LAWRENCE COUNTY PROPOSED WETLAND MITIGATION BANK: HYDROGEOLOGIC CHARACTERIZATION REPORT

County Road 800N and 1500E
Lawrence County, Illinois
(Sequence # 14912)

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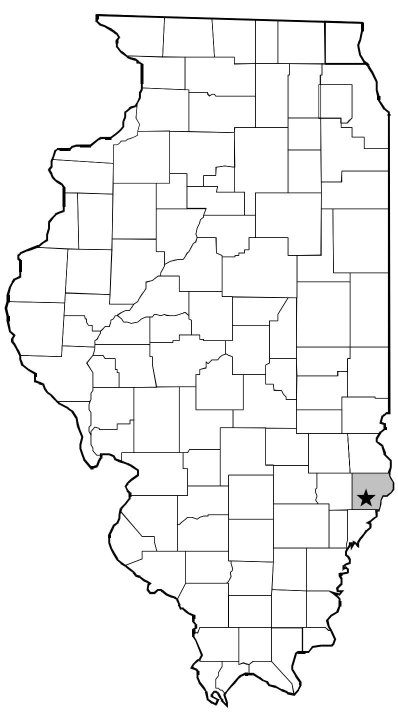

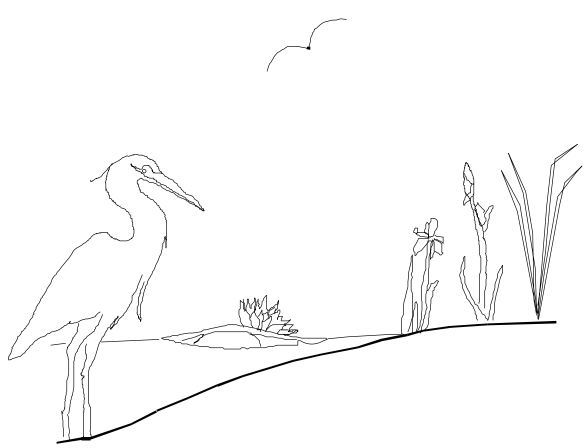

EXECUTIVE SUMMARY

In July 2009, the Illinois Department of Transportation tasked the Wetlands Geology Section of the Illinois State Geological Survey with conducting a hydrogeologic characterization of the potential wetland mitigation bank site in Lawrence County, Illinois. Data collected were analyzed to determine the geology and hydrology of the site and to determine if wetland hydrology could be restored or created. Field work at this site began in November 2009 with the installation of a network of monitoring wells, staff gauges, and data loggers.

This site has a total area of 29.6 ha (73.1 ac); 13.3 ha (32.8 ac) have been delineated as wetland and 16.3 ha (40.3 ac) have been delineated as non-wetland. Of the non-wetland portion of the site, 12.1 ha (29.9 ac), consisting of agricultural fields, are available for wetland restoration/creation. The site is mostly mapped as hydric soils, including the 12.1 ha (29.9 ac) that is currently available for wetland restoration/creation. There are three reversible hydrologic alterations on the site, two culverts and a drain tile. The primary water source supporting wetland hydrology is flooding from Beaver Pond Ditch. Flooding occurs regularly before the start of pumping in Beaver Pond Ditch, which begins in March or April and ends in October. Reversing the hydrologic alterations and excavating portions of the agricultural fields in order to trap flood waters and lengthen the period of inundation will likely result in inundation and/or saturation during the non-pumping portion of the growing season (late February through March) for periods sufficient to satisfy criteria for jurisdictional wetland hydrology.

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INTRODUCTION

This report was prepared by the Illinois State Geological Survey (ISGS) to provide the Illinois Department of Transportation (IDOT) with conclusions regarding the hydrogeologic conditions at a potential wetland mitigation bank near Lawrenceville, Illinois in Allison Township (SW ¼, SW ¼, Section 15, and the W ½, NW ¼, NW ¼, Section 22, T3N, R11W), Lawrence County, Illinois (Figure 1). The area of the site is about 29.6 ha (73.1 ac). Portions of the site are currently used for agriculture and the remainder is forested.

The purpose of this report is to provide IDOT with data regarding the hydrogeologic conditions of the site and to make recommendations regarding restoration and/or creation of wetlands. Therefore, for convenience, the report presents conclusions and design recommendations first, followed by a discussion of the methods and supporting data. The supporting data include groundwater and surface-water data, and precipitation data collected from November 2009 through May 2011, and geologic data collected during the installation of monitoring wells.

Data collection at the site is ongoing and will continue until terminated by IDOT. The data currently being collected will be used to compare the pre- and post-construction hydrology of the site and to determine the impact of restoration/creation activities on the area and the duration of wetland hydrology.

SUMMARY AND CONCLUSIONS

The following factors indicate that the potential for wetland restoration and creation at this site is **MODERATE**:

- A detailed on-site wetland determination, conducted by the INHS (Weisbrook, et al. 2009), delineated a total of 13.3 ha (32.8 ac) of wetlands at the site (Figure 2, sites 1, 2, and 3). The remainder, totaling 16.3 ha (40.3 ac), was delineated as non-wetland, and consisted of agricultural fields (site 5), levees and berms along Beaver Pond Ditch (site 0), and a portion of the forest west of Beaver Pond Ditch (site 4). The agricultural fields, totaling 12.1 ha (29.9 ac), are available for wetland restoration and/or creation.

- The primary water source supporting wetland hydrology at this site is inundation due to backflooding of Beaver Pond Ditch as the result of flooding on the Embarras River. Flood frequency analysis reveals that flooding on the Embarras River most often occurs in the months of February through May.

- Pumping of Beaver Pond Ditch by the Consolidated Drainage District starts about mid-March and ends in October or November. Despite this pumping, wetlands exist on the site because wetland hydrology criteria can be satisfied by floods that occur after the growing season begins, but before the site is ordinarily pumped for farming. Therefore, wetlands likely can be created or restored despite the continued presence of the ditch and pump.

- The hydrology of the site has been altered regionally, locally, and on-site (Figure 3). The regional hydrologic alteration is the Russell-Allison Levee, and the local alterations are Beaver Pond Ditch, a pumping station in the ditch, and two gravity drains with flapper gates in the ditch that pass through the levee. On-site alterations include

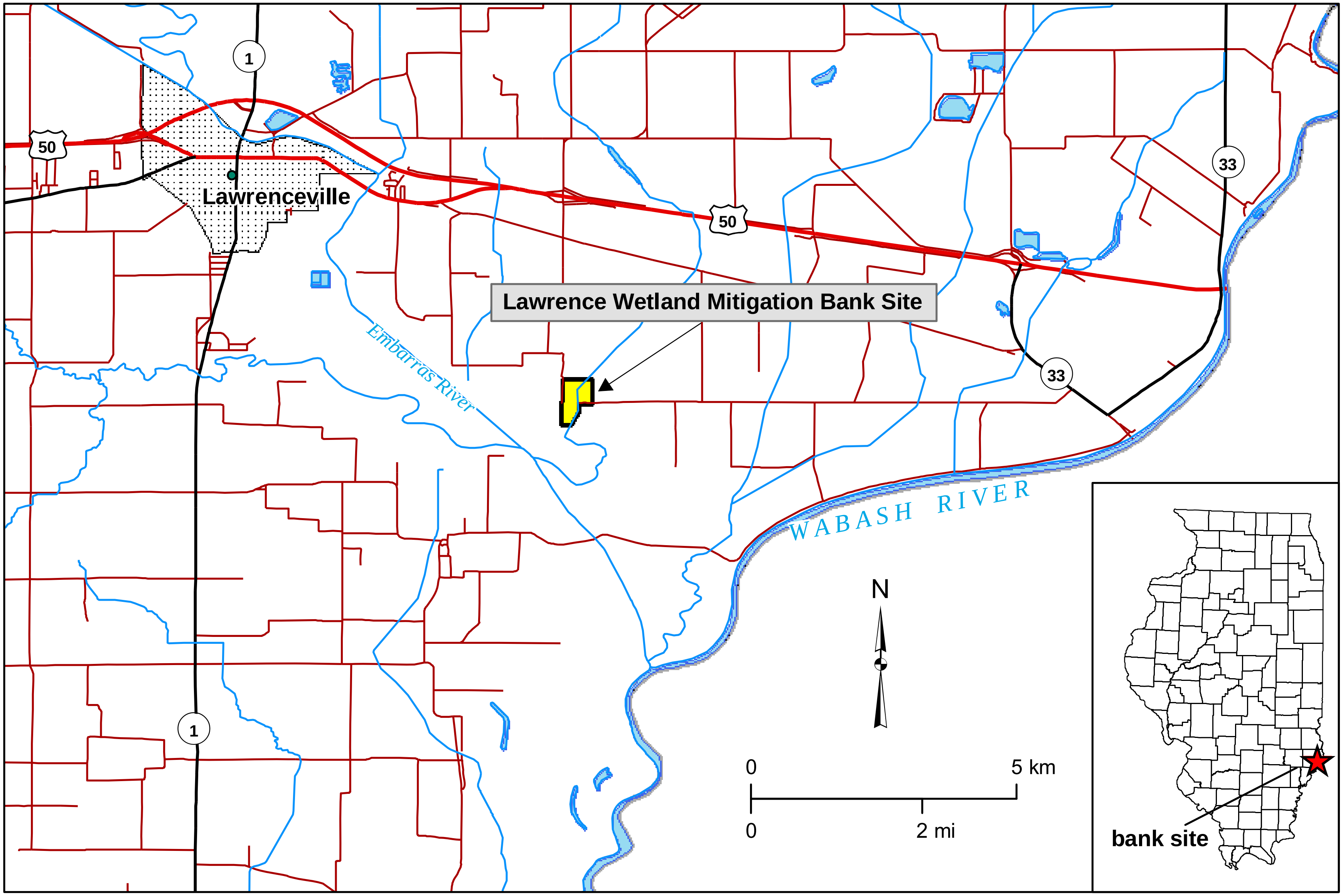

Figure 1. Location of the proposed Lawrence Wetland Mitigation Bank site (highlighted in yellow). The site is located southeast of the city of Lawrenceville and is within the Embarras River watershed in southeastern Lawrence County, IL.

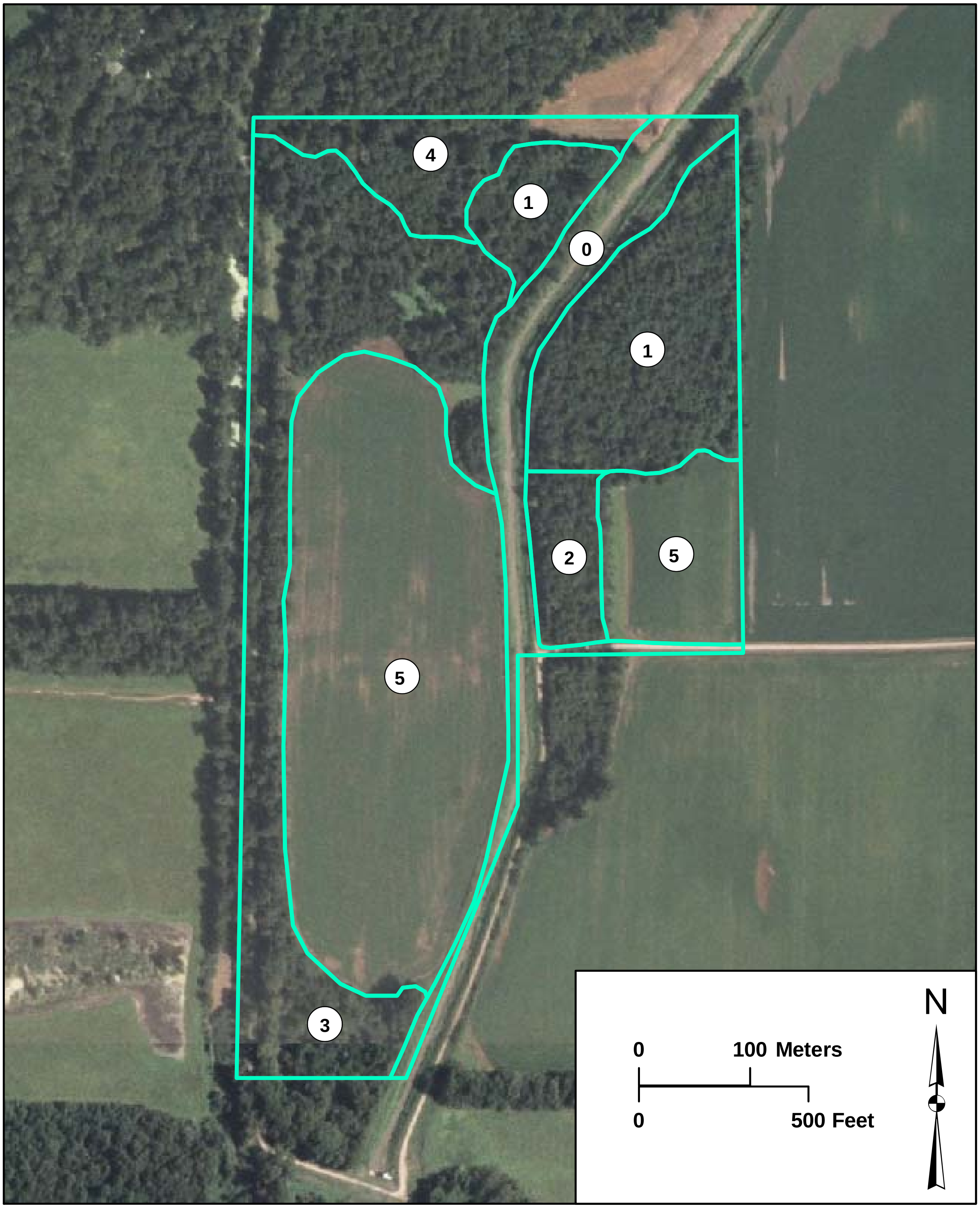

Figure 2. Exisitng habitats delineated by the Illinois Natural History Survey (Weisbrook et al. 2009). Map based on 2009 National Agricultural Imagery Program aerial photography (U.S. Department of Agriculture 2010).

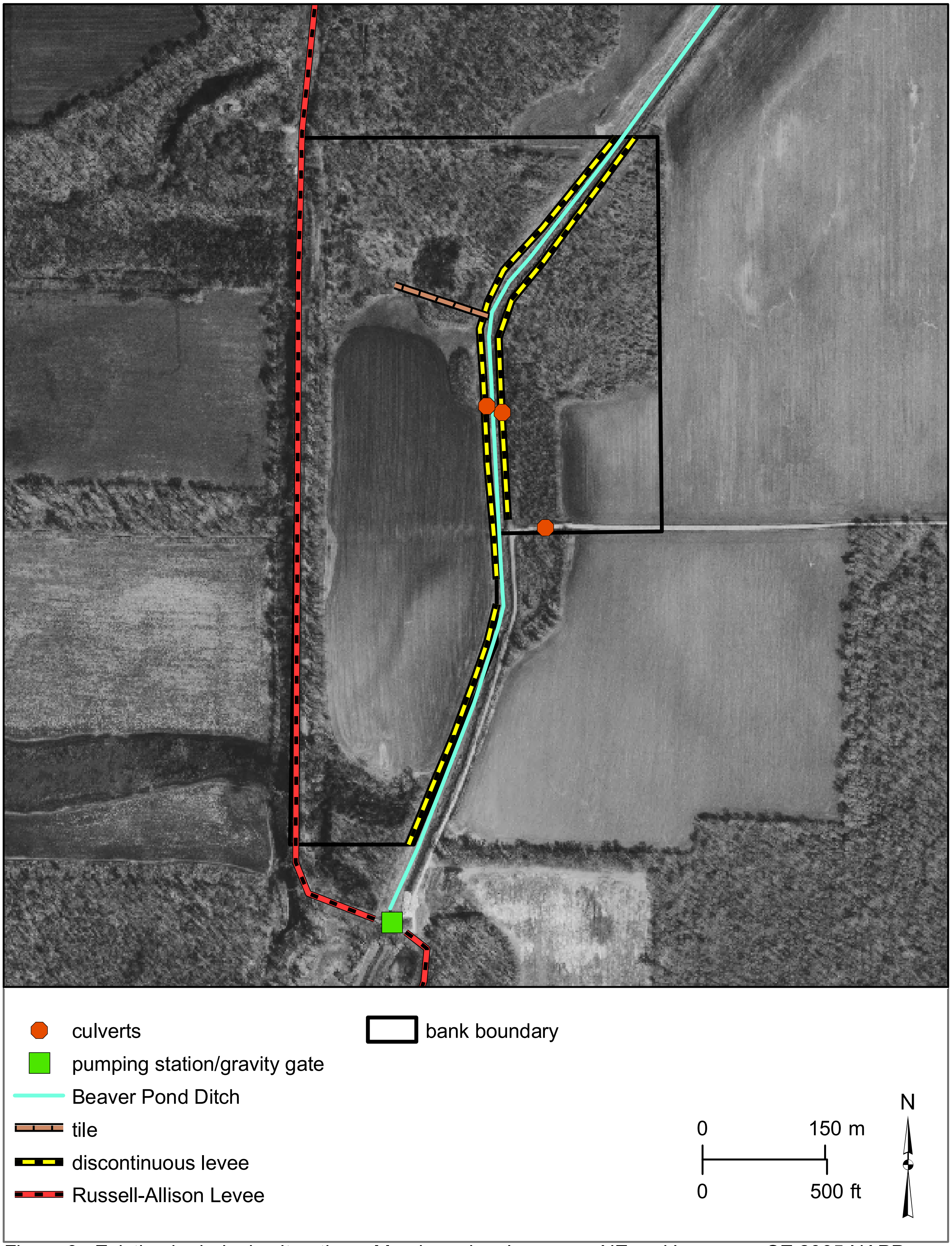

Figure 3. Existing hydrologic alterations. Map based on Lawernce NE and Lawrence SE 2005 NAPP digital othophoto quarter quadrangles (Illinois State Geological Survey 2006).

culverts in both banks of Beaver Pond Ditch, a drain tile in the forest north of the west field, and a discontinuous berm along Beaver Pond Ditch.

- It is not feasible to reverse the regional or local hydrologic alterations in order to restore wetland hydrology. Flooding of the site by the Embarras and Wabash Rivers was the primary water source supporting past wetland hydrology, but the regional levee and the local drainage system currently serves to protect and drain most of the surrounding floodplain for agriculture. However, the on-site hydrologic alterations can be reversed without affecting off-site properties.

- The agricultural fields did not exhibit wetland hydrology in 2010, a year that received nearly normal precipitation, and therefore are not likely to be wetland at present. This represents 12.1 ha (29.9 ac) of potential mitigation area.

- Almost the entire site is mapped as hydric soil, including the agricultural fields (Figure 4), indicating that most of the site formerly supported wetlands prior to drainage for conversion to agriculture.

- Most of the site is underlain by slowly permeable geologic materials that are conducive to ponding and a seasonal high water table. On-site soil borings show that the sediments are dominantly silty clay, and permeameter tests indicate that the areas mapped as Darwin, Wabash and Petrolia will likely retain surface water for periods of weeks to months. Areas mapped as Westland are more permeable and are less conducive to lengthy inundation and saturation.

WETLAND RESTORATION/CREATION RECOMMENDATIONS

The following alterations (Figure 5) are recommended for restoring or creating wetland on the site.

West of Beaver Pond Ditch

- Remove the culvert that discharges into Beaver Pond Ditch (Figure 5) and replace it with a spillway in order to allow input of floodwaters and retention of surface water. The recommended elevation of the spillway is 124.7 m (409.1 ft), based on recorded water levels in the ditch.

- Remove the drain tile located north of the agricultural field, thereby preventing drainage of the forested area and the northern portion of the agricultural field.

- Excavate about 4.2 ha (10.5 ac) of the agricultural field (Figure 5) to an elevation of 124.5 m (408.8 ft), removing as much as 0.7 m (2.3 ft) of sediment. With a spillway elevation of 124.7 m (409.1 ft), this will result in inundation depths ranging from 0.2 m (0.6 ft) to 0.6 m (1.9 ft) Construct a levee along the bank of Beaver Pond Ditch to an top elevation no lower than 125.0 m (410.1 ft).

East of Beaver Pond Ditch

- Remove the culvert that discharges into Beaver Pond Ditch (Figure 5) and replace it

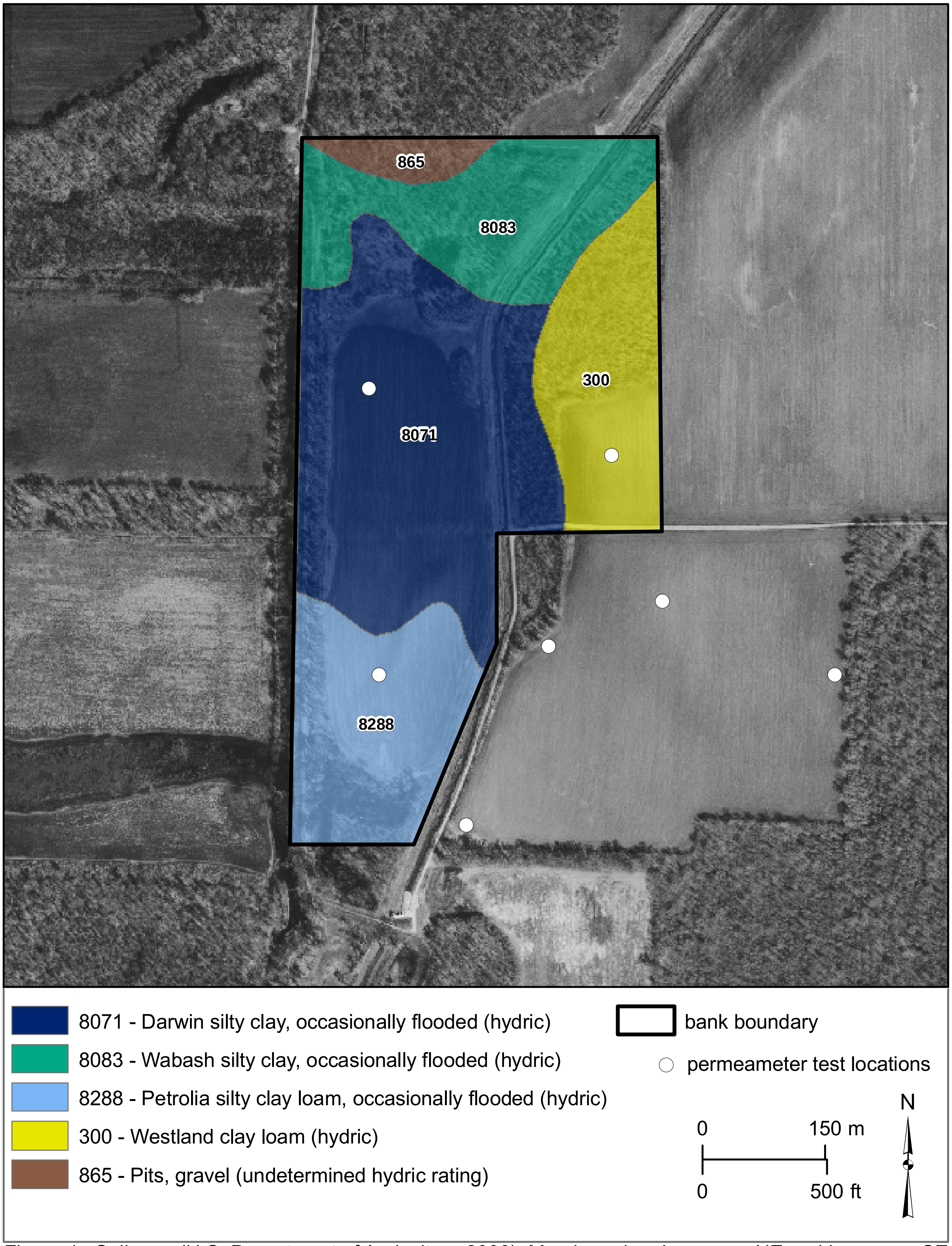

Figure 4. Soil map (U.S. Department of Agriculture 2009). Map based on Lawernce NE and Lawrence SE 2005 NAPP digital othophoto quarter quadrangles (Illinois State Geological Survey 2006).

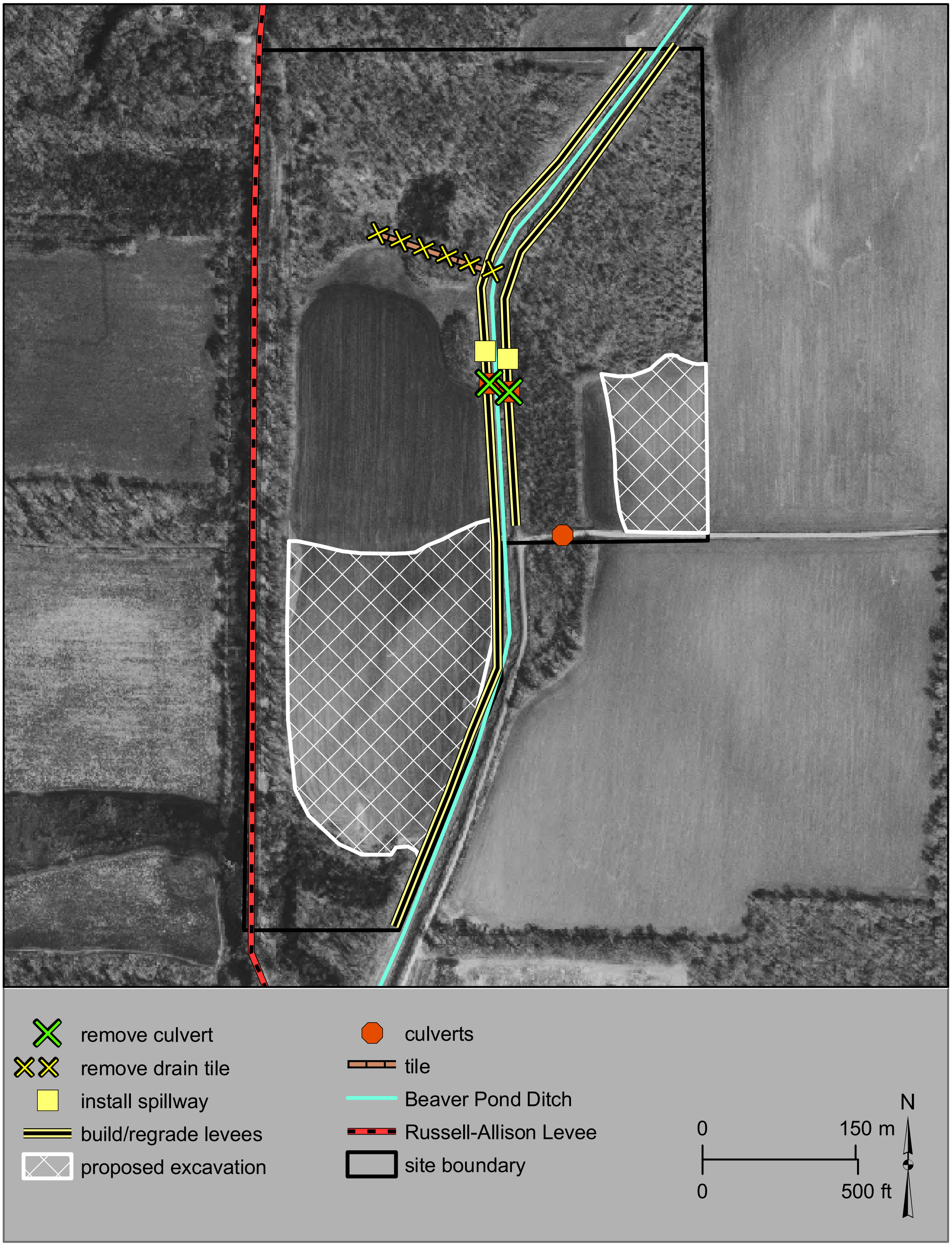

Figure 5. Planned hydrologic modifications. Map based on Lawernce NE and Lawrence SE 2005 NAPP digital othophoto quarter quadrangles (Illinois State Geological Survey 2006).

with a spillway in order to allow the input of floodwaters and retention of surface water. The recommended elevation of the spillway is 124.6 m (408.8 ft), which was chosen in order to maximize the area of inundation, but minimize potential impacts on the road along the southern boundary, which is at an elevation of about 124.8 m (409.5 ft).

- Excavate about 1.4 ha (3.5 ac) of the agricultural field (Figure 5) to an elevation of 124.5 m (408.5 ft), removing as much as 0.4 m (1.3 ft) of sediment. With a spillway elevation of 124.6 m (408.8 ft), this will result in inundation depths ranging from about 0.5 m (1.6 ft) near the spillway to about 0.1 m (0.3 ft) at the eastern boundary of the site. The area proposed for excavation is mapped as Westland clay loam (Figure 4). Permeameter tests in this soil reveal that the saturated hydraulic conductivity is highly variable, and the time for water on ground surface to infiltrate to a depth of 30.0 cm (12.0 in) ranges from 3 days to 1 year.

The invert elevation of the culvert under the east-west road east of Beaver Pond Ditch (Figure 5) is about 124.0 m (406.8 ft), which is lower than the proposed spillway elevation. Land surface elevation in the forested area south of the road (124.3 m [407.9 ft] at well 5S) is also lower than the proposed spillway elevation. Therefore, raising the elevation at which surface-water flows off the site into Beaver Pond Ditch will likely increase area of inundation south of the road, possibly impacting the adjacent farm field. Therefore, assuming the landowner gives permission, it is recommended that, either the elevation of the culvert and the road be raised, or that the culvert be removed, and a new culvert installed that will discharge directly into Beaver Pond Ditch, assuming the landowner agrees to the plan.

METHODS

The hydrology of the site was monitored using a combination of shallow monitoring wells and staff gauges (Figure 6) to evaluate the hydrogeologic conditions and to estimate the area of wetland hydrology. Water levels were measured on a biweekly to weekly basis from March to June and monthly during the remainder of the monitoring period. Groundwater levels were converted to depth-to-water below ground surface (Appendix A) and water-level elevation (Appendix B), but surface-water levels were expressed as elevation only (Appendix B).

Groundwater data were collected from 16 monitoring wells (Figure 6). Details of well construction are in Appendix C. The shallow (S) wells were designed to monitor groundwater within 0.75 m (2.5 ft) of ground surface, and were used to determine the timing and duration of saturation. Depth to groundwater was measured manually in all of the wells, but wells 4S, 7S, and 10S were also equipped with pressure transducers in order provide a more continuous record of groundwater levels. At well 10S, the data were initially recorded in 1-hour intervals, but this was later increased to 3-hour intervals; at wells 4S and 7S the data were all recorded in 3-hour intervals. The barometrically compensated height of the water column in each well was converted to depth-to-water below ground surface and to water-level elevation.

Surface-water data were collected from three staff gauges (Gauges A, B, and C). Gauges A and B were manually read gauges that were installed in areas of the site that are prone to prolonged inundation. Gauge C was a pressure-transducer installed first (November 2009) in Beaver Pond Ditch near the culvert in the west bank of the ditch, and, after it was destroyed by vandals in Fall 2010, replaced with a second pressure-transducer in February 2011, installed in a channel that drains water from the agricultural field west of Beaver Pond Ditch to the culvert

Figure 6. Monitoring network and elevation contours in the planned restoration areas at the proposed Lawrence Wetland Mitigation Bank (Illinois State Geological Survey 2006).

in the west bank of the ditch. Both transducers were programmed to record surface-water depth in 3-hour intervals.

Additionally, flood frequency analysis for the Embarras River was conducted using stage data recorded by the U.S. Geological Survey (USGS) at Lawrenceville, Illinois (gauge 03346500, U.S. Geological Survey 2011). The gauge is located on the U.S. 50 bridge, about 6.4 km (4.0 miles) upstream of the site by river. Stage data from 2002 to 2011 were used to characterize the influence that water levels on the Embarras River have on Beaver Pond Ditch and the site. For this investigation, we evaluated flood frequency above “action stage (27 ft)” and “flood stage (30 ft)” as defined by the National Weather Service, Advanced Hydrologic Prediction Service (Advanced Hydrologic Prediction Service 2011). These flood thresholds were chosen because observed backups in Beaver Pond Ditch generally commence with the exceedance of action stage, and the flapper gates on the gravity drains close when flood stage is exceeded.

Precipitation and potential evapotranspiration (PET) data were obtained the Midwestern Regional Climate Center (Midwestern Regional Climate Center 2011) at the Illinois State Water Survey (ISWS), and climatic data were obtained from the National Water and Climate Center (National Water and Climate Center 2011) at the Natural Resources Conservation Service (NRCS).

Daily precipitation data recorded at Lawrenceville, Illinois (station#114957) and daily potential evapotranspiration (PET) data recorded at Olney, Illinois (station#116446) were obtained from the Midwest Regional Climate Center (2011), and were used to evaluate the influence of annual and seasonal climate trends on groundwater, surface water, and wetland hydrology. The daily data were summed into monthly totals. In one instance (March 2011), it was found that monthly precipitation recorded at Lawrenceville was significantly less than the amount recorded at Vincennes, Indiana due to missing data. Therefore, the monthly total recorded at Vincennes, Indiana (MRCC station# 129113) was used instead. This station is about the same distance from the site as the Lawrenceville station. The total monthly precipitation values were compared to 30-year precipitation averages and thresholds obtained from the National Water and Climate Center (2011) in order to determine if the months were above or below normal, or within the normal range. Monthly PET values were compared to the 20-year (1991-2010) average monthly PET in order to determine which months were above or below normal, or within the normal range. In addition, ratios of monthly precipitation and PET were calculated in order to determine if a month had a precipitation surplus or deficit.

The start date, end date, and length of the growing season were determined using methods outlined in the 1987 U.S. Army Corps of Engineers Wetland Delineation Manual (Environmental Laboratory 1987), and in the 2010 Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Midwest Region (U.S. Army Corps of Engineers 2010).

According to the 1987 Manual, the growing season is the period between the last occurrence of -2.2°C (28°F) temperatures in the spring and the first occurrence in the fall. The growing season dates were obtained from WETS tables for adjacent Richland County, Illinois (Olney, station#116446, National Water and Climate Center 2011) because no data were available for Lawrence County. The median length (5 out of 10 years) of the growing season for the region is 204 days, and the median starting date is April 6 and the median ending date is October 26.

According the Midwest Regional Supplement, the growing season start dates are determined by above-ground growth and development of non-evergreen vascular plants or the entire period of continuous 30-cm (12-in.) soil temperature at or above 5.0°C (41°F). For this investigation, we measured soil temperatures at the site to determine growing season starting dates. Using this method, it was estimated that March 8 was the starting date of the 2010 growing season, and that February 28 was the starting date of the 2011 growing season.

The elevations of the staff gauges, water-level loggers, and monitoring wells were measured using a Sokkia B-1 automatic level and a fiberglass extending rod relative to benchmarks established on the site by the ISGS. The elevations of the benchmarks were established relative to the North American Vertical Datum of 1988 using a survey-grade Leica GPS 1200+.

SITE CHARACTERIZATION

Geographic Setting

The study site is located in the catchment of Beaver Pond Ditch, within the Embarras River watershed (HUC 05120112). The mouth of the ditch is 4.3 km (2.7 mi.) by river above the confluence of the Embarras River with the Wabash River, and 6.4 km (4.0 mi.) by river downstream of the USGS gauge near Lawrenceville, Illinois (Healy 1979). The site lies in the broad floodplain between the Embarras and Wabash rivers and is within the Springfield Plain in the Till Plains Section of the Central Lowlands Physiographic Province (Leighton et al. 1948).

Total relief at the site (Figure 6) is about 2.2 m (7.1 ft), not including the Russell-Allison Levee or Beaver Pond Ditch (Figure 4). West of the ditch, the lowest areas are closed depressions in the forested areas north and south of the agricultural field (near Gauges A and B). East of the ditch, the lowest area is the forest north of the road and south of well 7S. These areas are the most flood-prone on the site, and were the only areas to satisfy criteria for jurisdictional wetland hydrology in 2010.

Except for the Russell-Allison levee, the highest area on the site is the forested area north of well 15S. Well 15S is at the toe of a slope that rises to a mostly flat area between Beaver Pond Ditch and the levee. In this area, land-surface elevation at well 14S is 125.8 m (412.8 ft), 1.7 m (5.7 ft) higher than at well 15S.

The topographic map of the site (Figure 6) shows that total relief in the agricultural fields is about 0.6 m (2.0 ft) for the field east of Beaver Pond Ditch, and about 1.2 m (3.9 ft) for the field west of Beaver Pond Ditch. The field east of Beaver Pond Ditch ranges in elevation from about 124.9 m (409.8 ft) along the eastern site boundary to about 124.3 m (407.8 ft) near the east edge of the forest. There is also a shallow drainage ditch along the north side of the road that grades from 124.6 m (408.8 ft) to 124.3 m (407.8 ft) from east to west. The field west of Beaver Pond Ditch ranges in elevation from about 125.3 m (411.1 ft) at the south end to about 124.1 m (407.2 ft) at the north end, with some small depressions within the field.

Geology

The uppermost bedrock unit is the Pennsylvanian Bond Formation, which is composed mostly of limestone and sandstone (Willman et al. 1967). The site is on the east-facing slope of the buried Wabash River Valley (Herzog et al. 1994, Weibel 2005a) (Figure 7).

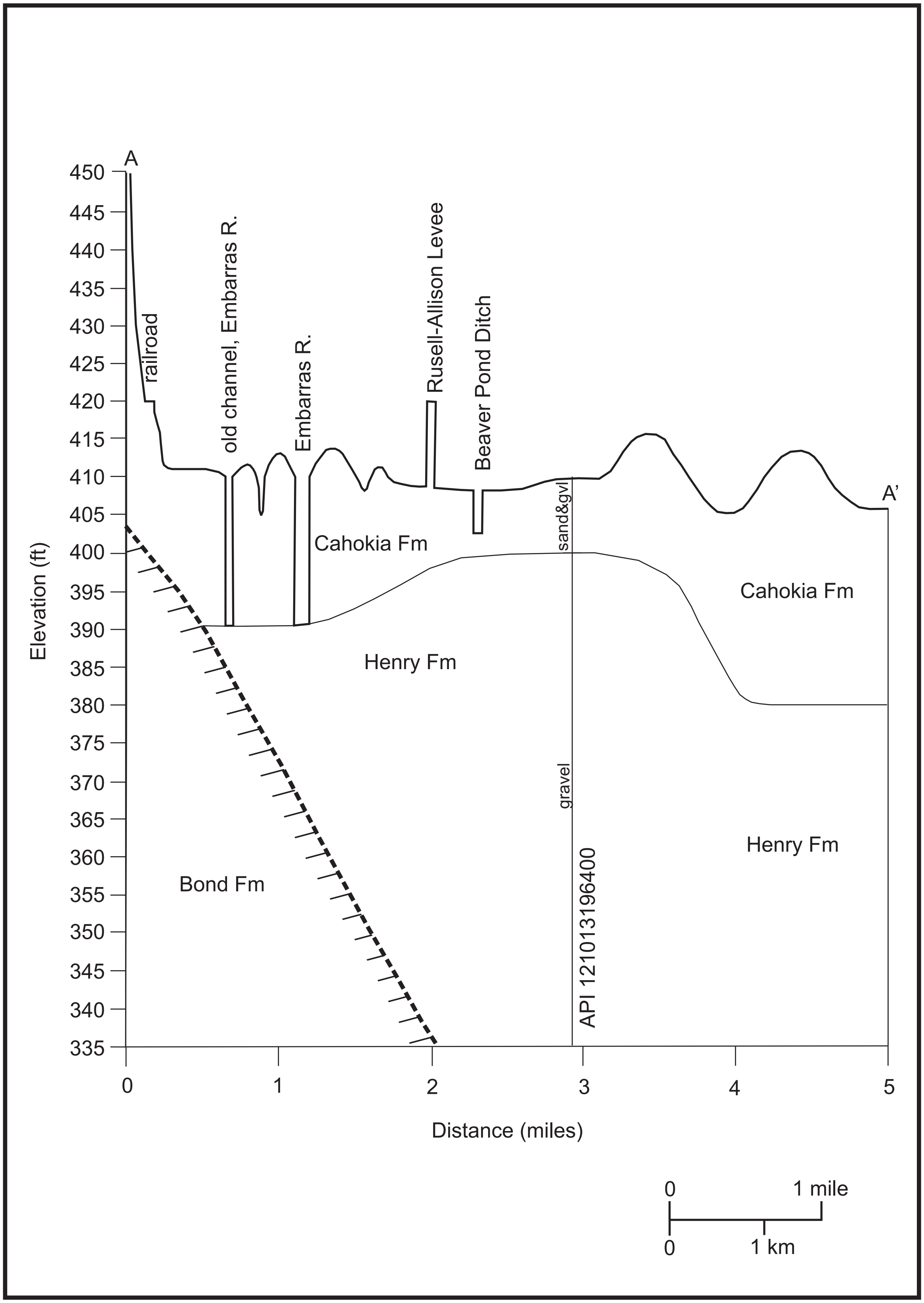

Figure 7. Geologic cross-section (vertical exaggeration 20 ft, line of section shown on Figure 8).

Unconsolidated sediment thickness at the site ranges from 7.6 m (25.0 ft) to 22.8 m (75.0 ft) (Piskin and Bergstrom 1975, Weibel 2005b). Surficial materials at the site are mapped as less than 6.0 m (19.7 ft) of Cahokia Formation overlying more than 6.0 m (19.7 ft) of the Henry Formation (Berg and Kempton 1988). The log of a water-supply well (Figure 7: API 12101396400), located in section 22, about 1 mile east of the site, shows 3.0 m (10.0 ft) of sand and gravel over 19.8 m (65.0 ft) of gravel. Logs of water-supply wells in sections 13, 14, and 15 (Illinois State Geological Survey 2011) are similar, showing sand and gravel to depths of as much as 24.4 m (80.0 ft).

The surficial deposit mapped at the site is Cahokia Formation alluvium (Lineback 1979, Figure 8), which generally consists of poorly sorted sand, silt and clay deposited on floodplains and in stream channels (Lineback 1979). The Mackinaw Member of the Henry Formation, which is a valley train deposit composed of sandy gravel or pebbly sand, is mapped just to the northwest of the site. It may underlie the site at depth, and may have been the source of the sediments mined from the former gravel pit in the northern portion of the site.

Soil borings completed at the site revealed that the Cahokia Formation is at least 2.0 m (6.5 ft) thick and was composed primarily of silty clay. There were some variations, such as at well 14S, where brown, loose, fine to medium sand was found to a depth of 75.0 cm (30.0 in), and at well 15S where the silty clay contained significant amount of gravel. Both of these wells are in or adjacent to the former gravel pit (Figure 3), and may represent disturbed conditions. Gravel was also found scattered on ground surface near the south end of the west field, but this may have been gravel from the road that formerly crossed the field from east to west.

The walls of Beaver Pond Ditch are composed of silty clay. However, the bottom of the ditch may intersect sand of the Henry Formation underlying the site, as was found in soil borings #1 and #3 (Benton et al. 2009).

Soils

All soils mapped at the site, except the area of the former gravel pits, are classified as hydric by the NRCS (Soil Survey Staff 2011) and are all poorly drained (Figure 4 and Table 1). The Darwin and Wabash soils are in hydrologic soil group D, meaning they have a very slow infiltration rate and high runoff potential when undrained, and are subject to occasional flooding and ponding (Soil Survey Staff 2011). The Petrolia soil belongs to hydrologic soil group C/D (Soil Survey Staff 2011), meaning it has a slow infiltration rate where drained (group C) and a very slow infiltration rate (group D) where undrained. The Petrolia is subject to occasional flooding and ponding (Soil Survey Staff 2009). Ponding has been observed during the monitoring period where this soil is mapped on the site, but flooding was observed only in May 2011. The Westland soil is in hydrologic soil group B/D (Soil Survey Staff 2011). This soil has a moderate infiltration rate where drained (group B) and a very slow infiltration rate where undrained (group D). The soil is not subject to flooding but it is subject to frequent ponding (Soil Survey Staff 2009). Ponding has not been observed during the monitoring period, however, flooding was observed in March and May 2011.

Several permeameter tests were conducted at the site to verify the permeability values reported by the Soil Survey. The results are given in Table 1, and the locations of the tests are shown on Figure 4. The test conducted in the Darwin soil in 2009 reveal that it has very slow permeability, within the range reported by the Soil Survey. The results of on-site permeameter

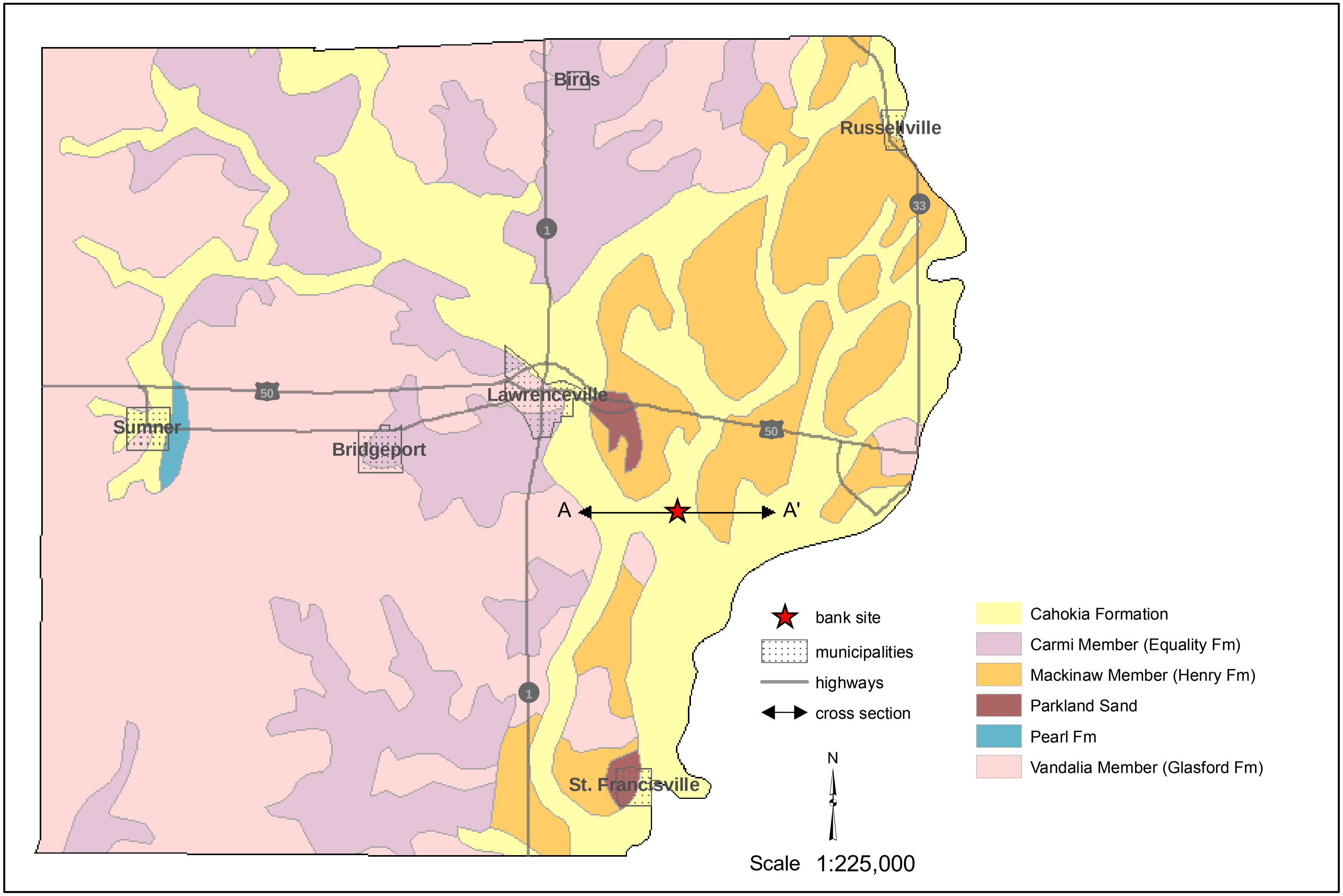

Figure 8. Quaternary Deposits of Lawrence County (adapted from Lineback 1979), original map scale is 1:500,000. Line of cross section corresponds with Figure 7.

tests conducted in the Petrolia soil show that it is somewhat less permeable than reported by the Soil Survey (Table 1).

The results of permeameter tests conducted in the Westland soil reveal that the saturated hydraulic conductivity of this soil is highly variable, in that, it would take as little as 3 days for water on ground surface to infiltrate 30.0 cm (12.0 in) into the soil (Table 1). Therefore, it is less likely that wetland hydrology can be restored in portions of the site where Westland soil is mapped (Figure 3) and excavation may be required to create wetlands in these areas, depending on elevation.

Soil Type	Hydric	Permeability of most limiting layer(cm/hr)	Permeability from on-site tests (cm/hr)	Flooding/Ponding	Water Table
Westland clay loam (300)	yes	1.52-5.08	0.0036-0.36	None/Frequent	Depth: 0.0 cm Period: Mar-Jun
Darwin silty clay (8071)	yes	0.00-0.15	0.00036	Occasional/Occasional	Depth: 0.0 cm Period: Mar-Jun
Petrolia silty clay loam (8288)	yes	0.51-1.52	0.036	Occasional/Occasional	Depth: 0.0 cm Period: Mar-Jun
Wabash silty clay 8083	yes	0.00-1.52	na	Occasional/None	Depth: 15.0 cm Period: Mar-Jun

Table 1: Hydrologic properties of on-site soil types (Soil Survey Staff 2009).

Wetlands

The NWI mapped about 17.5 ha (43.1 ac) of forested wetlands (PFO1A) at the site (Appendix D, U.S. Fish and Wildlife Service 2009), and the certified wetland determination by the NRCS indicates that the wetland status of the approximately 28.9 acres of cropland is prior converted, indicated as ‘PC’ in Appendix E.

A more detailed on-site wetland determination, conducted by the INHS, resulted in a total of 13.3 ha (32.8 ac) of wetlands delineated at the site (Wiesbrook et al. 2009, Figure 2). The remainder of the site 16.3 ha (40.3 ac) is non-wetland. The non-wetland areas identified by the INHS (Figure 2) include roads, levees, and Beaver Pond Ditch (Site 0), mesic floodplain forest (Site 4) and agricultural fields (Site 5). The levees and ditch within Site 0 cannot be restored to wetland because the Russell-Allison Levee and Beaver Pond Ditch will be maintained for flood control. The mesic floodplain forest in Site 4 does not have hydric soil and therefore was never wetland. The agricultural fields in Site 5 have hydric soil and dominant hydrophytic vegetation; however, they are currently drained and used for crop production. Therefore, the agricultural fields (Figure 2, site 5), totaling 12.1 ha (29.9 ac), are the target area for potential wetland restoration and/or creation.

Hydrology

Precipitation and Evapotranspiration

Average annual precipitation (1971-2000) at the Lawrenceville weather station is 114.6 cm (45.2 in.) (Midwestern Regional Climate Center 2011). The 30-year monthly averages show that most of the annual precipitation falls during the period March through June, with seasonal peaks occurring in May and November (Figure 9). Drier periods typically occur during late summer into fall (August through October) and winter (December through February).

Precipitation amounts recorded at the Lawrenceville weather station were 92% of normal for 2010 and, in 2011, 125% of normal through May 31. During the early growing season (February through May), precipitation was 94% normal in 2010 and 135% of normal in 2011, with an exceedingly wet April. Monthly precipitation during the monitoring period (Figure 9) was well-above average in 6 of the months, near average in 6 of the months, and well-below average in 7 of the months. The wettest month during the monitoring period was April 2011 with 296% of the 30-year average, and the driest month was October 2010 with 24% of the 30-year average.

Total PET during the monitoring period was 156.46 cm (61.60 in), which was 103% of the 20-year (1991-2010) average. On average, PET tends to be lowest in the winter (December through February), and highest in the summer (June through August) (Figure 10). Monthly PET during the monitoring period was generally close to the 20-year average. Ratios of monthly precipitation and PET (Figure 10) show that moisture surpluses (ratio $\geq$ 1.0) occurred in most months during the monitoring period, and have occurred every month starting in November 2010, which may have affected the number of duration of flood events in 2011.

Surface Water

Inundation on the site generally occurs when Beaver Pond Ditch is at least bank-full, which has happened at least twelve times during the monitoring period (Appendix F). At bank-full (Figure 11), water backs up the culverts in the banks of the ditch and inundates adjacent areas (see Appendix F, March 22, 2010). In this type of event, inundation west of Beaver Pond Ditch is generally confined to the forested area north of the agricultural field, and the northern portion of the field, and east of Beaver Pond Ditch it is generally confined to the forested areas adjacent to the east-west access road. At higher levels (Figure 11), inundation is more wide-spread. The area inundated depends of the height of the flood peak, but has encompassed the entire site (see Appendix F, March 15, 2011 and May 3, 2011).

The water level in Beaver Pond Ditch is influenced by the Embarras River. Analysis of peaks on the hydrographs of Embarras River stage and Beaver Pond Ditch stage in 2010 (Figure 11) reveals that they mostly occur at the same time. On-site observations revealed that the water level in the ditch was rising when the Embarras River at Lawrenceville reached action stage (8.2 m [27.0 ft]). This was observed at the site on February 23, 2011, when it was noticed that the flow of water in Beaver Pond Ditch was reversed, that is, the water was flowing upstream. In addition, the water level in the ditch rose noticeably during the course of the day (Figure 11), revealing that the gravity drains in the Russell-Allison levee were still open. At Lawrenceville, river stage that day was above action stage (Figure 11), and stage increased from 8.5 m (28.0 ft) to 8.8 m (28.8 ft) during the course of the day (U.S. Geological Survey 2011).

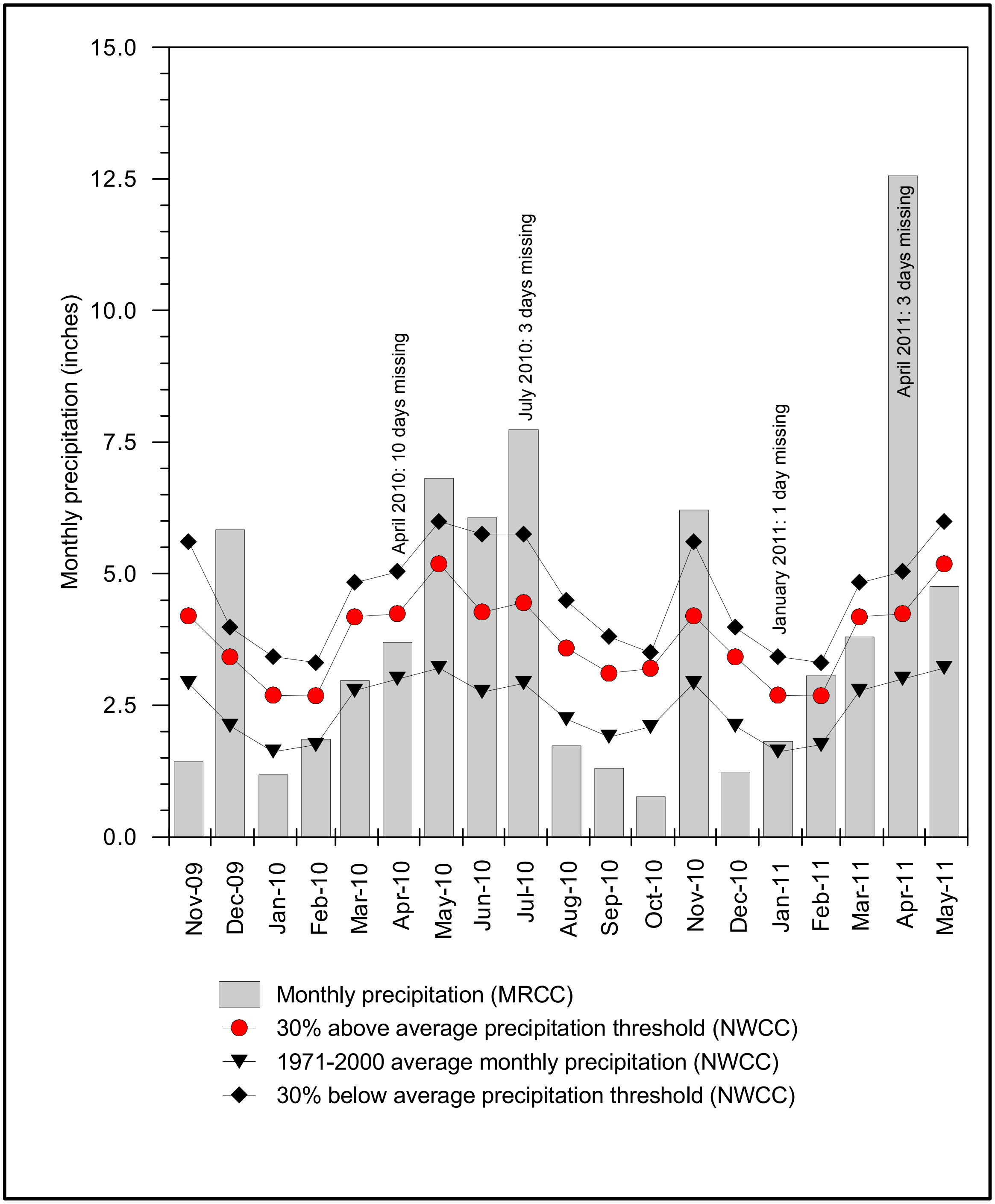

Figure 9. Monthly precipitation during the monitoring period.

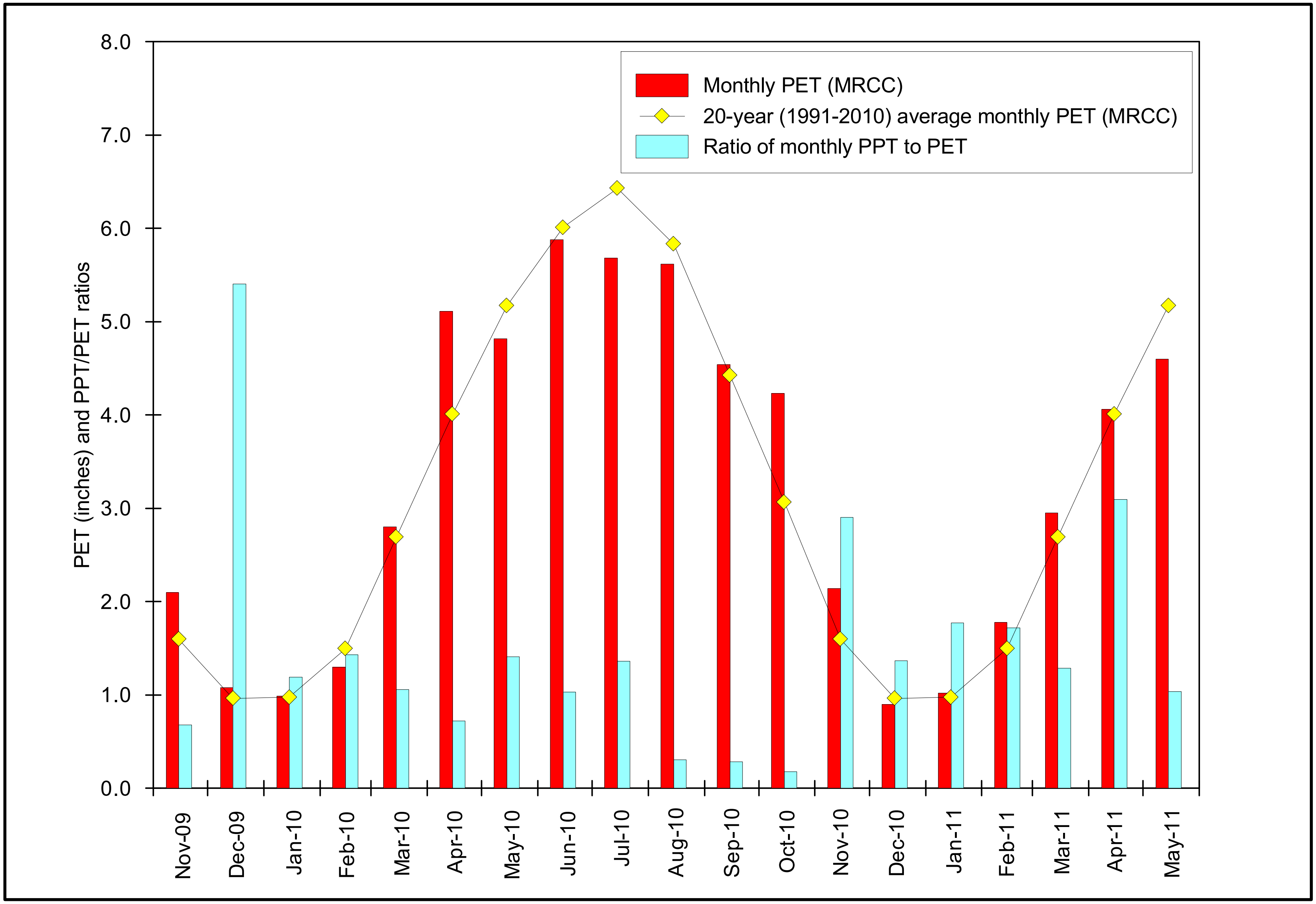

Figure 10. Potential evapotranspiration measured at Olney, Illinois and ratios of precipitation and potential evapotranspiration

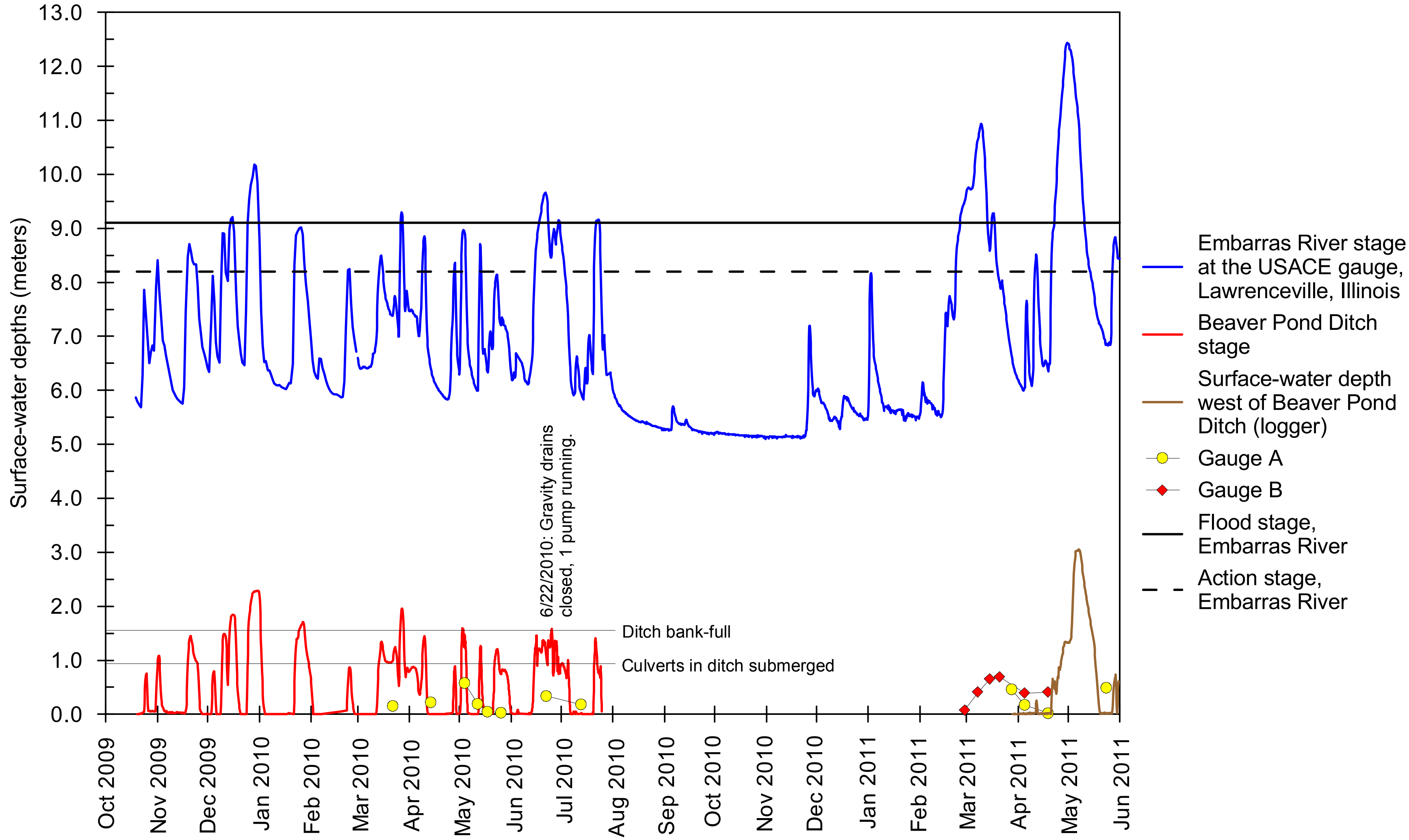

Figure 11. Embarras River stage, Beaver Pond Ditch stage, and on-site surface-water depth

When the Embarras River reaches flood stage at Lawrenceville, then the water level outside the Russell-Allison levee exceeds the elevation of the gravity drains, and the water pressure forces them closed. This traps any further runoff inside the levee, and, if the pumps are not running, results in the inundation of the site. In March 2011, about two-thirds of the site was inundated during a flood event on the Embarras River. The river reached action stage on February 22, and flood stage (9.1 m [30.0 ft]) on February 25. During a site visit on March 8, it was observed that the portion of the site west of Beaver Pond Ditch was inundated as far south as well 11S (Figure 6), and that inundation extended up to 0.8 km (0.5 mile) east of the site. The Embarras River remained above action stage until March 18. On March 15, 2011, most of the site was still inundated (Appendix F), and on March 21, it was observed that the gravity drains were still submerged, but that water was flowing out. By March 28, the site was mostly drained. The only inundation was in the forest north of the agricultural field west of Beaver Pond Ditch, and in the forest adjacent to the east-west road east of Beaver Pond Ditch.

The greatest extent of inundation on the site occurs as the result of the Russell-Allison Levee being overtopped and/or breached. On the morning of May 3, 2011, it was discovered that the levee had been breached overnight in several locations near the confluence of the Embarras and Wabash Rivers (Lawrence County Emergency Management Agency 2011). During a visit to the site on May 24, erosion gullies on the inside of, and sand bags on the top of, the portion of the Russell-Allison levee along the western boundary of the site, reveal that it had been overtopped during the recent flood event. On April 29, the Embarras River had reached a stage of 12.3 m (40.2 ft), which was more than 3.0 m (10.0 ft) above flood stage. The hydrograph of the logger in the field west of Beaver Pond Ditch (Figure 11) shows that surface water on the site had peaked at a depth of about 1.3 m (4.3 ft) on April 29. However, starting at about 6PM on May 2, water depth began to increase again, likely as the result of the levee breaches. As a result, the entire site was inundated (Appendix F), and surface-water depth peaked at about 3.0 m (10.0 ft) on May 6.

Flood frequency analysis shows that Embarras River levels are high enough to likely cause back flooding of Beaver Pond Ditch in most years, and occurred most often in the winter and spring. Table 2 shows the number of days per month that the Embarras River was at or above action stage in the period 2002 through 2011. The table shows that action stage events mostly occurred in the winter (December to February) and spring (March to May), which is usual for Illinois (Changnon et al. 1983). The months with the highest probability of having an action stage event are March, April, and May, followed by February. The months with the lowest probability of having an action stage event are August, September, and October.

Overland flow and storm runoff are relatively minor water sources at the site, although they may provide more of a contribution to the portion of the site east of Beaver Pond Ditch due to higher land elevations adjacent to the eastern boundary.

Groundwater

The Henry Formation and the Pennsylvanian Bond Formation are major aquifers in Lawrence County, and are utilized for municipal, agricultural, and domestic water supply (Hanson 1950, Illinois State Geological Survey 2011, Selkregg et al. 1957). At the site, the Henry Formation likely does not contribute to wetland hydrology because it is overlain by Cahokia Formation alluvium (Figure 7 and 8). Instead, saturation in the soil zone at the site occurs as perched groundwater. Figures 12, 13, 14, and 15 show, respectively, groundwater elevation and depth to groundwater in monitoring wells west of Beaver Pond Ditch, and groundwater elevation and depth to groundwater in monitoring wells east of Beaver Pond Ditch. On both sides of the ditch, groundwater tends to be closest to ground surface in the spring, and furthest from ground surface in the fall. This is because inundation of the site is most likely to occur in the spring (Table 2).

Calender year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002		7	11	11	27							
2003					10		10		3			
2004			8	4	4	10				1	8	14
2005	25	16										
2006			11	12	1						3	13
2007	26	4	10	7								
2008	5	17	19	15	10	15	4					7
2009	5	11	23	28	8							
2010			5	4	1	18	4					
2011		6	19	12	18							
Total	61	61	106	93	79	43	18	0	3	1	11	34

Table 2: Days per month Embarras River at Lawrenceville, Illinois was at or above action stage.

Local groundwater flow often is towards Beaver Pond Ditch as shown on Figure 16. The ditch tends to flow year-round, and seepage has been observed in the bottom and walls of the ditch when the water level is low, suggesting that it receives groundwater discharge.

The site is likely affected by groundwater recharge when the Embarras River is at or above action stage. It has been observed at the site that flood water outside the Russell-Allison levee rises about halfway up the levee when the Embarras River is near flood stage. This likely causes an upward groundwater gradient inside the levee, which is a factor contributing to on-site saturation.

Hydrologic Alterations

Various hydrologic alterations facilitate drainage of the site for agriculture. The regional hydrologic alteration is the Russell-Allison Levee, which protects an area of about 12,150 ha (30,000 ac) from Embarras and Wabash River flooding. The levee is about 6.1 m (20.0 ft) tall at the site. Local alterations are Beaver Pond Ditch, two gravity drains with flapper gates in the levee, and a pumping station (Figure 3). Beaver Pond Ditch is about 16 km (10 mi.) long and drains an area of about 3,240 ha (8,000 ac) within the leveed area (Healy 1979, Pickels and

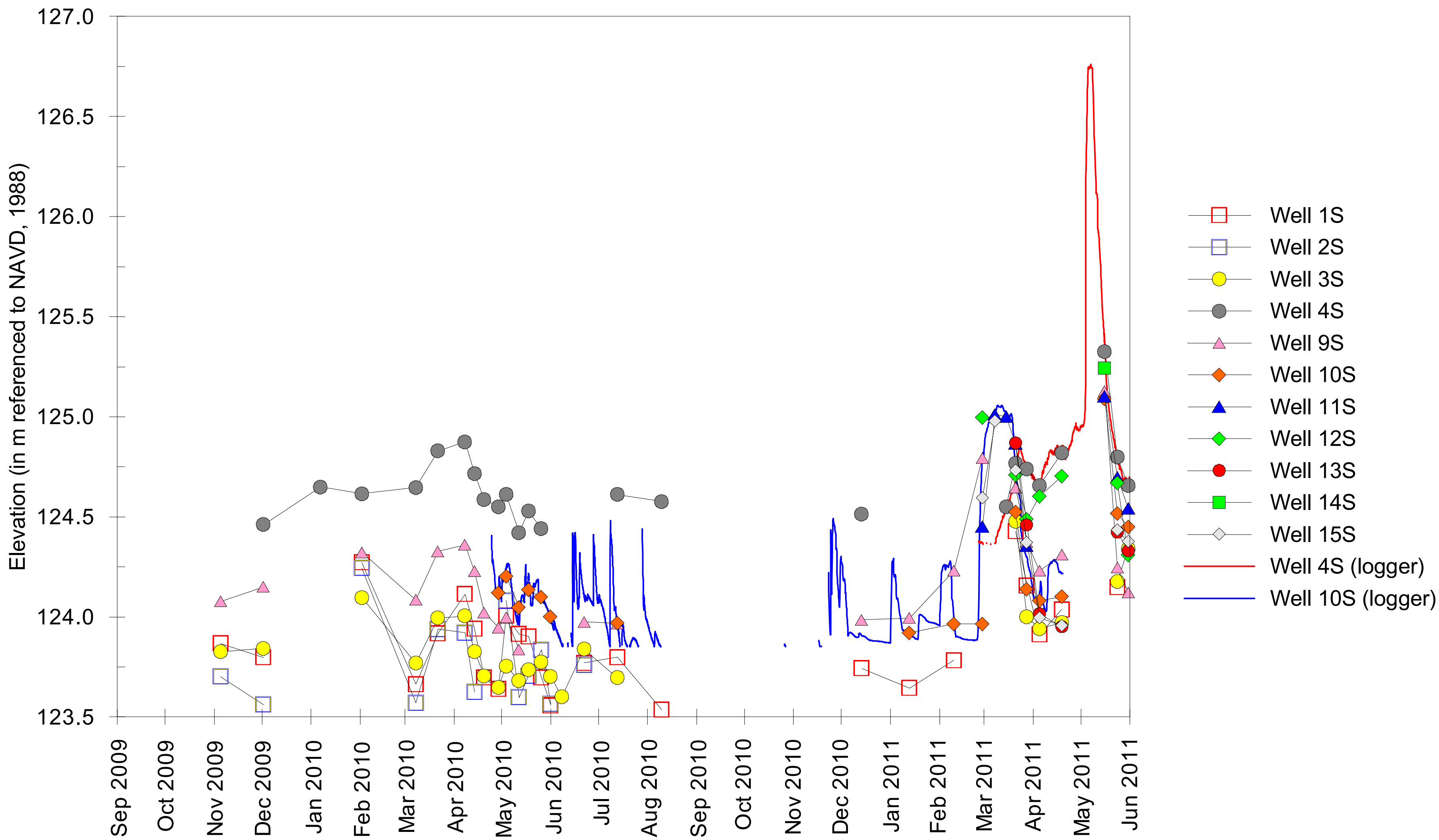

Figure 12: Groundwater elevations in monitoring wells west of Beaver Pond Ditch.

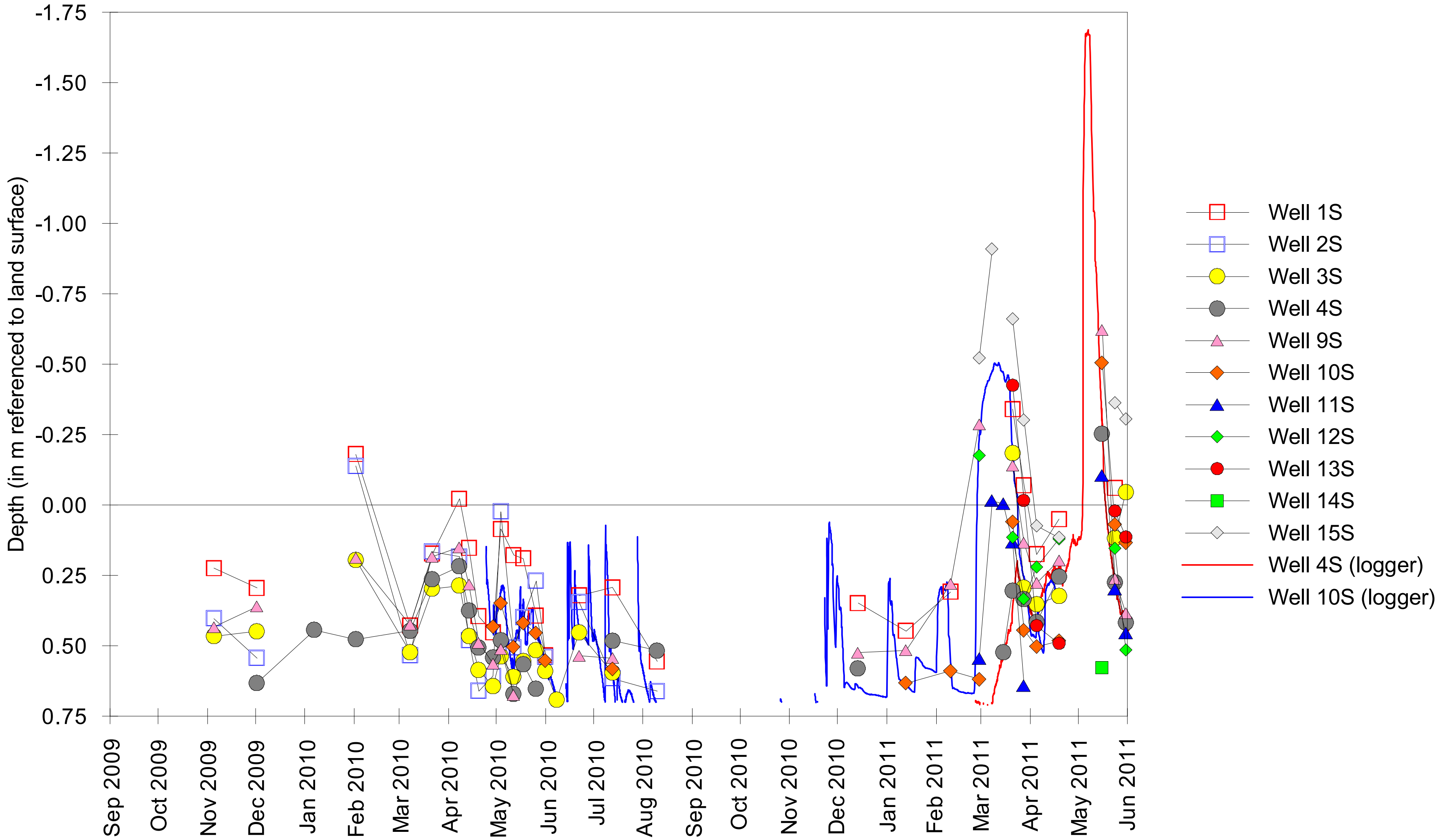

Figure 13: Depth to groundwater in monitoring wells west of Beaver Pond Ditch

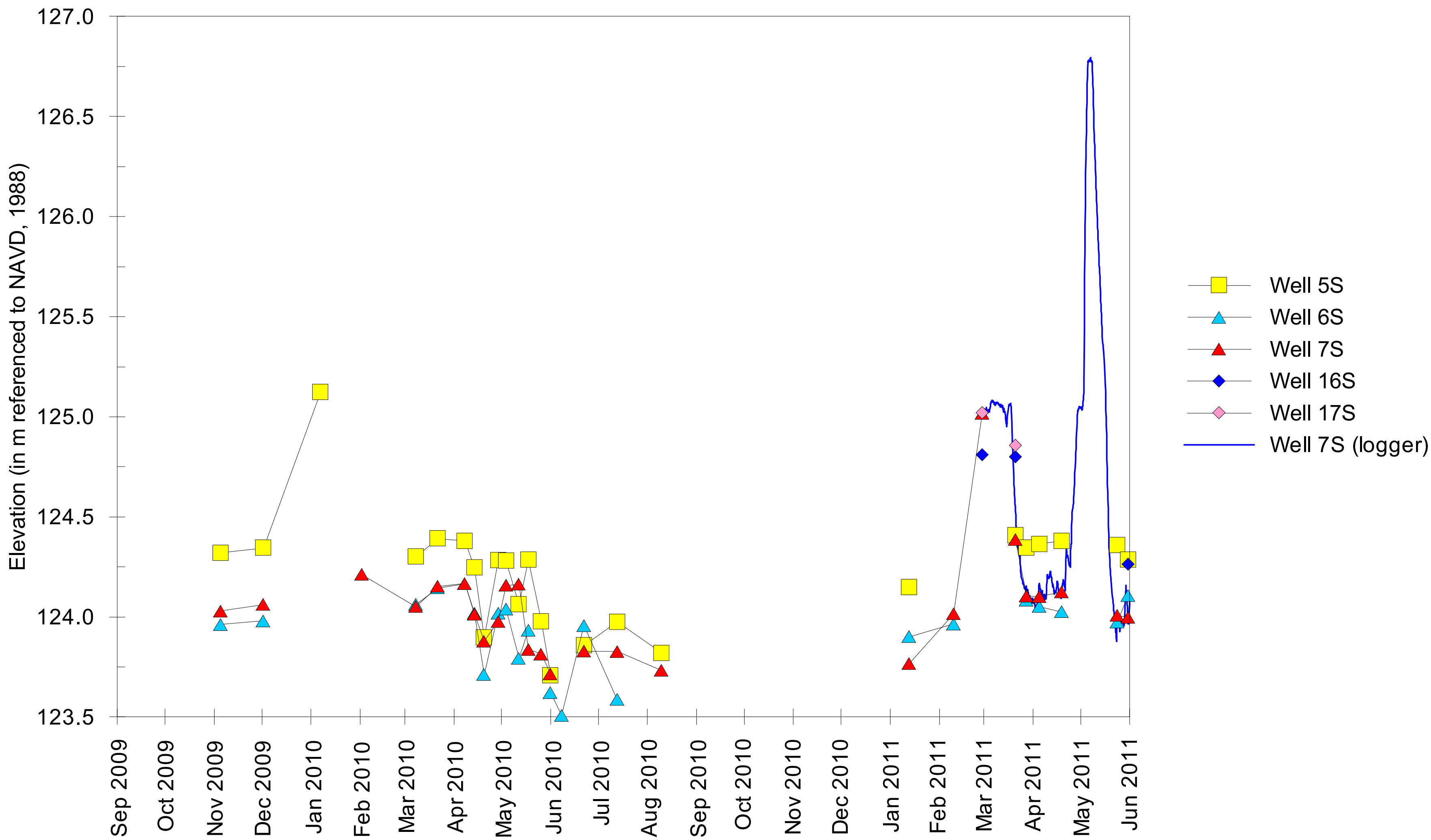

Figure 14: Groundwater elevation in monitoring wells east of Beaver Pond Ditch.

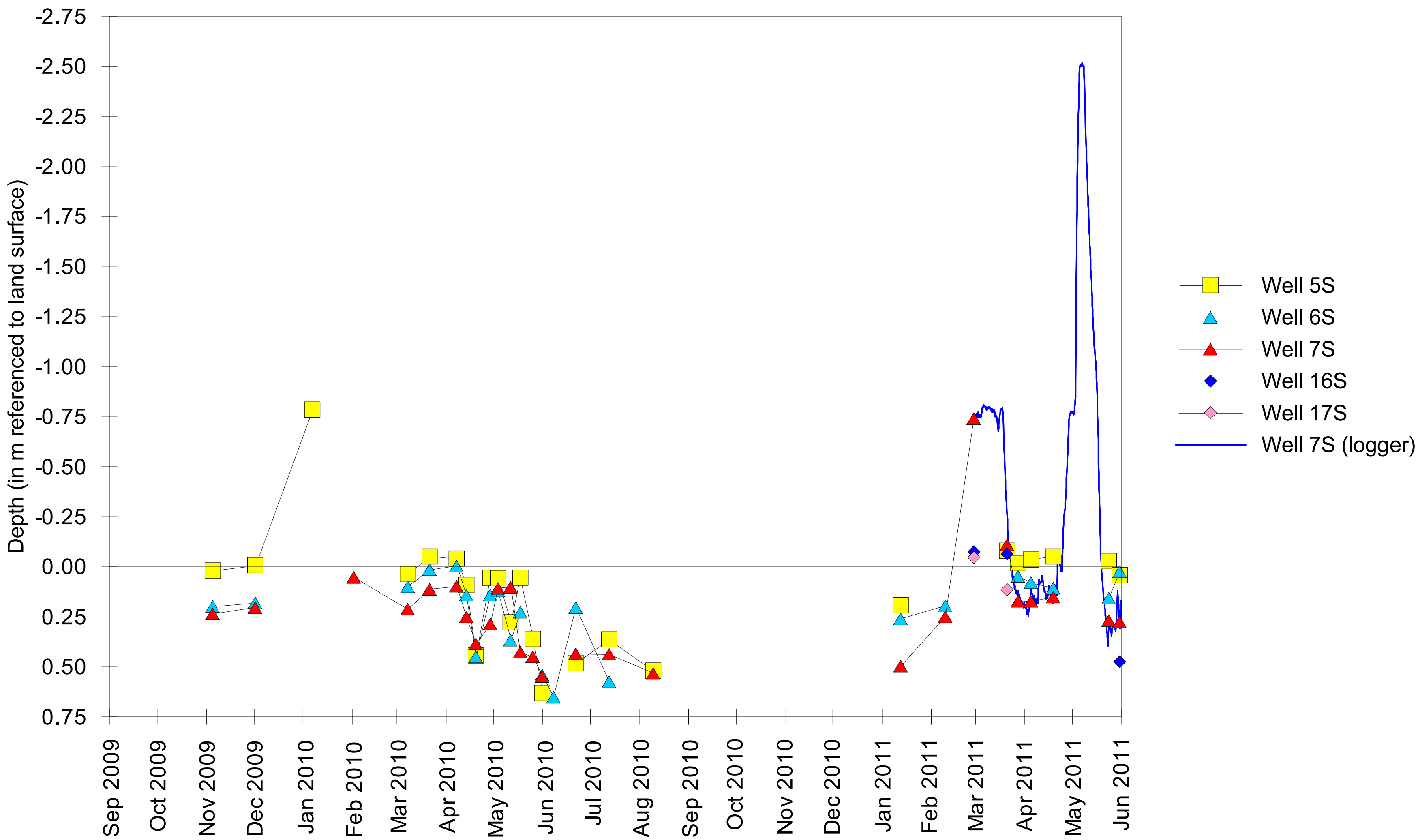

Figure 15: Depth to groundwater in monitoring wells east of Beaver Pond Ditch

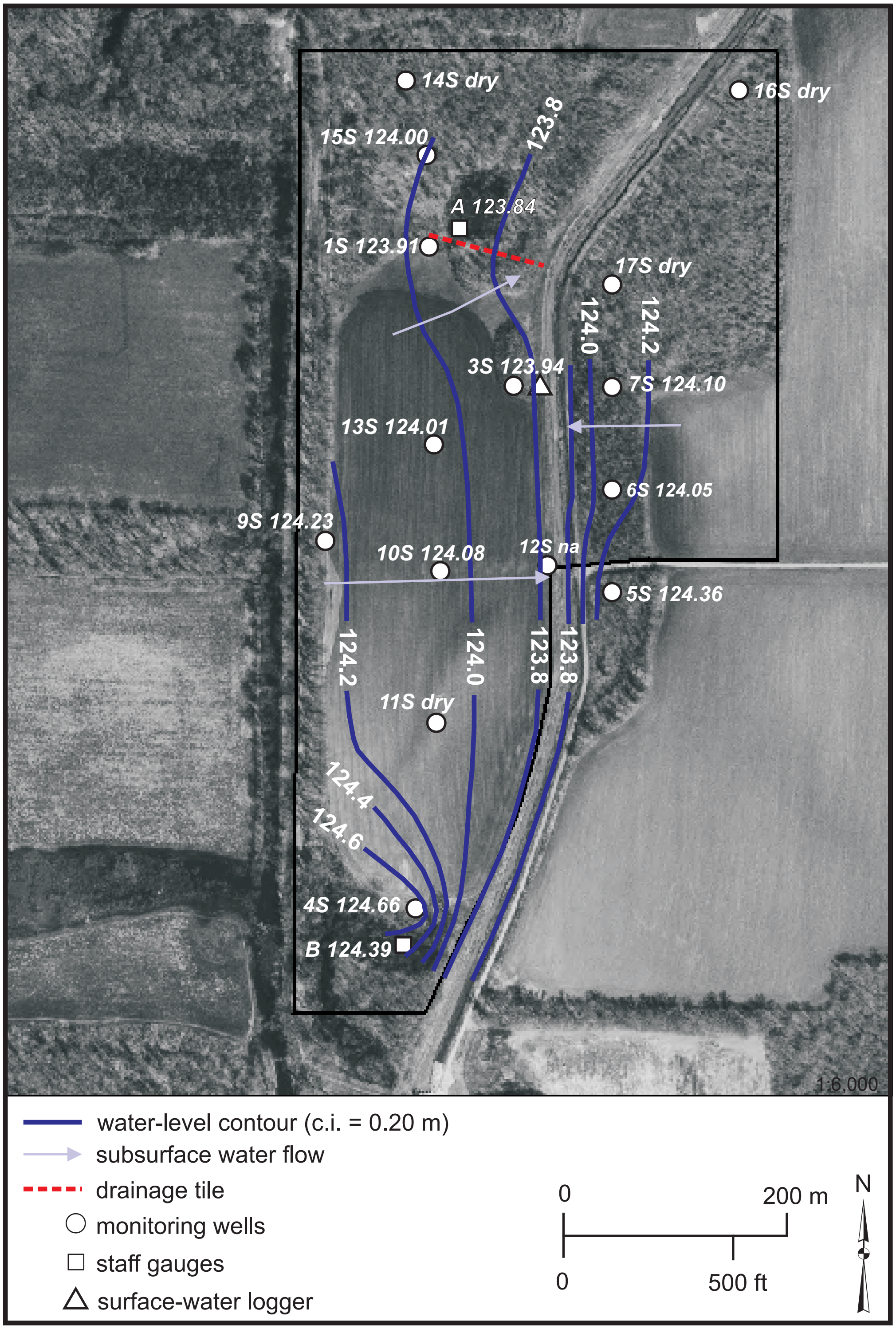

Figure 16. Water-level contour and flow map (April 5, 2011).

Leonard 1929). The ditch divides the site and is about 5.5 m (18.0 ft) wide and about 2.4 m (8.0 ft) deep where it passes through the site. Exact dates for levee construction, pumping station installation, and ditch excavation could not be determined from a records search, but the levee was first proposed in 1912 (Harman 1912), and a map in the same publication depicts the ditch in its current location.

The on-site hydrologic alterations include culverts in both banks of Beaver Pond Ditch, a drain tile in the forest north of the west field, and a discontinuous levee along Beaver Pond Ditch (Figure 3). The culverts are 61-cm (24-in) diameter corrugated steel. The invert elevation of the west culvert is 123.51 m (405.24 ft), which is 0.89 m (2.92 ft) below the top of the bank, and the invert elevation of the east culvert is 123.32 m (404.61 ft), which is 0.80 m (2.62 ft) below the top of the bank. The drain tile is 5.1-cm (2.0-in) diameter PVC at the outlet. It is about 1.5 m (5.0 ft) below the top of the bank where it discharges into the ditch. The length of the tile is not known.

The west bank of Beaver Pond Ditch was likely formed by spoil when the ditch was excavated. Its height above the adjacent farm field ranges from 0.19 m (0.62 ft) near the south end of the field to 0.45 m (1.47 ft) near the north end of the field. The top of the bank is mostly at or above an elevation of 125.0 m (410.1 ft). Only in the vicinity of the culvert and a former bridge abutment (near well 12S) is it below that elevation. At the culvert, the top of the bank is at an elevation of 124.4 m (408.1 ft), while at the abutment it is at an elevation of 124.6 m (408.8 ft). In addition, there is a drainage channel at the abutment that directs water around it and into Beaver Pond Ditch, that appears to be lower than 124.6 m (408.8 ft).

The east bank of Beaver Pond Ditch is a dirt road north of the T-intersection and a gravel road south of the intersection (Figure 3). There are noticeable spoil piles, overgrown with trees and brush, along the east side of the road that are likely spoil from Beaver Pond Ditch. The dirt road is mostly at or above an elevation of about 124.5 m (408.5 ft), except in the vicinity of the culvert, where it is at an elevation of 124.1 m (407.2 ft). The spoil piles are somewhat higher than the road, except at the location of the culvert where they are missing.

A potentially significant hydrologic alteration adjacent to the site is a 0.3 m (1.0 ft) diameter, corrugated steel culvert under the east-west road east of Beaver Pond Ditch (Figure 3). This culvert drains the forested area, and portions of the adjacent farm field south of the road into the forested area north of the road, which then discharges into Beaver Pond Ditch via the culvert there. The invert elevation of the road culvert is about 124.0 m (406.8 ft), which is higher than that of the Beaver Pond Ditch culvert. If the latter culvert is removed and replaced with a spillway at a higher elevation, then water would likely back up the road culvert, flooding the forested area south of the road, and possibly the adjacent agricultural field. On the other hand, keeping the invert elevation of the Beaver Pond Ditch culvert lower than that of the road culvert would likely result in an area of inundation north of the road smaller than the area that could potentially support wetland hydrology. Therefore, the road culvert will have to be removed, elevated, or replaced with a culvert that discharges westward directly into Beaver Pond Ditch. Removing the culvert altogether or raising its elevation will likely increase saturation south of the road in an area that is not being acquired by IDOT, and landowner agreement would be needed for any alteration at all.

Effect of Pumping

The Consolidated Drainage District operates a pumping station (Figure 3) just south of the site that drains Beaver Pond Ditch and surrounding farm fields. Although no pumping records are available, the drainage district manager stated that the pumps are typically switched on only during floods that occur within the growing season, usually mid-March through November (Gene Marenholtz personal communication).

Comparison of the Embarras River stage with stage in Beaver Pond Ditch during 2010 shows the signature of when pumping occurred (see Figure 11). Usually, the hydrograph of Beaver Pond Ditch stage is smooth and similar, except in magnitude, to the hydrograph of Embarras River stage (e.g., see March and April 2010). In addition, peaks in the stage of Beaver Pond Ditch tend to occur on the same day as peaks in the stage of the Embarras River. However, when Beaver Pond Ditch is being pumped, the hydrograph of the ditch is truncated, which can be seen in June and July 2010 (Figure 11). A flood event was occurring on the Embarras River, and pumping at the site was confirmed during a site visit on June 22, 2010. The pumping prevented the inundation of the site, and, as a result, saturation mostly did not occur. Depth-to-groundwater data show that, in June 2010, saturation occurred only at monitoring well 6S (Appendix A), and for several brief periods at monitoring well 10S (Figure 13). These brief periods corresponded to precipitation events that caused saturation, but it lasted for a day or less.

Wetland Hydrology

In 2010, only small areas of the site satisfied the criteria wetland hydrology (Environmental Laboratories 1987, U. S. Army Corps of Engineers 2010, Figure 17). It was estimated that a total of 2.4 ha (6.0 ac) satisfied the wetland hydrology criteria for 14 or more consecutive days during the growing season, and that 1.5 ha (3.8 ac) and 1.3 ha (3.3 ac) satisfied the wetland hydrology criteria for 5% and 12.5% of the growing season, respectively (Miner et al. 2010). In contrast, in 2011 it was estimated that about 15.8 ha (39.1 ac) of the site satisfied the wetland hydrology criteria for 14 or more consecutive days during the growing season (Figure 18), and that 26.2 ha (64.7 ac) and 15.7 ha (38.8 ac) satisfied the wetland hydrology criteria for 5% and 12.5% of the growing season, respectively.

In 2010, precipitation and PET were about average, though comparing seasonal totals reveals that winter precipitation was more than twice winter PET (Table 3). There were eight action stage events during the year, and the Embarras River was at or above action stage a total of 35 days. The average duration of the events was 4.4 days, which was typical, because 36.0% of the events that have occurred during the period of record (U.S. Geological Survey 2011) have lasted 5 days or less. Almost all of the action stage events resulted in the water levels in Beaver Pond Ditch being high enough to at least submerge the culverts and prevent drainage of the site for periods ranging from < 2 days to about 18 days.

In 2011, precipitation and PET were not as close to average as 2010 (Table 2), but the area and duration of wetland hydrology in 2011 were both much greater than in 2010. This was due primarily to the two unusual flood events that occurred on the Embarras River (Figure 16), and included levee breaks and widespread flooding. These events both lasted more than 20 days, and only a total of 6 such events have occurred since river monitoring began in 2002 (U.S. Geological Survey 2011). The provisional peak stages of these events were 10.94 m (35.89

Figure 17. Area of wetland hydrology in 2010 (Miner et al. 2010)

Figure 18. Area of wetland hydrology in 2011 (Miner et al. 2011).

ft), and 12.44 m (40.82 ft). If these become the final peak stages, then they will be among the top 10 ever recorded there (Advanced Hydrologic Prediction Service 2011).

	Precipitation Percent of 30-year (1971-2000) average			Potential Evapotranspiration Percent of 20-year (1991-2010) average			PPT vs PET Percent of seasonal totals	
	Year	Winter	Spring	Year	Winter	Spring	Winter	Spring
2010	91.6	100.6	99.0	103.1	100.0	107.2	263.5	105.9
2011	na	69.1	138.7	na	110.1	97.8	164.9	162.6

Table 3: Climate statistics

CONCLUSIONS

Wetland hydrology mostly occurs at this site as the result of inundation. However, under current drainage conditions, only small areas of the site are expected to satisfy wetland hydrology criteria in an average year. Therefore, in order to increase area and duration of inundation and saturation on the site, the following hydrologic modifications suggested. We anticipate 25.4 ha (62.7 ac) of the site, which includes 13.3 ha (32.8 ac) of delineated wetland, and 12.1 ha (29.9 ac) currently used for agriculture, could satisfy wetland hydrology criteria in an average year:

- Excavate the portions of the site shown on figure 5, thereby allowing the greater volume of water retained on the site to inundate a larger area.

- Remove the two culverts and replace them with spillways set at a higher elevation, and remove the drain tile, causing more water to be retained in the excavations.

- Raise the banks of the ditch to a higher elevation in order to retain additional surface water. There are currently a few spots along the banks that are near or lower in elevation than the recommended spillway elevation. These could become focal points for drainage, perhaps resulting in damage to the banks.

- If drainage from the site is prevented (e.g., by removing the culverts, the drainage tile, and installing spillways), then late winter and early spring floods and precipitation events should supply enough water to restore wetland. However, in years in which a flood does not occur, or flooding events occur after the start of pumping, then wetland hydrology acreage may not achieve the target acreage goals.

Pumping of Beaver Pond Ditch is likely to have the greatest impact on the potential for wetland restoration at this site. Nevertheless, the following suggests that even this can be overcome:

- The pumping of Beaver Pond Ditch generally starts about mid-March, and ends in October or November.

- Soil temperatures collected at the site reveal that the growing season can begin in February, that is, before the start of the pumping season.

- Flood frequency analysis reveals that the month in which action stage events are most likely to occur is March, which is the start of the pumping season.

- Even if only one action stage event occurs after the start of the growing season, but before the start of the pumping season, then it is likely that the target wetland acreage can be achieved if the recommended modifications are made to the site. However, if the event occurs during the pumping season, and the water level in Beaver Pond Ditch remains below bank-full, thereby preventing flooding of the site, then the area satisfying wetland hydrology criteria would likely be smaller than expected.

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REFERENCES

Advanced Hydrologic Prediction Service, 2011, National Weather Service, http://water.weather. gov/ahps/, accessed June 23, 2011 and August 23, 2011.

Benton, S. E., K. E. Bryant, E. T. Plankell, and G. E. Pociask, 2009, Initial Site Evaluation, Lawrence Proposed Wetland Bank Site, Lawrence Co., IL: unpublished contract report presented to the Illinois Department of Transportation, Illinois State Geological Survey, Champaign, IL, 26 p.

Berg, R. C., and J. P. Kempton, 1988, Stack-Unit Mapping of Geologic Materials in Illinois to a Depth of 15 Meters: Illinois State Geological Survey Circular 542, ISGS, Urbana, IL, 23 p.

Changnon, S. A., Jr., J. P. Lardner, J. L. Vogel, and P. G. Vinzani, 1983, Floods of Winter-Spring 1982 in Illinois: Report of Investigation 105, Illinois State Water Survey, Champaign, IL, 61 p.

Environmental Laboratory, 1987, Corps of Engineers Wetlands Delineation Manual: Technical Report Y-87-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, 100 p.

Hanson, R., 1950, Public Ground-Water Supplies in Illinois: Illinois State Water Survey Bulletin 40, State of Illinois, Department of Registration and Education, Urbana, IL, 1300 p.

Harman, J. A., 1912, Report and plans for the reclamation of lands subject to overflow in the Embarras River Valley: Illinois State Geological Survey Bulletin 25, University of Illinois, Urbana, IL, 42 p.

Healy, W. R., 1979, River mileages and drainage areas for Illinois streams, volume 1, Illinois except Illinois River Basin: U.S. Geological Survey, Water Resources Investigation Report 79-110, 350 p.

Herzog, B., B. Stiff, C. Chenoweth, K. Warner, J. Sieverling, and C. Avery, 1994, Buried Bedrock Surface of Illinois: Illinois State Geological Survey, Illinois Map 5, Champaign, Illinois, map scale 1:500,000, 1 sheet.

Illinois State Geological Survey, 2006, Lawrence, NE and SE digital orthophoto quarter quadrangles: Illinois Natural Resources Geospatial Data Clearinghouse, Champaign, Illinois, online at http://www.isgs.uiuc.edu/nsdihome/webdocs/doq05/.

Illinois State Geological Survey, 2011, Illinois Water Well (ILWATER) Internet Mapping Service, available at http://www.isgs.illinois.edu/maps-data-pub/wwdb/launchims.shtm, accessed August 15, 2011.

Lawrence County Emergency Management Agency, 2011, flood alerts and flood photographs, http://www.LCEMA.org/, accessed 5/3/2011.

Leighton, M. M., G. E. Ekblaw, and L. Horberg, 1948, Physiographic Divisions of Illinois: Illinois

State Geological Survey Report of Investigations 129, Champaign, IL, 19 p.

Lineback, J. A. (map compiler), 1979, Quaternary Deposits of Illinois: Illinois State Geological Survey, Champaign, Illinois, map scale 1:500,000, 1 sheet.

Midwestern Regional Climate Center, 2011, Precipitation data recorded in 2010 and 2011 at Lawrenceville, Charleston, Newton, Casey, Robinson, and Tuscola Illinois: Midwest Climate Information System: Illinois State Water Survey, Champaign, IL, available on line at http://www.mcc.sws.uiuc.edu.

Miner, J.J., J. R. Ackerman, S.E. Benton, K.E. Bryant, M.C. Campbell, K.W. Carr, A.K.M. Knight, C.W. Knight, J. L. B. Monson, E.T. Plankell, and G.E. Pociask, 2010, Annual Report for Active IDOT Wetland Mitigation and Hydrologic Monitoring Sites, September 1, 2009 through August 31, 2010: Illinois State Geological Survey Open-File Series 2010-4, Champaign, Illinois, 251 p.

Miner, J.J., S.E. Benton, K.E. Bryant, M.C. Campbell, K.W. Carr, A.K.M. Knight, C.W. Knight, E.T. Plankell, and G.E. Pociask, 2011, Annual Report for Active IDOT Wetland Mitigation and Hydrologic Monitoring Sites, September 1, 2010 through August 31, 2011: Illinois State Geological Survey Open-File Series 2011-3, Champaign, Illinois, 242 p.

National Water and Climate Center, 2011, Lawrenceville, Illinois rain gauge, U.S. Department of Agriculture, Natural Resources Conservation Service, Portland, OR, available on line at http://www.wcc.nrcs.usda. gov/wcc.html.

Pickels, G. W., and Leonard, F. B., 1929, Engineering and legal aspects of land drainage in Illinois: Illinois State Geological Survey Bulletin 42, Department of Registration and Education Division of the State Geological Survey, Urbana, IL, 334 p.

Piskin, K., and R. Bergstrom, 1975, Thickness of Glacial Drift in Illinois: Illinois State Geological Survey Circular 490, Champaign, Illinois, 34 p.

Selkregg, L. F., W. A. Pryor, and J. P. Kempton, 1957, Groundwater Geology in South-Central Illinois: Illinois State Geological Survey Circular 225, State of Illinois, Department of Registration and Education, Urbana, IL, 30 p.

Soil Survey Staff, 2009, Custom soil resource report for Lawrence County, Illinois: Soil Survey Staff, National Resource Conservation Service, U.S. Department of Agriculture, Web Soil Survey, available online at http://websoilsurvey.nrcs.usda.gov/, accessed April 30, 2009, 17 pp.

Soil Survey Staff, 2011, Web soil survey, Soil Survey Staff, National Resource Conservation Service, United States Department of Agriculture, available online at http://websoil survey.nrcs.usda.gov/, accessed June 21, 2011.

U.S. Army Corps of Engineers, 2010, Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Midwest Region (Version 2.0): J.S. Wakeley, R.W. Lichvar, and C.V. Noble (eds.), ERDC/ELTR-10-16, U.S. Army Engineers Engineer Research and Development Center, Vicksburg, MS, 152 p.

U.S. Department of Agriculture, 2009, Web Soil Survey, Soil Survey Staff, Natural Resources Conservation Service, U. S. Department of Agriculture, available online at http://websoil survey.nrcs.usda.gov/accessed.

U.S. Department of Agriculture, 2010, Lawrence County, Illinois, 2009 National Agriculture Imagery Program (NAIP) aerial photography, USDA Aerial Photography Field Office Salt Lake City, UT.

U.S. Fish and Wildlife Service, 2009, National Wetlands Inventory: Wetlands Mapper, online at http://wetlandsfws.er.usgs.gov/NWI/.

U.S. Geological Survey, 2011, Lawrenceville, Illinois, Embarras River gauge, USGS gauge number 03346500;
http://waterdata.usgs.gov/nwis/nwisman/?site_no=03346500&agency_cd= USGS

Weibel, C. P., 2005a, Bedrock Topography of Vincennes Quadrangle, Knox County, Indiana and Lawrence County, Illinois: Illinois State Geological Survey, Champaign, IL, map scale 1:24,000, 1 sheet.

Weibel, C. P., 2005b, Drift Thickness of Vincennes Quadrangle, Knox County, Indiana and Lawrence County, Illinois: Illinois State Geological Survey, Champaign, IL, map scale 1:24,000, 1 sheet.

Weisbrook, Scott M., Brian Wilm, and Brad Zercher, 2009, Mitigation site assessment for Lawrence County wetland mitigation bank site, Lawrence County, Illinois: Illinois Natural History Survey, unpublished contract report, Champaign, IL, 27 p.

Willman, H., J. Frye, J. Simon, K. Clegg, D. Swann, E. Atherton, C. Collinson, J. Lineback, and T. Buschbach, 1967, Geologic map of Illinois: Illinois State Geological Survey, Champaign, Illinois, map scale 1:500,000, 1 sheet.

Appendix A: Depth to groundwater below land surface (meters)

Read_Date	Well 1S	Well 2S	Well 3S	Well 4S	Well 5S	Well 6S	Well 7S	Well 9S	Well 10S
11/5/2009	**0.224**	0.402	0.465	dry	**0.019**	**0.198**	**0.235**	0.433	n.i.
12/2/2009	**0.294**	0.543	0.448	0.631	**-0.006**	**0.180**	**0.202**	0.360	n.i.
1/7/2010	frozen	frozen	frozen	0.443	**-0.785**	frozen	frozen	frozen	n.i.
2/2/2010	**-0.181**	**-0.139**	**0.194**	0.476	frozen	frozen	**0.052**	**0.187**	n.i.
3/8/2010	0.427	0.533	0.522	0.446	**0.038**	**0.098**	**0.212**	0.425	n.i.
3/22/2010	**0.173**	**0.165**	**0.297**	**0.263**	**-0.052**	**0.015**	**0.111**	**0.183**	n.i.
4/8/2010	**-0.023**	**0.183**	**0.286**	**0.217**	**-0.040**	**-0.005**	**0.097**	**0.150**	dry
4/14/2010	**0.151**	0.479	0.464	0.375	**0.092**	**0.141**	**0.250**	**0.282**	dry
4/20/2010	0.395	0.660	0.585	0.506	0.443	0.448	0.385	0.488	dry
4/29/2010	0.452	0.607	0.643	0.541	**0.055**	**0.141**	**0.287**	0.563	0.432
5/4/2010	**0.085**	**0.023**	0.537	0.480	**0.059**	**0.121**	**0.106**	0.512	0.349
5/12/2010	**0.177**	0.506	0.610	0.671	**0.277**	0.366	**0.101**	0.674	0.504
5/18/2010	**0.189**	0.399	0.554	0.564	**0.054**	**0.227**	0.427	dry	0.418
5/26/2010	0.393	**0.269**	0.515	0.652	0.361	missed	0.450	mud	0.454
6/1/2010	0.533	0.539	0.588	dry	0.632	0.539	0.549	dry	0.552
6/8/2010	dry	dry	0.690	dry	dry	0.651	dry	dry	dry
6/22/2010	0.321	0.344	0.452	not read	0.482	**0.203**	0.435	0.535	not read
7/13/2010	**0.292**	0.615	0.595	0.481	0.364	0.573	0.437	0.543	0.582
8/10/2010	0.555	0.661	dry	0.516	0.520	dry	0.531	dry	dry
9/8/2010	dry	dry	dry	dry	dry	dry	dry	dry	dry
10/5/2010	dry	dry	dry	dry	dry	dry	dry	dry	dry
11/9/2010	dry	destroyed	dry	dry	dry	dry	dry	dry	dry
12/14/2010	0.348		dry	0.579	not read	not read	not read	0.524	dry
1/13/2011	0.447		dry	dry	**0.192**	**0.259**	0.496	0.515	0.632
2/10/2011	0.308		dry	dry	ice	**0.195**	**0.249**	**0.280**	0.588
2/28/2011	flooded		flooded	dry	flooded	flooded	**-0.742**	**-0.287**	0.618
3/8/2011	flooded		flooded	dry	flooded	flooded	flooded	flooded	flooded
3/15/2011	flooded		flooded	0.522	flooded	flooded	flooded	flooded	flooded
3/21/2011	**-0.341**		**-0.185**	**0.303**	**-0.080**	not read	**-0.112**	**-0.140**	**0.060**
3/28/2011	**-0.070**		**0.293**	0.334	**-0.018**	**0.047**	**0.171**	**0.134**	0.444
4/5/2011	**0.175**		0.352	0.415	**-0.036**	**0.079**	**0.172**	**0.276**	0.502
4/19/2011	**0.050**		0.322	**0.253**	**-0.052**	**0.106**	**0.150**	**0.196**	0.482
5/5/2011	flooded		flooded	flooded	flooded	flooded	flooded	flooded	flooded
5/16/2011	flooded		flooded	**-0.253**	flooded	flooded	flooded	**-0.622**	**-0.506**
5/24/2011	**-0.062**		**0.116**	**0.274**	**-0.029**	**0.157**	**0.267**	**0.261**	**0.068**
5/31/2011	flooded		**-0.047**	0.417	**0.043**	**0.025**	**0.275**	0.384	**0.133**

n.i. = not yet installed
grey box = saturation/inundation

Appendix A: Depth to groundwater below land surface (meters)

Read_Date	Well 11S	Well 12S	Well 13S	Well 14S	Well 15S	Well 16S	Well 17S
11/5/2009	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
12/2/2009	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
1/7/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
2/2/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
3/8/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
3/22/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
4/8/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
4/14/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
4/20/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
4/29/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
5/4/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
5/12/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
5/18/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
5/26/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
6/1/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
6/8/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
6/22/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
7/13/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
8/10/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
9/8/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
10/5/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
11/9/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
12/14/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
1/13/2011	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
2/10/2011	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.
2/28/2011	0.545	**-0.175**	flooded	dry	**-0.523**	**-0.074**	**-0.047**
3/8/2011	**-0.016**	flooded	flooded	dry	**-0.909**	flooded	flooded
3/15/2011	**-0.005**	flooded	flooded	dry	flooded	flooded	flooded
3/21/2011	**0.131**	**0.114**	**-0.426**	dry	**-0.662**	**-0.064**	**0.116**
3/28/2011	0.640	0.334	**-0.016**	dry	**-0.302**	dry	dry
4/5/2011	dry	**0.220**	0.428	dry	**0.074**	dry	dry
4/19/2011	dry	**0.120**	0.491	dry	**0.115**	dry	dry
5/5/2011	flooded	flooded	flooded	flooded	flooded	flooded	flooded
5/16/2011	**-0.105**	flooded	flooded	0.578	flooded	flooded	flooded
5/24/2011	**0.298**	**0.154**	**0.021**	dry	**-0.363**	dry	not found
5/31/2011	0.454	0.514	**0.113**	dry	**-0.306**	0.475	dry

n.i. = not yet installed
grey box = saturation/inundation

Appendix B: Groundwater and surface-water elevations (meters)

Read_Date	Well 1S	Well 2S	Well 3S	Well 4S	Well 5S	Well 6S	Well 7S	Well 9S	Well 10S	Well 11S
11/5/2009	123.867	123.702	123.826	dry	124.320	123.962	124.029	124.077	n.i.	n.i.
12/2/2009	123.797	123.561	123.843	124.461	124.345	123.980	124.062	124.150	n.i.	n.i.
1/7/2010	frozen	frozen	frozen	124.649	125.124	frozen	frozen	frozen	n.i.	n.i.
2/2/2010	124.272	124.243	124.097	124.616	frozen	frozen	124.212	124.323	n.i.	n.i.
3/8/2010	123.664	123.571	123.769	124.646	124.301	124.062	124.052	124.085	n.i.	n.i.
3/22/2010	123.918	123.939	123.994	124.829	124.391	124.145	124.153	124.327	n.i.	n.i.
4/8/2010	124.114	123.921	124.005	124.875	124.379	124.165	124.167	124.360	dry	n.i.
4/14/2010	123.940	123.625	123.827	124.717	124.247	124.019	124.014	124.228	dry	n.i.
4/20/2010	123.696	123.444	123.706	124.586	123.896	123.712	123.879	124.022	dry	n.i.
4/29/2010	123.639	123.497	123.648	124.551	124.284	124.019	123.977	123.947	124.120	n.i.
5/4/2010	124.006	124.081	123.754	124.612	124.280	124.039	124.158	123.998	124.203	n.i.
5/12/2010	123.914	123.598	123.681	124.421	124.062	123.794	124.163	123.836	124.048	n.i.
5/18/2010	123.902	123.705	123.737	124.528	124.285	123.933	123.837	dry	124.134	n.i.
5/26/2010	123.698	123.835	123.776	124.440	123.978	missed	123.814	mud	124.098	n.i.
6/1/2010	123.558	123.565	123.703	dry	123.707	123.621	123.715	dry	124.000	n.i.
6/8/2010	dry	dry	123.601	dry	dry	123.509	dry	dry	dry	n.i.
6/22/2010	123.770	123.760	123.839	not read	123.857	123.957	123.829	123.975	not read	n.i.
7/13/2010	123.799	123.489	123.696	124.611	123.975	123.587	123.827	123.967	123.970	n.i.
8/10/2010	123.536	123.443	dry	124.576	123.819	dry	123.733	dry	dry	n.i.
9/8/2010	dry	dry	dry	dry	dry	dry	dry	dry	dry	n.i.
10/5/2010	dry	dry	dry	dry	dry	dry	dry	dry	dry	n.i.
11/9/2010	dry	destroyed	dry	dry	dry	dry	dry	dry	dry	n.i.
12/14/2010	123.743		dry	124.513	not read	not read	not read	123.986	dry	n.i.
1/13/2011	123.644		dry	dry	124.147	123.901	123.768	123.995	123.920	n.i.
2/10/2011	123.783		dry	dry	ice	123.965	124.015	124.230	123.964	n.i.
2/28/2011	flooded		flooded	dry	flooded	flooded	125.016	124.794	123.965	124.451
3/8/2011	flooded		flooded	dry	flooded	flooded	flooded	flooded	flooded	125.012
3/15/2011	flooded		flooded	124.550	flooded	flooded	flooded	flooded	flooded	125.001
3/21/2011	124.428		124.478	124.769	124.408	not read	124.386	124.647	124.523	124.865
3/28/2011	124.157		124.000	124.738	124.346	124.084	124.103	124.373	124.139	124.356
4/5/2011	123.912		123.941	124.657	124.364	124.052	124.102	124.231	124.081	dry
4/19/2011	124.037		123.971	124.819	124.380	124.025	124.124	124.311	124.101	dry
5/5/2011	flooded		flooded	flooded	flooded	flooded	flooded	flooded	flooded	flooded
5/16/2011	flooded		flooded	125.325	flooded	flooded	flooded	125.129	125.089	125.101
5/24/2011	124.149		124.177	124.798	124.357	123.974	124.007	124.246	124.515	124.698
5/31/2011	flooded		124.340	124.655	124.285	124.106	123.999	124.123	124.450	124.542

n.i.= not yet installed

Appendix B: Groundwater and surface-water elevations (meters)

Read_Date	Well 12S	Well 13S	Well 14S	Well 15S	Well 16S	Well 17S	Gauge A	Gauge B
11/5/2009	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	dry	n.i.
12/2/2009	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	dry	n.i.
1/7/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	frozen	n.i.
2/2/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	frozen	n.i.
3/8/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	dry	n.i.
3/22/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	123.820	n.i.
4/8/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	not read	n.i.
4/14/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	123.896	n.i.
4/20/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	dry	n.i.
4/29/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	dry	n.i.
5/4/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	124.253	n.i.
5/12/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	123.869	n.i.
5/18/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	123.723	n.i.
5/26/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	123.701	n.i.
6/1/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	dry	n.i.
6/8/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	dry	n.i.
6/22/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	124.015	n.i.
7/13/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	123.854	n.i.
8/10/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	dry	n.i.
9/8/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	dry	n.i.
10/5/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	dry	n.i.
11/9/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	dry	n.i.
12/14/2010	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	dry	n.i.
1/13/2011	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	dry	n.i.
2/10/2011	n.i.	n.i.	n.i.	n.i.	n.i.	n.i.	dry	n.i.
2/28/2011	124.997	flooded	dry	124.593	124.810	125.018	flooded	124.081
3/8/2011	flooded	flooded	dry	124.979	flooded	flooded	flooded	124.407
3/15/2011	flooded	flooded	dry	flooded	flooded	flooded	flooded	124.651
3/21/2011	124.708	124.869	dry	124.732	124.800	124.855	flooded	124.693
3/28/2011	124.488	124.459	dry	124.372	dry	dry	124.137	124.657
4/5/2011	124.602	124.015	dry	123.996	dry	dry	123.845	124.388
4/19/2011	124.702	123.952	dry	123.955	dry	dry	123.695	124.407
5/5/2011	flooded	flooded	flooded	flooded	flooded	flooded	flooded	flooded
5/16/2011	flooded	flooded	125.243	flooded	flooded	flooded	flooded	flooded
5/24/2011	124.668	124.422	dry	124.433	dry	not found	124.168	flooded
5/31/2011	124.308	124.330	dry	124.376	124.261	dry	flooded	flooded

n.i.= not yet installed

Appendix C: Well construction

Well#	installation date	borehole depth (m)	well length (m)	stick-up (m)	total well depth (calculated) (m)	screen length (m)	screened interval relative to ground surface (m)	sand pack (m)	bentonite seal (m)
1	10/20/2009	0.75	1.896	1.152	0.744	0.312	0.712-0.400	0.712-0.270	0.270-0.000
2	10/20/2009	0.75	1.888	1.148	0.740	0.299	0.708-0.409	0.708-0.280	0.280-0.000
3	10/20/2009	0.76	1.919	1.176	0.743	0.294	0.711-0.417	0.711-0.290	0.290-0.000
4	10/20/2009	0.74	1.848	1.125	0.723	0.309	0.691-0.382	0.691-0.280	0.280-0.000
5	10/20/2009	0.76	1.847	1.083	0.764	0.280	0.732-0.452	0.732-0.280	0.280-0.000
6	10/20/2009	0.77	1.876	1.086	0.790	0.309	0.758-0.449	0.758-0.300	0.300-0.000
7	10/20/2009	0.76	1.877	1.135	0.742	0.295	0.711-0.416	0.711-0.300	0.300-0.000
8	10/20/2009	0.76	1.849	1.088	0.761	0.308	0.729-0.421	0.729-0.300	0.300-0.000
9	10/21/2009	0.74	1.886	1.080	0.806	0.304	0.775-0.471	0.775-0.300	0.300-0.000
10	4/8/2010	0.75	1.750	1.025	0.725	0.294	0.693-0.399	0.693-0.295	0.295-0.000
11	2/22/2011	0.76	1.705	0.911	0.794	0.313	0.762-0.449	0.762-0.300	0.300-0.000
12	2/22/2011	0.77	1.742	0.954	0.788	0.304	0.756-0.452	0.756-0.210	0.210-0.000
13	2/22/2011	0.75	1.697	0.927	0.770	0.251	0.738-0.487	0.738-0.300	0.300-0.000
14	2/22/2011	0.75	1.705			0.302		0.300	0.300-0.000
15	2/22/2011	0.75	1.700	0.940	0.760	0.310	0.728-0.418	0.728-0.300	0.300-0.000
16	2/23/2011	0.73	1.700	0.955	0.745	0.335	0.713-0.378	0.713-0.270	0.270-0.000
17	2/23/2011	0.74	1.699	0.969	0.730	0.310	0.698-0.388	0.698-0.260	0.260-0.000

Appendix D: NWI Wetland Determination (U.S. Fish and Wildlife Service 2009). Map based on Lawrence, NE and SE digital orthophoto quarter quadrangles (Illinois State Geological Survey 2006).

Appendix E: NRCS wetland determination

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
2812 West Haven Road
Lawrenceville, IL 62439
Phone: 618.943.2621 Ext 3 Fax: 618.943.5613

August 18, 2009

Dear USDA Participant:

Per your request we have completed the Wetland Determination.

The non-cropland (woodland) that is adjacent to the Prior Converted (PC) fields is potentially wetlands please do not install perforated tile within 100 feet of the non-cropland (woodland) area. If you would like to tile closer to the woodland please completed a new 1026 request indicating this.

This determination has been conducted for the purpose of implementing the wetland conservation provisions of the Food Security Act of 1985. This determination may not be valid for identifying the Army Corps of Engineers' (COE) Clean Water Act jurisdiction for this site. If you intend to conduct any activity that constitutes a discharge of dredged or fill material into wetlands or other waters, you should request a jurisdictional determination from the local office of the COE prior to starting the work.

Attached you will find an NRCS-CPA-026E and a Map for your records.

If you have any questions please contact the office.

Respectfully,

Jeremy B. Bennett

Jeremy Bennett
District Conservationist
Lawrenceville Field Office (Lawrence and Wabash Counties)

Phone: (618) 943-2621 ext.3
Fax: (618) 943-5613

cc: case file

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United States Department of Agriculture

Natural Resources Conservation Service

NRCS-CPA-026E
9/2000

HIGHLY ERODIBLE LAND AND WETLAND CONSERVATION DETERMINATION

Name Address:	Bart Pals 270 CO RD 950 E Jewett, IL 62436	Request Date:	7/14/09	County:	Lawrence
Agency or Person Requesting Determination:	Bart Pals	Tract No:	647	FSA Farm No.:	61

Section I - Highly Erodible Land

Is a soil survey now available for making a highly erodible land determination?	Yes
Are there highly erodible soil map units on this farm?	Yes

Fields in this section have undergone a determination of whether they are highly erodible land (HEL) or not; fields for which an HEL Determination has not been completed are not listed. In order to be eligible for USDA benefits, a person must be using an approved conservation system on all HEL.

Field(s)	HEL(Y/N)	Sodbust(Y/N)	Acres	Determination Date
1	N	N	12.1	8/18/09
2	N	N	13.0	8/18/09
3	N	N	5.7	8/18/09
4	N	N	38.7	8/18/09
	-	-		

The Highly Erodible Land determination was completed in thefield .

Section II - Wetlands

Are there hydric soils on this farm?	Yes

Fields in this section have had wetland determinations completed. See the Definition of Wetland Label Codes for additional information regarding allowable activities under the wetland conservation provisions of the Food Security Act and/or when wetland determinations are necessary to determine USDA program eligibility.

Field(s)	Wetland Label*	Occurrence Year (CW)**	Acres	Determination Date	Certification Date
1	PC		12.1	8/18/09	8/18/09
2	PC		13.0	8/18/09	8/18/09
3	PC		5.7	8/18/09	8/18/09
4	PC		38.7	8/18/09	8/18/09
	-				

COPY

The wetland determination was completed in the -Field It was -mailed to the person on 8/18/09.

Remarks: If you tile the Prior Converted Cropland (PC) fields please do not install perforated tile within 100 feet of the Woodland area because the woodland is a potential wetland.

This wetland determination was completed only for the specific area(s) or field(s) listed above. Other wetlands may occur on this tract. Please request a determination for other areas before clearing, draining or performing other activities that may impact or cause a conversion of wetlands.

I certify that the above determinations are correct and were conducted in accordance with policies and procedures contained in the National Food Security Act Manual.

Signature Designated Conservationist	Date
	8/18/09

***DEFINITIONS OF WETLAND LABEL CODES**

AW	Artificial Wetland. An area that is artificial or irrigation induced wetland. These wetlands are not subject to the wetland conservation provision.
AW/FW	An area that contains both AW and FW.
AW/W	An area that contains both AW and W.
CC	Commenced Conversion exemption.
CPD	Corps Permit Decision. Corps of Engineers permit decisions regarding section 404 of the Clean Water Act will be relied upon to satisfy the wetland conservation provisions of the Food Security Act of 1985, as amended.
CMW	An area that receives a Categorical Minimal Effect determination.
CW	Converted Wetlands. An area converted between December 23, 1985 and November 28, 1990. IN any year that an agricultural commodity is planted on these converted wetlands, you will ineligible for USDA benefits.
**CW+year	An area converted after November 28, 1990. You will be ineligible for USDA program benefits until this wetland is restored.
CWNA	Converted Wetland Non-Agricultural use. A wetland area converted to other than agricultural commodity production.
CWTE	Converted Wetland Technical Error. An area converted or commenced based on an incorrect NRCS determination or misinformation from a NRCS or FSA employee.
FW	Farmed Wetland. An area that is farmed wetland; was manipulated and planted before December 23, 1985, but still meets wetland criteria. These may be farmed and maintained in the same manner as long as they are not abandoned.
FWP	Farmed Wetlands Pasture. An area that is pasture or hayland, manipulated before December 23, 1985 but still meets wetland criteria. These may be farmed and maintained in the same manner as long as they are not abandoned.
MIW	Mitigation Wetlands. Wetlands on which a person is actively mitigating a frequently cropped area or a wetland converted between December 23, 1985 and November 28, 1990. A converted wetland, farmed wetland, or farmed wetland pasture on which functions and values were lost are compensated for through wetland restoration, enhancement or creation.
MW	Minimal effect Wetland. An area determined to be minimal effect. These wetlands are to be farmed according to the minimal-effect agreement signed at the time the minimal-effect determination was made,
MWM	An area determined to be minimal effect with mitigation.
NI	Not Inventoried – No wetland determination has been completed.
NW	Non-Wetland. An area that does not contain a wetland.
NW/NAD	An area determined to be a non-wetland resulting from a decision from the National Appeals Division.
OW	Other Waters of the U.S. Area that fall under the jurisdiction of the Clean Water Act.
PC	Prior Converted cropland, which was drained filled, or manipulated before December 23, 1985; was cropped prior to December 23, 1985; was not abandoned; and does not meet FW criteria. These are not subject to the wetland conservation provision unless the area reverts to wetland as a result of abandonment.
PC/NW	An area that contains both PC and NW.
TP	Third Party Exemption.
W	Wetlands. An area meeting wetland criteria, including wetland farmed under natural conditions. If you plan to clear, drain, fill, level or manipulate these areas, contact NRCS and the Army Corp of Engineers prior to any such activity.
WX	A wetland area that has been manipulated after December 23, 1985, but was not, for the purpose of making production possible and production was not made possible. These include wetlands manipulated by drainage maintenance agreements.

Appendix E: continued

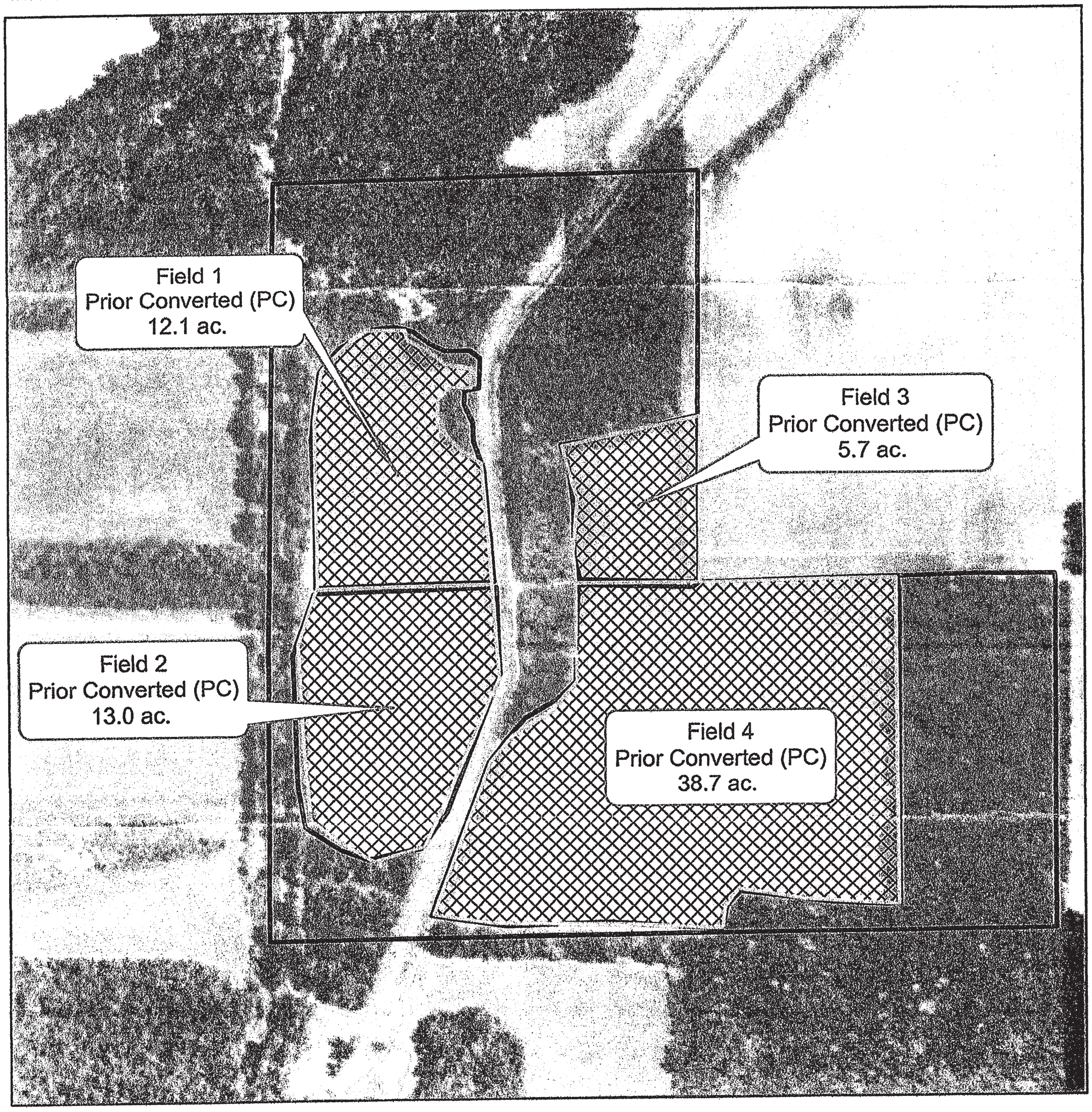
Determination MAP

Customer(s): BART C PALS

District: LAWRENCE COUNTY SOIL & WATER CONSERVATION DISTRICT

Field Office: LAWRENCEVILLE SERVICE CENTER

Map prepared by Jeremy Bennett



Legend

Prior Converted (PC)

T 647

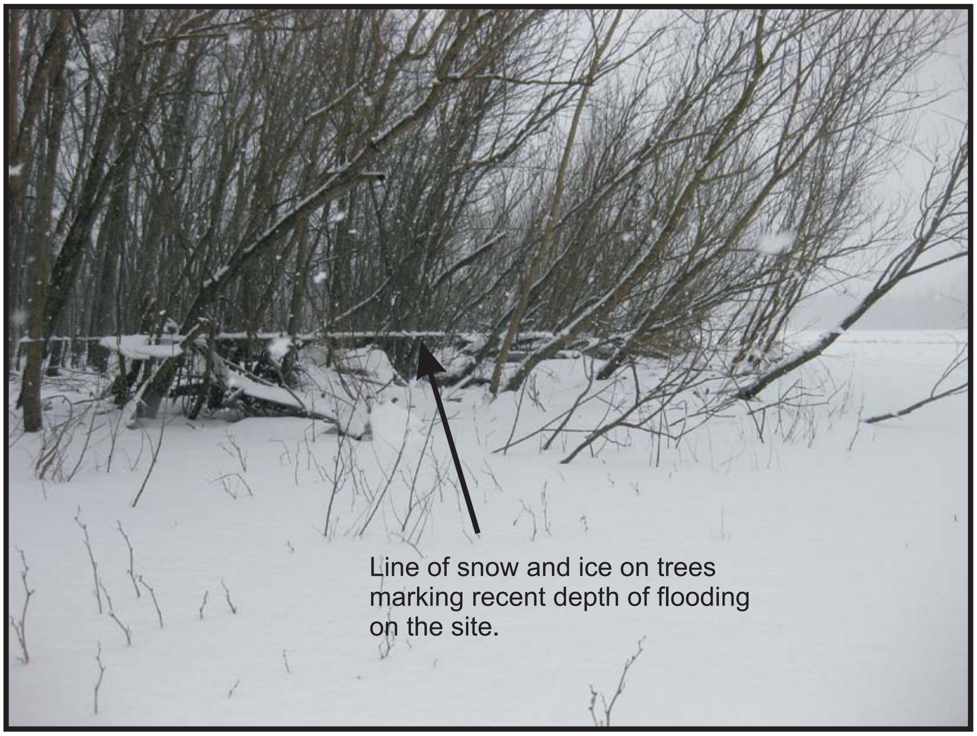
300 0 300 600 900 1,200 Feet

N

Agency: NRCS

Date: 8/18/2009

Appendix F. Photographs of flooding at the proposed wetland bank.



These photographs were taken on January 7, 2010 in the forest north of the agricultural field west of Beaver Pond Ditch, and show evidence of recent inundation. This was likely the result of Beaver Pond Ditch overtopping its banks on December 29 and 30, 2009 which was likely due to a flood event on the Embarras River that was occurring at the same time (Figure 11).

Appendix F. Continued.

These photographs were taken March 22, 2010 and show Beaver Pond Ditch in a bank-full condition (top), inundation in the forested are west of the ditch (top), and inundation in the south end of the agricultural field west of Beaver Pond Ditch (bottom). This inundation was likely due to an action stage event that occurred on the Embarras River on March 15, 2010.

Appendix F. Continued.

These photographs show flooding at the site on March 15, 2011 (top) and May 3, 2011 (bottom). The view in both is looking southeastward towards the farm field west of Beaver Pond Ditch from the top of the Russell-Allison Levee that forms the western boundary of the site. In the top photograph, the surface water is 0.6-0.9 m (2.0-3.0 ft) deep, and extends south to well 11S (Figure 6), and in the bottom photograph it is 1.8-2.4 m (6.0-8.0 ft) deep, and covers the entire site.