Site: Wetlands 8,9,10,11,12,18,19,20	Rater(s): Ruby/Swartz	Date: 9/3/2010

50.5
subtotal first page

5	55.5
max 10 pts.	subtotal

Metric 5. Special Wetlands.

Check all that apply and score as indicated.

- [ ] Bog (10)
- [ ] Fen (10)
- [ ] Old growth forest (10)
- [x] Mature forested wetland (5)
- [ ] Lake Erie coastal/tributary wetland-unrestricted hydrology (10)
- [ ] Lake Erie coastal/tributary wetland-restricted hydrology (5)
- [ ] Lake Plain Sand Prairies (Oak Openings) (10)
- [ ] Relict Wet Prairies (10)
- [ ] Known occurrence state/federal threatened or endangered species (10)
- [ ] Significant migratory songbird/water fowl habitat or usage (10)
- [ ] Category 1 Wetland. See Question 1 Qualitative Rating (-10)

13	68.5
max 20 pts.	subtotal

Metric 6. Plant communities, interspersion, microtopography.

6a. Wetland Vegetation Communities.
Score all present using 0 to 3 scale.

- [ ] Aquatic bed
- [2] Emergent
- [1] Shrub
- [2] Forest
- [ ] Mudflats
- [ ] Open water
- [ ] Other_____

6b. horizontal (plan view) Interspersion.
Select only one.

- [ ] High (5)
- [ ] Moderately high(4)
- [x] Moderate (3)
- [ ] Moderately low (2)
- [ ] Low (1)
- [ ] None (0)

6c. Coverage of invasive plants. Refer to Table 1 ORAM long form for list. Add or deduct points for coverage

- [ ] Extensive >75% cover (-5)
- [x] Moderate 25-75% cover (-3)
- [ ] Sparse 5-25% cover (-1)
- [ ] Nearly absent <5% cover (0)
- [ ] Absent (1)

6d. Microtopography.
Score all present using 0 to 3 scale.

- [2] Vegetated hummucks/tussucks
- [2] Coarse woody debris >15cm (6in)
- [2] Standing dead >25cm (10in) dbh
- [2] Amphibian breeding pools

Vegetation Community Cover Scale

0	Absent or comprises <0.1ha (0.2471 acres) contiguous area
1	Present and either comprises small part of wetland's vegetation and is of moderate quality, or comprises a significant part but is of low quality
2	Present and either comprises significant part of wetland's vegetation and is of moderate quality or comprises a small part and is of high quality
3	Present and comprises significant part, or more, of wetland's vegetation and is of high quality

Narrative Description of Vegetation Quality

low	Low spp diversity and/or predominance of nonnative or disturbance tolerant native species
mod	Native spp are dominant component of the vegetation, although nonnative and/or disturbance tolerant native spp can also be present, and species diversity moderate to moderately high, but generally w/o presence of rare threatened or endangered spp
high	A predominance of native species, with nonnative spp and/or disturbance tolerant native spp absent or virtually absent, and high spp diversity and often, but not always, the presence of rare, threatened, or endangered spp

Mudflat and Open Water Class Quality

0	Absent <0.1ha (0.247 acres)
1	Low 0.1 to <1ha (0.247 to 2.47 acres)
2	Moderate 1 to <4ha (2.47 to 9.88 acres)
3	High 4ha (9.88 acres) or more

Microtopography Cover Scale

0	Absent
1	Present very small amounts or if more common of marginal quality
2	Present in moderate amounts, but not of highest quality or in small amounts of highest quality
3	Present in moderate or greater amounts and of highest quality

68.5

End of Quantitative Rating. Complete Categorization Worksheets.

ORAM Summary Worksheet

		circle answer or insert score	Result
Narrative Rating	Question 1 Critical Habitat	YES NO	If yes, Category 3.
	Question 2. Threatened or Endangered Species	YES NO	If yes, Category 3.
	Question 3. High Quality Natural Wetland	YES NO	If yes, Category 3.
	Question 4. Significant bird habitat	YES NO	If yes, Category 3.
	Question 5. Category 1 Wetlands	YES NO	If yes, Category 1.
	Question 6. Bogs	YES NO	If yes, Category 3.
	Question 7. Fens	YES NO	If yes, Category 3.
	Question 8a. Old Growth Forest	YES NO	If yes, Category 3.
	Question 8b. Mature Forested Wetland	YES NO	If yes, evaluate for Category 3; may also be 1 or 2.
	Question 9b. Lake Erie Wetlands - Restricted	YES NO	If yes, evaluate for Category 3; may also be 1 or 2.
	Question 9d. Lake Erie Wetlands – Unrestricted with native plants	YES NO	If yes, Category 3
	Question 9e. Lake Erie Wetlands - Unrestricted with invasive plants	YES NO	If yes, evaluate for Category 3; may also be 1 or 2.
	Question 10. Oak Openings	YES NO	If yes, Category 3
	Question 11. Relict Wet Prairies	YES NO	If yes, evaluate for Category 3; may also be 1 or 2.
Quantitative Rating	Metric 1. Size	5	
	Metric 2. Buffers and surrounding land use	6	
	Metric 3. Hydrology	24.5	
	Metric 4. Habitat	15	
	Metric 5. Special Wetland Communities	5	
	Metric 6. Plant communities, interspersion, microtopography	13	
	TOTAL SCORE	68.5	Category based on score breakpoints 3

Complete Wetland Categorization Worksheet.

Wetland Categorization Worksheet

Choices	Circle one		Evaluation of Categorization Result of ORAM
Did you answer "Yes" to any of the following questions: Narrative Rating Nos. 2, 3, 4, 6, 7, 8a, 9d, 10	YES Wetland is categorized as a Category 3 wetland	NO	Is quantitative rating score *less* than the Category 2 scoring threshold (*excluding* gray zone)? If yes, reevaluate the category of the wetland using the narrative criteria in OAC Rule 3745-1-54(C) and biological and/or functional assessments to determine if the wetland has been over-categorized by the ORAM
Did you answer "Yes" to any of the following questions: Narrative Rating Nos. 1, 8b, 9b, 9e, 11	YES Wetland should be evaluated for possible Category 3 status	NO	Evaluate the wetland using the 1) narrative criteria in OAC Rule 3745-1-54(C) and 2) the quantitative rating score. If the wetland is determined to be a Category 3 wetland using either of these, it should be categorized as a Category 3 wetland. Detailed biological and/or functional assessments may also be used to determine the wetland's category.
Did you answer "Yes" to Narrative Rating No. 5	YES Wetland is categorized as a Category 1 wetland	NO	Is quantitative rating score *greater* than the Category 2 scoring threshold *(including* any gray zone)? If yes, reevaluate the category of the wetland using the narrative criteria in OAC Rule 3745-1-54(C) and biological and/or functional assessments to determine if the wetland has been under-categorized by the ORAM
Does the quantitative score fall within the scoring range of a Category 1, 2, or 3 wetland?	YES Wetland is assigned to the appropriate category based on the scoring range	NO	If the score of the wetland is located within the scoring range for a particular category, the wetland should be assigned to that category. In all instances however, the narrative criteria described in OAC Rule 3745-1-54(C) can be used to clarify or change a categorization based on a quantitative score.
Does the quantitative score fall with the *"gray zone"* for Category 1 or 2 or Category 2 or 3 wetlands?	YES Wetland is assigned to the higher of the two categories or assigned to a category based on detailed assessments and the narrative criteria	NO	Rater has the option of assigning the wetland to the higher of the two categories or to assign a category based on the results of a nonrapid wetland assessment method, e.g. functional assessment, biological assessment, etc, and a consideration of the narrative criteria in OAC rule 3745-1-54(C).
Does the wetland otherwise exhibit *moderate OR superior* hydrologic OR habitat, OR recreational functions AND the wetland was *not* categorized as a Category 2 wetland (in the case of moderate functions) or a Category 3 wetland (in the case of superior functions) by this method?	YES Wetland was undercategorized by this method. A written justification for recategorization should be provided on Background Information Form	NO Wetland is assigned to category as determined by the ORAM.	A wetland may be undercategorized using this method, but still exhibit one or more superior functions, e.g. a wetland's biotic communities may be degraded by human activities, but the wetland may still exhibit superior hydrologic functions because of its type, landscape position, size, local or regional significance, etc. In this circumstance, the narrative criteria in OAC Rule 3745-1-54(C)(2) and (3) are controlling, and the under-categorization should be corrected. A written justification with supporting reasons or information for this determination should be provided.

Final Category

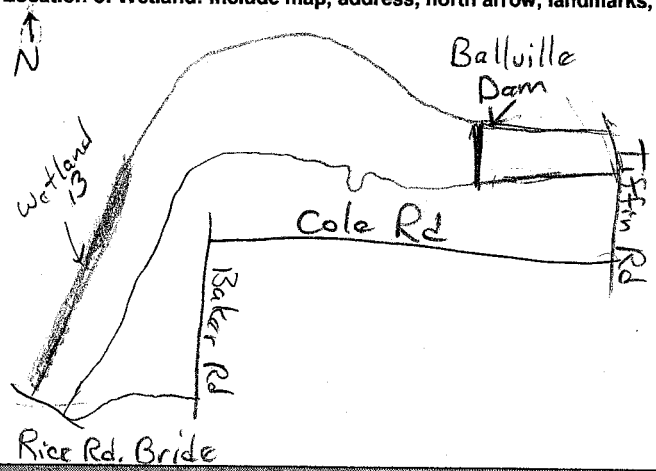
Choose one	Category 1	Category 2	Category 3

End of Ohio Rapid Assessment Method for Wetlands.

Background Information

Name:	Richard Ruby / Brian Swartz
Date:	31 Aug 2010
Affiliation:	USACE - Buffalo District
Address:	1776 Niagara Street, Buffalo, NY 14207
Phone Number:	716-879-4109
e-mail address:	richard.j.ruby@usace.army.mil
Name of Wetland:	Wetland 13
Vegetation Communit(ies):	Emergent / Scrub-Shrub / Forested
HGM Class(es):	Riverine

Location of Wetland: include map, address, north arrow, landmarks, distances, roads, etc.



West/North Bank of Sandusky River from Rice Rd. Bridge to Campground off South River Rd. in Balluille Township, Sandusky County, Ohio.

Lat/Long or UTM Coordinate	Lat: 41.31636 Long: -83.15462
USGS Quad Name	Fremont-West, Ohio
County	Sandusky
Township	Balluille
Section and Subsection	N½ 17, E½ 8
Hydrologic Unit Code	04100011
Site Visit	31 Aug 2010
National Wetland Inventory Map	NWI Online
Ohio Wetland Inventory Map	
Soil Survey	NRCS Online
Delineation report/map	Yes

Name of Wetland: Wetland 13

Wetland Size (acres, hectares): 1.68 acres

Sketch: Include north arrow, relationship with other surface waters, vegetation zones, etc.

See attach Maps 1 & 2

Comments, Narrative Discussion, Justification of Category Changes:

- Emergent wetland fringe and floodplain forested scrub-shrub wetland along the north/west bank of the Sandusky River.

Final score : 42.5 **Category:** Mod 2

Scoring Boundary Worksheet

INSTRUCTIONS. The initial step in completing the ORAM is to identify the "scoring boundaries" of the wetland being rated. In many instances this determination will be relatively easy and the scoring boundaries will coincide with the "jurisdictional boundaries." For example, the scoring boundary of an isolated cattail marsh located in the middle of a farm field will likely be the same as that wetland's jurisdictional boundaries. In other instances, however, the scoring boundary will not be as easily determined. Wetlands that are small or isolated from other surface waters often form large contiguous areas or heterogeneous complexes of wetland and upland. In separating wetlands for scoring purposes, the hydrologic regime of the wetland is the main criterion that should be used. Boundaries between contiguous or connected wetlands should be established where the volume, flow, or velocity of water moving through the wetland changes significantly. *Areas with a high degree of hydrologic interaction should be scored as a single wetland.* In determining a wetland's scoring boundaries, use the guidelines in the ORAM Manual Section 5.0. In certain instances, it may be difficult to establish the scoring boundary for the wetland being rated. These problem situations include wetlands that form a patchwork on the landscape, wetlands divided by artificial boundaries like property fences, roads, or railroad embankments, wetlands that are contiguous with streams, lakes, or rivers, and estuarine or coastal wetlands. These situations are discussed below, however, it is recommended that Rater contact Ohio EPA, Division of Surface Water, 401/Wetlands Section if there are additional questions or a need for further clarification of the appropriate scoring boundaries of a particular wetland.

#	Steps in properly establishing scoring boundaries	done?	not applicable
Step 1	Identify the wetland area of interest. This may be the site of a proposed impact, a reference site, conservation site, etc.	X	
Step 2	Identify the locations where there is physical evidence that hydrology changes rapidly. Such evidence includes both natural and human-induced changes including, constrictions caused by berms or dikes, points where the water velocity changes rapidly at rapids or falls, points where significant inflows occur at the confluence of rivers, or other factors that may restrict hydrologic interaction between the wetlands or parts of a single wetland.	X	
Step 3	Delineate the boundary of the wetland to be rated such that all areas of interest that are contiguous to and within the areas where the hydrology does not change significantly, i.e. areas that have a high degree of hydrologic interaction are included within the scoring boundary.	X	
Step 4	Determine if artificial boundaries, such as property lines, state lines, roads, railroad embankments, etc., are present. These should not be used to establish scoring boundaries unless they coincide with areas where the hydrologic regime changes.	X	
Step 5	In all instances, the Rater may enlarge the minimum scoring boundaries discussed here to score together wetlands that could be scored separately.	X	
Step 6	Consult ORAM Manual Section 5.0 for how to establish scoring boundaries for wetlands that form a patchwork on the landscape, divided by artificial boundaries, contiguous to streams, lakes or rivers, or for dual classifications.	X	

End of Scoring Boundary Determination. Begin Narrative Rating on next page.

Narrative Rating

INSTRUCTIONS. Answer each of the following questions. Questions 1, 2, 3 and 4 should be answered based on information obtained from the site visit or the literature *and* by submitting a Data Services Request to the Ohio Department of Natural Resources, Division of Natural Areas and Preserves, Natural Heritage Data Services, 1889 Fountain Square Court, Building F-1, Columbus, Ohio 43224, 614-265-6453 (phone), 614-265-3096 (fax), http://www.dnr.state.oh.us/dnap. The remaining questions are designed to be answered primarily by the results of the site visit. Refer to the User's Manual for descriptions of these wetland types. Note: "Critical habitat" is legally defined in the Endangered Species Act and is the geographic area containing physical or biological features essential to the conservation of a listed species or as an area that may require special management considerations or protection. The Rater should contact the Region 3 Headquarters or the Columbus Ecological Services Office for updates as to whether critical habitat has been designated for other federally listed threatened or endangered species. "Documented" means the wetland is listed in the appropriate State of Ohio database.

#	Question	Circle one	
1	**Critical Habitat.** Is the wetland in a township, section, or subsection of a United States Geological Survey 7.5 minute Quadrangle that has been designated by the U.S. Fish and Wildlife Service as "critical habitat" for any threatened or endangered plant or animal species? Note: as of January 1, 2001, of the federally listed endangered or threatened species which can be found in Ohio, the Indiana Bat has had critical habitat designated (50 CFR 17.95(a)) and the piping plover has had critical habitat proposed (65 FR 41812 July 6, 2000).	YES Wetland should be evaluated for possible Category 3 status Go to Question 2	NO Go to Question 2
2	**Threatened or Endangered Species.** Is the wetland known to contain an individual of, or documented occurrences of federal or state-listed threatened or endangered plant or animal species?	YES Wetland is a Category 3 wetland. Go to Question 3	NO Go to Question 3
3	**Documented High Quality Wetland.** Is the wetland on record in Natural Heritage Database as a high quality wetland?	YES Wetland is a Category 3 wetland Go to Question 4	NO Go to Question 4
4	**Significant Breeding or Concentration Area.** Does the wetland contain documented regionally significant breeding or nonbreeding waterfowl, neotropical songbird, or shorebird concentration areas?	YES Wetland is a Category 3 wetland Go to Question 5	NO Go to Question 5
5	**Category 1 Wetlands.** Is the wetland less than 0.5 hectares (1 acre) in size and **hydrologically isolated** and either 1) comprised of vegetation that is dominated (greater than eighty per cent areal cover) by *Phalaris arundinacea, Lythrum salicaria,* or *Phragmites australis*, or 2) an acidic pond created or excavated on mined lands that has little or no vegetation?	YES Wetland is a Category 1 wetland Go to Question 6	NO Go to Question 6
6	**Bogs.** Is the wetland a peat-accumulating wetland that 1) has no significant inflows or outflows, 2) supports acidophilic mosses, particularly *Sphagnum* spp., 3) the acidophilic mosses have >30% cover, 4) at least one species from Table 1 is present, and 5) the cover of invasive species (see Table 1) is <25%?	YES Wetland is a Category 3 wetland Go to Question 7	NO Go to Question 7
7	**Fens.** Is the wetland a carbon accumulating (peat, muck) wetland that is saturated during most of the year, primarily by a discharge of free flowing, mineral rich, ground water with a circumneutral ph (5.5-9.0) and with one or more plant species listed in Table 1 and the cover of invasive species listed in Table 1 is <25%?	YES Wetland is a Category 3 wetland Go to Question 8a	NO Go to Question 8a
8a	**"Old Growth Forest."** Is the wetland a forested wetland and is the forest characterized by, but not limited to, the following characteristics: overstory canopy trees of great age (exceeding at least 50% of a projected maximum attainable age for a species); little or no evidence of human-caused understory disturbance during the past 80 to 100 years; an all-aged structure and multilayered canopies; aggregations of canopy trees interspersed with canopy gaps; and significant numbers of standing dead snags and downed logs?	YES Wetland is a Category 3 wetland. Go to Question 8b	NO Go to Question 8b

8b	**Mature forested wetlands.** Is the wetland a forested wetland with 50% or more of the cover of upper forest canopy consisting of deciduous trees with large diameters at breast height (dbh), generally diameters greater than 45cm (17.7in) dbh?	YES Wetland should be evaluated for possible Category 3 status. Go to Question 9a	NO Go to Question 9a
9a	**Lake Erie coastal and tributary wetlands.** Is the wetland located at an elevation less than 575 feet on the USGS map, adjacent to this elevation, or along a tributary to Lake Erie that is accessible to fish?	YES Go to Question 9b	NO Go to Question 10
9b	Does the wetland's hydrology result from measures designed to prevent erosion and the loss of aquatic plants, i.e. the wetland is partially hydrologically restricted from Lake Erie due to lakeward or landward dikes or other hydrological controls?	YES Wetland should be evaluated for possible Category 3 status Go to Question 10	NO Go to Question 9c
9c	Are Lake Erie water levels the wetland's primary hydrological influence, i.e. the wetland is hydrologically unrestricted (no lakeward or upland border alterations), or the wetland can be characterized as an "estuarine" wetland with lake and river influenced hydrology. These include sandbar deposition wetlands, estuarine wetlands, river mouth wetlands, or those dominated by submersed aquatic vegetation.	YES Go to Question 9d	NO Go to Question 10
9d	Does the wetland have a predominance of native species within its vegetation communities, although non-native or disturbance tolerant native species can also be present?	YES Wetland is a Category 3 wetland Go to Question 10	NO Go to Question 9e
9e	Does the wetland have a predominance of non-native or disturbance tolerant native plant species within its vegetation communities?	YES Wetland should be evaluated for possible Category 3 status Go to Question 10	NO Go to Question 10
10	**Lake Plain Sand Prairies (Oak Openings)** Is the wetland located in Lucas, Fulton, Henry, or Wood Counties and can the wetland be characterized by the following description: the wetland has a sandy substrate with interspersed organic matter, a water table often within several inches of the surface, and often with a dominance of the gramineous vegetation listed in Table 1 (woody species may also be present). The Ohio Department of Natural Resources Division of Natural Areas and Preserves can provide assistance in confirming this type of wetland and its quality.	YES Wetland is a Category 3 wetland. Go to Question 11	NO Go to Question 11
11	**Relict Wet Prairies.** Is the wetland a relict wet prairie community dominated by some or all of the species in Table 1. Extensive prairies were formerly located in the Darby Plains (Madison and Union Counties), Sandusky Plains (Wyandot, Crawford, and Marion Counties), northwest Ohio (e.g. Erie, Huron, Lucas, Wood Counties), and portions of western Ohio Counties (e.g. Darke, Mercer, Miami, Montgomery, Van Wert etc.).	YES Wetland should be evaluated for possible Category 3 status Complete Quantitative Rating	NO Complete Quantitative Rating

Table 1. Characteristic plant species.

invasive/exotic spp	fen species	bog species	0ak Opening species	wet prairie species
Lythrum salicaria	*Zygadenus elegans var. glaucus*	*Calla palustris*	*Carex cryptolepis*	*Calamagrostis canadensis*
Myriophyllum spicatum	*Cacalia plantaginea*	*Carex atlantica var. capillacea*	*Carex lasiocarpa*	*Calamogrostis stricta*
Najas minor	*Carex flava*	*Carex echinata*	*Carex stricta*	*Carex atherodes*
Phalaris arundinacea	*Carex sterilis*	*Carex oligosperma*	*Cladium mariscoides*	*Carex buxbaumii*
Phragmites australis	*Carex stricta*	*Carex trisperma*	*Calamagrostis stricta*	*Carex pellita*
Potamogeton crispus	*Deschampsia caespitosa*	*Chamaedaphne calyculata*	*Calamagrostis canadensis*	*Carex sartwellii*
Ranunculus ficaria	*Eleocharis rostellata*	*Decodon verticillatus*	*Quercus palustris*	*Gentiana andrewsii*
Rhamnus frangula	*Eriophorum viridicarinatum*	*Eriophorum virginicum*		*Helianthus grosseserratus*
Typha angustifolia	*Gentianopsis spp.*	*Larix laricina*		*Liatris spicata*
Typha xglauca	*Lobelia kalmii*	*Nemopanthus mucronatus*		*Lysimachia quadriflora*
	Parnassia glauca	*Schechzeria palustris*		*Lythrum alatum*
	Potentilla fruticosa	*Sphagnum spp.*		*Pycnanthemum virginianum*
	Rhamnus alnifolia	*Vaccinium macrocarpon*		*Silphium terebinthinaceum*
	Rhynchospora capillacea	*Vaccinium corymbosum*		*Sorghastrum nutans*
	Salix candida	*Vaccinium oxycoccos*		*Spartina pectinata*
	Salix myricoides	*Woodwardia virginica*		*Solidago riddellii*
	Salix serissima	*Xyris difformis*		
	Solidago ohioensis			
	Tofieldia glutinosa			
	Triglochin maritimum			
	Triglochin palustre			

End of Narrative Rating. Begin Quantitative Rating on next page.

ORAM v. 5.0 Field Form Quantitative Rating

Site: Wetland 13	Rater(s): Ruby/Swartz	Date: 8/31/2010

2	2
max 6 pts.	subtotal

Metric 1. Wetland Area (size).

Select one size class and assign score.

- [ ] >50 acres (>20.2ha) (6 pts)
- [ ] 25 to <50 acres (10.1 to <20.2ha) (5 pts)
- [ ] 10 to <25 acres (4 to <10.1ha) (4 pts)
- [ ] 3 to <10 acres (1.2 to <4ha) (3 pts)
- [x] 0.3 to <3 acres (0.12 to <1.2ha) (2pts)
- [ ] 0.1 to <0.3 acres (0.04 to <0.12ha) (1 pt)
- [ ] <0.1 acres (0.04ha) (0 pts)

3	5
max 14 pts.	subtotal

Metric 2. Upland buffers and surrounding land use.

2a. Calculate average buffer width. Select only one and assign score. Do not double check.

- [ ] WIDE. Buffers average 50m (164ft) or more around wetland perimeter (7)
- [ ] MEDIUM. Buffers average 25m to <50m (82 to <164ft) around wetland perimeter (4)
- [x] NARROW. Buffers average 10m to <25m (32ft to <82ft) around wetland perimeter (1)
- [ ] VERY NARROW. Buffers average <10m (<32ft) around wetland perimeter (0)

2b. Intensity of surrounding land use. Select one or double check and average.

- [ ] VERY LOW. 2nd growth or older forest, prairie, savannah, wildlife area, etc. (7)
- [ ] LOW. Old field (>10 years), shrub land, young second growth forest. (5)
- [x] MODERATELY HIGH. Residential, fenced pasture, park, conservation tillage, new fallow field. (3)
- [x] HIGH. Urban, industrial, open pasture, row cropping, mining, construction. (1)

21.5	26.5
max 30 pts.	subtotal

Metric 3. Hydrology.

3a. Sources of Water. Score all that apply.

- [ ] High pH groundwater (5)
- [ ] Other groundwater (3)
- [x] Precipitation (1)
- [x] Seasonal/Intermittent surface water (3)
- [x] Perennial surface water (lake or stream) (5)

3b. Connectivity. Score all that apply.

- [x] 100 year floodplain (1)
- [x] Between stream/lake and other human use (1)
- [ ] Part of wetland/upland (e.g. forest), complex (1)
- [x] Part of riparian or upland corridor (1)

3c. Maximum water depth. Select only one and assign score.

- [x] >0.7 (27.6in) (3)
- [ ] 0.4 to 0.7m (15.7 to 27.6in) (2)
- [ ] <0.4m (<15.7in) (1)

3d. Duration inundation/saturation. Score one or dbl check.

- [x] Semi- to permanently inundated/saturated (4)
- [x] Regularly inundated/saturated (3)
- [ ] Seasonally inundated (2)
- [ ] Seasonally saturated in upper 30cm (12in) (1)

3e. Modifications to natural hydrologic regime. Score one or double check and average.

- [ ] None or none apparent (12)
- [ ] Recovered (7)
- [x] Recovering (3)
- [ ] Recent or no recovery (1)

Check all disturbances observed

- [ ] ditch
- [ ] tile
- [ ] dike
- [ ] weir
- [ ] stormwater input
- [ ] point source (nonstormwater)
- [ ] filling/grading
- [x] road bed/RR track
- [ ] dredging
- [ ] other_____

9	35.5
max 20 pts.	subtotal

Metric 4. Habitat Alteration and Development.

4a. Substrate disturbance. Score one or double check and average.

- [ ] None or none apparent (4)
- [x] Recovered (3)
- [ ] Recovering (2)
- [ ] Recent or no recovery (1)

4b. Habitat development. Select only one and assign score.

- [ ] Excellent (7)
- [ ] Very good (6)
- [ ] Good (5)
- [ ] Moderately good (4)
- [x] Fair (3)
- [ ] Poor to fair (2)
- [ ] Poor (1)

4c. Habitat alteration. Score one or double check and average.

- [ ] None or none apparent (9)
- [ ] Recovered (6)
- [x] Recovering (3)
- [ ] Recent or no recovery (1)

Check all disturbances observed

- [x] mowing
- [ ] grazing
- [ ] clearcutting
- [ ] selective cutting
- [ ] woody debris removal
- [ ] toxic pollutants
- [ ] shrub/sapling removal
- [ ] herbaceous/aquatic bed removal
- [ ] sedimentation
- [ ] dredging
- [ ] farming
- [ ] nutrient enrichment

35.5
subtotal this page

last revised 1 February 2001 jjm

Site: Wetland 13	Rater(s): Ruby / Swartz	Date: 8/31/2010

35.5
subtotal first page

0	35.5
max 10 pts.	subtotal

Metric 5. Special Wetlands.

Check all that apply and score as indicated.

- [ ] Bog (10)
- [ ] Fen (10)
- [ ] Old growth forest (10)
- [ ] Mature forested wetland (5)
- [ ] Lake Erie coastal/tributary wetland-unrestricted hydrology (10)
- [ ] Lake Erie coastal/tributary wetland-restricted hydrology (5)
- [ ] Lake Plain Sand Prairies (Oak Openings) (10)
- [ ] Relict Wet Prairies (10)
- [ ] Known occurrence state/federal threatened or endangered species (10)
- [ ] Significant migratory songbird/water fowl habitat or usage (10)
- [ ] Category 1 Wetland. See Question 1 Qualitative Rating (-10)

7	42.5
max 20 pts.	subtotal

Metric 6. Plant communities, interspersion, microtopography.

6a. Wetland Vegetation Communities.
Score all present using 0 to 3 scale.

- [0] Aquatic bed
- [2] Emergent
- [1] Shrub
- [1] Forest
- [0] Mudflats
- [0] Open water
- [0] Other_____

6b. horizontal (plan view) Interspersion.
Select only one.

- [ ] High (5)
- [ ] Moderately high(4)
- [X] Moderate (3)
- [ ] Moderately low (2)
- [ ] Low (1)
- [ ] None (0)

6c. Coverage of invasive plants. Refer to Table 1 ORAM long form for list. Add or deduct points for coverage

- [ ] Extensive >75% cover (-5)
- [X] Moderate 25-75% cover (-3)
- [ ] Sparse 5-25% cover (-1)
- [ ] Nearly absent <5% cover (0)
- [ ] Absent (1)

6d. Microtopography.
Score all present using 0 to 3 scale.

- [1] Vegetated hummucks/tussucks
- [1] Coarse woody debris >15cm (6in)
- [1] Standing dead >25cm (10in) dbh
- [0] Amphibian breeding pools

Vegetation Community Cover Scale

0	Absent or comprises <0.1ha (0.2471 acres) contiguous area
1	Present and either comprises small part of wetland's vegetation and is of moderate quality, or comprises a significant part but is of low quality
2	Present and either comprises significant part of wetland's vegetation and is of moderate quality or comprises a small part and is of high quality
3	Present and comprises significant part, or more, of wetland's vegetation and is of high quality

Narrative Description of Vegetation Quality

low	Low spp diversity and/or predominance of nonnative or disturbance tolerant native species
mod	Native spp are dominant component of the vegetation, although nonnative and/or disturbance tolerant native spp can also be present, and species diversity moderate to moderately high, but generally w/o presence of rare threatened or endangered spp
high	A predominance of native species, with nonnative spp and/or disturbance tolerant native spp absent or virtually absent, and high spp diversity and often, but not always, the presence of rare, threatened, or endangered spp

Mudflat and Open Water Class Quality

0	Absent <0.1ha (0.247 acres)
1	Low 0.1 to <1ha (0.247 to 2.47 acres)
2	Moderate 1 to <4ha (2.47 to 9.88 acres)
3	High 4ha (9.88 acres) or more

Microtopography Cover Scale

0	Absent
1	Present very small amounts or if more common of marginal quality
2	Present in moderate amounts, but not of highest quality or in small amounts of highest quality
3	Present in moderate or greater amounts and of highest quality

42.5

End of Quantitative Rating. Complete Categorization Worksheets.

ORAM Summary Worksheet

		circle answer or insert score	Result
Narrative Rating	Question 1 Critical Habitat	YES NO	If yes, Category 3.
	Question 2. Threatened or Endangered Species	YES NO	If yes, Category 3.
	Question 3. High Quality Natural Wetland	YES NO	If yes, Category 3.
	Question 4. Significant bird habitat	YES NO	If yes, Category 3.
	Question 5. Category 1 Wetlands	YES NO	If yes, Category 1.
	Question 6. Bogs	YES NO	If yes, Category 3.
	Question 7. Fens	YES NO	If yes, Category 3.
	Question 8a. Old Growth Forest	YES NO	If yes, Category 3.
	Question 8b. Mature Forested Wetland	YES NO	If yes, evaluate for Category 3; may also be 1 or 2.
	Question 9b. Lake Erie Wetlands - Restricted	YES NO	If yes, evaluate for Category 3; may also be 1 or 2.
	Question 9d. Lake Erie Wetlands – Unrestricted with native plants	YES NO	If yes, Category 3
	Question 9e. Lake Erie Wetlands - Unrestricted with invasive plants	YES NO	If yes, evaluate for Category 3; may also be 1 or 2.
	Question 10. Oak Openings	YES NO	If yes, Category 3
	Question 11. Relict Wet Prairies	YES NO	If yes, evaluate for Category 3; may also be 1 or 2.
Quantitative Rating	Metric 1. Size	2	
	Metric 2. Buffers and surrounding land use	3	
	Metric 3. Hydrology	21.5	
	Metric 4. Habitat	9	
	Metric 5. Special Wetland Communities	0	
	Metric 6. Plant communities, interspersion, microtopography	7	
	TOTAL SCORE	42.5	Category based on score breakpoints Mod 2

Complete Wetland Categorization Worksheet.

Wetland Categorization Worksheet

Choices	Circle one		Evaluation of Categorization Result of ORAM
Did you answer "Yes" to any of the following questions: Narrative Rating Nos. 2, 3, 4, 6, 7, 8a, 9d, 10	YES Wetland is categorized as a Category 3 wetland	NO	Is quantitative rating score *less* than the Category 2 scoring threshold (*excluding* gray zone)? If yes, reevaluate the category of the wetland using the narrative criteria in OAC Rule 3745-1-54(C) and biological and/or functional assessments to determine if the wetland has been over-categorized by the ORAM
Did you answer "Yes" to any of the following questions: Narrative Rating Nos. 1, 8b, 9b, 9e, 11	YES Wetland should be evaluated for possible Category 3 status	NO	Evaluate the wetland using the 1) narrative criteria in OAC Rule 3745-1-54(C) and 2) the quantitative rating score. If the wetland is determined to be a Category 3 wetland using either of these, it should be categorized as a Category 3 wetland. Detailed biological and/or functional assessments may also be used to determine the wetland's category.
Did you answer "Yes" to Narrative Rating No. 5	YES Wetland is categorized as a Category 1 wetland	NO	Is quantitative rating score *greater* than the Category 2 scoring threshold *(including* any gray zone)? If yes, reevaluate the category of the wetland using the narrative criteria in OAC Rule 3745-1-54(C) and biological and/or functional assessments to determine if the wetland has been under-categorized by the ORAM
Does the quantitative score fall within the scoring range of a Category 1, 2, or 3 wetland?	YES Wetland is assigned to the appropriate category based on the scoring range	NO	If the score of the wetland is located within the scoring range for a particular category, the wetland should be assigned to that category. In all instances however, the narrative criteria described in OAC Rule 3745-1-54(C) can be used to clarify or change a categorization based on a quantitative score.
Does the quantitative score fall with the *"gray zone"* for Category 1 or 2 or Category 2 or 3 wetlands?	YES Wetland is assigned to the higher of the two categories or assigned to a category based on detailed assessments and the narrative criteria	NO	Rater has the option of assigning the wetland to the higher of the two categories or to assign a category based on the results of a nonrapid wetland assessment method, e.g. functional assessment, biological assessment, etc, and a consideration of the narrative criteria in OAC rule 3745-1-54(C).
Does the wetland otherwise exhibit *moderate OR superior* hydrologic OR habitat, OR recreational functions AND the wetland was *not* categorized as a Category 2 wetland (in the case of moderate functions) or a Category 3 wetland (in the case of superior functions) by this method?	YES Wetland was undercategorized by this method. A written justification for recategorization should be provided on Background Information Form	NO Wetland is assigned to category as determined by the ORAM.	A wetland may be undercategorized using this method, but still exhibit one or more superior functions, e.g. a wetland's biotic communities may be degraded by human activities, but the wetland may still exhibit superior hydrologic functions because of its type, landscape position, size, local or regional significance, etc. In this circumstance, the narrative criteria in OAC Rule 3745-1-54(C)(2) and (3) are controlling, and the under-categorization should be corrected. A written justification with supporting reasons or information for this determination should be provided.

Final Category

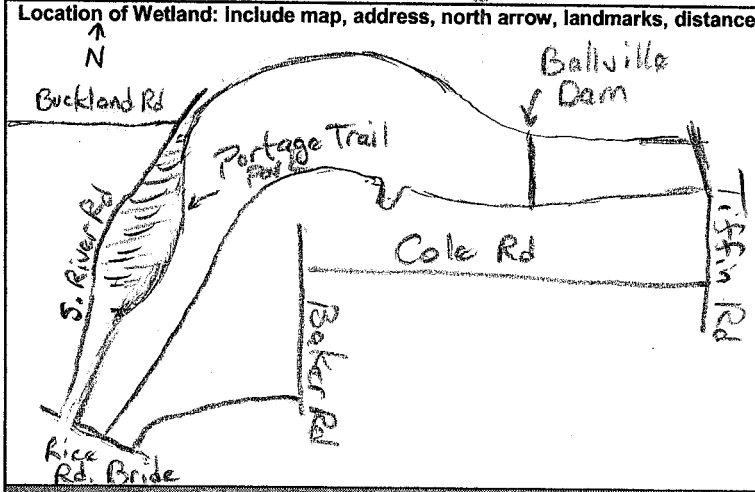
Choose one	Category 1	Category 2	Category 3

End of Ohio Rapid Assessment Method for Wetlands.

Background Information

Name:	Richard Ruby / Brian Swartz
Date:	2 Sep 2010
Affiliation:	USACE - Buffalo District
Address:	1776 Niagara Street, Buffalo, NY 14207
Phone Number:	716-879-4109
e-mail address:	richard.j.ruby@usace.army.mil
Name of Wetland:	Wetlands 14 & 15
Vegetation Communit(ies):	Emergent / Scrub-Shrub / Forested
HGM Class(es):	Riverine

Location of Wetland: Include map, address, north arrow, landmarks, distances, roads, etc.



West/North Bank of Sandusky River at Portage Trail Park in Ballville Township, Sandusky County, Ohio.

Lat/Long or UTM Coordinate	Lat: 41.32347 Long: -83.15333
USGS Quad Name	Fremont - West, Ohio
County	Sandusky
Township	Ballville
Section and Subsection	E½ 8
Hydrologic Unit Code	04100011
Site Visit	2 Sep 2010
National Wetland Inventory Map	NWI Online
Ohio Wetland Inventory Map	
Soil Survey	NRCS Online
Delineation report/map	Yes

Name of Wetland: Wetlands 14 & 15

Wetland Size (acres, hectares): 13.36 acres

Sketch: Include north arrow, relationship with other surface waters, vegetation zones, etc.

See attached maps 3, 3a, & 3b.

Comments, Narrative Discussion, Justification of Category Changes:

- Emergent wetland fringe and floodplain forested scrub-shrub wetland along the north/west bank of the Sandusky River in Portage Trail Park.

Final score : 75 **Category:** 3

Scoring Boundary Worksheet

INSTRUCTIONS. The initial step in completing the ORAM is to identify the "scoring boundaries" of the wetland being rated. In many instances this determination will be relatively easy and the scoring boundaries will coincide with the "jurisdictional boundaries." For example, the scoring boundary of an isolated cattail marsh located in the middle of a farm field will likely be the same as that wetland's jurisdictional boundaries. In other instances, however, the scoring boundary will not be as easily determined. Wetlands that are small or isolated from other surface waters often form large contiguous areas or heterogeneous complexes of wetland and upland. In separating wetlands for scoring purposes, the hydrologic regime of the wetland is the main criterion that should be used. Boundaries between contiguous or connected wetlands should be established where the volume, flow, or velocity of water moving through the wetland changes significantly. *Areas with a high degree of hydrologic interaction should be scored as a single wetland.* In determining a wetland's scoring boundaries, use the guidelines in the ORAM Manual Section 5.0. In certain instances, it may be difficult to establish the scoring boundary for the wetland being rated. These problem situations include wetlands that form a patchwork on the landscape, wetlands divided by artificial boundaries like property fences, roads, or railroad embankments, wetlands that are contiguous with streams, lakes, or rivers, and estuarine or coastal wetlands. These situations are discussed below, however, it is recommended that Rater contact Ohio EPA, Division of Surface Water, 401/Wetlands Section if there are additional questions or a need for further clarification of the appropriate scoring boundaries of a particular wetland.

#	Steps in properly establishing scoring boundaries	done?	not applicable
Step 1	Identify the wetland area of interest. This may be the site of a proposed impact, a reference site, conservation site, etc.	X	
Step 2	Identify the locations where there is physical evidence that hydrology changes rapidly. Such evidence includes both natural and human-induced changes including, constrictions caused by berms or dikes, points where the water velocity changes rapidly at rapids or falls, points where significant inflows occur at the confluence of rivers, or other factors that may restrict hydrologic interaction between the wetlands or parts of a single wetland.	X	
Step 3	Delineate the boundary of the wetland to be rated such that all areas of interest that are contiguous to and within the areas where the hydrology does not change significantly, i.e. areas that have a high degree of hydrologic interaction are included within the scoring boundary.	X	
Step 4	Determine if artificial boundaries, such as property lines, state lines, roads, railroad embankments, etc., are present. These should not be used to establish scoring boundaries unless they coincide with areas where the hydrologic regime changes.	X	
Step 5	In all instances, the Rater may enlarge the minimum scoring boundaries discussed here to score together wetlands that could be scored separately.	X	
Step 6	Consult ORAM Manual Section 5.0 for how to establish scoring boundaries for wetlands that form a patchwork on the landscape, divided by artificial boundaries, contiguous to streams, lakes or rivers, or for dual classifications.	X	

End of Scoring Boundary Determination. Begin Narrative Rating on next page.

Narrative Rating

INSTRUCTIONS. Answer each of the following questions. Questions 1, 2, 3 and 4 should be answered based on information obtained from the site visit or the literature *and* by submitting a Data Services Request to the Ohio Department of Natural Resources, Division of Natural Areas and Preserves, Natural Heritage Data Services, 1889 Fountain Square Court, Building F-1, Columbus, Ohio 43224, 614-265-6453 (phone), 614-265-3096 (fax), http://www.dnr.state.oh.us/dnap . The remaining questions are designed to be answered primarily by the results of the site visit. Refer to the User's Manual for descriptions of these wetland types. Note: "Critical habitat" is legally defined in the Endangered Species Act and is the geographic area containing physical or biological features essential to the conservation of a listed species or as an area that may require special management considerations or protection. The Rater should contact the Region 3 Headquarters or the Columbus Ecological Services Office for updates as to whether critical habitat has been designated for other federally listed threatened or endangered species. "Documented" means the wetland is listed in the appropriate State of Ohio database.

#	Question	Circle one	
1	**Critical Habitat.** Is the wetland in a township, section, or subsection of a United States Geological Survey 7.5 minute Quadrangle that has been designated by the U.S. Fish and Wildlife Service as "critical habitat" for any threatened or endangered plant or animal species? Note: as of January 1, 2001, of the federally listed endangered or threatened species which can be found in Ohio, the Indiana Bat has had critical habitat designated (50 CFR 17.95(a)) and the piping plover has had critical habitat proposed (65 FR 41812 July 6, 2000).	YES Wetland should be evaluated for possible Category 3 status Go to Question 2	NO Go to Question 2
2	**Threatened or Endangered Species.** Is the wetland known to contain an individual of, or documented occurrences of federal or state-listed threatened or endangered plant or animal species?	YES Wetland is a Category 3 wetland. Go to Question 3	NO Go to Question 3
3	**Documented High Quality Wetland.** Is the wetland on record in Natural Heritage Database as a high quality wetland?	YES Wetland is a Category 3 wetland Go to Question 4	NO Go to Question 4
4	**Significant Breeding or Concentration Area.** Does the wetland contain documented regionally significant breeding or nonbreeding waterfowl, neotropical songbird, or shorebird concentration areas?	YES Wetland is a Category 3 wetland Go to Question 5	NO Go to Question 5
5	**Category 1 Wetlands.** Is the wetland less than 0.5 hectares (1 acre) in size and **hydrologically isolated** and either 1) comprised of vegetation that is dominated (greater than eighty per cent areal cover) by *Phalaris arundinacea, Lythrum salicaria,* or *Phragmites australis*, or 2) an acidic pond created or excavated on mined lands that has little or no vegetation?	YES Wetland is a Category 1 wetland Go to Question 6	NO Go to Question 6
6	**Bogs.** Is the wetland a peat-accumulating wetland that 1) has no significant inflows or outflows, 2) supports acidophilic mosses, particularly *Sphagnum* spp., 3) the acidophilic mosses have >30% cover, 4) at least one species from Table 1 is present, and 5) the cover of invasive species (see Table 1) is <25%?	YES Wetland is a Category 3 wetland Go to Question 7	NO Go to Question 7
7	**Fens.** Is the wetland a carbon accumulating (peat, muck) wetland that is saturated during most of the year, primarily by a discharge of free flowing, mineral rich, ground water with a circumneutral ph (5.5-9.0) and with one or more plant species listed in Table 1 and the cover of invasive species listed in Table 1 is <25%?	YES Wetland is a Category 3 wetland Go to Question 8a	NO Go to Question 8a
8a	**"Old Growth Forest."** Is the wetland a forested wetland and is the forest characterized by, but not limited to, the following characteristics: overstory canopy trees of great age (exceeding at least 50% of a projected maximum attainable age for a species); little or no evidence of human-caused understory disturbance during the past 80 to 100 years; an all-aged structure and multilayered canopies; aggregations of canopy trees interspersed with canopy gaps; and significant numbers of standing dead snags and downed logs?	YES Wetland is a Category 3 wetland. Go to Question 8b	NO Go to Question 8b

8b	**Mature forested wetlands.** Is the wetland a forested wetland with 50% or more of the cover of upper forest canopy consisting of deciduous trees with large diameters at breast height (dbh), generally diameters greater than 45cm (17.7in) dbh?	YES Wetland should be evaluated for possible Category 3 status. Go to Question 9a	NO Go to Question 9a
9a	**Lake Erie coastal and tributary wetlands.** Is the wetland located at an elevation less than 575 feet on the USGS map, adjacent to this elevation, or along a tributary to Lake Erie that is accessible to fish?	YES Go to Question 9b	NO Go to Question 10
9b	Does the wetland's hydrology result from measures designed to prevent erosion and the loss of aquatic plants, i.e. the wetland is partially hydrologically restricted from Lake Erie due to lakeward or landward dikes or other hydrological controls?	YES Wetland should be evaluated for possible Category 3 status Go to Question 10	NO Go to Question 9c
9c	Are Lake Erie water levels the wetland's primary hydrological influence, i.e. the wetland is hydrologically unrestricted (no lakeward or upland border alterations), or the wetland can be characterized as an "estuarine" wetland with lake and river influenced hydrology. These include sandbar deposition wetlands, estuarine wetlands, river mouth wetlands, or those dominated by submersed aquatic vegetation.	YES Go to Question 9d	NO Go to Question 10
9d	Does the wetland have a predominance of native species within its vegetation communities, although non-native or disturbance tolerant native species can also be present?	YES Wetland is a Category 3 wetland Go to Question 10	NO Go to Question 9e
9e	Does the wetland have a predominance of non-native or disturbance tolerant native plant species within its vegetation communities?	YES Wetland should be evaluated for possible Category 3 status Go to Question 10	NO Go to Question 10
10	**Lake Plain Sand Prairies (Oak Openings)** Is the wetland located in Lucas, Fulton, Henry, or Wood Counties and can the wetland be characterized by the following description: the wetland has a sandy substrate with interspersed organic matter, a water table often within several inches of the surface, and often with a dominance of the gramineous vegetation listed in Table 1 (woody species may also be present). The Ohio Department of Natural Resources Division of Natural Areas and Preserves can provide assistance in confirming this type of wetland and its quality.	YES Wetland is a Category 3 wetland. Go to Question 11	NO Go to Question 11
11	**Relict Wet Prairies.** Is the wetland a relict wet prairie community dominated by some or all of the species in Table 1. Extensive prairies were formerly located in the Darby Plains (Madison and Union Counties), Sandusky Plains (Wyandot, Crawford, and Marion Counties), northwest Ohio (e.g. Erie, Huron, Lucas, Wood Counties), and portions of western Ohio Counties (e.g. Darke, Mercer, Miami, Montgomery, Van Wert etc.).	YES Wetland should be evaluated for possible Category 3 status Complete Quantitative Rating	NO Complete Quantitative Rating

Table 1. Characteristic plant species.

invasive/exotic spp	fen species	bog species	0ak Opening species	wet prairie species
Lythrum salicaria	*Zygadenus elegans var. glaucus*	*Calla palustris*	*Carex cryptolepis*	*Calamagrostis canadensis*
Myriophyllum spicatum	*Cacalia plantaginea*	*Carex atlantica var. capillacea*	*Carex lasiocarpa*	*Calamogrostis stricta*
Najas minor	*Carex flava*	*Carex echinata*	*Carex stricta*	*Carex atherodes*
Phalaris arundinacea	*Carex sterilis*	*Carex oligosperma*	*Cladium mariscoides*	*Carex buxbaumii*
Phragmites australis	*Carex stricta*	*Carex trisperma*	*Calamagrostis stricta*	*Carex pellita*
Potamogeton crispus	*Deschampsia caespitosa*	*Chamaedaphne calyculata*	*Calamagrostis canadensis*	*Carex sartwellii*
Ranunculus ficaria	*Eleocharis rostellata*	*Decodon verticillatus*	*Quercus palustris*	*Gentiana andrewsii*
Rhamnus frangula	*Eriophorum viridicarinatum*	*Eriophorum virginicum*		*Helianthus grosseserratus*
Typha angustifolia	*Gentianopsis spp.*	*Larix laricina*		*Liatris spicata*
Typha xglauca	*Lobelia kalmii*	*Nemopanthus mucronatus*		*Lysimachia quadriflora*
	Parnassia glauca	*Schechzeria palustris*		*Lythrum alatum*
	Potentilla fruticosa	*Sphagnum spp.*		*Pycnanthemum virginianum*
	Rhamnus alnifolia	*Vaccinium macrocarpon*		*Silphium terebinthinaceum*
	Rhynchospora capillacea	*Vaccinium corymbosum*		*Sorghastrum nutans*
	Salix candida	*Vaccinium oxycoccos*		*Spartina pectinata*
	Salix myricoides	*Woodwardia virginica*		*Solidago riddellii*
	Salix serissima	*Xyris difformis*		
	Solidago ohioensis			
	Tofieldia glutinosa			
	Triglochin maritimum			
	Triglochin palustre			

End of Narrative Rating. Begin Quantitative Rating on next page.

ORAM v. 5.0 Field Form Quantitative Rating

Site: Wetlands 14 & 15	Rater(s): Ruby / Swartz	Date: 9/2/2010

4	4
max 6 pts.	subtotal

Metric 1. Wetland Area (size).

Select one size class and assign score.

- [ ] >50 acres (>20.2ha) (6 pts)
- [ ] 25 to <50 acres (10.1 to <20.2ha) (5 pts)
- [x] 10 to <25 acres (4 to <10.1ha) (4 pts)
- [ ] 3 to <10 acres (1.2 to <4ha) (3 pts)
- [ ] 0.3 to <3 acres (0.12 to <1.2ha) (2pts)
- [ ] 0.1 to <0.3 acres (0.04 to <0.12ha) (1 pt)
- [ ] <0.1 acres (0.04ha) (0 pts)

3	7
max 14 pts.	subtotal

Metric 2. Upland buffers and surrounding land use.

2a. Calculate average buffer width. Select only one and assign score. Do not double check.

- [ ] WIDE. Buffers average 50m (164ft) or more around wetland perimeter (7)
- [ ] MEDIUM. Buffers average 25m to <50m (82 to <164ft) around wetland perimeter (4)
- [x] NARROW. Buffers average 10m to <25m (32ft to <82ft) around wetland perimeter (1)
- [ ] VERY NARROW. Buffers average <10m (<32ft) around wetland perimeter (0)

2b. Intensity of surrounding land use. Select one or double check and average.

- [ ] VERY LOW. 2nd growth or older forest, prairie, savannah, wildlife area, etc. (7)
- [ ] LOW. Old field (>10 years), shrub land, young second growth forest. (5)
- [x] MODERATELY HIGH. Residential, fenced pasture, park, conservation tillage, new fallow field. (3)
- [x] HIGH. Urban, industrial, open pasture, row cropping, mining, construction. (1)

24.5	33.5
max 30 pts.	subtotal

Metric 3. Hydrology.

3a. Sources of Water. Score all that apply.

- [ ] High pH groundwater (5)
- [ ] Other groundwater (3)
- [x] Precipitation (1)
- [x] Seasonal/Intermittent surface water (3)
- [x] Perennial surface water (lake or stream) (5)

3b. Connectivity. Score all that apply.

- [x] 100 year floodplain (1)
- [x] Between stream/lake and other human use (1)
- [x] Part of wetland/upland (e.g. forest), complex (1)
- [x] Part of riparian or upland corridor (1)

3c. Maximum water depth. Select only one and assign score.

- [x] >0.7 (27.6in) (3)
- [ ] 0.4 to 0.7m (15.7 to 27.6in) (2)
- [ ] <0.4m (<15.7in) (1)

3d. Duration inundation/saturation. Score one or dbl check.

- [x] Semi- to permanently inundated/saturated (4)
- [x] Regularly inundated/saturated (3)
- [ ] Seasonally inundated (2)
- [ ] Seasonally saturated in upper 30cm (12in) (1)

3e. Modifications to natural hydrologic regime. Score one or double check and average.

- [ ] None or none apparent (12)
- [x] Recovered (7)
- [x] Recovering (3)
- [ ] Recent or no recovery (1)

Check all disturbances observed

- [ ] ditch
- [ ] tile
- [ ] dike
- [ ] weir
- [ ] stormwater input
- [ ] point source (nonstormwater)
- [ ] filling/grading
- [x] road bed/RR track
- [ ] dredging
- [ ] other_____

13.5	47
max 20 pts.	subtotal

Metric 4. Habitat Alteration and Development.

4a. Substrate disturbance. Score one or double check and average.

- [x] None or none apparent (4)
- [ ] Recovered (3)
- [ ] Recovering (2)
- [ ] Recent or no recovery (1)

4b. Habitat development. Select only one and assign score.

- [ ] Excellent (7)
- [ ] Very good (6)
- [x] Good (5)
- [ ] Moderately good (4)
- [ ] Fair (3)
- [ ] Poor to fair (2)
- [ ] Poor (1)

4c. Habitat alteration. Score one or double check and average.

- [ ] None or none apparent (9)
- [x] Recovered (6)
- [x] Recovering (3)
- [ ] Recent or no recovery (1)

Check all disturbances observed

- [x] mowing
- [ ] grazing
- [ ] clearcutting
- [ ] selective cutting
- [ ] woody debris removal
- [ ] toxic pollutants
- [ ] shrub/sapling removal
- [ ] herbaceous/aquatic bed removal
- [ ] sedimentation
- [ ] dredging
- [ ] farming
- [ ] nutrient enrichment

47
subtotal this page

last revised 1 February 2001 jjm

Site: Wetlands 14 & 15	Rater(s): Ruby / Swartz	Date: 9/2/2010

47
subtotal first page

Metric 5. Special Wetlands.

15	62
max 10 pts.	subtotal

Check all that apply and score as indicated.

- [ ] Bog (10)
- [ ] Fen (10)
- [ ] Old growth forest (10)
- [x] Mature forested wetland (5)
- [ ] Lake Erie coastal/tributary wetland-unrestricted hydrology (10)
- [ ] Lake Erie coastal/tributary wetland-restricted hydrology (5)
- [ ] Lake Plain Sand Prairies (Oak Openings) (10)
- [ ] Relict Wet Prairies (10)
- [x] Known occurrence state/federal threatened or endangered species (10)
- [ ] Significant migratory songbird/water fowl habitat or usage (10)
- [ ] Category 1 Wetland. See Question 1 Qualitative Rating (-10)

Metric 6. Plant communities, interspersion, microtopography.

13	75
max 20 pts.	subtotal

6a. Wetland Vegetation Communities.
Score all present using 0 to 3 scale.

- [0] Aquatic bed
- [2] Emergent
- [1] Shrub
- [2] Forest
- [0] Mudflats
- [0] Open water
- [0] Other_____

6b. horizontal (plan view) Interspersion.
Select only one.

- [ ] High (5)
- [ ] Moderately high(4)
- [x] Moderate (3)
- [ ] Moderately low (2)
- [ ] Low (1)
- [ ] None (0)

6c. Coverage of invasive plants. Refer to Table 1 ORAM long form for list. Add or deduct points for coverage

- [ ] Extensive >75% cover (-5)
- [x] Moderate 25-75% cover (-3)
- [ ] Sparse 5-25% cover (-1)
- [ ] Nearly absent <5% cover (0)
- [ ] Absent (1)

6d. Microtopography.
Score all present using 0 to 3 scale.

- [2] Vegetated hummucks/tussucks
- [2] Coarse woody debris >15cm (6in)
- [2] Standing dead >25cm (10in) dbh
- [2] Amphibian breeding pools

Vegetation Community Cover Scale

0	Absent or comprises <0.1ha (0.2471 acres) contiguous area
1	Present and either comprises small part of wetland's vegetation and is of moderate quality, or comprises a significant part but is of low quality
2	Present and either comprises significant part of wetland's vegetation and is of moderate quality or comprises a small part and is of high quality
3	Present and comprises significant part, or more, of wetland's vegetation and is of high quality

Narrative Description of Vegetation Quality

low	Low spp diversity and/or predominance of nonnative or disturbance tolerant native species
mod	Native spp are dominant component of the vegetation, although nonnative and/or disturbance tolerant native spp can also be present, and species diversity moderate to moderately high, but generally w/o presence of rare threatened or endangered spp
high	A predominance of native species, with nonnative spp and/or disturbance tolerant native spp absent or virtually absent, and high spp diversity and often, but not always, the presence of rare, threatened, or endangered spp

Mudflat and Open Water Class Quality

0	Absent <0.1ha (0.247 acres)
1	Low 0.1 to <1ha (0.247 to 2.47 acres)
2	Moderate 1 to <4ha (2.47 to 9.88 acres)
3	High 4ha (9.88 acres) or more

Microtopography Cover Scale

0	Absent
1	Present very small amounts or if more common of marginal quality
2	Present in moderate amounts, but not of highest quality or in small amounts of highest quality
3	Present in moderate or greater amounts and of highest quality

75

End of Quantitative Rating. Complete Categorization Worksheets.

ORAM Summary Worksheet

		circle answer or insert score	Result
Narrative Rating	Question 1 Critical Habitat	YES NO	If yes, Category 3.
	Question 2. Threatened or Endangered Species	YES NO	If yes, Category 3.
	Question 3. High Quality Natural Wetland	YES NO	If yes, Category 3.
	Question 4. Significant bird habitat	YES NO	If yes, Category 3.
	Question 5. Category 1 Wetlands	YES NO	If yes, Category 1.
	Question 6. Bogs	YES NO	If yes, Category 3.
	Question 7. Fens	YES NO	If yes, Category 3.
	Question 8a. Old Growth Forest	YES NO	If yes, Category 3.
	Question 8b. Mature Forested Wetland	YES NO	If yes, evaluate for Category 3; may also be 1 or 2.
	Question 9b. Lake Erie Wetlands - Restricted	YES NO	If yes, evaluate for Category 3; may also be 1 or 2.
	Question 9d. Lake Erie Wetlands – Unrestricted with native plants	YES NO	If yes, Category 3
	Question 9e. Lake Erie Wetlands - Unrestricted with invasive plants	YES NO	If yes, evaluate for Category 3; may also be 1 or 2.
	Question 10. Oak Openings	YES NO	If yes, Category 3
	Question 11. Relict Wet Prairies	YES NO	If yes, evaluate for Category 3; may also be 1 or 2.
Quantitative Rating	Metric 1. Size	14	
	Metric 2. Buffers and surrounding land use	3	
	Metric 3. Hydrology	24.5	
	Metric 4. Habitat	13.5	
	Metric 5. Special Wetland Communities	15	
	Metric 6. Plant communities, interspersion, microtopography	13	
	TOTAL SCORE	75	Category based on score breakpoints 3

Complete Wetland Categorization Worksheet.

Wetland Categorization Worksheet

Choices	Circle one		Evaluation of Categorization Result of ORAM
Did you answer "Yes" to any of the following questions: Narrative Rating Nos. 2, 3, 4, 6, 7, 8a, 9d, 10	YES Wetland is categorized as a Category 3 wetland	NO	Is quantitative rating score *less* than the Category 2 scoring threshold (*excluding* gray zone)? If yes, reevaluate the category of the wetland using the narrative criteria in OAC Rule 3745-1-54(C) and biological and/or functional assessments to determine if the wetland has been over-categorized by the ORAM
Did you answer "Yes" to any of the following questions: Narrative Rating Nos. 1, 8b, 9b, 9e, 11	YES Wetland should be evaluated for possible Category 3 status	NO	Evaluate the wetland using the 1) narrative criteria in OAC Rule 3745-1-54(C) and 2) the quantitative rating score. If the wetland is determined to be a Category 3 wetland using either of these, it should be categorized as a Category 3 wetland. Detailed biological and/or functional assessments may also be used to determine the wetland's category.
Did you answer "Yes" to Narrative Rating No. 5	YES Wetland is categorized as a Category 1 wetland	NO	Is quantitative rating score *greater* than the Category 2 scoring threshold (*including* any gray zone)? If yes, reevaluate the category of the wetland using the narrative criteria in OAC Rule 3745-1-54(C) and biological and/or functional assessments to determine if the wetland has been under-categorized by the ORAM
Does the quantitative score fall within the scoring range of a Category 1, 2, or 3 wetland?	YES Wetland is assigned to the appropriate category based on the scoring range	NO	If the score of the wetland is located within the scoring range for a particular category, the wetland should be assigned to that category. In all instances however, the narrative criteria described in OAC Rule 3745-1-54(C) can be used to clarify or change a categorization based on a quantitative score.
Does the quantitative score fall with the *"gray zone"* for Category 1 or 2 or Category 2 or 3 wetlands?	YES Wetland is assigned to the higher of the two categories or assigned to a category based on detailed assessments and the narrative criteria	NO	Rater has the option of assigning the wetland to the higher of the two categories or to assign a category based on the results of a nonrapid wetland assessment method, e.g. functional assessment, biological assessment, etc, and a consideration of the narrative criteria in OAC rule 3745-1-54(C).
Does the wetland otherwise exhibit *moderate OR superior* hydrologic OR habitat, OR recreational functions AND the wetland was *not* categorized as a Category 2 wetland (in the case of moderate functions) or a Category 3 wetland (in the case of superior functions) by this method?	YES Wetland was undercategorized by this method. A written justification for recategorization should be provided on Background Information Form	NO Wetland is assigned to category as determined by the ORAM.	A wetland may be undercategorized using this method, but still exhibit one or more superior functions, e.g. a wetland's biotic communities may be degraded by human activities, but the wetland may still exhibit superior hydrologic functions because of its type, landscape position, size, local or regional significance, etc. In this circumstance, the narrative criteria in OAC Rule 3745-1-54(C)(2) and (3) are controlling, and the under-categorization should be corrected. A written justification with supporting reasons or information for this determination should be provided.

Final Category

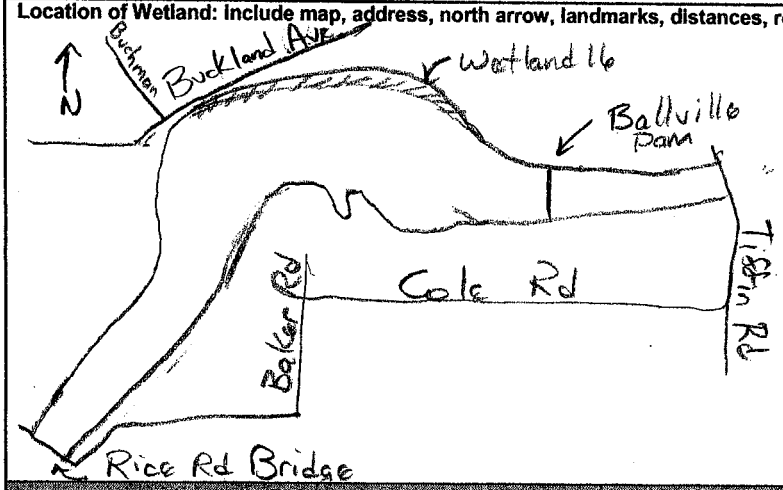
Choose one	Category 1	Category 2	Category 3

End of Ohio Rapid Assessment Method for Wetlands.

Background Information

Name:	Richard Ruby / Brian Swartz
Date:	2 Sep 2010
Affiliation:	USACE - Buffalo District
Address:	1776 Niagara Street, Buffalo, NY 14207
Phone Number:	716-879-4109
e-mail address:	richard.j.ruby@usace.army.mil
Name of Wetland:	Wetland 16
Vegetation Communit(ies):	Emergent / scrub shrub / Forested
HGM Class(es):	Riverine

Location of Wetland: include map, address, north arrow, landmarks, distances, roads, etc.



West/North Bank of Sandusky River from intersection of Buchman Rd & Buckland Ave in Ballville Township, Sandusky County, Ohio

Lat/Long or UTM Coordinate	Lat: 41.33020 Long: -83.14261
USGS Quad Name	Fremont-West, Ohio
County	Sandusky
Township	Ballville
Section and Subsection	SW¼ 4, NE¼ 9
Hydrologic Unit Code	04100011
Site Visit	2 Sep 2010
National Wetland Inventory Map	NWI Online
Ohio Wetland Inventory Map	
Soil Survey	NRCS Online
Delineation report/map	Yes

Name of Wetland: Wetland 16

Wetland Size (acres, hectares): 1.23 acres

Sketch: Include north arrow, relationship with other surface waters, vegetation zones, etc.

See attache map 4

Comments, Narrative Discussion, Justification of Category Changes:

- Emergent wetland fringe and floodplain forested scrub-shrub wetland along the north/west bank of the Sandusky River upstream of the Ballville Dam.

Final score : 52 **Category:** 2

Scoring Boundary Worksheet

INSTRUCTIONS. The initial step in completing the ORAM is to identify the "scoring boundaries" of the wetland being rated. In many instances this determination will be relatively easy and the scoring boundaries will coincide with the "jurisdictional boundaries." For example, the scoring boundary of an isolated cattail marsh located in the middle of a farm field will likely be the same as that wetland's jurisdictional boundaries. In other instances, however, the scoring boundary will not be as easily determined. Wetlands that are small or isolated from other surface waters often form large contiguous areas or heterogeneous complexes of wetland and upland. In separating wetlands for scoring purposes, the hydrologic regime of the wetland is the main criterion that should be used. Boundaries between contiguous or connected wetlands should be established where the volume, flow, or velocity of water moving through the wetland changes significantly. *Areas with a high degree of hydrologic interaction should be scored as a single wetland.* In determining a wetland's scoring boundaries, use the guidelines in the ORAM Manual Section 5.0. In certain instances, it may be difficult to establish the scoring boundary for the wetland being rated. These problem situations include wetlands that form a patchwork on the landscape, wetlands divided by artificial boundaries like property fences, roads, or railroad embankments, wetlands that are contiguous with streams, lakes, or rivers, and estuarine or coastal wetlands. These situations are discussed below, however, it is recommended that Rater contact Ohio EPA, Division of Surface Water, 401/Wetlands Section if there are additional questions or a need for further clarification of the appropriate scoring boundaries of a particular wetland.

#	Steps in properly establishing scoring boundaries	done?	not applicable
Step 1	Identify the wetland area of interest. This may be the site of a proposed impact, a reference site, conservation site, etc.	X	
Step 2	Identify the locations where there is physical evidence that hydrology changes rapidly. Such evidence includes both natural and human-induced changes including, constrictions caused by berms or dikes, points where the water velocity changes rapidly at rapids or falls, points where significant inflows occur at the confluence of rivers, or other factors that may restrict hydrologic interaction between the wetlands or parts of a single wetland.	X	
Step 3	Delineate the boundary of the wetland to be rated such that all areas of interest that are contiguous to and within the areas where the hydrology does not change significantly, i.e. areas that have a high degree of hydrologic interaction are included within the scoring boundary.	X	
Step 4	Determine if artificial boundaries, such as property lines, state lines, roads, railroad embankments, etc., are present. These should not be used to establish scoring boundaries unless they coincide with areas where the hydrologic regime changes.	X	
Step 5	In all instances, the Rater may enlarge the minimum scoring boundaries discussed here to score together wetlands that could be scored separately.	X	
Step 6	Consult ORAM Manual Section 5.0 for how to establish scoring boundaries for wetlands that form a patchwork on the landscape, divided by artificial boundaries, contiguous to streams, lakes or rivers, or for dual classifications.	X	

End of Scoring Boundary Determination. Begin Narrative Rating on next page.

Narrative Rating

INSTRUCTIONS. Answer each of the following questions. Questions 1, 2, 3 and 4 should be answered based on information obtained from the site visit or the literature *and* by submitting a Data Services Request to the Ohio Department of Natural Resources, Division of Natural Areas and Preserves, Natural Heritage Data Services, 1889 Fountain Square Court, Building F-1, Columbus, Ohio 43224, 614-265-6453 (phone), 614-265-3096 (fax), http://www.dnr.state.oh.us/dnap . The remaining questions are designed to be answered primarily by the results of the site visit. Refer to the User's Manual for descriptions of these wetland types. Note: "Critical habitat" is legally defined in the Endangered Species Act and is the geographic area containing physical or biological features essential to the conservation of a listed species or as an area that may require special management considerations or protection. The Rater should contact the Region 3 Headquarters or the Columbus Ecological Services Office for updates as to whether critical habitat has been designated for other federally listed threatened or endangered species. "Documented" means the wetland is listed in the appropriate State of Ohio database.

#	Question	Circle one	
1	**Critical Habitat.** Is the wetland in a township, section, or subsection of a United States Geological Survey 7.5 minute Quadrangle that has been designated by the U.S. Fish and Wildlife Service as "critical habitat" for any threatened or endangered plant or animal species? Note: as of January 1, 2001, of the federally listed endangered or threatened species which can be found in Ohio, the Indiana Bat has had critical habitat designated (50 CFR 17.95(a)) and the piping plover has had critical habitat proposed (65 FR 41812 July 6, 2000).	YES Wetland should be evaluated for possible Category 3 status Go to Question 2	NO Go to Question 2
2	**Threatened or Endangered Species.** Is the wetland known to contain an individual of, or documented occurrences of federal or state-listed threatened or endangered plant or animal species?	YES Wetland is a Category 3 wetland. Go to Question 3	NO Go to Question 3
3	**Documented High Quality Wetland.** Is the wetland on record in Natural Heritage Database as a high quality wetland?	YES Wetland is a Category 3 wetland Go to Question 4	NO Go to Question 4
4	**Significant Breeding or Concentration Area.** Does the wetland contain documented regionally significant breeding or nonbreeding waterfowl, neotropical songbird, or shorebird concentration areas?	YES Wetland is a Category 3 wetland Go to Question 5	NO Go to Question 5
5	**Category 1 Wetlands.** Is the wetland less than 0.5 hectares (1 acre) in size and **hydrologically isolated** and either 1) comprised of vegetation that is dominated (greater than eighty per cent areal cover) by *Phalaris arundinacea, Lythrum salicaria,* or *Phragmites australis*, or 2) an acidic pond created or excavated on mined lands that has little or no vegetation?	YES Wetland is a Category 1 wetland Go to Question 6	NO Go to Question 6
6	**Bogs.** Is the wetland a peat-accumulating wetland that 1) has no significant inflows or outflows, 2) supports acidophilic mosses, particularly *Sphagnum* spp., 3) the acidophilic mosses have >30% cover, 4) at least one species from Table 1 is present, and 5) the cover of invasive species (see Table 1) is <25%?	YES Wetland is a Category 3 wetland Go to Question 7	NO Go to Question 7
7	**Fens.** Is the wetland a carbon accumulating (peat, muck) wetland that is saturated during most of the year, primarily by a discharge of free flowing, mineral rich, ground water with a circumneutral ph (5.5-9.0) and with one or more plant species listed in Table 1 and the cover of invasive species listed in Table 1 is <25%?	YES Wetland is a Category 3 wetland Go to Question 8a	NO Go to Question 8a
8a	**"Old Growth Forest."** Is the wetland a forested wetland and is the forest characterized by, but not limited to, the following characteristics: overstory canopy trees of great age (exceeding at least 50% of a projected maximum attainable age for a species); little or no evidence of human-caused understory disturbance during the past 80 to 100 years; an all-aged structure and multilayered canopies; aggregations of canopy trees interspersed with canopy gaps; and significant numbers of standing dead snags and downed logs?	YES Wetland is a Category 3 wetland. Go to Question 8b	NO Go to Question 8b

8b	**Mature forested wetlands.** Is the wetland a forested wetland with 50% or more of the cover of upper forest canopy consisting of deciduous trees with large diameters at breast height (dbh), generally diameters greater than 45cm (17.7in) dbh?	YES Wetland should be evaluated for possible Category 3 status. Go to Question 9a	NO Go to Question 9a
9a	**Lake Erie coastal and tributary wetlands.** Is the wetland located at an elevation less than 575 feet on the USGS map, adjacent to this elevation, or along a tributary to Lake Erie that is accessible to fish?	YES Go to Question 9b	NO Go to Question 10
9b	Does the wetland's hydrology result from measures designed to prevent erosion and the loss of aquatic plants, i.e. the wetland is partially hydrologically restricted from Lake Erie due to lakeward or landward dikes or other hydrological controls?	YES Wetland should be evaluated for possible Category 3 status Go to Question 10	NO Go to Question 9c
9c	Are Lake Erie water levels the wetland's primary hydrological influence, i.e. the wetland is hydrologically unrestricted (no lakeward or upland border alterations), or the wetland can be characterized as an "estuarine" wetland with lake and river influenced hydrology. These include sandbar deposition wetlands, estuarine wetlands, river mouth wetlands, or those dominated by submersed aquatic vegetation.	YES Go to Question 9d	NO Go to Question 10
9d	Does the wetland have a predominance of native species within its vegetation communities, although non-native or disturbance tolerant native species can also be present?	YES Wetland is a Category 3 wetland Go to Question 10	NO Go to Question 9e
9e	Does the wetland have a predominance of non-native or disturbance tolerant native plant species within its vegetation communities?	YES Wetland should be evaluated for possible Category 3 status Go to Question 10	NO Go to Question 10
10	**Lake Plain Sand Prairies (Oak Openings)** Is the wetland located in Lucas, Fulton, Henry, or Wood Counties and can the wetland be characterized by the following description: the wetland has a sandy substrate with interspersed organic matter, a water table often within several inches of the surface, and often with a dominance of the gramineous vegetation listed in Table 1 (woody species may also be present). The Ohio Department of Natural Resources Division of Natural Areas and Preserves can provide assistance in confirming this type of wetland and its quality.	YES Wetland is a Category 3 wetland. Go to Question 11	NO Go to Question 11
11	**Relict Wet Prairies.** Is the wetland a relict wet prairie community dominated by some or all of the species in Table 1. Extensive prairies were formerly located in the Darby Plains (Madison and Union Counties), Sandusky Plains (Wyandot, Crawford, and Marion Counties), northwest Ohio (e.g. Erie, Huron, Lucas, Wood Counties), and portions of western Ohio Counties (e.g. Darke, Mercer, Miami, Montgomery, Van Wert etc.).	YES Wetland should be evaluated for possible Category 3 status Complete Quantitative Rating	NO Complete Quantitative Rating

Table 1. Characteristic plant species.

invasive/exotic spp	fen species	bog species	0ak Opening species	wet prairie species
Lythrum salicaria	*Zygadenus elegans var. glaucus*	*Calla palustris*	*Carex cryptolepis*	*Calamagrostis canadensis*
Myriophyllum spicatum	*Cacalia plantaginea*	*Carex atlantica var. capillacea*	*Carex lasiocarpa*	*Calamogrostis stricta*
Najas minor	*Carex flava*	*Carex echinata*	*Carex stricta*	*Carex atherodes*
Phalaris arundinacea	*Carex sterilis*	*Carex oligosperma*	*Cladium mariscoides*	*Carex buxbaumii*
Phragmites australis	*Carex stricta*	*Carex trisperma*	*Calamagrostis stricta*	*Carex pellita*
Potamogeton crispus	*Deschampsia caespitosa*	*Chamaedaphne calyculata*	*Calamagrostis canadensis*	*Carex sartwellii*
Ranunculus ficaria	*Eleocharis rostellata*	*Decodon verticillatus*	*Quercus palustris*	*Gentiana andrewsii*
Rhamnus frangula	*Eriophorum viridicarinatum*	*Eriophorum virginicum*		*Helianthus grosseserratus*
Typha angustifolia	*Gentianopsis spp.*	*Larix laricina*		*Liatris spicata*
Typha xglauca	*Lobelia kalmii*	*Nemopanthus mucronatus*		*Lysimachia quadriflora*
	Parnassia glauca	*Schechzeria palustris*		*Lythrum alatum*
	Potentilla fruticosa	*Sphagnum spp.*		*Pycnanthemum virginianum*
	Rhamnus alnifolia	*Vaccinium macrocarpon*		*Silphium terebinthinaceum*
	Rhynchospora capillacea	*Vaccinium corymbosum*		*Sorghastrum nutans*
	Salix candida	*Vaccinium oxycoccos*		*Spartina pectinata*
	Salix myricoides	*Woodwardia virginica*		*Solidago riddellii*
	Salix serissima	*Xyris difformis*		
	Solidago ohioensis			
	Tofieldia glutinosa			
	Triglochin maritimum			
	Triglochin palustre			

End of Narrative Rating. Begin Quantitative Rating on next page.

Site: Wetland 16	Rater(s): Ruby / Swartz	Date: 9/2/2010

Metric 1. Wetland Area (size).

2	2
max 6 pts.	subtotal

Select one size class and assign score.

- [ ] >50 acres (>20.2ha) (6 pts)
- [ ] 25 to <50 acres (10.1 to <20.2ha) (5 pts)
- [ ] 10 to <25 acres (4 to <10.1ha) (4 pts)
- [ ] 3 to <10 acres (1.2 to <4ha) (3 pts)
- [x] 0.3 to <3 acres (0.12 to <1.2ha) (2pts)
- [ ] 0.1 to <0.3 acres (0.04 to <0.12ha) (1 pt)
- [ ] <0.1 acres (0.04ha) (0 pts)

Metric 2. Upland buffers and surrounding land use.

3	5
max 14 pts.	subtotal

2a. Calculate average buffer width. Select only one and assign score. Do not double check.

- [ ] WIDE. Buffers average 50m (164ft) or more around wetland perimeter (7)
- [ ] MEDIUM. Buffers average 25m to <50m (82 to <164ft) around wetland perimeter (4)
- [x] NARROW. Buffers average 10m to <25m (32ft to <82ft) around wetland perimeter (1)
- [ ] VERY NARROW. Buffers average <10m (<32ft) around wetland perimeter (0)

2b. Intensity of surrounding land use. Select one or double check and average.

- [ ] VERY LOW. 2nd growth or older forest, prairie, savannah, wildlife area, etc. (7)
- [ ] LOW. Old field (>10 years), shrub land, young second growth forest. (5)
- [x] MODERATELY HIGH. Residential, fenced pasture, park, conservation tillage, new fallow field. (3)
- [x] HIGH. Urban, industrial, open pasture, row cropping, mining, construction. (1)

Metric 3. Hydrology.

23.5	28.5
max 30 pts.	subtotal

3a. Sources of Water. Score all that apply.

- [ ] High pH groundwater (5)
- [ ] Other groundwater (3)
- [x] Precipitation (1)
- [x] Seasonal/Intermittent surface water (3)
- [x] Perennial surface water (lake or stream) (5)

3b. Connectivity. Score all that apply.

- [x] 100 year floodplain (1)
- [x] Between stream/lake and other human use (1)
- [ ] Part of wetland/upland (e.g. forest), complex (1)
- [x] Part of riparian or upland corridor (1)

3c. Maximum water depth. Select only one and assign score.

- [x] >0.7 (27.6in) (3)
- [ ] 0.4 to 0.7m (15.7 to 27.6in) (2)
- [ ] <0.4m (<15.7in) (1)

3d. Duration inundation/saturation. Score one or dbl check.

- [x] Semi- to permanently inundated/saturated (4)
- [x] Regularly inundated/saturated (3)
- [ ] Seasonally inundated (2)
- [ ] Seasonally saturated in upper 30cm (12in) (1)

3e. Modifications to natural hydrologic regime. Score one or double check and average.

- [ ] None or none apparent (12)
- [x] Recovered (7)
- [x] Recovering (3)
- [ ] Recent or no recovery (1)

Check all disturbances observed

- [ ] ditch
- [ ] tile
- [ ] dike
- [ ] weir
- [ ] stormwater input
- [ ] point source (nonstormwater)
- [ ] filling/grading
- [x] road bed/RR track
- [ ] dredging
- [ ] other_____

Metric 4. Habitat Alteration and Development.

10.5	39
max 20 pts.	subtotal

4a. Substrate disturbance. Score one or double check and average.

- [ ] None or none apparent (4)
- [x] Recovered (3)
- [ ] Recovering (2)
- [ ] Recent or no recovery (1)

4b. Habitat development. Select only one and assign score.

- [ ] Excellent (7)
- [ ] Very good (6)
- [ ] Good (5)
- [ ] Moderately good (4)
- [x] Fair (3)
- [ ] Poor to fair (2)
- [ ] Poor (1)

4c. Habitat alteration. Score one or double check and average.

- [ ] None or none apparent (9)
- [x] Recovered (6)
- [x] Recovering (3)
- [ ] Recent or no recovery (1)

Check all disturbances observed

- [x] mowing
- [ ] grazing
- [ ] clearcutting
- [x] selective cutting
- [ ] woody debris removal
- [ ] toxic pollutants
- [ ] shrub/sapling removal
- [ ] herbaceous/aquatic bed removal
- [ ] sedimentation
- [ ] dredging
- [ ] farming
- [ ] nutrient enrichment

39
subtotal this page

last revised 1 February 2001 jjm

Site: Wetland 16	Rater(s): Ruby/Swartz	Date: 9/2/2010

39
subtotal first page

0	39
max 10 pts.	subtotal

Metric 5. Special Wetlands.

Check all that apply and score as indicated.

- [ ] Bog (10)
- [ ] Fen (10)
- [ ] Old growth forest (10)
- [ ] Mature forested wetland (5)
- [ ] Lake Erie coastal/tributary wetland-unrestricted hydrology (10)
- [ ] Lake Erie coastal/tributary wetland-restricted hydrology (5)
- [ ] Lake Plain Sand Prairies (Oak Openings) (10)
- [ ] Relict Wet Prairies (10)
- [ ] Known occurrence state/federal threatened or endangered species (10)
- [ ] Significant migratory songbird/water fowl habitat or usage (10)
- [ ] Category 1 Wetland. See Question 1 Qualitative Rating (-10)

13	52
max 20 pts.	subtotal

Metric 6. Plant communities, interspersion, microtopography.

6a. Wetland Vegetation Communities.
Score all present using 0 to 3 scale.

- [1] Aquatic bed
- [2] Emergent
- [2] Shrub
- [1] Forest
- [1] Mudflats
- [0] Open water
- [0] Other_____

6b. horizontal (plan view) Interspersion.
Select only one.

- [ ] High (5)
- [ ] Moderately high(4)
- [X] Moderate (3)
- [ ] Moderately low (2)
- [ ] Low (1)
- [ ] None (0)

6c. Coverage of invasive plants. Refer to Table 1 ORAM long form for list. Add or deduct points for coverage

- [ ] Extensive >75% cover (-5)
- [X] Moderate 25-75% cover (-3)
- [ ] Sparse 5-25% cover (-1)
- [ ] Nearly absent <5% cover (0)
- [ ] Absent (1)

6d. Microtopography.
Score all present using 0 to 3 scale.

- [1] Vegetated hummucks/tussucks
- [2] Coarse woody debris >15cm (6in)
- [2] Standing dead >25cm (10in) dbh
- [1] Amphibian breeding pools

Vegetation Community Cover Scale

0	Absent or comprises <0.1ha (0.2471 acres) contiguous area
1	Present and either comprises small part of wetland's vegetation and is of moderate quality, or comprises a significant part but is of low quality
2	Present and either comprises significant part of wetland's vegetation and is of moderate quality or comprises a small part and is of high quality
3	Present and comprises significant part, or more, of wetland's vegetation and is of high quality

Narrative Description of Vegetation Quality

low	Low spp diversity and/or predominance of nonnative or disturbance tolerant native species
mod	Native spp are dominant component of the vegetation, although nonnative and/or disturbance tolerant native spp can also be present, and species diversity moderate to moderately high, but generally w/o presence of rare threatened or endangered spp
high	A predominance of native species, with nonnative spp and/or disturbance tolerant native spp absent or virtually absent, and high spp diversity and often, but not always, the presence of rare, threatened, or endangered spp

Mudflat and Open Water Class Quality

0	Absent <0.1ha (0.247 acres)
1	Low 0.1 to <1ha (0.247 to 2.47 acres)
2	Moderate 1 to <4ha (2.47 to 9.88 acres)
3	High 4ha (9.88 acres) or more

Microtopography Cover Scale

0	Absent
1	Present very small amounts or if more common of marginal quality
2	Present in moderate amounts, but not of highest quality or in small amounts of highest quality
3	Present in moderate or greater amounts and of highest quality

52

End of Quantitative Rating. Complete Categorization Worksheets.

ORAM Summary Worksheet

		circle answer or insert score	Result
Narrative Rating	Question 1 Critical Habitat	YES NO	If yes, Category 3.
	Question 2. Threatened or Endangered Species	YES NO	If yes, Category 3.
	Question 3. High Quality Natural Wetland	YES NO	If yes, Category 3.
	Question 4. Significant bird habitat	YES NO	If yes, Category 3.
	Question 5. Category 1 Wetlands	YES NO	If yes, Category 1.
	Question 6. Bogs	YES NO	If yes, Category 3.
	Question 7. Fens	YES NO	If yes, Category 3.
	Question 8a. Old Growth Forest	YES NO	If yes, Category 3.
	Question 8b. Mature Forested Wetland	YES NO	If yes, evaluate for Category 3; may also be 1 or 2.
	Question 9b. Lake Erie Wetlands - Restricted	YES NO	If yes, evaluate for Category 3; may also be 1 or 2.
	Question 9d. Lake Erie Wetlands – Unrestricted with native plants	YES NO	If yes, Category 3
	Question 9e. Lake Erie Wetlands - Unrestricted with invasive plants	YES NO	If yes, evaluate for Category 3; may also be 1 or 2.
	Question 10. Oak Openings	YES NO	If yes, Category 3
	Question 11. Relict Wet Prairies	YES NO	If yes, evaluate for Category 3; may also be 1 or 2.
Quantitative Rating	Metric 1. Size	2	
	Metric 2. Buffers and surrounding land use	3	
	Metric 3. Hydrology	23.5	
	Metric 4. Habitat	10.5	
	Metric 5. Special Wetland Communities	0	
	Metric 6. Plant communities, interspersion, microtopography	13	
	TOTAL SCORE	52	Category based on score breakpoints 2

Complete Wetland Categorization Worksheet.

Wetland Categorization Worksheet

Choices	Circle one		Evaluation of Categorization Result of ORAM
Did you answer "Yes" to any of the following questions: Narrative Rating Nos. 2, 3, 4, 6, 7, 8a, 9d, 10	YES Wetland is categorized as a Category 3 wetland	NO	Is quantitative rating score *less* than the Category 2 scoring threshold (*excluding* gray zone)? If yes, reevaluate the category of the wetland using the narrative criteria in OAC Rule 3745-1-54(C) and biological and/or functional assessments to determine if the wetland has been over-categorized by the ORAM
Did you answer "Yes" to any of the following questions: Narrative Rating Nos. 1, 8b, 9b, 9e, 11	YES Wetland should be evaluated for possible Category 3 status	NO	Evaluate the wetland using the 1) narrative criteria in OAC Rule 3745-1-54(C) and 2) the quantitative rating score. If the wetland is determined to be a Category 3 wetland using either of these, it should be categorized as a Category 3 wetland. Detailed biological and/or functional assessments may also be used to determine the wetland's category.
Did you answer "Yes" to Narrative Rating No. 5	YES Wetland is categorized as a Category 1 wetland	NO	Is quantitative rating score *greater* than the Category 2 scoring threshold (*including* any gray zone)? If yes, reevaluate the category of the wetland using the narrative criteria in OAC Rule 3745-1-54(C) and biological and/or functional assessments to determine if the wetland has been under-categorized by the ORAM
Does the quantitative score fall within the scoring range of a Category 1, 2, or 3 wetland?	YES Wetland is assigned to the appropriate category based on the scoring range	NO	If the score of the wetland is located within the scoring range for a particular category, the wetland should be assigned to that category. In all instances however, the narrative criteria described in OAC Rule 3745-1-54(C) can be used to clarify or change a categorization based on a quantitative score.
Does the quantitative score fall with the *"gray zone"* for Category 1 or 2 or Category 2 or 3 wetlands?	YES Wetland is assigned to the higher of the two categories or assigned to a category based on detailed assessments and the narrative criteria	NO	Rater has the option of assigning the wetland to the higher of the two categories or to assign a category based on the results of a nonrapid wetland assessment method, e.g. functional assessment, biological assessment, etc, and a consideration of the narrative criteria in OAC rule 3745-1-54(C).
Does the wetland otherwise exhibit *moderate OR superior* hydrologic OR habitat, OR recreational functions AND the wetland was *not* categorized as a Category 2 wetland (in the case of moderate functions) or a Category 3 wetland (in the case of superior functions) by this method?	YES Wetland was undercategorized by this method. A written justification for recategorization should be provided on Background Information Form	NO Wetland is assigned to category as determined by the ORAM.	A wetland may be undercategorized using this method, but still exhibit one or more superior functions, e.g. a wetland's biotic communities may be degraded by human activities, but the wetland may still exhibit superior hydrologic functions because of its type, landscape position, size, local or regional significance, etc. In this circumstance, the narrative criteria in OAC Rule 3745-1-54(C)(2) and (3) are controlling, and the under-categorization should be corrected. A written justification with supporting reasons or information for this determination should be provided.

Final Category

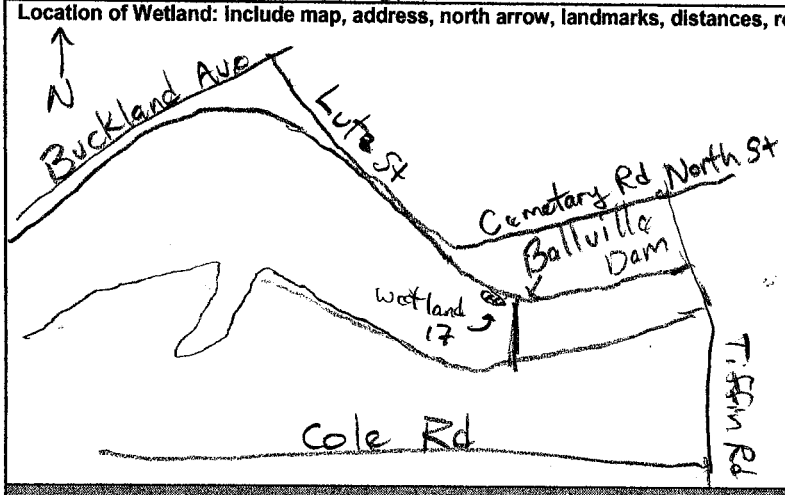
Choose one	Category 1	Category 2	Category 3

End of Ohio Rapid Assessment Method for Wetlands.

Background Information

Name:	Richard Ruby / Brian Swartz
Date:	2 Sep 2010
Affiliation:	USACE - Buffalo District
Address:	1776 Niagara Street, Buffalo, NY 14207
Phone Number:	716-879-4109
e-mail address:	richardj.ruby@usace.army.mil
Name of Wetland:	Wetland 17
Vegetation Communit(ies):	Emergent
HGM Class(es):	Riverine

Location of Wetland: include map, address, north arrow, landmarks, distances, roads, etc.



Small fringe wetland near the upstream side of the Ballville Dam, Ballville Township, Sandusky Co., Ohio

Lat/Long or UTM Coordinate	Lat: 41.32671 Long: -83.13644
USGS Quad Name	Fremont-West, Ohio
County	Sandusky
Township	Ballville
Section and Subsection	NE¼ 9
Hydrologic Unit Code	04100011
Site Visit	2 Sep 2010
National Wetland Inventory Map	NWI Online
Ohio Wetland Inventory Map	
Soil Survey	NRCS Online
Delineation report/map	Yes

Name of Wetland: Wetland 17

Wetland Size (acres, hectares): 0.09 acre

Sketch: Include north arrow, relationship with other surface waters, vegetation zones, etc.

See attached Maps 4, 5, & 5a.

Comments, Narrative Discussion, Justification of Category Changes:

Emergent Fringe Wetland that is dominated by Phalaris arundinacea. The wetland has developed in front of power generation intake on north bank just upstream of Ballville Dam.

Final score : 14.5 **Category:** 1

Scoring Boundary Worksheet

INSTRUCTIONS. The initial step in completing the ORAM is to identify the "scoring boundaries" of the wetland being rated. In many instances this determination will be relatively easy and the scoring boundaries will coincide with the "jurisdictional boundaries." For example, the scoring boundary of an isolated cattail marsh located in the middle of a farm field will likely be the same as that wetland's jurisdictional boundaries. In other instances, however, the scoring boundary will not be as easily determined. Wetlands that are small or isolated from other surface waters often form large contiguous areas or heterogeneous complexes of wetland and upland. In separating wetlands for scoring purposes, the hydrologic regime of the wetland is the main criterion that should be used. Boundaries between contiguous or connected wetlands should be established where the volume, flow, or velocity of water moving through the wetland changes significantly. *Areas with a high degree of hydrologic interaction should be scored as a single wetland.* In determining a wetland's scoring boundaries, use the guidelines in the ORAM Manual Section 5.0. In certain instances, it may be difficult to establish the scoring boundary for the wetland being rated. These problem situations include wetlands that form a patchwork on the landscape, wetlands divided by artificial boundaries like property fences, roads, or railroad embankments, wetlands that are contiguous with streams, lakes, or rivers, and estuarine or coastal wetlands. These situations are discussed below, however, it is recommended that Rater contact Ohio EPA, Division of Surface Water, 401/Wetlands Section if there are additional questions or a need for further clarification of the appropriate scoring boundaries of a particular wetland.

#	Steps in properly establishing scoring boundaries	done?	not applicable
Step 1	Identify the wetland area of interest. This may be the site of a proposed impact, a reference site, conservation site, etc.	X	
Step 2	Identify the locations where there is physical evidence that hydrology changes rapidly. Such evidence includes both natural and human-induced changes including, constrictions caused by berms or dikes, points where the water velocity changes rapidly at rapids or falls, points where significant inflows occur at the confluence of rivers, or other factors that may restrict hydrologic interaction between the wetlands or parts of a single wetland.	X	
Step 3	Delineate the boundary of the wetland to be rated such that all areas of interest that are contiguous to and within the areas where the hydrology does not change significantly, i.e. areas that have a high degree of hydrologic interaction are included within the scoring boundary.	X	
Step 4	Determine if artificial boundaries, such as property lines, state lines, roads, railroad embankments, etc., are present. These should not be used to establish scoring boundaries unless they coincide with areas where the hydrologic regime changes.	X	
Step 5	In all instances, the Rater may enlarge the minimum scoring boundaries discussed here to score together wetlands that could be scored separately.	X	
Step 6	Consult ORAM Manual Section 5.0 for how to establish scoring boundaries for wetlands that form a patchwork on the landscape, divided by artificial boundaries, contiguous to streams, lakes or rivers, or for dual classifications.	X	

End of Scoring Boundary Determination. Begin Narrative Rating on next page.

Narrative Rating

INSTRUCTIONS. Answer each of the following questions. Questions 1, 2, 3 and 4 should be answered based on information obtained from the site visit or the literature *and* by submitting a Data Services Request to the Ohio Department of Natural Resources, Division of Natural Areas and Preserves, Natural Heritage Data Services, 1889 Fountain Square Court, Building F-1, Columbus, Ohio 43224, 614-265-6453 (phone), 614-265-3096 (fax), http://www.dnr.state.oh.us/dnap. The remaining questions are designed to be answered primarily by the results of the site visit. Refer to the User's Manual for descriptions of these wetland types. Note: "Critical habitat" is legally defined in the Endangered Species Act and is the geographic area containing physical or biological features essential to the conservation of a listed species or as an area that may require special management considerations or protection. The Rater should contact the Region 3 Headquarters or the Columbus Ecological Services Office for updates as to whether critical habitat has been designated for other federally listed threatened or endangered species. "Documented" means the wetland is listed in the appropriate State of Ohio database.

#	Question	Circle one	
1	**Critical Habitat.** Is the wetland in a township, section, or subsection of a United States Geological Survey 7.5 minute Quadrangle that has been designated by the U.S. Fish and Wildlife Service as "critical habitat" for any threatened or endangered plant or animal species? Note: as of January 1, 2001, of the federally listed endangered or threatened species which can be found in Ohio, the Indiana Bat has had critical habitat designated (50 CFR 17.95(a)) and the piping plover has had critical habitat proposed (65 FR 41812 July 6, 2000).	YES Wetland should be evaluated for possible Category 3 status Go to Question 2	NO Go to Question 2
2	**Threatened or Endangered Species.** Is the wetland known to contain an individual of, or documented occurrences of federal or state-listed threatened or endangered plant or animal species?	YES Wetland is a Category 3 wetland. Go to Question 3	NO Go to Question 3
3	**Documented High Quality Wetland.** Is the wetland on record in Natural Heritage Database as a high quality wetland?	YES Wetland is a Category 3 wetland Go to Question 4	NO Go to Question 4
4	**Significant Breeding or Concentration Area.** Does the wetland contain documented regionally significant breeding or nonbreeding waterfowl, neotropical songbird, or shorebird concentration areas?	YES Wetland is a Category 3 wetland Go to Question 5	NO Go to Question 5
5	**Category 1 Wetlands.** Is the wetland less than 0.5 hectares (1 acre) in size and **hydrologically isolated** and either 1) comprised of vegetation that is dominated (greater than eighty per cent areal cover) by *Phalaris arundinacea, Lythrum salicaria,* or *Phragmites australis*, or 2) an acidic pond created or excavated on mined lands that has little or no vegetation?	YES Wetland is a Category 1 wetland Go to Question 6	NO Go to Question 6
6	**Bogs.** Is the wetland a peat-accumulating wetland that 1) has no significant inflows or outflows, 2) supports acidophilic mosses, particularly *Sphagnum* spp., 3) the acidophilic mosses have >30% cover, 4) at least one species from Table 1 is present, and 5) the cover of invasive species (see Table 1) is <25%?	YES Wetland is a Category 3 wetland Go to Question 7	NO Go to Question 7
7	**Fens.** Is the wetland a carbon accumulating (peat, muck) wetland that is saturated during most of the year, primarily by a discharge of free flowing, mineral rich, ground water with a circumneutral ph (5.5-9.0) and with one or more plant species listed in Table 1 and the cover of invasive species listed in Table 1 is <25%?	YES Wetland is a Category 3 wetland Go to Question 8a	NO Go to Question 8a
8a	**"Old Growth Forest."** Is the wetland a forested wetland and is the forest characterized by, but not limited to, the following characteristics: overstory canopy trees of great age (exceeding at least 50% of a projected maximum attainable age for a species); little or no evidence of human-caused understory disturbance during the past 80 to 100 years; an all-aged structure and multilayered canopies; aggregations of canopy trees interspersed with canopy gaps; and significant numbers of standing dead snags and downed logs?	YES Wetland is a Category 3 wetland. Go to Question 8b	NO Go to Question 8b

8b	**Mature forested wetlands.** Is the wetland a forested wetland with 50% or more of the cover of upper forest canopy consisting of deciduous trees with large diameters at breast height (dbh), generally diameters greater than 45cm (17.7in) dbh?	YES Wetland should be evaluated for possible Category 3 status. Go to Question 9a	NO Go to Question 9a
9a	**Lake Erie coastal and tributary wetlands.** Is the wetland located at an elevation less than 575 feet on the USGS map, adjacent to this elevation, or along a tributary to Lake Erie that is accessible to fish?	YES Go to Question 9b	NO Go to Question 10
9b	Does the wetland's hydrology result from measures designed to prevent erosion and the loss of aquatic plants, i.e. the wetland is partially hydrologically restricted from Lake Erie due to lakeward or landward dikes or other hydrological controls?	YES Wetland should be evaluated for possible Category 3 status Go to Question 10	NO Go to Question 9c
9c	Are Lake Erie water levels the wetland's primary hydrological influence, i.e. the wetland is hydrologically unrestricted (no lakeward or upland border alterations), or the wetland can be characterized as an "estuarine" wetland with lake and river influenced hydrology. These include sandbar deposition wetlands, estuarine wetlands, river mouth wetlands, or those dominated by submersed aquatic vegetation.	YES Go to Question 9d	NO Go to Question 10
9d	Does the wetland have a predominance of native species within its vegetation communities, although non-native or disturbance tolerant native species can also be present?	YES Wetland is a Category 3 wetland Go to Question 10	NO Go to Question 9e
9e	Does the wetland have a predominance of non-native or disturbance tolerant native plant species within its vegetation communities?	YES Wetland should be evaluated for possible Category 3 status Go to Question 10	NO Go to Question 10
10	**Lake Plain Sand Prairies (Oak Openings)** Is the wetland located in Lucas, Fulton, Henry, or Wood Counties and can the wetland be characterized by the following description: the wetland has a sandy substrate with interspersed organic matter, a water table often within several inches of the surface, and often with a dominance of the gramineous vegetation listed in Table 1 (woody species may also be present). The Ohio Department of Natural Resources Division of Natural Areas and Preserves can provide assistance in confirming this type of wetland and its quality.	YES Wetland is a Category 3 wetland. Go to Question 11	NO Go to Question 11
11	**Relict Wet Prairies.** Is the wetland a relict wet prairie community dominated by some or all of the species in Table 1. Extensive prairies were formerly located in the Darby Plains (Madison and Union Counties), Sandusky Plains (Wyandot, Crawford, and Marion Counties), northwest Ohio (e.g. Erie, Huron, Lucas, Wood Counties), and portions of western Ohio Counties (e.g. Darke, Mercer, Miami, Montgomery, Van Wert etc.).	YES Wetland should be evaluated for possible Category 3 status Complete Quantitative Rating	NO Complete Quantitative Rating

Table 1. Characteristic plant species.

invasive/exotic spp	fen species	bog species	0ak Opening species	wet prairie species
Lythrum salicaria	*Zygadenus elegans var. glaucus*	*Calla palustris*	*Carex cryptolepis*	*Calamagrostis canadensis*
Myriophyllum spicatum	*Cacalia plantaginea*	*Carex atlantica var. capillacea*	*Carex lasiocarpa*	*Calamogrostis stricta*
Najas minor	*Carex flava*	*Carex echinata*	*Carex stricta*	*Carex atherodes*
Phalaris arundinacea	*Carex sterilis*	*Carex oligosperma*	*Cladium mariscoides*	*Carex buxbaumii*
Phragmites australis	*Carex stricta*	*Carex trisperma*	*Calamagrostis stricta*	*Carex pellita*
Potamogeton crispus	*Deschampsia caespitosa*	*Chamaedaphne calyculata*	*Calamagrostis canadensis*	*Carex sartwellii*
Ranunculus ficaria	*Eleocharis rostellata*	*Decodon verticillatus*	*Quercus palustris*	*Gentiana andrewsii*
Rhamnus frangula	*Eriophorum viridicarinatum*	*Eriophorum virginicum*		*Helianthus grosseserratus*
Typha angustifolia	*Gentianopsis spp.*	*Larix laricina*		*Liatris spicata*
Typha xglauca	*Lobelia kalmii*	*Nemopanthus mucronatus*		*Lysimachia quadriflora*
	Parnassia glauca	*Schechzeria palustris*		*Lythrum alatum*
	Potentilla fruticosa	*Sphagnum spp.*		*Pycnanthemum virginianum*
	Rhamnus alnifolia	*Vaccinium macrocarpon*		*Silphium terebinthinaceum*
	Rhynchospora capillacea	*Vaccinium corymbosum*		*Sorghastrum nutans*
	Salix candida	*Vaccinium oxycoccos*		*Spartina pectinata*
	Salix myricoides	*Woodwardia virginica*		*Solidago riddellii*
	Salix serissima	*Xyris difformis*		
	Solidago ohioensis			
	Tofieldia glutinosa			
	Triglochin maritimum			
	Triglochin palustre			

End of Narrative Rating. Begin Quantitative Rating on next page.

Site: Wetland 17	Rater(s): Ruby/Swartz	Date: 9/2/2010

Metric 1. Wetland Area (size).

max 6 pts.	subtotal
0	0

Select one size class and assign score.

- [ ] >50 acres (>20.2ha) (6 pts)
- [ ] 25 to <50 acres (10.1 to <20.2ha) (5 pts)
- [ ] 10 to <25 acres (4 to <10.1ha) (4 pts)
- [ ] 3 to <10 acres (1.2 to <4ha) (3 pts)
- [ ] 0.3 to <3 acres (0.12 to <1.2ha) (2pts)
- [ ] 0.1 to <0.3 acres (0.04 to <0.12ha) (1 pt)
- [ ] <0.1 acres (0.04ha) (0 pts)

Metric 2. Upland buffers and surrounding land use.

max 14 pts.	subtotal
1	1

2a. Calculate average buffer width. Select only one and assign score. Do not double check.

- [ ] WIDE. Buffers average 50m (164ft) or more around wetland perimeter (7)
- [ ] MEDIUM. Buffers average 25m to <50m (82 to <164ft) around wetland perimeter (4)
- [ ] NARROW. Buffers average 10m to <25m (32ft to <82ft) around wetland perimeter (1)
- [x] VERY NARROW. Buffers average <10m (<32ft) around wetland perimeter (0)

2b. Intensity of surrounding land use. Select one or double check and average.

- [ ] VERY LOW. 2nd growth or older forest, prairie, savannah, wildlife area, etc. (7)
- [ ] LOW. Old field (>10 years), shrub land, young second growth forest. (5)
- [ ] MODERATELY HIGH. Residential, fenced pasture, park, conservation tillage, new fallow field. (3)
- [x] HIGH. Urban, industrial, open pasture, row cropping, mining, construction. (1)

Metric 3. Hydrology.

max 30 pts.	subtotal
20.5	21.5

3a. Sources of Water. Score all that apply.

- [ ] High pH groundwater (5)
- [ ] Other groundwater (3)
- [x] Precipitation (1)
- [x] Seasonal/Intermittent surface water (3)
- [x] Perennial surface water (lake or stream) (5)

3b. Connectivity. Score all that apply.

- [x] 100 year floodplain (1)
- [x] Between stream/lake and other human use (1)
- [ ] Part of wetland/upland (e.g. forest), complex (1)
- [ ] Part of riparian or upland corridor (1)

3c. Maximum water depth. Select only one and assign score.

- [x] >0.7 (27.6in) (3)
- [ ] 0.4 to 0.7m (15.7 to 27.6in) (2)
- [ ] <0.4m (<15.7in) (1)

3d. Duration inundation/saturation. Score one or dbl check.

- [x] Semi- to permanently inundated/saturated (4)
- [x] Regularly inundated/saturated (3)
- [ ] Seasonally inundated (2)
- [ ] Seasonally saturated in upper 30cm (12in) (1)

3e. Modifications to natural hydrologic regime. Score one or double check and average.

- [ ] None or none apparent (12)
- [ ] Recovered (7)
- [x] Recovering (3)
- [ ] Recent or no recovery (1)

Check all disturbances observed

- [ ] ditch
- [ ] tile
- [ ] dike
- [ ] weir
- [ ] stormwater input
- [ ] point source (nonstormwater)
- [ ] filling/grading
- [ ] road bed/RR track
- [ ] dredging
- [ ] other_____

Metric 4. Habitat Alteration and Development.

max 20 pts.	subtotal
6	27.5

4a. Substrate disturbance. Score one or double check and average.

- [ ] None or none apparent (4)
- [ ] Recovered (3)
- [x] Recovering (2)
- [ ] Recent or no recovery (1)

4b. Habitat development. Select only one and assign score.

- [ ] Excellent (7)
- [ ] Very good (6)
- [ ] Good (5)
- [ ] Moderately good (4)
- [ ] Fair (3)
- [ ] Poor to fair (2)
- [x] Poor (1)

4c. Habitat alteration. Score one or double check and average.

- [ ] None or none apparent (9)
- [ ] Recovered (6)
- [x] Recovering (3)
- [ ] Recent or no recovery (1)

Check all disturbances observed

- [ ] mowing
- [ ] grazing
- [ ] clearcutting
- [ ] selective cutting
- [ ] woody debris removal
- [ ] toxic pollutants
- [ ] shrub/sapling removal
- [ ] herbaceous/aquatic bed removal
- [ ] sedimentation
- [ ] dredging
- [ ] farming
- [ ] nutrient enrichment

27.5
subtotal this page

last revised 1 February 2001 jjm

Site: Wetland 17	Rater(s): Ruby / Swartz	Date: 9/2/2010

27.5
subtotal first page

Metric 5. Special Wetlands.

-10	17.5
max 10 pts.	subtotal

Check all that apply and score as indicated.

- [ ] Bog (10)
- [ ] Fen (10)
- [ ] Old growth forest (10)
- [ ] Mature forested wetland (5)
- [ ] Lake Erie coastal/tributary wetland-unrestricted hydrology (10)
- [ ] Lake Erie coastal/tributary wetland-restricted hydrology (5)
- [ ] Lake Plain Sand Prairies (Oak Openings) (10)
- [ ] Relict Wet Prairies (10)
- [ ] Known occurrence state/federal threatened or endangered species (10)
- [ ] Significant migratory songbird/water fowl habitat or usage (10)
- [x] Category 1 Wetland. See Question 1 Qualitative Rating (-10)

Metric 6. Plant communities, interspersion, microtopography.

-3	14.5
max 20 pts.	subtotal

6a. Wetland Vegetation Communities.
Score all present using 0 to 3 scale.

- [0] Aquatic bed
- [1] Emergent
- [0] Shrub
- [0] Forest
- [0] Mudflats
- [0] Open water
- [0] Other_____

6b. horizontal (plan view) Interspersion.
Select only one.

- [ ] High (5)
- [ ] Moderately high(4)
- [ ] Moderate (3)
- [ ] Moderately low (2)
- [ ] Low (1)
- [x] None (0)

6c. Coverage of invasive plants. Refer to Table 1 ORAM long form for list. Add or deduct points for coverage

- [x] Extensive >75% cover (-5)
- [ ] Moderate 25-75% cover (-3)
- [ ] Sparse 5-25% cover (-1)
- [ ] Nearly absent <5% cover (0)
- [ ] Absent (1)

6d. Microtopography.
Score all present using 0 to 3 scale.

- [1] Vegetated hummucks/tussucks
- [0] Coarse woody debris >15cm (6in)
- [0] Standing dead >25cm (10in) dbh
- [0] Amphibian breeding pools

Vegetation Community Cover Scale

0	Absent or comprises <0.1ha (0.2471 acres) contiguous area
1	Present and either comprises small part of wetland's vegetation and is of moderate quality, or comprises a significant part but is of low quality
2	Present and either comprises significant part of wetland's vegetation and is of moderate quality or comprises a small part and is of high quality
3	Present and comprises significant part, or more, of wetland's vegetation and is of high quality

Narrative Description of Vegetation Quality

low	Low spp diversity and/or predominance of nonnative or disturbance tolerant native species
mod	Native spp are dominant component of the vegetation, although nonnative and/or disturbance tolerant native spp can also be present, and species diversity moderate to moderately high, but generally w/o presence of rare threatened or endangered spp
high	A predominance of native species, with nonnative spp and/or disturbance tolerant native spp absent or virtually absent, and high spp diversity and often, but not always, the presence of rare, threatened, or endangered spp

Mudflat and Open Water Class Quality

0	Absent <0.1ha (0.247 acres)
1	Low 0.1 to <1ha (0.247 to 2.47 acres)
2	Moderate 1 to <4ha (2.47 to 9.88 acres)
3	High 4ha (9.88 acres) or more

Microtopography Cover Scale

0	Absent
1	Present very small amounts or if more common of marginal quality
2	Present in moderate amounts, but not of highest quality or in small amounts of highest quality
3	Present in moderate or greater amounts and of highest quality

14.5

End of Quantitative Rating. Complete Categorization Worksheets.

ORAM Summary Worksheet

		circle answer or insert score	Result
Narrative Rating	Question 1 Critical Habitat	YES NO	If yes, Category 3.
	Question 2. Threatened or Endangered Species	YES NO	If yes, Category 3.
	Question 3. High Quality Natural Wetland	YES NO	If yes, Category 3.
	Question 4. Significant bird habitat	YES NO	If yes, Category 3.
	Question 5. Category 1 Wetlands	YES NO	If yes, Category 1.
	Question 6. Bogs	YES NO	If yes, Category 3.
	Question 7. Fens	YES NO	If yes, Category 3.
	Question 8a. Old Growth Forest	YES NO	If yes, Category 3.
	Question 8b. Mature Forested Wetland	YES NO	If yes, evaluate for Category 3; may also be 1 or 2.
	Question 9b. Lake Erie Wetlands - Restricted	YES NO	If yes, evaluate for Category 3; may also be 1 or 2.
	Question 9d. Lake Erie Wetlands – Unrestricted with native plants	YES NO	If yes, Category 3
	Question 9e. Lake Erie Wetlands - Unrestricted with invasive plants	YES NO	If yes, evaluate for Category 3; may also be 1 or 2.
	Question 10. Oak Openings	YES NO	If yes, Category 3
	Question 11. Relict Wet Prairies	YES NO	If yes, evaluate for Category 3; may also be 1 or 2.
Quantitative Rating	Metric 1. Size	0	
	Metric 2. Buffers and surrounding land use	1	
	Metric 3. Hydrology	20.5	
	Metric 4. Habitat	6	
	Metric 5. Special Wetland Communities	10	
	Metric 6. Plant communities, interspersion, microtopography	3	
	TOTAL SCORE	14.5	Category based on score breakpoints 1

Complete Wetland Categorization Worksheet.

Wetland Categorization Worksheet

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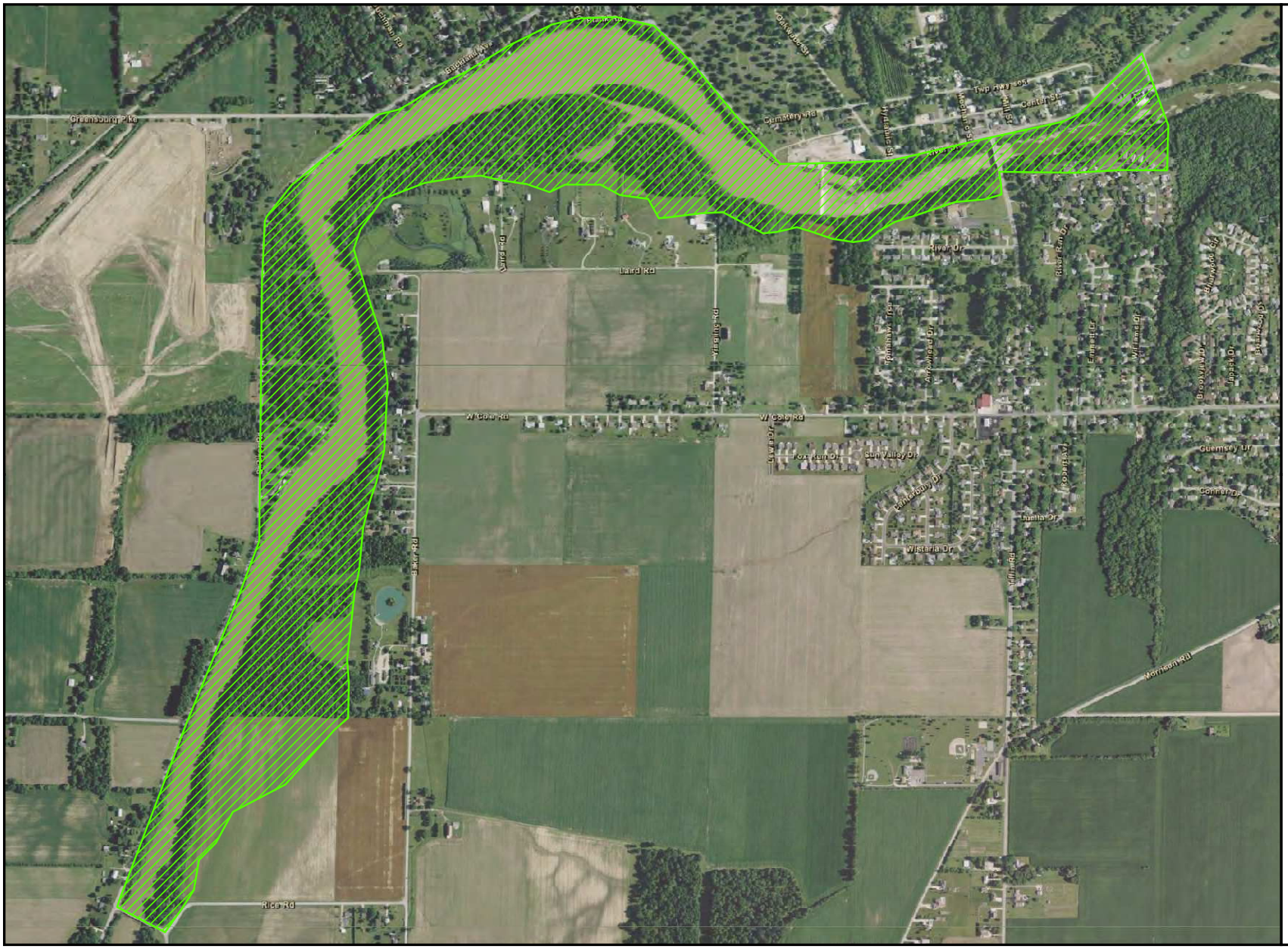
Did you answer "Yes" to any of the following questions: Narrative Rating Nos. 1, 8b, 9b, 9e, 11	YES Wetland should be evaluated for possible Category 3 status	NO	Evaluate the wetland using the 1) narrative criteria in OAC Rule 3745-1-54(C) and 2) the quantitative rating score. If the wetland is determined to be a Category 3 wetland using either of these, it should be categorized as a Category 3 wetland. Detailed biological and/or functional assessments may also be used to determine the wetland's category.
Did you answer "Yes" to Narrative Rating No. 5	YES Wetland is categorized as a Category 1 wetland	NO	Is quantitative rating score *greater* than the Category 2 scoring threshold (*including* any gray zone)? If yes, reevaluate the category of the wetland using the narrative criteria in OAC Rule 3745-1-54(C) and biological and/or functional assessments to determine if the wetland has been under-categorized by the ORAM
Does the quantitative score fall within the scoring range of a Category 1, 2, or 3 wetland?	YES Wetland is assigned to the appropriate category based on the scoring range	NO	If the score of the wetland is located within the scoring range for a particular category, the wetland should be assigned to that category. In all instances however, the narrative criteria described in OAC Rule 3745-1-54(C) can be used to clarify or change a categorization based on a quantitative score.
Does the quantitative score fall with the *"gray zone"* for Category 1 or 2 or Category 2 or 3 wetlands?	YES Wetland is assigned to the higher of the two categories or assigned to a category based on detailed assessments and the narrative criteria	NO	Rater has the option of assigning the wetland to the higher of the two categories or to assign a category based on the results of a nonrapid wetland assessment method, e.g. functional assessment, biological assessment, etc, and a consideration of the narrative criteria in OAC rule 3745-1-54(C).
Does the wetland otherwise exhibit *moderate OR superior* hydrologic OR habitat, OR recreational functions AND the wetland was *not* categorized as a Category 2 wetland (in the case of moderate functions) or a Category 3 wetland (in the case of superior functions) by this method?	YES Wetland was undercategorized by this method. A written justification for recategorization should be provided on Background Information Form	NO Wetland is assigned to category as determined by the ORAM.	A wetland may be undercategorized using this method, but still exhibit one or more superior functions, e.g. a wetland's biotic communities may be degraded by human activities, but the wetland may still exhibit superior hydrologic functions because of its type, landscape position, size, local or regional significance, etc. In this circumstance, the narrative criteria in OAC Rule 3745-1-54(C)(2) and (3) are controlling, and the under-categorization should be corrected. A written justification with supporting reasons or information for this determination should be provided.

Final Category

Choose one	Category 1	Category 2	Category 3

End of Ohio Rapid Assessment Method for Wetlands.



Ballville Dam Removal Project

Wetland Delineation

Aerial Photo

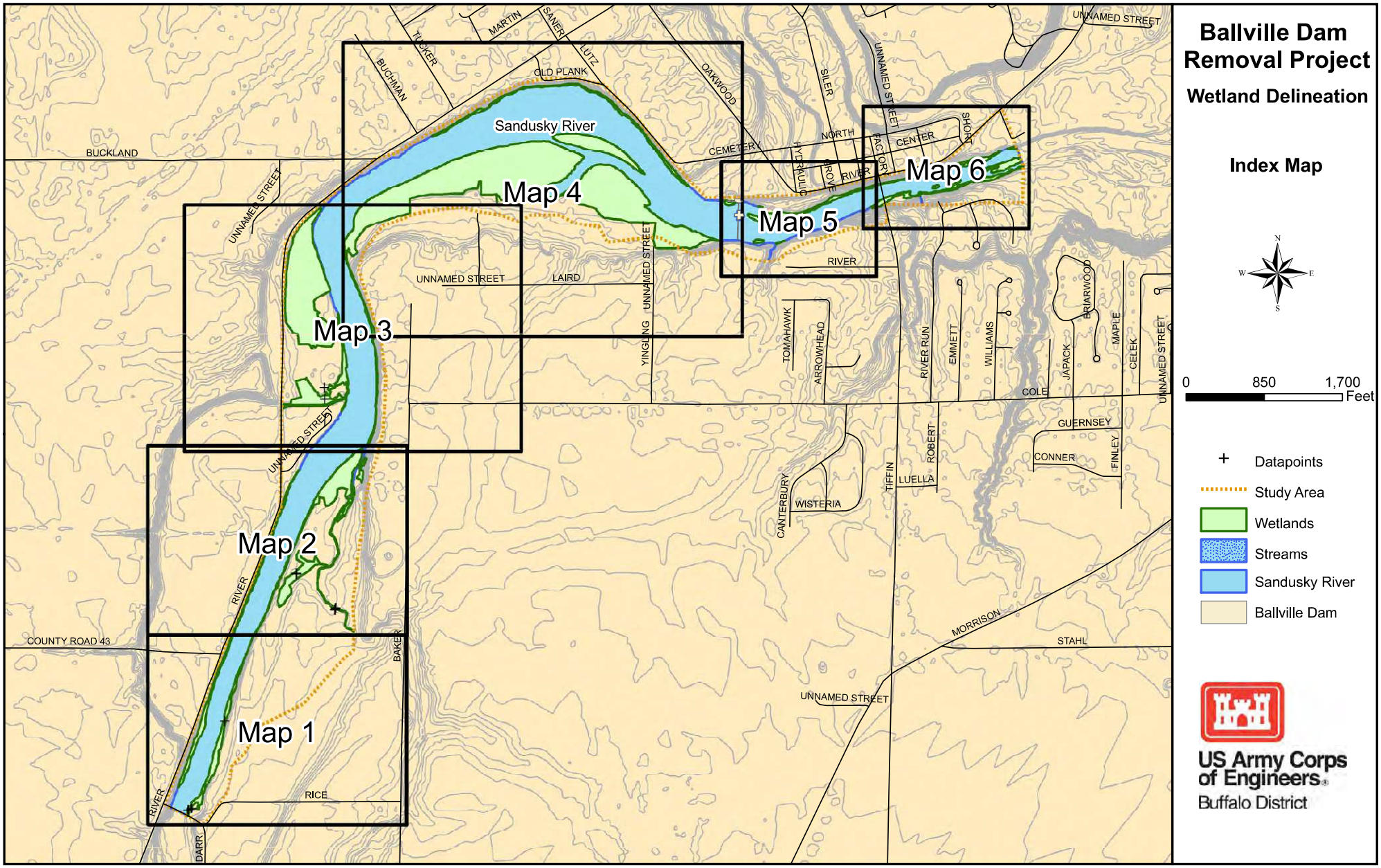
N
W E
S

0 670 1,340 Feet

Study Area

US Army Corps of Engineers®
Buffalo District

NOT TO SCALE


Ballville Dam Removal Project
Wetland Delineation
Index Map
Map 1
Map 2
Map 3
Map 4
Map 5
Map 6
Sandusky River
BUCKLAND
UNNAMED STREET
OLD PLANK
TUCKER
MARTIN
SAUER
LUTZ
BUCHMAN
OAKWOOD
CEMETERY
SILER
NORTH
CENTER
SHORT
FACTORY
HYDRAULIC
BROWN
RIVER
LAIRD
YINGLING
TOMAHAWK
ARROWHEAD
RIVER RUN
EMMETT
WILLIAMS
BRIARWOOD
MAPLE
CELEK
JAPACK
COLE
GUERNSEY
CONNER
FINLEY
ROBERT
TIFFIN
LUELLA
WISTERIA
CANTERBURY
MORRISON
STAHL
COUNTY ROAD 43
BAKER
RICE
DARR
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850
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Feet
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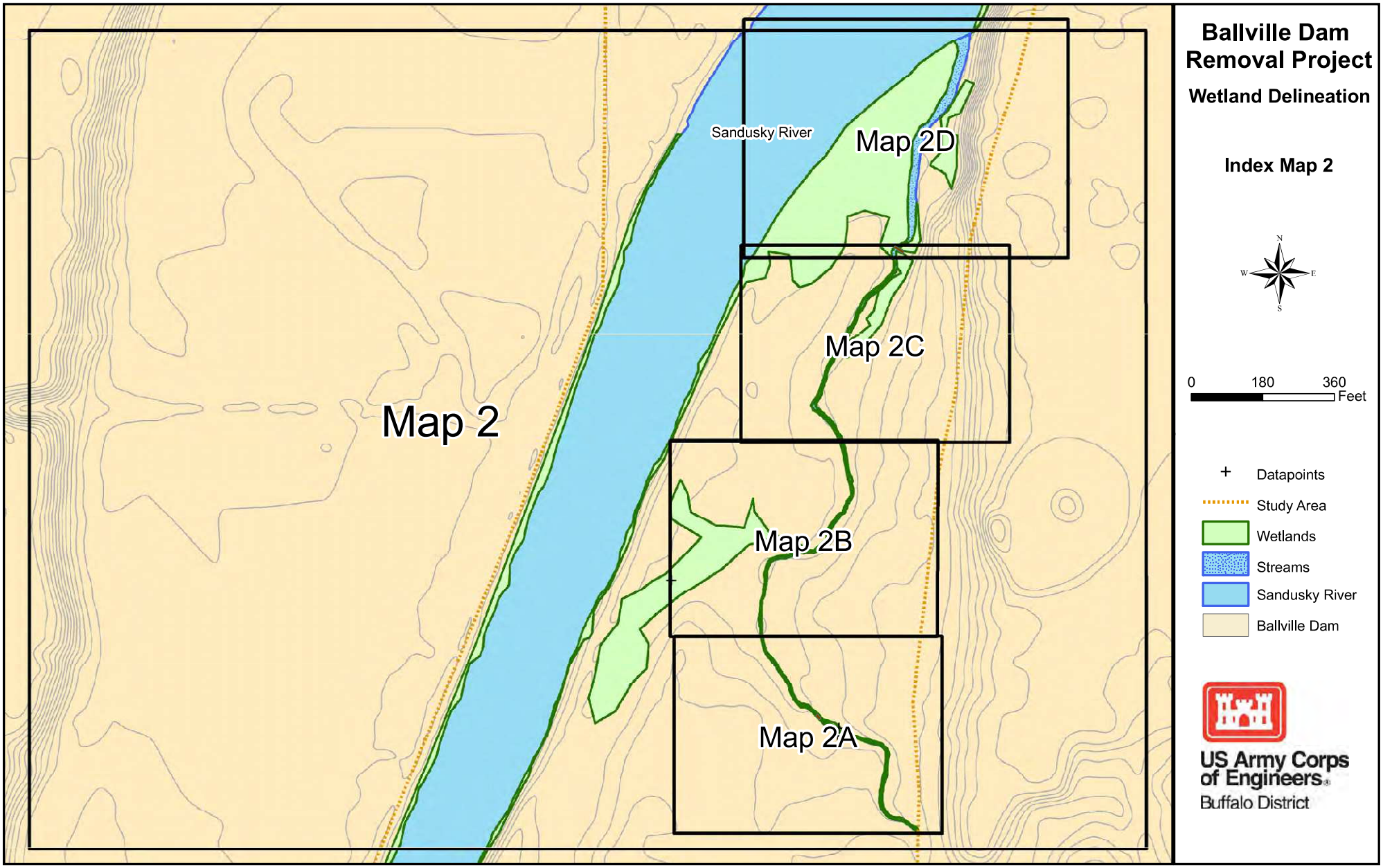
Datapoints
Study Area
Wetlands
Streams
Sandusky River
Ballville Dam
US Army Corps of Engineers
Buffalo District

NOT TO SCALE


Ballville Dam Removal Project
Wetland Delineation
Index Map 2
Sandusky River
Map 2D
Map 2C
Map 2
Map 2B
Map 2A
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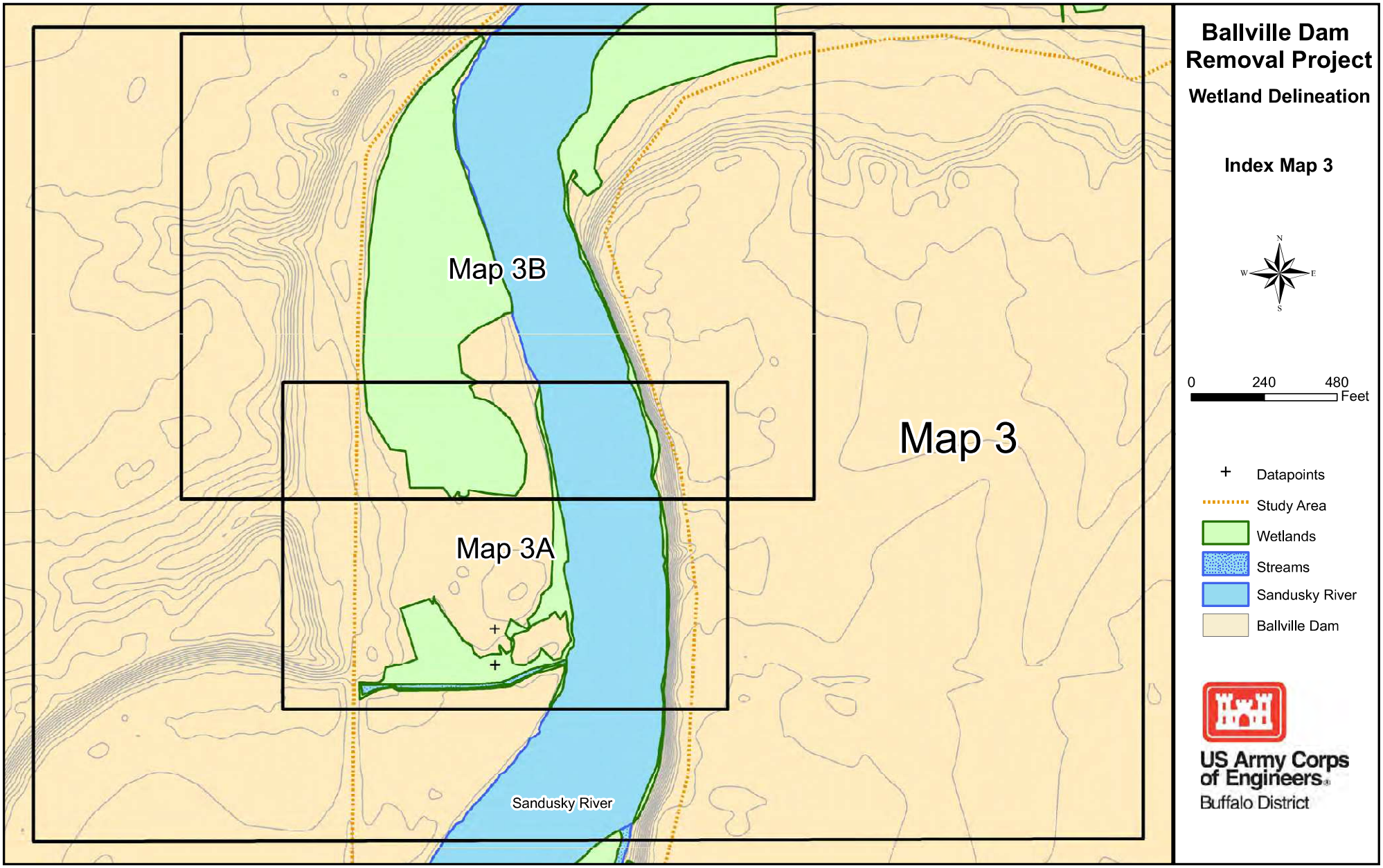
Study Area
Wetlands
Streams
Sandusky River
Ballville Dam
US Army Corps of Engineers
Buffalo District

NOT TO SCALE


Map 3B
Map 3A
Map 3
Sandusky River
Ballville Dam Removal Project
Wetland Delineation
Index Map 3
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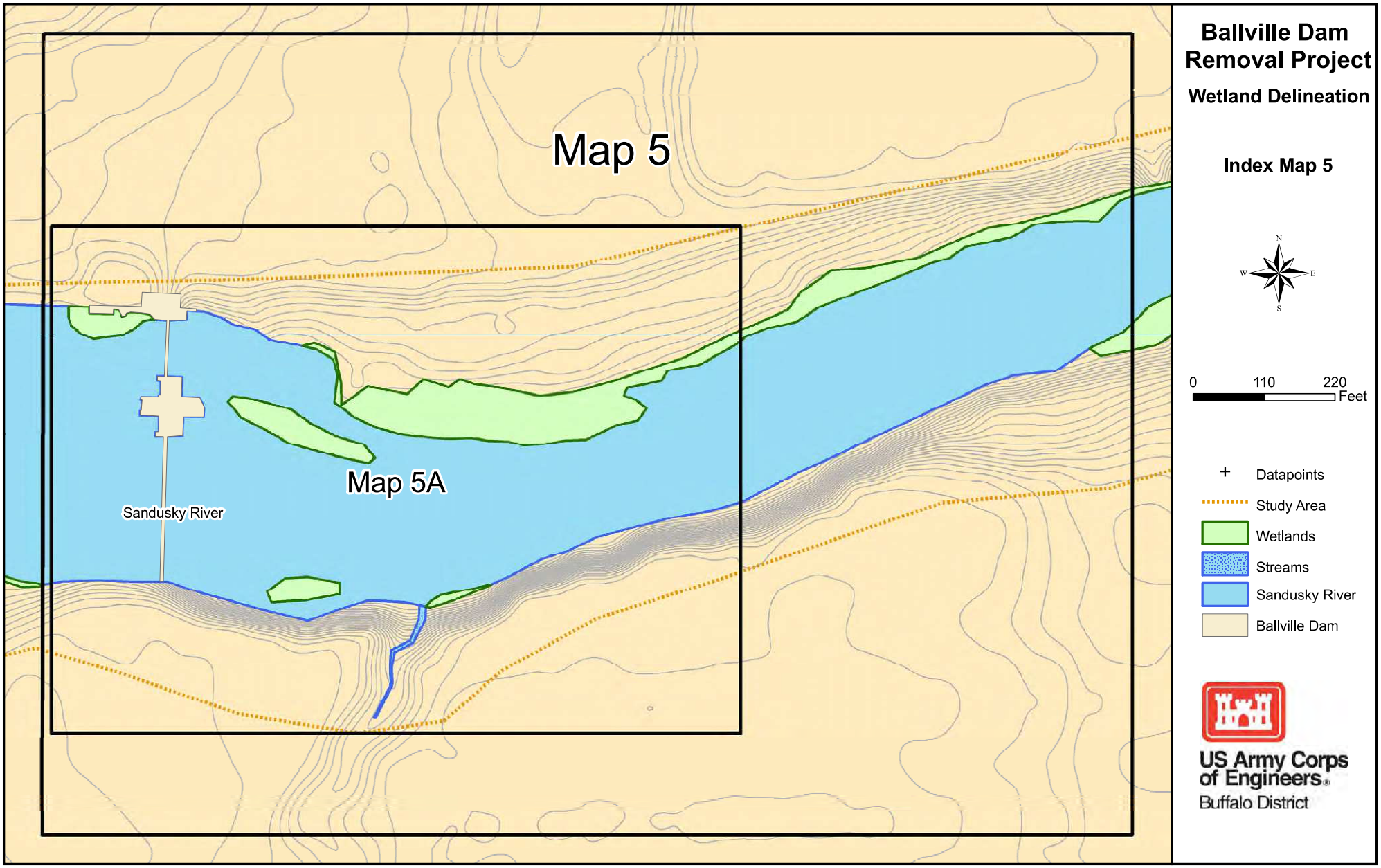
Feet
Datapoints
Study Area
Wetlands
Streams
Sandusky River
Ballville Dam
US Army Corps of Engineers
Buffalo District

NOT TO SCALE


Map 5
Map 5A
Sandusky River
Ballville Dam Removal Project
Wetland Delineation
Index Map 5
N
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Feet
Datapoints
Study Area
Wetlands
Streams
Sandusky River
Ballville Dam
US Army Corps of Engineers
Buffalo District

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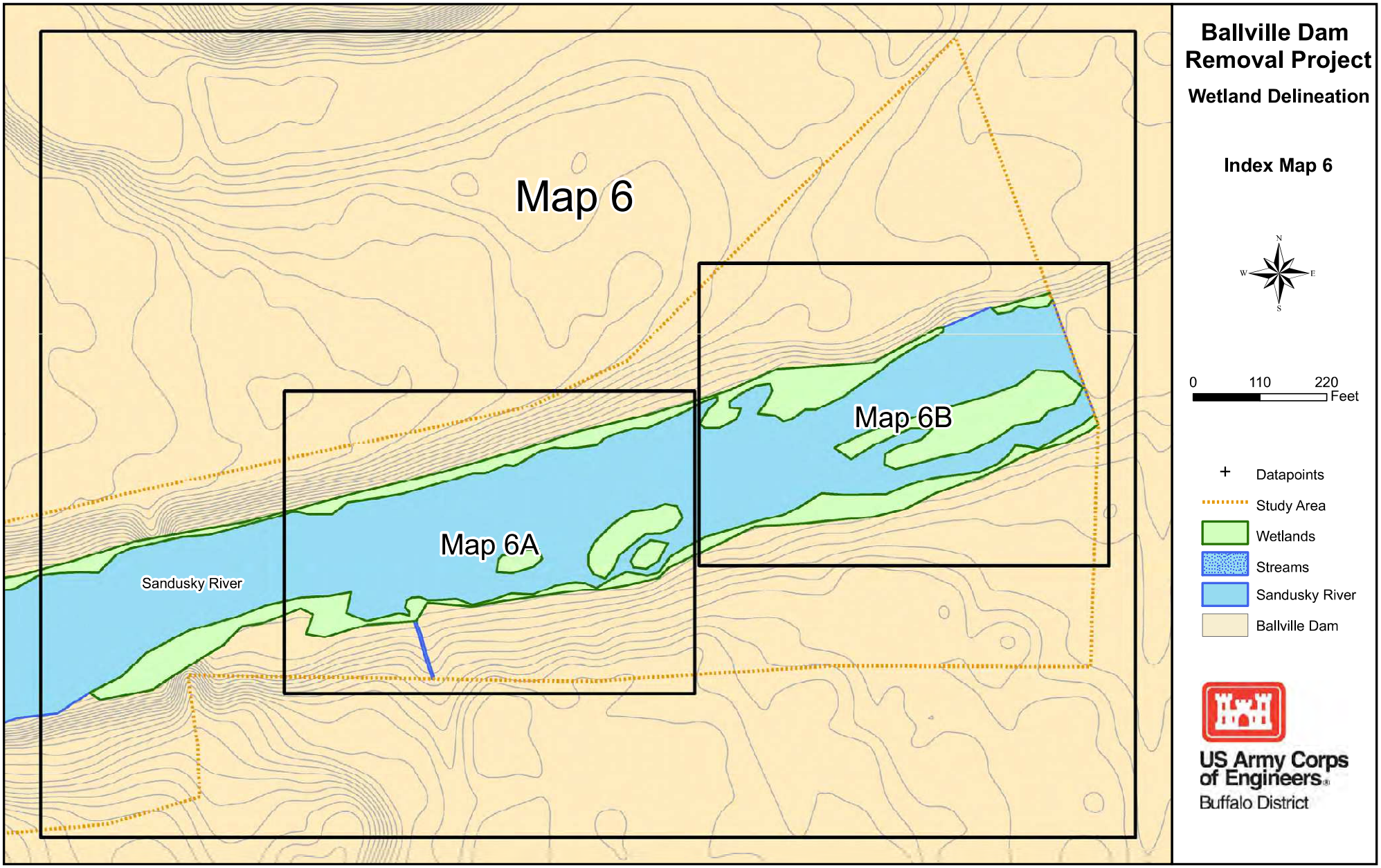
Map 6
Map 6A
Map 6B
Sandusky River
Ballville Dam Removal Project
Wetland Delineation
Index Map 6
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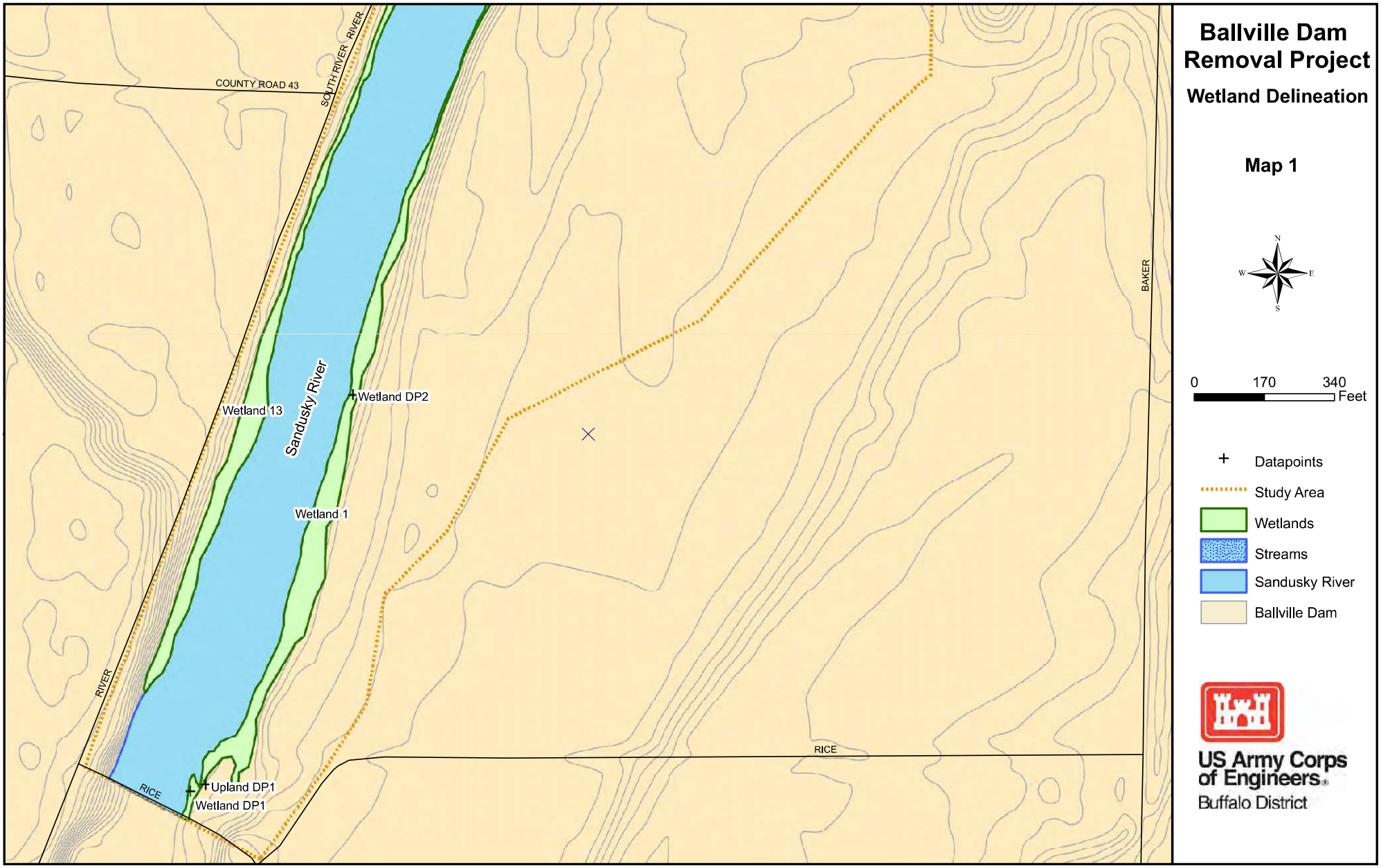
Datapoints
Study Area
Wetlands
Streams
Sandusky River
Ballville Dam
US Army Corps of Engineers
Buffalo District

NOT TO SCALE


COUNTY ROAD 43
SOUTH RIVER RIVER
Sandusky River
Wetland 13
Wetland DP2
Wetland 1
RIVER
RICE
Upland DP1
Wetland DP1
RICE
BAKER
Ballville Dam Removal Project
Wetland Delineation
Map 1
N
W
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170
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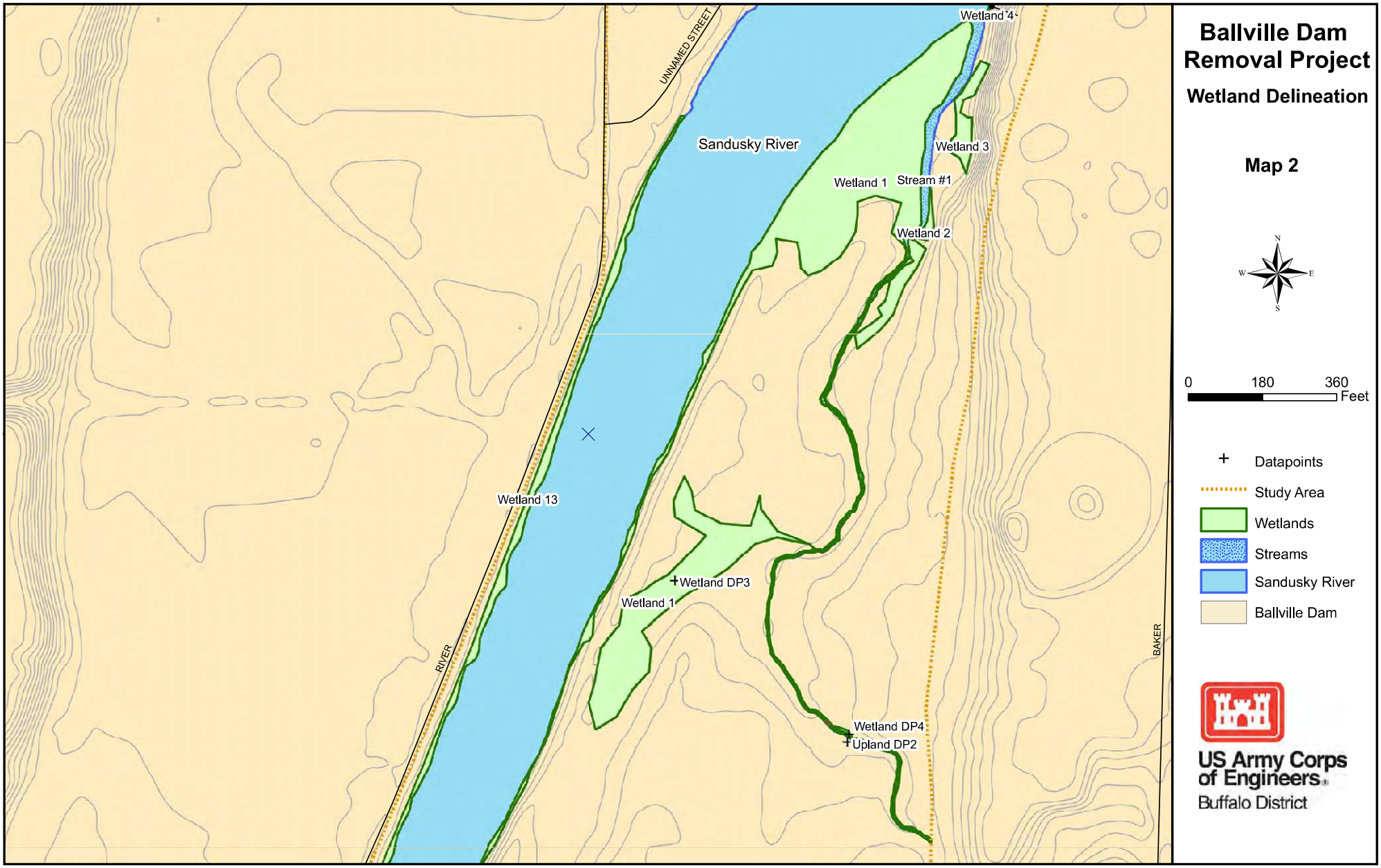
Feet
Datapoints
Study Area
Wetlands
Streams
Sandusky River
Ballville Dam
US Army Corps of Engineers
Buffalo District

NOT TO SCALE


Ballville Dam Removal Project
Wetland Delineation
Map 2
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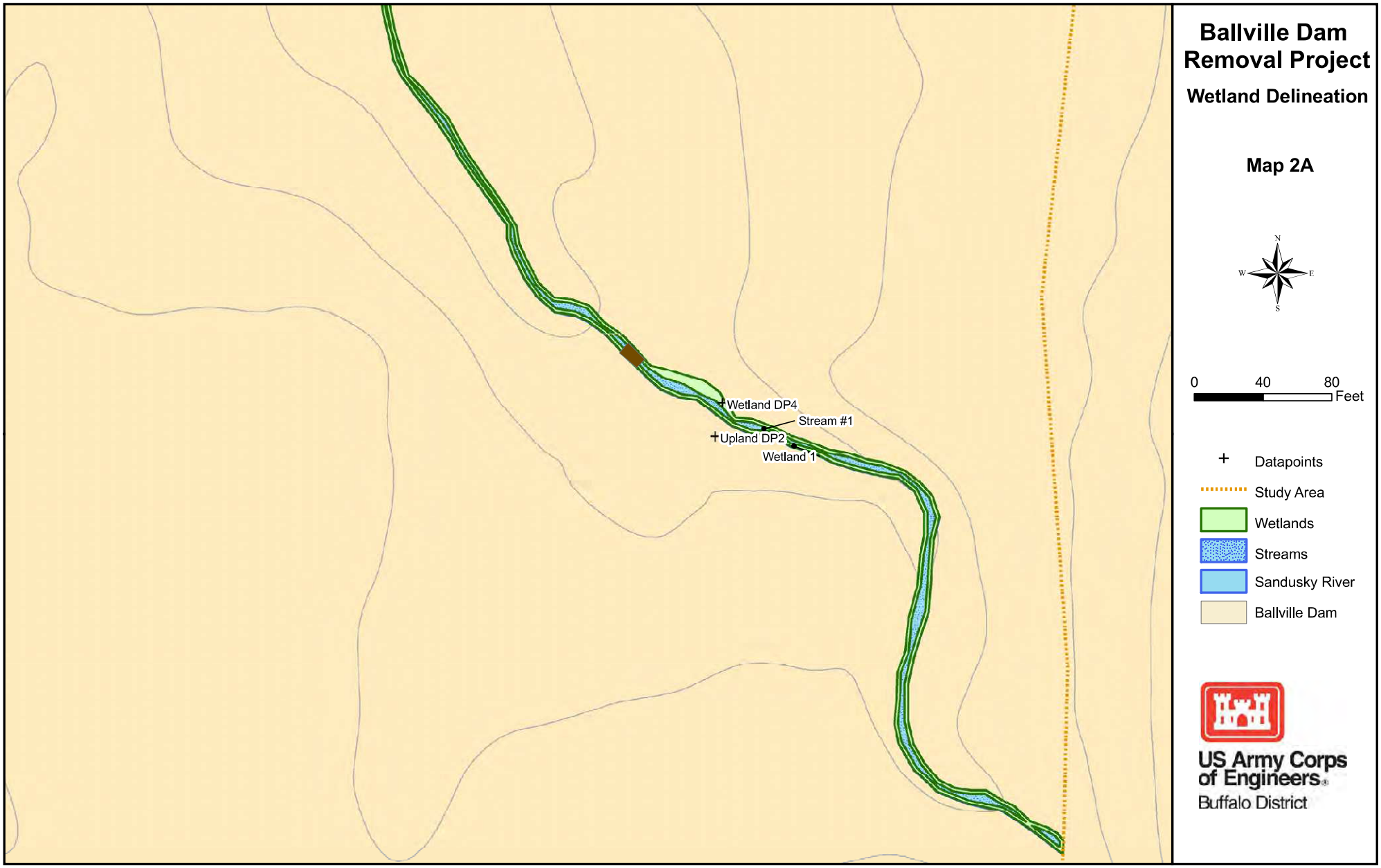
360
Feet
Datapoints
Study Area
Wetlands
Streams
Sandusky River
Ballville Dam
US Army Corps of Engineers
Buffalo District
Wetland 4
UNNAMED STREET
Sandusky River
Wetland 3
Wetland 1
Stream #1
Wetland 2
Wetland 13
Wetland DP3
Wetland 1
RIVER
BAKER
Wetland DP4
Upland DP2

NOT TO SCALE


Wetland DP4
Stream #1
Upland DP2
Wetland 1
Ballville Dam
Removal Project
Wetland Delineation
Map 2A
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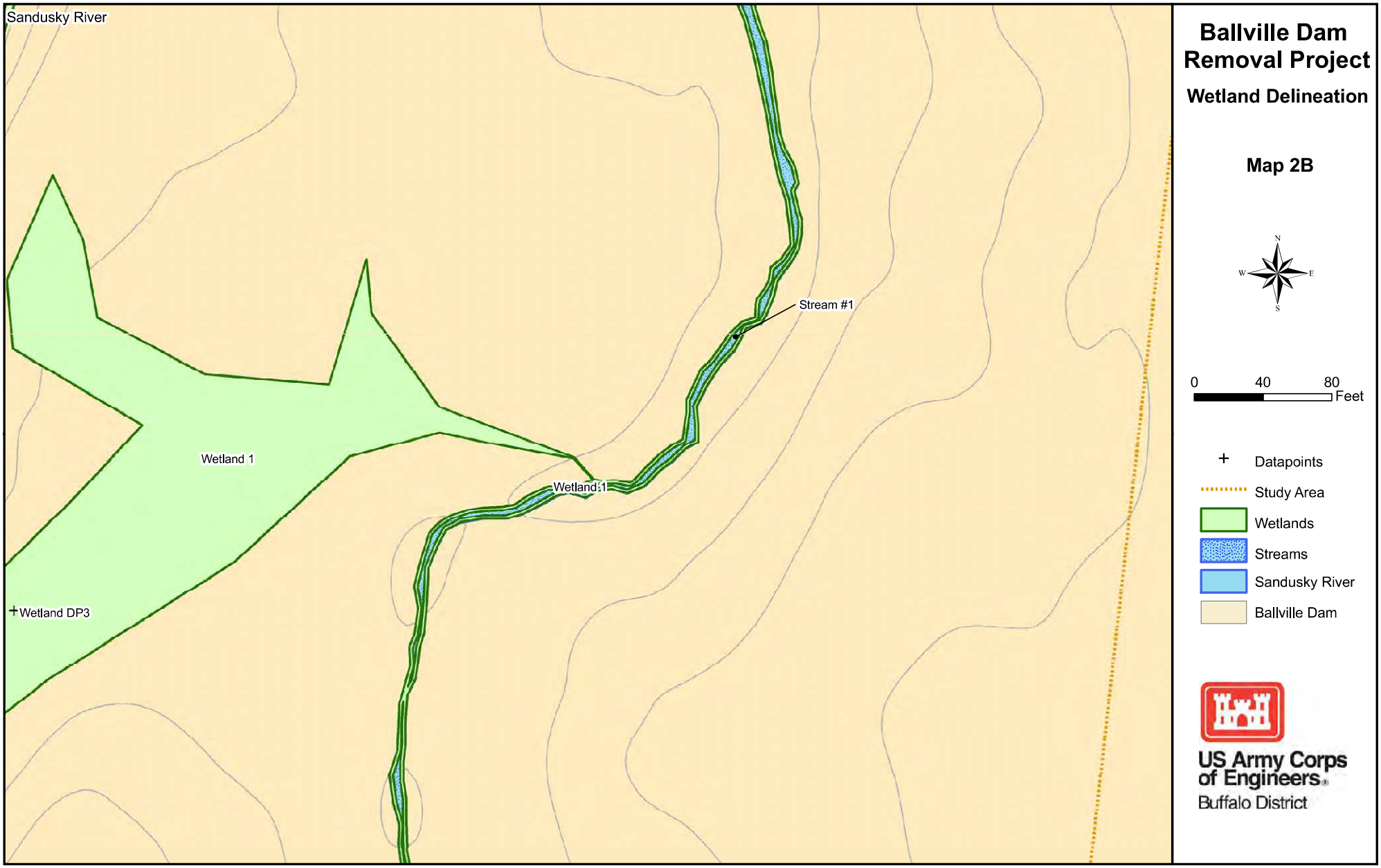
Datapoints
Study Area
Wetlands
Streams
Sandusky River
Ballville Dam
US Army Corps
of Engineers
Buffalo District

NOT TO SCALE


Sandusky River
Stream #1
Wetland 1
Wetland 1
Wetland DP3
Ballville Dam Removal Project
Wetland Delineation
Map 2B
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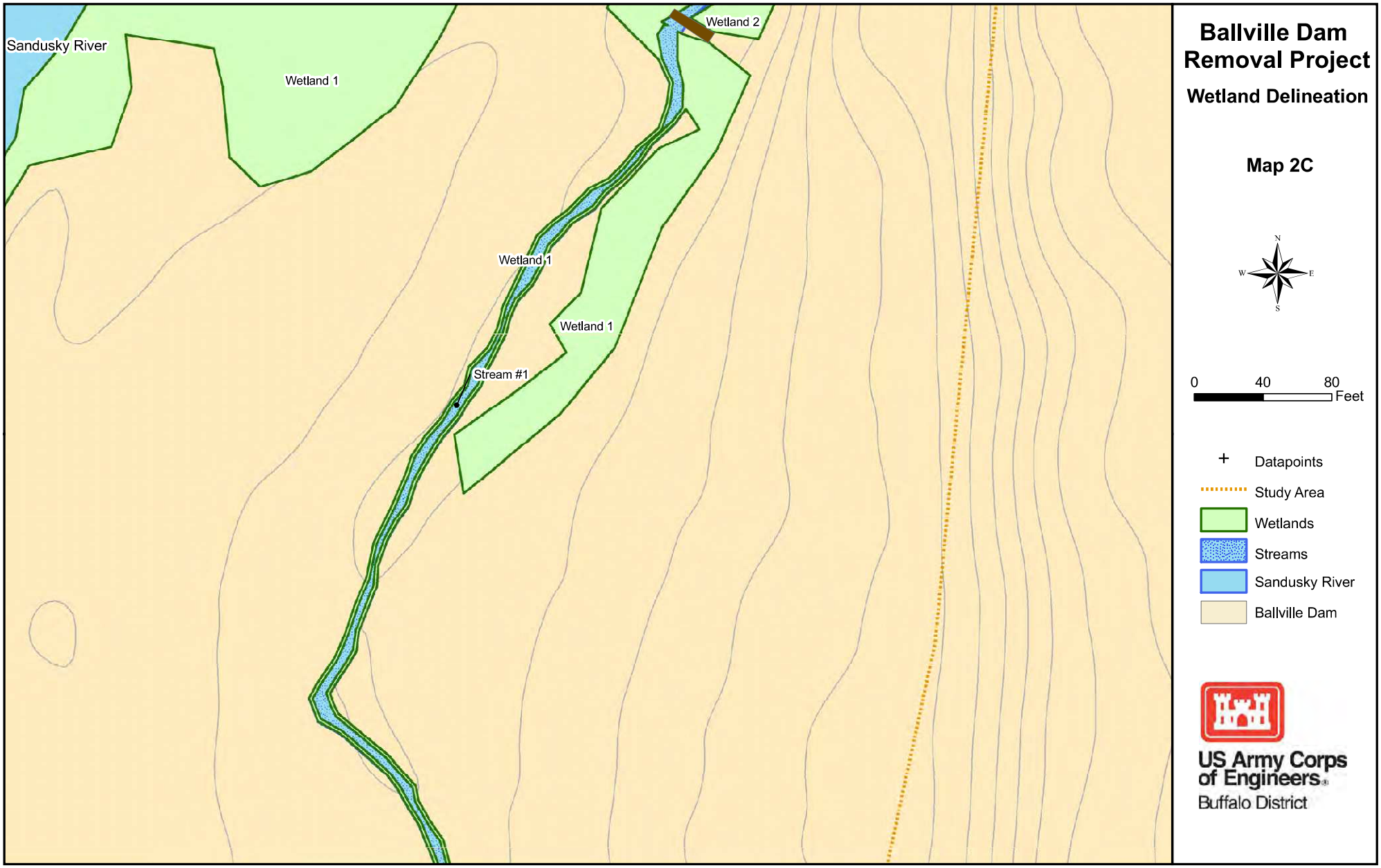
Feet
Datapoints
Study Area
Wetlands
Streams
Sandusky River
Ballville Dam
US Army Corps of Engineers
Buffalo District

NOT TO SCALE


Sandusky River
Wetland 1
Wetland 2
Wetland 1
Wetland 1
Stream #1
Ballville Dam
Removal Project
Wetland Delineation
Map 2C
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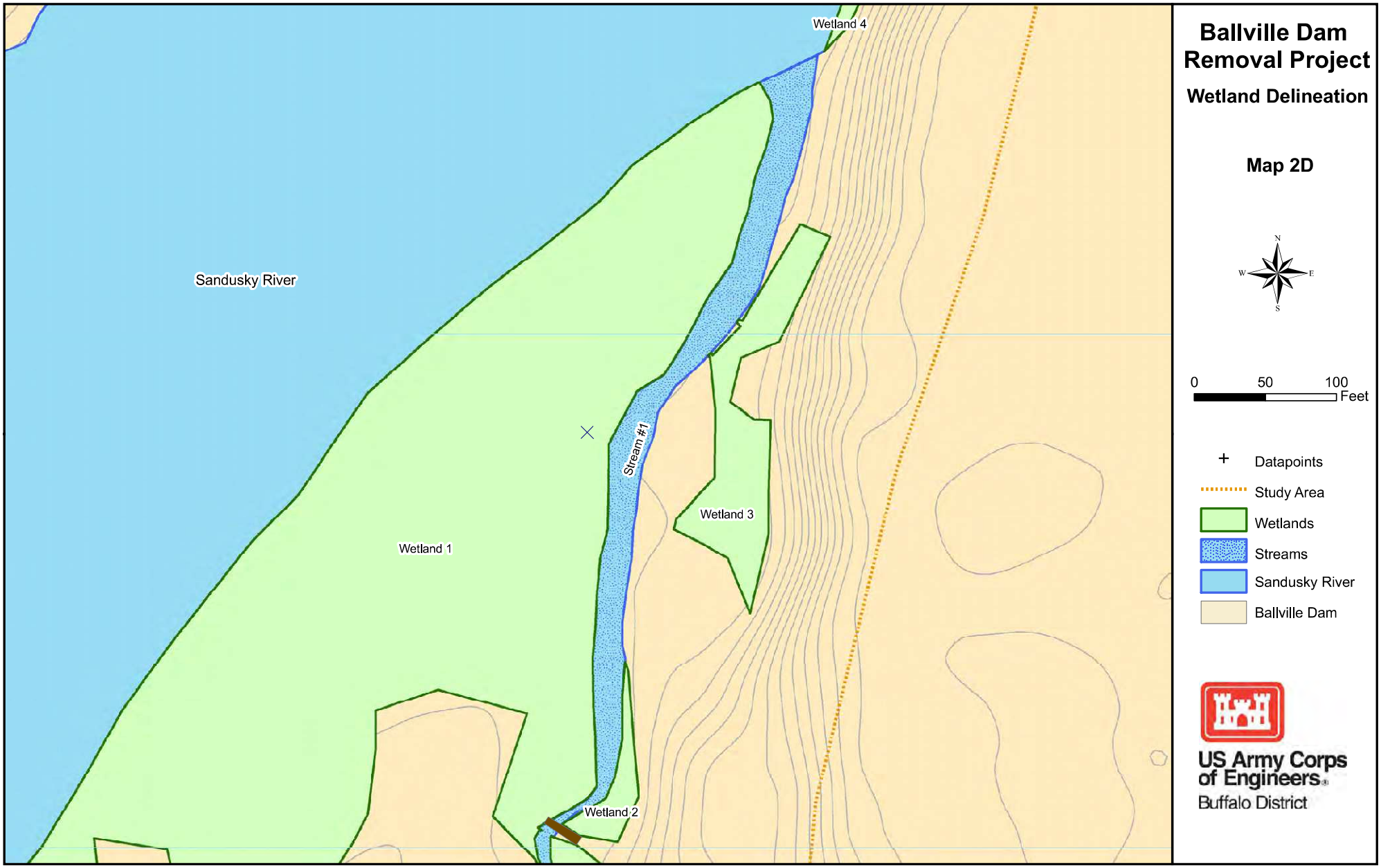
Datapoints
Study Area
Wetlands
Streams
Sandusky River
Ballville Dam
US Army Corps
of Engineers
Buffalo District

NOT TO SCALE


Wetland 4
Sandusky River
Stream #1
Wetland 3
Wetland 1
Wetland 2
Ballville Dam
Removal Project
Wetland Delineation
Map 2D
N
W
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50
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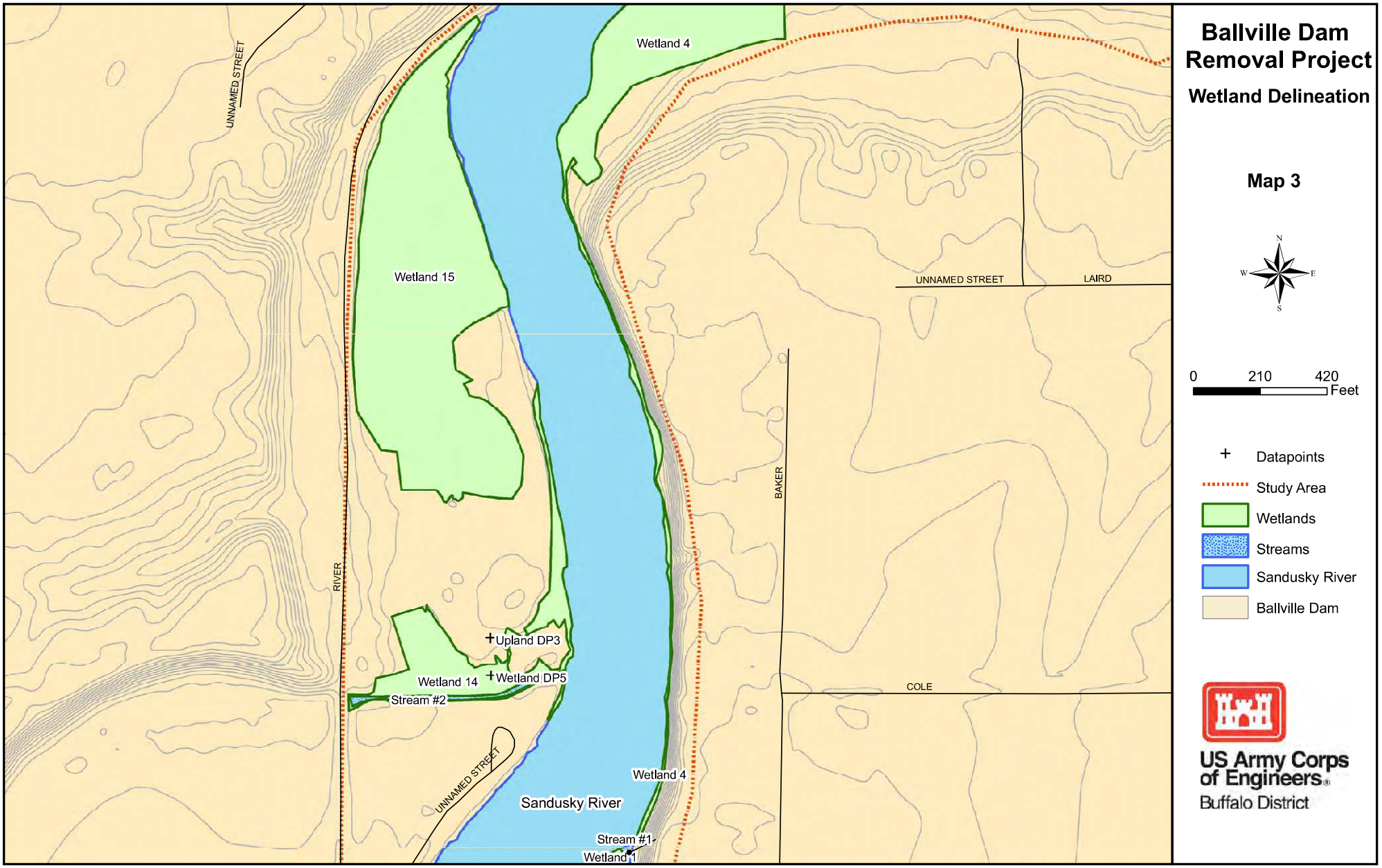
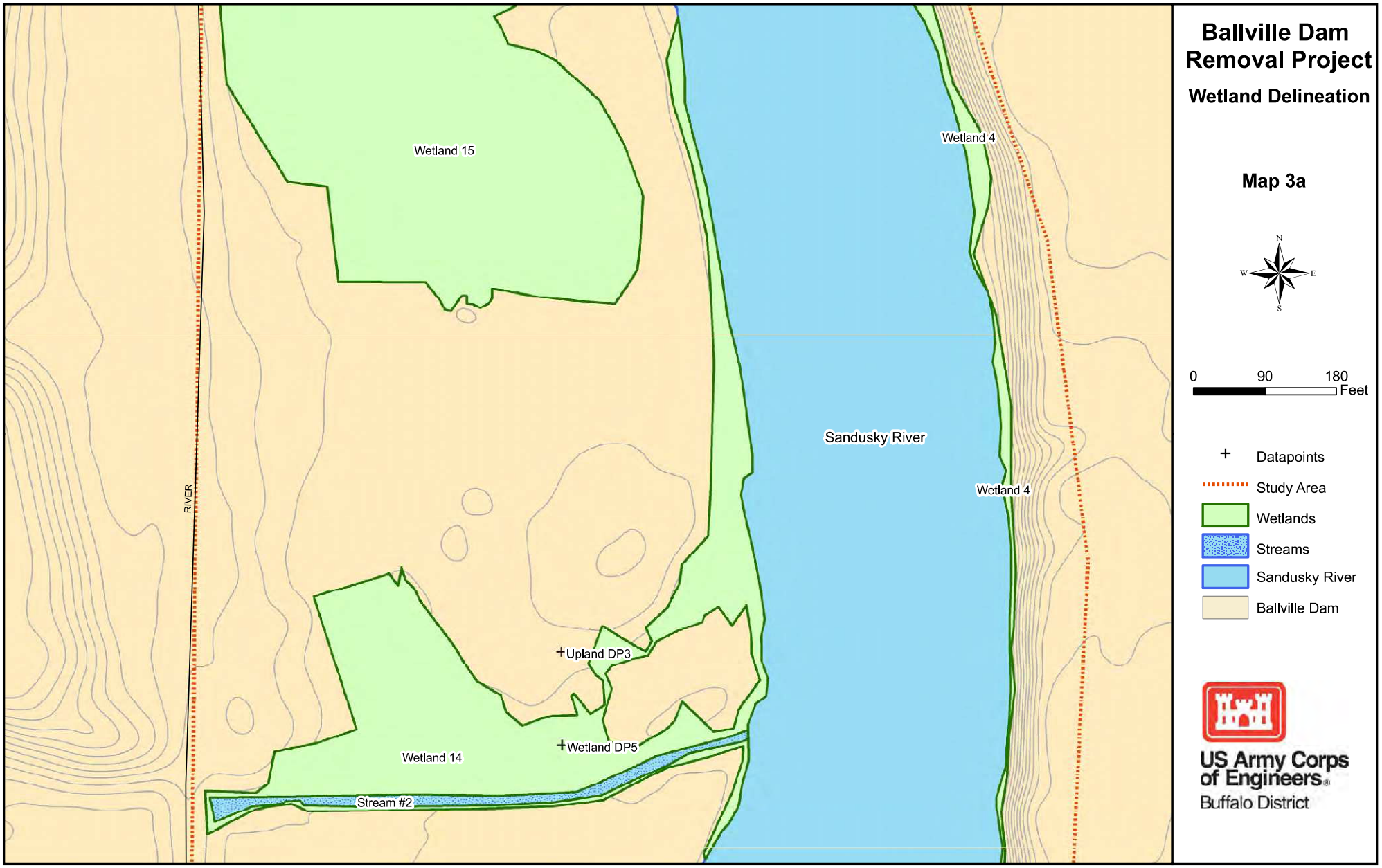
Feet
Datapoints
Study Area
Wetlands
Streams
Sandusky River
Ballville Dam
US Army Corps
of Engineers
Buffalo District

NOT TO SCALE


Ballville Dam Removal Project
Wetland Delineation
Map 3
N
W
E
S
0
210
420
Feet
Datapoints
Study Area
Wetlands
Streams
Sandusky River
Ballville Dam
US Army Corps of Engineers
Buffalo District
Wetland 4
Wetland 15
UNNAMED STREET
LAIRD
BAKER
COLE
RIVER
Upland DP3
Wetland DP5
Wetland 14
Stream #2
Wetland 4
Sandusky River
Stream #1
Wetland 1

NOT TO SCALE


Ballville Dam Removal Project
Wetland Delineation
Map 3a
N
W
E
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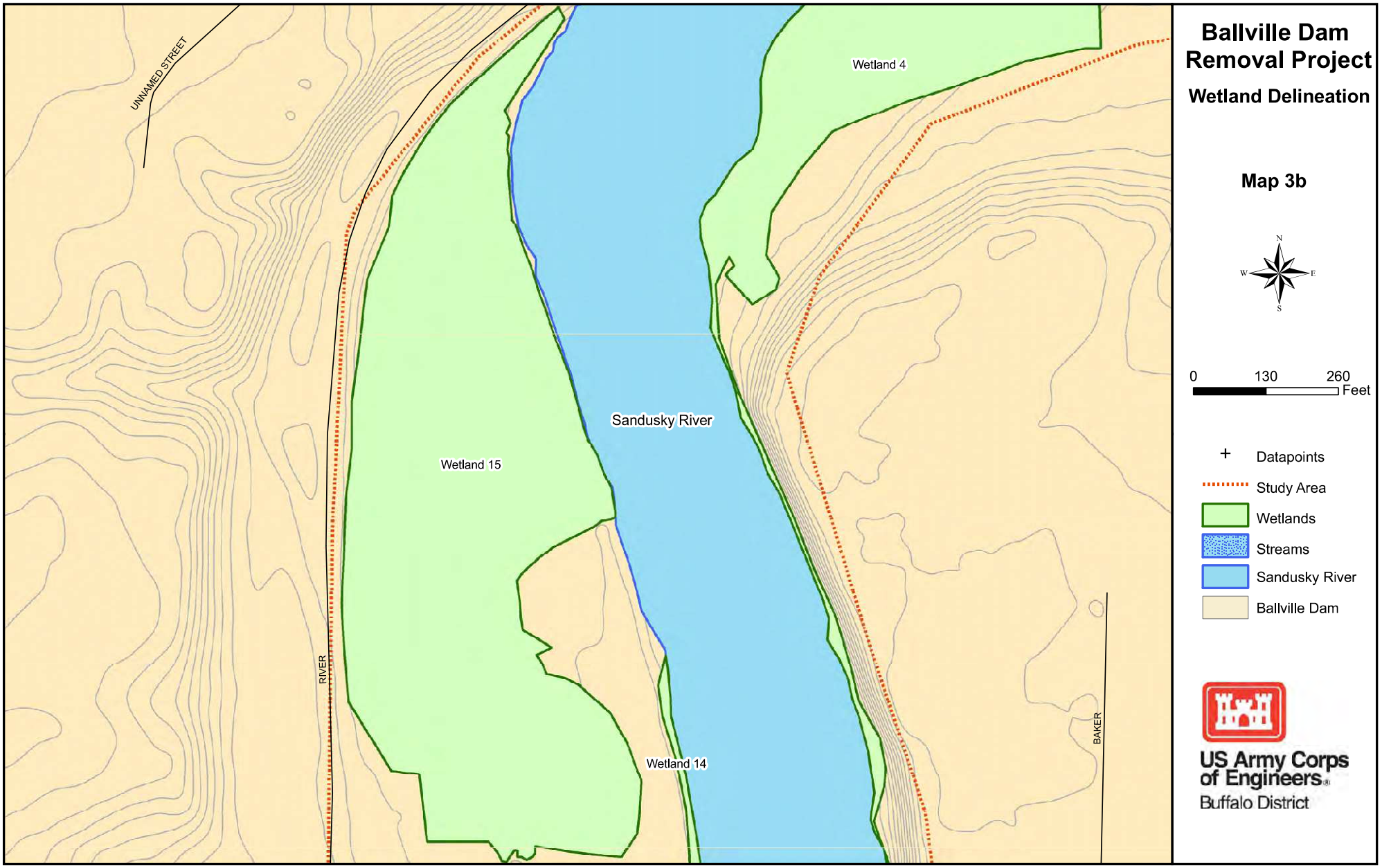
180
Feet
Datapoints
Study Area
Wetlands
Streams
Sandusky River
Ballville Dam
US Army Corps of Engineers
Buffalo District
Wetland 15
Wetland 4
Wetland 4
Sandusky River
RIVER
Upland DP3
Wetland DP5
Wetland 14
Stream #2

NOT TO SCALE


Ballville Dam Removal Project
Wetland Delineation
Map 3b
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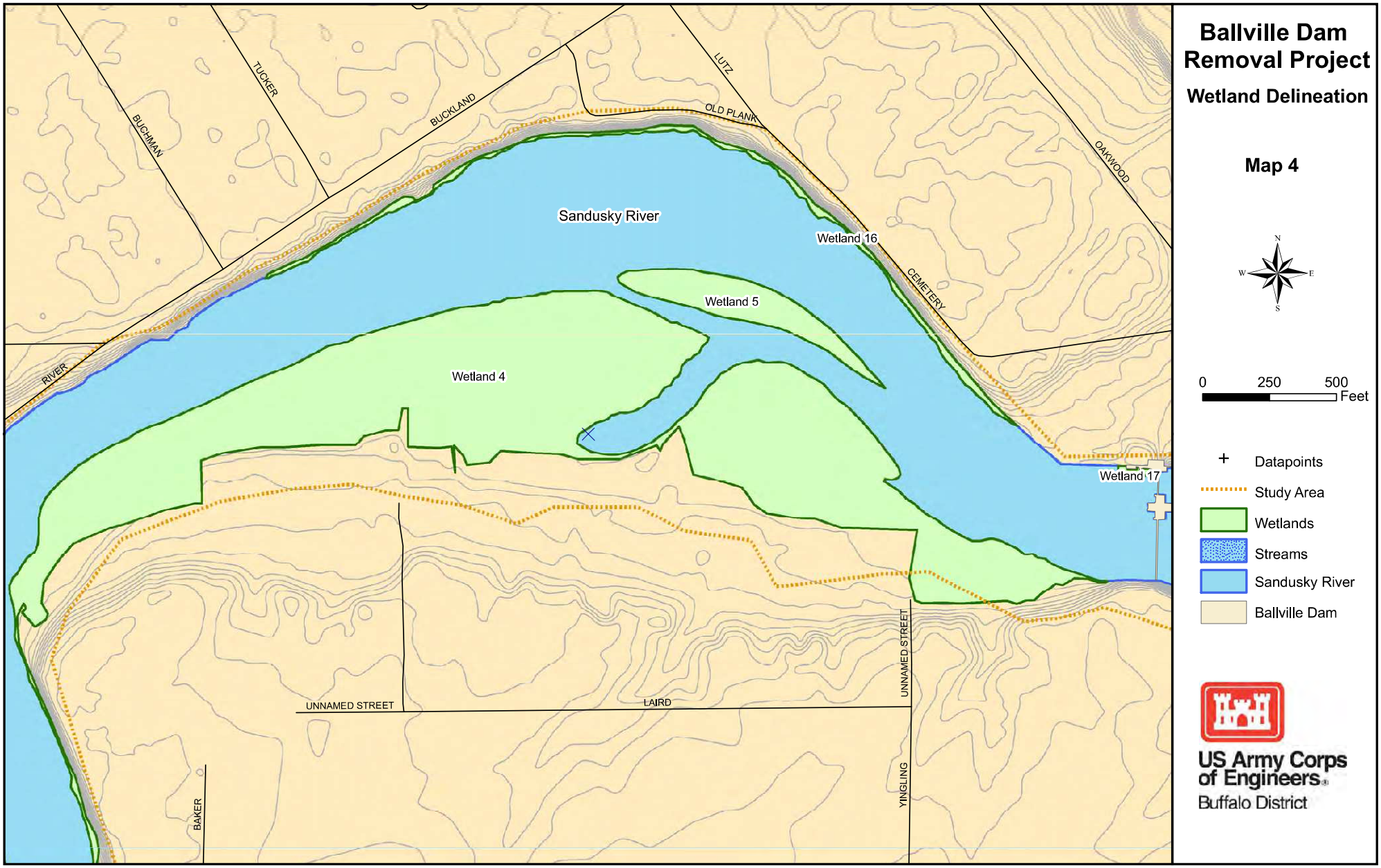
Feet
Datapoints
Study Area
Wetlands
Streams
Sandusky River
Ballville Dam
US Army Corps of Engineers
Buffalo District
UNNAMED STREET
RIVER
BAKER
Wetland 4
Wetland 15
Wetland 14
Sandusky River

NOT TO SCALE


Ballville Dam Removal Project
Wetland Delineation
Map 4
N
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E
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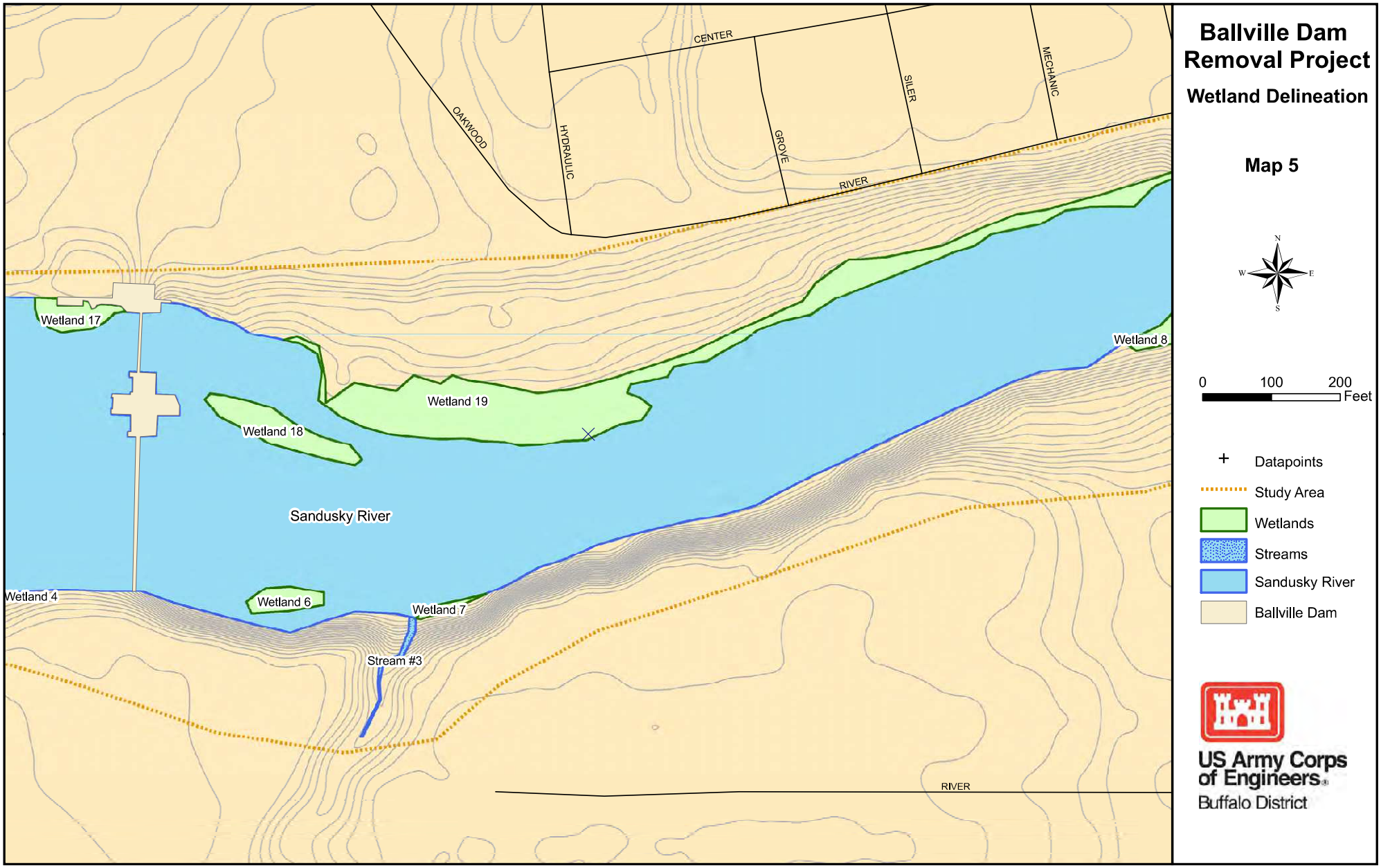
500
Feet
Datapoints
Study Area
Wetlands
Streams
Sandusky River
Ballville Dam
US Army Corps of Engineers
Buffalo District
Sandusky River
Wetland 16
Wetland 5
Wetland 4
Wetland 17
BUCHMAN
TUCKER
BUCKLAND
LUTZ
OLD PLANK
OAKWOOD
CEMETERY
RIVER
UNNAMED STREET
LAIRD
UNNAMED STREET
YINGLING
BAKER

NOT TO SCALE


Ballville Dam Removal Project
Wetland Delineation
Map 5
CENTER
OAKWOOD
HYDRAULIC
GROVE
SILER
MECHANIC
RIVER
Wetland 17
Wetland 19
Wetland 18
Wetland 8
Sandusky River
Wetland 4
Wetland 6
Wetland 7
Stream #3
RIVER
N
W
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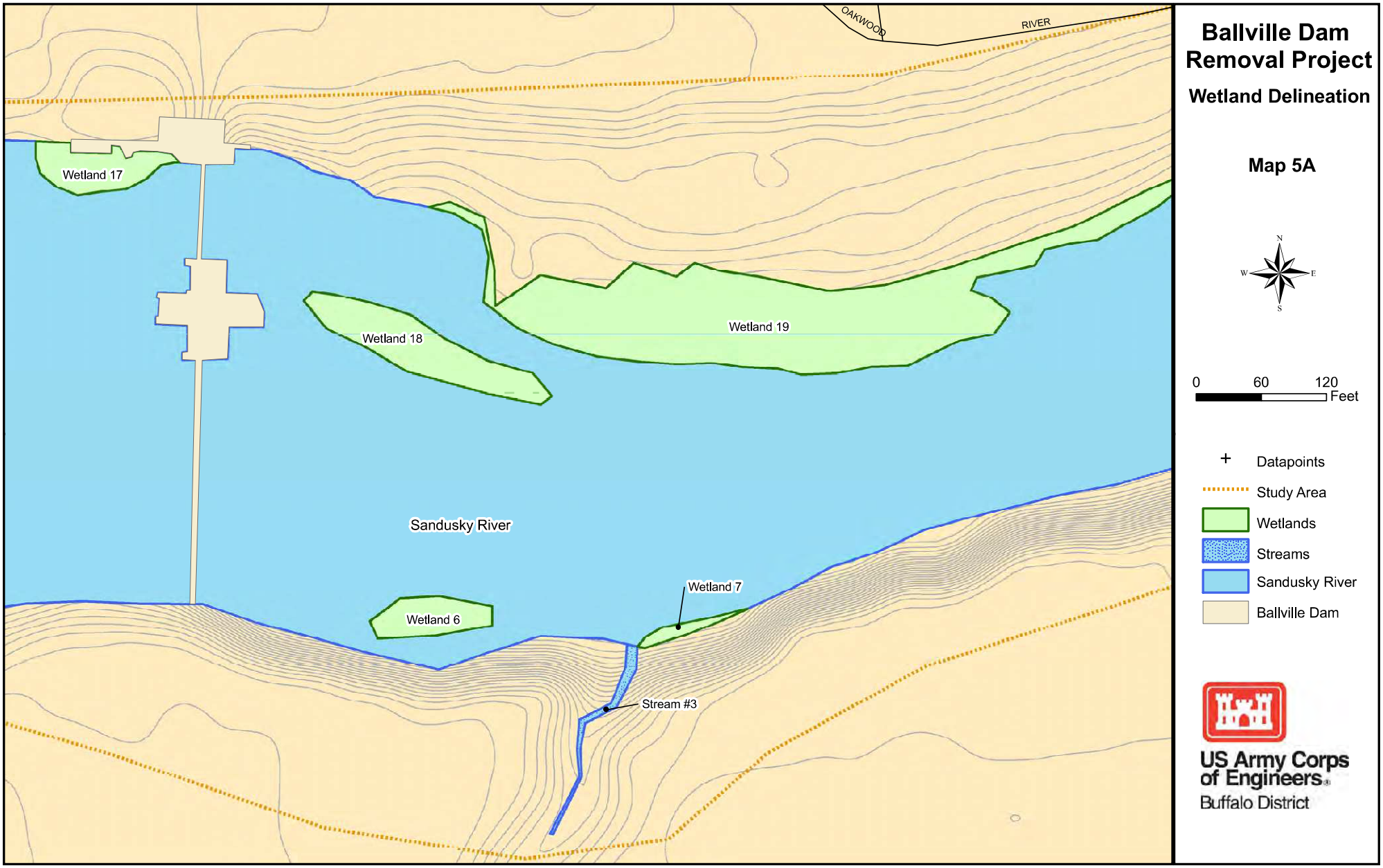
Feet
Datapoints
Study Area
Wetlands
Streams
Sandusky River
Ballville Dam
US Army Corps of Engineers
Buffalo District

NOT TO SCALE


OAKWOOD
RIVER
Wetland 17
Wetland 18
Wetland 19
Sandusky River
Wetland 7
Wetland 6
Stream #3
Ballville Dam
Removal Project
Wetland Delineation
Map 5A
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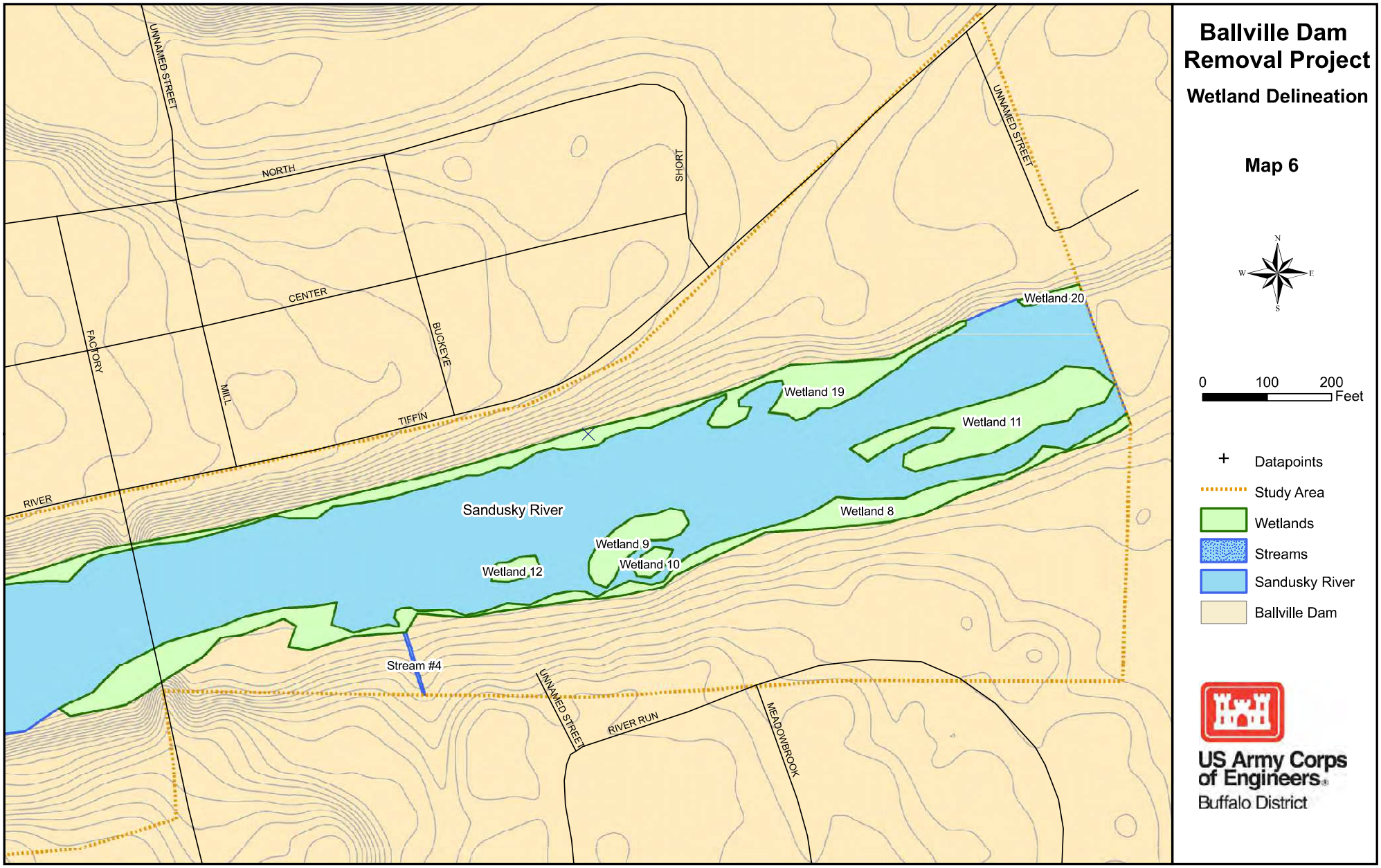
Feet
Datapoints
Study Area
Wetlands
Streams
Sandusky River
Ballville Dam
US Army Corps
of Engineers
Buffalo District

NOT TO SCALE


Ballville Dam Removal Project
Wetland Delineation
Map 6
N
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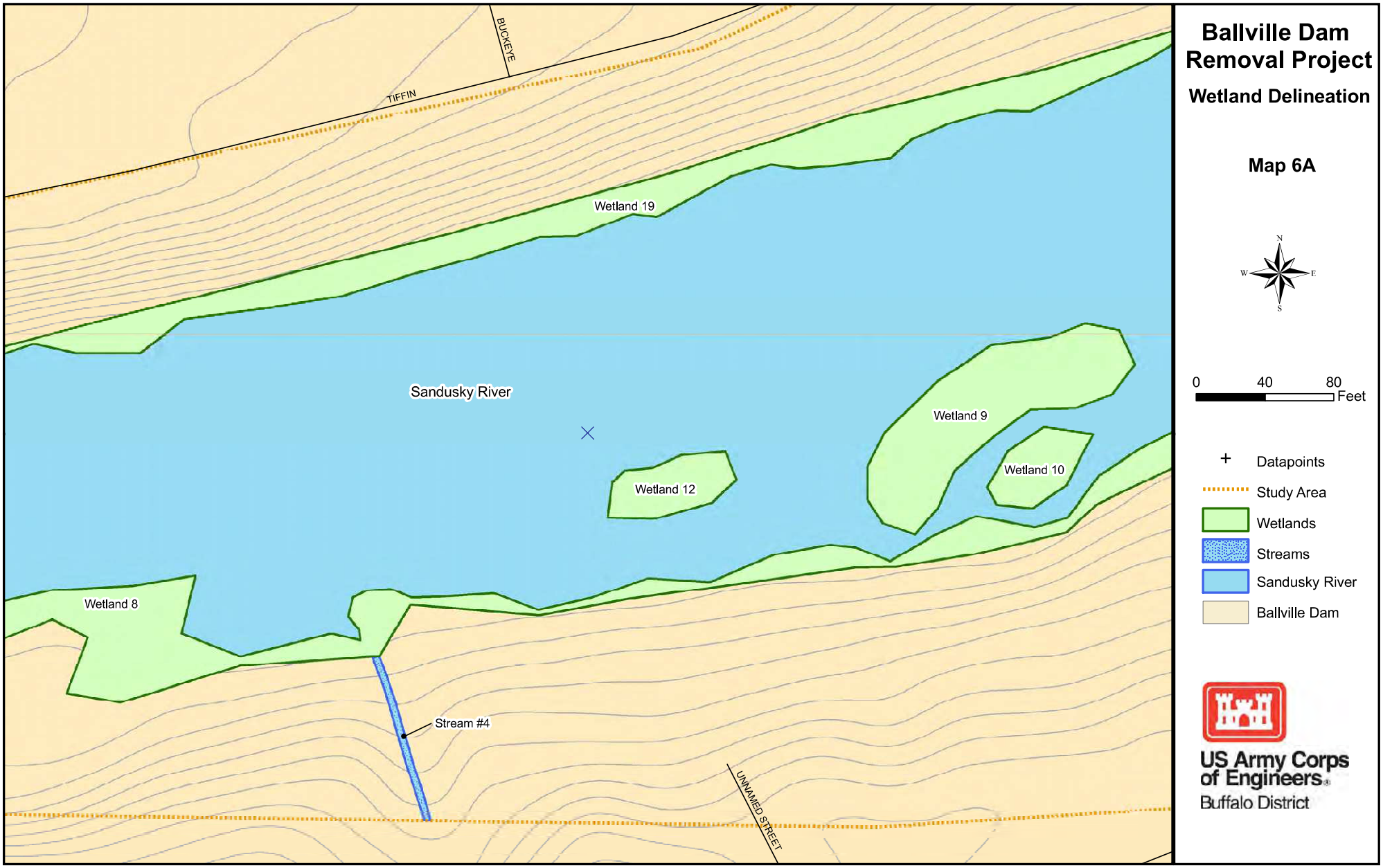
Feet
Datapoints
Study Area
Wetlands
Streams
Sandusky River
Ballville Dam
US Army Corps of Engineers
Buffalo District
UNNAMED STREET
NORTH
SHORT
UNNAMED STREET
CENTER
FACTORY
MILL
BUCKEYE
TIFFIN
RIVER
Wetland 20
Wetland 19
Wetland 11
Sandusky River
Wetland 8
Wetland 9
Wetland 10
Wetland 12
Stream #4
UNNAMED STREET
RIVER RUN
MEADOWBROOK

NOT TO SCALE


Ballville Dam Removal Project
Wetland Delineation
Map 6A
N
W
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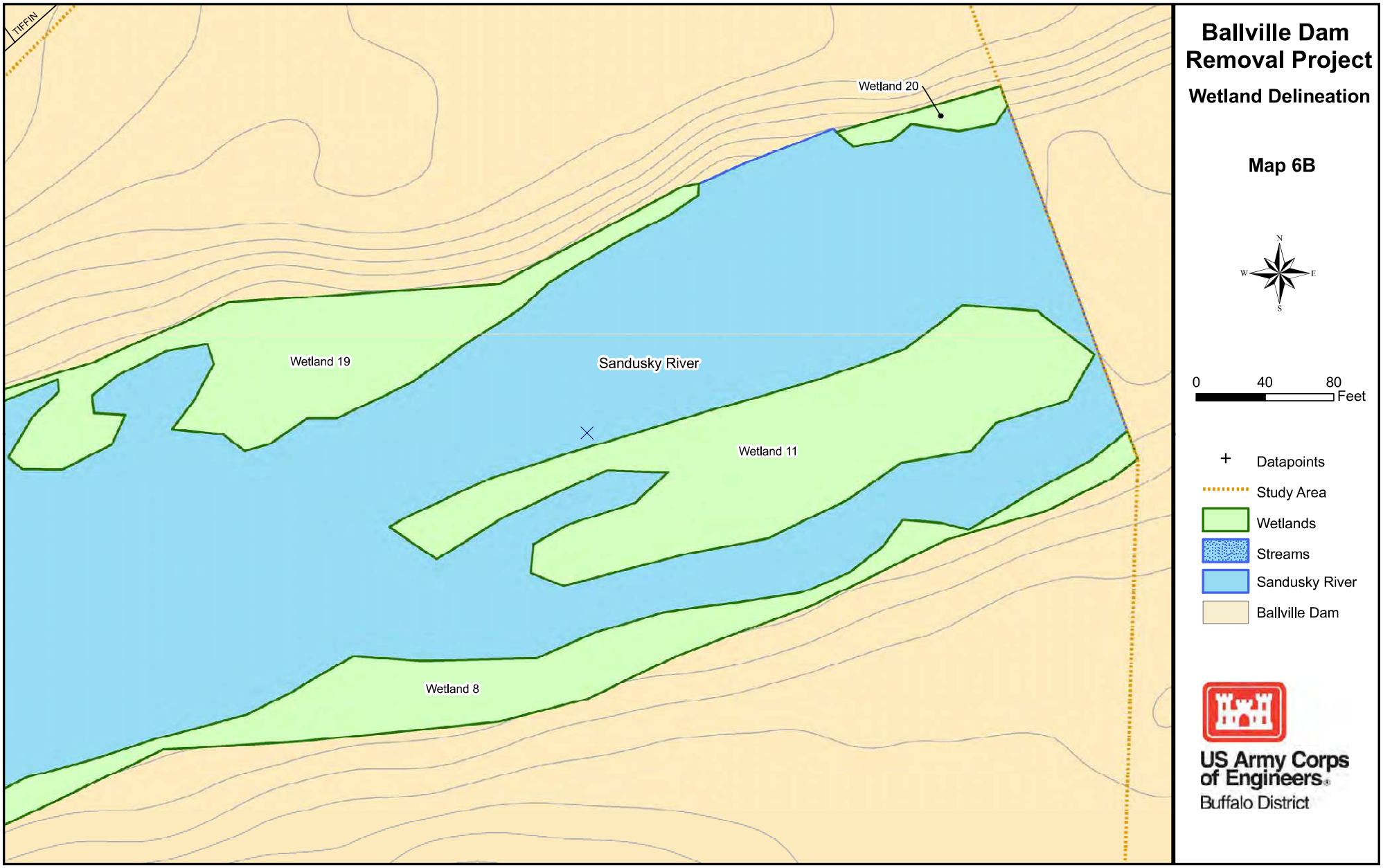
80
Feet
Datapoints
Study Area
Wetlands
Streams
Sandusky River
Ballville Dam
US Army Corps of Engineers
Buffalo District
BUCKEYE
TIFFIN
Wetland 19
Sandusky River
Wetland 9
Wetland 10
Wetland 12
Wetland 8
Stream #4
UNNAMED STREET

NOT TO SCALE


TIFFIN
Wetland 20
Wetland 19
Sandusky River
Wetland 11
Wetland 8
Ballville Dam
Removal Project
Wetland Delineation
Map 6B
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Feet
Datapoints
Study Area
Wetlands
Streams
Sandusky River
Ballville Dam
US Army Corps
of Engineers
Buffalo District

NOT TO SCALE

APPENDIX B

Photo Log Block 10B

Photo ID: 1. Wetland 1 looking upstream (southwest) at Tindall Bridge (5/22/2012)

Photo ID: 2. Wetland 1 facing upstream (southwest) at Tindall Bridge (5/22/2012)

Photo ID 3. Wetland 13 facing northwest (5/24/2012)

Photo ID: 4a. Stream 1 facing upstream (south) (5/22/2012)

Photo ID: 4b. Stream 1 looking downstream (north) (5/22/2012)

Photo ID 5a. Wetland 2 facing downstream (southwest) of Stream 1 (5/22/2012)

Photo ID 5b. Wetland 2 (5/22/2012)

Photo ID: 6. Wetland 3 (5/22/2012)

Photo ID 7. Stream 2 facing downstream (east) (5/23/2012)

Photo ID 8. Wetland 14 (5/23/2012)

Photo ID 9. Wetland 14 (5/23/2012)

Photo ID 10. Wetland 15 (5/23/2012)

Photo ID 11a. Wetland 15 (5/23/2012)

Photo ID 11b. Wetland 15 (5/23/2012)

Photo ID 12. Wetland 15 (5/23/2012)

Photo ID 13. Wetland 4 (5/24/2012)

Photo ID 14. Wetland 4 (5/24/2012)

Photo ID 15. Wetland 4 (5/24/2012)

Photo ID 16. Wetland 16 facing downstream (southeast) (5/24/2012)

Photo ID 17a. Wetland 17 facing upstream (West) (5/23/2012)

Photo ID 17b. Wetland 17 facing downstream (east) (5/23/2012)

Photo ID 18. Wetland 19 facing Northeast (5/23/2012)

Photo ID 19. Wetland 19 below the dam facing downstream (East) (5/23/2012)

Photo ID 20. Wetland 6 facing upstream (northwest) (5/24/2012)

Photo ID 20. Wetland 6 facing downstream (northeast) (5/24/2012)

Photo ID 21a. Stream 3 facing upstream (south) (5/24/2012)

Photo ID 21b. Stream 3 facing downstream (north) (5/24/2012)

Photo ID 22. Wetland 8 facing downstream (northeast) (5/23/2012)

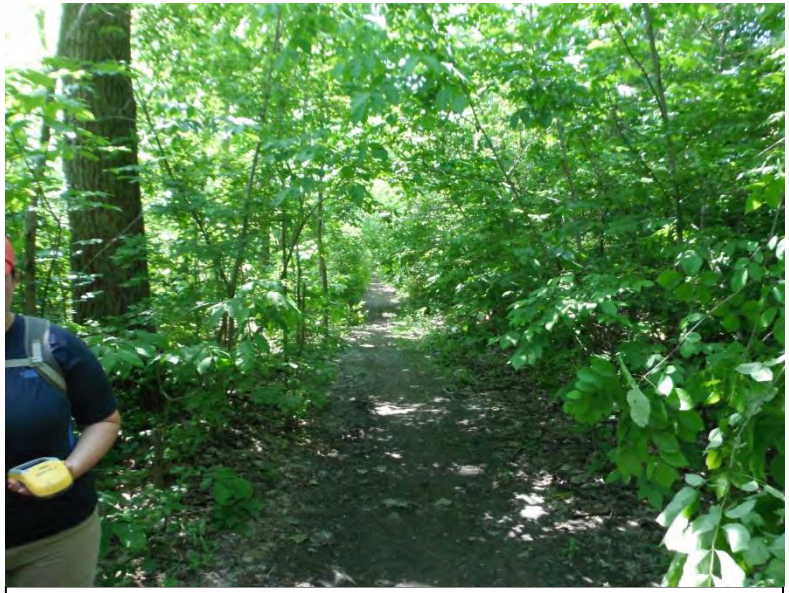

Photo ID 23. North abutment access road facing west (5/24/2012)

Photo ID 24. North abutment access road facing east (5/24/2012)

APPENDIX B

Section 8 - Conceptual Mitigation Report: Photo Log

Photo ID 1: Wetland 1; viewing upstream at Tindall Bridge (5/22/2012)

Photo ID 2: Wetland 1; Bore ID 1 viewing out at river from widened floodplain (5/22/2012)

Photo ID 3: Wetland 1: viewing upstream toward Tindall Bridge (5/22/2012)

Photo ID 4; Wetland 1: Bore ID 2 in floodplain forest section (5/22/2012)

Photo ID 5. Wetland 2; Bore ID 3 (5/22/2012)

Photo ID 6. Wetland 3; Bore ID 4 (5/22/2012)

Photo ID 7: Wetland 4; viewing east, narrow fringe riparian area along south portion of wetland (5/24/2012)

Photo ID 8. Wetland 4; viewing downstream, wetland begins to widen, large patch of reed canarygrass (5/24/2012)

Photo ID 9: Wetland 4; Bore ID 5. Wetland 4 (5/24/2012)

Photo ID 10: Wetland 4; vernal pool and drift deposits (5/24/2012)

Photo ID 11: Wetland 4; Bore ID 6. Wetland 4 (5/24/2012)

Photo ID 12: Wetland 4; Bore ID 7. Wetland 4 (5/24/2012)

Photo ID 13: Wetland 4; Bore ID 9. Soil Profile. (5/24/2012)

Photo ID 14: Wetland 4; Bore ID 9. view of vegetation (5/24/2012)

Photo ID 15: Wetland 4; Bore ID 10. Wetland 4 (5/24/2012)

Photo ID 16: Wetland 4; Bore ID 11. Wetland 4 (5/24/2012)

Photo ID 17: Wetland 5; Bore ID 12. (5/24/2012)

Photo ID 18: Wetland 6; viewing upstream (5/24/2012)

Photo ID 19: Wetland 6; viewing downstream (5/24/2012)

Photo ID 20: Wetland 7; viewing upstream (5/24/2012)

Photo ID 21: Wetland 8; viewing downstream from Tiffin Rd Bridge (5/24/2012)

Photo ID 22: Wetland 8, viewing upstream under Tiffin Rd bridge (5/24/2012)

Photo ID 23: Wetland 8; viewing upstream from below Tiffin Rd bridge (5/24/2012)

Photo ID 24: Wetland 8; viewing downstream approximately 500' downstream of Tiffin Rd bridge (5/24/2012)

Photo ID 25: Wetland 9 & 10; viewing downstream in between Wetland 9 and 10 (5/24/2012)

Photo ID 26: Wetland 9, viewing upstream (5/24/2012)

Photo ID 27: Wetland 10; viewing upstream (5/24/2012)

Photo ID 28: Wetland 11; viewing south of the left descending bank (5/24/2012)

Photo ID 29: Wetland 12 (5/24/2012)

Photo ID 30: Wetland 12 (5/24/2012)

Photo ID 31: Wetland 18, viewing downstream (5/24/2012)

Photo ID 32: Wetland 18 , viewing upstream toward dam, detailed looked at plant assemblages (5/24/2012)

Photo ID 37: Wetland 19, Riverine Intermittent Streambed (5/24/2012)

Photo ID 38: Wetland 19; Riverine Intermittent Streambed (5/24/2012)

Photo ID 39: Wetland 19; viewing downstream into beginning of forest cover(5/24/2012)

Photo ID 40: Wetland 19, viewing downstream at narrow fringe on left descending bank (5/24/2012)

Photo ID 41: Wetland 20, appearing to be underwater (5/24/2012)

Photo ID 42: Wetland 13,; viewing downstream on left descending bank at narrow fringe riparian (5/24/2012)

Photo ID 43: Wetland 14; thick reed canarygrass (5/24/2012)

Photo ID 44: Wetland 14; a view of understory (5/24/2012)

Photo ID 45: Wetland 15, view of vernal pool (5/24/2012)

Photo ID 46: Wetland 16,; (5/24/2012)

Photo ID 47: Wetland 16; (5/24/2012)

Photo ID 48: Wetland 17; reed canarygrass, on seawall (5/24/2012)

Photo ID 49: Wetland 17, reed canarygrass, on seawall (5/24/2012)

Photo ID 50: Wetland 5 (5/24/2012)

Photo ID 51: Wetland 5 (5/24/2012)

Photo ID 52: Wetland 5 (5/24/2012)

APPENDIX C

Section 8 - Conceptual Mitigation Report: Wetland Descriptions

At each wetland, the vegetation and soils were analyzed on May of 2012 by Stantec. For some sites the soil profiles up to 4 feet were observed pending on substrate and the vegetation plots for each stratum were documented using the Corp's Regional Supplement plot radius (See Regional Supplement) pending on feature size. See Figure 8-1 and 8-2 in the Conceptual Mitigation Report for a map of ORAM scoring boundaries and Cowardin classifications.

Scoring Boundary 1 (43.1 acres): Located above the Ballville Dam between the dam and Rice Road Bridge consisting of the JD wetlands (1, 2, 3, 4, 5) surrounding the Sandusky River and an unnamed tributary (Stream 1) on the right descending bank. This boundary received a Category 3 rating (71.5). It is our professional opinion that the cumulative rating of these 5 separate JD boundaries is not of Category 3 quality and function. Only parts of Wetland 4 have Category 3 characteristics. It is generous rating to apply this categorization to the entire scoring boundary. Since the entire scoring boundary has open canopy areas has dense cover of the invasive species reed canarygrass, and forest understory has thick stands of mix nettle species with dense woody drift deposits on the forest floor, it does not offer the quality and function of typical of Category 3 wetland habitat.

Wetland 1: Is a large wetland (5.05 acres) composed of mixed PSS, PEM and PFO Cowardin types with predominantly PFO. The wetland has narrow fringe sections directly along the Sandusky River as well as wider forested floodplain where floodwaters extend. The long narrow fringe section along Stream 1 was also delineated as Wetland 1. This wetland receives hydrology from the flooding of the Sandusky River and Stream 1. The wetland is located on the landscape between the river and residential land use. The wetland is a diverse mix of rocky cobble and boulder substrates in along the shore, scrub shrub dominated areas, open herbaceous areas, and a few vernal pools in the wider forested areas. The forest canopy is composed of boxelder, cottonwood, silver maple, sycamore, elm and green ash. The herbaceous layer is composed of reed canarygrass, prairie cordgrass, smartweeds, and sedges. Breaks in the canopy sometimes caused by emerald ash borer have been invaded by reed canarygrass. Reed canarygrass dominates where there is full sun exposure especially on the edges of the wetlands abutting the river and Stream 1. The shrubs found in this wetland are roughleaf dogwood, bush honeysuckle, black willow, and sandbar willow.

Bore ID 1: 0-3.5 ft: 10YR 4/2 - with 7.5YR 4/4 @ 35% in matrix, silty clay

Bore ID 2: 0-20" - 10YR 3/2 with 5YR 5/6 silty clay 20%; 20-30" - 10YR 4/2 with 10YR 5/8 - 70% - loam; 30 - 36" - 10YR 4/4 with 10YR 5/8 - 60% - sandy loam

Table C.1 Vegetation Plot Bore ID 2

Scientific Name	Stratum	Percent Cover
Populus deltoides	tree	40
Acer negundo	tree	30
Fraxinus pennsylvanica	tree	10
Lysimachia nummularia	herb	20
Toxicodendron radicans	herb	5

Wetland 2: This wetland feature is a small low lying feature (0.04 acres) PEM abutting perennial Stream 1. It receives seasonal flooding from backwater flooding from the Sandusky River as well as flooding from Stream 1. The herbaceous layer is composed of creeping jenny, lizard's tail, reed canarygrass and

boxelder. It is positioned on the landscape between Stream 1 and a narrow woods (<100ft) adjacent a residential area. In the middle of the wetland were burned pieces of wood (fire pit for camping).

The results of a survey plot similar to the Corps manual (regional supplement) vegetation and soils procedures are as follows:

Bore ID 3: 10YR 4/2 - mottles is 20% in matrix, 7.5YR 4/4 20% silty clay

Table C.2 Vegetation Plot Bore ID 3

Scientific Name	Stratum	Percent Cover
Acer negundo	sapling	10
Salix nigra	sapling	1
Lysimachia nummularia	herb	60
Saururus cernuus	herb	30
Phalaris arundinacea	herb	10
Carex grayi	herb	5
Rudbeckia laciniata	herb	1
Iris versicolor	herb	1
Polygonum hydropiperoides	herb	1
Polygonum persicaria	herb	1
Scutellaria lateriflora	herb	1

Wetland 3: This wetland is a small PFO (0.19 acres) composed of intermittent vernal pools, patches of reed canary grass, and the upper canopy is dominated by large (>20 dbh) cottonwood trees and green ash. Flooding is from the backwater of the Sandusky River and Stream 1. It is located on the right descending bank of Stream 1 in between a perennial stream and residential land use (100 feet away). The canopy is composed of boxelder, cottonwood, and sycamore. The herbaceous layer is composed of jewelweed, white avens, poison ivy, creeping jenny, and waterleaf.

The results of 2 survey plots were performed similar to the Corps (regional supplement) sampling procedure for sampling hydric vegetation and soils.

Bore ID 4: 0" - 24" 10YR 4/2 silty clay, mottles 10YR 6/8 - 5%.

Table C.3 Vegetation Plot Bore ID 4

Scientific Name	Stratum	Percent Cover
Acer negundo	tree	55
Platanus occidentalis	tree	15
Acer negundo	shrub	20
Rosa multiflora	shrub	1
Viburnum acerfolium	shrub	1
Lysimachia nummularia	herb	30
Carex grayi	herb	20
Platanus occidentalis	herb	15
Geum canadense	herb	5
Rudbeckia laciniata	herb	5
Impatiens capensis	herb	5
Toxicodendron radicans	herb	5

Osmorhiza longistylis	herb	1

Wetland 4: This is a large forested floodplain wetland totaling 34.11 acres. It is a PFO composed of both narrow fringe and wider forested floodplain. The wetland is between the river and residential areas with mowed lawns that abut the wetland in some places. A section of the wetland surrounds the large reservoir inlet. The wetland has features such as large vernal pools used by waterfowl, and amphibians. The canopy is composed of mature tree species such as cottonwood, silver maple, boxelder, American elm, and black willow. The subcanopy is composed of hawthorn, American elm, black willow, boxelder, and green ash. The shrub layer is composed of dogwood, sandbar willow and multiflora rose. The dominant patches of herbaceous species consisted of reed canarygrass, fringed loosestrife, harlequin blueflag, giant ragweed, Gray's sedge, lizard's tail, wood nettle, swamp smartweed, Canada goldenrod, wingstem, common reed, cutleaf and swamp dock. The wide areas have swamp like characteristics with a diverse floristic interspersion of plant communities. However much of the wetland is dense, with woody drift deposits and nettles. It also has patches of dead ash trees due to emerald ash borer. Reed canarygrass dominates in open sunlit areas especially along the edges abutting the river.

The results of 5 survey plots were performed similar to the Corps (regional supplement) sampling procedure for sampling hydric vegetation and soils.

Bore ID 5: Silty Clay from 0 - 3.4', water at 3.5ft - sandy loam to 5 ft; 0-3.4' - 10YR 3/2 with 10YR 5/6 - 5%; 3.5ft - 5ft 7.5YR 4/6 with 5YR 4/4 - 25% sandy clay

Table C.4 Vegetation Plot Bore ID 5

Scientific Name	**Stratum**	**Percent Cover**
Acer saccharinum	tree	50
Platanus occidentalis	tree	20
Acer negundo	tree	10
Fraxinus pennsylvanica	tree	5
Fraxinus pennsylvanica	shrub	5
Ulmus americana	shrub	5
Lysimachia nummularia	herb	35
Phalaris arundunaceae	herb	20
Laportea canadensis	herb	10
Solidago canadensis	herb	10
Hydrophyllum virginianum	herb	5

Bore ID 6: 0-30" - 10YR 3/2 with 10YR 5/8 10% silt clay; 30-60" - 10YR 4/2 with 5YR 4/4 15% silty clay loam

Table C.5 Vegetation Plot Bore ID 6

Scientific Name	**Stratum**	**Percent Cover**
Acer saccharinum	tree	40
Acer negundo	tree	40
Populus deltoides	tree	20
Fraxinus pennsylvanica	tree	20
Acer negundo	shrub	10

Fraxinus pennsylvanica	shrub	10
Solidago canadensis	herb	50
*Viola*spp	herb	1
Osmorhiza longistylis	herb	1
Polygonum pensylvanicum	herb	1
Lysimachia nummularia	herb	1
Pilea pumila	herb	1
Impatiens capensis	herb	1

Bore ID 7: 0-1' organic layer 10YR 3/3 silty clay; 12"-48" 10YR 4/2 and 5YR 3/3 pore lining 70%, 48-60" 5YR 4/1 with 5YR 4/6 porelinings 5% silty clay all soil types

Table C.6 Vegetation Plot Bore ID 7

Scientific Name	**Stratum**	**Percent Cover**
Acer saccharinum	tree	50
Salix nigra	tree	10
Ulmus americana	tree	10
Acer negundo	shrub	25
Salix nigra	shrub	10
Pilea pumila	herb	25
Osmorhiza longistylis	herb	15
Laportea canadensis	herb	10
Geum canadense	herb	10
Solidago canadensis	herb	5
Impatiens capensis	herb	1

Bore ID 8: Root refusal at 1ft, 0-12" 10YR 3/2 silty clay with 7.5YR 4/6 - 5%

Table C.7 Vegetation Plot Bore ID 8

Scientific Name	**Stratum**	**Percent Cover**
Populus deltoides	tree	55
Acer saccharinum	tree	5
Acer negundo	shrub	15
Ulmus americana	shrub	15
Crataegus spp	shrub	15
Fraxinus pennsylvanica	shrub	5
Lysimachia nummularia	herb	25
Carex grayi	herb	10
Acalypha virginica	herb	10
Laportea canadensis	herb	10
Solidago canadensis	herb	5

Bore ID 9: water at 3ft, refusal at 3.5 ft, 0-2ft 10YR 3/2 with 7.5YR 5/8 pore lining silty clay 10%; 2 - 3ft 10YR 5/2 with 5YR 5/8 65-70% loam; 3 - 3.5ft 2.5YR 3/1 with 5YR 5/8 45% clay loam

Table C.8 Vegetation Plot Bore ID 9

Scientific Name	Stratum	Percent Cover
Acer saccharinum	tree	30
Populus deltoides	tree	15
Salix nigra	tree	10
Acer negundo	tree	5
Fraxinus pennsylvanica	shrub	5
Carex grayi	herb	10
Iris versicolor	herb	10
Carex spp	herb	10
Acalypha virginica	herb	10
Laportea canadensis	herb	10
Lysimachia nummularia	herb	5

Bore ID 10: Restrictive layer at 2 ft, 0-24" 10YR 3/3 silty clay

Table C.9 Vegetation Plot Bore ID 10

Scientific Name	Stratum	Percent Cover
Toxicodendron radicans	vine	10
Ulmus americana	tree	20
Salix nigra	tree	15
Acer negundo	tree	10
Rosa spp	shrub	10
Pilea pumila	herb	45
Eragrostis spp	herb	15
Carex grayi	herb	15
Toxicodendron radicans	herb	10
Geum canadense	herb	10
Polygonum virginianum	herb	10
Phalaris arundunaceae	herb	10
Impatiens capensis	herb	5
Solidago canadensis	herb	5
Boehmeria cylindrica	herb	1

Bore ID 11: Restrictive layer at 1ft (stone), 0-12" 10YR 3/2 silty clay, both Bore ID 10 and 11 had gravel at end of bore before refusal

Table C.10 Vegetation Plot Bore ID 11

Scientific Name	Stratum	Percent Cover
Acer saccharinum	tree	20
Acer negundo	tree	15
Ailanthus altissima	tree	15
Fraxinus pennsylvanica	tree	10
Crataegus spp	tree	10
Cornus drummondi	shrub	25
Rubus allegheniesis	shrub	10
Carex grayi	herb	60

Lysimachia nummularia	herb	25
Geum canadense	herb	10
Phalaris arundunaceae	herb	10
Acer saccharinum	herb	5
Polygonum hydropiperoides	herb	5
Ulmus americana	herb	5
Carex frankii	herb	5
Parthenocissus quinquefolia	herb	5

Wetland 5: The wetland is 2.47 acres of PFO above the OHWM of the Sandusky River as an isolated island in the impoundment. The canopy is composed of cottonwood, silver maple, and black willow. The island gets a seasonal flux of alluvial soil deposition due to its position in the reservoir. The island a thick layer of drift deposits and water stained leaves present. Due to its geomorphic positioning and lack of low-lying areas it did not have the presence of vernal pools. The herbaceous strata are low in diversity. The herbaceous layer is composed of clearweed, ragweed, and stinging nettle. Shrubs found in this wetland are green ash and sandbar willow.

This entire habitat was considered Category 3 quality and function. Wetland 5, (2.47 acres) however, did not have the same qualities as other Class 3 wetlands (Wetlands 1, 2, 3, and 4) within this ORAM scoring boundary (Figure 8-2). Since it is geographically isolated (island) that lacks the floristic interspersion, floristic richness, and vernal pools typical of this scoring boundary, and mature forest canopy a dual wetland rating may be appropriate in this situation (Section 5.7 –ORAM manual). Stantec recommends that these 2.47 acres be re-categorized to a Category 2 status.

Wetland 5: lack of floristic diversity, heavy amount of drift deposits and young trees

Bore ID 12: 0-1.5 ft - 10YR 2/2 - sandy clay, 1.5 - 5ft - 10YR3/2 silty clay mottles 7.5YR 4/6 - 5%,

Table C.11 Vegetation Plot Bore ID 12

Scientific Name	Stratum	Percent Cover
Populus deltoides	tree	70
Salix nigra	tree	10
Pilea pumila	herb	25
Polygonum spp	herb	10
Acer rubrum	herb	5
Impatiens capensis	herb	5
Verbesina alternifolia	herb	5
Solidago canadensis	herb	5
Acalypha virginica	herb	1
Lysimachia ciliata	herb	1

ORAM Scoring Boundary 2 (0.075 acres): This is a small boundary only consisting of JD delineated Wetland 6 directly below the dam. Due to the rocky nature of the substrate, no soil profiles were observed. This boundary received a Category 2 rating (46.5).

Wetland 6: The wetland is 0.08 acres and is Category 2 wetland. It is a Riverine Lower Perennial Rocky Shore Cowardin classification, and is located downstream of the dam and appears to be below the OHWM of the Sandusky River. It is composed of rocky and boulder substrates with sparse vegetation. The wetland was sparsely covered with sandbar willow, raspberry, *Carex* spp. and a few sycamore saplings. A restrictive layer at the surface of large cobble and boulder did not allow for a soil sample (See Photo ID 20 and 21 in Section 1).

ORAM Scoring Boundary 3 (0.019 acres): This is a small boundary only consisting of JD delineated Wetland 7 approximately 400 feet below the dam on the right descending bank. Due to the rocky nature of the substrate, no soil profiles were observed. This boundary received a Category Modified 2 rating (44.5).

Wetland 7: The wetland is 0.02 acres and is considered a Modified Class 2 wetland. It is a Riverine Lower Perennial Emergent Wetland Cowardin classification (Cowardin 1979). A small high gradient ephemeral stream feeds into this wetland. At the time of survey, (May 2012) this wetland was mainly under water due to the water level of the Sandusky River. The riparian canopy species observed in the area were cottonwood, green ash, and elm trees with hanging poison ivy. A few sandbar willow shrubs were located on the rocky shore. A few herbaceous species were observed further up on the bank such as jewelweed, riverbank grape, and Virginia creeper.

ORAM Scoring Boundary 4 (3.80 acres): This is a large boundary consisting of most of the of the in stream wetland types below the dam (Wetlands 8, 9, 10, 11, 12, 18, 19, & 20). This boundary has both Riverine and Palustrine Cowardin classes with extremely sparse vegetation and rocky shore substrate. This boundary was given a Category 3 status (68.5). Due to the rocky nature of the substrate, no soil profiles were observed. This boundary received a Category 3 rating (68.5). Although there is hydrologic connection between each wetland with a defined scoring boundary, it is our professional opinion that Wetland 19 is the only wetland that provides Category 3 quality and function.

Wetland 8: This wetland is 0.90 acres of PFO Cowardin classification has features such as narrow riparian section with a few wider mixed rocky shore areas. The wetland for the most part is above the OHWM of the Sandusky River. The boundary starts just upstream of Tiffin Bridge and follows the shores of the Sandusky River approximately 1500 feet. Due to the urban land use consisting of the Tiffin Road Bridge and the adjacent residential areas, the wetland has many large breaks in the forest canopy with scrub shrub and invasive plant species. The forest canopy is composed of cottonwood, river birch, black willow, princesstree, and green ash. The shrub stratum is composed of sandbar willow, black willow, boxelder and roughleaf dogwood. The herbaceous layer is composed of raspberry and reed canary grass.

Wetland 9: This wetland is 0.18 acres of rocky shore intermittent island classified as PFO with overall thin vegetation cover. The island has features as intermittent pools and think clumps of Canada goldenrod. The canopy is composed of, eastern cottonwood, American sycamore, silver maple, and black willow. The shrub layer is composed of roughleaf dogwood, sandbar willow and blackwillow. The thin herbaceous layer is composed of broadleaf arrowhead, and American water-willow. Shrubs found in this wetland are sandbar willow and dogwood.

Wetland 10: This 0.04 acres feature appeared to be a continuation of Wetland 9. This island like feature was sparsely vegetated with one large cottonwood that overshadowed the entire wetland. The wetland was classified as a PFO. The substrate was composed of large boulders and bedrock. A few sparse sandbar willow and American sycamore shrubs were observed.

Wetland 11: This wetland is a larger rocky shore island (0.55 acres) PSS wetland that is above the OWHM of the Sandusky River. It overall has sparse vegetation cover with clumps of shrubs and minimal herbaceous vegetation and one large eastern cottonwood. Shrubs observed were sandbar willow, boxelder, eastern cottonwood and green ash.

Wetland 12: The wetland is 0.05 acres of PSS rocky island that is generally above the OHWM of the Sandusky River. The vegetation consists of a fairly dense cover of sandbar willow and sycamore shrubs.

Wetland 18: The wetland is 0.18 acres PSS just below the dam that appears to be an island above the OHWM of the Sandusky River. Since it is located in between two spillways, it was most likely formed by deposits because flows do not directly run into this wetland. A large amount of drift wood was deposited on the island at the time of observation. It consists of large boulder substrates with occasional eastern cottonwood and American elm trees with very minimal herbaceous cover. The dominant shrub layer consists of green ash, sycamore, sandbar willow, and princess tree.

Wetland 19: The wetland is 1.87 acres which is dived up into two Cowardin classifications: PFO (1.64) and Riverine Intermittent Streambed (0.23 acres). This wetland consists of interspersed habitat types such as large bedrock areas, wide riparian forest with intermittent pools, patches of PSS, patches of sedges, narrow fringe riparian streambank. The majority of the area is located above the OHWM of the Sandusky River on the left descending bank. The riparian tree canopy consisted of eastern cottonwood, American sycamore, green ash, silver maple, American elm, and black willow. The shrub layer consists of box elder, rough leaf dogwood, and sandbar willow.

Wetland 20: This small feature of 0.03 acres was completely under water at the time of survey in May of 2012. Therefore it was considered below the OHWM and classified as a Riverine Lower Perennial Rocky Shore Cowardin classification (Cowardin 1979). It is located just downstream of the haunted house on the left descending bank. The surrounding riparian canopy consists of cottonwood, green ash, and black willow with some bush honeysuckle below the canopy.

ORAM Scoring Boundary 5 (1.68 acres): This Scoring Boundary consists of JD delineated Wetland 13. It starts just downstream of Rice Road Bridge and extends approximately 3600 feet downstream along the Sandusky River. This boundary received a Category Modified 2 rating (42.5).

Wetland 13: The wetland is 1.02 acres and is considered a Modified Class 2 fringe wetland. It is a narrow fringe wetland located between the river and South River Road. It is a PFO that has been modified by the road development and associated culverts. The wetland is wider toward Rice Road Bridge but for the most part is a long narrow feature with steep banks. The dominant canopy along the river's edge observed was eastern cottonwood, American sycamore, honeylocust, silver maple, and black walnut. Shrubs found in this wetland are boxelder, sandbar willow, black willow, green ash, princesstree and roughleaf dogwood. The herbaceous layer is nearly 95% of the cover and is composed of Canada goldenrod, *Carex* spp., and reed canary grass.

ORAM Scoring Boundary 6 (13.36 acres): This Scoring Boundary consists of JD delineated wetlands 14 and 15. It expands approximately 2200 feet along the left descending bank of the Sandusky River as part of a wide forested floodplain. It also cover the areas surrounding an unnamed tributary (Stream 2) next to a campground. The extent of the wetland boundary is dictated by South River Road. This boundary received a Category 3 rating (75.0). Although there is hydrologic connection between each wetland with a defined scoring boundary, it is our professional opinion that Wetland 15 is the only wetland that provides Category 3 quality and function. Wetland 14 has open mudflat areas under the canopy and the open areas are dominated by reed canarygrass.

Wetland 14: The wetland is an 2.47 acres is PFO that receives hydrology both from the Sandusky River and Stream 2 flooding. It starts just north of the campground next to Steam 2. It has narrow fringe parts along the Sandusky River as well as wide forested floodplain. Within the forest community are interspersed plant assemblages such as dominated by patches of roughleaf dogwood, and reed canarygrass. The canopy is composed of eastern cottonwood, silver maple, black walnut, red maple, sycamore, and black willow. Other common herbaceous species observed were clearweed, swamp buttercup, false nettle, Canada goldenrod, jumpseed, Kentucky bluegrass, prairie cordgrass, Gray's sedge, great ragweed, and swamp smartweed. Reed canarygrass dominates the open areas north of Stream 2.

No vernal pools were observed. The observed vegetation along the fringe of the Sandusky River was eastern cottonwood, American sycamore and green ash trees with black and sandbar willow understory.

Bore ID 14: Water table at 2ft, sand at 3 ft, refusal at 4 ft, 0-2" - 10YR 4/2 organic layer silty clay; 2-36" - 10YR 3/2 with 5YR 3/3 mottles 35% silty clay; 36-44" - 10YR 4/1 with 10YR 5/6 - 65% abd 5YR 2.5/2 - 10% Sandy Clay; 44-48" - 2.5YR 4/3 Sand

Table C.12 Vegetation Plot Bore ID 14

Scientific Name	Stratum	Percent Cover
Populus deltoides	tree	20
Acer negundo	tree	5
Phalaris arundinacea	herb	75
Poa pratensis	herb	20
Polygonum pensylvanicum	herb	5
Rumex crispus	herb	1
Glechoma hederacea	herb	1

Wetland 15: The wetland is a 10.89 acre PFO that is part of the wide floodplain of the Sandusky River. This wetland had a diverse interspersion of mixed plant assemblages of herbaceous and shrubs underneath the forest canopy. The canopy is composed of cottonwood, silver maple, American elm, sycamore, and black willow. The subcanopy and shrub communities consist of cottonwood, boxelder, green ash, American elm, black willow, amur honeysuckle, hawthorn and honeylocust. The herbaceous vegetation is composed of Virginia iris, Canada goldenrod, lizard's tail, Frank's sedge, reed canarygrass, common reed, and broadleaf arrowhead. Standing water and vernal pool were observed. Reed canarygrass dominates open areas. Emerald ash borer has killed many of the ash trees.

Bore ID 5: water table at 2.3ft, 0-16" - 10YR 4/2 with 5YR 3/3 - 10% -silty clay; 16-36" - 10YR 2/2 loam; 36-60" - 10YR 3/2 with 10YR 5/6 - 40% silty clay

ORAM Scoring Boundary 7 (1.24 acres): This scoring boundary consists of JD delineated Wetland 16. This wetland is part of the riparian corridor for approximately 3200 feet along the left descending bank of the Sandusky River. This boundary received a Category 2 rating (52.0).

Wetland 16: The wetland is 1.23 acres PFO along the Sandusky River. It is a narrow fringe wetland adjacent to residential lawns with mixed forest, shrub and herbaceous plant assemblages. The canopy is composed of cottonwood, silver maple, green ash, sycamore, and box elder. The shrub layer consists of sandbar willow and black willow. The herbaceous vegetation is composed of lizard's tail, water hemlock, wild parsnip, and reed canary grass. Large patches of lizard tail are inundated on the edge of the resevoir.

ORAM Scoring Boundary 8 (0.09 acres): This is a small boundary only consisting of JD delineated Wetland 17. This boundary received a Category 1 rating (14.5).

Wetland 17: This PEM wetland is 0.09 acres and is a Category 1 wetland due to the dominant presence of reed canarygrass. The other herbaceous vegetation is composed Pennsylvania smartweed and common ragweed. The wetland is located below the seawall just above the dam.

APPENDIX D

Section 8 - Conceptual Mitigation Report: Plant List

A general meandering vegetation survey was performed throughout the entire project area documenting the common plants observed in the JD delineated wetlands. The following is the list of common plants:

Table D-1. Plant List

Scientific Name	**Common Name**
Acalypha virginica	Virginia threeseed mercury
Acer negundo	boxelder
Acer rubrum	red maple
Acer saccharinum	silver maple
Ailanthus altissima	tree-of-heaven
Alisma triviale	northern water plantain
Alliaria petiolata	garlic mustard
Allium canadense	meadow garlic
Ambrosia artemisifolia	annual ragweed
Ambrosia trifida	great ragweed
Anemone canadensis	Canadian anenome
Apocynum cannabinum	Indianhemp
Arctium minus	lesser burdock
Arisaema dracontium	green dragon
Asclepias incarnata	swamp milkweed
Asclepias spp	milkweed
Asclepias syriaca	common milkweed
Betula nigra	river birch
Bidens frondosa	devil's beggartick
Boehmeria cylindrica	smallspike false nettle
Carex crinita	fringed sedge
Carex frankii	Frank's sedge
Carex grayi	Gray's Sedge
Carex lasiocarpa	awlfruit sedge
Carex planispicata	flat-spiked sedge
Carex scoparia	broom sedge
Carex spp	sedge
Carex stipata	woollyfruit sedge
Catalpa speciosa	northern catalpa
Cephalanthus occidentalis	common buttonbush
Cercis canadensis	eastern redbud
Chamaecrista fasciculata	partridge pea
Cicuta maculata	spotted water hemlock
Convolvulus arvensis	field bindweed
Cornus drummondi	roughleaf dogwood
Crataegus spp	hawthorn
Cryptotaenia canadensis	Canadian honewort
Cuscuta americana	American dodder
Elymus riparius	riverbank wildrye

Elymus virginicus	Virginia wildrye
Equisetum hyemale	scouringrush horsetail
Eragrostis spp	lovegrass
Fraxinus pensylvanica	green ash
Geranium maculatum	spotted geranium
Gerardia spp	foxglove
Geum canadense	white avens
Geum laciniatum	rough avens
Glechoma hederacea	ground ivy
Gleditsia triacanthos	honeylocust
Helenium autumnale	common sneezeweed
Heracleum maximum	common cowparsnip
Humulus lupulus	common hop
Hydrophyllum canadense	bluntleaf waterleaf
Impatiens capensis	jewelweed
Iris pseudacorus	paleyellow iris
Iris versicolor	harlequin blueflag
Juglans nigra	black walnut
Justicia americana	American water-willow
Laportea canadensis	Canadian woodnettle
Leersia oryzoides	rice cutgrass
Leersia virginica	whitegrass
Lonicera maackii	Amur honesuckle
Ludwigia alternifolia	seedbox
Lycopus americanus	American water horehound
Lysimachia ciliata	fringed loosestrife
Lysimachia nummularia	creeping jenny
Menispermum canadense	common moonseed
Mimulus ringens	Allegheny monkeyflower
Morus rubra	red mulberry
Osmorhiza longistylis	longstyle sweetroot
Oxalis stricta	common yellow oxalis
Parthenocissus quinquefolia	Virginia creeper
Pastinaca sativa	wild parsnip
Paulownia tomentosa	princesstree
Penstemon canescens	eastern gray beardtongue
Penthorum sedoides	ditch stonecrop
Phalaris arundinacea	reed canarygrass
Phlox glaberrima	smooth phlox
Phragmites australis	common reed
Phyla lanceolata	lanceleaf fogfruit
Pilea pumila	Canadian clearweed
Plantago lanceolota	narrowleaf plantain
Plantago major	common plantain
Platanus occidentalis	American sycamore
Poa pratensis	Kentucky bluegrass

Polygonum hydropiperoides	swamp smartweed
Polygonum pensylvanicum	Pennsylvania smartweed
Polygonum persicaria	spotted ladysthumb
Polygonum spp	smartweed
Polygonum virginianum	jumpseed
Polymnia canadensis	whiteflower leafcup
Populus deltoides	eastern cottonwood
Populus grandidentata	bigtooth aspen
Potentilla simplex	common cinquefoil
Quercus palustris	pin oak
Ranunculus hispidus	bristly buttercup
Ranunculus septentrionalis	swamp buttecup
Ranunculus spp	buttercup
Rosa multiflora	multiflora rose
Rosa spp	rose
Rubus allegheniesis	Allegheny blackberry
Rubus idaeus	raspberry
Rudbeckia lacianata	cutleaf coneflower
Rumex altissimus	pale dock
Rumex crispus	curly dock
Rumex verticillatus	swamp dock
Sagittaria latifolia	broadleaf arrowhead
Salix interior	sandbar willow
Salix nigra	black willow
Saururus cernuus	lizard's tail
Scutellaria lateriflora	blue skullcap
Senecio spp.	ragwort
Smilax rotundifolia	roundleaf greenbriar
Solidago canadensis	Canada goldenrod
Solidago graminifolia	flat-top goldentop
Solidago juncea	early goldenrod
Solidago spp	goldenrod
Solidago uliginosa	bog goldenrod
Spartina pectinata	prairie cordgrass
Symphyotrichum lateriflorum	calico aster
Toxicodendron radicans	eastern poison ivy
Ulmus americana	American elm
Urtica dioica	stinging nettle
Verbesina alternifolia	wingstem
Veronia spp	ironweed
Viburnum acerfolium	maple leaf viburnum
Viola spp	violet
Vitis riparia	riverbank grape

APPENDIX E

Ice Control Structure Design Report

Ice Control Structure
Design Report

Ballville Dam Removal
Sandusky River
Fremont, Ohio

Stantec

August 26, 2013

Sign-off Sheet

This document entitled Ice Control Structure Design Report was prepared by Stantec Consulting Services Inc. for the City of Fremont, Ohio. The material in it reflects Stantec's best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. Stantec Consulting Services Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

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Table of Contents

EXECUTIVE SUMMARY I

1.0 ICE CONTROL STRUCTURE PROJECT OVERVIEW 1
1.1 STANTEC'S STUDY OF BALLVILLE DAM AND ICE RELATED FLOOD CONTROL 1
1.2 ICE FLOODING ON THE SANDUSKY RIVER 2
1.3 ICS DESIGN OBJECTIVE 3

2.0 ICS SELECTION 3
2.1 ICE BOOMS 4
2.2 ICE NET STRUCTURE 5
2.3 THRUST BLOCKS, BOULDERS, AND PIERS 6
2.4 COMBINATION STRUCTURES 7
2.5 RECOMMENDED ICE CONTROL STRUCTURE 8

3.0 ICS LOCATION AND DESIGN GEOMETRY 9
3.1 HYDRAULIC MODELING 9
3.2 LOCATION SELECTION 10
3.2.1 Upstream Areas 11
3.2.2 Current Dam Location (Downstream) 11
3.2.3 Downstream Areas 12
3.3 ICS GEOMETRIC DESIGN CRITERIA 12
3.3.1 Design Event 12
3.3.2 Pier Spacing 14
3.3.3 Pier Diameter 15
3.3.4 Embedment Depth 15
3.3.5 Pier Strength Analyses 15

4.0 ICS DESIGN SUMMARY 16
4.1 PRELIMINARY OPINION OF CONSTRUCTION COSTS 16

5.0 REFERENCES 18

LIST OF TABLES

Table 1 Ice Control Structure Evaluation Summary 9
Table 2 Summary of Results of Structural Analyses of ICS Piers 16
Table 3 Preliminary Opinion of Construction Costs 17

LIST OF FIGURES

Figure 1 Floating Ice Boom 4
Figure 2 Debris Net Structure 5
Figure 3 Ice Pier Structure Cazenovia Creek 7
Figure 4 Ice Pier-Net Structure Laboratory Model 8
Figure 5 ICS Locations Considered 10
Figure 6 Sandusky River Historic Flood Discharges 13
Figure 7 Sandusky River Recorded Ice Thicknesses 14

LIST OF APPENDICES

APPENDIX A HYDRAULIC MODELING RESULTS A.0
A.1 Graphical Flood Profile A.1
A.2 Tabular HYDRAULIC MODEL Results A.2

APPENDIX B STATISTICAL ANALYSES B.0
B.1 STATISTICAL ANALYSES B.1

APPENDIX C STRUCTURAL CALCULATIONS C.0
C.1 STRUCTURAL CALCULATIONS C.1
C.2 LPile COMPUTER Program Output C.2

Executive Summary

This report addresses design considerations for an Ice Control Structure (ICS) to help reduce potential ice jam related flooding damage associated with the accumulation of ice downstream of the City of Fremont, Ohio due to the removal of Ballville Dam.

The Ballville Dam is located on the Sandusky River upstream of the City of Fremont (City). The concrete gravity overflow structure is approximately 410 feet in length and 35 feet in height. The dam, originally constructed in 1911 for hydroelectric power, was purchased by Fremont in 1959. The impoundment was used for the community's raw water supply until 2013.

The dam and its associated structures and gates have deteriorated over the years, and are now considered unsafe. In 2007, the Ohio Department of Natural Resources (ODNR) issued a Notice of Violation to the City requiring the city to repair, correct, or remove the dam. In lieu of costly repairs, the City proposes to remove the dam. This action provides additional benefits by promoting fish passage to fish spawning habitat located in the reach above the dam, as well as improving water quality.

The dam currently provides some level of ice retention for downstream areas, particularly during floods influenced by ice floes. During winter months, sheet ice can form behind the dam and catch other ice floes. Removal of the dam could allow this ice to continue downstream, worsening the impact of ice jams or causing new ice jams to form.

Ice related floods could reduce the effectiveness Fremont's system of flood control levees. Therefore, the USACE Cold Regions Research and Engineering Laboratory (CRREL) has recommended that an Ice Control Structure (ICS) be incorporated into the dam removal project (Vuyovich, 2008) (Carr, Tuthill, & Vuyovich, 2011).

This report addresses issues related to the design of an ICS that will be constructed as a part of the dam removal project. The report includes: an overview of the mechanics of ice control on the Sandusky River; a review of types of ICS structures and a recommendation for the Ballville Dam Removal project; a description of the hydraulic modeling used to assess alternative locations; and geometric design considerations for the ICS.

A preliminary design for a proposed break-up ICS also is presented. The recommended "comb-like" structure allows fish passage and recreational activities and requires less maintenance than some other ICSs. This design would consist of approximately 15 concrete cylindrical piers approximately 6-feet in diameter and spaced approximately 21 feet on center across the river channel. This design allows for passing the 10-percent-annual-chance (10-year) storm event while retaining the captured ice. A conceptual opinion of ICS project costs of $1.56 million is included for planning purposes.

1.0 Ice Control Structure Project Overview

The Ballville Dam is located on the Sandusky River upstream of the City of Fremont (City), Ohio. The concrete gravity overflow structure is approximately 410 feet in length and 35 feet in height. The dam was originally constructed in 1911 for hydroelectric power. Fremont purchased it in 1959 after it was no longer used for generating electricity, and used the impoundment as the community's raw water supply for many years, before completing a separate, off channel raw water reservoir in 2013.

The dam and its associated gates and sea wall have deteriorated over the years, and are now considered unsafe. In 2007, the Ohio Department of Natural Resources (ODNR) issued a Notice of Violation to the City requiring repairs, correction, or removal. In lieu of costly repairs and with support of grants from the U.S. Fish and Wildlife Agency and other Federal and State interests, removal of the dam is being proposed by the City to promote fish passage, improve water quality and aquatic habitat, and provide increased recreational opportunities. Consideration for removing the dam was previously discussed by Stantec in the *Ballville Dam Removal Feasibility Study* in 2011 (Stantec, 2011) (Feasibility Study). The City has engaged Stantec to continue the design and permitting effort for removing Ballville Dam.

An issue discussed in the Feasibility Study is the dam's ability to provide flood control for downstream areas during floods influenced by ice floes and ice jams. This report addresses the design considerations for an Ice Control Structure (ICS) to help reduce potential flooding associated with the accumulation of ice downstream of Fremont due to the removal of Ballville Dam.

1.1 STANTEC'S STUDY OF BALLVILLE DAM AND ICE RELATED FLOOD CONTROL

The Sandusky River is located in north-central Ohio and generally flows in a northeasterly direction to its outlet into Lake Erie. The Feasibility Study focused on a reach of the Sandusky River that extends from its confluence at Muddy Creek Bay and Sandusky Bay, upstream approximately 20 river miles past the City of Fremont (river mile (RM) 15 to 18) and Ballville Dam (RM 18), to a point upstream of West County Road 201 and downstream of the community of Old Fort. The US Army Corps of Engineers (USACE) Buffalo District previously studied flood potential along this reach for the community's Federal Emergency Management Agency (FEMA) Flood Insurance Study by developing a hydraulic simulation model using the USACE HEC-RAS software. Stantec obtained a copy of this model and used it to analyze the hydraulic effects of the dam removal project for non-ice related events as a part of the Feasibility Study.

Stantec's hydraulic analyses completed in 2011 primarily considered flood elevation reductions upstream of the dam and the potential for scouring of the accumulated sediment upstream of the dam. The following fundamental assumptions applied to those analyses:

- Post-dam removal channel geometry in the model consisted of channel bedrock elevations achieved after scour similar to reaches upstream and downstream of the dam
- Hydrologic attenuation of flood peaks was not considered
- Hydrologic storage by Ballville Dam was assumed to provide no appreciable flood reduction benefits
- Sub-critical flow regime was assumed throughout the reach; upstream changes will not cause a decrease in downstream water surface elevations

Stantec concluded that the velocities generated in the river near the dam location after removal would be enough to support scour of the accumulated sediment. Stantec determined that the sediment would not have a long-term adverse flood impact downstream (less than 0.5-foot maximum rise).

The USACE Cold Regions Research and Engineering Laboratory (CRREL) suggests that removing the dam would increase the volume of ice available to lower reaches of the Sandusky River, therefore increasing the potential of ice jams downstream of Fremont. CRREL recommended an ICS be considered as a potential way of mitigating the ice jam flood threat (Vuyovich, 2008; Carr, Tuthill & Vuyovich, 2011).

1.2 ICE FLOODING ON THE SANDUSKY RIVER

The cause for the ice related floods in Fremont is related directly to the mechanics of ice jam formation and “ice cover progression” as described by USACE in EM-1110-2-161, “Engineering Design, Ice Engineering Manual”. (USACE, 2002) (Vuyovich, 2008) The following terms are key to understanding ice jam processes and ICS design as described in this report:

- Sheet ice is formed along slow moving areas of water when freezing temperatures occur for several days. This formation is often described as “thermally grown” sheet ice.
- Frazil ice can be described as floating slush within a very cold, but not yet frozen, water body.
- Floes are masses of floating ice, either frazil or larger solid pieces of sheet ice, which are transported downstream.

The City of Fremont is located near the boundary of lake level influence on the Sandusky River. The low grade, low energy section of the river from the City to the mouth of the river enables the accumulation and formation of thermally grown sheet ice. When frazil ice and breakup ice floes from upstream reaches encounter the thermally grown sheet ice, they can accumulate and form ice jams. When an ice jam is present and a flood occurs, the ice jam becomes an obstruction to flow and may lead to higher upstream or backwater river stages, increasing the chances of flooding in Fremont.

The reach upstream of Fremont near the Ballville Dam is characterized by a steeper grade and faster moving water of the type where frazil ice might form. Instead, the presence of Ballville Dam allows sheet ice to form. Upstream of the dam to downstream of Tiffin, the river bed has a more gradual slope causing sheet ice to form.

The presence of sheet ice upstream of Ballville Dam interrupts the ice cover progression process upstream of Fremont. The dam's sheet ice acts as a partial barrier to upstream floes of frazil and break-up ice. This promotes the formation of ice jams near the upstream end of Ballville Dam's impoundment and reduces the amount of ice available to form jams downstream, thus reducing the risk of ice jam-related flooding. It should be noted that the dam does not prevent all ice from reaching Fremont as Vuyovich documents ice flows over the dam (Vuyovich, 2008).

CRREL, in the investigation of ice hydraulics associated with the removal of Ballville Dam, recommended an ICS be included in the removal project to help mitigate potential negative effects associated with ice that would have otherwise been captured or controlled by the dam. (Carr, Tuthill, & Vuyovich, 2011)

1.3 ICS DESIGN OBJECTIVE

Based on the ice cover progression, jam development, and potential flood scenario described above, Stantec was asked by the City to incorporate an ICS into the design if Ballville Dam is to be removed. The objective of this study is to choose a location and design an ICS that attempts to have a commensurate level of protection to Fremont from ice jam related flooding risk associated with removing the dam. The goal of the ICS selection and design process is to create a structure that will replicate or improve on the ability of the existing Ballville Dam to control ice in this portion of the Sandusky River.

Control of frazil and break-up ice, with comparatively low cost of installation, operation, and maintenance are desirable features of the ICS. During this study, Stantec reviewed several potential types of ICS structures often used and recommends a type for this application, makes use of the hydraulic modeling developed for the Feasibility Study to further explore potential locations and geometric configurations, develops a design geometry based on risk assessment methods, and provides a recommended configuration for the proposed structure based on the data presented.

2.0 ICS Selection

Ice Control Structures generally fall into two classes based on their function: those that form and control sheet ice or those that catch and retain break-up ice floes from upstream areas.

Sheet ice retention structures such as booms, nets, weirs, or dams are frequently used to induce thermally grown ice sheets over larger spans. Sheet ice retention structures typically

require low surface velocities (< 2.3 ft/s), low energy slopes, and low Froude Numbers (< 0.08) (a measure of energy and hydraulic flow conditions). (USACE, 2002)

Breakup ice control structures such as thrust blocks, divided weirs, channel blocks or boulders, and pier structures are generally placed at strategic locations in a stream and are designed to catch breakup ice floes to form a controlled jam that protects downstream areas.

The ICS for the Sandusky River must at a minimum provide breakup ice control in order to prevent increases in size of downstream ice jams from occurring. A breakup ICS would protect bridges by preventing ice jams from occurring at bridge piers. One important benefit for removing the dam is fish passage so it is important that the selected ICS allow fish to move freely along the river.

ICS configurations that may be appropriate for the Sandusky River include: booms; net structures; thrust blocks, boulders and piers; and combination structures. The sections that follow describe how they might be applied to the Ballville Dam Removal Project.

2.1 ICE BOOMS

Ice booms like the one shown in Figure 1 have been primarily used for developing sheet ice cover and inducing freeze up jams. Booms are generally temporary structures that can be installed and removed as needed. They are constructed of floating pontoons attached to a flexible wire or cable system with varying size and spacing. They may be anchored to the stream bed as well; however, caution must be exercised to avoid freezing of the boom to the river bottom, which can cause a blockage.

BMT Fleet Technology

Figure 1 Floating Ice Boom

These structures have little impact on natural river function under no-ice conditions. They require relatively small upfront capital investment to install, but have higher operation and maintenance costs throughout their lifecycle. Regular operation and maintenance would include annual installation of the boom, regular inspection for wear and potential defects, and likely

repairs or replacement after large ice events. Debris removal would also be required as needed.

For a boom to work in the Sandusky River, a suitable location with deeper, slow moving water would need to be identified. The boom would help control sheet ice formation, but would not provide much benefit for frazil or breakup ice, unless the velocity was relatively low. Structurally, the boom would not likely have the required strength to withstand larger ice jams. From the review of potential ICS locations, described in Section 3 of this report, a boom could function as intended if it were placed downstream of Fremont or farther upstream of the Ballville Dam location. Unfortunately, these locations are not ideal to form ice jams that would help protect Fremont from flooding damage. Because of the poor suitability of the location and inability to control frazil and breakup ice, an ice boom is not recommended.

2.2 ICE NET STRUCTURE

In some locations, structures consisting of cables and nets are stretched across smaller channels to help control debris and trap ice. An example designed to control debris is shown in Figure 2. Many of these are improvised structures intended only to catch debris or control access, but they often inadvertently act as ice control structures during winter freeze-up conditions. For those intended to control ice, like ice booms with suspended debris nets, these are generally temporary in nature. Depending on the design, the structures may fill with ice and freeze up to form a weir, or be used in conjunction with a fixed weir to catch ice and provide a delay before failure at some preset design limit. The nets may be a way to catch frazil floes and initiate a jam. The relatively weak structural integrity makes them easily overwhelmed when faced with sufficient forces. Stacking of ice behind a jam formed upstream of the structure, as described in “ice cover progression” scenario previously discussed, would likely produce better results than stacking at the structure itself due to the added structural support of the banks and other in channel features. Stacking at the net could lead to the increased probability of pushing it down and releasing ice over the top. (Morse, Francoeur, Delcourt, & Leclerc, 2006)

Geobrugg

Figure 2 Debris Net Structure

Nets with proper opening sizes would promote fish passage between up- and downstream river segments. Initial investment for net structures would be relatively low, but operation and maintenance costs could be higher with likely frequent maintenance while in use.

A net structure in the Sandusky River would be required to have to span a distance of 200-feet or more and would control a significant volume of ice. Flood discharges would be anticipated to make the river elevations and velocities fluctuate. The forces involved would require the net structure to be substantial to resist failure. Literature indicates some scale modeling studies have been performed to simulate how they might function on larger streams, but there does not appear to be an application of these for a waterbody the size of the Sandusky River. Due to the anticipated loading conditions and the difficulty in operation and maintenance, not to mention the uncertainty on how it would perform on a river the size of the Sandusky, an ice net structure is not recommended.

2.3 THRUST BLOCKS, BOULDERS, AND PIERS

These types of ICSs appear to be the most frequently used and studied. Literature review indicates some documented success in catching and retaining breakup ice floes. The typical configuration consists of a series of permanent obstructions spaced evenly across the width of the river. A variety of configurations have been used in previous designs, including: large boulders placed on the stream bed, concrete thrust blocks anchored into the channel, and round or elongated concrete piers oriented parallel with flow. Geometric dimensions (height, length, and widths) as well as spacing on these structures vary, with many pier structures resembling a “comb-like” arrangement.

The function of this type of ICS is generally to catch large sheets of ice, which then interlock to bridge over the gaps and form an ice jam. The ice jam is typically grounded at the toe of the structure, building vertically and upstream. The structure generally must be capable of maintaining excess flow around or over the ice jam, or be located adjacent to an accessible floodplain for flood flow relief. This prevents further increases in water level that could overtop the structure, compromise the grounded toe, or washout ice through the piers. Pier heights vary based on floodplain elevations, ice storage requirements, and design discharge. Structures placed in river reaches where the formation of sheet ice immediately upstream is possible also benefit from the structural strength of the sheet ice and potential ice jams associated with it. Design loads must be given careful considerations and are often comparable to highway bridge pier specifications.

One example of this type of structure, a series of ice-retaining piers, was constructed by USACE on Cazenovia Creek, located in West Seneca, NY. Figure 3 is a photo of the Cazenovia Creek ice pier structure from USACE. The slope of the channel and post-dam removal average flow velocities (0.004-0.005 ft/ft and ~4-6 ft/s respectively) for that structure appear to be comparable to the typical winter conditions downstream of Ballville Dam on the Sandusky River. At Cazenovia Creek, the 5 ft. diameter cylindrical piers are spaced with 12-ft gaps and protrude 2 feet above the adjacent floodplain elevation, where there is a relief flow channel adjacent to the

structure. (Tuthill & Lever, 2006) The Cazenovia Creek structure was constructed in 2005 and successfully controlled ice during an ice floe in 2007. (Vuyovich, 2008)

USACE

Figure 3 Ice Pier Structure Cazenovia Creek

These structures allow for fish passage, but would be a permanent visual impact on the river. Initial costs for pier structures are relatively high, due to the amount of work and materials needed, but operation and maintenance efforts are lower than temporary structures. No operation is involved with the structures as they are permanent and stand alone. Maintenance may be required for debris removal and less frequently in the form of concrete repair and abutment armor replacement. An ICS structure of the type described, particularly a comb pier structure, has precedence in other locations and appears to be a suitable option for the Sandusky River.

2.4 COMBINATION STRUCTURES

Combinations of the previous structures may also be used for ice protection. A boom-net structure utilizes booms attached to the top of a single-span net across a river section. Pontoons on the boom help catch surface ice and support the net, so that ice is successfully wedged into the net to start a jam and ice does not flow over the top. Structures like the one shown in Figure 4 have been tested in laboratory applications and at small scales; however, little is known about how well they might function on a larger river. Research suggests these structures are more appropriate for smaller rivers (<100 feet width) and greater flow depths. (Morse, Francoeur, Delcourt, & Leclerc, 2006) Greater widths increase forces on the structural elements, thus prohibitively driving up the cost of the structure. Shallow flow depths are not as effective due to potential freeze-up of the net to the channel bottom and strength required to sustain ice piling up on the net. The boom-net structure is not recommended due to the location constraints, anticipated forces on the net structure, and operation and maintenance concerns.

(Morse, Francoeur, Delcourt, & Leclerc, 2006)

Figure 4 Ice Pier-Net Structure Laboratory Model

Pier-net structures combine a comb pier structure with a temporary net anchored to the piers. They are comprised of permanent piers spaced across the channel with the addition of temporary, high tensile steel nets between piers. The nets are anchored to the river bed and the piers. Loading analyses determine the span of the net (or pier spacing). The combination allows for fewer piers and subsequently wider spacing. The nets potentially have higher capture efficiency of smaller frazil floes, which reduces the need for sheet ice upstream of the piers for jam formation at the structure. As previously mentioned, there does not appear to be an application of these for a waterbody the size of the Sandusky River. Due to the anticipated loading conditions and the difficulty in operation and maintenance of the net, and the absence of scale trials of such a structure, a combination pier-net structure is not recommended.

2.5 RECOMMENDED ICE CONTROL STRUCTURE

Table 1 summarizes the desired criterion for an ICS on the Sandusky River and the benefits delivered by each type of ICS considered. Based on this summary, a pier type ICS is recommended. This structure may not be as effective at promoting formation of sheet ice or capturing frazil ice, but it would function to control break-up ice and fit within the geometry of the Sandusky River near the Ballville Dam location.

Table 1 Ice Control Structure Evaluation Summary

	Type of Structure			
	Boom	Net	Piers	Combination Pier-Net
Forms Sheet Ice	✓	✓	✗	✓
Captures Frazil Ice	✗	✓	✗	✓
Captures Breakup Ice	✗	✓	✓	✓
Compatible w/ Flow & Velocity	✗	✗	✓	✗
Compatible w/ Sandusky River Geometry	✓	✓	✓	✓
Visual Impact (Rank)	1	2	3	4
Installation Cost (Rank)	1	2	3	4
Operation and Maintenance Cost	2	3	1	4
Precedence in Other Locations	✓	✗	✓	✗
Perceived Overall Rank	4	3	1	2

Rankings are presented as Best (1) to Worst (4)

3.0 ICS Location and Design Geometry

Key design features of the ICS have been identified in terms of location and physical geometry. Stantec used the anticipated hydraulic operation of the ICS to determine design parameters and geometry.

3.1 HYDRAULIC MODELING

Stantec used the HEC-RAS model developed by the USACE Buffalo District for the ICS design. This was the same base model used for the Feasibility Study. For comparison Stantec obtained a copy of the HEC-RAS model that CRREL used in their 2011 study of potential ice impacts of the removal of Ballville Dam. The CRREL model was based on the same Buffalo District model with no apparent changes to the model geometry. CRREL added ice accumulation behind various cross sections based on ice jam locations and thicknesses determined from reviewing historic records of the Sandusky River.

The average winter flow was used as the base condition for the ICS design. The average winter discharge and ice thickness values were calculated using monthly averages for November through February between the years 1923 and 2011 from US Geological Survey (USGS) Stream Flow Gage # 04198000 located on the Sandusky River at river mile 2.4. The results and comparison of simulations with and without the dam is presented in Appendix A.

Removal of the dam caused increased velocity and decreased water surface elevations at and just upstream of the dam location. Simulations using the average winter flow indicated removal caused an increase in velocity of approximately 5.3 feet/second (ft/s) and a decrease in water

surface elevation of approximately 24.0 feet immediately upstream of the dam location. This combination will likely result in sediment erosion, causing a decrease in channel bed elevation of ten feet or more at the location of the dam. This decrease in minimum channel elevation is apparent on the graphical profile shown in Appendix A.

The resulting HEC-RAS model was then used to evaluate potential locations for an ICS and potential interactions with the City's flood protection system.

3.2 LOCATION SELECTION

Based on the prior CRREL analyses of the Sandusky River ice floes and review of the hydraulic modeling results, the most suitable location for the ice structure would be near the current dam. Based on the design and operation of the ICS on Cazenovia Creek, the site would need to have an area for bypass flow (i.e. an adjacent floodplain) or be capable of maintaining the ice and flood event within the channel. Stantec considered three areas with these criteria in mind: upstream of the dam (two different locations), at the current dam location (actually slightly downstream), and well downstream of the dam. The four locations are shown on Figure 5 and discussed further below.

Figure 5 ICS Locations Considered

3.2.1 Upstream Areas

In the CRREL study from 2011, two possible sites for the ICS location were proposed upstream of the current dam: one around River Mile (RM) 19.1 (XS 92000 in the model) and another close to RM 18.4 (XS 88000). (Carr, Tuthill, & Vuyovich, 2011) River mile (RM) 19.1 is close to the location of the City's new raw water reservoir intake. The anticipated width and depth of the channel after the Ballville Dam is removed would support a pier ICS structure. The higher elevations of the channel banks make it a feasible location for providing floodplain release of bypass flow, though some homes could be at increased risk of flooding in the vicinity. In addition, the distance from the current dam may contribute to excess frazil ice generation downstream of the ICS. Due to risk to homes in the vicinity and distance from the current dam location, this location was omitted from further consideration.

Approximately 1,500 feet upstream of the dam, at RM 18.3-18.4 (XS 87500), the depth of the river (based on model results and assuming scour has occurred) is approximately 4 feet and the velocity is 2.3 ft/s during average winter flow. Based on USACE guidelines this flow regime would be suitable for sheet ice retention and could allow sheet ice to form. (USACE, 2002) There is a secondary channel and a large wetland area on the right side of the Sandusky River that could be modified to allow overflow. This location is close to the dam and operation of an ICS here would provide similar protection as the dam and affect a similar area.

An assumption with this location is that the desired channel configuration would depend on scour, which may take several years to achieve without extensive intervention through construction. Construction would be costly as approximately 10 feet of sediment will need to be removed from the channel bed before the ICS could be placed and natural channel scour processes will need to occur before the ICS reaches its full effectiveness. These activities could be difficult and costly to implement before the pool is drawn down and the dam is removed. At that point, any delays in construction result in exposure of areas downstream to increased risks.

Other features of this location that make it less desirable are that it would be highly visible from the adjacent cemetery and properties to the northeast (a possible negative effect on the current viewshed) and an access road will need to be constructed along the previously undisturbed left embankment (increased direct impact effects).

Although this location is feasible from an operational standpoint, the constructability issues could lead to increased costs and its impacts are not desirable.

3.2.2 Current Dam Location (Downstream)

A location just downstream of the dam near RM 17.9 (XS 85750) was considered based on constructability and geometry. This area is essentially within the discharge zone for Ballville Dam and is characterized by a shallow channel that is founded on bedrock. Model results of typical winter flow conditions indicate that after dam removal the anticipated depth of water would be approximately 2 feet and the velocity would be 6 ft/s. The velocity is fast enough to preclude the use of this location for developing sheet ice cover, but a break up structure could

be used. The channel is wide enough and deep enough such that a storm and ice event can be maintained within the channel, so an overflow channel would not be needed.

The ICS construction could occur largely independent of the dam removal effort with minimal changes to the existing conditions and minimal additional impacts beyond the dam removal effort. Upstream flooding impacts of this structure would also be less than the existing dam.

3.2.3 Downstream Areas

Downstream of the dam at RM 16.6 (XS 78500), the depth of the river is approximately 4 feet and the velocity is 1.43 ft/s, based on model results. On the left side of the river is a golf course that could be configured to allow flood overflows without impacting structures. This area seems to fit the necessary hydraulic criteria with low velocity and an available overflow area. This location is downstream of County Road 53 Bridge. There is a chance for ice to collect upstream of the bridge causing flooding to structures in the vicinity. This is also near the area protected by levees, so flooding here increases the risk of flood impacts to the levee system. Other areas downstream of the Ballville Dam location were reviewed and found to have similar issues. The increased risk of flooding makes these areas ineffective for an ICS and they were eliminated from consideration as potential locations.

3.3 ICS GEOMETRIC DESIGN CRITERIA

The current dam location is recommended for the ICS placement. Depths and velocities during the typical winter condition would be anticipated to be on the order of 2 feet and 6 ft/s respectively. Stantec has based the design on desired operation. The goal is for the piers to capture a designated amount of ice, allow a chosen storm to pass while retaining that captured ice, withstand the forces associated with the combination event, and have a geometry conducive to effective operation. This design results in a pier height, pier spacing, pier diameter, and embedment depth directly related to the hydraulic operation of the ICS and the geologic conditions at the chosen site. Further discussion of the design aspects follows.

3.3.1 Design Event

The design event was calculated using historical records of flood and ice events reported by CRREL and stream flow gage data obtained from USGS Gage #04198000. Each historical event has a corresponding peak flood discharge and estimated ice thickness. Ice thickness and flow were ranked from highest to lowest and subsequently a frequency was calculated for each of these occurrences, using Equation 1.

$$P(x) = \frac{m}{N} \qquad \text{Equation 1.}$$

Where: x = a particular occurrence, P(x) = probability of the occurrence of x, m=the rank of x with all observed occurrences, N = total number of observations.

Ice jam related flooding occurs when these two events, accumulation of ice and occurrence of a large discharge, happen simultaneously. These events are not related and are independent. To relate the relative frequency or risk of the two independent events happening at the same time, the combined probability of the two independent datasets was calculated using Equation 2.

$$P(x,y) = \frac{cd}{(cd+(1-c)(1-d))} \qquad \text{Equation 2.}$$

Where: x or y = a particular occurrence of an independent event, P(x,y) = probability of the occurrence of x and y, c = probability of x from Eq.1, d = probability of y from Eq.1

From equations 1 and 2, the probability of event X can be explained as the probability of a flood peak discharge exceeding a certain value X. The probability of event Y would relate to the probability of ice thickness exceeding a certain value Y. The probability of X and Y would be the probability of ice being thicker Y when a flood with a discharge greater than X occurred. Results from this analysis are included in Appendix B and the datasets are presented graphically in Figures 6 and 7. It can be noted that the two events highlighted in yellow in Figures 6 and 7 (1959 and 1963) had ice jams that caused flooding in Fremont, and occurred while Ballville Dam was in place.

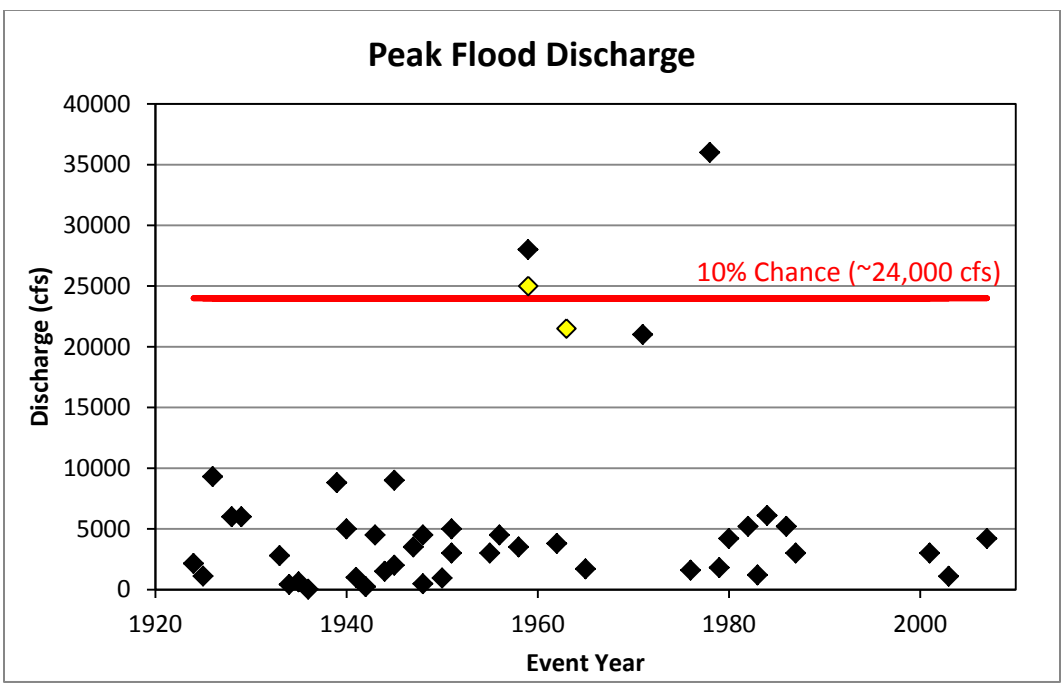

Figure 6 Sandusky River Historic Flood Discharges

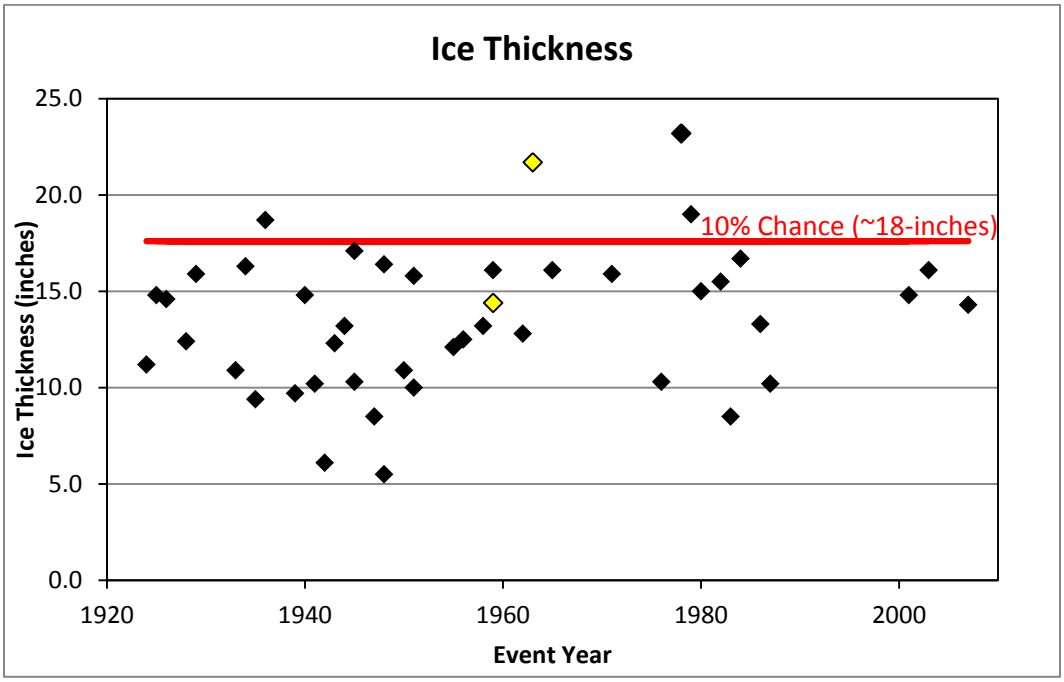

Figure 7 Sandusky River Recorded Ice Thicknesses

The ICS needs to be at least as effective as the current dam. The two combined events which caused flooding (1959 and 1963) occurred when the joint probability had an 11.2-percent or less chance of occurring. To be conservative, the ICS was designed to hold both the ice thickness and discharge of 10-percent or lower chances of occurrence independently. At 10-percent probability of occurrence the ice thickness based on historic records would be about 18 inches thick or greater. At 10-percent probability of occurrence, the USGS gage discharge would be 24,000 cfs or greater. The actual combined probability of these two events would be 1.2-percent, which is much more conservative than the 11.2-percent for the events in 1959 and 1963 that Ballville Dam could not prevent.

As a factor of safety and to account for stacking of ice, the ice thickness allowance was actually set at twice the design value or 3 feet and the ICS was designed to still pass the 10-percent chance flood event without overtopping or flowing around the structure with that amount of ice in place. Based on model geometry at the recommended location, these design parameters translated to an ICS height of approximately 12 feet as predicted by the results of the HEC-RAS model.

3.3.2 Pier Spacing

Spacing of the piers was selected based on capturing and containing the largest free-floating mass of sheet ice that would be of concern downstream. The USACE Cazenovia Creek ICS design reports that “ICS gap width can be set at about 15 times the *minimum* ice thickness that poses an ice jam threat under existing conditions”. (Tuthill & Lever, 2006) From Figure 7, the typical recorded ice thickness is about 12 inches (1.0 foot) and the design thickness is about 18

inches (1.5 feet). Therefore, 15-22.5 feet would be the designed gap width, with the smaller end of that range, which is more conservative, having a better chance of capturing smaller sheets of ice from upstream.

3.3.3 Pier Diameter

The pier diameter was assumed to be 6 feet. It was set in accordance to USACE guidelines for ice control structures in similar conditions. (Tuthill & Lever, 2006) (Stantec, March 2013) For a pier diameter of 6 feet and a desired gap width of 15 feet, the pier spacing would be 21 feet on center.

3.3.4 Embedment Depth

Stantec performed a geotechnical exploration of the proposed site and the results have been submitted separately. (Stantec, March 2013) In general, the channel bottom at the project site was found to consist of dolomitic limestone. The embedment depth for each pier was assumed to be 15 feet based on strength requirements. Additional discussion is included in the Stantec geotechnical exploration report.

3.3.5 Pier Strength Analyses

The loads from ice for the piers were determined using guidelines found in AASHTO “Bridge Design Specifications”. (American Association of State Highway Transporation Officials (AASHTO), 2010) A copy of the calculation spreadsheet containing the method for determining loads using the equations is presented in Appendix C. For reference, the top of the ICS piers was assumed to be elevation 610 feet.

Two loading conditions were analyzed:

- Loading Condition 1 – Ice breakup upstream occurs at melting temperatures resulting in an ice floe 2 feet thick, in addition to the design flood discharge. The top elevation of the ice floe is 610.0 feet. This simulates ice jam during a flood.

- Loading Condition 2 – Ice breakup or major ice movement occurs when the ice temperature is below the melting point (averaged over its depth). The top elevation of the ice floe is 600.5 feet. The ice is assumed 2 feet thick. This simulates ice loading without a flood.

The L-Pile computer program (Version 5.0, Ensoft, Inc.) and the ShortCol program for use in spreadsheets (shareware,Yakpol.net) were used for iterative analyses of the pier. Load Resistance Factor Design (LRFD) resistance factors of 0.9 for bending and 0.75 for compression were used in ShortCol. The results of the strength analyses are presented in Table 2.

Table 2 Summary of Results of Structural Analyses of ICS Piers

Loading Condition	Horizontal Force (kips)	Maximum Moment (kip-ft)	Deflection At Top Of Pier (inches)	Factor of Safety	Steel Reinforcement (No. & Size)
1	157	1912.8	0.20	2.1	24, #10
2	627	1856.3	0.05	2.2	24, #10

The steel reinforcing is circular and is to be tied with nominal spiral shear reinforcing. Computer program output is presented in Appendix C.

4.0 ICS Design Summary

The potential exists for the dam removal to contribute to downstream ice jams, which could cause increased water surface elevations and associated flood damage downstream. An ice control structure would reduce the likelihood of ice continuing downstream from the Ballville Dam location, where it could cause associated flooding risks. Therefore, an ICS is recommended downstream of the current dam location as a part of removing the dam. This location is suitable to capture breakup ice. This section of the river is capable of containing the storm event and ice buildup within the channel. The location is close enough to the dam that it can capture a similar amount of ice breakup from upstream as the existing dam does.

The ICS is recommended to be a pier structure consisting of approximately 15 piers, spaced 21 feet on center. The piers would be approximately 12 feet tall and 6 feet in diameter, embedded approximately 15 feet into rock. A pier structure is being recommended because it has the ability to protect downstream areas from breakup ice floes with minimal operation and maintenance requirements compared to other types of structures. The pier structure allows the passage of fish and recreational activities.

This design was used in the Cazenovia Creek ICS, which has proved successful in its ice jam flood prevention. (Carr, Tuthill, & Vuyovich, 2011) The Sandusky River ICS and the Cazenovia Creek ICS are comparable in structure and channel characteristics. Based on results thus far for the Cazenovia Creek ICS, the Sandusky River ICS would be expected to perform in a similar manner.

4.1 PRELIMINARY OPINION OF CONSTRUCTION COSTS

Stantec developed a preliminary opinion of construction cost for the proposed ICS. The opinion shown in Table 3 is conceptual.

Table 3 Preliminary Opinion of Construction Costs

Item No.	Description	Units	Quantity	Unit Price	Item Cost*
1	ICS Coffer dam for water diversion	Ea.	15	$5,000	$75,000
2	Floodplain protection (rock or wood bollards)	Ea.	6	$2,000	$12,000
3	ICS Dewatering pump/treatment system	Day	60	$1,500	$90,000
4	ICS caissons	V.L.F.	760	$500	$380,000
5	ICS Caisson rock excavation	C.F.	3,534	$100	$354,000
6	ICS Caisson rig mob/demob.	Ea.	4	$15,000	$60,000
7	Steel Reinforcing	TN	67.8	$3,350	$228,000
				ICS Construction Cost:	$1,199,000
				+ Construction Contingency (30%):	$360,000
				=Total Opinion of Cost:	**$1,559,000**

* - Costs are rounded up to the nearest thousand ($1,000)

5.0 References

American Association of State Highway Transporation Officials (AASHTO). (2010). *Load and Resistance Factor Design (LRFD) Bridge Design Specifications, 5th Edition.*

Carr, M., Tuthill, A., & Vuyovich, C. (2011). *Removal of the Ballville Dam on the Sandusky River at Fremont, OH Ice-Hydraulic Analysis.* Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory. New Hampshire: US Army Corps of Engineers.

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USACE. (2002). *EM-1110-2-1612 Engineering and Design-Ice Engineering Manual.* US Army Corps of Engineering.

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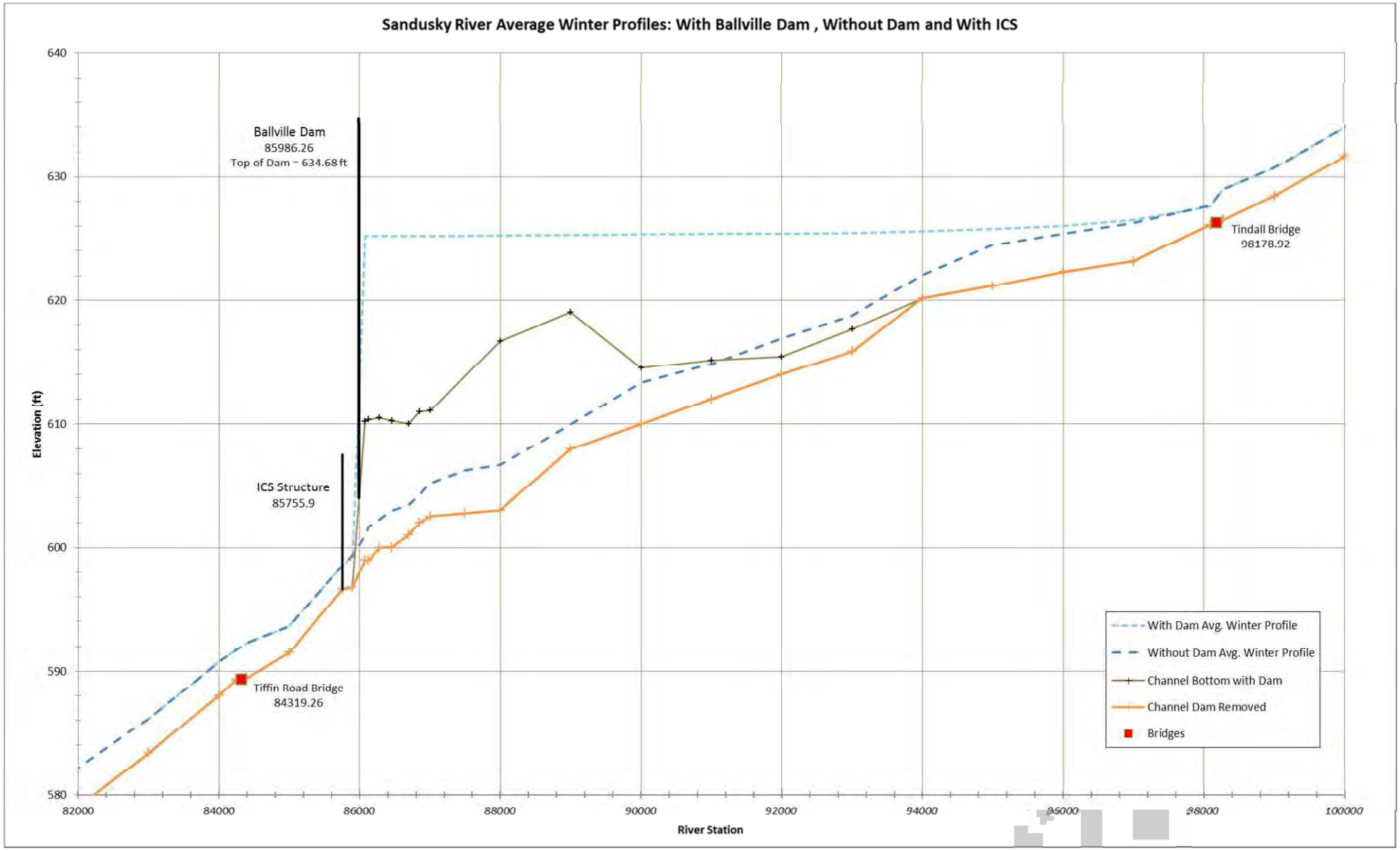
Appendix A Hydraulic Modeling Results

A.1 GRAPHICAL FLOOD PROFILE

APPENDIX A.1 GRAPHICAL FLOOD PROFILE



NOT TO SCALE

A.2 TABULAR HYDRAULIC MODEL RESULTS

APPENDIX A.2 TABULAR HYDRAULIC MODEL RESULTS

River Station	WITH DAM				WITHOUT DAM				DIFFERENCE [w/o-with]	
	Min Channel El. With Dam	WSEL With Dam 1%	Depth of Water (ft)	Velocity with Dam (ft/s)	Min Channel El. - Eroded	WSEL Without Dam 1%	Depth of Water (ft)	Velocity without Dam (ft/s)	Velocity (ft/s)	Depth (ft)
105000.00	635.77	639.05	3.28	1.79	635.77	639.05	3.28	1.79	0.00	0.00
104000.00	634.98	638.39	3.41	2.41	634.98	638.39	3.41	2.41	0.00	0.00
103000.00	634.04	637.74	3.70	2.00	634.04	637.74	3.70	2.00	0.00	0.00
102015.90	633.78	637.33	3.55	1.69	633.78	637.33	3.55	1.69	0.00	0.00
101000.00	633.40	636.52	3.12	2.76	633.40	636.52	3.12	2.76	0.00	0.00
100000.00	631.67	633.97	2.30	3.71	631.67	633.97	2.30	3.71	0.00	0.00
99000.00	628.45	630.75	2.30	3.48	628.45	630.75	2.30	3.48	0.00	0.00
98270.85	626.52	628.99	2.47	3.36	626.52	628.99	2.47	3.35	-0.01	0.00
98088.88	626.12	627.59	1.47	5.58	626.12	627.66	1.54	5.26	-0.32	0.07
97000.00	623.17	626.50	3.33	2.06	623.17	626.25	3.08	2.25	0.19	-0.25
96000.00	622.32	626.02	3.70	2.15	622.32	625.38	3.06	2.83	0.68	-0.64
95000.00	621.16	625.77	4.61	1.41	621.16	624.50	3.34	2.18	0.77	-1.27
94000.00	620.16	625.59	5.43	1.28	620.16	622.06	1.90	6.24	4.96	-3.53
93000.00	617.66	625.43	7.77	1.17	615.87	618.75	2.88	2.67	1.50	-4.89
92000.00	615.46	625.40	9.94	0.67	614.00	616.94	2.94	3.17	2.50	-7.00
91000.00	615.13	625.38	10.25	0.64	612.00	614.85	2.85	3.07	2.43	-7.40
90000.00	614.50	625.36	10.86	0.67	610.00	613.31	3.31	2.44	1.77	-7.55
89000.00	619.01	625.32	6.31	0.76	608.00	609.98	1.98	5.75	4.99	-4.33
88000.00	616.71	625.25	8.54	0.80	603.00	606.66	3.66	2.12	1.32	-4.88
87000.00	611.07	625.22	14.15	0.67	602.50	605.18	2.68	3.38	2.71	-11.47
86850.00	611.00	625.22	14.22	0.54	602.00	604.23	2.23	4.61	4.07	-11.99
86700.00	609.99	625.22	15.23	0.49	601.00	603.43	2.43	3.98	3.49	-12.80
86455.00	610.24	625.22	14.98	0.52	600.00	602.96	2.96	2.89	2.37	-12.02
86280.00	610.49	625.22	14.73	0.51	600.00	602.30	2.30	4.38	3.87	-12.43
86130.00	610.34	625.22	14.88	0.45	599.00	601.69	2.69	3.36	2.91	-12.19
86076.27	610.20	625.22	15.02	0.43	599.00	600.98	1.98	5.77	5.34	-13.04
85895.92	593.49	595.12	1.63	2.27	593.49	595.11	1.62	2.29	0.02	-0.65
85755.90	593.18	594.89	1.71	2.34	593.18	594.89	1.71	2.34	0.00	-1.11
85000.00	591.49	593.59	2.10	2.82	591.49	593.59	2.10	2.82	0.00	-1.27
84400.10	589.46	592.31	2.85	3.37	589.46	592.31	2.85	3.37	0.00	2.85

River Station	WITH DAM				WITHOUT DAM				DIFFERENCE [w/o-with]	
	Min Channel El. With Dam	WSEL With Dam 1%	Depth of Water (ft)	Velocity with Dam (ft/s)	Min Channel El. - Eroded	WSEL Without Dam 1%	Depth of Water (ft)	Velocity without Dam (ft/s)	Velocity (ft/s)	Depth (ft)
105000.00	635.77	639.05	3.28	1.79	635.77	639.05	3.28	1.79	0.00	0.00
104000.00	634.98	638.39	3.41	2.41	634.98	638.39	3.41	2.41	0.00	0.00
103000.00	634.04	637.74	3.70	2.00	634.04	637.74	3.70	2.00	0.00	0.00
102015.90	633.78	637.33	3.55	1.69	633.78	637.33	3.55	1.69	0.00	0.00
101000.00	633.40	636.52	3.12	2.76	633.40	636.52	3.12	2.76	0.00	0.00
100000.00	631.67	633.97	2.30	3.71	631.67	633.97	2.30	3.71	0.00	0.00
99000.00	628.45	630.75	2.30	3.48	628.45	630.75	2.30	3.48	0.00	0.00
98270.85	626.52	628.99	2.47	3.36	626.52	628.99	2.47	3.35	-0.01	0.00
98088.88	626.12	627.59	1.47	5.58	626.12	627.66	1.54	5.26	-0.32	0.07
97000.00	623.17	626.50	3.33	2.06	623.17	626.25	3.08	2.25	0.19	-0.25
96000.00	622.32	626.02	3.70	2.15	622.32	625.38	3.06	2.83	0.68	-0.64
95000.00	621.16	625.77	4.61	1.41	621.16	624.50	3.34	2.18	0.77	-1.27
94000.00	620.16	625.59	5.43	1.28	620.16	622.06	1.90	6.24	4.96	-3.53
93000.00	617.66	625.43	7.77	1.17	615.87	618.75	2.88	2.67	1.50	-4.89
92000.00	615.46	625.40	9.94	0.67	614.00	616.94	2.94	3.17	2.50	-7.00
91000.00	615.13	625.38	10.25	0.64	612.00	614.85	2.85	3.07	2.43	-7.40
90000.00	614.50	625.36	10.86	0.67	610.00	613.31	3.31	2.44	1.77	-7.55
89000.00	619.01	625.32	6.31	0.76	608.00	609.98	1.98	5.75	4.99	-4.33
88000.00	616.71	625.25	8.54	0.80	603.00	606.66	3.66	2.12	1.32	-4.88
87000.00	611.07	625.22	14.15	0.67	602.50	605.18	2.68	3.38	2.71	-11.47
86850.00	611.00	625.22	14.22	0.54	602.00	604.23	2.23	4.61	4.07	-11.99
86700.00	609.99	625.22	15.23	0.49	601.00	603.43	2.43	3.98	3.49	-12.80
86455.00	610.24	625.22	14.98	0.52	600.00	602.96	2.96	2.89	2.37	-12.02
86280.00	610.49	625.22	14.73	0.51	600.00	602.30	2.30	4.38	3.87	-12.43
86130.00	610.34	625.22	14.88	0.45	599.00	601.69	2.69	3.36	2.91	-12.19
86076.27	610.20	625.22	15.02	0.43	599.00	600.98	1.98	5.77	5.34	-13.04
85895.92	593.49	595.12	1.63	2.27	593.49	595.11	1.62	2.29	0.02	-0.65
85755.90	593.18	594.89	1.71	2.34	593.18	594.89	1.71	2.34	0.00	-1.11
85000.00	591.49	593.59	2.10	2.82	591.49	593.59	2.10	2.82	0.00	-1.27
84400.10	589.46	592.31	2.85	3.37	589.46	592.31	2.85	3.37	0.00	2.85

Appendix B Statistical Analyses

APPENDIX B STATISTICAL ANALYSES

Rank	Date	Date (year)	Estimated Ice Thickness (in)	Daily Average Discharge (cfs)	Ice Probability (%)	Discharge Probability (%)	Combined Probability (%)
1	15-Mar-78	1978	23.20	36000	1.69	8.43	0.16
2	6-Mar-63	1963	21.70	21500	3.93	6.18	0.27
3	10-Feb-59	1959	16.10	28000	19.66	1.69	0.42
4	23-Feb-45	1945	17.10	9000	10.67	15.17	2.09
5	22-Jan-59	1959	14.40	25000	46.63	3.93	3.45
6	27-Jan-84	1984	16.70	6100	12.92	19.66	3.50
7	23-Feb-71	1971	15.90	21000	26.40	10.67	4.11
8	14-Feb-48	1948	16.40	4500	15.17	35.39	8.92
9	26-Feb-29	1929	15.90	6000	28.65	21.91	10.13
10	26-Feb-26	1926	14.60	9310	44.38	12.92	10.59
11	24-Feb-79	1979	19.00	1800	6.18	69.10	12.84
12	31-Jan-82	1982	15.50	5200	33.15	26.40	15.10
13	20-Feb-40	1940	14.80	5000	37.64	30.90	21.25
14	20-Jan-86	1986	13.30	5200	51.12	28.65	29.58
15	23-Feb-80	1980	15.00	4200	35.39	44.38	30.42
16	13-Feb-51	1951	15.80	3000	30.90	53.37	33.85
17	6-Feb-28	1928	12.40	6000	62.36	24.16	34.54
18	2-Mar-07	2007	14.30	4211	48.88	42.13	41.04
19	26-Feb-65	1965	16.10	1700	21.91	71.35	41.13
20	31-Jan-01	2001	14.80	3000	39.89	55.62	45.40
21	9-Feb-56	1956	12.50	4500	60.11	37.64	47.63
22	24-Feb-58	1958	13.20	3500	53.37	48.88	52.25
23	26-Jan-62	1962	12.80	3800	57.87	46.63	54.54
24	25-Jan-43	1943	12.30	4500	64.61	39.89	54.78
25	3-Feb-39	1939	9.70	8800	87.08	17.42	58.70
26	23-Feb-03	2003	16.10	1100	24.16	82.58	60.17
27	13-Feb-55	1955	12.10	3000	66.85	57.87	73.47
28	30-Dec-51	1951	10.00	5000	84.83	33.15	73.49
29	7-Feb-25	1925	14.80	1110	42.13	80.34	74.84
30	10-Mar-34	1934	16.30	426	17.42	93.82	76.20
31	10-Mar-44	1944	13.20	1500	55.62	75.84	79.73
32	30-Jan-24	1924	11.20	2150	69.10	64.61	80.32
33	1OFeb33	1933	10.90	2800	71.35	62.36	80.49
34	26-Feb-36	1936	18.70	28	8.43	98.31	84.30
35	4-Feb-87	1987	10.20	3000	80.34	60.11	86.03
36	27-Dec-45	1945	10.30	2000	75.84	66.85	86.36
37	15-Jan-76	1976	10.30	1600	78.09	73.60	90.85
38	23-Jan-47	1947	8.50	3500	91.57	51.12	91.91
39	3-Mar-50	1950	10.90	950	73.60	87.08	94.95
40	9-Feb-41	1941	10.20	1000	82.58	84.83	96.37
41	24-Dec-83	1983	8.50	1200	93.82	78.09	98.19
42	24-Jan-35	1935	9.40	630	89.33	89.33	98.59
43	6-Jan-42	1942	6.10	240	96.07	96.07	99.83
44	27-Dec-48	1948	5.50	480	98.31	91.57	99.84

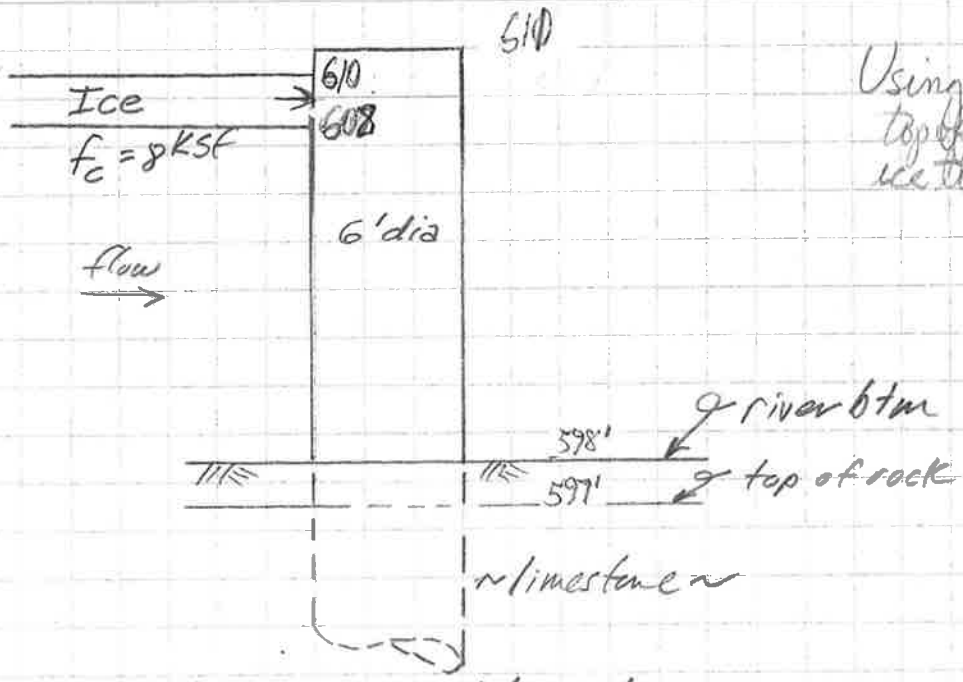
Flooded Freemont with Dam

Appendix C Structural Calculations

C.1 STRUCTURAL CALCULATIONS

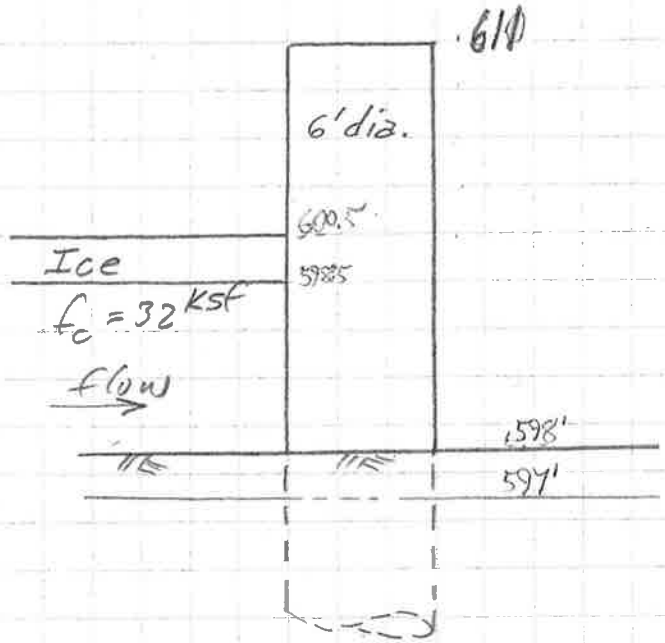
Stantec

Ballville Dam Removal 175630015 Task 416
Ice Control Structure



Using 500yr flood model
top of ice = 610'
ice thickness = 2'

Loading Condition 1



Using flow model from report
- 1.5' of flow
- 2.0' of ice

Loading Condition 2

NTS

Designed by: J Banton PE 1/11/12 Checked by:
D. Rogers, PE 5/23/2013

V:\1756\active\175630015\geotech\Civil\ICS loading\Dynamic and Static Loading.xlsx

175630015: Ballville Dam Removal - Ice Control Structure (ICS)

Following the guidelines found in AASHTO LRFD Bridge Design Specifications, Section 3, 5th Ed. 2010

General Info

Effective Ice Strength	
8.0 ksf	Breakup occurs at melting temperatures; structure is substantially disintegrated
16.0 ksf	Breakup occurs at melting temperatures; structure is somewhat disintegrated
24.0 ksf	Breakup or major ice movement occurs at melting temperatures; ice moves and is internally sound
32.0 ksf	Breakup or major ice movement occurs when the ice temperature is below the melting point (averaged over the its depth)

Equations

$C_a = (5t/w + 1)^{0.5}$

$$Cn = \frac{0.5}{\tan(\alpha - 15)}$$

$F_c = Ca*p*t*w$

$F_b = C_n*p*t^2$

$$Fv = 80.0t^2(0.35 + \frac{0.03R}{t^{0.75}})$$

Variables	
R	Pier radius (ft)
α	Inclination of the nose to the vertical
d	Pier diameter (ft)
w	Pier width at level of ice action (ft)
t	Thickness of ice (ft)
p	Effective ice crushing strength as specified in Article 3.9.2.1 (ksf)
C_a	Coefficient accounting for the effect of the pier width/ice thickness ratio where the floe fails by crushing
C_n	Coefficient accounting for the inclination of the pier nose with respect to a vertical
F_c	Horizontal ice force caused by ice floes that fail by crushing over the full width of the pier (kips)
F_b	Horizontal ice force caused by ice floes that fail by flexure as they ride up the inclined pier nose (kips)
F_v	Vertical force on a bridge pier due to rapid water level fluctuations (kips)

User Defined Values	
d (ft)	6.00
α (degrees)	0.00
w (ft)	6.00
t (ft)	2.00
p (ksf)	8.0
R (ft)	3.00

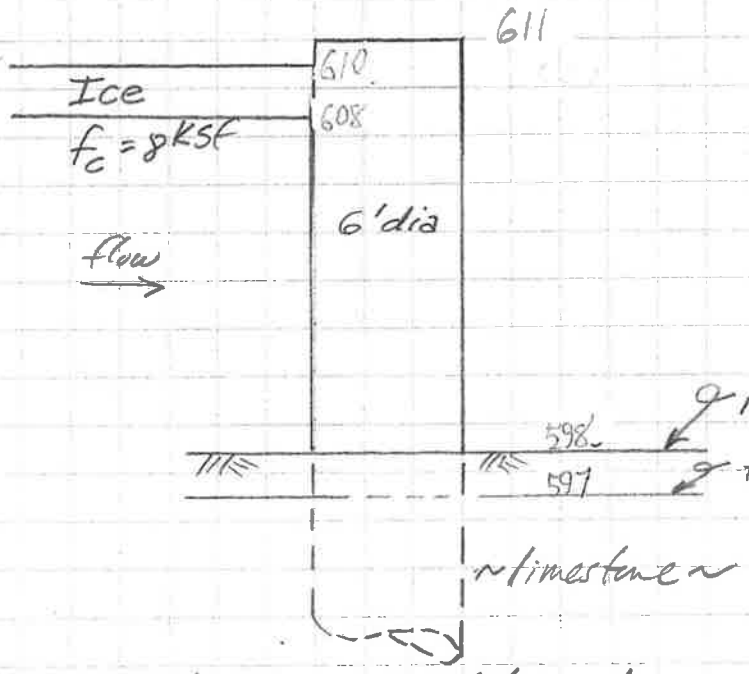
Dynamic Loading			
$w/t \le 6$	✓ 3.00	$w/t > 6$	✗ 3.00
If $w/t \le 6$, F = lesser of either F_c or, when ice failure by flexure is considered applicable, F_b **		If $w/t > 6$, $F = F_c$	
C_a	1.633		
C_n	-1.866		
F_c (kips)	156.7673435		
F_c (Tons)	78		
F_b (kips)**	-59.713		
F_b (Tons)**	-29.856		
Static Loading			
F_v (kips)	129.125		
F_v (Tons)	65		

** When $\alpha \le 15$ degrees, ice failure by flexure shall not be considered to be a possible ice failure mode for the purpose of calculating the horizontal force, F, in which case F shall be taken as F_c

Ballville Dam Removal 175630015 Task 416
Ice Control Structure

Stantec

LPile Input



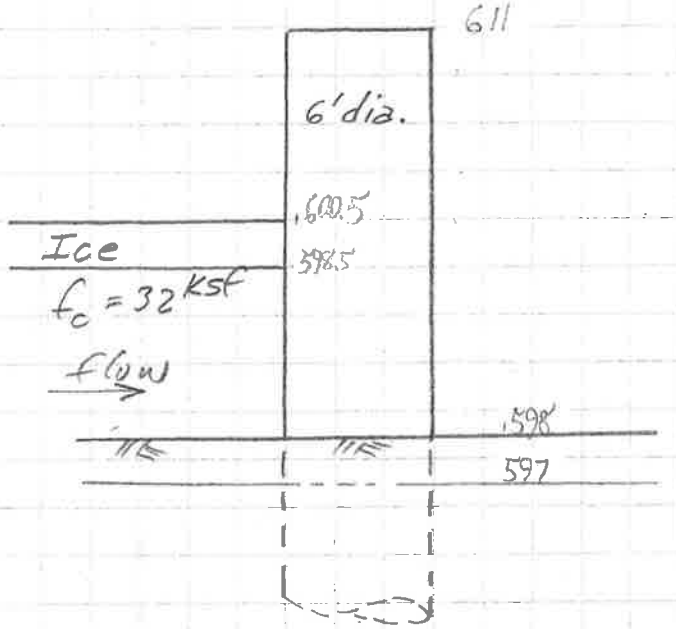
-0" → 157 kip

-144"

Total Length ~ 324"

0.081" 3600 psi

Loading Condition 1



-0" → 627 kip

42"

-30"

Total length 210"

0.081" 3600 psi

Loading Condition 2

NTS

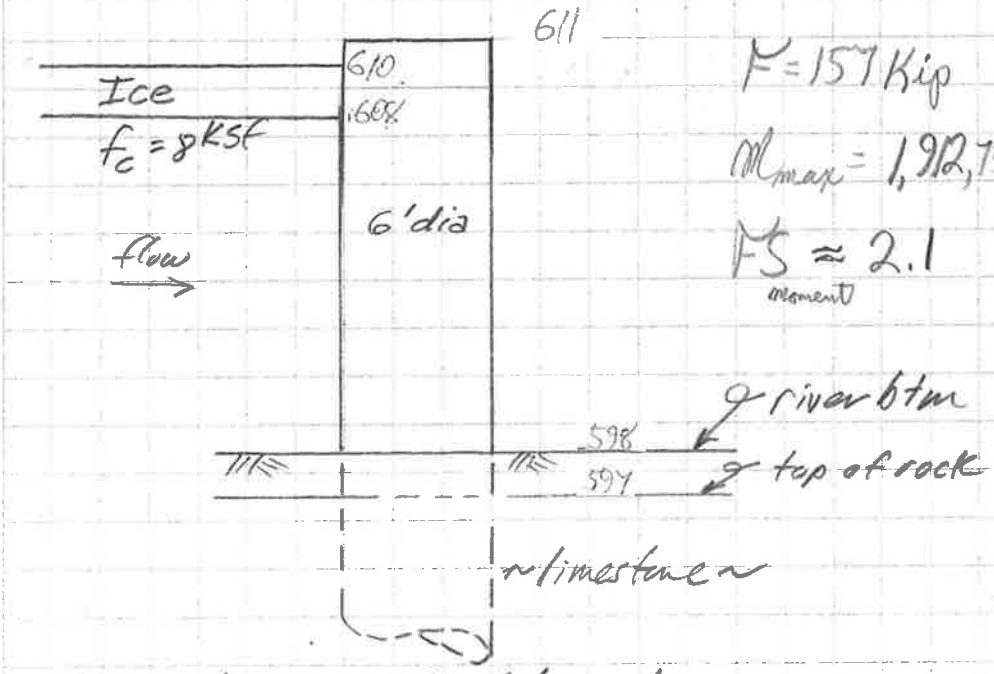
Designed by: J Banton PE 1/11/12 Checked by:

D. Rogers, PE 5/23/2013

Ballville Dam Removal 175630015 Task 416
Ice Control Structure

Stantec

Results

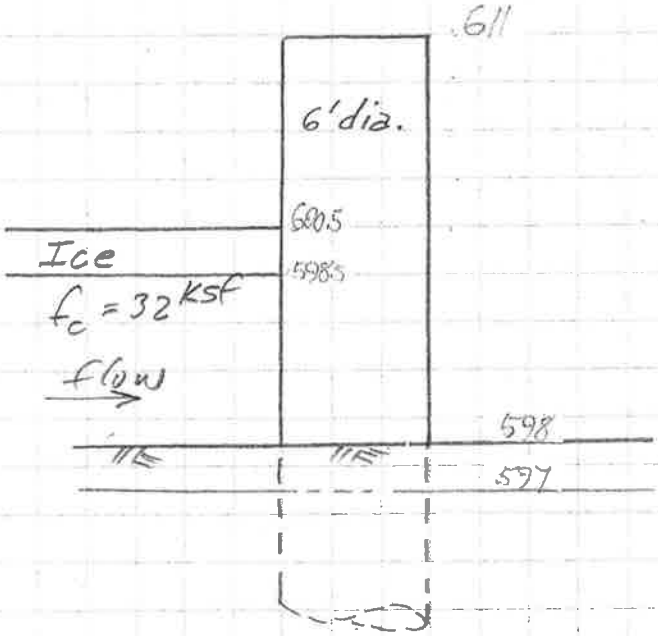


$F = 157$ Kip

$M_{max} = 1{,}912{,}750$ ft-lbs

$FS_{moment} \approx 2.1$

Loading Condition 1



$F = 627$ Kip

$M_{max} = 1{,}856{,}250$ ft-lbs

$FS_{moment} \approx 2.2$

Loading Condition 2

NTS

Designed by: JBanton PE 1/11/12 Checked by:

D. Rogers, PE 5/23/2013

Z:\Spreadsheets\Templates\Concrete column.xls

Stantec	Project: Ballville Ice Control Structure	Engineer: mrs Date: 23-May-13	Project #
ShortCol Copyright © 2007	Subject: 72" Drilled Shaft	Checker: Date:	Page:

Last modified: 06-May-10

Reinforced concrete column capacity

Materials:

Concrete f'_c = 4.5 ksi γ_c = 145 lb/ft³

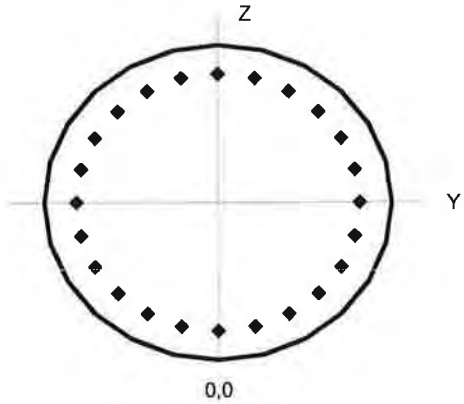
Steel f_y = 60 ksi E_c = 3,865 ksi

Ultimate conc. strain ε_c = -0.003 E_s = 29,000 ksi

Design Code: AASHTO LRFD-static

Resistance Factors ϕ_b = 0.9 ϕ_c = 0.75

Confinement: Spiral



Section Properties:

Diameter = 72 in Width =

A_C = 4071.5 in² A_T = 4269.7 in²

I_C = 1319167 in⁴ I_T = 1404683 in⁴

Y_{bC} = 36 in Y_{bT} = 36.00 in

Reinforcing bars:

Bar Area = 1.27 in²

No.bars = 24 (< 100)

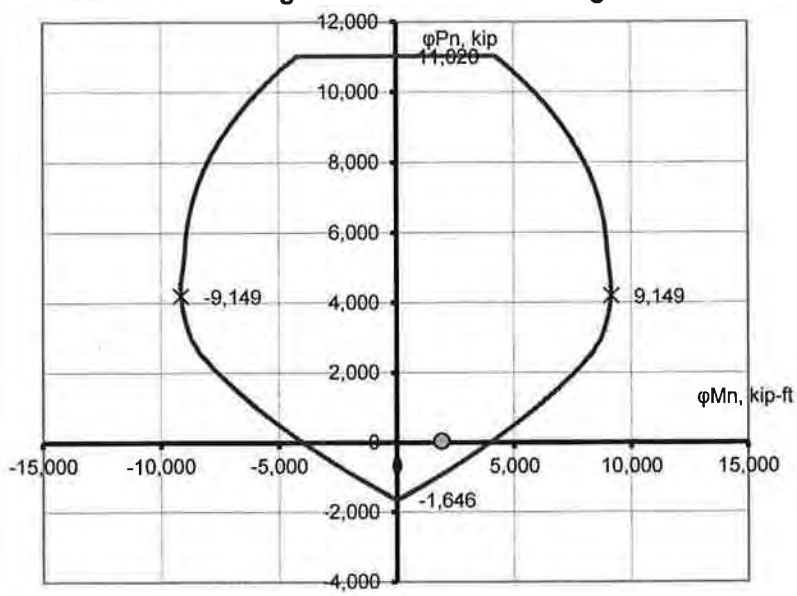
Σ(As) = 30.48 in²

As/Ac = 0.75%

Edge dist. = 6.625 in

Reinforcing Bar No.	Area A_s in²	Coordinates, in Y (from ctr.)	Z (from bot.)
1	1.27	29.38	36.00
2	1.27	28.37	43.60
3	1.27	25.44	50.69
4	1.27	20.77	56.77
5	1.27	14.69	61.44
6	1.27	7.60	64.37
7	1.27	0.00	65.38
8	1.27	-7.60	64.37
9	1.27	-14.69	61.44
10	1.27	-20.77	56.77
11	1.27	-25.44	50.69
12	1.27	-28.37	43.60
13	1.27	-29.38	36.00
14	1.27	-28.37	28.40
15	1.27	-25.44	21.31
16	1.27	-20.77	15.23
17	1.27	-14.69	10.56
18	1.27	-7.60	7.63
19	1.27	0.00	6.63
20	1.27	7.60	7.63
21	1.27	14.69	10.56
22	1.27	20.77	15.23
23	1.27	25.44	21.31

Axial Force/Bending Moment Interaction Diagram

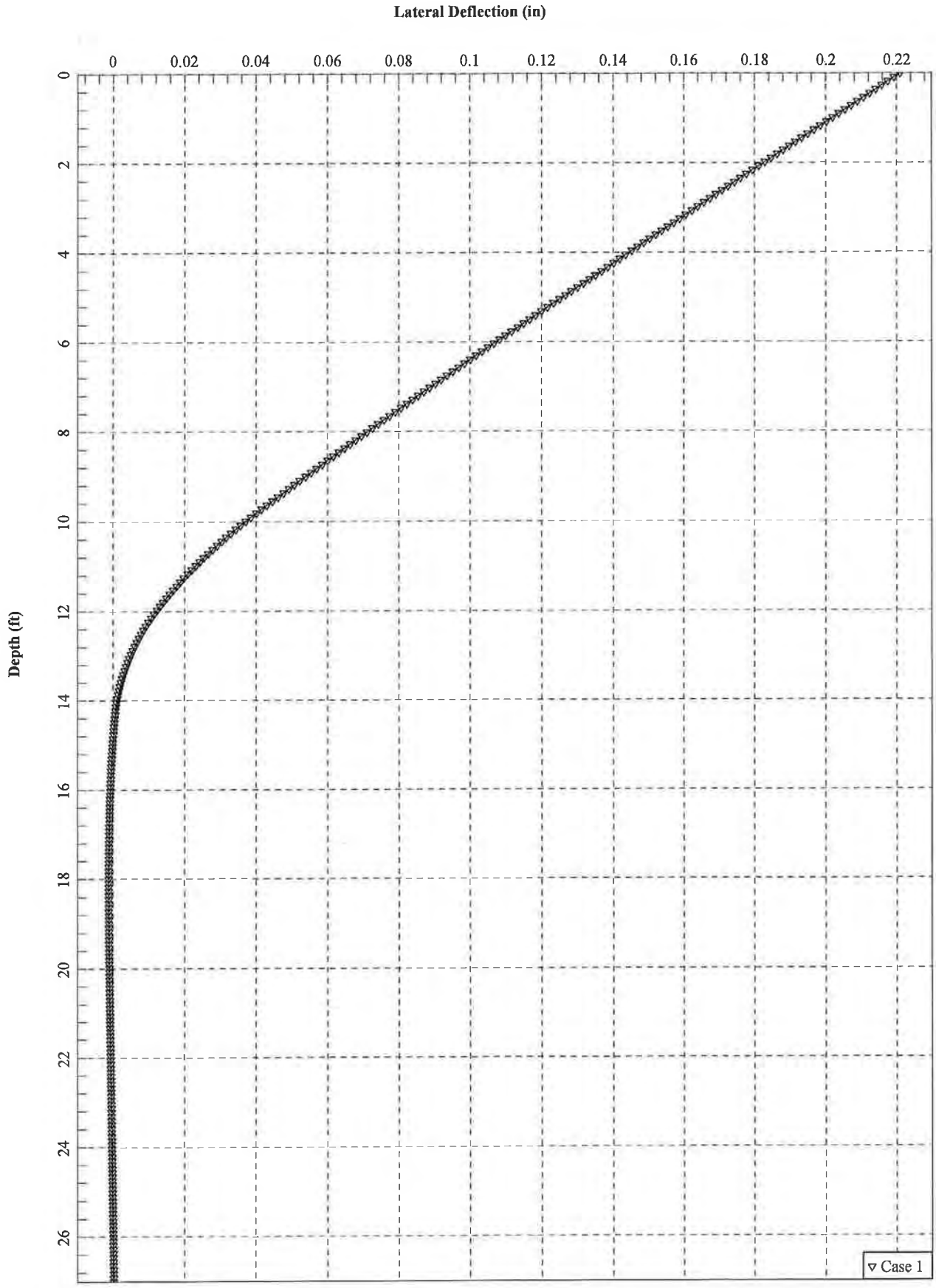


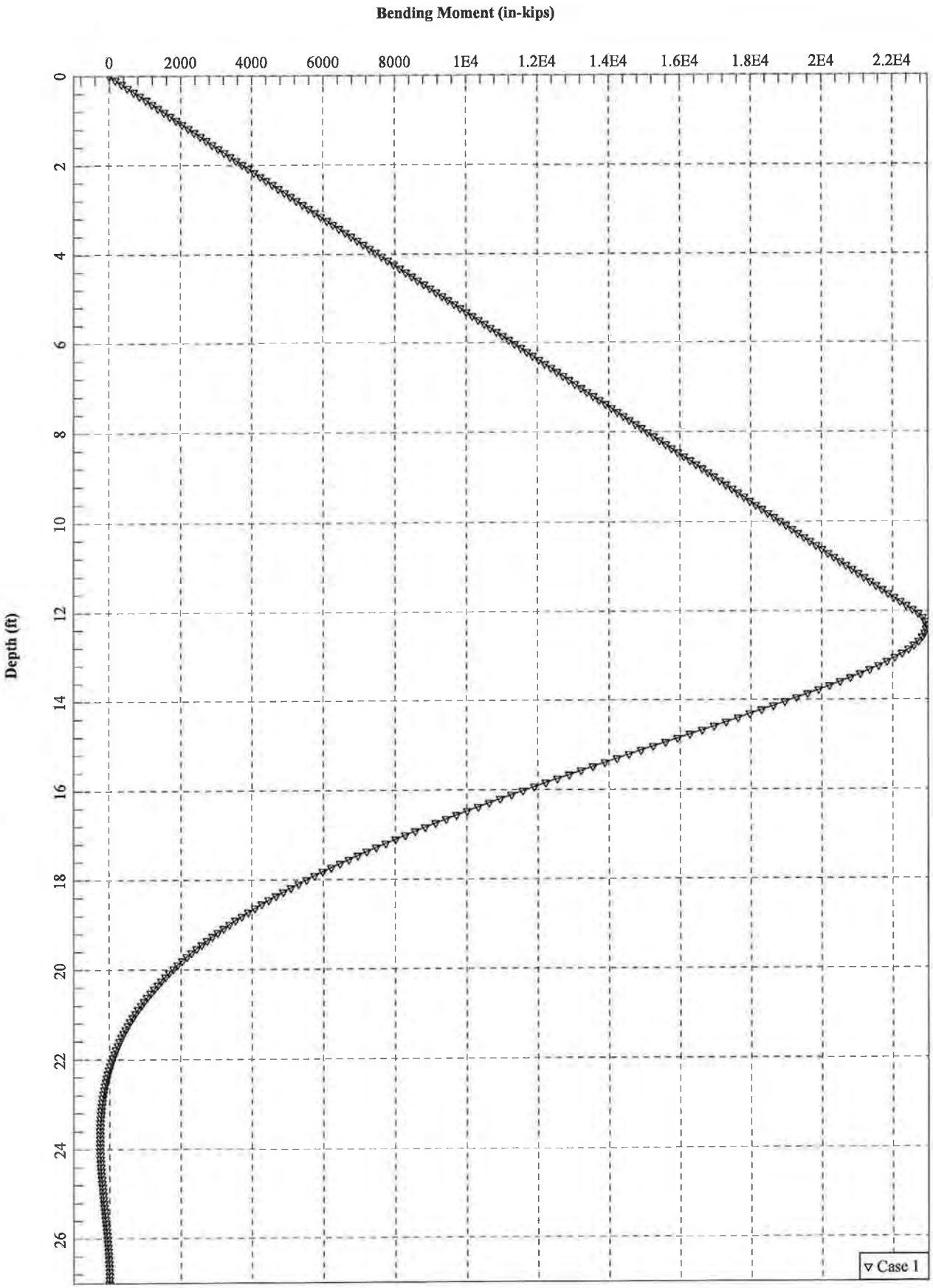
Positive moment corresponds to tension in bottom fibers of the section
Positive axial force is compressive force

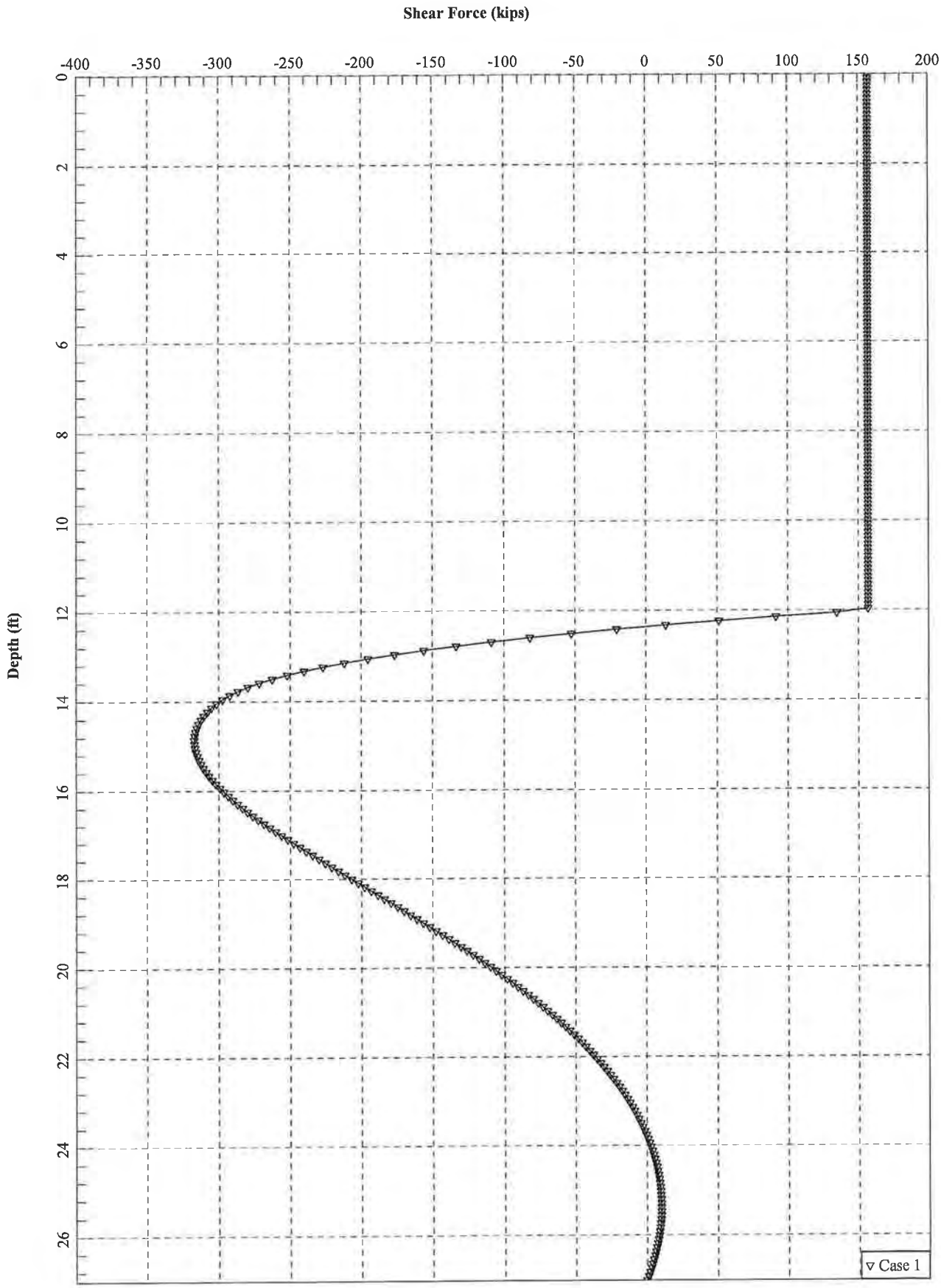
Description	Factored Loads Pu kip	Mu kip-ft	Capacity φMn kip-ft	Demand/ Capacity Ratio
1	31	1918	4058	47%
2	31	1900.8	4058	47%
3				
4				
5				

C.2 LPILE COMPUTER PROGRAM OUTPUT

LPile LC 1


Lateral Deflection (in)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
Case 1


Bending Moment (in-kips)
0
2000
4000
6000
8000
1E4
1.2E4
1.4E4
1.6E4
1.8E4
2E4
2.2E4
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
Case 1


Shear Force (kips)
-400
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
Case 1

==========

LPILE Plus for Windows, Version 5.0 (5.0.47)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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==========

This program is licensed to:

Daniel Rogers, PE
Stantec Consulting Services Inc

Files Used for Analysis

Path to file locations:
V:\1756\active\175630015\geotechnical\analysis\Ballville Dam LPILE\UPDATE 05222013\
Name of input data file: Ballville Dam_LC_1_Downstream.lpd
Name of output file: Ballville Dam_LC_1_Downstream.lpo
Name of plot output file: Ballville Dam_LC_1_Downstream.lpp
Name of runtime file: Ballville Dam_LC_1_Downstream.lpr

Time and Date of Analysis

Date: May 23, 2013 Time: 11:59:17

Problem Title

Ballville Dam Ice Control Structure-LC_1_Downstream

Program Options

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 3:
- Computation of Nonlinear Bending Stiffness and Ultimate Bending Moment Capacity with Pile Response Computed Using Nonlinear EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile

- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments = 300
- Maximum number of iterations allowed = 300
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 324.00 in

Depth of ground surface below top of pile = 144.00 in

Slope angle of ground surface = 0.00 deg.

Structural properties of pile defined using 2 points

Point No.	Point Depth in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	72.00000000	1319167.	4071.5000	3865000.
2	324.0000	72.00000000	1319167.	4071.5000	3865000.

Please note that because this analysis makes computations of ultimate moment capacity and pile response using nonlinear bending stiffness that the above values of moment of inertia and modulus of are not used for any computations other than total stress due to combined axial loading and bending.

Soil and Rock Layering Information

The soil profile is modelled using 1 layers

Layer 1 is strong rock (vuggy limestone)
Distance from top of pile to top of layer = 144.000 in
Distance from top of pile to bottom of layer = 800.000 in

(Depth of lowest layer extends 476.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 2 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3

1	144.00	0.08100
2	800.00	0.08100

Shear Strength of Soils

Shear strength parameters with depth defined using 2 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	144.000	3600.00000	0.00	------	------
2	800.000	3600.00000	0.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 157000.000 lbs
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 0.000 lbs

(Zero moment at pile head for this load indicates a free-head condition)

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Number of sections = 1

Pile Section No. 1

The sectional shape is a circular drilled shaft (bored pile).

Outside Diameter = 72.0000 in

Material Properties:

Compressive Strength of Concrete	=	4.500	kip/in**2
Yield Stress of Reinforcement	=	60.	kip/in**2
Modulus of Elasticity of Reinforcement	=	29000.	kip/in**2
Number of Reinforcing Bars	=	24	
Area of Single Bar	=	1.27000	in**2
Number of Rows of Reinforcing Bars	=	13	
Area of Steel	=	30.480	in**2
Area of Shaft	=	4071.504	in**2
Percentage of Steel Reinforcement	=	0.749	percent
Cover Thickness (edge to bar center)	=	6.625	in

Unfactored Axial Squash Load Capacity = 17285.72 kip

Distribution and Area of Steel Reinforcement

Row Number	Area of Reinforcement in**2	Distance to Centroidal Axis in
1	1.270	29.375
2	2.540	28.374
3	2.540	25.439
4	2.540	20.771
5	2.540	14.687
6	2.540	7.603
7	2.540	0.000
8	2.540	-7.603
9	2.540	-14.687
10	2.540	-20.771
11	2.540	-25.439
12	2.540	-28.374
13	1.270	-29.375

Axial Thrust Force = 0.00 lbs

Bending Moment in-lbs	Bending Stiffness lb-in2	Bending Curvature rad/in	Maximum Strain in/in	Neutral Axis Position inches	Max. Concrete Stress psi	Max. Steel Stress psi
4547209.	5.456651E+12	8.333333E-07	0.00003010	36.11977994	113.32093	712.79052
9050696.	5.430418E+12	0.00000167	0.00006020	36.11953318	224.93635	1425.56910
13510462.	5.404185E+12	0.00000250	0.00009030	36.11928213	334.84627	2138.33545
17926505.	5.377951E+12	0.00000333	0.00012040	36.11903107	443.05079	2851.08967
17926505.	4.302361E+12	0.00000417	0.00006880	16.51232994	251.46414	5904.23930
17926505.	3.585301E+12	0.00000500	0.00008261	16.52262747	300.92168	7083.59402
17926505.	3.073115E+12	0.00000583	0.00009644	16.53297007	350.09865	8262.44340

17926505.	2.688976E+12	0.00000667	0.00011029	16.54336202	398.99421
9440.78334					
17926505.	2.390201E+12	0.00000750	0.00012415	16.55379903	447.60733
10618.61121					
17926505.	2.151181E+12	0.00000833	0.00013804	16.56428325	495.93709
11795.92321					
17926505.	1.955619E+12	0.00000917	0.00015194	16.57481468	543.98253
12972.71593					
17926505.	1.792650E+12	0.00001000	0.00016585	16.58539546	591.74274
14148.98532					
17926505.	1.654754E+12	0.00001083	0.00017979	16.59602559	639.21675
15324.72780					
17926505.	1.536558E+12	0.00001167	0.00019374	16.60670292	686.40347
16499.94051					
17926505.	1.434120E+12	0.00001250	0.00020772	16.61742961	733.30198
17674.61926					
17926505.	1.344488E+12	0.00001333	0.00022171	16.62820780	779.91134
18848.75965					
17926505.	1.265400E+12	0.00001417	0.00023572	16.63903749	826.23054
20022.35793					
17926505.	1.195100E+12	0.00001500	0.00024975	16.64991653	872.25843
21195.41131					
17926505.	1.132200E+12	0.00001583	0.00026380	16.66084707	917.99406
22367.91522					
17926505.	1.075590E+12	0.00001667	0.00027786	16.67182910	963.43635
23539.86593					
17926505.	1.024372E+12	0.00001750	0.00029195	16.68286479	1008.58435
24711.25862					
17926505.	9.778093E+11	0.00001833	0.00030606	16.69395411	1053.43698
25882.08940					
17926505.	9.352959E+11	0.00001917	0.00032018	16.70509493	1097.99299
27052.35557					
18022639.	9.011320E+11	0.00002000	0.00033433	16.71628940	1142.25140
28222.05215					
18763365.	9.006415E+11	0.00002083	0.00034849	16.72753966	1186.21122
29391.17396					
19503234.	9.001492E+11	0.00002167	0.00036267	16.73884571	1229.87130
30559.71695					
20242236.	8.996549E+11	0.00002250	0.00037688	16.75020540	1273.23034
31727.67848					
20980371.	8.991588E+11	0.00002333	0.00039110	16.76162302	1316.28747
32895.05175					
21717631.	8.986606E+11	0.00002417	0.00040535	16.77309644	1359.04136
34061.83408					
22454009.	8.981603E+11	0.00002500	0.00041962	16.78462565	1401.49079
35228.02140					
23189505.	8.976583E+11	0.00002583	0.00043390	16.79621494	1443.63488
36393.60648					
23999380.	8.999768E+11	0.00002667	0.00044800	16.80000007	1484.83975
37564.66661					
24716290.	8.987742E+11	0.00002750	0.00046200	16.80000007	1525.39258
38738.56244					
25431195.	8.975716E+11	0.00002833	0.00047600	16.80000007	1565.59095
39912.45827					
26144096.	8.963690E+11	0.00002917	0.00049000	16.80000007	1605.43488
41086.35411					
26856269.	8.952090E+11	0.00003000	0.00050402	16.80066097	1644.98209
42259.67496					
27586616.	8.947010E+11	0.00003083	0.00051835	16.81149280	1685.08186
43423.86935					
28316055.	8.941912E+11	0.00003167	0.00053271	16.82237613	1724.86565
44587.49292					
29044585.	8.936795E+11	0.00003250	0.00054708	16.83331311	1764.33244

45750.53990					
30498883.	8.926502E+11	0.00003417	0.00057589	16.85534370	1842.30965
48074.89278					
31949465.	8.916130E+11	0.00003583	0.00060478	16.87758887	1919.00381
50396.89307					
33396286.	8.905676E+11	0.00003750	0.00063375	16.90005291	1994.40500
52716.50497					
34839305.	8.895142E+11	0.00003917	0.00066281	16.92274225	2068.50330
55033.68943					
36278469.	8.884523E+11	0.00004083	0.00069195	16.94565904	2141.28812
57348.41125					
37713733.	8.873819E+11	0.00004250	0.00072117	16.96880972	2212.74904
59660.62952					
38934730.	8.815411E+11	0.00004417	0.00074911	16.96100342	2279.49892
60000.00000					
39936015.	8.713312E+11	0.00004583	0.00077568	16.92401898	2341.56454
60000.00000					
40771614.	8.583498E+11	0.00004750	0.00080116	16.86655319	2399.77853
60000.00000					
41506716.	8.442044E+11	0.00004917	0.00082600	16.80000007	2455.35431
60000.00000					
42251988.	8.311866E+11	0.00005083	0.00085368	16.79364216	2516.23614
60000.00000					
42874447.	8.166561E+11	0.00005250	0.00087747	16.71372521	2567.15955
60000.00000					
43377331.	8.008123E+11	0.00005417	0.00090027	16.62040579	2614.92052
60000.00000					
43878754.	7.858881E+11	0.00005583	0.00092312	16.53345931	2661.85230
60000.00000					
44378692.	7.718033E+11	0.00005750	0.00094601	16.45233643	2707.94976
60000.00000					
44877139.	7.584869E+11	0.00005917	0.00096895	16.37655437	2753.20829
60000.00000					
45310123.	7.448239E+11	0.00006083	0.00099126	16.29467404	2796.28390
60000.00000					
45631820.	7.301091E+11	0.00006250	0.00101246	16.19935906	2836.29539
60000.00000					
45952401.	7.161413E+11	0.00006417	0.00103370	16.10956514	2875.58348
60000.00000					
46271862.	7.028637E+11	0.00006583	0.00105497	16.02487814	2914.14453
60000.00000					
46590196.	6.902251E+11	0.00006750	0.00107628	15.94492471	2951.97476
60000.00000					
46907396.	6.781792E+11	0.00006917	0.00109763	15.86936796	2989.07044
60000.00000					
47223451.	6.666840E+11	0.00007083	0.00111902	15.79790103	3025.42754
60000.00000					
47538354.	6.557014E+11	0.00007250	0.00114044	15.73024714	3061.04220
60000.00000					
47844998.	6.451011E+11	0.00007417	0.00116181	15.66488707	3095.75224
60000.00000					
47855180.	6.310573E+11	0.00007583	0.00118300	15.59999907	3129.35587
60000.00000					
48268062.	6.228137E+11	0.00007750	0.00120669	15.57018149	3166.17770
60000.00000					
48452715.	6.120343E+11	0.00007917	0.00122602	15.48656523	3195.19507
60000.00000					
48636571.	6.016895E+11	0.00008083	0.00124538	15.40678561	3223.60699
60000.00000					
48819634.	5.917531E+11	0.00008250	0.00126478	15.33061516	3251.41070
60000.00000					
49001896.	5.822007E+11	0.00008417	0.00128420	15.25784147	3278.60305
60000.00000					

49183338.	5.730098E+11	0.00008583	0.00130366	15.18826711	3305.18063
60000.00000					
49363974.	5.641597E+11	0.00008750	0.00132315	15.12171614	3331.14084
60000.00000					
49543784.	5.556312E+11	0.00008917	0.00134267	15.05801904	3356.48016
60000.00000					
49722772.	5.474067E+11	0.00009083	0.00136223	14.99702346	3381.19562
60000.00000					
49900927.	5.394695E+11	0.00009250	0.00138182	14.93858564	3405.28392
60000.00000					
50078245.	5.318044E+11	0.00009417	0.00140144	14.88257253	3428.74177
60000.00000					
50254714.	5.243970E+11	0.00009583	0.00142110	14.82885969	3451.56576
60000.00000					
50429881.	5.172296E+11	0.00009750	0.00144078	14.77723897	3473.74195
60000.00000					
50529280.	5.095390E+11	0.00009917	0.00145897	14.71230376	3493.54696
60000.00000					
50726176.	4.948895E+11	0.00010250	0.00149543	14.58959806	3531.52388
60000.00000					
50920501.	4.811386E+11	0.00010583	0.00153201	14.47570288	3567.30536
60000.00000					
51270699.	4.696553E+11	0.00010917	0.00157200	14.40000021	3603.93493
60000.00000					
51348584.	4.564319E+11	0.00011250	0.00161389	14.34565008	3639.37371
60000.00000					
51526301.	4.448314E+11	0.00011583	0.00164944	14.23976076	3666.79001
60000.00000					
51701617.	4.338597E+11	0.00011917	0.00168511	14.14078295	3692.10139
60000.00000					
51874506.	4.234654E+11	0.00012250	0.00172090	14.04816949	3715.28607
60000.00000					
52044930.	4.136021E+11	0.00012583	0.00175681	13.96142900	3736.32151
60000.00000					
52212847.	4.042285E+11	0.00012917	0.00179285	13.88012159	3755.18465
60000.00000					
52378233.	3.953074E+11	0.00013250	0.00182901	13.80385458	3771.85200
60000.00000					
52541054.	3.868053E+11	0.00013583	0.00186530	13.73227394	3786.29939
60000.00000					
52701266.	3.786917E+11	0.00013917	0.00190172	13.66505778	3798.50186
60000.00000					
52805551.	3.705653E+11	0.00014250	0.00193632	13.58818781	3807.93352
60000.00000					
52882380.	3.626220E+11	0.00014583	0.00197010	13.50923002	3815.13941
60000.00000					
52957190.	3.550203E+11	0.00014917	0.00200399	13.43454874	3820.39608
60000.00000					
53029953.	3.477374E+11	0.00015250	0.00203799	13.36387360	3823.68289
60000.00000					
53100626.	3.407527E+11	0.00015583	0.00207211	13.29695570	3824.97875
60000.00000					
53164752.	3.340194E+11	0.00015917	0.00210634	13.23356974	3816.30002
60000.00000					
53164752.	3.271677E+11	0.00016250	0.00214500	13.19999921	3808.36442
60000.00000					
53216658.	3.209045E+11	0.00016583	0.00218900	13.19999921	3816.62658
60000.00000					
53396763.	3.156459E+11	0.00016917	0.00222629	13.16033256	3821.32148
60000.00000					
53450681.	3.098590E+11	0.00017250	0.00225960	13.09913099	3823.86305
60000.00000					
53503677.	3.042863E+11	0.00017583	0.00229304	13.04097855	3824.95572

60000.00000					
53554306.	2.989078E+11	0.00017917	0.00232675	12.98652971	3818.38125
60000.00000					
53603812.	2.937195E+11	0.00018250	0.00236062	12.93490684	3809.58024
60000.00000					
53652660.	2.887139E+11	0.00018583	0.00239459	12.88568723	3804.21364
60000.00000					
53700837.	2.838811E+11	0.00018917	0.00242866	12.83875287	3810.49540
60000.00000					
53748353.	2.792122E+11	0.00019250	0.00246284	12.79399860	3815.67037
60000.00000					
53795175.	2.746988E+11	0.00019583	0.00249713	12.75131929	3819.72367
60000.00000					
53841289.	2.703328E+11	0.00019917	0.00253153	12.71062052	3822.64016
60000.00000					
53886706.	2.661072E+11	0.00020250	0.00256604	12.67181861	3824.40435
60000.00000					
53931399.	2.620149E+11	0.00020583	0.00260067	12.63482988	3825.00009
60000.00000					
53973437.	2.580403E+11	0.00020917	0.00263564	12.60068643	3817.15261
60000.00000					
54015027.	2.541884E+11	0.00021250	0.00267070	12.56801713	3809.23816
60000.00000					
54056143.	2.504532E+11	0.00021583	0.00270585	12.53674901	3801.29699
60000.00000					
54096788.	2.468295E+11	0.00021917	0.00274108	12.50682628	3799.25376
60000.00000					
54136957.	2.433122E+11	0.00022250	0.00277640	12.47819531	3805.55837
60000.00000					
54176648.	2.398966E+11	0.00022583	0.00281181	12.45080674	3810.99998
60000.00000					
54215844.	2.365782E+11	0.00022917	0.00284731	12.42461121	3815.56761
60000.00000					
54251803.	2.333411E+11	0.00023250	0.00288264	12.39846933	3819.21195
60000.00000					
54269372.	2.269103E+11	0.00023917	0.00294859	12.32860529	3823.50556
60000.00000					
54285685.	2.208231E+11	0.00024583	0.00301483	12.26373231	3824.99921
60000.00000					
54298122.	2.150421E+11	0.00025250	0.00308184	12.20532238	3812.98369
60000.00000					
54309833.	2.095556E+11	0.00025917	0.00314906	12.15071476	3800.59843
60000.00000					
54320861.	2.043418E+11	0.00026583	0.00321647	12.09958541	3788.15109
60000.00000					
54331185.	1.993805E+11	0.00027250	0.00328409	12.05169404	3796.66224
60000.00000					
54340812.	1.946537E+11	0.00027917	0.00335191	12.00682819	3806.24187
60000.00000					
54576556.	1.909384E+11	0.00028583	0.00343000	12.00000036	3815.88917
60000.00000					
54842916.	1.874971E+11	0.00029250	0.00351000	12.00000036	3822.28965
60000.00000					
55096344.	1.841661E+11	0.00029917	0.00359000	12.00000036	3824.92489
60000.00000					
55323034.	1.808928E+11	0.00030583	0.00367000	12.00000036	3813.88182
60000.00000					
55323034.	1.770337E+11	0.00031250	0.00374595	11.98704636	3801.26425
60000.00000					
55323034.	1.733359E+11	0.00031917	0.00381355	11.94845903	3791.28505
60000.00000					

Unfactored (Nominal) Moment Capacity at Concrete Strain of 0.003 = 54282.03186

in-kip

Computed Values of Load Distribution and Deflection
for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (Pile-head Condition Type 1)
Specified shear force at pile head = 157000.000 lbs
Specified moment at pile head = 0.000 in-lbs
Specified axial load at pile head = 0.000 lbs

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Flx. Rig. EI lbs-in**2	Soil Res. p lbs/in	Es*h F/L
0.000	0.220977	0.001169	1.57E+05	-0.001604	3.19E-08	5.46E+12	0.000	0.000
1.080	0.219244	1.70E+05	1.57E+05	-0.001604	4.627	5.46E+12	0.000	0.000
2.160	0.217511	3.39E+05	1.57E+05	-0.001604	9.255	5.46E+12	0.000	0.000
3.240	0.215779	5.09E+05	1.57E+05	-0.001604	13.882	5.46E+12	0.000	0.000
4.320	0.214046	6.78E+05	1.57E+05	-0.001604	18.509	5.46E+12	0.000	0.000
5.400	0.212314	8.48E+05	1.57E+05	-0.001604	23.136	5.46E+12	0.000	0.000
6.480	0.210582	1.02E+06	1.57E+05	-0.001604	27.764	5.46E+12	0.000	0.000
7.560	0.208850	1.19E+06	1.57E+05	-0.001604	32.391	5.46E+12	0.000	0.000
8.640	0.207118	1.36E+06	1.57E+05	-0.001603	37.018	5.46E+12	0.000	0.000
9.720	0.205387	1.53E+06	1.57E+05	-0.001603	41.646	5.46E+12	0.000	0.000
10.800	0.203655	1.70E+06	1.57E+05	-0.001603	46.273	5.46E+12	0.000	0.000
11.880	0.201925	1.87E+06	1.57E+05	-0.001602	50.900	5.46E+12	0.000	0.000
12.960	0.200194	2.03E+06	1.57E+05	-0.001602	55.527	5.46E+12	0.000	0.000
14.040	0.198465	2.20E+06	1.57E+05	-0.001602	60.155	5.46E+12	0.000	0.000
15.120	0.196735	2.37E+06	1.57E+05	-0.001601	64.782	5.46E+12	0.000	0.000
16.200	0.195006	2.54E+06	1.57E+05	-0.001601	69.409	5.46E+12	0.000	0.000
17.280	0.193278	2.71E+06	1.57E+05	-0.001600	74.037	5.46E+12	0.000	0.000
18.360	0.191550	2.88E+06	1.57E+05	-0.001600	78.664	5.46E+12	0.000	0.000
19.440	0.189823	3.05E+06	1.57E+05	-0.001599	83.291	5.46E+12	0.000	0.000
20.520	0.188096	3.22E+06	1.57E+05	-0.001598	87.918	5.46E+12	0.000	0.000
21.600	0.186370	3.39E+06	1.57E+05	-0.001598	92.546	5.46E+12	0.000	

0.000							
22.680	0.184645	3.56E+06	1.57E+05	-0.001597	97.173	5.46E+12	0.000
0.000							
23.760	0.182921	3.73E+06	1.57E+05	-0.001596	101.800	5.46E+12	0.000
0.000							
24.840	0.181197	3.90E+06	1.57E+05	-0.001595	106.428	5.46E+12	0.000
0.000							
25.920	0.179475	4.07E+06	1.57E+05	-0.001595	111.055	5.46E+12	0.000
0.000							
27.000	0.177753	4.24E+06	1.57E+05	-0.001594	115.682	5.46E+12	0.000
0.000							
28.080	0.176032	4.41E+06	1.57E+05	-0.001593	120.309	5.46E+12	0.000
0.000							
29.160	0.174312	4.58E+06	1.57E+05	-0.001592	124.937	5.46E+12	0.000
0.000							
30.240	0.172593	4.75E+06	1.57E+05	-0.001591	129.564	5.45E+12	0.000
0.000							
31.320	0.170875	4.92E+06	1.57E+05	-0.001590	134.191	5.45E+12	0.000
0.000							
32.400	0.169158	5.09E+06	1.57E+05	-0.001589	138.818	5.45E+12	0.000
0.000							
33.480	0.167442	5.26E+06	1.57E+05	-0.001588	143.446	5.45E+12	0.000
0.000							
34.560	0.165727	5.43E+06	1.57E+05	-0.001587	148.073	5.45E+12	0.000
0.000							
35.640	0.164014	5.60E+06	1.57E+05	-0.001586	152.700	5.45E+12	0.000
0.000							
36.720	0.162301	5.77E+06	1.57E+05	-0.001585	157.328	5.45E+12	0.000
0.000							
37.800	0.160590	5.93E+06	1.57E+05	-0.001584	161.955	5.44E+12	0.000
0.000							
38.880	0.158880	6.10E+06	1.57E+05	-0.001583	166.582	5.44E+12	0.000
0.000							
39.960	0.157172	6.27E+06	1.57E+05	-0.001581	171.209	5.44E+12	0.000
0.000							
41.040	0.155465	6.44E+06	1.57E+05	-0.001580	175.837	5.44E+12	0.000
0.000							
42.120	0.153759	6.61E+06	1.57E+05	-0.001579	180.464	5.44E+12	0.000
0.000							
43.200	0.152054	6.78E+06	1.57E+05	-0.001577	185.091	5.44E+12	0.000
0.000							
44.280	0.150351	6.95E+06	1.57E+05	-0.001576	189.719	5.44E+12	0.000
0.000							
45.360	0.148650	7.12E+06	1.57E+05	-0.001575	194.346	5.44E+12	0.000
0.000							
46.440	0.146950	7.29E+06	1.57E+05	-0.001573	198.973	5.44E+12	0.000
0.000							
47.520	0.145251	7.46E+06	1.57E+05	-0.001572	203.600	5.44E+12	0.000
0.000							
48.600	0.143555	7.63E+06	1.57E+05	-0.001570	208.228	5.44E+12	0.000
0.000							
49.680	0.141860	7.80E+06	1.57E+05	-0.001569	212.855	5.43E+12	0.000
0.000							
50.760	0.140166	7.97E+06	1.57E+05	-0.001567	217.482	5.43E+12	0.000
0.000							
51.840	0.138474	8.14E+06	1.57E+05	-0.001566	222.110	5.43E+12	0.000
0.000							
52.920	0.136784	8.31E+06	1.57E+05	-0.001564	226.737	5.43E+12	0.000
0.000							
54.000	0.135096	8.48E+06	1.57E+05	-0.001562	231.364	5.43E+12	0.000
0.000							
55.080	0.133410	8.65E+06	1.57E+05	-0.001561	235.991	5.43E+12	0.000
0.000							

56.160	0.131725	8.82E+06	1.57E+05	-0.001559	240.619	5.43E+12	0.000	0.000
57.240	0.130042	8.99E+06	1.57E+05	-0.001557	245.246	5.43E+12	0.000	0.000
58.320	0.128362	9.16E+06	1.57E+05	-0.001555	249.873	5.43E+12	0.000	0.000
59.400	0.126683	9.33E+06	1.57E+05	-0.001553	254.501	5.43E+12	0.000	0.000
60.480	0.125006	9.50E+06	1.57E+05	-0.001552	259.128	5.43E+12	0.000	0.000
61.560	0.123331	9.66E+06	1.57E+05	-0.001550	263.755	5.43E+12	0.000	0.000
62.640	0.121659	9.83E+06	1.57E+05	-0.001548	268.382	5.42E+12	0.000	0.000
63.720	0.119988	1.00E+07	1.57E+05	-0.001546	273.010	5.42E+12	0.000	0.000
64.800	0.118320	1.02E+07	1.57E+05	-0.001544	277.637	5.42E+12	0.000	0.000
65.880	0.116654	1.03E+07	1.57E+05	-0.001542	282.264	5.42E+12	0.000	0.000
66.960	0.114990	1.05E+07	1.57E+05	-0.001540	286.892	5.42E+12	0.000	0.000
68.040	0.113328	1.07E+07	1.57E+05	-0.001538	291.519	5.42E+12	0.000	0.000
69.120	0.111669	1.09E+07	1.57E+05	-0.001535	296.146	5.42E+12	0.000	0.000
70.200	0.110012	1.10E+07	1.57E+05	-0.001533	300.773	5.42E+12	0.000	0.000
71.280	0.108357	1.12E+07	1.57E+05	-0.001531	305.401	5.42E+12	0.000	0.000
72.360	0.106705	1.14E+07	1.57E+05	-0.001529	310.028	5.41E+12	0.000	0.000
73.440	0.105055	1.15E+07	1.57E+05	-0.001526	314.655	5.41E+12	0.000	0.000
74.520	0.103407	1.17E+07	1.57E+05	-0.001524	319.283	5.41E+12	0.000	0.000
75.600	0.101763	1.19E+07	1.57E+05	-0.001522	323.910	5.41E+12	0.000	0.000
76.680	0.100120	1.20E+07	1.57E+05	-0.001519	328.537	5.41E+12	0.000	0.000
77.760	0.098481	1.22E+07	1.57E+05	-0.001517	333.164	5.41E+12	0.000	0.000
78.840	0.096844	1.24E+07	1.57E+05	-0.001515	337.792	5.41E+12	0.000	0.000
79.920	0.095209	1.25E+07	1.57E+05	-0.001512	342.419	5.41E+12	0.000	0.000
81.000	0.093578	1.27E+07	1.57E+05	-0.001510	347.046	5.41E+12	0.000	0.000
82.080	0.091949	1.29E+07	1.57E+05	-0.001507	351.673	5.41E+12	0.000	0.000
83.160	0.090322	1.31E+07	1.57E+05	-0.001504	356.301	5.41E+12	0.000	0.000
84.240	0.088699	1.32E+07	1.57E+05	-0.001502	360.928	5.41E+12	0.000	0.000
85.320	0.087079	1.34E+07	1.57E+05	-0.001499	365.555	5.40E+12	0.000	0.000
86.400	0.085461	1.36E+07	1.57E+05	-0.001496	370.183	5.40E+12	0.000	0.000
87.480	0.083846	1.37E+07	1.57E+05	-0.001494	374.810	5.40E+12	0.000	0.000
88.560	0.082235	1.39E+07	1.57E+05	-0.001491	379.437	5.40E+12	0.000	0.000
89.640	0.080626	1.41E+07	1.57E+05	-0.001488	384.064	5.40E+12	0.000	

0.000							
90.720	0.079020	1.42E+07	1.57E+05	-0.001485	388.692	5.40E+12	0.000
0.000							
91.800	0.077418	1.44E+07	1.57E+05	-0.001482	393.319	5.40E+12	0.000
0.000							
92.880	0.075818	1.46E+07	1.57E+05	-0.001480	397.946	5.40E+12	0.000
0.000							
93.960	0.074222	1.48E+07	1.57E+05	-0.001477	402.574	5.40E+12	0.000
0.000							
95.040	0.072629	1.49E+07	1.57E+05	-0.001474	407.201	5.39E+12	0.000
0.000							
96.120	0.071039	1.51E+07	1.57E+05	-0.001471	411.828	5.39E+12	0.000
0.000							
97.200	0.069452	1.53E+07	1.57E+05	-0.001468	416.455	5.39E+12	0.000
0.000							
98.280	0.067869	1.54E+07	1.57E+05	-0.001464	421.083	5.39E+12	0.000
0.000							
99.360	0.066289	1.56E+07	1.57E+05	-0.001461	425.710	5.39E+12	0.000
0.000							
100.440	0.064713	1.58E+07	1.57E+05	-0.001458	430.337	5.39E+12	0.000
0.000							
101.520	0.063139	1.59E+07	1.57E+05	-0.001455	434.965	5.39E+12	0.000
0.000							
102.600	0.061570	1.61E+07	1.57E+05	-0.001452	439.592	5.39E+12	0.000
0.000							
103.680	0.060003	1.63E+07	1.57E+05	-0.001449	444.219	5.39E+12	0.000
0.000							
104.760	0.058441	1.64E+07	1.57E+05	-0.001445	448.846	5.39E+12	0.000
0.000							
105.840	0.056881	1.66E+07	1.57E+05	-0.001442	453.474	5.38E+12	0.000
0.000							
106.920	0.055326	1.68E+07	1.57E+05	-0.001439	458.101	5.38E+12	0.000
0.000							
108.000	0.053774	1.70E+07	1.57E+05	-0.001435	462.728	5.38E+12	0.000
0.000							
109.080	0.052226	1.71E+07	1.57E+05	-0.001432	467.356	5.38E+12	0.000
0.000							
110.160	0.050681	1.73E+07	1.57E+05	-0.001428	471.983	5.38E+12	0.000
0.000							
111.240	0.049140	1.75E+07	1.57E+05	-0.001425	476.610	5.38E+12	0.000
0.000							
112.320	0.047603	1.76E+07	1.57E+05	-0.001421	481.237	5.38E+12	0.000
0.000							
113.400	0.046070	1.78E+07	1.57E+05	-0.001418	485.865	5.38E+12	0.000
0.000							
114.480	0.044541	1.80E+07	1.57E+05	-0.001413	490.492	3.63E+12	0.000
0.000							
115.560	0.043017	1.81E+07	1.57E+05	-0.001400	495.119	9.01E+11	0.000
0.000							
116.640	0.041517	1.83E+07	1.57E+05	-0.001378	499.747	9.01E+11	0.000
0.000							
117.720	0.040041	1.85E+07	1.57E+05	-0.001356	504.374	9.01E+11	0.000
0.000							
118.800	0.038588	1.87E+07	1.57E+05	-0.001334	509.001	9.01E+11	0.000
0.000							
119.880	0.037160	1.88E+07	1.57E+05	-0.001311	513.628	9.01E+11	0.000
0.000							
120.960	0.035756	1.90E+07	1.57E+05	-0.001289	518.256	9.00E+11	0.000
0.000							
122.040	0.034377	1.92E+07	1.57E+05	-0.001266	522.883	9.00E+11	0.000
0.000							
123.120	0.033023	1.93E+07	1.57E+05	-0.001243	527.510	9.00E+11	0.000
0.000							

124.200	0.031693	1.95E+07	1.57E+05	-0.001219	532.138	9.00E+11	0.000	0.000
125.280	0.030389	1.97E+07	1.57E+05	-0.001196	536.765	9.00E+11	0.000	0.000
126.360	0.029110	1.98E+07	1.57E+05	-0.001172	541.392	9.00E+11	0.000	0.000
127.440	0.027857	2.00E+07	1.57E+05	-0.001148	546.019	9.00E+11	0.000	0.000
128.520	0.026630	2.02E+07	1.57E+05	-0.001124	550.647	9.00E+11	0.000	0.000
129.600	0.025429	2.03E+07	1.57E+05	-0.001100	555.274	9.00E+11	0.000	0.000
130.680	0.024255	2.05E+07	1.57E+05	-0.001075	559.901	8.99E+11	0.000	0.000
131.760	0.023107	2.07E+07	1.57E+05	-0.001050	564.528	8.99E+11	0.000	0.000
132.840	0.021986	2.09E+07	1.57E+05	-0.001025	569.156	8.99E+11	0.000	0.000
133.920	0.020892	2.10E+07	1.57E+05	-0.001000	573.783	8.99E+11	0.000	0.000
135.000	0.019825	2.12E+07	1.57E+05	-0.000975	578.410	8.99E+11	0.000	0.000
136.080	0.018786	2.14E+07	1.57E+05	-0.000949	583.038	8.99E+11	0.000	0.000
137.160	0.017775	2.15E+07	1.57E+05	-0.000924	587.665	8.99E+11	0.000	0.000
138.240	0.016791	2.17E+07	1.57E+05	-0.000898	592.292	8.99E+11	0.000	0.000
139.320	0.015836	2.19E+07	1.57E+05	-0.000871	596.919	8.99E+11	0.000	0.000
140.400	0.014909	2.20E+07	1.57E+05	-0.000845	601.547	8.98E+11	0.000	0.000
141.480	0.014010	2.22E+07	1.57E+05	-0.000818	606.174	8.98E+11	0.000	0.000
142.560	0.013141	2.24E+07	1.57E+05	-0.000792	610.801	8.98E+11	0.000	0.000
143.640	0.012300	2.26E+07	1.57E+05	-0.000765	615.429	8.98E+11	0.000	0.000
144.720	0.011489	2.27E+07	1.35E+05	-0.000737	620.056	8.98E+11	-41361.	3.89E+06
145.800	0.010708	2.28E+07	91515.	-0.000710	623.367	8.98E+11	-38547.	3.89E+06
146.880	0.009956	2.29E+07	51346.	-0.000683	625.450	8.98E+11	-35840.	3.89E+06
147.960	0.009233	2.30E+07	14043.	-0.000655	626.393	8.98E+11	-33240.	3.89E+06
149.040	0.008541	2.29E+07	-20511.	-0.000627	626.278	8.98E+11	-30747.	3.89E+06
150.120	0.007878	2.29E+07	-52430.	-0.000600	625.184	8.98E+11	-28362.	3.89E+06
151.200	0.007246	2.28E+07	-81830.	-0.000572	623.188	8.98E+11	-26084.	3.89E+06
152.280	0.006642	2.27E+07	-1.09E+05	-0.000545	620.361	8.98E+11	-23913.	3.89E+06
153.360	0.006069	2.26E+07	-1.34E+05	-0.000518	616.773	8.98E+11	-21847.	3.89E+06
154.440	0.005524	2.24E+07	-1.56E+05	-0.000490	612.489	8.98E+11	-19888.	3.89E+06
155.520	0.005009	2.23E+07	-1.77E+05	-0.000464	607.572	8.98E+11	-18034.	3.89E+06
156.600	0.004523	2.21E+07	-1.95E+05	-0.000437	602.082	8.98E+11	-16283.	3.89E+06
157.680	0.004066	2.18E+07	-2.12E+05	-0.000411	596.073	8.99E+11	-14636.	

3.89E+06							
158.760	0.003636	2.16E+07	-2.27E+05	-0.000384	589.598	8.99E+11	-13091.
3.89E+06							
159.840	0.003235	2.14E+07	-2.40E+05	-0.000359	582.707	8.99E+11	-11647.
3.89E+06							
160.920	0.002862	2.11E+07	-2.52E+05	-0.000333	575.444	8.99E+11	-10302.
3.89E+06							
162.000	0.002516	2.08E+07	-2.62E+05	-0.000308	567.854	8.99E+11	-9055.959
3.89E+06							
163.080	0.002196	2.05E+07	-2.72E+05	-0.000283	559.976	8.99E+11	-7907.086
3.89E+06							
164.160	0.001904	2.02E+07	-2.80E+05	-0.000259	551.846	9.00E+11	-6854.005
3.89E+06							
165.240	0.001638	1.99E+07	-2.86E+05	-0.000235	543.498	9.00E+11	-5895.305
3.89E+06							
166.320	0.001397	1.96E+07	-2.92E+05	-0.000211	534.962	9.00E+11	-5029.537
3.89E+06							
167.400	0.001182	1.93E+07	-2.97E+05	-0.000188	526.266	9.00E+11	-4255.220
3.89E+06							
168.480	0.000992	1.90E+07	-3.02E+05	-0.000165	517.434	9.01E+11	-3570.847
3.89E+06							
169.560	0.000826	1.86E+07	-3.05E+05	-0.000142	508.489	9.01E+11	-2974.886
3.89E+06							
170.640	0.000685	1.83E+07	-3.08E+05	-0.000120	499.449	9.01E+11	-2465.789
3.89E+06							
171.720	0.000567	1.80E+07	-3.10E+05	-0.000101	490.331	1.21E+12	-2041.991
3.89E+06							
172.800	0.000467	1.76E+07	-3.12E+05	-9.11E-05	481.148	5.38E+12	-1680.786
3.89E+06							
173.880	0.000370	1.73E+07	-3.14E+05	-8.76E-05	471.911	5.38E+12	-1333.343
3.89E+06							
174.960	0.000278	1.70E+07	-3.15E+05	-8.42E-05	462.632	5.38E+12	-999.396
3.89E+06							
176.040	0.000189	1.66E+07	-3.16E+05	-8.08E-05	453.321	5.38E+12	-678.673
3.89E+06							
177.120	0.000103	1.63E+07	-3.17E+05	-7.75E-05	443.988	5.39E+12	-370.904
3.89E+06							
178.200	2.11E-05	1.59E+07	-3.17E+05	-7.43E-05	434.644	5.39E+12	-75.820
3.89E+06							
179.280	-5.75E-05	1.56E+07	-3.17E+05	-7.11E-05	425.297	5.39E+12	206.853
3.89E+06							
180.360	-0.000133	1.52E+07	-3.17E+05	-6.81E-05	415.956	5.39E+12	477.384
3.89E+06							
181.440	-0.000204	1.49E+07	-3.16E+05	-6.50E-05	406.631	5.39E+12	736.046
3.89E+06							
182.520	-0.000273	1.46E+07	-3.15E+05	-6.21E-05	397.330	5.40E+12	983.108
3.89E+06							
183.600	-0.000339	1.42E+07	-3.14E+05	-5.92E-05	388.059	5.40E+12	1218.842
3.89E+06							
184.680	-0.000401	1.39E+07	-3.12E+05	-5.64E-05	378.828	5.40E+12	1443.516
3.89E+06							
185.760	-0.000460	1.35E+07	-3.11E+05	-5.37E-05	369.642	5.40E+12	1657.399
3.89E+06							
186.840	-0.000517	1.32E+07	-3.09E+05	-5.10E-05	360.509	5.41E+12	1860.756
3.89E+06							
187.920	-0.000571	1.29E+07	-3.07E+05	-4.84E-05	351.436	5.41E+12	2053.851
3.89E+06							
189.000	-0.000621	1.25E+07	-3.04E+05	-4.58E-05	342.427	5.41E+12	2236.945
3.89E+06							
190.080	-0.000670	1.22E+07	-3.02E+05	-4.34E-05	333.490	5.41E+12	2410.297
3.89E+06							
191.160	-0.000715	1.19E+07	-2.99E+05	-4.10E-05	324.630	5.41E+12	2574.164
3.89E+06							

192.240	-0.000758	1.16E+07	-2.96E+05	-3.86E-05	315.852	5.41E+12	2728.800
3.89E+06							
193.320	-0.000798	1.13E+07	-2.93E+05	-3.63E-05	307.160	5.41E+12	2874.457
3.89E+06							
194.400	-0.000836	1.09E+07	-2.90E+05	-3.41E-05	298.560	5.42E+12	3011.387
3.89E+06							
195.480	-0.000872	1.06E+07	-2.87E+05	-3.20E-05	290.056	5.42E+12	3139.835
3.89E+06							
196.560	-0.000906	1.03E+07	-2.83E+05	-2.99E-05	281.652	5.42E+12	3260.047
3.89E+06							
197.640	-0.000937	1.00E+07	-2.80E+05	-2.79E-05	273.351	5.42E+12	3372.265
3.89E+06							
198.720	-0.000966	9.72E+06	-2.76E+05	-2.59E-05	265.158	5.42E+12	3476.725
3.89E+06							
199.800	-0.000993	9.42E+06	-2.72E+05	-2.40E-05	257.075	5.43E+12	3573.666
3.89E+06							
200.880	-0.001018	9.13E+06	-2.68E+05	-2.22E-05	249.107	5.43E+12	3663.318
3.89E+06							
201.960	-0.001041	8.84E+06	-2.64E+05	-2.04E-05	241.255	5.43E+12	3745.910
3.89E+06							
203.040	-0.001062	8.56E+06	-2.60E+05	-1.86E-05	233.522	5.43E+12	3821.668
3.89E+06							
204.120	-0.001081	8.28E+06	-2.56E+05	-1.70E-05	225.911	5.43E+12	3890.811
3.89E+06							
205.200	-0.001098	8.00E+06	-2.52E+05	-1.53E-05	218.423	5.43E+12	3953.556
3.89E+06							
206.280	-0.001114	7.73E+06	-2.48E+05	-1.38E-05	211.062	5.43E+12	4010.116
3.89E+06							
207.360	-0.001128	7.47E+06	-2.43E+05	-1.23E-05	203.828	5.44E+12	4060.700
3.89E+06							
208.440	-0.001140	7.21E+06	-2.39E+05	-1.08E-05	196.723	5.44E+12	4105.515
3.89E+06							
209.520	-0.001151	6.95E+06	-2.34E+05	-9.40E-06	189.749	5.44E+12	4144.763
3.89E+06							
210.600	-0.001161	6.70E+06	-2.30E+05	-8.05E-06	182.907	5.44E+12	4178.642
3.89E+06							
211.680	-0.001169	6.46E+06	-2.25E+05	-6.74E-06	176.198	5.44E+12	4207.348
3.89E+06							
212.760	-0.001175	6.22E+06	-2.21E+05	-5.48E-06	169.623	5.44E+12	4231.070
3.89E+06							
213.840	-0.001181	5.98E+06	-2.16E+05	-4.27E-06	163.183	5.44E+12	4249.998
3.89E+06							
214.920	-0.001185	5.75E+06	-2.12E+05	-3.11E-06	156.878	5.45E+12	4264.313
3.89E+06							
216.000	-0.001187	5.52E+06	-2.07E+05	-1.99E-06	150.708	5.45E+12	4274.195
3.89E+06							
217.080	-0.001189	5.30E+06	-2.02E+05	-9.22E-07	144.675	5.45E+12	4279.821
3.89E+06							
218.160	-0.001189	5.09E+06	-1.98E+05	1.08E-07	138.778	5.45E+12	4281.361
3.89E+06							
219.240	-0.001189	4.87E+06	-1.93E+05	1.09E-06	133.017	5.45E+12	4278.984
3.89E+06							
220.320	-0.001187	4.67E+06	-1.89E+05	2.04E-06	127.393	5.46E+12	4272.854
3.89E+06							
221.400	-0.001184	4.47E+06	-1.84E+05	2.94E-06	121.904	5.46E+12	4263.130
3.89E+06							
222.480	-0.001181	4.27E+06	-1.79E+05	3.81E-06	116.551	5.46E+12	4249.969
3.89E+06							
223.560	-0.001176	4.08E+06	-1.75E+05	4.63E-06	111.333	5.46E+12	4233.522
3.89E+06							
224.640	-0.001171	3.89E+06	-1.70E+05	5.42E-06	106.251	5.46E+12	4213.935
3.89E+06							
225.720	-0.001164	3.71E+06	-1.66E+05	6.18E-06	101.302	5.46E+12	4191.352

3.89E+06								
226.800	-0.001157	3.54E+06	-1.61E+05	6.89E-06	96.487	5.46E+12	4165.912	
3.89E+06								
227.880	-0.001149	3.36E+06	-1.57E+05	7.58E-06	91.804	5.46E+12	4137.752	
3.89E+06								
228.960	-0.001141	3.20E+06	-1.52E+05	8.23E-06	87.253	5.46E+12	4107.003	
3.89E+06								
230.040	-0.001132	3.04E+06	-1.48E+05	8.84E-06	82.833	5.46E+12	4073.794	
3.89E+06								
231.120	-0.001122	2.88E+06	-1.43E+05	9.43E-06	78.542	5.46E+12	4038.249	
3.89E+06								
232.200	-0.001111	2.73E+06	-1.39E+05	9.98E-06	74.380	5.46E+12	4000.489	
3.89E+06								
233.280	-0.001100	2.58E+06	-1.35E+05	1.05E-05	70.345	5.46E+12	3960.632	
3.89E+06								
234.360	-0.001089	2.43E+06	-1.31E+05	1.10E-05	66.437	5.46E+12	3918.791	
3.89E+06								
235.440	-0.001076	2.30E+06	-1.26E+05	1.15E-05	62.653	5.46E+12	3875.077	
3.89E+06								
236.520	-0.001064	2.16E+06	-1.22E+05	1.19E-05	58.992	5.46E+12	3829.596	
3.89E+06								
237.600	-0.001051	2.03E+06	-1.18E+05	1.23E-05	55.454	5.46E+12	3782.452	
3.89E+06								
238.680	-0.001037	1.91E+06	-1.14E+05	1.27E-05	52.035	5.46E+12	3733.744	
3.89E+06								
239.760	-0.001023	1.79E+06	-1.10E+05	1.31E-05	48.736	5.46E+12	3683.568	
3.89E+06								
240.840	-0.001009	1.67E+06	-1.06E+05	1.34E-05	45.554	5.46E+12	3632.019	
3.89E+06								
241.920	-0.000994	1.56E+06	-1.02E+05	1.37E-05	42.487	5.46E+12	3579.185	
3.89E+06								
243.000	-0.000979	1.45E+06	-98276.	1.40E-05	39.535	5.46E+12	3525.153	
3.89E+06								
244.080	-0.000964	1.34E+06	-94499.	1.43E-05	36.694	5.46E+12	3470.006	
3.89E+06								
245.160	-0.000948	1.24E+06	-90782.	1.46E-05	33.964	5.46E+12	3413.824	
3.89E+06								
246.240	-0.000932	1.15E+06	-87125.	1.48E-05	31.343	5.46E+12	3356.684	
3.89E+06								
247.320	-0.000916	1.06E+06	-83532.	1.50E-05	28.828	5.46E+12	3298.661	
3.89E+06								
248.400	-0.000900	9.68E+05	-80001.	1.52E-05	26.419	5.46E+12	3239.825	
3.89E+06								
249.480	-0.000883	8.84E+05	-76534.	1.54E-05	24.113	5.46E+12	3180.244	
3.89E+06								
250.560	-0.000867	8.03E+05	-73132.	1.56E-05	21.908	5.46E+12	3119.983	
3.89E+06								
251.640	-0.000850	7.26E+05	-69795.	1.57E-05	19.802	5.46E+12	3059.104	
3.89E+06								
252.720	-0.000833	6.52E+05	-66524.	1.59E-05	17.793	5.46E+12	2997.667	
3.89E+06								
253.800	-0.000815	5.82E+05	-63320.	1.60E-05	15.881	5.46E+12	2935.728	
3.89E+06								
254.880	-0.000798	5.15E+05	-60184.	1.61E-05	14.061	5.46E+12	2873.341	
3.89E+06								
255.960	-0.000781	4.52E+05	-57114.	1.62E-05	12.333	5.46E+12	2810.558	
3.89E+06								
257.040	-0.000763	3.92E+05	-54113.	1.63E-05	10.694	5.46E+12	2747.427	
3.89E+06								
258.120	-0.000746	3.35E+05	-51180.	1.63E-05	9.143	5.46E+12	2683.994	
3.89E+06								
259.200	-0.000728	2.81E+05	-48316.	1.64E-05	7.677	5.46E+12	2620.304	
3.89E+06								

260.280	-0.000710	2.31E+05	-45520.	1.65E-05	6.295	5.46E+12	2556.397	3.89E+06
261.360	-0.000692	1.83E+05	-42794.	1.65E-05	4.994	5.46E+12	2492.313	3.89E+06
262.440	-0.000674	1.38E+05	-40137.	1.65E-05	3.773	5.46E+12	2428.088	3.89E+06
263.520	-0.000657	96310.	-37549.	1.66E-05	2.628	5.46E+12	2363.756	3.89E+06
264.600	-0.000639	57135.	-35031.	1.66E-05	1.559	5.46E+12	2299.350	3.89E+06
265.680	-0.000621	20642.	-32583.	1.66E-05	0.563319	5.46E+12	2234.901	3.89E+06
266.760	-0.000603	-13244.	-30204.	1.66E-05	0.361427	5.46E+12	2170.435	3.89E+06
267.840	-0.000585	-44598.	-27895.	1.66E-05	1.217	5.46E+12	2105.980	3.89E+06
268.920	-0.000567	-73496.	-25655.	1.66E-05	2.006	5.46E+12	2041.559	3.89E+06
270.000	-0.000549	-1.00E+05	-23485.	1.65E-05	2.729	5.46E+12	1977.194	3.89E+06
271.080	-0.000531	-1.24E+05	-21384.	1.65E-05	3.390	5.46E+12	1912.907	3.89E+06
272.160	-0.000514	-1.46E+05	-19353.	1.65E-05	3.990	5.46E+12	1848.715	3.89E+06
273.240	-0.000496	-1.66E+05	-17391.	1.65E-05	4.531	5.46E+12	1784.635	3.89E+06
274.320	-0.000478	-1.84E+05	-15498.	1.64E-05	5.015	5.46E+12	1720.684	3.89E+06
275.400	-0.000460	-2.00E+05	-13674.	1.64E-05	5.444	5.46E+12	1656.873	3.89E+06
276.480	-0.000443	-2.13E+05	-11919.	1.64E-05	5.821	5.46E+12	1593.217	3.89E+06
277.560	-0.000425	-2.25E+05	-10233.	1.63E-05	6.147	5.46E+12	1529.724	3.89E+06
278.640	-0.000407	-2.35E+05	-8614.771	1.63E-05	6.424	5.46E+12	1466.405	3.89E+06
279.720	-0.000390	-2.44E+05	-7065.149	1.62E-05	6.655	5.46E+12	1403.267	3.89E+06
280.800	-0.000372	-2.51E+05	-5583.614	1.62E-05	6.841	5.46E+12	1340.316	3.89E+06
281.880	-0.000355	-2.56E+05	-4169.961	1.61E-05	6.984	5.46E+12	1277.559	3.89E+06
282.960	-0.000337	-2.60E+05	-2823.981	1.61E-05	7.086	5.46E+12	1214.998	3.89E+06
284.040	-0.000320	-2.62E+05	-1545.457	1.60E-05	7.150	5.46E+12	1152.637	3.89E+06
285.120	-0.000303	-2.63E+05	-334.175	1.60E-05	7.178	5.46E+12	1090.478	3.89E+06
286.200	-0.000286	-2.63E+05	810.085	1.59E-05	7.170	5.46E+12	1028.521	3.89E+06
287.280	-0.000269	-2.61E+05	1887.540	1.59E-05	7.130	5.46E+12	966.767	3.89E+06
288.360	-0.000251	-2.59E+05	2898.410	1.58E-05	7.059	5.46E+12	905.213	3.89E+06
289.440	-0.000234	-2.55E+05	3842.909	1.58E-05	6.959	5.46E+12	843.859	3.89E+06
290.520	-0.000217	-2.50E+05	4721.251	1.57E-05	6.832	5.46E+12	782.701	3.89E+06
291.600	-0.000200	-2.45E+05	5533.646	1.57E-05	6.681	5.46E+12	721.735	3.89E+06
292.680	-0.000184	-2.38E+05	6280.300	1.56E-05	6.506	5.46E+12	660.958	3.89E+06
293.760	-0.000167	-2.31E+05	6961.413	1.56E-05	6.310	5.46E+12	600.364	

3.89E+06								
294.840	-0.000150	-2.23E+05	7577.182	1.55E-05	6.096	5.46E+12	539.948	
3.89E+06								
295.920	-0.000133	-2.15E+05	8127.794	1.55E-05	5.864	5.46E+12	479.704	
3.89E+06								
297.000	-0.000117	-2.06E+05	8613.432	1.54E-05	5.617	5.46E+12	419.626	
3.89E+06								
298.080	-9.99E-05	-1.96E+05	9034.271	1.54E-05	5.356	5.46E+12	359.705	
3.89E+06								
299.160	-8.33E-05	-1.86E+05	9390.478	1.54E-05	5.084	5.46E+12	299.936	
3.89E+06								
300.240	-6.68E-05	-1.76E+05	9682.211	1.53E-05	4.803	5.46E+12	240.310	
3.89E+06								
301.320	-5.02E-05	-1.65E+05	9909.621	1.53E-05	4.513	5.46E+12	180.820	
3.89E+06								
302.400	-3.37E-05	-1.55E+05	10073.	1.53E-05	4.218	5.46E+12	121.457	
3.89E+06								
303.480	-1.73E-05	-1.44E+05	10172.	1.52E-05	3.920	5.46E+12	62.213	
3.89E+06								
304.560	-8.55E-07	-1.33E+05	10207.	1.52E-05	3.619	5.46E+12	3.079	
3.89E+06								
305.640	1.55E-05	-1.22E+05	10179.	1.52E-05	3.318	5.46E+12	-55.952	
3.89E+06								
306.720	3.19E-05	-1.11E+05	10086.	1.51E-05	3.019	5.46E+12	-114.890	
3.89E+06								
307.800	4.83E-05	-99794.	9930.621	1.51E-05	2.723	5.46E+12	-173.743	
3.89E+06								
308.880	6.46E-05	-89170.	9711.239	1.51E-05	2.433	5.46E+12	-232.519	
3.89E+06								
309.960	8.09E-05	-78818.	9428.416	1.51E-05	2.151	5.46E+12	-291.227	
3.89E+06								
311.040	9.72E-05	-68805.	9082.222	1.51E-05	1.878	5.46E+12	-349.874	
3.89E+06								
312.120	0.000113	-59200.	8672.718	1.51E-05	1.616	5.46E+12	-408.468	
3.89E+06								
313.200	0.000130	-50072.	8199.956	1.51E-05	1.366	5.46E+12	-467.016	
3.89E+06								
314.280	0.000146	-41488.	7663.984	1.50E-05	1.132	5.46E+12	-525.526	
3.89E+06								
315.360	0.000162	-33518.	7064.838	1.50E-05	0.914695	5.46E+12	-584.004	
3.89E+06								
316.440	0.000178	-26228.	6402.550	1.50E-05	0.715767	5.46E+12	-642.456	
3.89E+06								
317.520	0.000195	-19688.	5677.144	1.50E-05	0.537289	5.46E+12	-700.888	
3.89E+06								
318.600	0.000211	-13966.	4888.641	1.50E-05	0.381121	5.46E+12	-759.304	
3.89E+06								
319.680	0.000227	-9128.702	4037.052	1.50E-05	0.249122	5.46E+12	-817.710	
3.89E+06								
320.760	0.000243	-5245.574	3122.390	1.50E-05	0.143151	5.46E+12	-876.109	
3.89E+06								
321.840	0.000260	-2384.340	2144.658	1.50E-05	0.065069	5.46E+12	-934.504	
3.89E+06								
322.920	0.000276	-613.112	1103.861	1.50E-05	0.016732	5.46E+12	-992.897	
3.89E+06								
324.000	0.000292	0.000	0.000	1.50E-05	0.000	5.46E+12	-1051.290	
1.94E+06								

Please note that because this analysis makes computations of ultimate moment capacity and pile response using nonlinear bending stiffness that the above values of total stress due to combined axial stress and bending may not be representative of actual conditions.

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

Pile-head deflection	=	0.22097676	in
Computed slope at pile head	=	-0.00160438	
Maximum bending moment	=	22953263.	lbs-in
Maximum shear force	=	-317090.82912	lbs
Depth of maximum bending moment	=	147.96000	in
Depth of maximum shear force	=	178.20000	in
Number of iterations	=	153	
Number of zero deflection points	=	2	

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 1.57E+05	M= 0.000	0.0000	0.2209768	2.2953E+07	-317091.

The analysis ended normally.