TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

This study investigates the water resource problems and the ecosystem restoration potential of the 303.8-acre Lockport Prairie Nature Preserve and the 623.7-acre Prairie Bluff Preserve. These areas are located along the Des Plaines River in Will County, Illinois as shown in Figure 1. It appears that in the last 5-10 years there has been a change in the surface and groundwater hydrology at the site in terms of the water quantity and quality. This change appears to have adversely impacted several threatened and endangered species, including the Hine's emerald dragonfly. This Appendix documents the hydrologic engineering analysis undertaken for this ecosystem restoration project.

OBJECTIVE

The hydrologic analysis of this project had two objectives: to understand the sources of water and the way it flows on the site, and to investigate some of the proposed measures to support the alternatives analysis. A water balance was performed for a portion of the site. Five measures were studied: drainage tile disablement, erosion control, a new culvert under Division St., an infiltration trench, and water level control structures.

SITE DESCRIPTION

Figure 1 shows the project area composed of four management units. MU1 is the 623.7-acre Prarie Bluff Preserve (PBP) immediately west of the Lockport Prairie Nature Preserve (LPNP) along Route 53. PBP is bordered by a residential subdivision to the west, Division Street to the south, Route 53 to the east and Renwick Road and the Prairie Bluff Golf Course to the north. MU2 is the 19.7-acre LPNP Bluff North which resides within the LPNP between the railroad tracks and Route 53 and north of Division Street. It encompasses a small sliver of land recently purchased from MWRD for management of invasive species and erosion along the bluffs. MU3 is the 142.6-acre LPNP North unit which is part of the original LPNP. The unit is located north of Division Street, south of Renwick Road, west of Des Plaines River and east of the railroad tracks. MU4 is the 141.5 LPNP South unit. The southern boundary is bordered by a forested area approximately 0.4 miles south of Division Street, with Division Street bordering the north, Des Plaines River bordering the east and Route 53 along the western border. Threatened and endangered species occupy the LPNP North (MU3) and LPNP South (MU4) areas.

WATER BALANCE

A water balance examines the relationship between inflow, outflow, and storage in and around the soil profile. The objective of the water balance exercise for Lockport Prairie was to gain a better understanding of the way water flows into and out of the site. The major components of the inflows and outflows were identified and existing data was used to quantify or estimate the amount of water from each component. The results of the water balance showed the relative magnitude of each component.

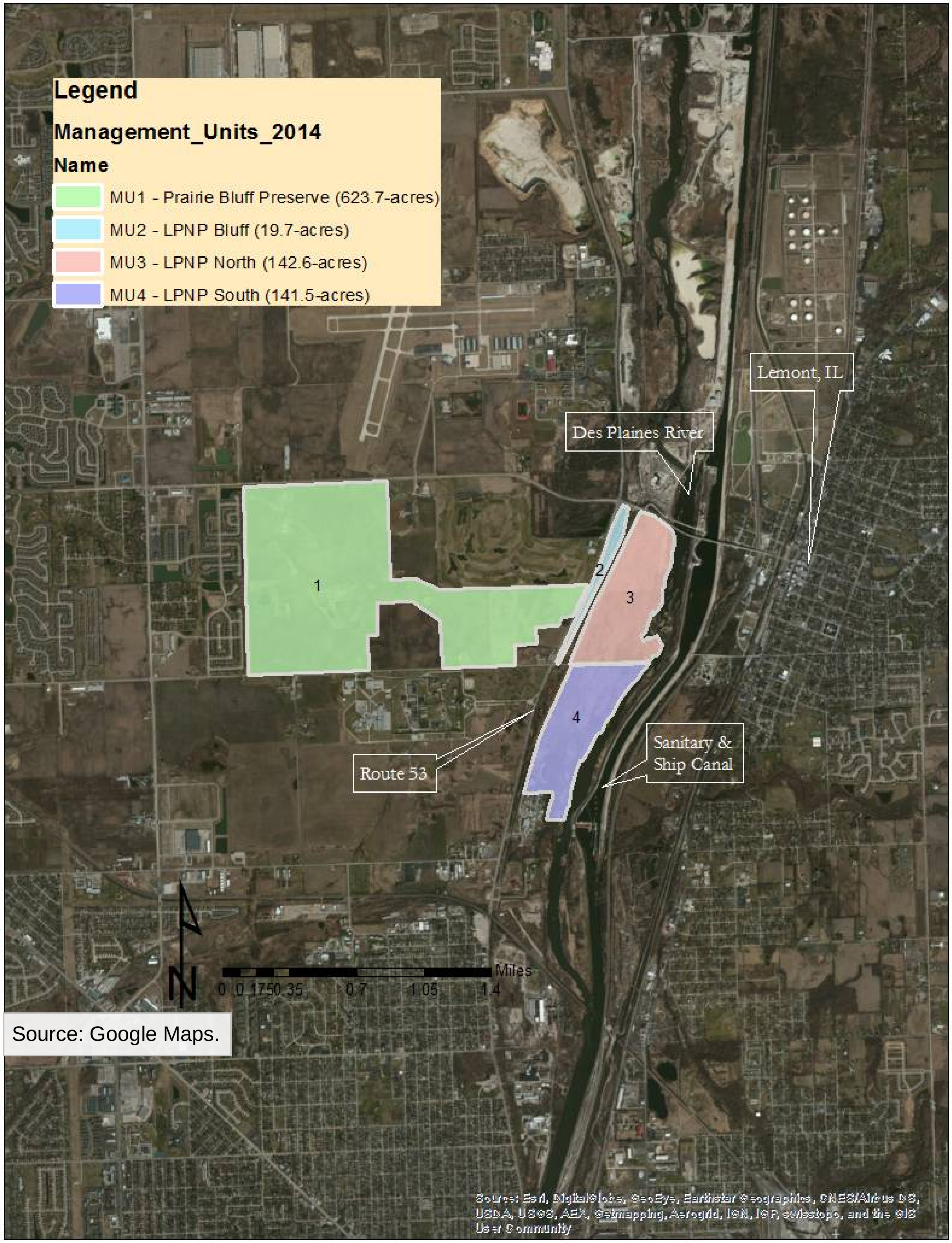


Figure 1. Project Location Map.

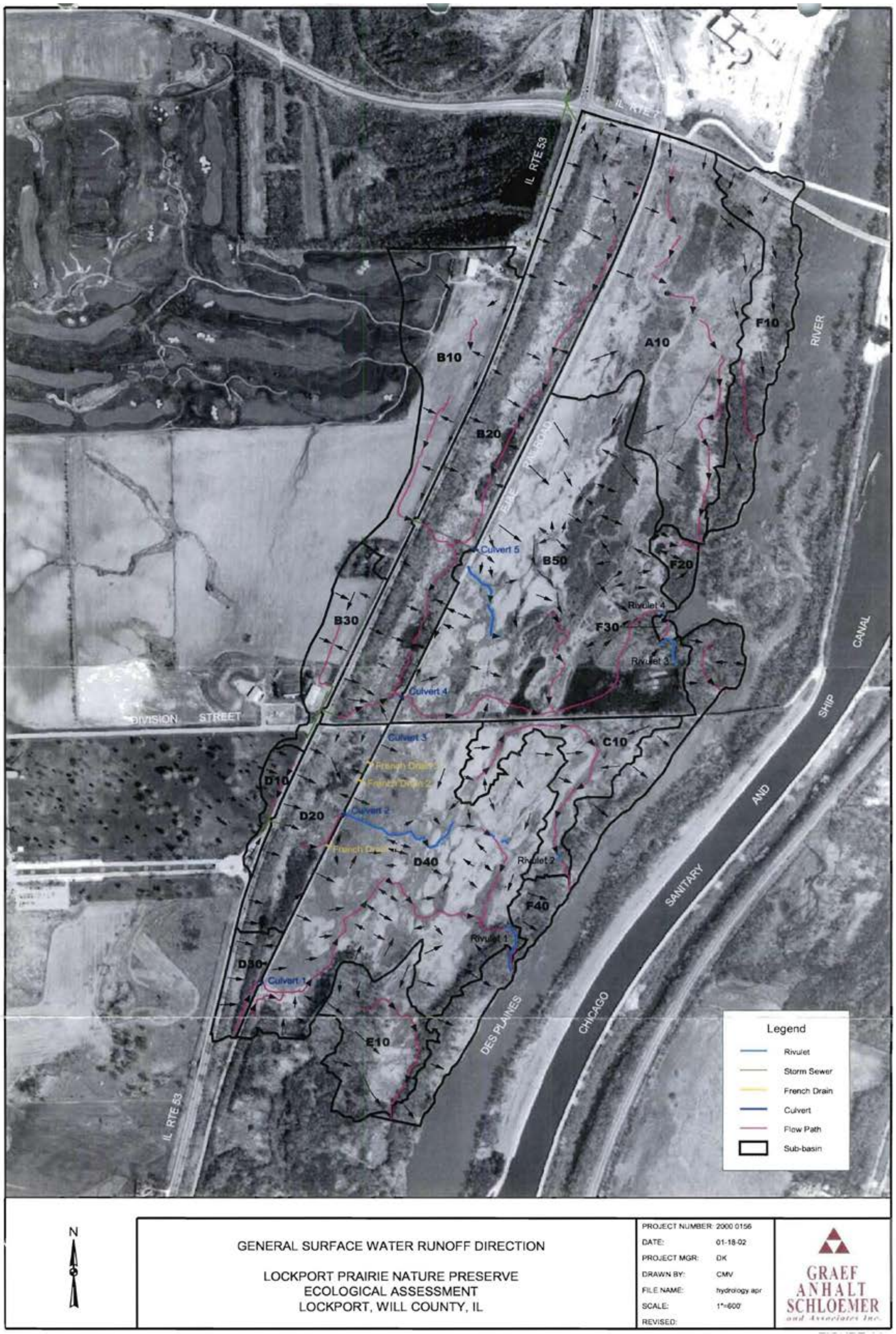


Figure 2. General Surface Water Runoff Direction

The general equation for a water balance is

$$\sum Inflows - \sum Outflows = \frac{\Delta Storage}{Time}.$$

Two inflows and three outflows were identified at Lockport Prairie. The inflows are precipitation (P) and groundwater seeps (G), and the outflows are evapotranspiration (ET), deep percolation (DP), and surface runoff (R). Water can also be stored (S) on the site in and just above the soil. Plugging these into the general equation, the water balance relationship for a given time interval at Lockport Prairie is

$$(P + G) - (ET + DP + R) = \Delta S.$$

The Lockport Prairie site area was delineated into multiple drainage basins by GAS (2004) as shown in Figure 2. The water balance was limited to the basins west of the railroad tracks. The railroad tracks are an artificial basin boundary, and the culverts and French drains through the tracks are discrete outflow points. The water balance results were compared to measured discharges as a check on the analysis. Division Street is another man-made basin boundary; the water balance for the area north of the road was computed separately from the area south of the road. In this report, the basins B10, B20, and B30 will be referred to collectively as Basin B; and basins D10, D20, and D30 will be referred to collectively as Basin D.

The water balance components are described in the following sections. Monthly climate data were used in order to see long-term, seasonal trends. Based on the amount of available data, the water balance was conducted for 2002-2005. The quantities in the water balance were expressed in inches, which is equivalent to volume per unit area.

PRECIPITATION

Precipitation, or P, is the amount of rain that falls on an area. Daily precipitation data was obtained from the National Climatic Data Center for the weather station at Lewis University in Romeoville. This station is about 1.7 miles northwest of Lockport Prairie. Precipitation data was available from 1997 through May 2006; monthly totals for 2002 through 2005 are summarized in Figure 3.

GROUNDWATER SEEPS

Groundwater, or G, enters the Lockport Prairie site through seeps on a hillside just east of Route 53. The water table intersects the fairly steep slope and the subsurface flow discharges over the surface. A flow net was used to estimate the seep flow into the site. The calculations were made based on available geologic data and water level measurements in wells on the site from 2001 through 2005. The computations were compared to streamflow measurements taken at the culverts and French drains during April through November of 2002 and 2003. The seep flow calculations were adjusted to approximately match the measured baseflow. Missing values for

March 2003 and October through December 2005 were set by interpolating between computed values or observing the overall seasonal trend in the computations. The monthly values of G are summarized in Figure 4 and Figure 5.

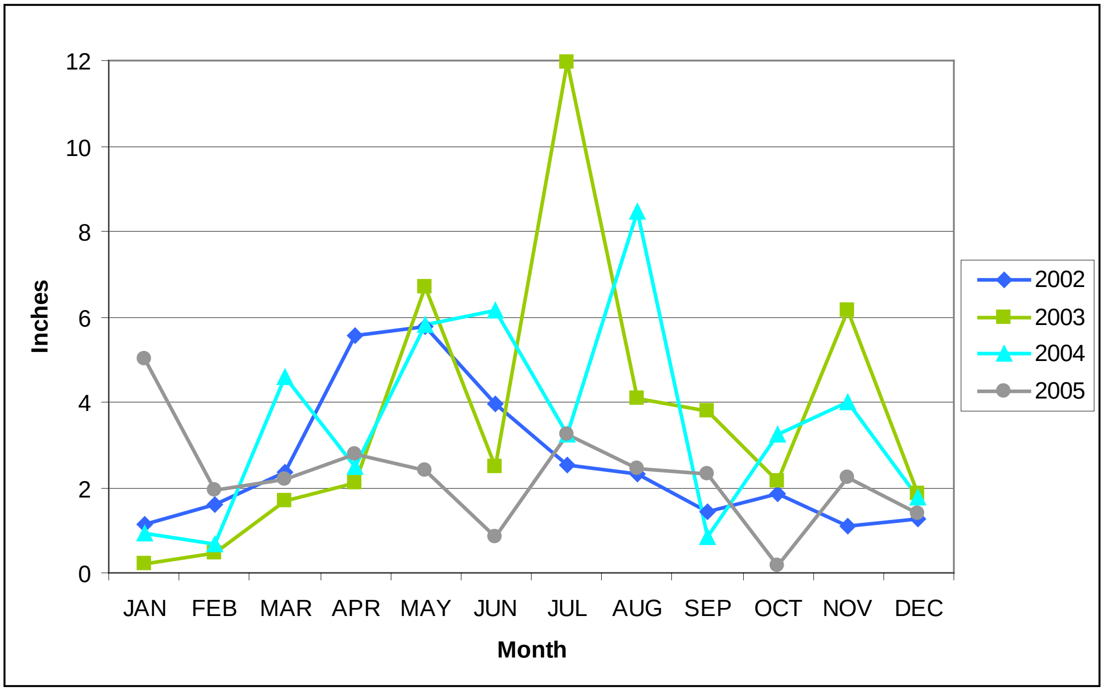


Figure 3. Precipitation 2002-2005.

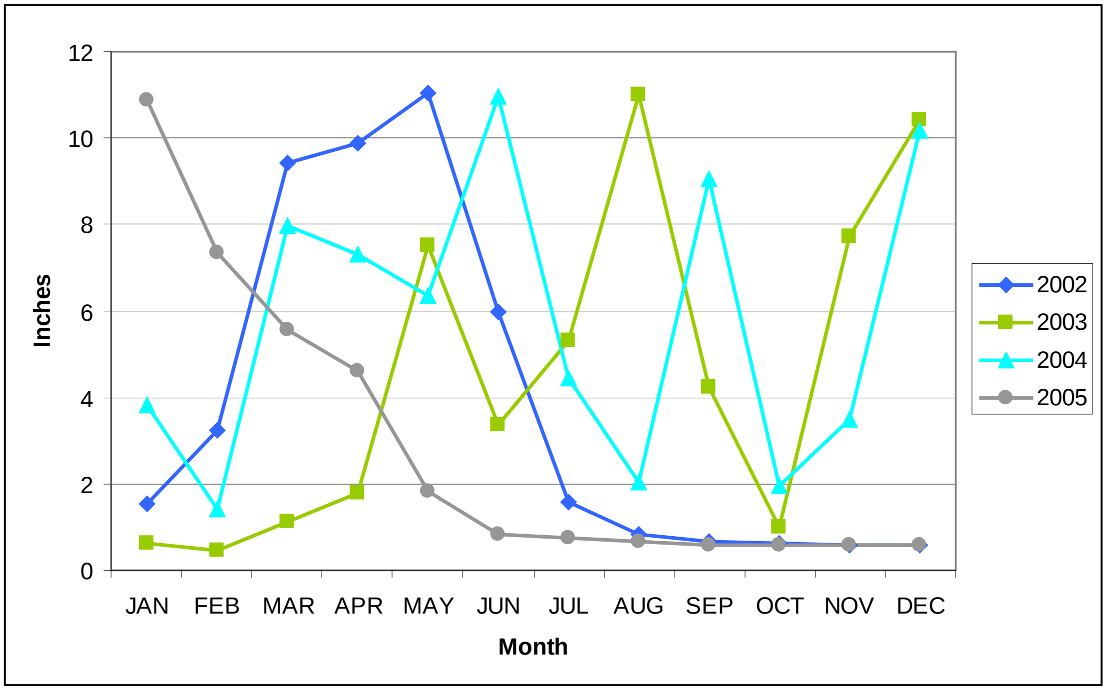


Figure 4. Basin B Groundwater Seeps 2002-2005.

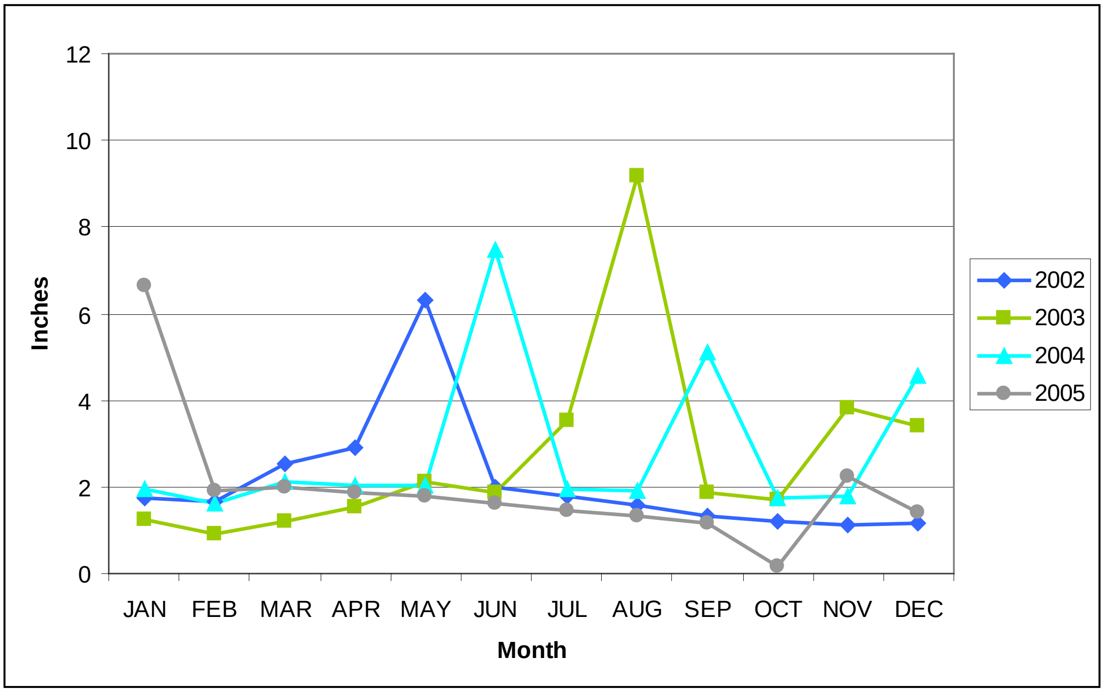


Figure 5. Basin D Groundwater Seeps 2002-2005.

EVAPOTRANSPIRATION

Evapotranspiration, or ET, is the combination of evaporation from the soil surface and transpiration from vegetation. It depends on the supply of energy in the air to vaporize water and carry it into the atmosphere. ET also varies based on the type of vegetation and the supply of moisture at the evaporative surface. The Penman-Monteith equation was used to compute the potential ET, or PET (Allen et al. 1998). The method assumed that the vegetation was even grass. Monthly averages of the following meteorological data taken at O'Hare Airport were used: daily maximum temperature, daily minimum temperature, wind speed, relative humidity, and precipitation. These data were obtained from the National Climatic Data Center. The station at O'Hare was the nearest station that collected the required data. Monthly crop coefficients were applied to adjust the ET values from even grass to other vegetation. The crop coefficients from Bowman and Collins (1987) were used. Figure 6 contains the values of PET used in this analysis.

Once the PET was computed for a given month, it was compared to (P + G). If (P + G) was greater than PET, then there was an adequate supply of water and ET was set equal to PET. Any excess (P + G) was assumed to either infiltrate or become runoff, depending on whether the soil was saturated. If P was less than PET, then ET depended on (P + G) and the amount of water available from the soil.

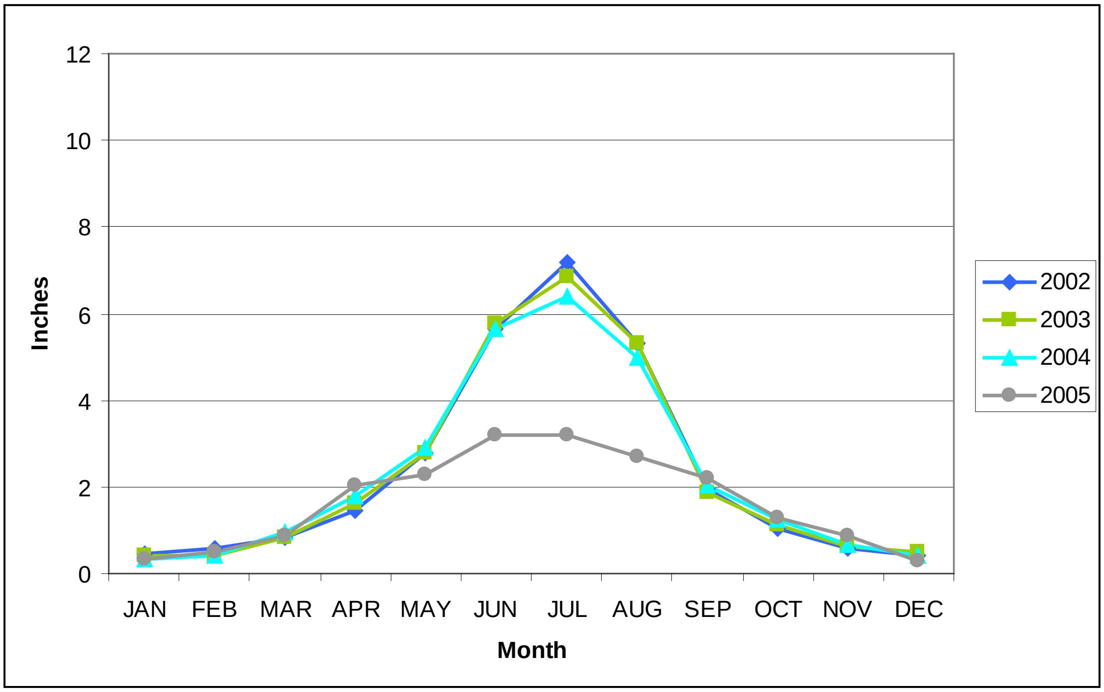


Figure 6. Potential Evapotranspiration 2002-2005.

DEEP PERCOLATION

Deep percolation, or DP, is the portion of water that infiltrates deep into the soil and recharges shallow aquifers. In Roadcap et al. (1993), the recharge rates for various areas in Will and Southern Cook Counties were computed with flow nets using 1990 data on the potentiometric surface of the aquifer. Using Figure 21 and Table 4 in that report, the recharge rate near Lockport Prairie was 139,000 gpd/mi^2, or 2.9 in/yr. In this water balance, DP was set to a constant value of 0.25 in per month, or 3.0 in/yr.

STORAGE CAPACITY

Storage Capacity, or S, is the amount of water that can be stored in an area. It is the sum of canopy interception storage, surface depression storage, and soil water storage. Canopy interception storage is the amount of precipitation that lands on vegetation above the ground and does not reach the ground surface. Surface depression storage is the amount of precipitation that accumulates in hollows on the ground surface. Soil water storage is the amount of water that infiltrates the void spaces in the soil. The canopy interception storage and surface depression storage were computed using vegetation and soil data from GAS (2004) and Norris (2003). The soil water storage was computed using the available water capacity of the top five feet of the soil column, found in the Will County Soil Survey (NRCS 2006). The storage capacity was 4.26 in for Basin B and 3.35 in for Basin D.

RUNOFF

Surface runoff, or R, is water that does not evaporate and does not infiltrate the soil. It flows above ground, eventually reaching a stream. Surface flow measurements were taken in 2002 and 2003 at the culverts and French drains under the railroad tracks, the outlets of the water balance boundaries. This data was used to calibrate the seep flow calculations as described above in the Groundwater Seeps section. However, since the measurements of R were not taken over the entire period of record used in the water balance, R was computed as a function of the other water balance parameters. In this analysis, R was the amount of precipitation that did not leave the system as ET or DP and could not be stored in the soil once it became saturated. A comparison of the computed and measured values of R is included in the next section.

RESULTS AND DISCUSSION

The period of record analyzed was limited by the availability of monitoring well observations. Since only four calendar years were included in the balance, one cannot draw conclusions about long-term trends or changes in the site hydrology. However, the water balance results can provide greater insight into how water enters and moves at Lockport Prairie.

The amount of inflow to the Basin B and Basin D systems was much lower in 2002 and 2005 than 2003 and 2004. In both basins, the soil water storage was completely depleted in the summer of 2002, and it took a few months for the soil to refill to capacity. In the summer of 2005, the soil water storage was only partially depleted, despite even lower precipitation and groundwater than 2002. This is because the potential evapotranspiration rate was also lower in 2005 due to other meteorological factors. Outside of those two drier periods, the soil was generally saturated, which makes sense considering that the water table is very close to the surface. There was enough inflow for the potential evapotranspiration rate to be achieved every month except for late summer 2002.

Figure 7 show the average annual contribution of the inflows and outflows to the water balance. Data from the entire period of record and both Basins B and D were combined. On average, the volume of groundwater entering the site is slightly greater (56%) than the volume of precipitation (44%). Almost two-thirds of the outflow from the basins leaves as surface runoff. Evapotranspiration accounts for less than one-third, and deep percolation accounts for 4%. The average change in soil water storage was negligible for the period of record because every time the soil dried out, it became saturated again within a few months. The amount of runoff entering the prairie is about 54 inches per year.

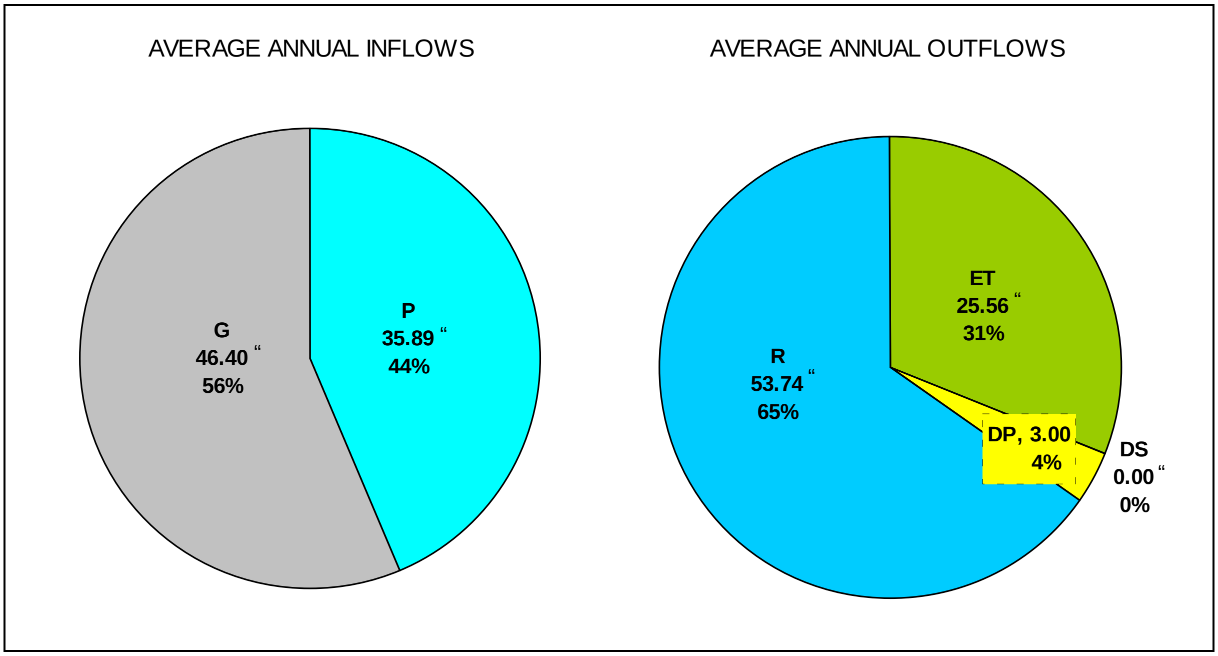


Figure 7. Water Balance Results, West of Railroad Tracks.

The computed runoff was compared to the raw streamflow measurements taken at the culverts and French drains in April through November, 2002 and 2003. In general both the computed and observed data followed similar trends, but there were varying degrees of difference over the time period. In both basins, runoff increased from early spring through early summer, and then decreased from late summer through the fall. Figure 8 compares the runoff volumes for Basin B, which includes Culverts 4 and 5.

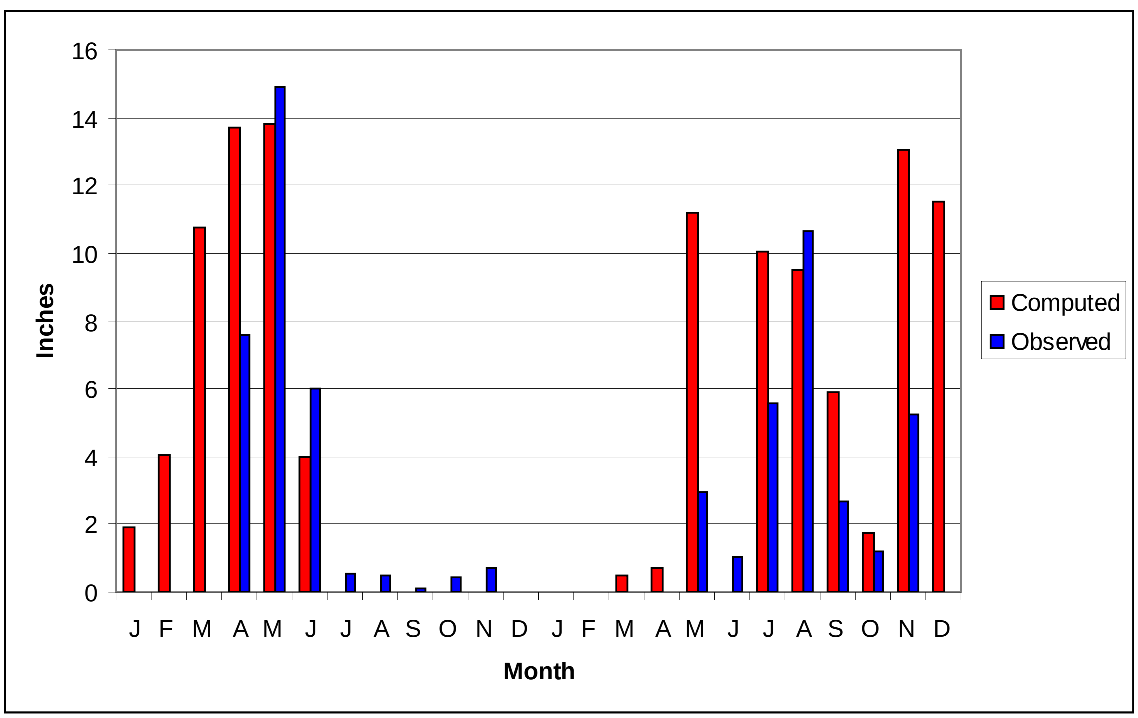


Figure 8. Comparison of Computed Runoff to Measured Flows in Basin B.

The observed volume for April 2002 is artificially low because about half of the data is missing for that month. During July through November 2002, there was no computed runoff. While surface flow was measured, the volume was low, less than one inch per month. In May 2003, the computed volume was much higher than observed; this may be due to the calculated seep flow, which was relatively high that month.

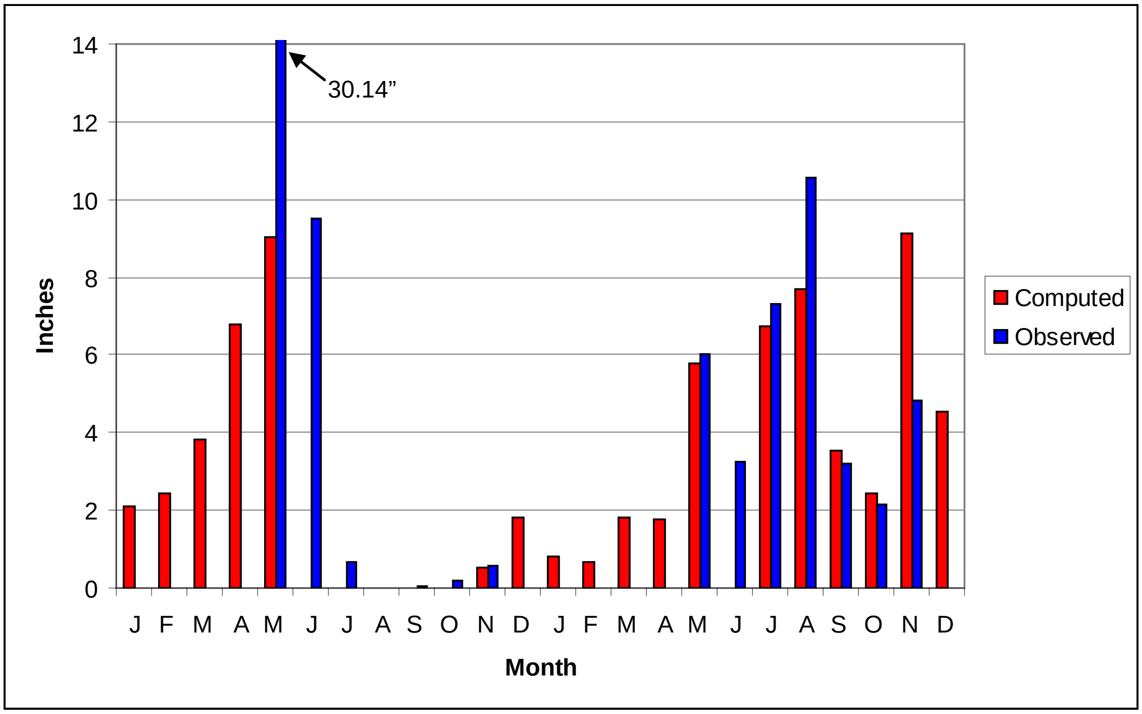


Figure 9. Comparison of Computed Runoff to Measured Flows in Basin D.

Figure 9 compares the runoff volumes for Basin D, which includes measurements at Culverts 1 and 2 and French Drains 2 and 3. In May and June 2002, the observed volumes are suspect; large fluctuations in flow were recorded that do not seem associated with rainfall. The computed and observed volumes compare well for the rest of 2002. Good agreement between computed and observed volumes was also achieved in May, July, September, and October 2003.

Future work could include modifying the water balance to investigate how proposed measures would affect the site hydrology. In 2006 the Hydrologic Engineering Center (HEC) developed recommendations for modeling various measures in a water balance. For example, changing the plant community to native species could affect evapotranspiration, and it could leave more water on-site to either infiltrate as groundwater or flow as surface runoff.

RESTORATION MEASURES

Five measures were investigated in this analysis: a culvert under Division St., infiltration trenches, water level control structures, drainage tile disablement, and erosion control of eroded area. These measures are included in this report in order to have a complete record of the hydrologic analysis; however, as the project progressed, the first three measures listed above were eliminated from future consideration for various reasons. For each measure, design and operational considerations are discussed as well as the reason for their elimination.

CULVERT

The purpose of a new culvert under Division Street is to reroute some water that enters the site in the hopes of distributing runoff more evenly on either side of the street. From surface water flow measurements taken in 2002 and 2003, the majority of surface runoff flows through Culvert 4, which is north of the road. The streamlet downstream of Culvert 3 was identified in Soluk et al. (2006) as a dragonfly habitat, but the population density has been low. Culvert 3 is completely clogged with sediment and is unable to convey water under the railroad tracks. The advantage of a gated culvert is that it is a simple and reversible way to manage surface water at Lockport Prairie. The structure would give site managers more control over the flow rate to the rivulets fed by the culverts.

Design Considerations and Operation

Looking at the flow measurements (GAS 2004), surface flow rates on this site are low: baseflow through the culverts is less than 0.1 cfs and peak flows during storm events range from 1-2 cfs. The new culvert does not need to be designed to carry flood flows, just to divert some water and connect the north and south sides of the site. Doing a simple calculation with the continuity equation, $Q = V * A$, if the design flow is 1 cfs and we assume velocity is 3 ft/s in a round pipe, then the required diameter is 8 in. However, a small pipe would get clogged more easily, so operation and maintenance considerations may dictate a larger pipe with a diameter of 1.5-2 ft. The new culvert could be sized similarly to the existing culverts on the site; Culvert 4 is a concrete box culvert about 2-ft wide by 2-ft high. The culvert should be about 80 ft long to pass under Division St and its embankment. The new culvert would be horizontal and have a control such as a gate on the north end. The culvert would also need inlet and outlet erosion protection, which could be a riprap blanket.

The location of the new culvert depends on the target location for the diverted water, the condition of the existing prairie across the site, and the existing topography. The target location has not been denoted specifically, except that it is south of Division St. and possibly east of Culvert 3. It has been noted that stakeholders would prefer to leave higher-quality areas undisturbed by construction equipment. This preference suggests placing the culvert west of the railroad tracks because this area has lower-quality vegetation. However, looking at the topography (GAS 2000) and the flow paths shown in Figure 2, water north of Division St. and west of the railroad tends to flow to the northeast, away from the road. Additionally, in this portion of the site, the area south of the road is higher than the area north of the road. Excavation and other earthwork would be required to induce some runoff on the north side of the road to flow south, and then that runoff would need an engineered flow path on the south side. The existing topography east of the railroad is better suited to the goal of this measure. The location of the new culvert could also be dependent on the elevation of the road compared to the surrounding area. The culvert should be placed at a reasonable invert elevation with a thickness of fill or aggregate on top of it, which is required to shield it from traffic loading. Operation would consist of opening and closing the gate as desired. Maintenance would consist of maintaining the gate, keeping the culvert openings free of debris and thick vegetation, and cleaning out the culvert if it gets clogged. The inlets and outlets should also be monitored for erosion.

Reason for Elimination

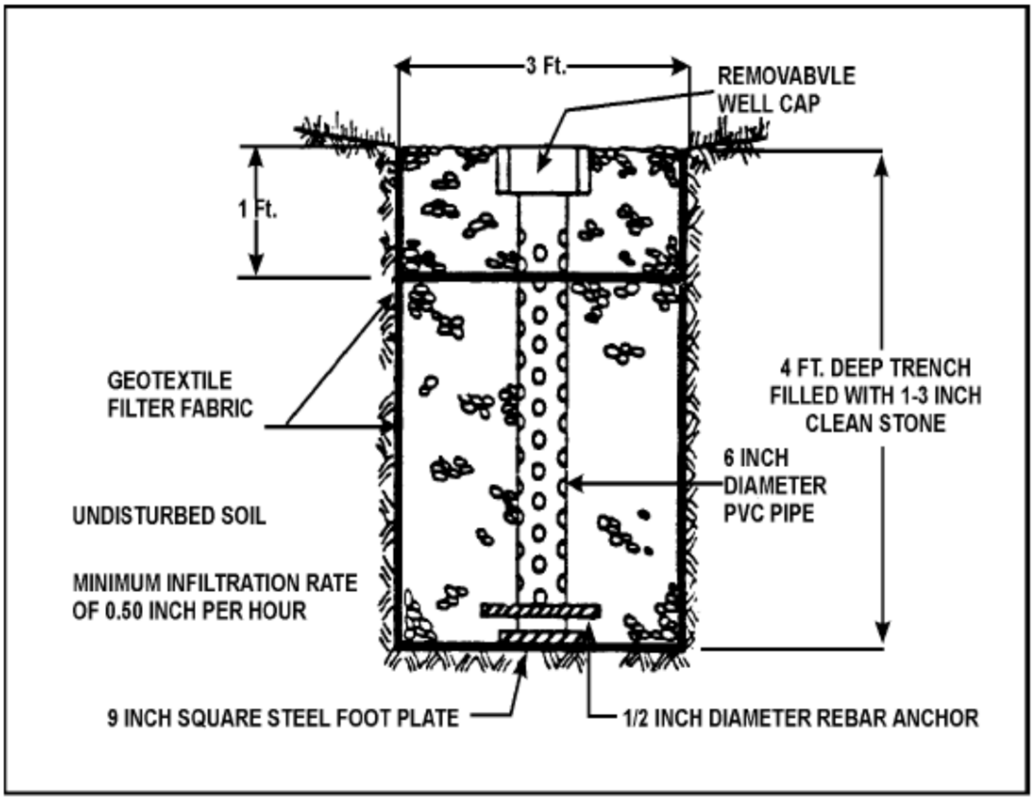
This measure was eliminated from further plan formulation because it would decrease the travel time for water to flow to the southeast portion of the site. Suspended sediments would have less time to settle, and this is an undesirable water quality impact.

INFILTRATION TRENCH

The purpose of infiltration trenches at Lockport Prairie is to filter particulates or oil and grease that are carried by runoff from Route 53. An infiltration trench is an excavated trench, 3 to 12 ft deep, backfilled with a stone aggregate, and lined with filter fabric. The trench captures a portion of an area's surface runoff and allows it to infiltrate the surrounding soil. Trenches are generally sized to capture the first 0.5-in of runoff, the first flush of a storm that generally carries the most pollutants. Infiltration trenches can remove a large portion of the particulates, pathogens, and metals from surface runoff, and they also increase groundwater recharge. Figure 10 is a cross section of a typical infiltration trench (USEPA 1999).

Design Considerations

There are five criteria that determine whether an infiltration trench is a suitable best management practice (BMP) for a site: drainage area, soil type, infiltration rate, depth to water table, and slope. The contributing drainage area should be less than 5 acres, although a drainage area of up to 10 acres could be acceptable if other BMPs such as vegetated filter strips are implemented as well. The soil surrounding the trench should be in Hydrologic Soil Group A or B and have a silt/clay content less than 40%. Soils in Groups A and B have moderate to high infiltration potential and would be able to accept runoff from the infiltration trench. The minimum infiltration rate of the surrounding soil should be 0.5 in/hr. If the infiltration rate is too low, the trench will drain slowly and anaerobic conditions may develop. If the infiltration rate is higher than 2.4 in/hr, the trench will not be able to remove the maximum amount of contaminants from the runoff (CASQA 2003). Additionally, the bottom of the trench should be at least 4 ft from the seasonally high water table to prevent possible groundwater contamination. Finally, infiltration trenches work best when the upgradient drainage area slope is less than 5%. The downgradient slope should be no greater than 20% to minimize slope failure and seepage (USEPA 1999).



Source: Southeastern Wisconsin Regional Planning Commission, 1991.

Figure 10. Typical Infiltration Trench.

Figure 11. Infiltration Trench Locations.

The documentation in Attachment 3 includes a detailed comparison of Lockport Prairie to the infiltration trench site criteria and preliminary trench design; the subject will be briefly summarized here. The type of soil east of Route 53 at Lockport Prairie meets the criteria for an infiltration trench; however, the steep land slopes limit where the trench could be placed. There are four areas east of Route 53 that meet the USEPA (1999) slope guidelines. The drainage areas and trench dimensions were determined for three locations on the site. Figure 11 shows the location of the proposed infiltration trenches. Each trench would be 8 ft wide and 4 ft deep. From north to south, the lengths of the proposed trenches would be 38 ft, 25 ft, and 22 ft.

Construction and Operation

To install an infiltration trench, first soil is excavated. Next, a 6-in layer of clean sand is placed on the bottom of the trench. The sides and top of the trench are lined with geotextile filter fabric to prevent soil piping but with a greater permeability than the surrounding soil. Then coarse aggregate is added and filter fabric is placed on top, about 2 to 6 inches from the top of the trench. The top layer of filter fabric prevents sediment from passing into the lower section. Pea gravel should be placed above the filter fabric to the top of the trench. The pea gravel layer improves filtering and pollutant removal. The pea gravel and fabric can be easily removed when they get clogged with sediment. Permeable topsoil planted with grass is an alternative to the pea gravel.

The area of the catchment around each trench, outside the ROW, should be planted with grass to act as a vegetated filter strip. This will remove some particulates from the runoff before it reaches the trench. A low berm should be constructed around the catchment to store runoff from higher-intensity storms and allow it to infiltrate in the trench. The trench should contain an observation well so that the water level and amount of clogging can be checked as part of regular maintenance. The observation well should consist of perforated PVC pipe, 4 to 6 inches in diameter. It should have a cap and a lock.

Discussion

The advantages of infiltration trenches are the removal of a large portion of the particulates, pathogens, and metals from the runoff and the increase in groundwater recharge. The disadvantages of infiltration trenches are the potential for groundwater contamination and the potential of the trench to get clogged with fine sediment. The long-term performance of the infiltration trenches will depend on regular inspection and maintenance. Infiltration trenches can remove about 80% of the total suspended solids, 60% of the nutrients, 90% of the metals, and 90% of the pathogens carried by runoff. However, these removal efficiencies are based on a retention time on the order of 24-48 hr. Since the soils surrounding the proposed trenches are composed of loamy sands and gravels, runoff will infiltrate from the trench to the soil in just a few hours. The water quality benefits of the infiltration trench will not be achieved to their full potential.

Daily precipitation data from 1998-2005 at nearby Lewis University were used to assess the percentage of runoff that would flow into the infiltration trenches. It was assumed that any daily rainfall less than or equal to 0.5 in would be captured by the trench. For the period of record, the percent of runoff in the trench catchments that flowed into the trench each month ranged from 39% to 100%, with an average of 68%. The trench catchment area is about 16% of the total area of the stretch of road. Comparing the amount of runoff captured by the trenches to the total precipitation on Route 53 along Lockport Prairie, about 11% of the runoff would flow into the infiltration trenches. Supporting calculations can be found in Attachment 3.

Reason for Elimination

The infiltration trench measure was eliminated from further plan formulation because of the risk of contaminating groundwater with road salt dissolved in surface runoff.

WATER LEVEL CONTROL STRUCTURES

The purpose of water level control structures on the existing culverts at Lockport Prairie is to manage the discharge of surface runoff into the prairie. Man-made structures such as roads, ditches, and storm sewers near the site have changed the way that surface water flows over the site.

Design Considerations and Operation

Stop log structures would be placed at the inlet of the culverts under the railroad tracks. It consists of a concrete base, a 36”- diameter corrugated metal pipe, and 3”-high, glued PVC stop logs that slide in and out of the vertical pipe. The stop logs could also be made of wood. Prefabricated structures are commercially available. Operation would consist of adding or removing stop logs as desired before or after storm events. For example, stop logs could be added to hold back water and allow a rivulet to dry for a period during a particularly wet summer, or to allow surface water to enter the prairie at a slower rate for a longer time after a heavy, intense rain. Maintenance would consist of maintaining the structure, keeping the inlet free of debris and thick vegetation, and cleaning out the metal pipe if it gets clogged.

Discussion

Stop log structures hold back the peak flow from storm events; this could prevent erosion and reduce sediment loading downstream of the culverts. One disadvantage of the stop log structures is that allowing water to pond behind stop logs before discharge to the prairie could affect temperature and evaporation rates.

Reason for Elimination

This measure was eliminated from further consideration because of right-of-way and funding issues that would arise since the stop-log structures would be attached to the existing railroad.

DRAINAGE TILE DISABLEMENT

A drainage tile system at the Prairie Bluff Preserve (PBP) (MU1 on Figure 1) has been in place to aid in the former high intensity farming practices that occurred in this area. The effect of this system is a significant reduction in the volume of stormwater that replenishes the groundwater recharge zone for the Lockport Prairie Nature Preserve (LPNP). This reduces the groundwater levels in the LPNP and has resulted in an increased mortality to some rare species that inhabit the site, especially the federally listed Hine's Emerald Dragonfly and the state listed Spotted Turtle.

Drain tile disablement is recommended to restore the natural hydrology at the PBP. The plan is to install water control valves at certain intervals to back up water in appropriate locations. This measure would effectively restore the hydrology within the PBP. Once the hydrology is naturalized, wetlands will be reestablished, water will be retained for longer periods which will increase the amount of water available to infiltrate into the groundwater table that discharges to LPNP. This groundwater table is a significant component of the critical recharge zone for LPNP. This measure coupled with native plant installation will result in reestablishing the wetlands within the PBP and naturalizing the critical recharge zone of the Lockport Prairie.

EROSION CONTROL OF ERODED AREA

An area within MU 2 (LPNP Bluff) between Route 53 and Division Street receives on occasion high volumes of runoff resulting in the formation of a gully. The areas is approximately 1-acre in size. This area contains high coverage of invasive woody species that has resulted in mostly bare soil underneath the woody species. After removal of all woody plant species and erosion control blanket will be installed. This erosion control blanket (in addition to native plant installation) will result in this area no longer acting as a source of excess sediment entering the rare plant communities of LPNP and ensure that the gully does not expand to engulf and degrade more of the oak savanna.

SUMMARY

In this report, the water balance was described for a portion of the Lockport Prairie site. Five ecosystem restoration measures were also discussed: a new culvert under Division St., an infiltration trench, water level control structures, drainage tile disablement, and erosion control of eroded area. The water balance showed that the area west of the railroad tracks receives about 36 in of rain a year, and about 46 in of surface or subsurface flow from groundwater seeps. Of the 82 in of water flowing into the site, about 54 in flows out to the rest of the nature preserve.

The majority of the remaining water leaves the site through evapotranspiration, and a small portion percolates to a deep aquifer.

The hydrologic analysis of this project had two objectives: to understand the sources of water and the way it flows on the site, and to investigate some of the proposed measures to support the alternatives analysis. A water balance was performed for a portion of the site, and five measures were studied: a new culvert under Division St., an infiltration trench, water level control structures, drainage tile disablement, and erosion control of eroded area. The first three measures were eliminated from consideration while the other two (drainage tile disablement and erosion control of eroded area) were retained.

REFERENCES

Allen, R.G., L.S. Pereira, D. Raes, and M. Smith. 1998. Crop Evapotranspiration: Guidelines for Computing Crop Water Requirements, Irrigation and Drainage Paper 56, Food and Agriculture Organization of the United Nations, Rome, Italy, http://www.fao.org/docrep/X0490E/xo490e00.htm#Contents.

Atlanta Regional Commission. 2001. Georgia Stormwater Management Manual, http://www.georgiastormwater.com.

Bowman, J.A. and M.A. Collins. 1987. Impacts of Irrigation and Drought on Illinois Ground-Water Resources, Report of Investigation 109, Illinois State Water Survey, Champaign, IL.

California Stormwater Quality Association. 2003. California Stormwater BMP Handbook: New Development and Redevelopment, http://www.cabmphandbooks.com.

Graf, Anhalt, Shloemer & Associates, Inc. 2000. Aerometric Survey of Lockport Prairie Nature Preserve, CD, ArcInfo coverages, Chicago, IL.

-----. 2004. Lockport Prairie Nature Preserve Ecological Assessment: Hydrologic Assessment, for the Forest Preserve District of Will County, Chicago, IL.

Hydrologic Engineering Center. 2006. Hydrologic and Hydraulic Modeling Recommendations for the Lockport Prairie Environmental Restoration Project, Institute for Water Resources, US Army Corps of Engineers, Davis, CA.

National Climatic Data Center. 2001-2005. Local Climatological Data: Annual Summary with Comparative Data, Chicago O'Hare International Airport (ORD), National Oceanic and Atmospheric Administration, US Department of Commerce, Washington, DC, http://www.ncdc.noaa.gov/oa/climate/climatedata.html.

-----. 2001-2005. Local Climatological Data: Chicago/Romeoville Lewis University Airport, National Oceanic and Atmospheric Administration, US Department of Commerce, Washington, DC, http://www.ncdc.noaa.gov/oa/climate/climatedata.html.

Natural Resources Conservation Service. 1999. Illinois Urban Manual, US Department of Agriculture, http://www.il.nrcs.usda.gov/technical/engineer/urban/contents.html.

-----. 2006. Illinois NRCS Engineering Drawings: Corrugated Pipe Stop Log Structure, US Department of Agriculture, http://www.il.nrcs.gov/technical/ engineer/enggdraw.html.

-----. 2006. Soil Survey Tabular Database for Will County, Illinois, Electronic Field Office Technical Guide, US Department of Agriculture, http://www.nrcs.gov/technical/efotg.

Norris & Associates, Inc. 2003. Data Collection and Hydrologic Model Report for the Lockport Prairie Nature Preserve Will County, Illinois, for the US Army Corps of Engineers, Chicago District, Chicago, IL.

Roadcap, G.S., S.J. Cravens, and E.C. Smith. 1993. Meeting the Growing Demand for Water: An Evaluation of the Shallow Ground-Water Resources in Will and Southern Cook Counties, Illinois, Research Report 123, Illinois State Water Survey, Champaign, IL.

Soluk, D.A., C. Satyshur, J. Holmes, and E. Blas. 2006. The Distribution and Quality of Hine's Emerald Dragonfly (*Somatochlora hineana*) Habitat in Relation to Surface and Groundwater Dynamics in the Lockport Prairie Nature Preserve, Department of Biology, University of South Dakota, for the Corporation for Openlands, Chicago, IL.

US Environmental Protection Agency. 1996. Protecting Natural Wetlands: A Guide to Stormwater Best Management Practices, EPA-843-B-96-001, Office of Water, Washington, DC.

-----. 1999. Storm Water Technology Fact Sheet: Infiltration Trench, EPA-832-F-99-019, Office of Water, Washington, DC.

Wisconsin Wetlands Association. 2002. Restoring Wetlands: Planning a Wetland Restoration Project, http://www.wiscwetlands.org/restorationplan.htm.