2. SITE ANALYSIS

Geology

This property is located in the physiographic region of the **eastern ridges and lowlands of Wisconsin** (Martin 1965). The bedrock formations underlying the unconsolidated surface deposits of all of Milwaukee County, including this property, consist of Niagara Dolomite from the Silurian-period. Below the Niagara formation are the Maquoketa shale, the Platteville, Decorah, and Galena formations, consisting of primarily limestone or dolomite, and sandstones of the Ordovician-period. Additional sandstones of the Cambrian-period underlie the Ordovician formations.

The bedrock is covered by deep, unconsolidated glacial deposits greater than 500 feet thick in some buried pre-glacial valleys. Whereas in other places the bedrock lies within 20 feet of the surface (Hales Corners, Greendale, Whitefish Bay, and Brown Deer regions of Milwaukee County). The depth of glacial deposits near the Bay View Wetland site is estimated between 100-200 feet.

Pre-European Settlement Conditions

The characteristic landscape of the pre-settlement conditions of the Milwaukee River Basin was different than it is today. Historic settlements of four Native American groups – The Fox, Mascouten, Potawatomi, and Menominee – were all documented along the Milwaukee River, and remained in the area until approximately 1833. Pere Jacques Marquette and Louis Jolliet paddled their canoes along the Lake Michigan shore line past the site in September of 1673 while returning from their exploration of the Mississippi River. They, along with other explorers, found an **area rich with upland forests** of maple, beech, and basswood, and lowland areas dominated by tamarack, cedar, and ash.

In addition to the forests, the basin was water and wetland rich. The abundant resources of the forest, rivers, and lakes provided needed resources for Native Americans and later European settlers to establish economic development in the basin. The southernmost portions of the basin, now known as the Milwaukee Area, were soon settled and incorporated, while many of the forested riverbanks were cut for lumber and cleared for farming. The relatively

Figure 2.1: 1832 Map of the township containing the Grand Trunk Property

flat landscape and rich soils formed by the glaciers in many areas of the basin supported a variety of agricultural crops. By the mid-late 1800's, farming was the primary land use in the upper basin, while mill operations were the first industries in and adjacent to Milwaukee's estuaries.

Early land surveyors described the area near the site as level land, wet, 3rd rate, and meadows with timber of ash, elm, bur oak and tamarack in the historic land survey. Other descriptions include meadows, marsh, swamp, and tamarack swamp communities. Land surveyor notes from near the site also describe the land as level, 3rd rate, noting a meadow and creek, with ash, aspen, and oak species present.

The field notes and mapped interpretations made

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by the early surveyors were only intended to broadly characterize the landscape in terms of key soil, water, and timber resources important to pioneer settlers and farmers. The observations of these surveyors were limited by their systematic mapping method of traveling along the mile-long section lines of their survey grid. As a result we can assume their interpolations of the intervening ground not traveled caused them to miss some level of detail about the variety of plant community types, unique hydrological settings, and subtle moisture gradients that created a more complex landscape mosaic of natural community types than their maps would indicate.

Given the limitations of early survey data, we must make some assumptions about the pre-settlement conditions on the Bay View Wetland property based on our understanding of the influence of the topography, slope aspect and soil types observed on the property today. Based on a review of the General Land Office Survey data for the township, conditions in theses survey sections contained many wetlands (meadow, swamp, marsh, tamarack swamp, and creek) and timber of oak, ash, maple, aspen, and tamarack.

Land Use History

The Bay View Wetland has been subject to several comprehensive environmental studies that have extensively documented the land use history and have detailed the current conditions (Giles Engineering Associates 2003, 2004, 2009). Prior to the late nineteenth century, **the Bay View project area sat within an extensive marshland**. A conceptual study of Giles soil boring data allowed the elevation of native wetland soil at the Bay View Wetland site to be interpolated. The marshland was subsequently in-filled to make land for improvements to the Port of Milwaukee beginning in the 19th Century. An 1853 map shows the project area within a broad wetland that by 1883 had been in-filled (Figure 1.1).

Documentation of the early twentieth century modifications to the geography of the Port of Milwaukee are clearly documented by the U.S. Army Corps of Engineers on harbor charts and early plats. By 1888, the channel that would later house the Grand Trunk car ferry slip had been created (Figure 2.2). The 1915 and 1916 harbor maps show the slip and by 1934 the slip is attributed to Grand Trunk (Figure 2.3).

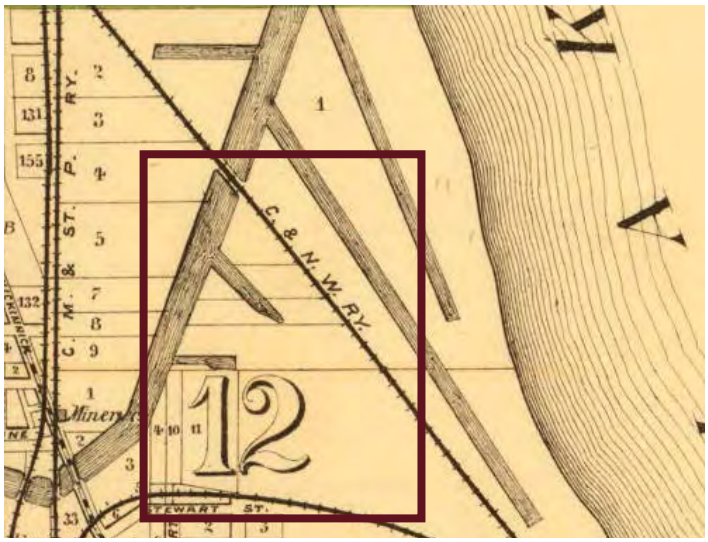

Figure 2.2: 1888 Map of the Grand Trunk Property

Historically, **portions of the site have been used as a lumberyard, salt storage warehouse, freight handling facility, railroad yard, and car ferry terminal** (Giles Engineering Associates 2003, 2009). The far northwestern portion of the project area once housed the Grand Trunk Freight House, an Incinerator, and Diesel Engine House (Giles Engineering Associates 2009). The southwestern portion was once used as a Truck Repair Building and Motor Freight Station. The Grand Trunk Car Ferry Company occupied the property through the 1960s. Jeff Cartage, Fort Transportation, and Johnson Truck Service were affiliated with the project area in the 1970s.

Figure 2.3: 1934 Map of the Grand Trunk Property

By the early 1980s, all structures were razed and the property has remained derelict to the present day. Railroad lines once crossed the northwestern portion of the project but were removed in the 1980s (Giles Engineering Associates 2003:31).

Figure 2.4: A 1960 aerial photo of the site (top) shows it in use as a rail road and truck repair yard. By 1982 (bottom) the site was abandoned.

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Archaelogical Survey

In January 2013, Great Lakes Archaeological Research Center, Inc. (GLARC) conducted archaeological investigations for the Bay View Wetland project site. An archives and literature search was conducted for the project that identified all previously reported archaeological and burial sites within one mile of the project area (Figure 2.5; Table 2.1). In all, 22 previously reported archaeological sites were identified within one mile of the project corridor. The archival and literature research identified two archaeological sites coincident with the Bay View Wetland project area. These sites include 47MI0492, **The Grand Trunk Car Ferry Slip**, and 47MI0493, **Allis Pond**. The reported boundaries of each site relative to the Bay View Wetland Project area are shown in Figure 8. Only Allis Pond has the potential to be impacted by this master plan.

Site No.	Site Name	Era	Affiliation	Type
MI0035	Chase Mounds	Precontact	"American Indian Woodland"	Mounds
MI0101	Deer Creek Village	Historic	American Indian	"Village, workshop, cemetery"
MI0168	Greulich Burials	Indeterminate	American Indian	Cemetery
MI0205	Pauschkenana's Village	Historic	American Indian	Campsite/Village
MI0206	Onautissah's Village	Historic	American Indian	Campsite/Village
MI0227	"Jones Island Fishing Community"	Historic	Euroamerican	Community
MI0334	Baran Park	Precontact	"American Indian Indeterminate"	Campsite/Village
MI0387	Ebersol	"Historic, Precontact"	"Euroamerican, American Indian"	Campsite/Village
MI0388	Bay Street	Precontact		Campsite/Village
MI0402	Lightship 57 (1891)	Historic	Euroamerican	Shipwreck
MI0462	Buckeye State	Historic	Euroamerican	Shipwreck
MI0464	Cape Horn	Historic	Euroamerican	Shipwreck
MI0465	Contest	Historic	Euroamerican	Shipwreck
MI0472	John V. Jones	Historic	Euroamerican	Shipwreck
MI0477	Muskegon	Historic	Euroamerican	Shipwreck
MI0479	Nile	Historic	Euroamerican	Shipwreck
MI0480	Orleans	Historic	Euroamerican	Shipwreck
MI0483	Twin Brothers	Historic	Euroamerican	Shipwreck
MI0492	**Grand Trunk Car Ferry Slip**	**Historic**	**Euroamerican**	**Transportation**
MI0493	**Allis Pond**	**Historic**	**Euroamerican**	**Shipwreck**
MI0497	"Gillen Towing Company Wreck"	Historic	Euroamerican	Shipwreck
MI0525	Stewart Allis Cemetery	Historic	Euroamerican	Cemetery

Table 2.1: Previously Reported Archaelogical and Burial Sites within One Mile of the Project Area

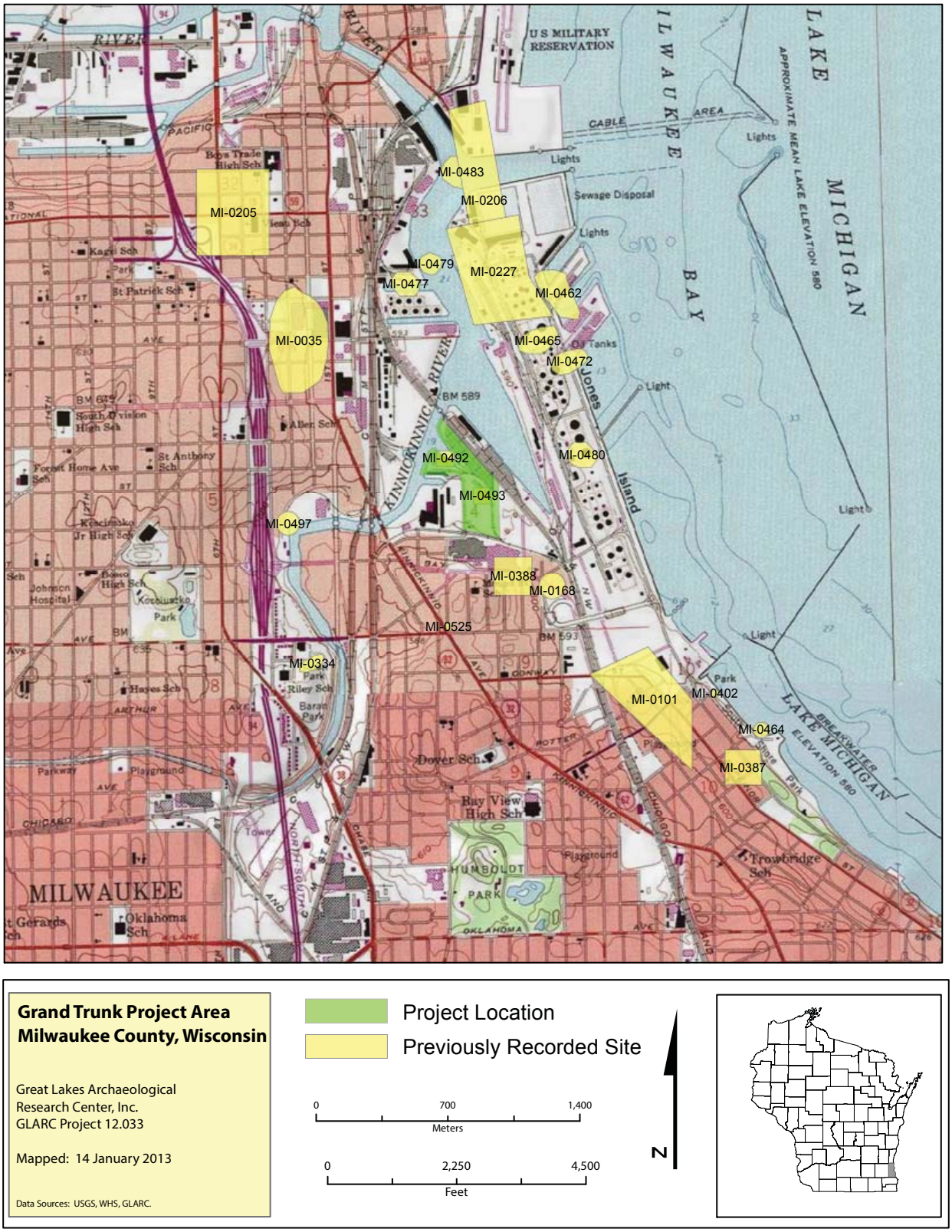

Figure 2.5: Previously recorded archaelogical sites within one mile of the project area

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Reconnaissance level archaeological investigations were conducted in order to:

- field verify the presence and condition of the two previously reported sites (47MI0492 and 47MI0493), and
- provide recommendations for more intensive Phase I and/or Phase II evaluation studies.

The field reconnaissance was conducted in January 2013, during a brief winter interlude when the project area was snow free, ground slightly thawed, and temperatures were above freezing. The reconnaissance survey identified evidence of both sites within the project area. The findings and recommendations are detailed below.

The Grand Trunk Car Ferry Slip (Site 47MI0492) defines the remnants of a twentieth century marine-related transportation structure, a car ferry slip, that served the Grand Trunk Car Ferry. The site is located in the northwestern portion of the project area and is clearly evident on historic and current aerial and topographic maps (Figure 2.6). The site is in the NW SW SE NW of Section 4, Township 6 North Range 22 East and occupies in-filled land created as part of the Port of Milwaukee.

The Archaeological Site Inventory (ASI) record defines the site as the remnants of a car ferry slip and a railroad car loading ramp that may have been used by the S.S. Milwaukee prior to 1929. The site includes a wooden dock, timbers, ties, pilings, cast iron ramp, cast concrete ramp, and counterweights. A review of historic maps and plats indicate that the in-filled land and channel cut, along which the slip would later occupy, were extant by 1888 (Wright 1888). A 1934 plat shows the current slip configuration, attributing the slip to Grand Trunk, and depicts the nearby Grand Trunk railroad tracks (American Geographical Library 1934) (Figure 2.3).

The Grand Trunk Car Ferry Slip was operated and used by the Grand Trunk Car Ferry Company that transported railroad cars between Milwaukee, Wisconsin and Muskegon, Michigan from circa 1905 through the late 1970s. Another car ferry slip is known for the Port of Milwaukee, the Municipal Car Ferry slip (on Jones Island), constructed in 1928. The Municipal Car Ferry slip was publicly owned, operated for 45 years, and served the Marquette Railway Company and Pere Marquette Car Ferry (Gregory 2003). During the early years of operation, car ferries contributed significantly to the economic well-being of the Port of Milwaukee, moving both goods and passengers through the harbor area (Gregory 2003:13). Deregulation of the railroad industry made car ferry facilities all but obsolete by allowing railway companies to more easily use track lines owned by other companies. Rather than bring cars and their contents to Milwaukee for shipment across Lake Michigan to eastern rail connections, a company could move cars along the rails of partner lines to destinations in the east and west without a car ferry connection (Gregory 2003: 13).

The field reconnaissance identified remnants of the Grand Trunk Car ferry slip within the project area (Figure 2.7). The slip is in a deteriorated condition,

Figure 2.6: The Grand Trunk Car Ferry Slip, 2013

with many of the piles broken or rotting, and the platform has been broken. The two concrete cubes are in good condition, though the southern one has collapsed through the wooden piles and is almost in the water, while the northern cube is slowly breaking through the platform and sinking. The piles on the southern side are burned, though the platform is in somewhat more stable condition.

The reconnaissance survey has confirmed the presence of 47MI0492 within the project area and has assessed its condition as relatively poor. Without more intensive investigations, coupled with historic document research, it is unknown if the key structural elements of the car ferry slip retain integrity. It is also unknown, without conducting more in depth

Grand Trunk Project Area
Milwaukee County, Wisconsin

Great Lakes Archaeological
Research Center, Inc.
GLARC Project 12.033

Mapped: 14 January 2013

Data Sources: USGS, WHS, GLARC.

Previously Recorded Site
Project Location

N

0 120 240
Meters

0 375 750
Feet

Figure 2.7: Location of Archaelogical Sites at the Bay View Wetland Restoration

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research, the potential historic significance of the car ferry slip to the Port of Milwaukee and early to mid-twentieth events. Although historical significance and integrity remain unknown, a review of the current plans does not call for any activities in or within the vicinity of the site. Therefore, the project will not have an effect (adverse or otherwise) on site 47MI0492. If project plans change, and physically destructive actions are planned for site 47MI0492, it is recommended than an intensive survey and more in depth historical research be conducted to assess integrity and significance of the site.

Allis Pond (Site 47MI0493) defines the remnants of a twentieth century ship wreck located within the central portion of the Bay View Wetland project area. The site is in the NE NE SW of Section 4, Township 6 North, Range 22 East and occupies in-filled land that caps a former marsh. The ASI record indicates that the site defines pieces of a lapstrake wooden boat, constructed ca 1920 to 1970, with an overall length of 16 feet, likely similar to Thompson, Chris-Craft, or Century Runabout.

The reconnaissance survey confirmed the presence of 47MI0493 within the project area (Figure 2.7). The remnants of the boat were observable on the ground surface and plotted with a GPS. The boat remnants appear to be located just to the north of ASI recorded boundaries in a large depression with wetland plants (Figure 2.8). The boat remnants appear to be within a larger wetland/pond that has been filled in with various type of historic and modern debris including railroad ties and timbers.

Figure 2.8: The remains of the Allis Pond Shipwreck

The reconnaissance survey has confirmed the presence of 47MI0493 within the project area. The boat appears to be within a larger depression that contains a considerable amount of historic and modern fill. As such, it is likely that the boat represents fill refuse, possibly in secondary context. The current project plans call for possible ground disturbing activities within the vicinity of the site. If the site cannot be avoided, then more intensive survey and more in depth historical research should be conducted to assess the integrity and significance of the site.

Hydrology

The Bay View Wetland is located in the 33-square mile **Kinnickinnic River Watershed**, which is the smallest and most urban of the Milwaukee River Basin watersheds (WIDNR 2001). This watershed is located in the southern portion of Milwaukee County and contains 25 miles of perennial streams and seven park ponds. The Kinnickinnic River is the only named stream, and comprises about half of the total stream miles in the watershed (WIDNR 2001). Land cover in this watershed is mostly urban (78%), with grassland (16%), and forests (4%) creating open space. Remaining wetlands comprise 0.3% of land area (WIDNR 2001).

Surface waters of Milwaukee County flow to Lake Michigan through all five Milwaukee River Basin watersheds. The Milwaukee River, the Menomonee River, and the Kinnickinnic River empty into Lake Michigan at the Milwaukee Harbor. The surface drainage in Milwaukee County ranges from well-developed dendritic patterns produced on permeable unconsolidated materials present over sedimentary bedrock to an uneven pattern characteristic of drainage formed in glacial deposits that have blocked the previous natural flow patterns. The result of the glaciers in Milwaukee County produced a large area of low flow and swamp-like conditions.

Due to the location of the project, the **ordinary water and flood elevations of the Kinnickinnic River are influenced solely by the water elevations of Lake Michigan**.

According to a 2009 Milwaukee Metropolitan Sewerage District hydraulic study of the Kinnickinnic River (Figure 2.9), all water surface profiles

for the river reach from the Union Pacific Railroad to the downstream portion of the South Kinnickinnic Avenue crossing were controlled by the Lake Michigan water level.

The average water level for Lake Michigan varies according to seasonal patterns and long-term cyclical patterns. From 1865 to 1998 water levels have ranged from a high near 582.5 feet (International Great Lakes Datum) to a low of 576 feet, with a long term mean water level of 579.5 feet.

In recent years Lake Michigan has experienced the extreme low levels of 1964 – 1965 to the high levels during the 1980s – 90s. Since 2000 the lake has seen a drop in water levels and continues to have water levels well below the mean. On the day of the topographic survey the water level was recorded between 577.5 and 577.8 feet (1.8 feet above the lowest recorded water level).

According to the NOAA-GLERL ("Water Levels of the Great Lakes," September 2012) the outlook for the near future, first half of 2013, will see the lake reach record low levels. A 2008 article in Environmental Science & Technology (Sellinger et al, 2008) demonstrated a **long term trend of lower water levels.** Mathematical models indicate that since 1900 water levels have been dropping. The article contends that this data combined with climatic changes present a scenario of continued lower lake levels. In addition to the climate, recent criticism has been placed on past dredging activities, particularly the St. Clair River, for contributing to the lower levels.

In a document from University of Wisconsin Sea Grant Institute the anticipated future lake levels on Lake Michigan due to climate change were discussed. Utilizing two different models, HadCM2 and CGCM1, NOAA-GLERL predicted that by 2030 water levels could differ by +0.2 feet to -2.4 feet from the base case period (1961 – 1990). By 2090 levels could be +1.1 to -4.5 feet.

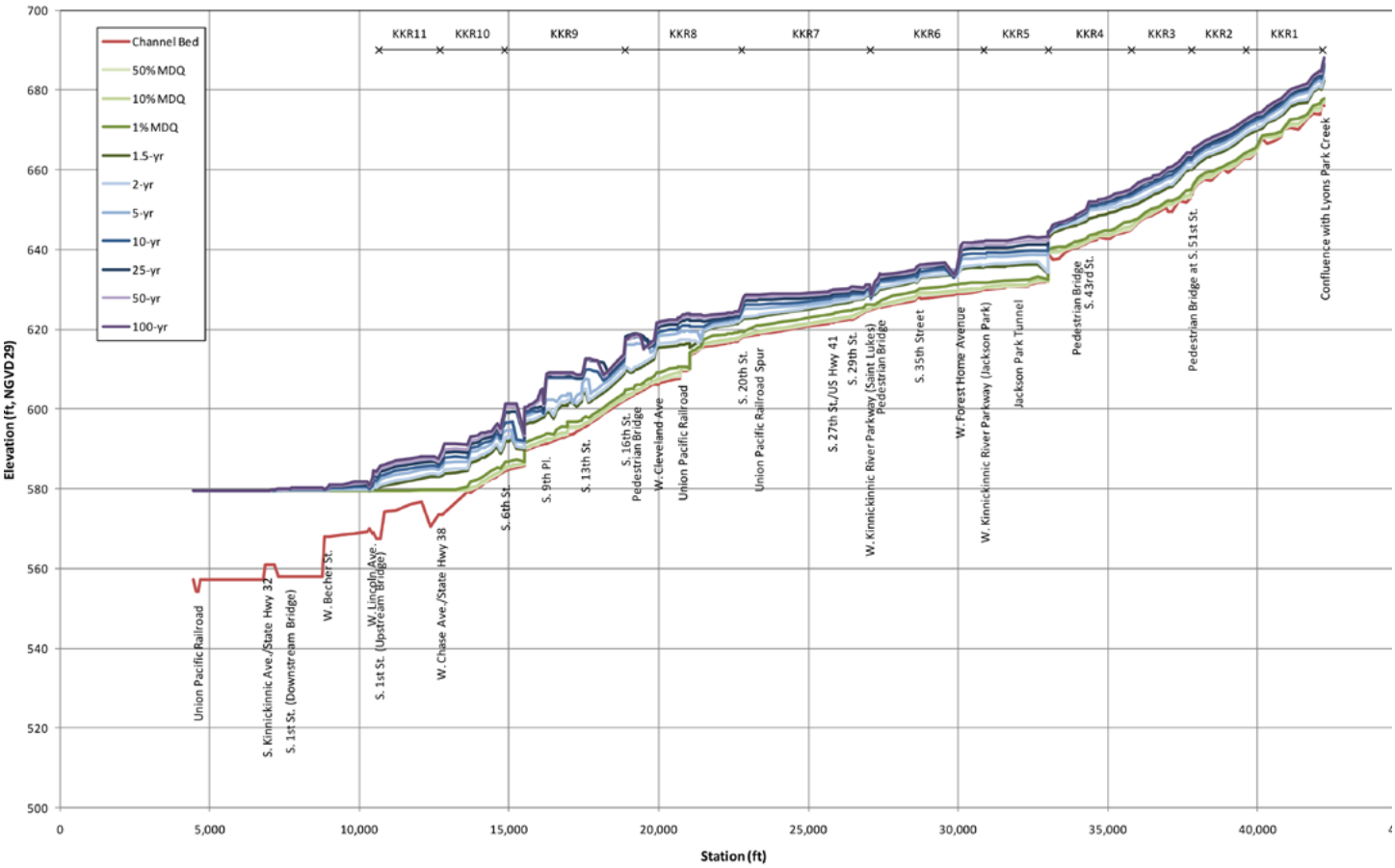

Figure 2.9: Water levels at stations on the Kinnickinnic River between S. Kinnickinnic Ave and the Union Pacific Railroad (stations nearest the site) show that water levels do not fluctuate significantly due to upstream influences.

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There will be several **effects of lower lake levels** on the project:

- More of the **river's banks** that were below water will be **exposed**
- The river could potentially experience **flashy rises in water levels** due to flood events, which will create further bank erosion unless they are restored and stabilized
- **Decreased functionality** of the existing slip for boat traffic
- **Groundwater level changes** – either a lowering or an increase in the flow gradient.

Existing Natural Communities

Methods

In preparation for an investigation of the Bay View Wetland property, several sources of natural resource data and historic site information were gathered and reviewed: digital air imagery (ortho-photography) (2010), the Wisconsin Department of Natural Resources databases (Bureau of Endangered Resources Natural Heritage Inventory database (WIDNR 2000)), and the General Land Office survey records (1832).

A scaled base map was prepared with a marked property boundary over aerial imagery dated 2010. This map was used for delineating land cover features and recording other findings in the field. On December 6, 2012, Applied Ecological Services, Inc. (AES) walked selected areas of the site to identify, characterize, and photo document natural communities and other land cover types and features, record dominant and characteristic plant species, and document critical resource issues. Examples of critical resource issues include species of concern or interest, base flow conditions, and examination of fish habitat areas.

Vegetation community classifications were described based on the Wisconsin Department of Natural Resources Natural Heritage Inventory (Epstein et al. 2002) natural community descriptions. Communities were mapped in Figure 2.12.

Emergent Marsh (0.4 acres) A lowland area was found along the northeastern project area boundary.

Figure 2.10: Emergent Marsh

This lowland area with standing water supports a species assemblage indicative of an emergent marsh habitat, including cattails (Typha species), phragmites (Phragmites australis), bulrush (Scirpus atrovirens), carex (Carex spp.), and cinnamon willow herb (Epilobium coloratum). Additional species documented in this community included Kentucky bluegrass (Poa pratensis), Canada goldenrod (Solidago canadensis), cottonwood saplings (Populus deltoides), New England aster (Aster novae-angliae), and teasel (Dipsacus sylvestris) .

Seepage Pond (0.1 acres) An open water area was located along the northeastern property boundary. Seepage ponds are described as land-locked water bodies with no inlet or outlet, and

Figure 2.11: Seepage Pond

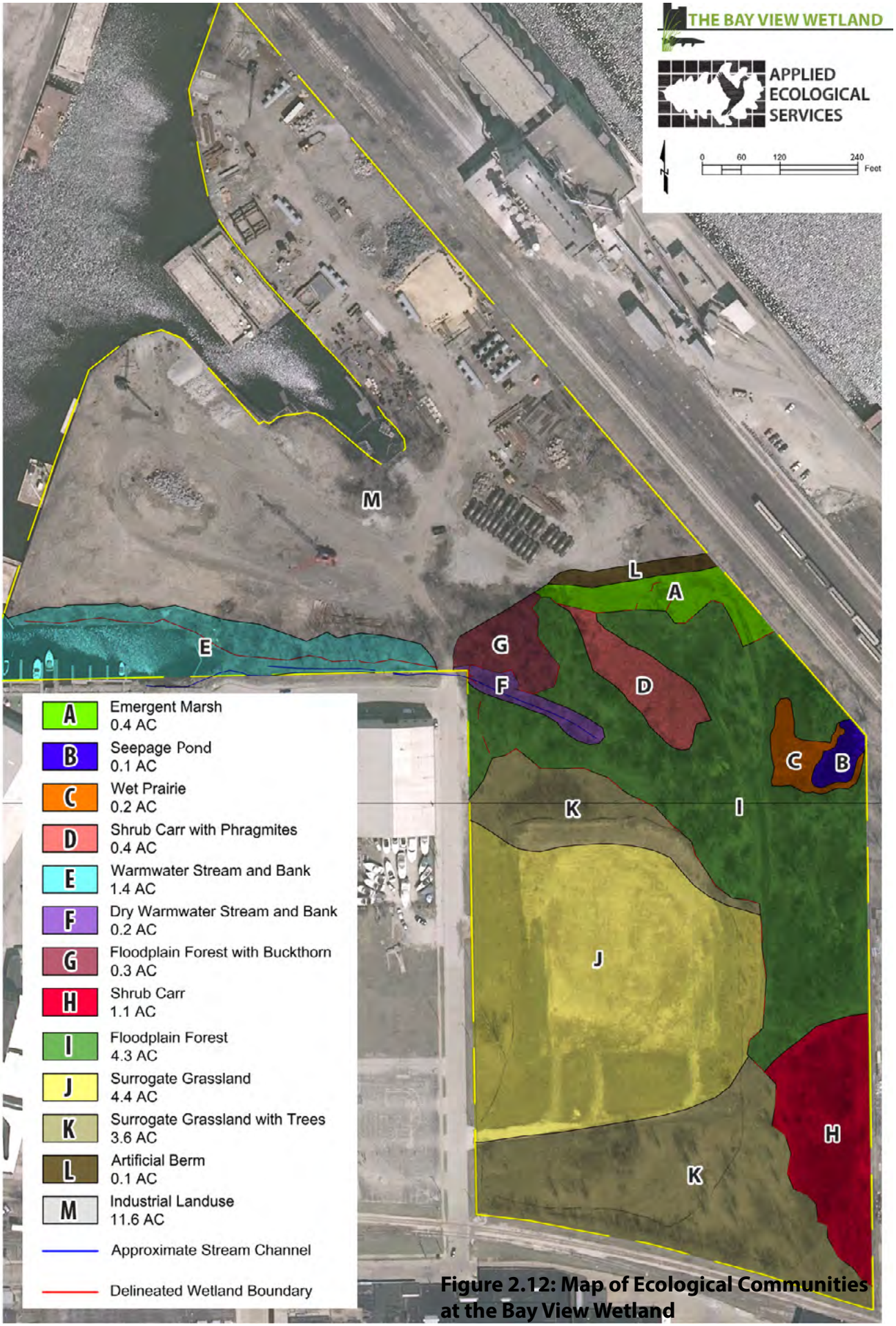

Figure 2.12: Map of Ecological Communities at the Bay View Wetland

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occasionally overflow. The principle source of water is precipitation or runoff, and supplemented by groundwater from the immediate drainage area. Since seepage ponds reflect groundwater levels and rainfall patterns, the water levels may fluctuate seasonally (Epstein et al. 2002). This open water area was surrounded by phragmites, with few scattered trees documented along the northern side of the open water. Poor water quality was observed, with little visibility and scattered garbage in and along the banks. Because of the presence of garbage and suspended solids in the open water it is unlikely this area is regularly occupied by fish, reptiles or amphibian species.

Wet Prairie (0.2 acres) This densely vegetated area was found around the seepage pond described above. The community is characterized as a variable tall grassland community that shares characteristics of prairies, sedge meadows, calcareous fens, and emergent aquatic communities (Epstein et al 2002). The only species documented in this area during the investigation was phragmites with a cover of 100% .

Shrub carr (1.1 acres) The shrub carr was found along the southeastern and southern border of the property. The community, as described above, had scattered cottonwood and aspen (Populus tremuloides) trees in the canopy, dense dogwood and willows throughout the shrub layer, and Canada goldenrod, Dudley's rush (Juncus dudleyi), Kentucky bluegrass, phragmites, hairy aster, Queen Ann's lace, and reed canary grass in the herbaceous layer.

Shrub Carr with Phragmites (0.4 acres) This community was found in the northeastern section of the property. The wetland community is typically dominated by tall shrub species (i.e. dogwoods) and various willows. This type of community typically occupies transitional areas between open wetlands and forested wetlands (Epstein et al. 2002).

Dominant species identified during the investigation include dogwood species (Cornus spp.) and sandbar willow (Salix interior), which comprised approximately 40% of the total cover. The remaining 60% was dominated by phragmites, with scattered cottonwood, box elder (Acer negundo), and elm (Ulmus americana) trees. Reed canary grass (Phalaris arundinacea) and Canada goldenrod were also documented.

Figure 2.13: Wet Prairie

Dry Warmwater Stream Bank (0.2 acres) The dry warmwater stream bank was found along the north-central portion of the property. This community is slightly different than the adjacent stream connecting to the Kinnickinnic River, described in the paragraph above. The stream bed is classified as ephemeral, flowing only briefly after rainfall events. AES ecologists observed that the culvert under the roadway connecting the two stream segments was clogged with debris and garbage, preventing the two segments from joining. Canopy and herbaceous species documented in this community were similar to those on the Warmwater Stream Bank.

Figure 2.14: Shrub Carr

Warmwater Stream and Bank (1.4 acres)

This community was found along the northwestern portion of the property. Warmwater streams are described as flowing waters with maximum water temperatures typically greater than 25 degrees Celsius. They usually have watershed areas less than 500 square miles and mean annual flow rates of less than 200 cubic feet per second.

These streams are common throughout the state, particularly in southeastern Wisconsin. A rich fauna, dominated by warmwater species from the Cyrinidae, Castostomidae, Centrarchidae, and Percidae families can be found in warmwater streams (Epstein et al. 2002).

The Kinnickinnic River is located directly west of the property with a small industrial inlet leading into the site connecting to a small stream channel flowing east-west (dry and/or muddy at the time of investigation). The stream channel was highly affected by the adjacent land use with runoff evident during periods of rainfall and abundant garbage located in and on the banks of the stream.

The stream bed was devoid of vegetation during the investigation. Documented canopy species along the bank included black willow (Salix nigra), box elder, dogwood species, cottonwood, and sandbar willow. Other documented herbaceous species include teasel, hairy aster (Aster pilosus), evening primrose (Oenothera biennis), Canada goldenrod, bull thistle (Cirsium vulgare), sweet clover (Melilotus alba), common milkweed (Asclepias syriaca), New England aster, wild parsnip (Pastinaca sativa), reed canary grass, iris (Iris virginica shrevei), curly dock (Rumex crispus), angelica (Angelica atropurpurea), blue vervain (Verbena hastata), Queen Ann's lace (Daucus carota), cinnamon willow herb, beggar's tick (Bidens frondosa), horseweed (Erigeron canadensis), germander (Teucrium canadense), false aster (Boltonia asteroides) and purple loosestrife (Lythrum salicaria).

Figure 2.15: Warmwater Stream

Figure 2.16: Floodplain Forest

Floodplain Forest (with Buckthorn) (0.3 acres)

This forest was identified along the north-central property line, north of the dry warmwater stream described above.

The vegetative community was indicative of a lowland hardwood forest typically found along larger rivers. Periodic floods, especially in spring, are the key natural disturbance event to which species in this community are adapted. Silt deposition and the creation of microtopography during flood events create a suitable habitat for tree germination and establishment (Epstein et al. 2002).

Canopy species documented during the investigation included American elm, box elder, black willow, and cottonwood trees. The shrub layer consisted

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Figure 2.17: Surrogate Grassland

of common buckthorn. Garlic mustard (Alliaria petiolata) was dominate in the herbaceous layer with few other scattered species.

Floodplain Forest (4.3 acres) The floodplain forest was found throughout the northern and northeastern portions of the project area. The community, as described in detail above, contained cottonwood, American elm, black willow, and box elder in the canopy, and scattered dogwood and willow species in the shrub layer. Herbaceous vegetation was scattered or absent in some areas, and included reed canary grass and Canada goldenrod as dominant species.

Surrogate Grassland (4.4 acres) This grassland community was found throughout the central and along the west-central property boundary. Surrogate grasslands are similar in structure to the former prairies that occurred in Wisconsin prior to settlement, and include agricultural habitats, fallow fields, old fields, pastures, and set-aside (CRP) land, planted to non-native cool-season grasses. Examples of surrogate grasslands include orchards, parks, golf courses, airports, roadsides, and abandoned public or private lands (Epstein et al. 2002).

This community contained Canada goldenrod, hairy aster, sweet clover, spotted knapweed (Centaurea maculosa), chicory (Cichorium intybus), evening primrose, annual sunflower (Helianthus annuus), and various cool-season grasses such as brome (Bromus inermis) and Kentucky bluegrass in the herbaceous layer. No trees were observed.

Surrogate Grassland (with scattered trees) (3.6 acres) This grassland community was found along the southern property boundary of the site.

This natural community, as describe in the above paragraph, had a similar herbaceous species layer with several additional species documented; reed canary grass, black raspberry (Rubus occidentalis), curly dock, yarrow (Achillea millefolium), and Canada thistle (Cirsium arvense). The canopy species documented in this community were box elder and cottonwood trees, with scattered patches of dogwoods.

Artificial Berm (0.1 acres) This man-made feature was located on the northeastern boundary of the property. The berm, constructed of sand and various other materials, was created to prevent runoff from the adjacent industrial site into the wetland communities.

While more than 50% of the berm was devoid of vegetation, scattered herbaceous species included horseweed, hairy aster, cocklebur (Xanthium strumarium), annual sunflower, evening primrose, reed canary grass, annual fleabane (Erigeron annuus), Queen Ann's lace, phragmites, and sweet clover.

Industrial Landuse (11.6 acres) This land use was located in the northern half of the property and contained a variety of equipment, buildings, and vehicles. This area is expected to remain as an industrial use area and is not considered part of the project area.

Figure 2.18: Artificial Berm

Threatened and Endangered Resources

Table 2.2: Rare Species at the Bay View Wetland

	Scientific Name	Common Name	*State Listing
Vertebrate	Anguilla rostrata	American Eel	Special Concern
	Falco peregrinus	Peregrine Falcon	Endangered
	Lepomis megalotis	Longear Sunfish	Threatened
	Luxilus (Notropis) chrysocephalus	Striped Shiner	Endangered
	Migratory Bird Concentration Site	Migratory Bird Concentration Site	
	Moxostoma valenciennesi	Greater Redhorse	Threatened
	Thamnophis butleri	Butler's Gartersnake	Threatened
Invertebrate	Procambarus gracilis	Prairie Crayfish	Special Concern
Plant	Chamaesyce polygonifolia	Seaside Spurge	Special Concern
	Cypripedium candidum	Small White Lady's-slipper	Threatened
	Erigenia bulbosa	Harbinger-of-spring	Endangered
	Liatris spicata	Marsh Blazing Star	Special Concern
	Penstemon hirsutus	Hairy Beardtongue	Special Concern
	Platanthera hookeri	Hooker's Orchid	Special Concern
	Solidago caesia	Bluestem Goldenrod	Endangered

*Endangered: Any species whose continued existence as a viable component of this state's wild animals or wild plants is determined by the WDNR to be in jeopardy on the basis of scientific evidence.

Threatened: Any species, which appears likely, within the foreseeable future, on the basis of scientific evidence to become endangered.

The Bureau of Endangered Resources Natural Heritage Inventory (NHI) Database currently contains 15 records in the vicinity of the Bay View Wetland site, including rare natural communities and terrestrial and aquatic organisms. Of these records, no known rare natural communities were documented on the property during this investigation, although the possibility exists that undetected species may emerge or reappear as the project progresses.

Species Records in the Vicinity of the Bay View Wetland Property

Special Concern: Species about which some problem of abundance or distribution is suspected but not yet proved. The main purpose of this category is to focus attention on certain species before they become endangered or threatened.

Figure 2.19: American Eel
stellwagen.noaa.gov

- American eel (Anguilla rostrata), a State Special Concern fish, prefers large streams, rivers and lakes with muddy bottoms and still waters. To reach these conditions the eel has to traverse a wide variety of less suitable habitat including swift-flowing waters with a wide variety of substrates. Spawning occurs in the Sargasso Sea.

  The American eel is known to occur within the area. Based on the habitat description of the site, it is likely to occur here.

- Bluestem Goldenrod (Solidago caesia), a State Endangered plant, is found in hardwood forests along Lake Michigan. Blooming occurs late August through late September; fruiting occurs

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throughout September. The optimal identification period for this species is early August through late September.

- Butler's gartersnake (Thamnophis butleri), a Threatened Species in Wisconsin, prefers almost any open-canopy wetland type (not open water) and adjacent open to semi-open canopy upland, including prairies, old fields and weedy vacant lots. It also prefers low-canopy vegetation (<24"), although it will occupy habitats with taller vegetation such as reed canary grass. Butler's gartersnakes can be active from mid-March through early November, usually emerging shortly after frost-out and remaining active until daytime temperatures fall consistently below 50 deg. F. Breeding usually occurs in April and early May but can occur in fall and live young are born between mid-July and mid-August.

  Butler's gartersnake is known to be present on site. This species inhabits open-canopy wetland types (not open water) and adjacent open to semi-open canopy upland, including prairies, old fields and weedy vacant lots. They also prefer low-canopy vegetation (<24"), although they will occupy habitats with taller vegetation such as reed canary grass.

- Greater Redhorse (Moxostoma valenciennesi), a fish listed as Threatened in Wisconsin, This species prefers clear water of medium to large rivers, over bottoms of sand, gravel, or boulders. Spawning occurs in May or June.

  The Greater Redhorse is known to occur within the area. Based on the habitat description of the site it is likely to occur here.

- Hairy Beardtongue (Penstemon hirsutus), a State Special Concern plant, is found on dry gravelly and sandy prairies, or in hillside oak woodlands. It is also naturalized on roadsides. Blooming occurs late May through late June; fruiting occurs late July through late August. The optimal identification period for this species is late May through late June.

- Harbinger-of-spring (Erigenia bulbosa), a State Endangered plant, is found in rich hardwoods. Blooming occurs late April through early May; fruiting occurs throughout May. The optimal identification period for this species is late April through early May.

Figure 2.20: Butler's Garter Snake
http://commons.wikimedia.org

- Hooker's Orchid (Platanthera hookeri), a State Special Concern plant, is found in a variety of dry to moist, mostly mixed coniferous-hardwood forests. Blooming occurs late May through late July; fruiting occurs early July through late August. The optimal identification period for this species is early June through early September.

- Longear Sunfish (Lepomis megalotis), a fish listed as Threatened in Wisconsin, prefers clear, shallow, moderately warm, still waters of streams and occasionally in lakes. Found in or near vegetation. Spawning occurs from late May through mid-July and sporadically through August.

  The Longear Sunfish is known to occur within the

Figure 2.21: Longear Sunfish
www.dnr.state.oh.us/Home/species_a_to_z/SpeciesGuideIndex/longearsunfish

area. Based on the habitat description of the site it is likely to occur here.

- Marsh Blazing Star (Liatris spicata), a State Special Concern plant, is found in moist, sandy calcareous prairies. Blooming occurs late July through early August; fruiting occurs throughout August. The optimal identification period for this species is early August through early September.
- Peregrine Falcon (Falco peregrinus), a bird listed as Endangered in Wisconsin, prefers relatively inaccessible rock ledges on the sides of steep bluffs and ledges on highrise buildings in urban areas. The recommended avoidance period is from early-April through late July.

Figure 2.22: Peregrin Falcon
audobonbirds.org

The Peregrine Falcon has been recorded in the vicinity of the project site and could be present in suitable habitat areas of the site. These birds are protected by Wisconsin's endangered species laws, and the birds and their nests and eggs are also protected under the federal Migratory Bird Treaty Act (MBTA).

- Prairie crayfish (Procambarus gracilis), a State Special Concern crayfish. This primarily burrowing crayfish is restricted to prairie regions of southeastern Wisconsin and is the rarest crayfish in Wisconsin. This species frequents burrows in banks of ponds, roadside ditches, small sluggish creeks, marshes, swamps, and small artificial lakes, as well as wet pastures and flat fields in prairies. The

Figure 2.23: Marsh Blazing Star
prairiemoon.com

burrows can be quite deep and branching, with a characteristic mud chimney. This species spends most of its life in its burrow habitat, coming out at night and during rain events. Breeding occurs and young hatch in early spring, as early as March, with juveniles occurring through spring and summer. Females move to open water for a relatively short period in the summer where the newly hatched young are released.

The Prairie crayfish has been recorded within the vicinity of the project area and suitable habitat may be impacted by this project. This species frequents burrows in banks of ponds, roadside ditches, small sluggish creeks, marshes, swamps, and small artificial lakes, as well as wet pastures

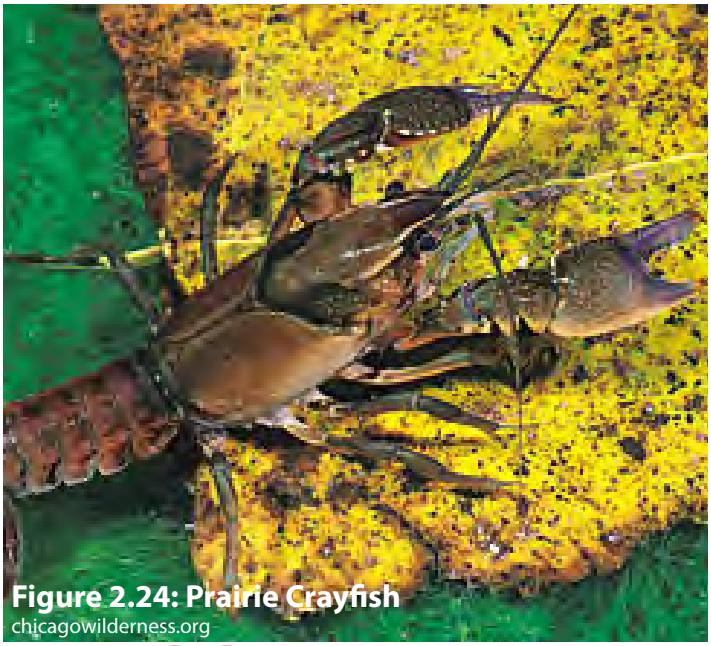

Figure 2.24: Prairie Crayfish
chicagowilderness.org

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Figure 2.25: Seaside Spurge
illinoiswildflowers.info

and flat fields in prairies.

- Seaside Spurge (Chamaesyce polygonifolia), a State Special Concern plant, is found on sandy beaches and dunes along Lake Michigan. Blooming occurs early July through late August; fruiting occurs early August through early October. The optimal identification period for this species is early July through late September.
- Small White Lady's-slipper (Cypripedium candidum), a State Threatened plant, is found in calcareous fens and moist prairies. Blooming occurs late May through early June; fruiting occurs throughout September. The optimal identification period for this species is late May through early June.
- Striped Shiner (Luxilus (Notropis) chrysocephalus), a fish listed as Endangered in Wisconsin, prefers clear to slightly turbid waters of runs and shallow pools of the lower Milwaukee River, with dense aquatic vegetation over substrates of cobble, boulders, silt, sand, mud or bedrock. Spawning occurs from late May through June.

  The Striped Shiner has been observed near the project site. Based on the habitat description of the site it is likely to occur here.
- Migratory Bird Concentration Sites are important resting and feeding areas for birds as they fly between their breeding and wintering grounds. These areas also can be locations where large numbers of migrating birds often become concentrated due to prevailing winds and or water barriers. Sites are used by many different species, both rare and non-rare.

  A migratory bird concentration site is within the vicinity of the project. Migratory birds are protected under the Migratory Bird Treaty Act. Migratory bird concentration sites are important resting and feeding areas for birds as they fly between their breeding and wintering grounds. These areas also can be locations where large numbers of migrating birds often become concentrated due to prevailing winds and/or water barriers. Sites are used by many different species, both rare and non-rare.

For additional information on the rare species, high-quality natural communities, and other endangered resources listed above, please visit the Wisconsin DNR Biodiversity web page.

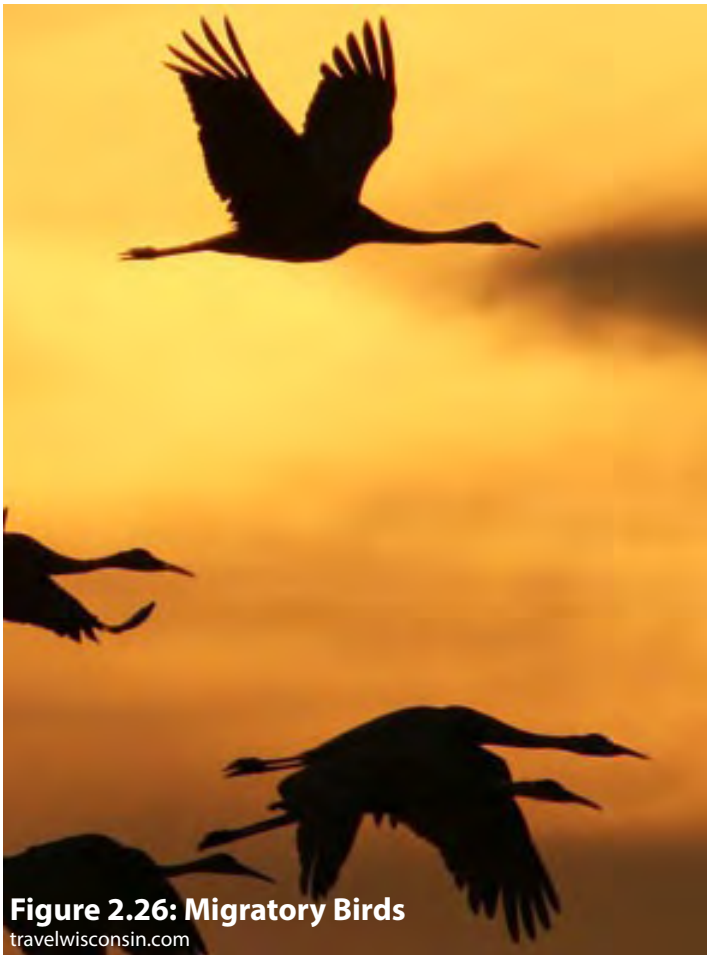

Figure 2.26: Migratory Birds
travelwisconsin.com

Regional Soils

The soils in Milwaukee County range from very poorly drained organic soils to well drained sandy or loamy soils. Six soil associations are found in the county, as identified by the U.S. Department of Agriculture and Natural Resource Conservation Service (NRCS). The soil association identified on the Bay View Wetland Site is the Ozaukee-Morley-Mequon Association, which extends westward from Lake Michigan.

A summary of soil types in this association and their characteristics are presented in Table 3. This association is found in glaciated uplands where soils formed a thin layer of loess over underlying glacial till. It consists of a narrow sand beach and intermittent "clay" bluffs and of gently sloping to rolling moraine ridges that roughly parallel the shoreline, and progressively rise towards the western edge of the association. None of these soil complexes are hydric soils.

Soil Type	Mapping Unit	% Slope	*Drainage	General Description
Major Soils in Association				
MtA	Mequon	1 to 3 %	Somewhat poorly drained	Silty soils that have a silty clay subsoil underlain by calcareous silty clay loam glacial till. These soils are on the concave side slopes of drainage ways and in slight depressions. Runoff is slow, but erosion can be a hazard in more sloping areas.
MzdB	Morley	2 to 6 %	Well to moderately well drained	Silty soils over calcareous silty clay loam glacial till. Runoff is generally medium, and erosion is a slight hazard.
OuB	Ozaukee	2 to 6 %	Well to moderately well drained	Silty soils that have a silty clay loam and silty clay subsoil underlain by calcareous silty clay loam glacial till. These soils occupy the convex side of slopes of glacial moraines. Runoff is medium, and erosion is a slight hazard.
Minor Soils in Association				
B1A	Blount	1 to 3 %	Somewhat poorly drained	These silt loam soils have formed in a thin layer of silt and in calcareous silty clay loam glacial till. It occupies concave slopes in small drainage ways and slight depressions. Runoff is slow, and ponding can occur in spring or periods of heavy rainfall.
EsA	Elliott	1 to 3 %	Somewhat poorly drained	Silty soils that have a silty clay subsoil underlain by calcareous silty clay loam glacial till. This soil occupies the concave side slopes of small drainageways, slight depressions, and glacial ground moraines.
MeB	Markham	2 to 6 %	Well to moderately well drained	Silty soils that have a silty clay subsoil over calcareous silty clay loam glacial till. Runoff is medium, and erosion is a slight hazard. This soil remains wet for several days after periods of heavy rain.

Table 2.3: Milwaukee County Soils (T6N, R22E, Sec 4)

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Figure 2.27: The approximate depth of native soils at the site was interpolated using Giles Engineering Associates' soil boring data from 2003. Darker blue color indicates thicker depth of fill.

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Soil and Groundwater Contamination

The Bay View Wetland parcel has localized occurrences of soil contamination that have been sampled. The most accurate soil data available to date is based on site investigation data from Giles Engineering Associates Soil Analytical Results (2003), and Moraine Environmental, Inc. subsurface investigation activities on 6/25/2012. These soil investigations were conducted to address areas of concern identified in a phase I Environmental Soil Assessment and were not meant to address the site's sutiability for wetland restoration. Further soil investigation is expected in 2014.

Contamination at the site appears to be contained within the fill material on site. This fill material generally extends 2-16 feet deep and consists of fine to coarse sand containing gravel, silt, clay, trace organic materials, concrete, brick, wood fragments, and slag. Below the fill, native soils consist of black to brown organic clay silt with trace shell fragments.

The **Phase I Site Assessment** conducted by Giles Engineering identified the following likely sources for soil and groundwater contamination:

- Undocumented fill
- Activities in historic buildings such as Diesel Engine House, Incinerator, Truck Repair Building and Motor Freight Station
- Historic presence of salt storage facility
- Illegal dumping of solid wastes, tires, construction debris, drums, and tanks
- Railroad activity and suspected presence of buried railroad ties
- Former Leaking Underground Storage Tank on the southwest corner of the property

Based on these findings a **Phase II Environmental Site Assessment (ESA)** was recommended to evaluate soil and groundwater conditions. The Phase II was written by Giles Engineering Associates, Inc. for the Port of Milwaukee in 2009, using data collected in October of 2003.

The Phase II ESA included forty one soil borings, with temporary wells constructed in thirty three of the

Figure 2.28: Suspected PVOC Contamination

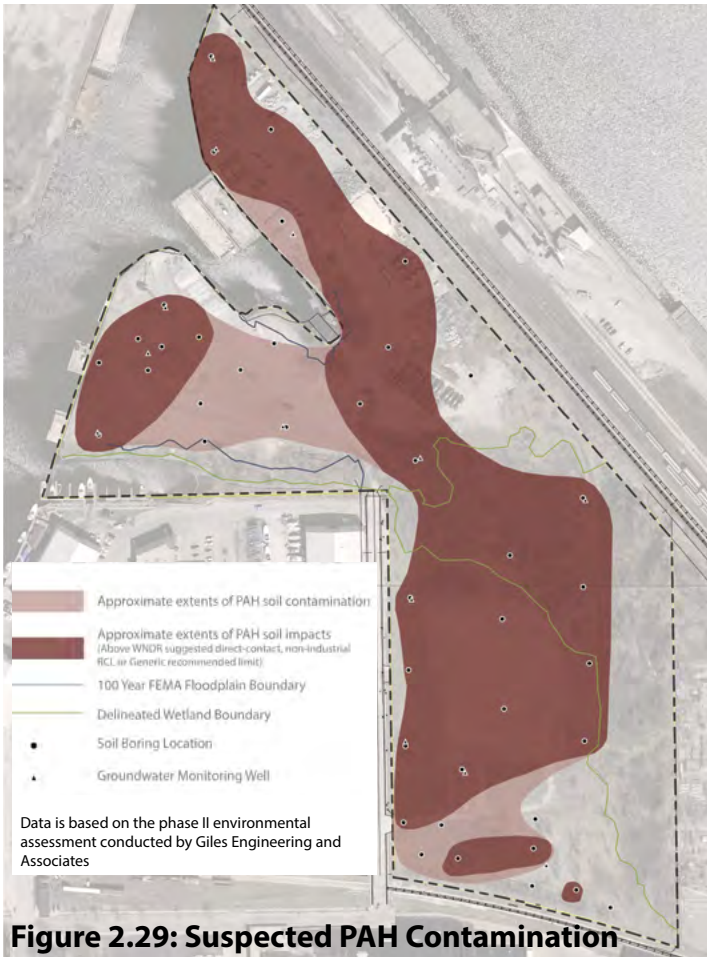

Figure 2.29: Suspected PAH Contamination

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soil boring sites to collect ground water. Sixteen of these wells were also used as soil vapor monitoring points. In 2004 thirteen additional groundwater monitoring wells were also installed on the site.

Soil borings were located near areas where contamination was most likely to occur based on the Phase I ESA. Soil headspace was screened in the field to assess whether volatile organic vapors were present at discrete intervals. Samples were sent to the laboratory for further analysis when field screening indicated the presence of contaminants.

Within the site study area, five locations were identified for the subsurface soil investigation. Each location was sampled twice, at varying soil depths (6, 7, 8, or 12 feet below ground surface) to collect, analyze, and identify any soil contaminants on the property.

Groundwater was also screened for VOC, RCRA metal, PAH, PCB, and total chloride analysis. Tests for each groundwater contaminant were not conducted uniformly across all sample points. Full details of the sampling procedure can be found in the Giles Phase II ESA.

The ESA Phase II found that multiple contaminants in soil and groundwater exceeded regulatory standards at the Bay View Wetland site. In some samples contamination did not exceed regulatory standards. However, because not all samples were taken for laboratory analysis the results of this assessment do not allow the current research team to affirm with certainty that these contaminants were not present at high levels. A summary of contaminant levels found at the site which exceeded regulatory standards at the time of the last environmental assessment can be found in table 2.4.

Moraine Environmental conducted a further analysis of soil contamination at the site in 2012. This analysis focused on the northern half of the site outside of the current project area, and on the former LUST site at the southwestern corner of the property only. It did not provide sufficient information to fully understand the condition of soils throughout the current project's grading foot print.

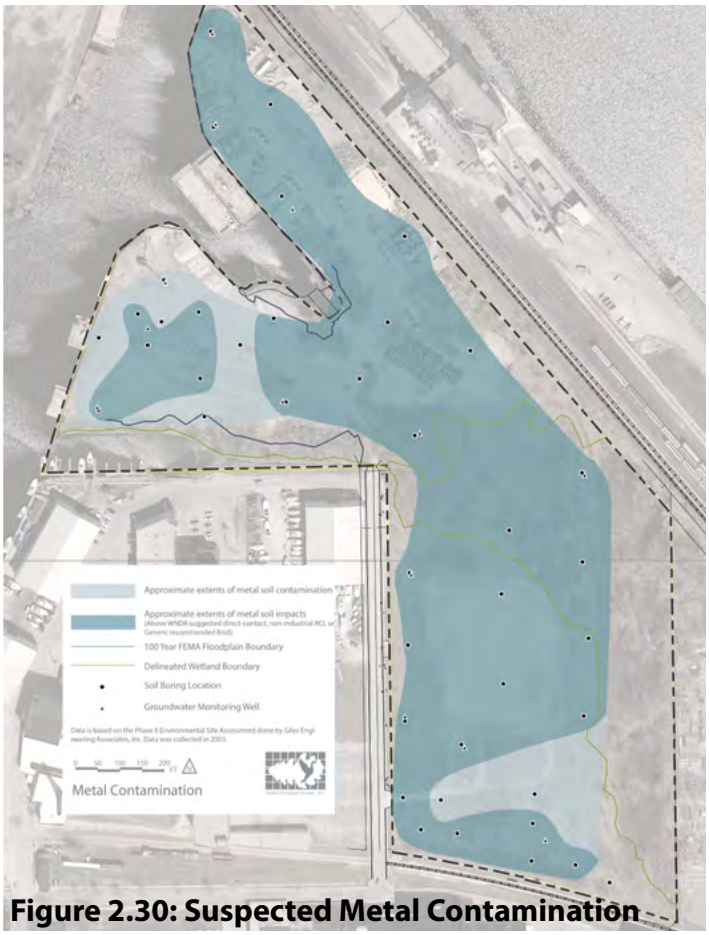

Figure 2.30: Suspected Metal Contamination

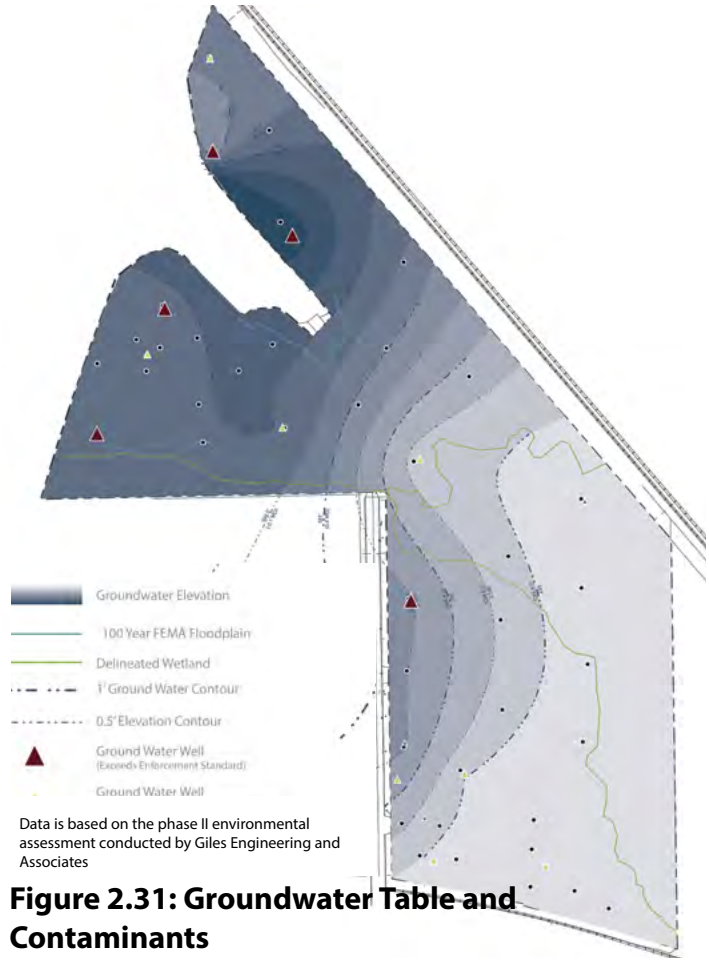

Figure 2.31: Groundwater Table and Contaminants

The Marquette Interchange Project

Northwest of the project site, the Marquette Interchange was a large reconstruction of a 1960s era highway interchange that occurred from 2004-2008. At some point during this construction period approximately 19,500 C.Y.* of fill from the interchange was deposited in the upland area of the Bay View Wetland property. It is believed that the fill was clean when deposited on-site. However, further sampling should be conducted to confirm the fill is uncontaminated.

*The quantity of fill was estimated via a comparison of topographic surveys from 1999 and 2013.

Contaminants Present at The Bay View Wetland

Soil contaminants identified during the environmental assessment process are described below.

Petroleum Volatile Organic Compounds (PVOCs) are "ground-water contaminants of concern because of very large environmental releases, human toxicity, and a tendency for some compounds to persist in and migrate with ground-water to drinking-water supply well … In general, VOCs have high vapor pressures, low-to-medium water solubilities, and low molecular weights. Some VOCs may occur naturally in the environment, other compounds occur only as a result of manmade activities, and some compounds have both origins." - Zorgoski and others, 2006 (USGS 2013).

Polycyclic Aromatic Hydrocarbons (PAHs) are found naturally in the environment, but can also be man-made. PAH's are created when products like coal, oil, gas, and garbage are burned but the burning process is incomplete. Many PAHs are known to be carcinogenic, mutagenic, and teratogenic in humans at high doses.

Resource Conservation and Recovery Act (RCRA) Metals are governed by the EPA. The RCRA gives the EPA authority to control hazardous waste "from cradle to grave." Multiple types of heavy metal were found throughout the Bay View Wetland property. Arsenic, Cadmium, Chromium, and Lead were all found at levels that exceeded NR 720.11 direct contact RCLs.

PCBs exceeded the enforcement standard for water quality at one location on the Bay View Wetland site. Further testing should be conducted to determine whether levels of PCB in the groundwater require remediation. PCB did not exceed regulatory standards in any soil samples.

Regulations Governing Soil Contamination

WIDNR NR 720 governs soil cleanup standards. USEPA Groundwater Pathway Soil RCLs and WIDNR NR 746 Soil Screening Level Concentrations present standardized risk-based screening levels and variable risk-based screening level calculation equations for chemical contaminants. The risk-based screening levels for chemicals are based on the carcinogenicity and systemic toxicity of the analytes.

WIDNR NR 140 governs groundwater quality standards. Exceeding the Preventative Action limit set forth in NR 140 triggers a review of the site by the WIDNR that may result in remedial action.

Exceeding the Enforcement Standard in an active industrial site can cause a regulatory response that may require a facility to revise its operational procedures, change its design or construction, find an alternate method of waste treatment or disposal, or require prohibition or closure and abandonment of a facility. Exemptions from this procedure can be granted.

To ensure that recreational use is permissible on most of the Bay View Wetland site, the project will strive to attain Non-Industrial Direct Contact Standards as set forth by the WIDNR. This regulatory standard can be achieved either by cleaning the soil, containing the soil so that human and groundwater contact is not possible, or by removing the soil from the site.

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Table 2.4: All contaminants found at the Bay View Wetland Site in previous environmental studies. Contaminants which exceeded a regulatory standard in soil or groundwater are highlighted in gray.

Compound Name	Compound Type	"Concentration in Soil (Range) (ug/kg)"		Direct Contact Standard	Concentration in Ground Water (ug/l)		Preventative Action Limit
		Low	High	(ug/kg)	Low	High	(ug/l)
1,2,4-Trimethylbenzene	**VOC**	**16**	**2360**	**89800**	**0.47**	**0.78**	**96**
1,3,5-Trimethylbenzene	VOC	18	241	182000	0.4	0.64	96
1-methylnaphthalene	PAHs	50	213	15600	5	75	NS
2-Chlorotoluene	VOC	16	31	907000			NS
2-methylnaphthalene	PAHs	50	216	229000	5	5	NS
Acenaphthene	PAHs	34	145	3440000	5	5	NS
Acenaphthylene	PAHs	42	425	487000			NS
Anthracene	PAHs	25	452	17200000	5	5	600
Arsenic	**RCRA Metals**	**2290**	**32000**	**390**	**1.7**	**7.9**	**1**
Barium	RCRA Metals	17000	1300000	15300000	60	310	400
Benzene	**VOC**	**14**	**344**	**1490**	**0.27**	**0.96**	**0.5**
Benzo (a) anthracene	**PAHs**	**19**	**1710**	**148**	**0.1**	**0.22**	**NS**
Benzo (a) pyrene	**PAHs**	**19**	**1740**	**15**	**0.02**	**0.2**	**0.02**
Benzo (b) fluoranthene	**PAHs**	**28**	**2680**	**148**	**0.02**	**0.19**	**0.02**
Benzo (ghi) perylene	PAHs	33	488				NS
Benzo (k) fluoranthene	PAHs	16	917	1480			NS
Cadmium	**RCRA Metals**	**410**	**12000**	**70200**	**0.4**	**0.51**	**0.5**
Chromium, Hexavalent	RCRA Metals	0.2	0.2	293			NS
Chromium, Total	**RCRA Metals**	**400**	**8380000**	**14000**	**7**	**310**	**10**
Chrysene	**PAHs**	**25**	**1610**	**14800**	**0.02**	**0.14**	**0.02**
Dibenzo (a,h) anthracene	PAHs	34	148	15			NS
Ethylbenzene	VOC	14	355	7470	0.25	0.41	140
Fluoranthene	PAHs	23	2730	2290000	5	5	80
Fluorene	PAHs	40	105	2290000	5	5	80
Indeno (1,2,3-cd) pyrene	PAHs	32	442	148			NS
Isopropylbenzene	VOC	16	1600		0.33	0.33	NS
Lead	**RCRA Metals**	**3.32**	**2330000**	**400000**	**1.5**	**8.2**	**1.5**
Mercury	**RCRA Metals**	**50**	**520**	**3130**	**0.2**	**0.2**	**0.2**
Methylene chloride	VOC	15	26	60700			0.5
MTBE	VOC	25	100	59400	0.38	0.54	12
Naphthalene	**PAH**	**25**	**9120**	**5150**	**0.4**	**10.6**	**10**
n-Propylbenzene	VOC	14	125	264000	0.28	0.25	NS
p-Isopropyltoluene	VOC				0.31	0.31	NS
Polychlorinated biphenyls	**PCB**				**0.11**	**0.11**	**0.003**
Phenanthrene	PAHs	21	1790	115000	5	5	NS
Pyrene	PAHs	25	3200	1720000			50
sec-Butylbenzene	VOC	17	45	145000	0.34	0.34	NS
Selenium	RCRA Metals	100	1900	3130	1.9	2.3	10
Silver	RCRA Metals	460	750	391000	9	9	10
tert-Butylbenzene	VOC	15	53	183000	0.36		NS
Toluene	VOC	15	700	818000	0.29	0.58	160
Xylenes, Total	VOC	41	1401	258000	0.43	1.25	400

Compound Name	Compound Type	Brownfield Classification	Human Health Risk (WOE Classification**)	Carcinogen	Teratogen	Mutagen	Bioaccumulates
			(USEPA/IRIS (2)				
Naphthalene	PAH	Non-halogenated SVOCs and Fuel	Group C				*
Benzo (a) pyrene	PAHs	Fuel	Group B2				*
Benzo (b) fluoranthene	PAHs	Fuel	Group B2				*
Arsenic	RCRA Metals	Metal and Metalloids	Group A	*	*	*	
Chromium, Total	RCRA Metals	Metal and Metalloids	N/A	*	*	*	
Lead	RCRA Metals	Metal and Metalloids	Group B2				
Benzene	VOC	Fuel	Group A				
Benzo (a) anthracene	PAHs	Fuel	Group B2				*
Dibenzo (a,h) anthracene	PAHs	Fuel	Group B2				*
Indeno (1,2,3-cd) pyrene	PAHs	Fuel	Group B2				*
1,2,4-Trimethylbenzene	VOC	Fuel	N/A				
Chrysene	PAHs	Fuel	Group B2				*
Cadmium	RCRA Metals	Metal and Metalloids	Group B1	*	*	*	
Mercury	RCRA Metals	Metal and Metalloids	Group D	*	*	*	*
Polychlorinated biphenyls	PCB			*			*

Exceeds Soil RCL Exceeds Ground Water Standard Exceeds both Soil RCL and Ground Water Standard

Table 2.5: This table describes the potential environmental and health risks that can be caused by the soil contaminants which exceeded regulatory standards in 2003 (last date of comprehensive soil testing). None of the health impacts described here are known to have occurred as a result of exposure to the Bay View Wetland site.

**** CATEGORIZATION OF OVERALL WEIGHT OF EVIDENCE (WOE) FOR HUMAN CARCINOGENICITY based on the Guidelines for Carcinogen Risk Assessment (1986 USEPA)**

Group A: Human Carcinogen This group is used only when there is sufficient evidence from epidemiologic studies to support a causal association between exposure to the agents and cancer.

Group B: Probable Human Carcinogen This group includes agents for which the weight of evidence of human carcinogenicity based on epidemiologic studies is "limited" and also includes agents for which the weight of evidence of carcinogenicity based on animal studies is "sufficient." The group is divided into two subgroups. Usually, Group B1 is reserved for agents for which there is limited evidence of carcinogenicity from epidemiologic studies. It is reasonable, for practical purposes, to regard an agent for which there is "sufficient"

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Translocates in Plants	Impacts Animal Health or Reproduction		Inhibits Plant Growth		Effects on Living Organisms
	Aquatic	Terrestrial	Aquatic	Terrestrial	
*	*	*	*	*	Delayed germination and transitory inhibition, Inhibit plant germination and growth. Bioaccumulation, translocation in plants, and wide ranging effects in mammals, fish, invertebrates, birds, and humans (3).
*	*	*			Bioaccumulation, translocation in plants, and wide ranging effects in mammals, fish, invertebrates, birds, and humans (3).
*	*	*			Bioaccumulation, translocation in plants, and wide ranging effects in mammals, fish, invertebrates, birds, and humans (3).
			*	*	Arsenic is a carcinogen, teratogen, and possible mutagen in mammals. In plants, arsenic has been shown to cause wilting, chlorosis, browning, dehydration, mortality, and inhibition of light activation (3).
	*		*		Chromium inhibits growth in duckweed and algae, reduces fecundity and survival of benthic invertebrates, and reduces growth of freshwater fingerlings. It is cancer-causing, mutation-causing, and teratogenic (3).
	*	*	*	*	Lead adversely affects algae, invertebrates, and fish. At elevated levels in plants, lead can cause reduced growth, photosynthesis, mitosis, and water absorption. Birds and mammals suffer effects from lead poisoning such as damage to the nervous system, kidneys, liver, sterility, growth inhibition, developmental retardation, and detrimental effects in blood (3).
			*	*	Inhibit plant germination and growth , Does not bioaccumulate in animals or plants
*	*	*			Bioaccumulation, translocation in plants, and wide ranging effects in mammals, fish, invertebrates, birds, and humans (3).
*	*	*			Bioaccumulation, translocation in plants, and wide ranging effects in mammals, fish, Fuelinvertebrates, birds, and humans (3).
*	*	*			Bioaccumulation, translocation in plants, and wide ranging effects in mammals, fish, invertebrates, birds, and humans (3).
			*	*	Affects growth and chlorophyll level
*	*	*			Bioaccumulation, translocation in plants, and wide ranging effects in mammals, fish, invertebrates, birds, and humans (3).
	*	*	*	*	Cadmium is highly toxic to wildlife; it is cancer-causing and teratogenic and potentially mutation-causing, with severe sublethal and lethal effects at low environmental concentrations. Cadmium can be toxic to plants at lower soil concentrations than other heavy metals and is more readily taken up than other metals (3).
	*	*			Mercury is a mutagen, teratogen, and carcinogen, with a high potential for bioaccumulation and biomagnification (3).
	*	*			PCBs are known carcinogens. They also produce effects animal immune, reproductive, nervous, and endocrine systems. PCBs bioaccumulate in animals but most do not bioaccumulate in plants due to the presence of the plant cuticle. Does not Biodegrade

evidence of carcinogenicity in animals as if it presented a carcinogenic risk to humans. Therefore, agents for which there is "sufficient" evidence from animal studies and for which there is "inadequate evidence" or "no data" from epidemiologic studies would usually be categorized under Group B2.

Group C: Possible Human Carcinogen This group is used for agents with limited evidence of carcinogenicity in animals in the absence of human data. It includes a wide variety of evidence, e.g., (a) a malignant tumor response in a single well-conducted experiment that does not meet conditions for sufficient evidence, (b) tumor responses of marginal statistical significance in studies having inadequate design or reporting, (c) benign but not malignant tumors with an agent showing no response in a variety of short-term tests for mutagenicity, and (d) responses of marginal statistical significance in a tissue known to have a high or variable background rate.

Group D: Not Classifiable as to Human Carcinogenicity This group is generally used for agents with inadequate human and animal evidence of carcinogenicity or for which no data are available.

Group E: Evidence of Non-Carcinogenicity for Humans This group is used for agents that show no evidence for carcinogenicity in at least two adequate animal tests in different species or in both adequate epidemiologic and animal studies. The designation of an agent as being in Group E is based on the available evidence and should not be interpreted as a definitive conclusion that the agent will not be a carcinogen under any circumstances.