer temperatures. Most of the samples from the north and south pools were supersaturated. Saturation was over 200 percent at all five sites during the storm event on June 16 and at the south pool on September 23, 1997. The high and supersaturated DO concentrations in the pools were likely due to photosynthesis of observed algal populations. The Calumet River water in the SEPA pool had DO concentrations that hovered around the saturation level, except on May 30 and June 16, 1997, when the DO was considerably supersaturated. The samples at the SEPA station were collected from the water in the uppermost pool, which undergoes some aeration as it is pumped up from the river.

The observed DO levels in the three pools and near the outlet generally met the Illinois Pollution Control Board's (IPCB) general-use standards of not less than 5.0 mg/L. Only three observations, May 13 at the north pool, June 29 at the south pool, and July 20, 1997, at the outlet, had DO concentrations below 5.0 mg/L. Due to alternating algae photosynthesis and

respiration, DO levels in a wetland can be on a diurnal cycle. The DO measurements were made at midday when the DO levels are highest; DO levels in thetd byde tTw 1 9j0 expectec (d)Tj-0.0119

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combined with other field observations may furnish information on suitable habitat for fish and other aquatic life, water quality and aesthetics, the state of the nutrient enrichment, and problems with recreational use impairment.

Median values observed for Secchi disc transparency at the five sampling sites were 22.5, 18.5, 20, 16.5, and 30 inches, respectively (table 10). In many cases, the Secchi disc was still visible when resting on the bottom. Secchi disc transparencies in the east pool on September 25 and October 15, 1997, were very low, only 4 inches (table 5). During those sampling periods, water depth was only about one-hal

Table 11. Ranges of Water Chemistry Results for Various Wetlands in Illinois

Analyte	*Natural marshes*	*Natural swamps*	*Restored or created marsh/ponds*	*Natural fens*	*Northern flatwood forests*	*General-use water quality standards**
Number of locations	8	3	6	2	1	
Number of samples	24	14	14	13	12	
Total Dissolved Carbon	37.3-265.6	27.2-60.1	39.2-156.6	73.9-130.7	75.3-164.1	
Dissolved Organic Carbon	14.9-75.2	13.4-27.1	14.2-80.5	14.2-30.7	46.4-85.7	
Total Nitrogen	0.38-9.06	0.50-3.9	0.68-5.34	0.05-8.74	0.48-2.12	
Total Kjeldahl Nitrogen	0.01-8.91	0.22-3.82	0.36-5.34	0.05-8.74	0.48-2.12	
Ammonia	0.01-3.18	0.06-0.81	0.01-0.33	0.01-2.17	0.01-0.10	15
Nitrate	0.07-7.29	0.05-0.25	0.06-0.58	0.05-0.22	0.05-0.15	
Total Phosphorus	0.02-2.20	0.05-0.55	0.01-1.29	0.02-1.55	0.01-0.20	
Sulfate	4.5-129.0	0.65-22.8	0.3-135.0	5.8-52.7	3.3-319.0	500
Fluoride	<0.01-0.13	<0.01-0.07	<0.01-0.17	<0.01-0.29	<0.01-0.12	1.4
Chloride	8-815	0.5-9.9	0.8-129.0	21.8-76.6	1.8-173.0	500
Bromide	<0.01-0.13	<0.01-0.22	<0.01-0.07	0.04-0.11	<0.01-0.10	
Total Alkalinity	8-815	20-176	38-311	232-421	46-314	
pH, units	6.0-9.5	6.2-8.7				

Table 12. Variation of Dissolved Oxygen (mg/L) with Depth in July and August 1997

	East Pool		North Pool		South Pool		Outlet
Depth	*7/20*	*8/20*	*7/20*	*8/20*	*7/20*	*8/20*	*7/20*
Surface	11.1	11.0	19.8	>20	13.2	19.6	4.4
1-foot	6.3	7.6	10.8	12.9	10.8	11.8	4.0
2-foot	3.0	6.2	7.0	7.7	9.1	3.5	

or absorbance. Turbidity is reported as nephelometric turbidity units (NTU). Generally, turbidity in lakes and wetlands is influenced by runoff containing high concentrations of suspended solids, resuspension of bottom sediments caused by flow or wind-induced turbulence, or blooms of algae in the water column.

The median turbidity for the five sampling sites was 22.5, 10, 12, 11.5, and 12 NTU, respectively (table 10). High turbidity values (117 and 97 NTU) were observed on September 23 and October 15, 1997, at the east pool and correspond to the very low Secchi disc transparency measurements made on the same date (table 5) and were related to sediment sources rather than algal blooms. At thTj0 Tc (s)5j-0.396nor -0.99899 Th(11

solids section. In Indian Ridge Marsh, the north and south pools have significantly higher conductivity values than found in other natural m 0.72w0 Tz 0 Tr 0.99001 0 0 1 89.76001 706.32e797(n

lakes usually have high alkalinity and thus are well buffered from the impacts of acid precipitation. Natural waters generally have a total alkalinity between 20 and 200 mg/L (APHA et al., 1992).

The median total alkalinity of the east pool and the SEPA station were around 123 mg/L (as $CaCO_3$) and varied little throughout the growing season (table 10). The median total alkalinity of 348 mg/L at the north pool was the highest, followed by 288 mg/L at the south pool and 136 mg/L at the outlet. The ranges of total alkalinity at the north and south pools also were greater than at the other three stations. Higher values were observed during coolery

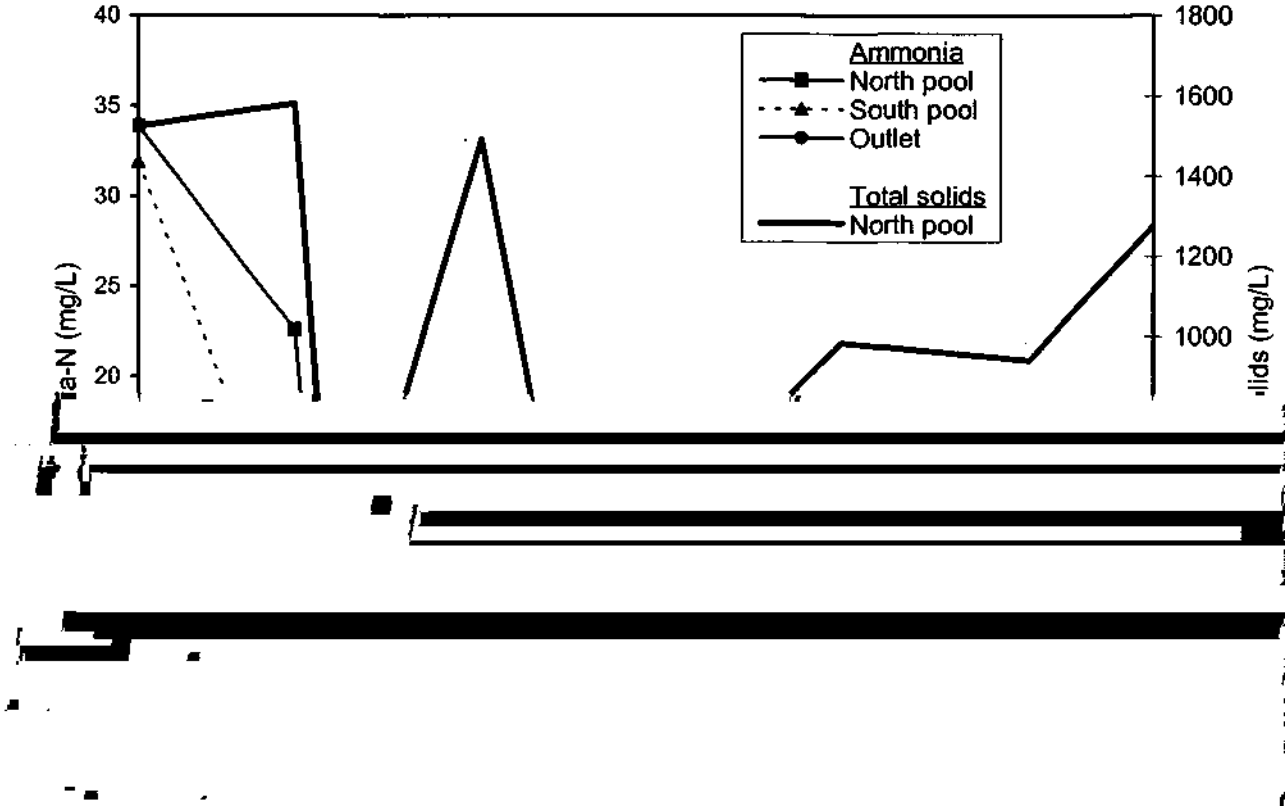
40
35
30
25
20
1800
1600
1400
1200
1000
Ammonia
North pool
South pool
Outlet
Total solids
North pool

Figure 4.

sampling site is in the main channel along the west side where any effect of runoff from the cluster site would be first felt. Mixing with more dilute waters in the central portions of the north pool (appendix A) may not occur until after the event is over. Because the cluster site is poorly graded, an unusual overflow event in the existing drainage on the site also may have occurred and flushed a considerable amount of dissolved solids off the surface or out of the many areas of standing water. As discussed in the nitrogen section, the composition of nitrogen species was more indicative of surface runoff than a large ground-water influx.

The TS concentration may have been additionally affected by a slow rise in the water level of the Calumet River in the spring and summer of 1997. This rise, which peaked in July, caused water levels to increase in the marsh (tables 5 and 6) by direct inflow from the river and/or by backing up thedgrne marse Thienn

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and increase the TSS concentration. High TSS concentration corresponded with low Secchi disc measurements at the east pool station.

On the basis of the Illinois Lake Assessment Criteria (IEPA, 1978), water with a TSS

gasification plants that produced coal gas and coke from coal (Davidson and Lerner, 1998). Ammonia wastes generated at the Acme Coke Plant north of Indian Ridge Marsh are treated, and the treated water is discharged into the sanitary sewer (David Holmberg, Acme Steel, 1999, personal communication). Ammonia has not been a problem in the Acme's permitted discharge into the Calumet River, which includes the storm water runoff from the plant along with significantly larger volumes of noncontact cooling water.

The amount of ammonia-N (as N) reported in tables 4-10 is the total amount of nitrogen in both the ammonium ion (NH_4^+) form and the un-ionized ammonia (NH_3^0) form. Eight often samples collected at the east pool had ammonia-N levels equal to or less than the detection limit of 0.02 mg/L (table 5). One sample collected from the SEPA station on September 23, 1997, had an ammonia-N concentration less than the detection limit. At the outlet, the maximum was 3.44 mg/L and occurred on June 16, 1997 (table 8). Very high concentrations of ammonia-N were found in the samples from the north and south pools; four samples exceeded the Illinois ammonia-N standard of 15 mg/L (tables 6 and 7). Their medians and ranges were 3.25 mg/L and 0.24-33.9 mg/L for the north pool and 3.08 mg/L and 0.69-31.9 mg/L for the south pool (table 10). The highest values occurred on April 15 and May 13, 1997, for both stations. These high ammonia-N levels are much higher than the range of 0.01-3.18 mg/L found in other Illinois natural marshes (table 11).

The temporal trend in ammonia-N for the north pool follows the same trends as the TS (figure 4). This would indicate that the source is also likely to be ground water. The ammonium concentration of the precipitation in the region is relatively much smaller at 0.48 mg/L (National Atmospheric Deposition Program, 1997). Similar to the TS, the increase in ammonia-N in early June also may be due to

Table 13. Ammonia-N Concentrations in Grab Samples from January 19, 1999

Location	*Ice thickness (inches)*	*Ammonia-N (mg/L)*	*Conductivity (µmho/cm)*	*pH*
116th St.	<1	21	1831	7.46
117th St.	12	3	1764	7.50
118th St.	<1	10	1874	7.49
119th St.	<1	7	1723	

Only one observation at the outlet exceeded the chronic limit. The chronic high levels of un-ionized ammonia-N are considered toxic to fish.

Total Kjeldahl

Nitrate and Nitrite. Nitrate is the end product of the aerobic stabilization of organic nitrogen, and as such it is

form adsorbed to soil particles. However, the major portion of phosphate-phosphorus

Table 14. Observed Metal Concentrations of Indian Ridge Marsh, 1997

		Alumi-	Anti-			Beryl-		Cad-	Chro-			
East Pool	5/13	960	1.8	2.3	23	<0.2	96	0.12	<0.4	0.22	3.5	930

20, 1997, from the north and south pools also were greater than the maximum concentration (67.2 mg/L) for the other marshes. Concentrations of barium, cadmium, iron, magnesium, and manganese in Indian Ridge Marsh were found to be lower than the highest values reported for the other Illinois natural marshes. Concentrations of arsenic, chromium, nickel, and selenium were detected at levels below the detection limits for the other marshes shown in table 11. Antimony, cobalt, molybdenum, and vanadium also were detected, but there is no data from the99 Tw (fro)T

Bosko (1998a) reported several additional compounds above USEPA (1996b) toxicological standards for aquatic life, suggesting there may be some increased risk to the ecosystem. Due to many other factors in an ecosystem, these lower thresholds are considered benchmarks and not standards, remediation goals, or sole measures of sediment toxicity.

Potential Impact of Water Quality on Biodiversity

The quality of the water in Indian Pudge Marsh may produce adverse effects on the diversity of the vegetation and may contribute greatly to the dominance of invasive and weedy species. Recently Roy F. Weston, Inc., performed an ecological analysis of several wetlands in the Calumet region for the City of Chicago (Bosko, 1998b). They reported finding 122 plant species in the wetland and upland areas of the northern portion of Indian Ridge Marsh. Of these species, 60 are normative to this area. A previous assessment by Southern (1983) found 178 plant species, of which 71 were normative. General observation indicates that normative purple loosestrife (*Lythrum salicaria*) and native, but very weedy, common reeds (*Phragmites australis*) and cattails (*Typha* spp.) dominate the lowland areas.

A high TDS level is one water-quality component that may have a significant effect on the vegetation. At the Sterne's Woods fen complex in McHenry County, Panno et al. (1999) found that contamination plumes with high concentrations of sodium and chloride in the discharging ground water had an adverse effect on the vegetation. Within the areas of the plumes, the diverse vegetation found in the rest of the fen was

Of the 175 bird species observed by Southern (1983) in the area over a 12-month period, 77 are dependent upon wetland habitats. Fifteen of the observed species were on the Illinois threatened and endangered lists, and 11 of these depend on wetlands including the black-crown, night heron. However, the percentage of bird species nesting in the area was lower than expected, which Southern (1983) attributes to poor habitat quality caused by dense plant growth that leaves very little open water.

The quality of the habitat for fish and birds in Indian Ridge Marsh also may be degraded by the hydrology and water quality of the site. Southern (1983) considered the fish habitat to be of low quality, with only five species found in the north pool. Sixty-seven percent of the individuals found in the north pool were green sunfish, a pioneering species with wide ecological tolerances, and 14 percent were carp.

The biodiversity of the marsh may still be recovering from past activities that occurred earlier in the 20th century. The infilling that occurred on the upland areas likely sent large pulses of sediment and polluted water into the marsh. Weedy and invasive plant species were likely to have been the first species to colonize these disturbed areas. Infilling and the other waste disposal activities that occurred on the Lake Calumet Cluster Site also could have created damaging inflows of sediment and pollution. The marsh also may have been severely tha 20td

discharging it over a series of waterfalls back into the river, a sufficient volume of water may be available to enhance Indian Ridge Marsh.

Reducing the Amount of Ground- Water Inflow

The water quality in the marsh could also be improved by reducing the amount of ground-water inflow. This could

for each day of the simulation as determined in the climate file. Topographic data, including watershed and wetland size and shape, are needed, as well as soil characteristics such as hydraulic conductivity, difference in volumetric water content at field capacity and wilting point, and water storage capacity of the soil. It also is necessary to know the depth to which the roots of the wetland plants extend. Management parameters can be used that define types and elevations of control structures incorporated into the wetland design. These control structures include a principal spillway that may or may not have an adjustable height, an emergency spillway, and an embankment.

Summary files generated by SWAMPMOD contain inflows, outflows, and water elevations in the wetland averaged over various time intervals. Another output file provides data that can be used to plot hydrographs of storm events when rainfall exceeds a trigger level. A retention time file contains outflow rate, water velocity, and retention time data. The retention times calculated assume complete mixing in the wetland; and, although this may not be a perfect assumption, the data are still useful when a usefu (fil)Tj0 Tc (e)Tj0tptThesTc 0.56 Tw (usefu)dnn t8920.18

Figure 6. Example of plant community succession, north pool of Indian Ridge Marsh: a) 1993, b) 1994, c) 1998.

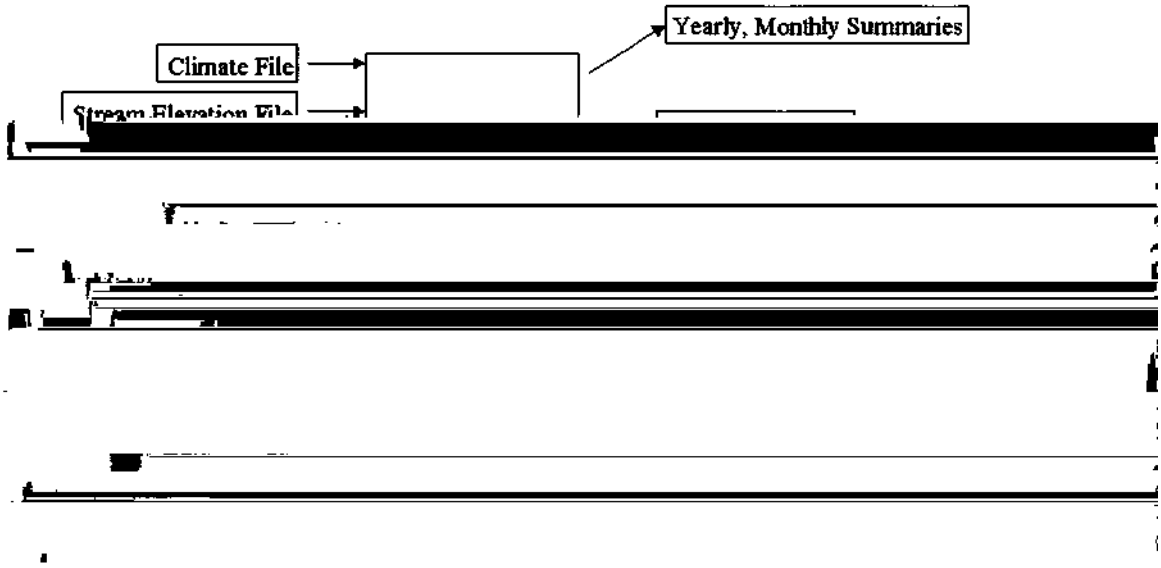


Figure 7. The modeling process.

(April) and only if the soil is dry more often than saturated. If the amount of time during the month the soil is dry exceeds the amount of time it is saturated, but the month is not April, that location will maintain its mixed system of wet and dry species.

A mixed emergent community will be succeeded by a deep marsh community if more than 4 cm of water covers the soil for six growing-season months. Mixed emergents will be joined by drier species to make a mixed-plant community if the soil remains dry (more than 10 cm above the surface of the water) for more than six months. If neither of these conditions occur, the mixed-emergent system will continue to dominate.

Deep marsh species will be joined by shallower species to make up a mixed-emergent community if,eem17(e)Tj0.03Tj0.07401 Tc -0.0c0.108 Tc38 T499 0e

Data Preparation

As described earlier, SWAMPMOD requires site data for calibration and operation. Some of the data used to run the model require on site data collection; other input data may be estimated. In the case of estimated data, a range of values was used in this study to determine the significance of any errors that might be introduced by estimation. The modeling exercise considered the north and south pools of thea exercis oe

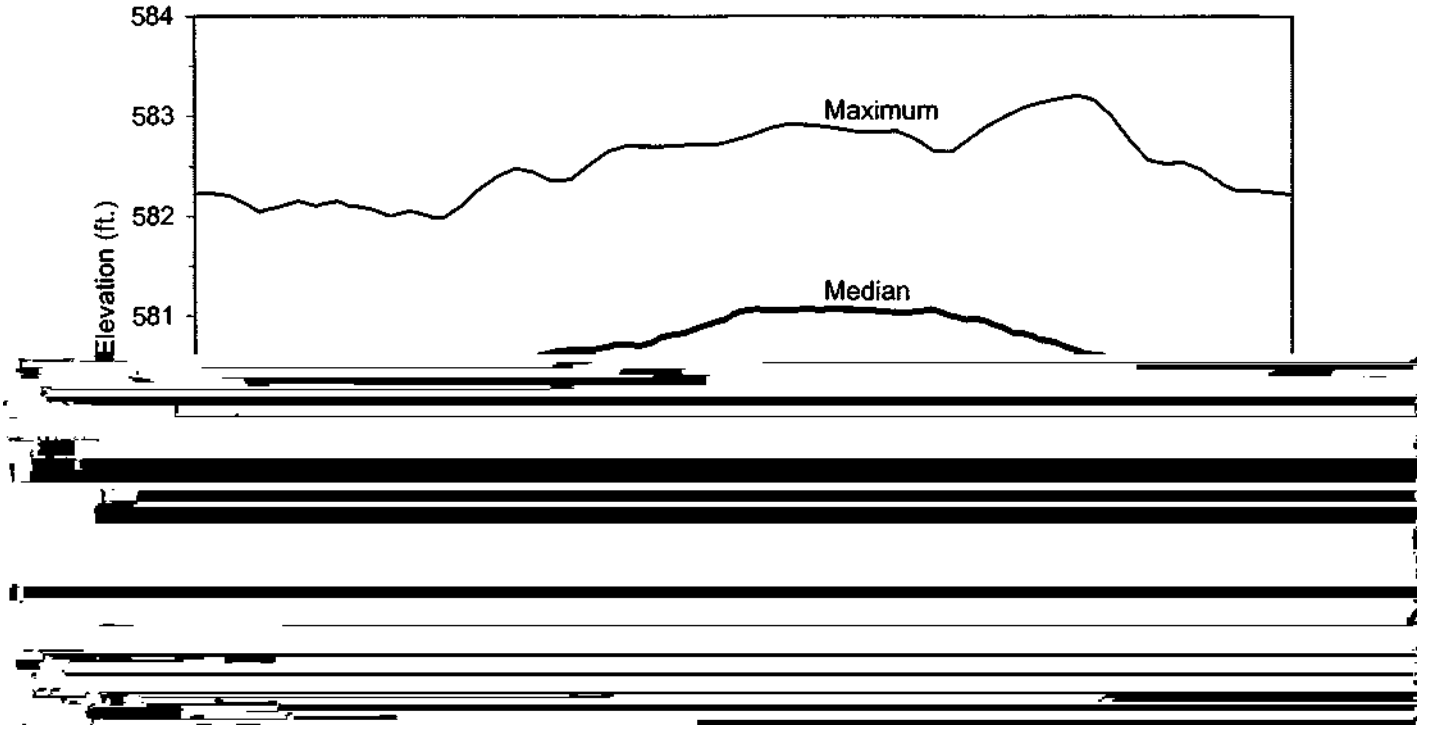


Figure 8. Statistical elevations of the Calumet River at Indian Ridge Marsh.

The topographic data for the wetland area were developed based on surveys of the area. For some parameters in this file, such as root depth and difference between water content at field capacity and water content at wilting point, typical values were assumed to be applicable. Parameters needed to determine lateral seepage from the wetland were based on the assumption that water would be seeping out at the south end to the river when the river is lower than the water level in the wetland.

The management file varied significantly based on the differenc fili

the 20-year simulation period. To choose the eight elevations analyzed and indicated on the vertical axis (appendix E), the wetland was divided into eight equivalent sized areas defined by elevation. The elevation in the middle of each zone was chosen to represent the area. For example, the bar labeled with the lowest elevation (appendix E) represents the deepest eighth of the marsh; that with the highest elevation represents the shallowest eighth of the marsh, and each other bar represents an eighth in between. The horizontal axis (appendix E) is

Effect of Flooding

A second simulation was done to determine the effect of adding a spillway weir at an elevation of 583 feet and an emergency spillway at 584 feet located at the existing outlet channel. There are several reasons for interest in such a scenario. First, interest has been expressed in creating more open water in the marsh to expand the hunting ground for birds that feed on fish. Second, flooding may be included in a possible schemes to help control invasive species and allow other species the opportunity to colonize. Large die-offs of common reeds (*Phragmites australis*) were observed in Big Marsh when it became flooded in late 1998 and early 1999; however, without other measures the same infested areas may be recolonized by common reeds in late 1999 and early 2000. Third, a potential scheme to move more water through the system and improve the water quality would add water from the SEPA station and move the marsh outlet from the south end to the northwest corner. The marsh could then drain into Big Marsh, whose elevation at the point closest to Indian Ridge Marsh is approximately 583 Tj-0.21899 Tc 1.618 Tw

Table 15. Summar

Table 15. (Concluded)

the wetland that were previously held back by the higher outlet channel bottom is released through the lower weir. The only significant change

A comparison of the statistical hydroperiods for a scenario with soil addition and a weir with a simulation of current conditions shows that the wet periods would be unaffected by the weir as in the other cases in which a weir was modeled. Under drier conditions, the level of water in the wetland would be higher because ground water would still be able to seep in, and outflow would be restricted to only seepage loss. The results of this modeling indicate that, at equal elevations, the wetland would be generally wetter than the existing situation. However, comparing only conditions at equal elevations obscures the effect of raising the wetland by adding the soil. When the total area of the wetland is divided evenly by area and vegetation is compared, the modifications described seem to favo

The most significant effect of adding the water that is apparent from SWAMPMOD would be the reduction in

wetlands. According to his studies, the water level in a wetland along the Great Lakes should be relatively low in the winter, rise roughly 2 feet through the early spring and summer, and decrease by late summer. The SWAMPMOD estimates of the current hydroperiod do show an average rise in the spring and summer, but this rise is only on the order of half a foot. To achieve a more suitable profile, this rise should be increased significantly.

The first attempt to mimic the profile proposed by Busch (1990) was made by simply simulating the installment of an adjustable weir similar to those described previously. The 10-foot wide weir was designed to be kept at 580.5 feet, the current outlet elevation, during the fall and winter months and raised to 582.5 feet from April 1st through August 15th. The resulting hydroperiod, shown in appendix D, indicates that the weir alone would not be enough to raise the median water level by 2 feet. The water rose less than 1 foot for the median hydroperiod and even less for drier years. A comparison of the predicted vegetation during this simulation with the simulation of the current conditions shows that more open water and mixed emergent vegetation would be expected with considerably less time and space occupied by wet meadow communities.

Several additional simulations were run in an attempt to achieve Busch's (1990) ideal hydroperiod that combined the use of an adjustable weir with the addition of water from the SEPA station. One of the hydroperiods that came reasonably close to this ideal was obtained by adding 2 cfs of water from May 1st0 Tc (s)TAy usl wf(w (additiona)Tj0 Tc (l)Tj0.09f99 Tw (wTw (con

those used by Poiani and Johnson (1993), the concept mayn theentn

DISCUSSION

The 92-acre Indian Ridge Marsh consists of several wetland pools connected to the Calumet River. The marsh is surrounded by additional wetlands, roads, railroads, a coke plant, the Lake Calumet Cluster Site, and a SEPA(Calume)Tj0Tc (d) o plant5gEMC /Span7m.dasr

marshes in Illinois. The turbidity frequently exceeded 15 NTU, which is indicative of substantial suspended sediment.

The north and south pools had very high levels of TS, but the SEPA station had a median level that was only 25 percent of those pools. Most of the solids are in the dissolved form, and one-third of the samples collected from the north and south pools exceeded the TDS standard of 1000 mg/L. Ground water is the likely source of the dissolved solids because surrounding monitoring wells had very high TDS concentrations. The TSS values generally increased during the growing season, with the higher values composed largely of VSS. With the exception of the SEPA station, almost half of the samples from the marsh had TSS concentrations that exceeded 25 mg/L, which is classified as having a high general-use impairment.

Very high concentrations of ammonia-N (>30 mg/L) were found in the north and south pools in the early spring. These high ammonia-N levels are much higher than the range of 0.01-3.18 mg/L found in other Illinois natural marshes. In these two pools, 19 percent of the samples exceeded the Illinois ammonia-N standard of 15 mg/L a0 Tc (d)Tj-0.01401c 0.4(e)Tj0.160.052 Tw (tha)Tj

s 76(n)Ti0w13(h)Tilevel0.108 Tc -s42990 03en7eedesexcep1 Tc -0.16t0.07xce03enoh hhs amm01 ohs di0.108 Tc -0.

The hydrologic modeling of Indian Ridge Marsh was conducted to characterize the hydrologic conditions and the effect of hydrology on retention times and on different plant communities in the wetland. The hydrologic model was constructed using SWAMPMOD (Konyha et al., 1995), which is a continuous hydrologic simulation that evaluates the hydrology of a wetland system using several years of daily climate and adjacent stream elevation data. The inflows into the model include precipitation, surface and subsurface runoff from the watershed, and seepage from ground water into the wetland. Outflows from the wetland include evaporation, transpiration, flow through a principal spillway, outflow over an emergency spillway, and lateral seepage leaving the wetland. Using the results from the hydroperiods produced by SWAMPMOD, a separate vegetation model was used to estimate the extent of th different vegetation zones that develop at different elevations based on The vegetation model is based on a set of general rules that relate water levels in a wetland over time to conditions that support seedling success and plant development

94atn 09conditionTc (s)Ti-0.006 Tc(mode)Tw2 Qu3lane 1hd09asedng09ased57ed

CONCLUSIONS

Indian Ridge Marsh, a valuable ecological resource to the Chicago region, is currently affected by several water-quality problems. If these problems could be successfully addressed, the quality of this resource could be substantially improved. Reducing the ammonium influx could improve the habitat for fish and other aquatic life; and reducing the total solids influx could improve the chances for survival of native wetland plants. Potential steps to remediate the water quality problems include:

- adding water from the SEPA station or the Calumet River,
- reducing the amount of ground-water inflow,
- controlling the runoff from 122nd Street,
- adding clean soil and removing fill, and
- placing a weir across the outlet.

The hydrologic modeling of the marsh shows that the proper hydroperiod currently exists to support a diversity of wetland plant communities, and that the potential for these communities could be maintained with properly designed remediation schemes.

The information contained in this report builds toward a naturalization design for Indian Ridge Marsh. A final design needs to couple community visions for the site with relevant engineering elements to produce final rehabilitation designs that are robust in this highly modified environment. As the ecological objectives and designs for the site become more defined, further sampling, modeling, and designing will be required. Soil and water quality issues, as well as biotic factors such as competition for resources by invasive species, need to be addressed. Rehabilitation strategies that may alter topography and/or water flow quantities should continue to be evaluated using the SWAMPMOD and vegetation modeling tools to estimate potential diversity that would result in the wetland.

REFERENCES

Admiraal, A.N., M.J. Morris, T.C. Brooks, J.W. Olson, and M.V. Miller. 1997. *Wetland Restoration and Creation Guide.* Illinois Natural History Survey Special Publication 19, Champaign, IL.

American Public Health Association, American Water Works Association, and Water Environment Federation. 1992. *Standard Methods for the Examination of Water and Wastewater,* 18th Ed. APHA, Washington, DC.

American Society of Civil Engineers, Committee on Sanitary Engineering Research. 1960. Solubility of Atmospheric Oxygen in Water. *Journal of the Sanitary Engineering Division* 82(12):1115-1130.

American Society of Testing Methods. 1989. *Standard Test Methods for Dissolved Oxygen in Water.* Annual Book of Boo54 T, B278.88 1 Tm(WaR8ngton)To68 T -0.590Secublicatio,,13-0.054 28. 0.89

Duwelius, R.F., R.T. Kay, and S.T. Prinos. 1996. *Ground-Water Quality in the Calumet Region of Northwestern Indiana and Northeastern Illinois, June 1993.* U.S. Geological Survey Water-Resources Investigations Report 95-4244, Indianapolis, IN.

Greeson, P.E. 1971. *Limnology of Lake Oneida with Emphasis on Factors Contributing to Algal Blooms.* U.S. Geological Survey, Open File Report, Reston, VA.

Illinois Environmental Protection Agency. 1978. *Assessment and Classification of Illinois Lakes.* Volume II. IEPA, Springfield, IL.

Illinois Environmental Protection Agency. 1987. *Quality Assurance and Field Methods Manual.* Division of Water Pollution Control, Planning Section, IEPA, Springfield, IL.

Illinois Environmental Protection Agency. 1999. *Title 35: Environmental Protection, Subtitle C: Water Pollution.* Section 302. State of Illinois, Rules and Regulations, IEPA, Springfield, IL. *http://www.ipcb.state.il.us/title35/35conten.htm*

Kay, R.T., T.K. Greeman, R.F. Duwelius, R.B. King, J.E. Nazimek, and D.M. Petrovski. 1996. *Characterization of Fill Deposits in the Calumet Region of Northwestern Indiana and Northeastern Illinois.* U.S. Geological Survey Water-Resources Investigations Report 96-4126, Urbana, IL.

Keedy, P.A. 1990. Water Level Fluctuations and Wetland Conservation. *Proceedings of the International Wetland Symposium: Wetlands of the Great Lakes,* Association of State Wetland Managers, Inc., Berne, NY, pp. 69-91.

Konyha, K.D., D.T. Shaw, and K.W. Weiler. 1995. Hydrologic Design of a Wetland: Advantages of Continuous Modeling. *Ecological Engineering* 4:99-116.

Leica. 1993. *SKI User's Manual.* Leica, A.G., Heerbrugg, Switzerland.

Lin, S.D., Rier's

Poiani, K.A., and W.C. Johnson. 1993. A Spatial Simulation Model of Hydrology and Vegetation Dynamics in Semi-Permanent Prairie Wetlands. *Ecological Applications* 3:279-293.

Roadcap, G.S., and W.R. Kelly.

U.S. Environmental Protection Agency. 1980. *Clean Lakes Program Guidance Manual.* EPA 440/5-81-003, Office of Water

Appendix A. Existing Water-Quality Data

	Ground water				*Indian Ridge Marsh*						
Site	*Well 17*[a]	*Well 18*[a]	*Well 20*[b]	*Well 70*	*East Pool*[c]	*East Pool*	*North Pool*	*Cental Pool*[d]	*Central Pool*[e]	*South Pool*	*Outlet*
Sample date	*5/96*	*6*									

Appendix A. (Concluded)

	Ground Water				*Indian Ridge Marsh*						
Site	*Well 17*[a]	*Well 18*[a]	*Well 20*[b]	*Well 70*	*East Pool*[c]	*East Pool*	*North Pool*	*Cental Pool*[d]	*Central Pool*[e]	*South Pool*	*Outlet*
Sample Date	*5/96*	*6/96*	*91-94*	*7/91*	*4/95*	*4/95*	*4/95*	*4/94*	*4/95*	*4/95*	*4/95*
Trace Metals (ug/L)											
Antimony	<100	<100	<100	<150	<100	<100	<100		<100	<100	187
Arsenic	<40	<40	<40	<80	<40	<40	<40		<40	<40	<40
Barium	23	22	96	451	6	21	90	51	75	113	95
Beryllium	<1	2	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cadmium	<4	<4	<4	<6	<4	<4	<4	<3	<4	<4	<4
Chromium	<4	8	<4	11	<4	<4	<4	<5	<4	<4	<4
Cobalt	6	8	<4	<6	<3	<3	<3	<5	<3	<3	4
Copper	<3	<3	<3	<1	<3	<3	<3	<5	<3	<3	<3
Lead	<12	<12	<12	<27	<12	<12	<12	<5	<12	<12	<12
Lithium	14	21	227	40	4	<4	48		24	67	57
Mercury	<20	<20	10	<30	<0.5	<0.5	<0.5	<0.05	<0.5	<0.5	<0.5
Molybdenum	<6	<6	<6	17	<6	7	<6		6	<6	<6
Nickel	<6	6	15	<18	<6	<6	<6	<15	<6	13	8
Selenium	<50	<50	<50	<110	<50	62	<50		<50	<50	<50
Silver	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Thallium	<50	<50	<50	<240	<50	<50	<50		58	<50	<50
Tin	<40	<40	<40	<60	<40	<40	<40		<40	<40	<40
Titanium	12	13	4	3	3	10	8		6	8	5
Vanadium	4	4	<3	<11	<3	4	3	<5	<3	<3	3
Zinc	55	91	78	<3	11	16	15	<100	19	15	7

Notes:

Values are in mg/L unless otherwise indicated.

[a] Median of 6 multi-level sampling ports.

[b] Median of 4 samples collected on 9/91, 6/92, 6/93, and 9/94.

[c] First east pool north of 122nd Street.

[d] South-central pool of the north pool.

[e] Central pool of the north pool

Appendix B.

Appendix C. Volatile and Semivolatile Organic Compound Analysis

Abbreviations

ACD =Acid compounds
BN = Base neutral
TOC = Total organic carbon
TOX = Total organic halides
PST = Pesticide
VOC = Volatile organic compounds

PDC Laboratories, Inc.

ILLINOIS STATE WATER SURV
SHUNDAR UN
PO BOX 697
PEORIA IL 61602

Purchase Order No: RUJ 6395 D
Date of Report: *9/24/97*

Sample Number: 97090112
Date Collected: 9/2/97
Date Recafved 9/3/97
Description: STATION #2 INDIAN RIDGE WETLAND

Analysis	Results	Unit of Measure
Inorganics		
INO		
TOC	21	mg/l
TOX	0.05	mg/l
Organics		
ACQ		
2,3,4,6-Tetrachlorophenol	<0.10	mg/l
2,4,5-Trichlorophenol	<0.010	mg/l
2,4,6-Trichlorophenol	<0.010	mg/l
2,4-Dichlorophenol	<0.010	mg/l
2,4-Oimethylphenol	<0-010	mg/l
2,4-Din'rtrophenol	<0.050	mg/l
2,6-Dichlorophenol	<0.010	mg/l
2-Chlorophenol	<0.010	mg/l
2-Methylphenol(o-cfesol)	<0.010	mg/l
2-Nitrophenol	<0.010	mg/1
3-Methyiphenol	<0.010	mg/1
4,6-Dinitro-2-methylphenoI	<0.050	mg/l
4-Chloro-3-methylphenol	<0.010	mg/l
4-Methylphenol(m. p-cresol)	<0.010	mg/l
4-Nitrophenol	<0.050	mg/l
Benzoic Acid	<0.050	mg/l
Pentachlorophenol	<0.050	mg/l
Phenol	<0.010	mg/l

Project Manager

Analysis	Results	Unit of Measure
BN		
1,2,4,5-Tetrachlorobenzene	<0.010	mg/l
1,2,4-TrichIorobenzene	<0.010	mg/l
1,2-Dichlorobenzene	<0.010	mg/l
1,2-Diphenylh.ydrazina	<0.010	mg/l
1,3,5-Trinitrobenzene	<0.010	mg/l
1,3-Dichlorobenzene	<0.010	mg/l
1,4-Dichlorobenzene	<0.010	mg/l
1,4-Naphthoquinone	<0.010	mg/l
1-Chloronapthalene	<0.010	mg/l
1-Naphthylamine	<0.010	mg/l
2,4-Dinitratoluane	<0.010	mg/l
2,6-Dinrtrotoluene	<0.010	mg/l
2-Acstylaminofluorene	<0.010	mg/l
2-Chloronaphthalene	<0.010	mg/l
2-Methytnaphthalene	<0.010	mg/l
2-Naphthyiamine	<0.010	mg/l
2-Nitroaniline	<0.010	mg/l
2-Picoline	<0.010	mg/l
3.3-Dichlorobenzidine	<0.010	mg/l
3,3-Dimethylbenzidine	<0.010	mg/l
3-Methyicholanthrene	<0.010	mg/l
3-Nitroaniline	<0.010	mg/l
4-Aminobiphenyl	<0.010	mg/l
4-Bromophanyl-phenylether	<0.010	mg/l
4-Chloroaniline	<0.010	mg/l
4-Chlorophanyl-phenylether	<0.010	mg/1
4-Nitroaniline	<0.010	mg/l
4-NitroquinoIine-1-oxide	<0.010	mg/l
5-Nitro-o-toluidine	<0.010	mg/l
7,12-Dimethytbenz(a)anthracane	<0.010	mg/l
a,a-Oirnethylphenethylamine	<0.010	mg/l
Acenaphthens	<0.010	mg/l
Acenaphthylene	<0.010	mg/l
Acetophenone	<0.010	mg/l
Aniline	<0.010	mg/l
Anthracene	<0.010	mg/l
Aramita	<0.050	mg/l
Benzidine	<0.050	mg/l
Benzo(a)anthracene	<0.010	mg/l
Benzo(a)pyrene	<0.010	mg/l
Benzo(b)fluoranthene	<0.010	mg/l
Benzo(g.h.i)perylene	<0.010	mg/l
Benzo(k)fluoranthene	<0.010	mg/l
Benzyl Alcohol	<0.010	mg/l
Bis(2-chloroethoxy)rnethane	<0.010	mg/l
Bis(2-chloroethyl)ether	<0.010	mg/l

Analysis	Results	Unit of

Appendix D. Statisticali

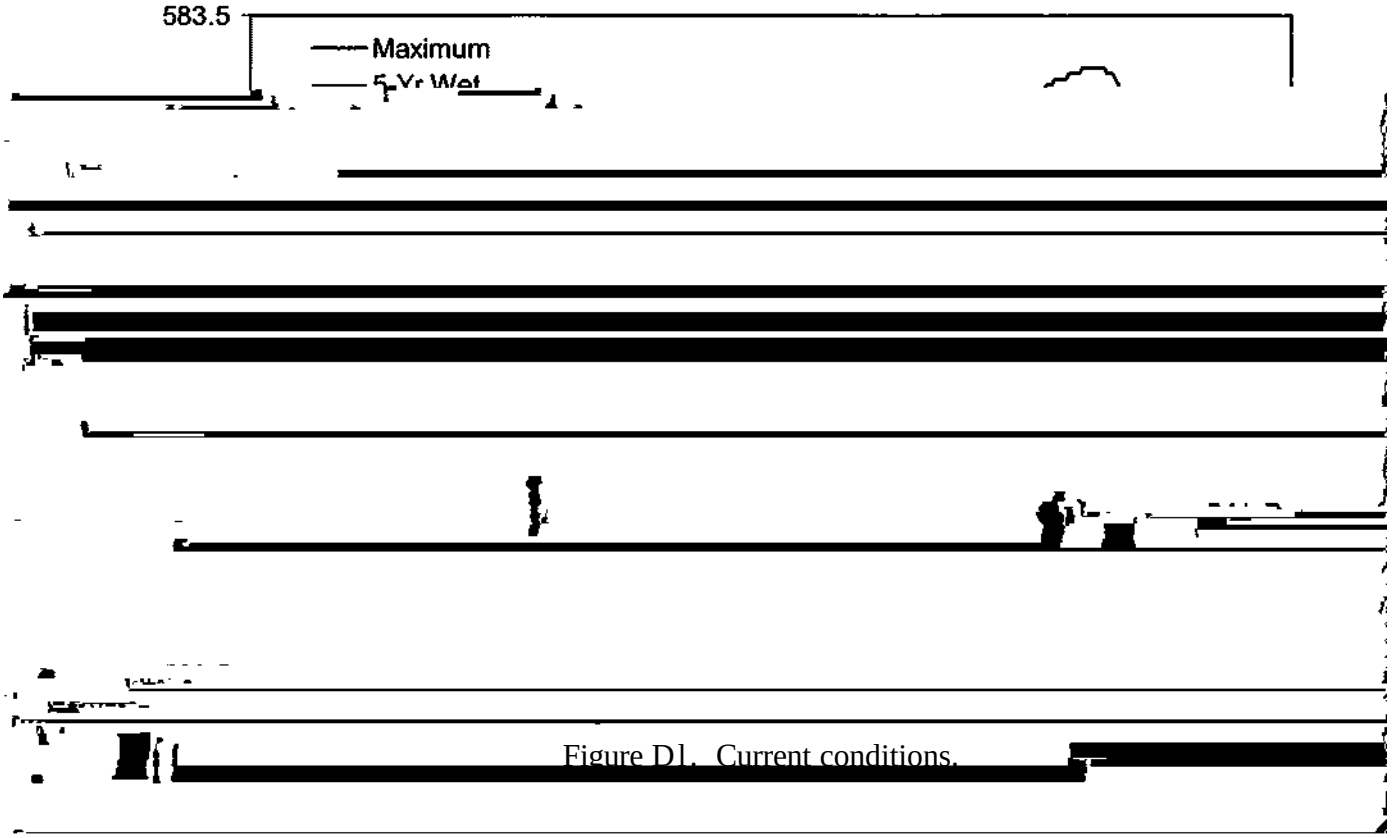


Figure D1. Current conditions.

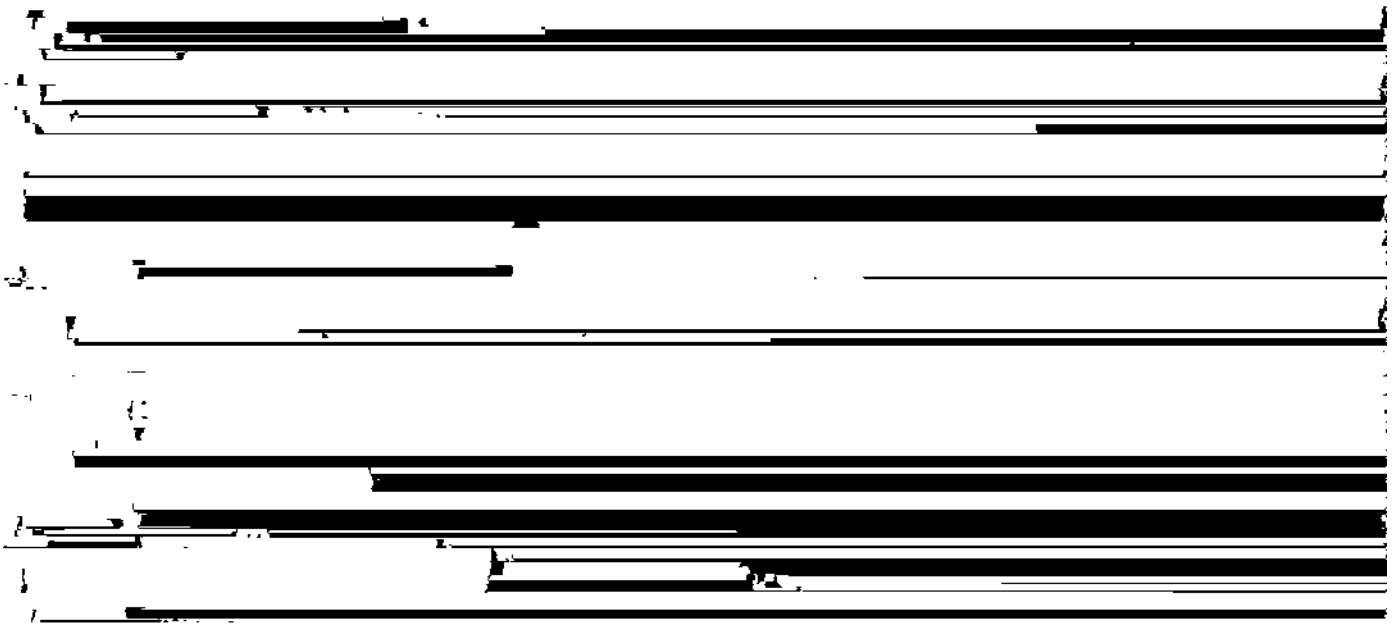


Figure D2. Weir at 583 feet.

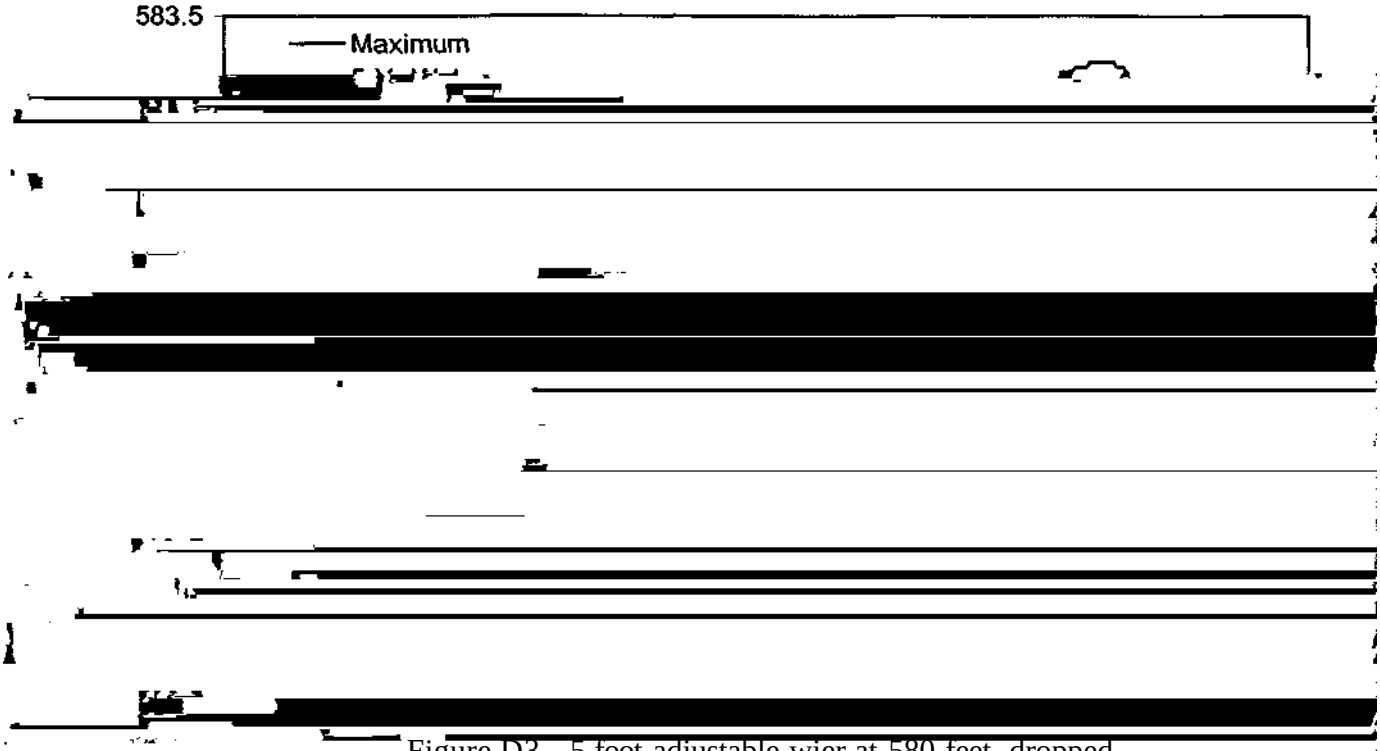


Figure D3. 5-foot adjustable wier at 580 feet dropped to 579 feet in July-August.

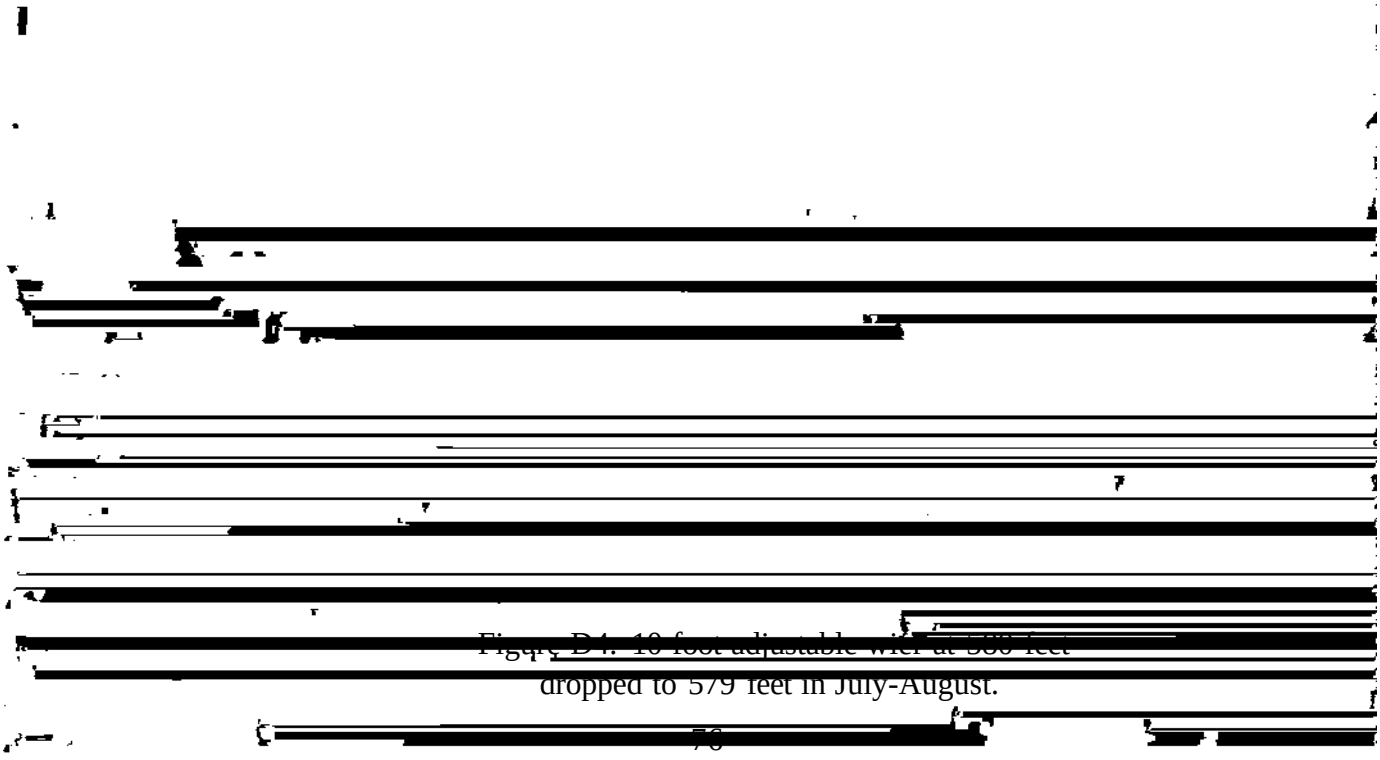


Figure D4. 10-foot adjustable wier at 580 feet dropped to 579 feet in July-August.

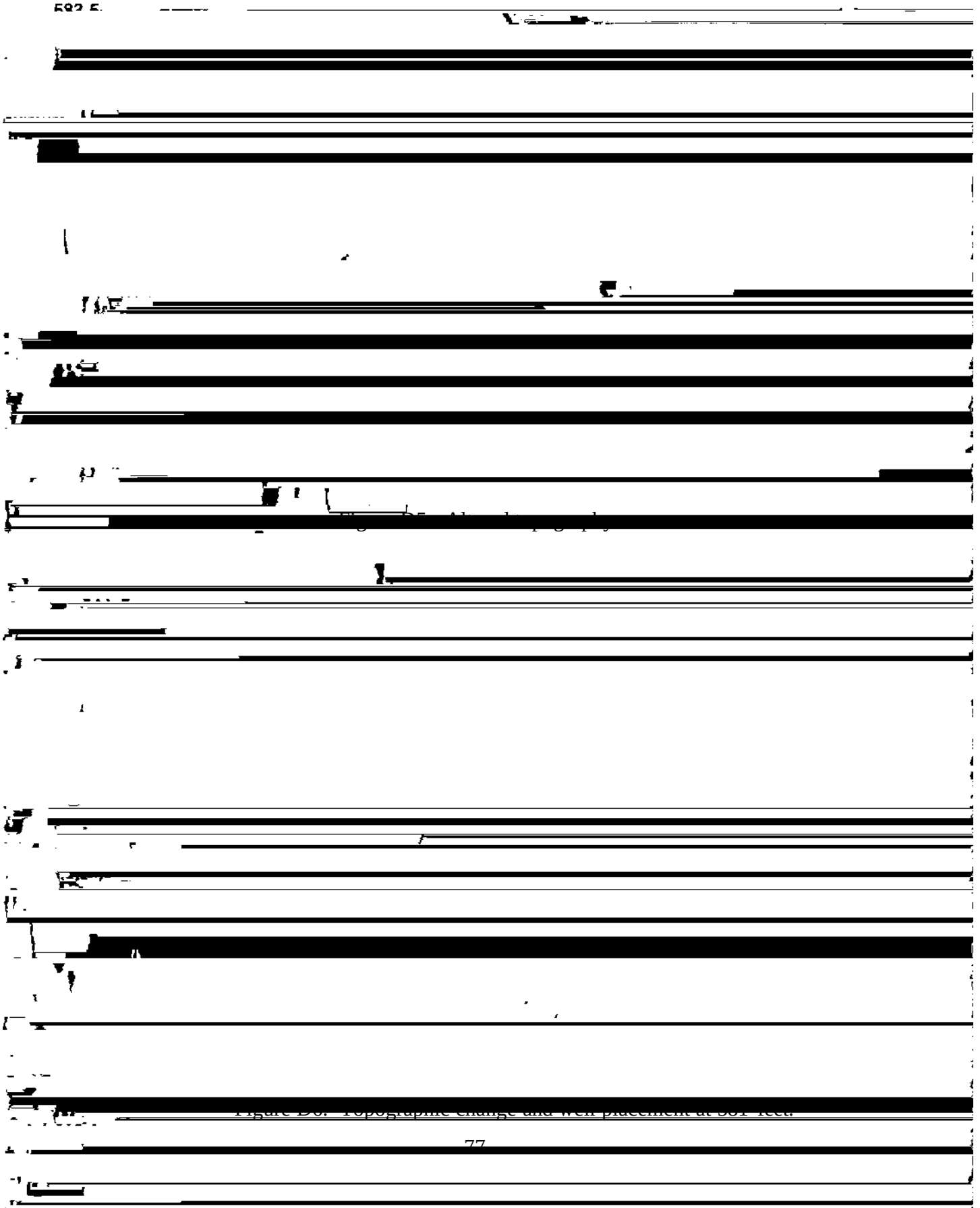


Figure D6. Topographic change and well placement at 381 feet.

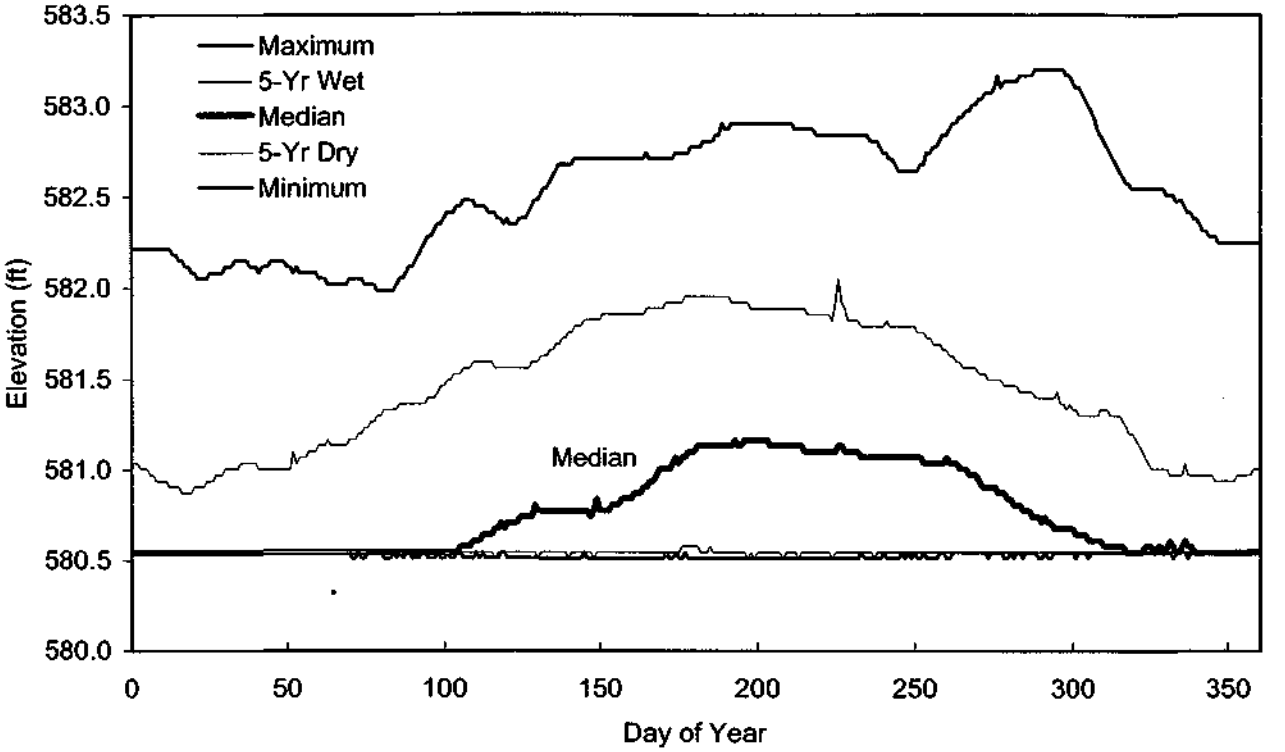


Figure D7. North pool with an open culvert.

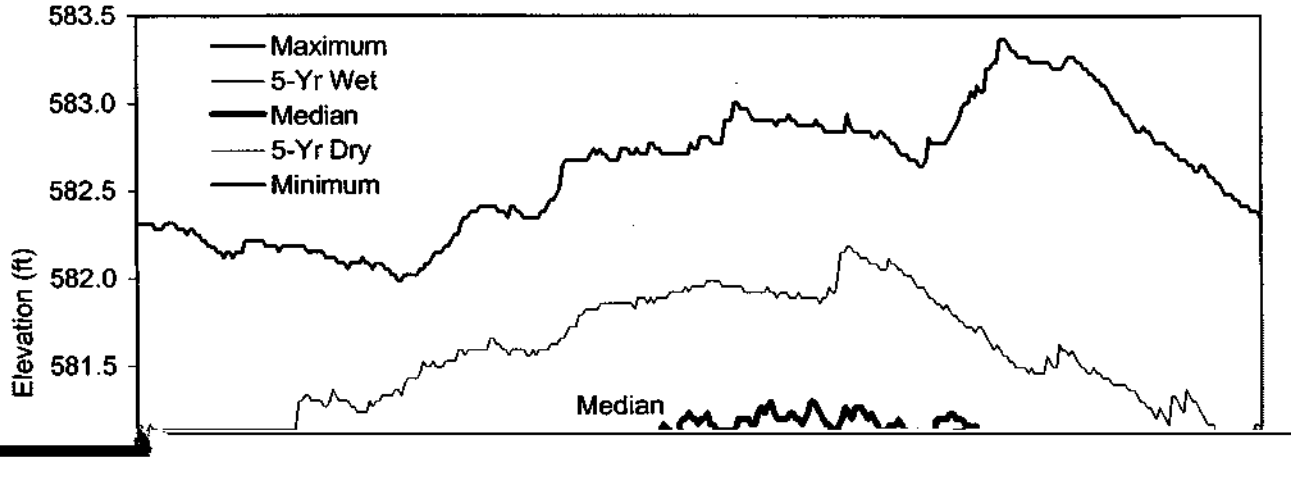
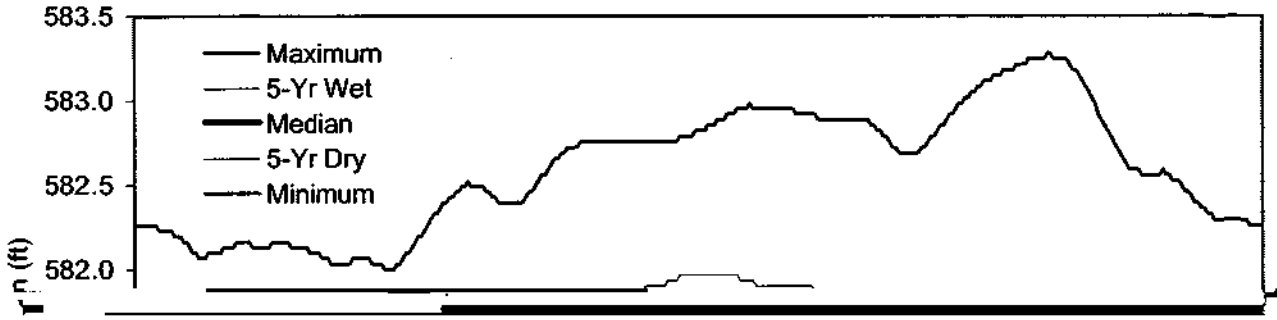
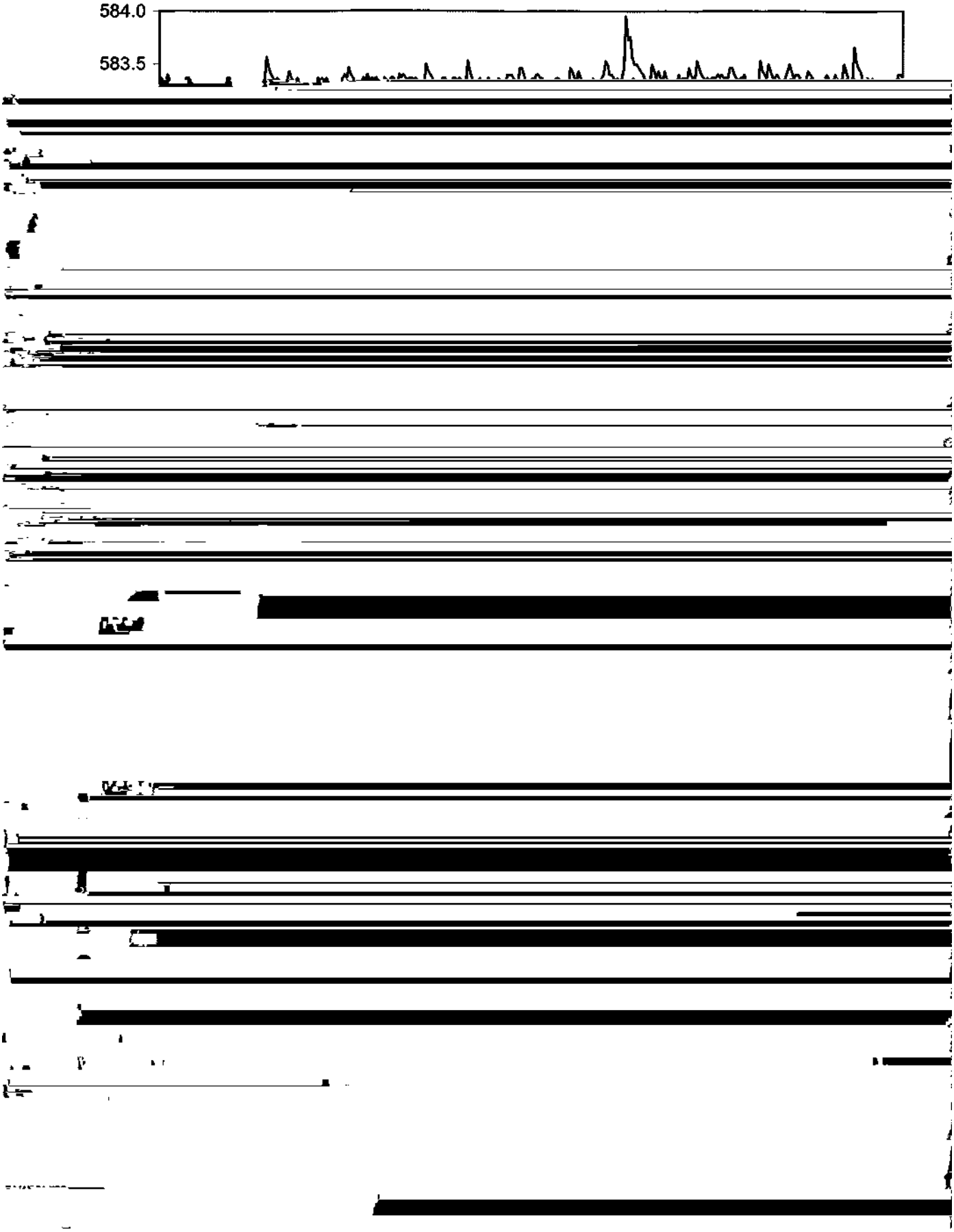


Figure D8. North pool with a constricted culvert.


583.5
583.0
582.5
582.0
n (ft)
Maximum
5-Yr Wet
Median
5-Yr Dry
Minimum


584.0
583.5

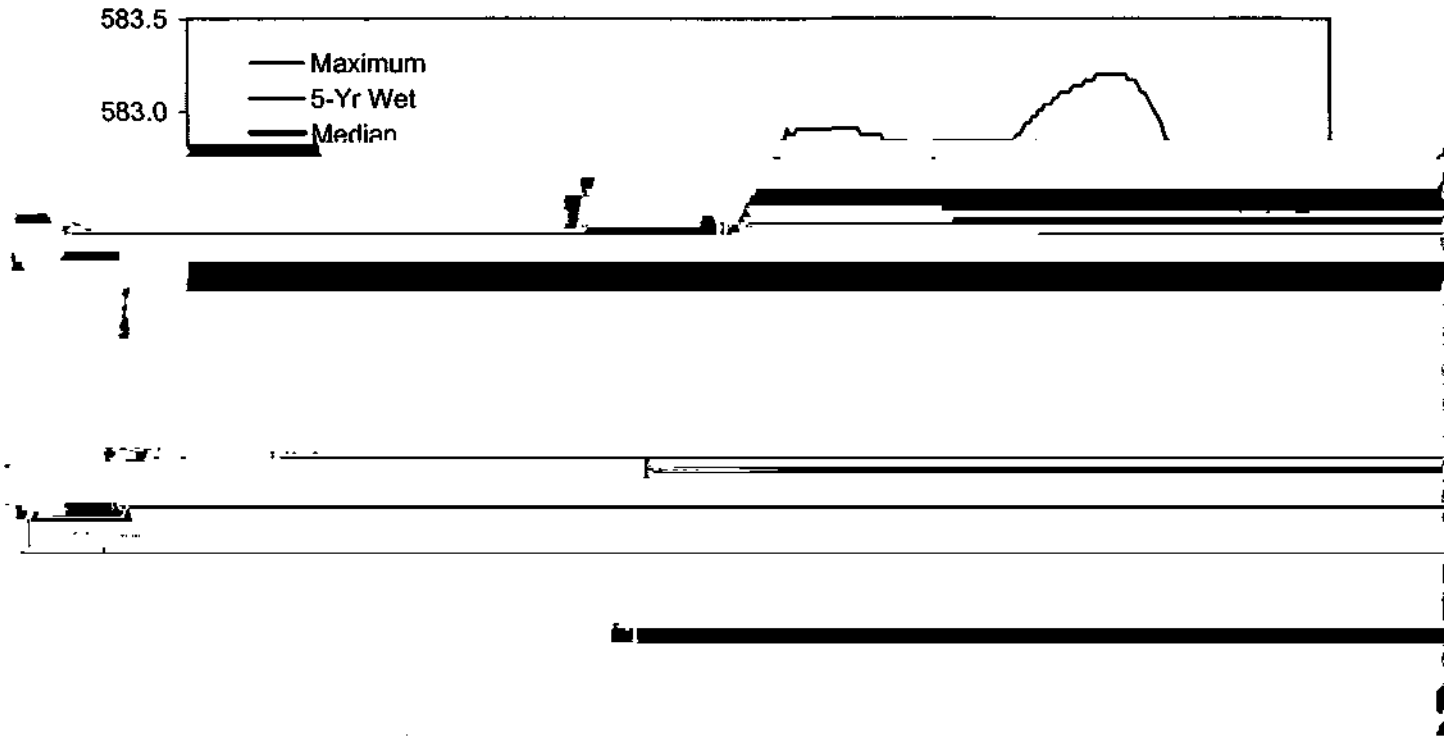
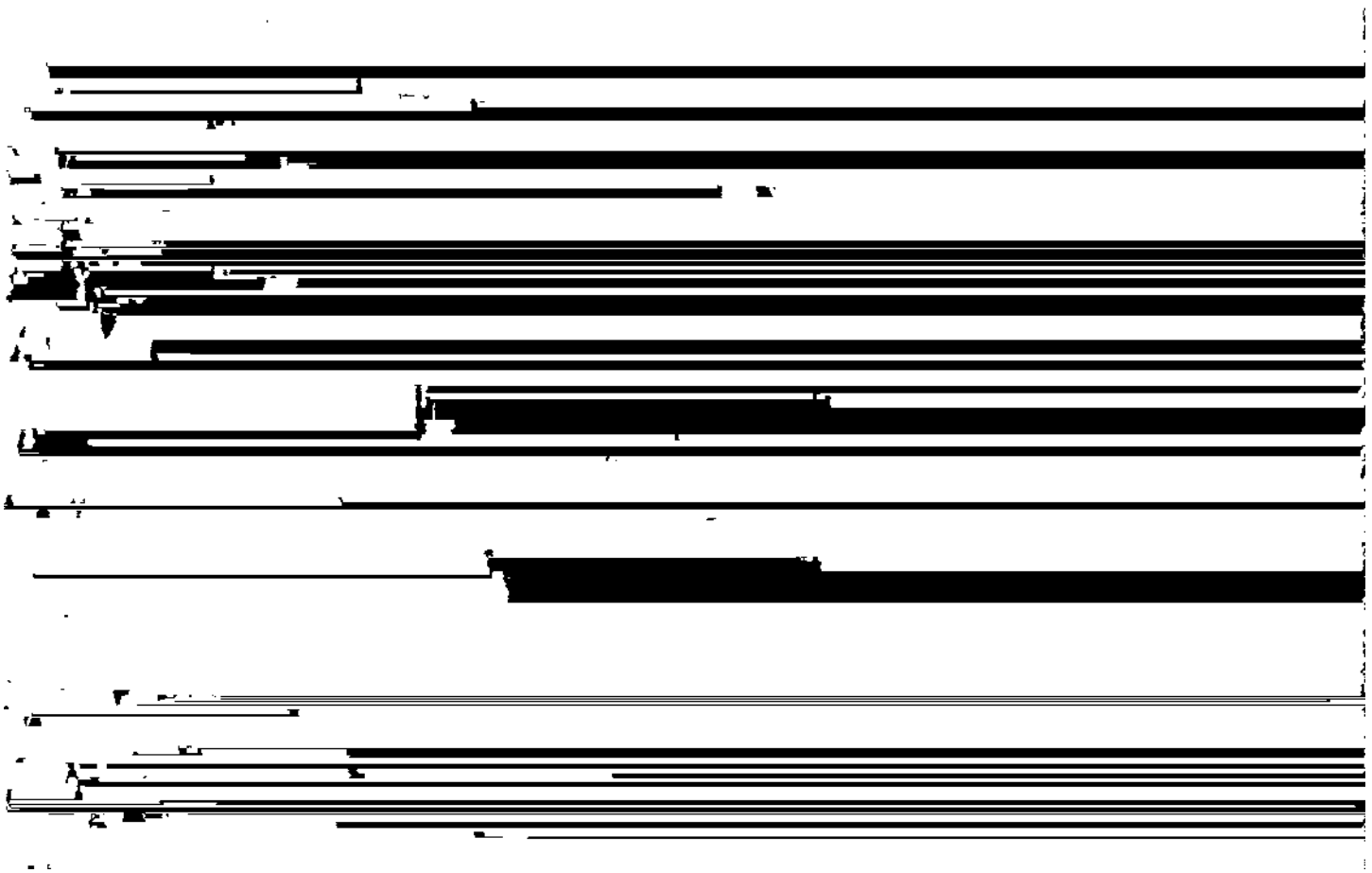


Figure D13. Addition of weir and e.5080/Fi 0nfr25 D13d.



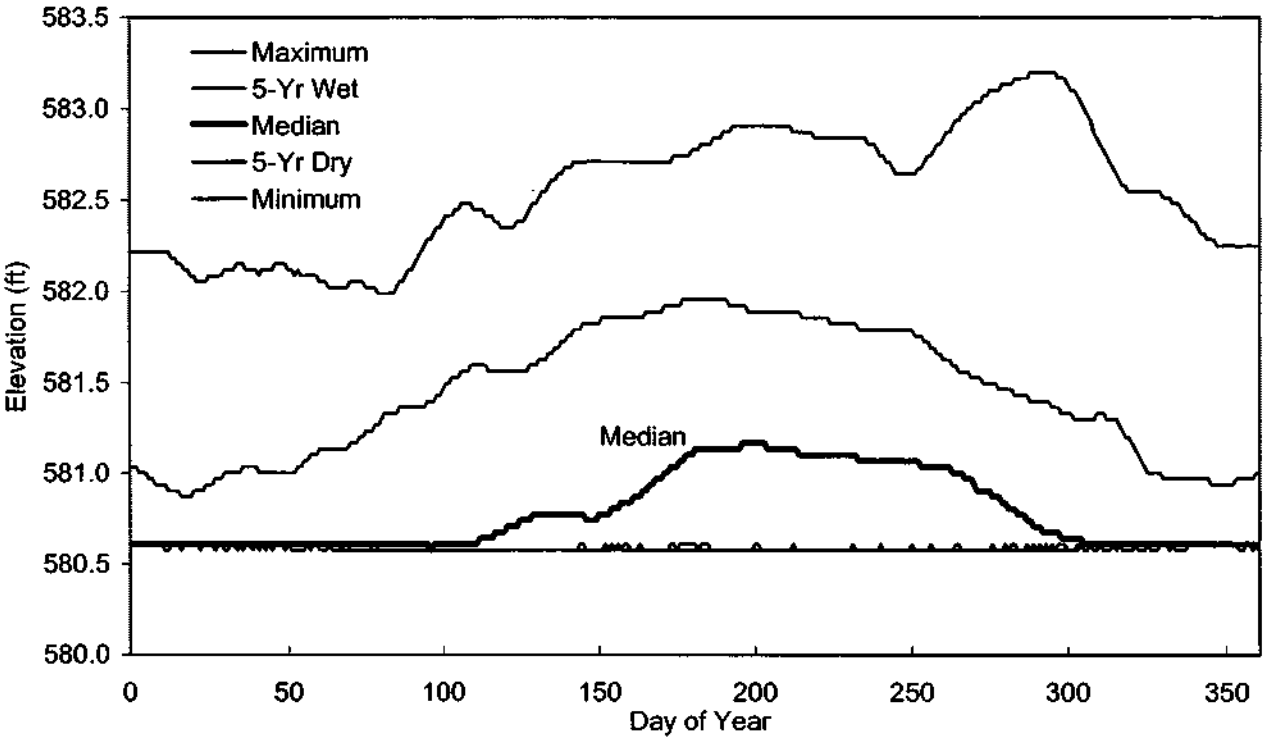


Figure D17. Current conditions with seepage inflow of 37,000 ft^3/day.

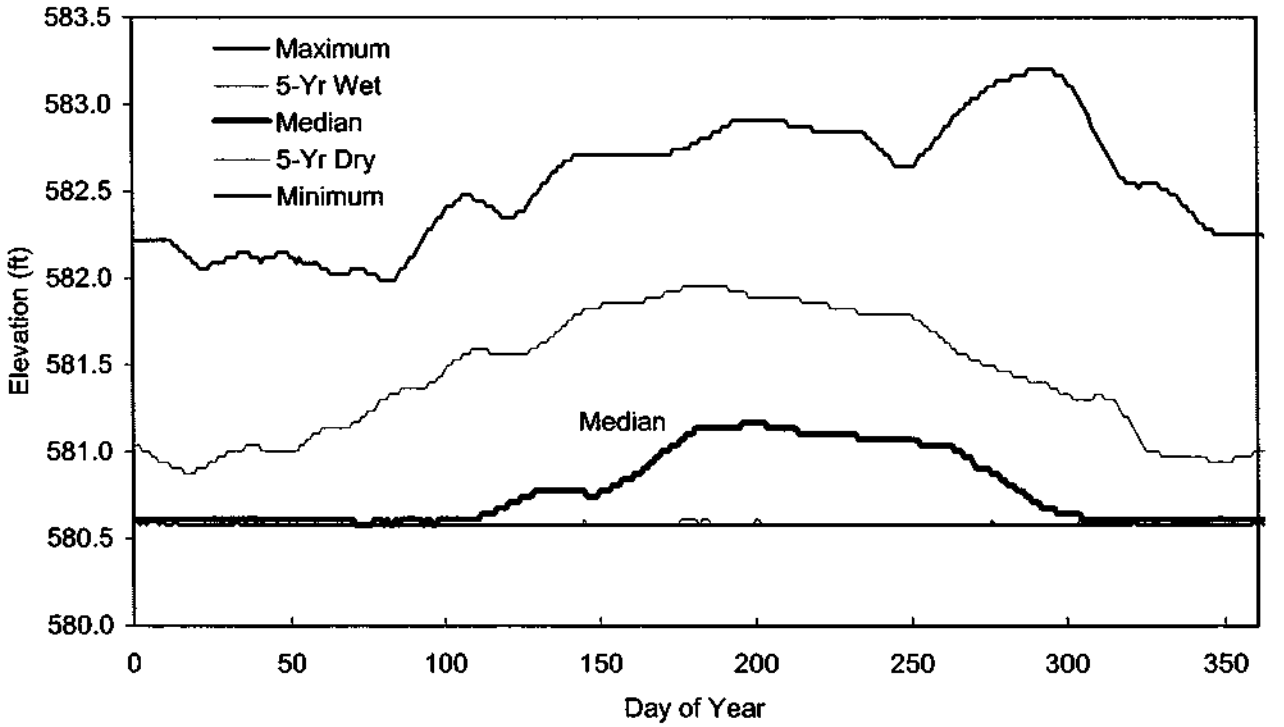


Figure D18. Current conditions with seepage inflow of 13,900 ft^3/day.

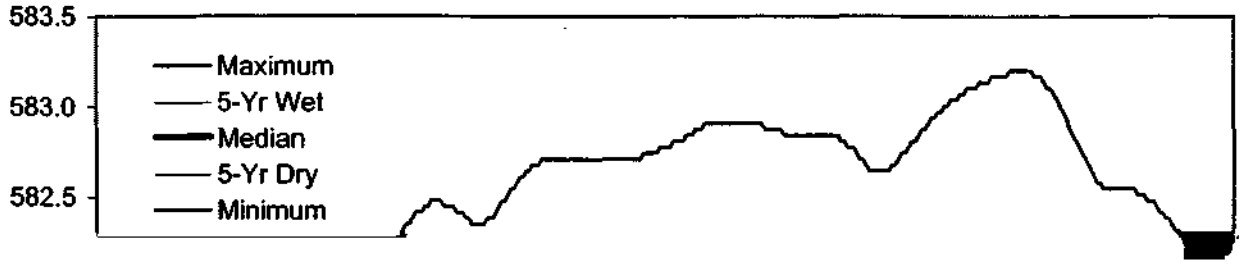


Figure D19. Current conditions with hydraulic conductivityf4 in./hr.

Figure D20. Current conditions with hydraulic conductivityf 2.9 in./hr.

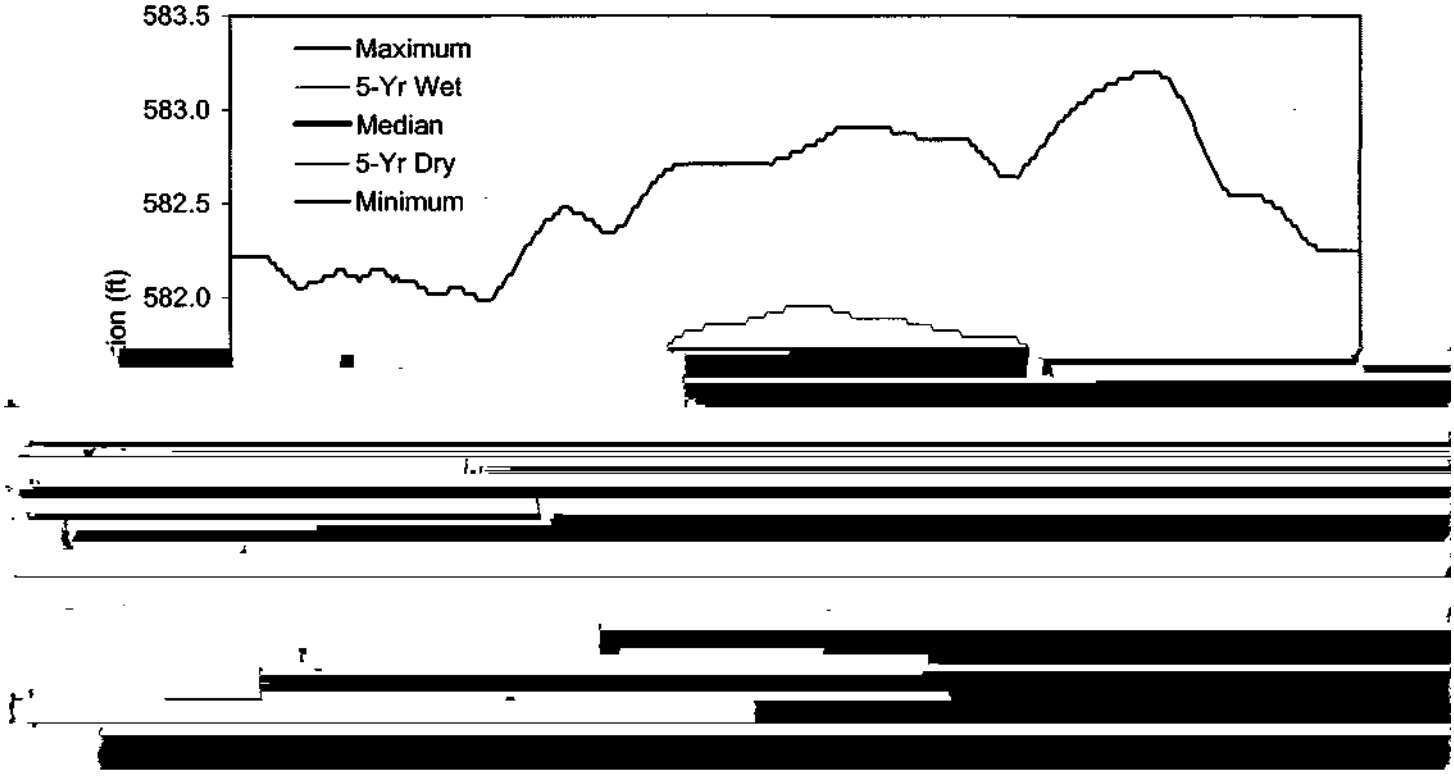


Figure D21. Current conditions with watershed of 30 acres.

Figure D22. Current conditions with watershed of 50 acres.

Appendix E. Predicted Vegetation at Incremental Areas

El Current conditions.
E2 Weir at 583 feet.
E3 Weir at 583 feet and ~2 cfs of SEPA station water added.
E4 5-foot adjustable weir at 580 feet dropped to 579 feet in July-August.
E5 10-foot adjustable weir at 580 feet dropped to 579 feet in July-August.
E6 Altered topography.
E7 Topographic change and weir placement at 581 feet.
E8 North pool with an open culvert.
E9 North pool with a constricted culvert.
E10 South pool with an open culvert.
E11 South pool with a constricted culvert.
El 2 Addition of weir and water for the "ideal" hydroperiod 1.
El 3 Addition of weir and water for the "ideal" hydroperiod 2.

Figure E1. Current conditions.

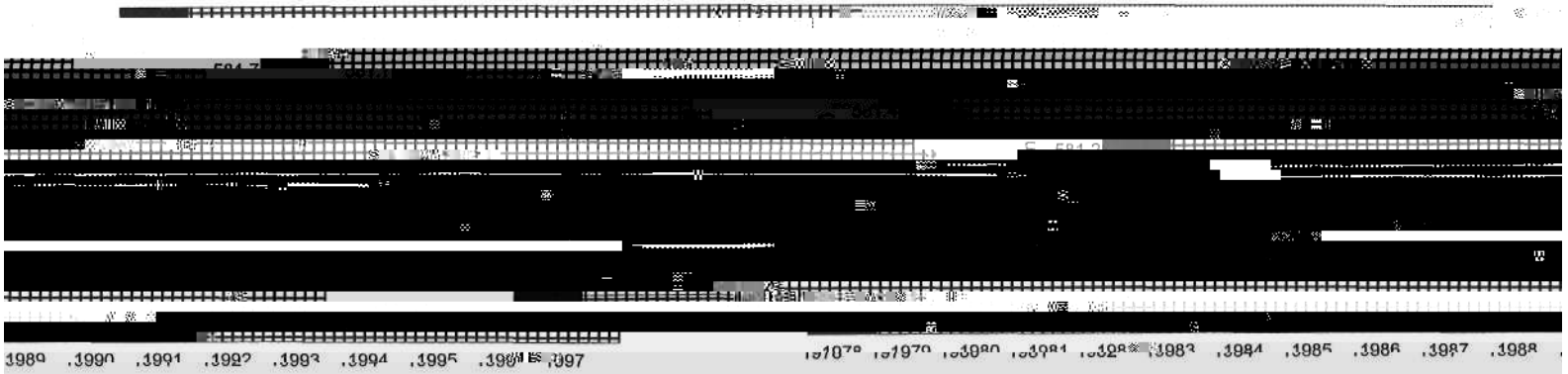


Figure E2. Weir at 583 feet.

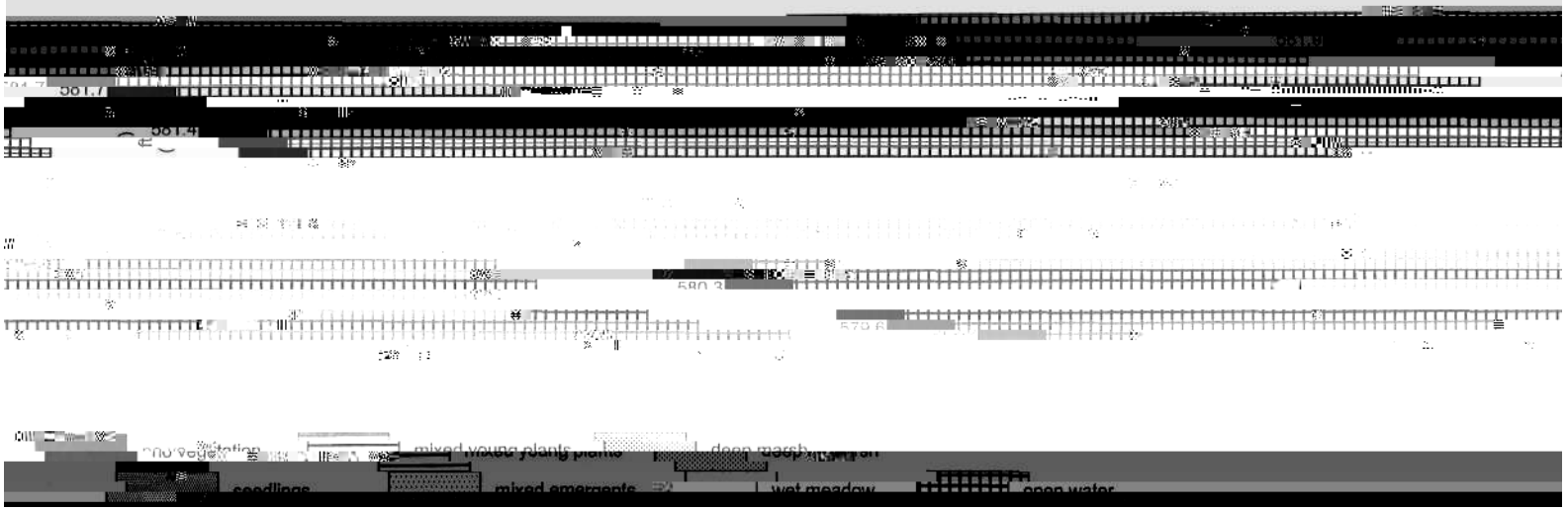


Figure E3. Weir at 583 feet and ~2 cfs of SEPA station water added.

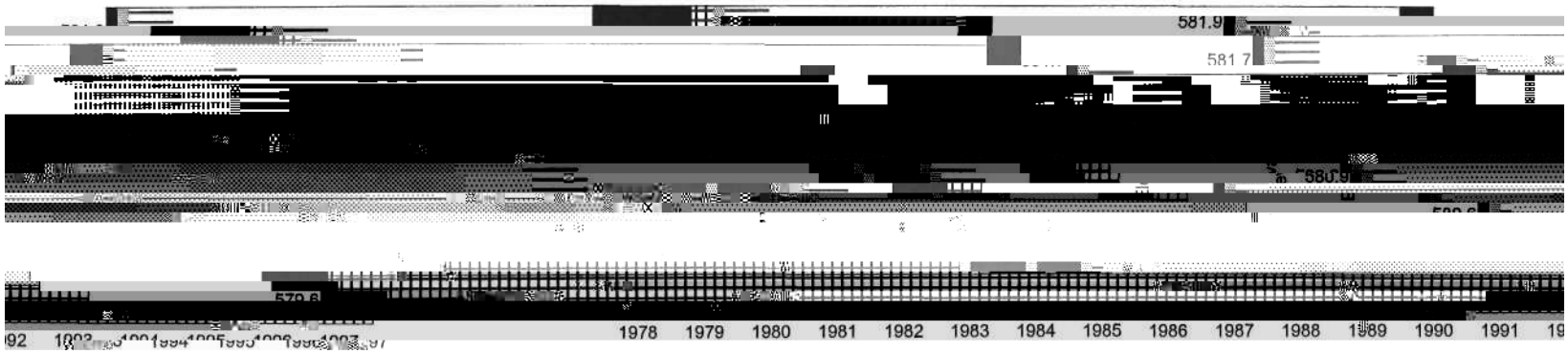


Figure E4. 5-foot adjustable weir at 580 feet dropped to 579 feet in July-August.

Figure E5. 10-foot adjustable weir at 580 feet dropped to 579 feet in July-August.

Figure E7. Topographic change and weir placement at 581 feet.

581.9
581.3
580.5
580.1
580.8
580.5
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1978
1979
1980
1981
1982
1983
1984
mixed young plants
deep marsh
no vegetation

Figure E10. South pool with an open culvert.

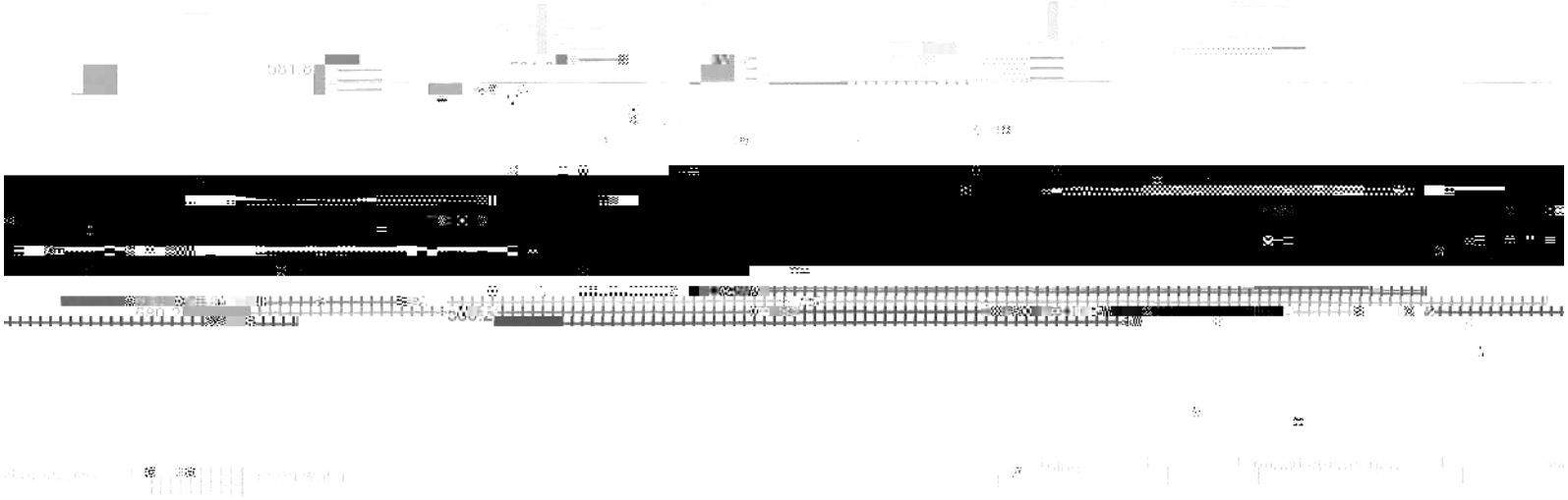


Figure E11. South pool with a constricted culvert.

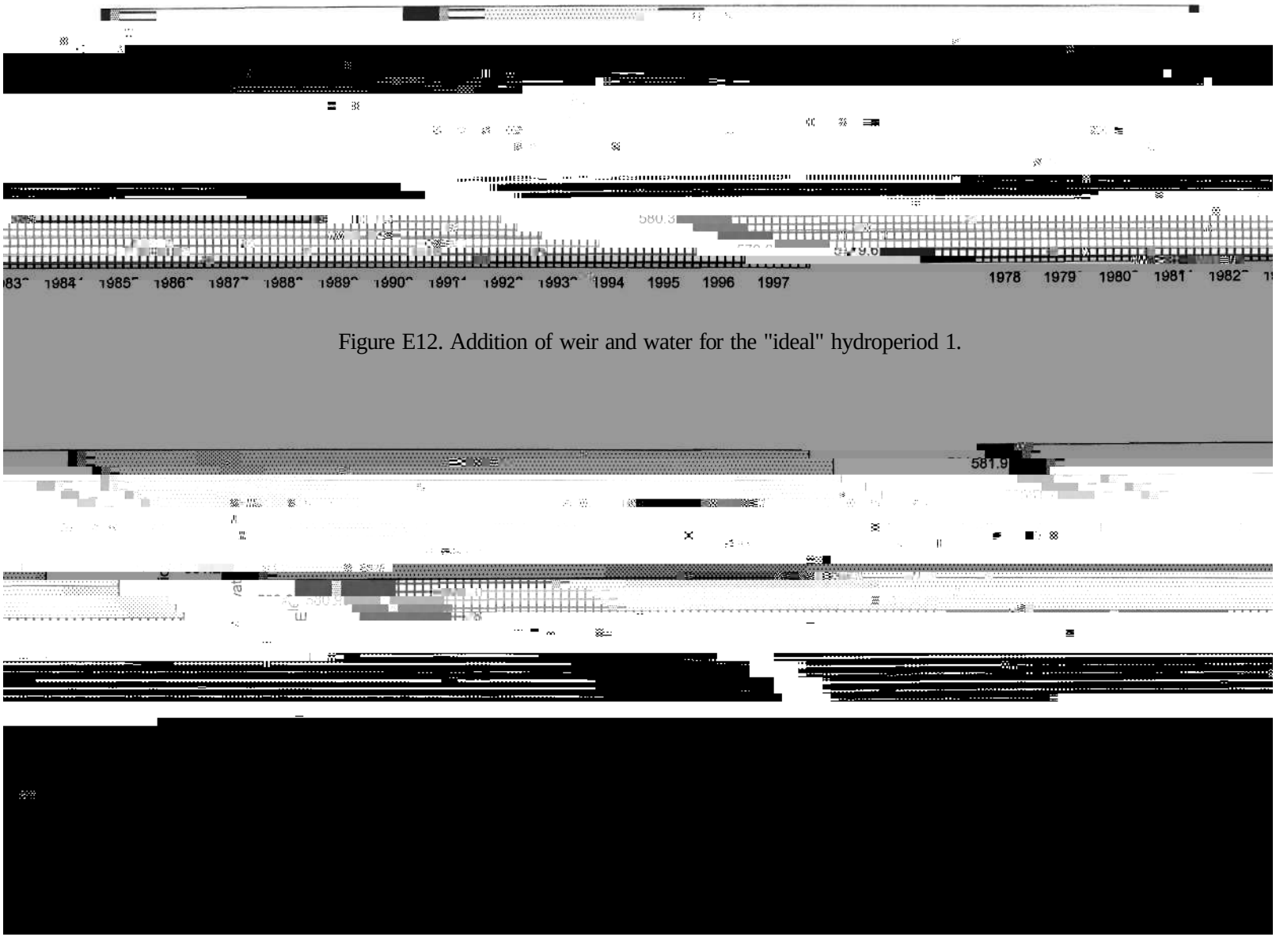
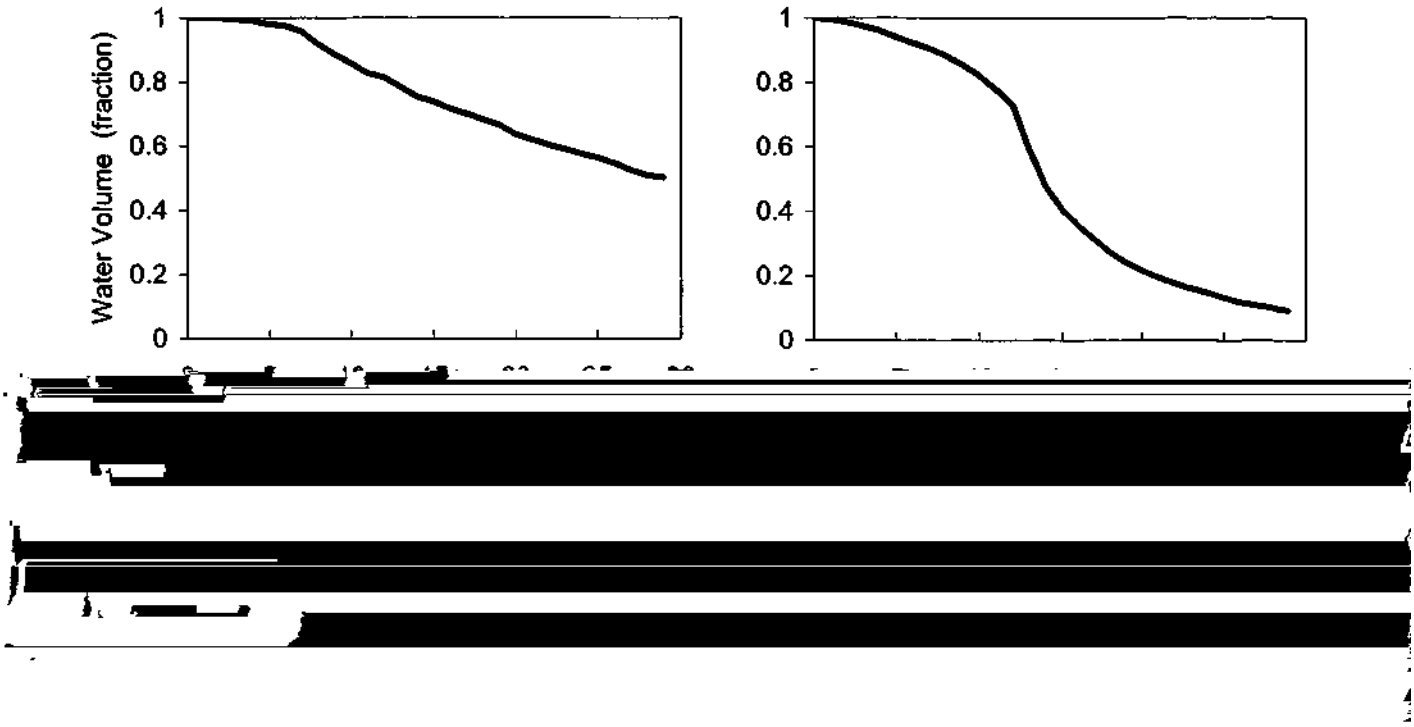
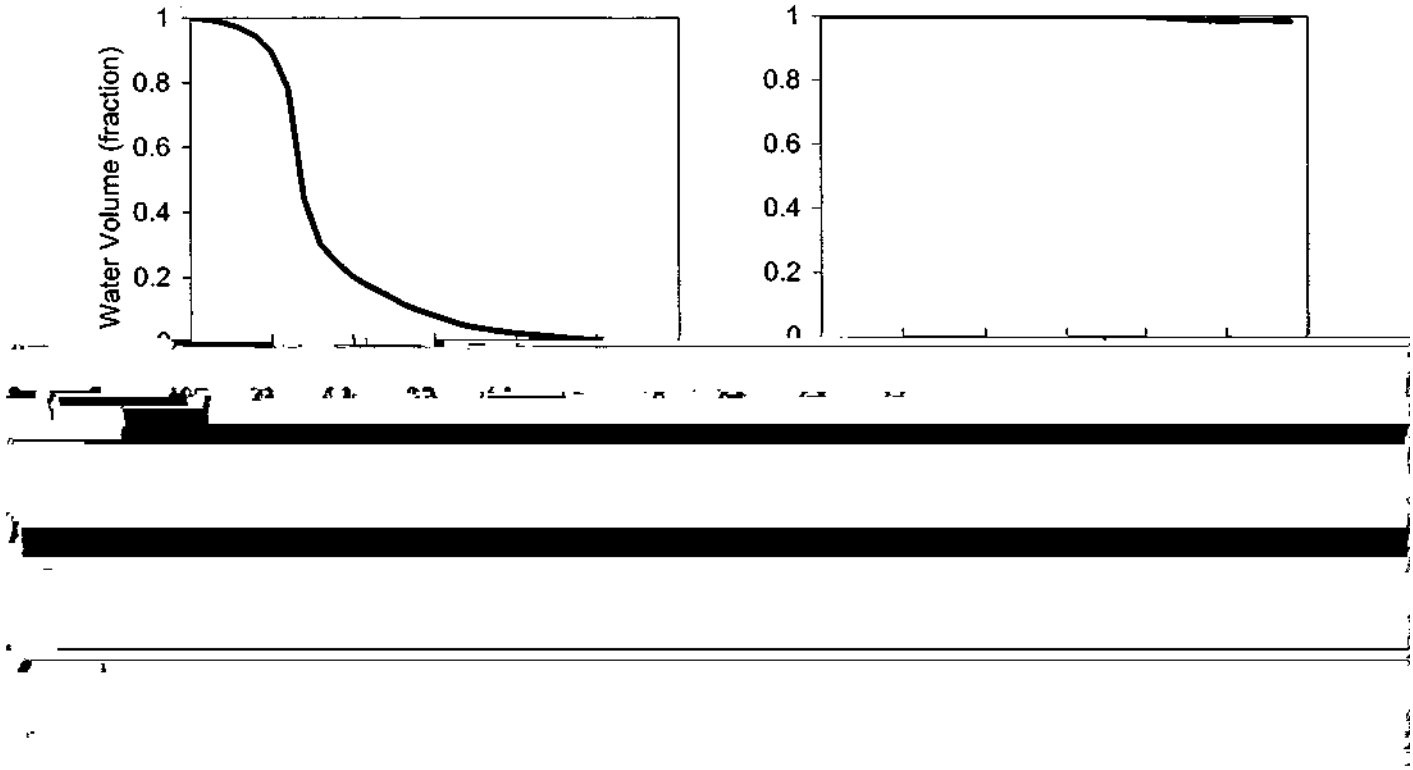


Figure E12. Addition of weir and water for the "ideal" hydroperiod 1.

Appendix F. Retention Time Distributions

F1 Current conditions.
F2 Current conditions with ~2 cfs SEPA station water added.
F3 Current conditions with ~4 cfs SEPA water added.
F4 Weir at 583 feet.
F5 Weir at 583 feet with ~2 cfs SEPA station water added.
F6 Weir at 583 feet with ~4 cfs SEPA station water added.
F7 5-foot adjustable weir at 580 feet dropped to 579 feet in July-August.
F8 10-foot adjustable weir at 580 feet dropped to 579 feet in July-August.
F9 10-foot adjustable weir at 580 feet dropped to 579 feet in July-August with ~2 cfs SEPA station water added.
F10 10-foot adjustable weir at 580 feet dropped to 579 feet in July-August with ~4 cfs SEPA station water added.
F11 Altered topography.
F12 Topographic change and weir placement at 581 feet.
F13 North pool with an open culvert.
F14 North pool with a constricted culvert.
F15 South pool with an open culvert.
F16 South pool with a constricted culvert.
F17 Addition of weir and water for the "ideal" hydroperiod 1.
F18 Addition of weir and water for the "ideal" hydroperiod 2.


Water Volume (fraction)
1
0.8
0.6
0.4
0.2
0


Water Volume (fraction)
1
0.8
0.6
0.4
0.2
0

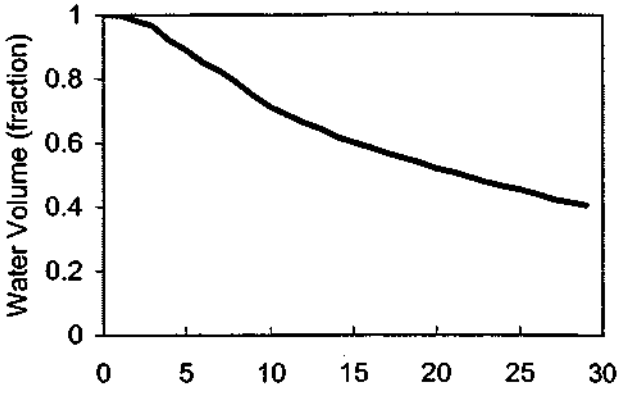


Figure F7. 5-foot adjustable weir at 580 feet dropped to 579 feet in July-August.

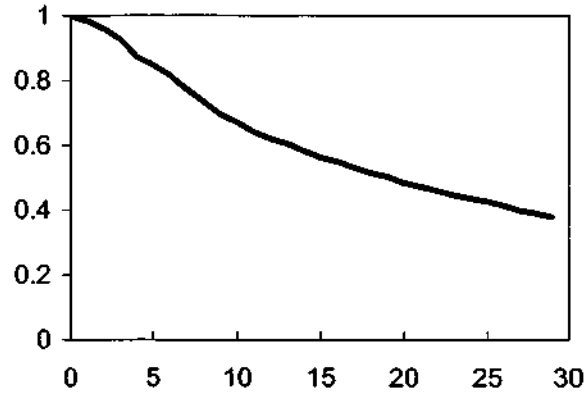


Figure F8. 10-foot adjustable weir at 580 feet dropped to 579 feet in July-August.

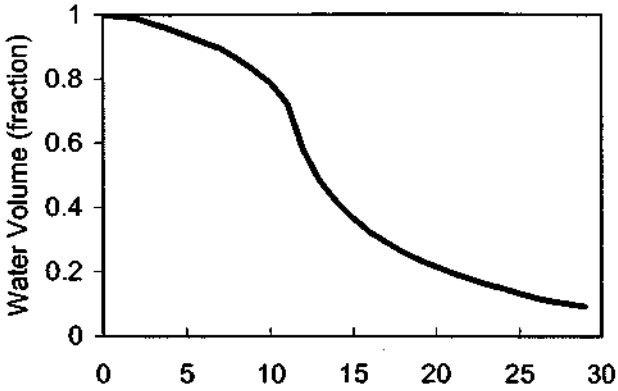


Figure F9. 10-foot adjustable weir at 580 feet dropped to 579 feet in July-August with ~2 cfs SEPA station water added.

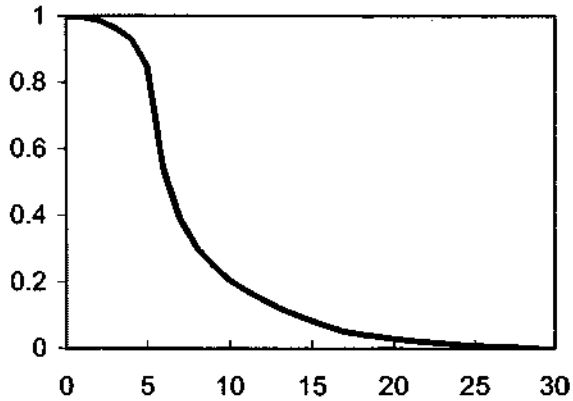


Figure F10. 10-foot adjustable weir at 580 feet dropped to 579 feet in July-Aug with ~4 cfs SEPA station water added.

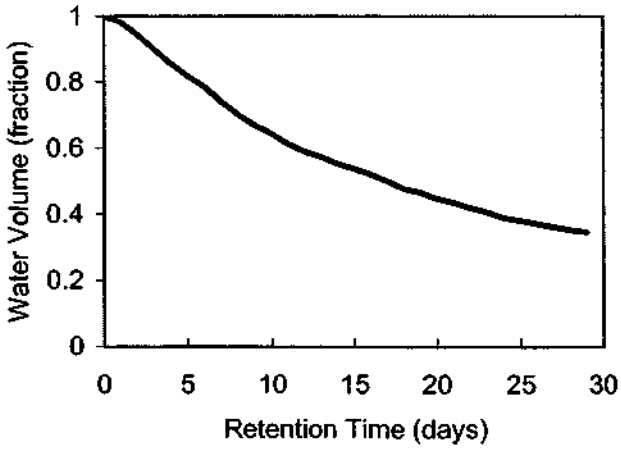


Figure F11. Altered topography.

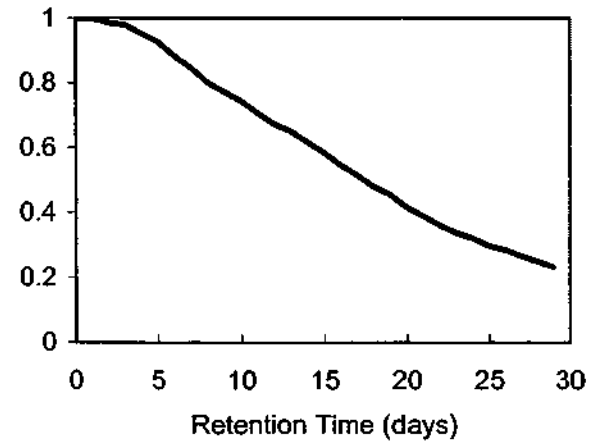


Figure F12. Topographic change and weir placement at 581feet.

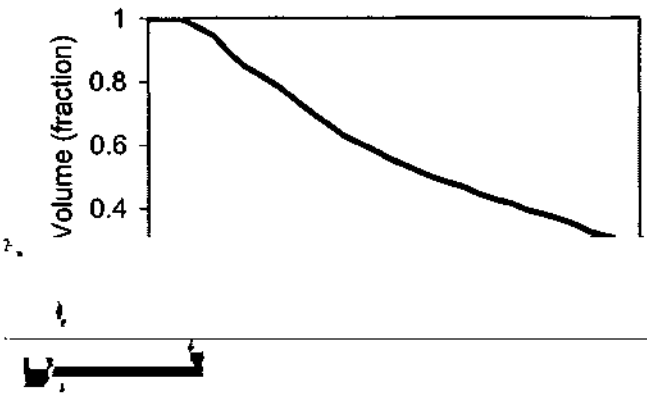


Figure F13. North pool with an open culvert.

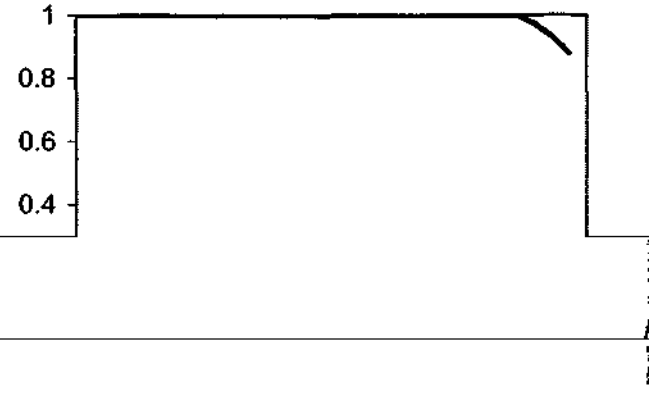


Figure F14. North pool with a constricted culvert.

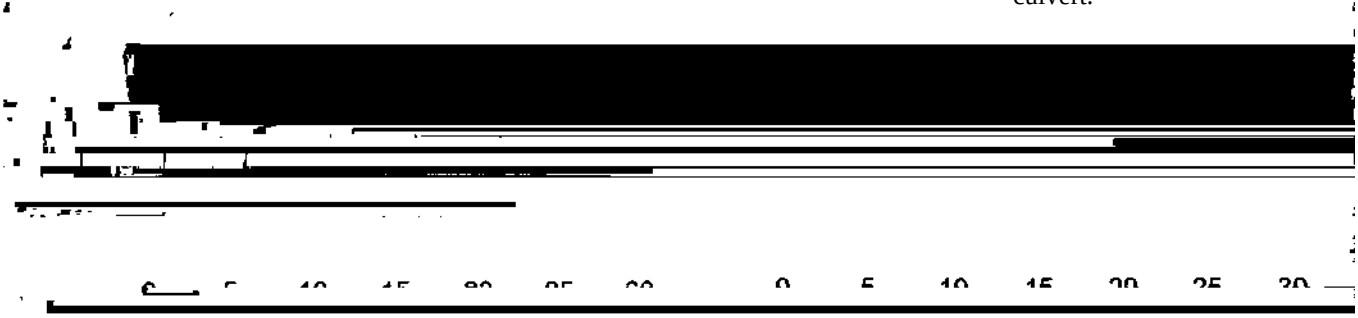


Figure F15. South pool with an open culvert.

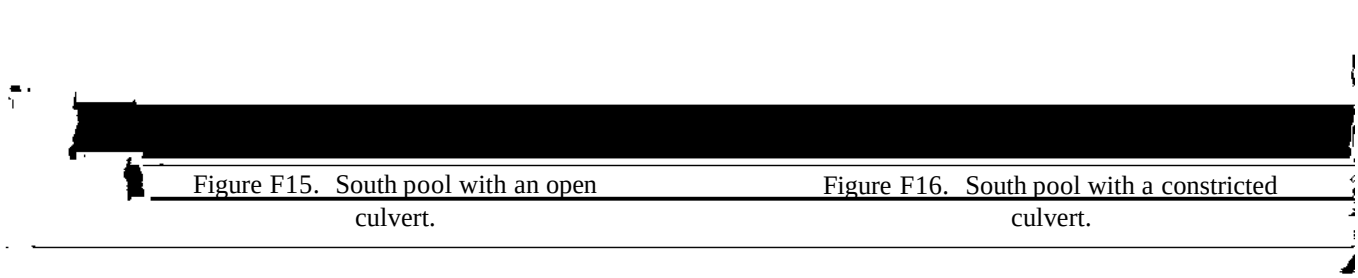


Figure F16. South pool with a constricted culvert.

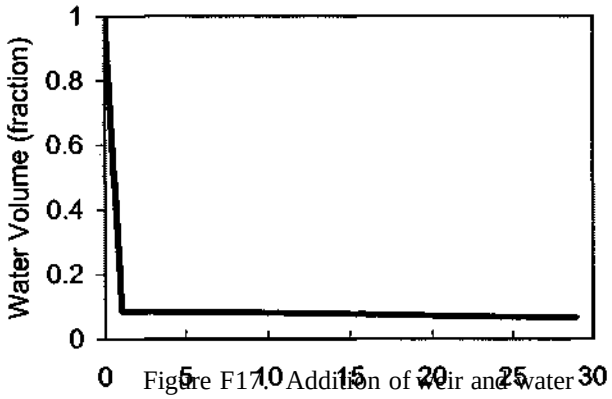


Figure F17. Addition of weir and water for the "ideal" hydroperiod 1.

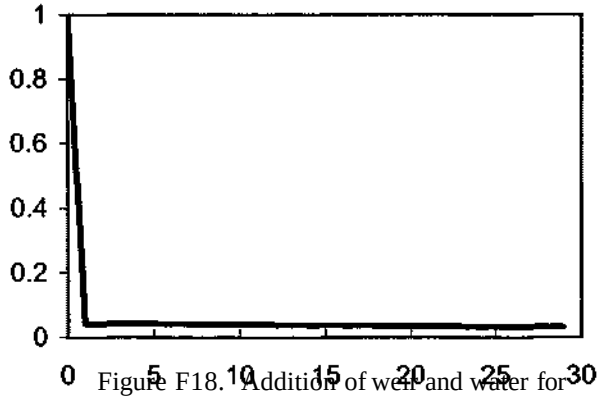
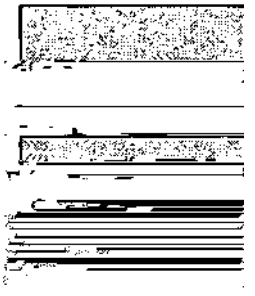


Figure F18. Addition of weir and water for the "ideal" hydroperiod 2.



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