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BUFFALO RIVER AREA OF CONCERN

Restrictions on Dredging Activities Beneficial Use Impairment Removal Report

AUGUST 2022

Photo courtesy of U.S Army Corps of Engineers (Andrew Kornacki)

Buffalo River Area Of Concern

Restrictions on Dredging Activities

Beneficial Use Impairment (BUI) Removal Report

August 2022

Prepared by:

New York State Department of Environmental Conservation

This Beneficial Use Impairment (BUI) Removal Report was prepared by the New York State Department of Environmental Conservation (NYSDEC) in cooperation with Buffalo Niagara Waterkeeper (BNW) and was substantially funded by the United States Environmental Protection Agency (USEPA) through the Great Lakes Restoration Initiative (GLRI). The NYSDEC and BNW acknowledge the significant efforts of the Remedial Advisory Committee (RAC) in engaging stakeholders and the public throughout the BUI removal process. For more information, please contact either the Remedial Action Plan (RAP) Coordinator at BNW or the AOC Coordinator at NYSDEC Division of Water.

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List of Abbreviations

AOC	Area of Concern
BNW	Buffalo Niagara Waterkeeper
BUD	Beneficial Use Determination
BUI	Beneficial Use Impairment
CDF	Confined Disposal Facility
COCs	Contaminants of Concern
DMU	Dredge Management Unit
GLLA	Great Lakes Legacy Act
GLNPO	Great Lakes National Program Office
GLRI	Great Lakes Restoration Initiative
GLWQA	Great lakes Water Quality Agreement
IJC	International Joint Commission
NYSDEC	New York State Department of Environmental Conservation
NYSDOS	New York State Department of State
NYSOGS	New York State Office of General Services
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
RAO	Remedial Action Objectives
RAP	Remedial Action Plan
RAC	Remedial Advisory Committee
RG	Remedial Goals

SCO	Soil Cleanup Objectives
SWAC	Surface-weighted Average Concentrations
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USPC	United States Policy Committee

1. Introduction

This Beneficial Use Impairment (BUI) Removal Report identifies the background, criteria, supporting data, and rationale to remove the *Restrictions on Dredging Activities* BUI from the Buffalo River Area of Concern (AOC). The status of this BUI is currently designated as “Impaired” due primarily to historic sediment contamination and associated restrictions placed on dredging activities within the federal navigation channel both in the City Ship Canal and Buffalo River. In recent years, significant remedial efforts have been completed to address this contamination, including sediment removal and capping, and upland source control at former and current industrial facilities along the river.

The New York State Department of Environmental Conservation (NYSDEC) recommends the removal of *Restrictions on Dredging Activities* BUI from the Buffalo River AOC, based on the completion of remedial efforts, ongoing source control, and an evaluation of applicable post-remediation sediment data sets and other evidence gathered to address this impairment. This recommendation is made with the full support of the Buffalo River AOC Remedial Advisory Committee (RAC).

2. Background

Under Annex One of the Great Lakes Water Quality Agreement (GLWQA), the International Joint Commission (IJC) has identified 43 AOCs in the Great Lakes Basin where pollution from past industrial production and waste disposal practices has caused significant ecological degradation. Up to fourteen BUIs, or indicators of poor water quality, are used to evaluate the condition of an AOC.

The Buffalo River AOC is located in the City of Buffalo, Erie County, in Western New York State. The Buffalo River flows from the east and discharges into Lake Erie near the head of the Niagara River. The AOC extends along the historically industrialized portion of the river, beginning at the mouth of the River and continuing approximately 6 miles upstream to the Bailey Avenue Bridge. The extent of the Buffalo River AOC is depicted in Figure 1. The impact area is 6.2 miles (10 km) in length, and the AOC also includes the entire 1.4 mile (2.3 km) stretch of the City Ship Canal, located adjacent to the River. The Buffalo River drainage area is 446 mi^2 (1155 km^2). The primary upstream tributaries which feed the Buffalo River are Buffalo Creek, Cazenovia Creek, and Cayuga Creek. A large extent of the Buffalo River and City Ship Canal within the AOC boundary is designated as a federal navigation channel, which is maintained by the United States Army Corps of Engineers (USACE) to a depth of 22 feet below low water datum.

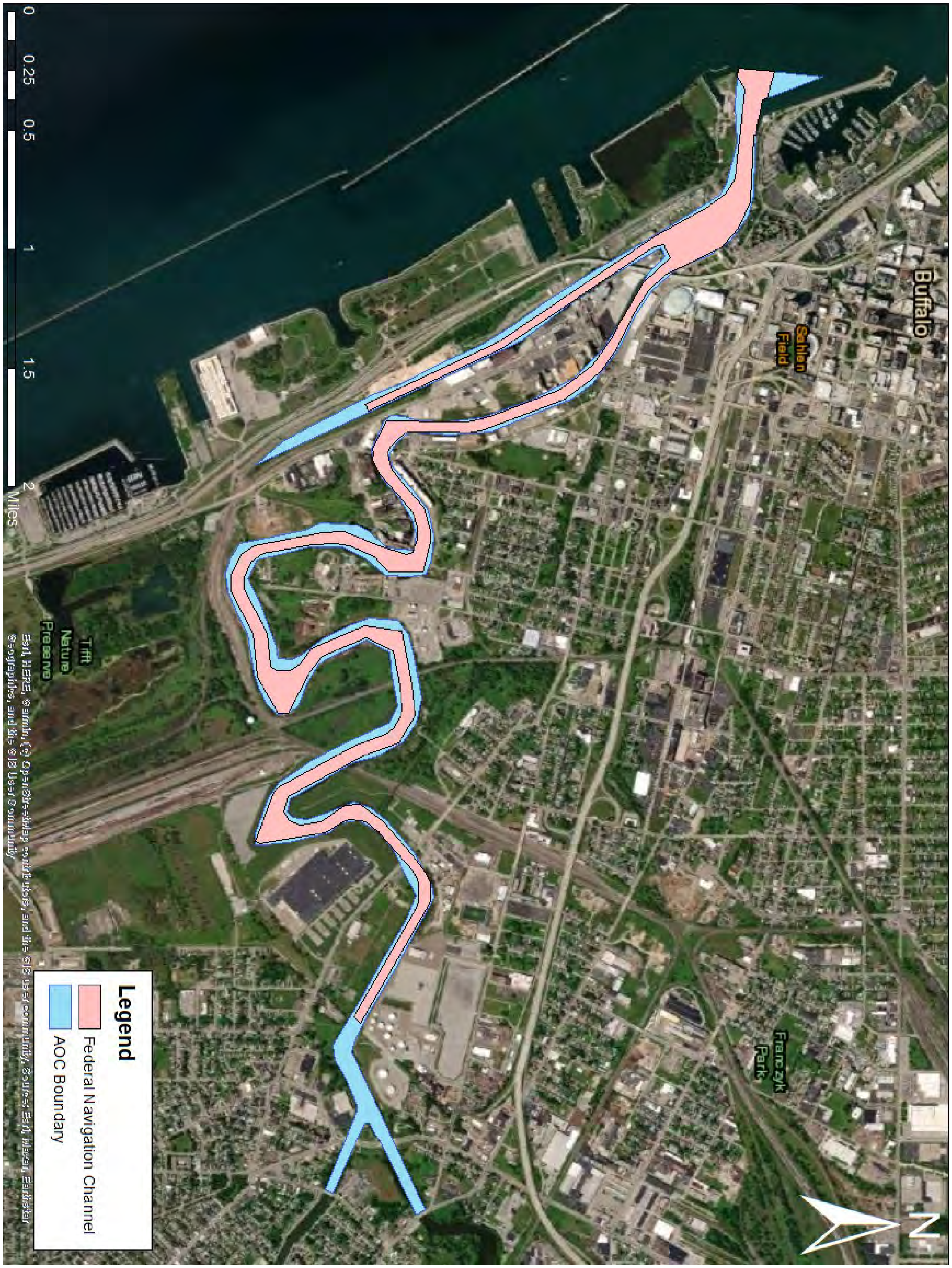

Figure 1 AOC boundary and federal navigation channel boundary in the Buffalo River

Prior to anthropogenic activities, the river was originally more of a marshy creek that was less than four feet deep. As the city of Buffalo experienced growth, the Buffalo River was modified to support commercial shipping activities. The river was dredged at the sides and in the center of the channel to accommodate cargo ships transporting goods to industrial facilities located along its banks. Nearly the entire stretch of the river within the AOC boundary was surrounded by industrial facilities from the late 1800s to 1980s. Over the course of the last century and even earlier, the Buffalo River had become polluted with direct industrial discharges including polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), chlorinated organic pesticides, aniline dye byproducts, and heavy metals. These contaminants settled into the sediments of the lower Buffalo River (Boyer 2010).

Chemical pollutants also found their way into the river indirectly, leaching from upland waste storage areas. Industries along the River disposed of their solid waste by burning, burying, weathering, or storing in lagoons on-site. These disposal practices led to chemicals entering the river through rain and snow runoff as well as groundwater leaching (Rossi 1996). Today, many of these sites have become inactive hazardous waste sites, though some facilities remain and are currently in use. In all cases, there are ongoing efforts to eliminate or control future contaminant releases, either through remedial program site cleanups or other environmental regulations that did not exist for most of the industrialized history of the Buffalo River.

In support of commercial activities, USACE continues to dredge the lower part of the Buffalo River within the federal navigation channel. Areas outside of the federal navigation channel, such as private marinas, are maintained by non-federal entities. The *Restrictions on Dredging Activities* BUI only applies to the federally maintained navigation channel within the AOC.

Under Annex One of the GLWQA, all AOCs are mandated to develop a Remedial Action Plan (RAP) in three stages:

- Stage I which collectively identifies specific BUIs and their causes,
- Stage II which outlines the restoration work needed to address the root problems and restore the identified BUIs, and
- Stage III which documents the fulfillment of the commitments made in Stage II and recommends the delisting of the AOC.

In 1987, a group of concerned citizens, scientists, and stakeholders, along with NYSDEC formed the Buffalo River Remedial Advisory Committee (RAC), formerly known as the Citizens Advisory Committee, to identify and address BUIs within the AOC. Collectively, the RAC developed and published a combined Stage I and II RAP for the Buffalo River AOC in 1989. The goal of the RAP is “to restore and maintain the chemical, physical, and biological integrity of the Buffalo River ecosystem in accordance with the Great Lakes Water Quality Agreement” (NYSDEC 1989).

Through the combined Stage I and Stage II RAP and subsequent RAP addenda, the Buffalo River RAC has designated nine out of the possible fourteen BUIs as being impaired for the Buffalo River AOC. The *Restrictions on Dredging Activities* BUI was initially designated as impaired in the 1989 Stage I and Stage II RAP.

2.1 Rationale for BUI Listing

The *Restrictions on Dredging Activities* BUI was originally listed as impaired in the Stage I/II RAP due to the presence of multiple contaminants at concentrations exceeding open lake disposal criteria. The primary contaminants of concern (COCs) include arsenic, barium, copper, iron, lead manganese, zinc, and cyanide. PAHs, PCBs, and mercury were later added to the list of COCs. The major sources of contamination of the bottom sediments were the inactive hazardous waste sites located along the banks of the Buffalo River.

In the early 1980s, data were collected on the bottom sediments to determine the extent of impairment. The first sediment data collection efforts were led by the United States Environmental Protection Agency (USEPA) Region 5 and USACE – Buffalo District in 1981. The USEPA collected samples at 17 sites primarily along outfall locations. The USACE sampled four sites three times each - three sites within the AOC and one sample site just outside of the AOC boundary in the Buffalo Harbor. In 1983, NYSDEC sampled 10 sites from the upstream portion of the AOC. Erie County conducted a sediment study in a 0.3-mile area in the upstream portion of the Buffalo River within the AOC in 1985, collecting 168 samples at regular intervals within the AOC and 16 samples were collected at an upstream control area located outside of the AOC boundary. These studies confirmed the presence of contaminants in the bottom sediment and concentrations were higher in the AOC portion than in upstream areas and nearshore areas of Lake Erie by an average of one order of magnitude (NYSDEC 1989).

The findings of these sediment investigations indicated that contaminant concentrations in the sediment exceeded open lake disposal criteria for eight substances: arsenic, barium, copper, iron, lead, manganese, zinc, and cyanide. The criteria thresholds were published in USEPAs *Interim Guidelines for the Pollutional Classification of Great Lakes Harbor Sediments* (USEPA 1977). Although mercury and PCBs were later identified as the primary COCs for the Buffalo River AOC, as further described in Section 3.1, concentrations in sediments collected in the 1980s did not exceed the interim criteria set in the mid-1970s.

2.2 BUI Removal Criteria

In December 2001, the Restoring United States Area of Concern: Delisting Principles and Guidelines document developed by the USEPA was adopted by the United States Policy Committee (USPC). This document was intended to "guide the restoration and maintenance of beneficial uses and the subsequent formal delisting in order to achieve a measure of consistency across the basin (USPC, 2001). This document provided the following scenarios under which a BUI can be removed:

A. A delisting target has been met through remedial actions which confirms that the beneficial use has been restored.
B. It can be demonstrated that the beneficial use impairment is due to natural rather than human causes.
C. It can be demonstrated that the impairment is not limited to the local geographic extent but rather is typical of lakewide, region-wide, or area-wide conditions (under this situation, the beneficial use may not have been originally needed to be recognized as impaired).
D. The impairment is caused by sources outside the AOC. The impairment is not restored but the impairment classification can be removed or changed to "impaired-not due to local sources." Responsibility for addressing "out of AOC" sources is given to another party.

The most comprehensive path to BUI removal is represented by option A, where specific targets or removal criteria are established and, after implementation of the necessary remedial actions, it can be demonstrated that the beneficial use has been restored.

The Buffalo River RAC originally published site specific *Restrictions on Dredging Activities* criteria in the *Monitoring Plan for the Delisting of Impaired Beneficial Use Impairments* (BNW 2014). The original criteria read:

There are no restrictions on routine commercial or recreational navigation dredging by the U.S. Army Corps of Engineers (COE) or another entity across any part of the AOC, such that no special management measures or use of a confined disposal facility are required for the dredged material due to chemical contamination.

The criteria had some vague terminology that was subject to interpretation and presented scenarios that were beyond the scope of the AOC program. The original criteria did not specify the restrictions on dredging activities applied to the federal navigation channel only. Routine maintenance dredging is regularly conducted by USACE and has always been the intended scope. There was also a need to clarify the use of the Confined Disposal Facility (CDF) that refers to the USACE CDF located in Buffalo Harbor, specifically. The USACE CDF has historically been the area dredged material is placed due to chemical contamination that exceeds state and federal standards, thereby preventing open lake disposal as a viable option. It is currently used for dredge material placement due to the technical efficiency, cost-effectiveness and proximity.

In 2021, the Buffalo River RAC formed a dredging subcommittee for the purpose of reviewing the existing removal criteria and developing modifications to ensure the criteria were logical, specific to the AOC, and achievable. The full RAC approved of the proposed changes at the December 17, 2021 meeting. The final removal criteria for the *Restrictions on Dredging Activities* BUI read as follows:

Sediment dredged from the federal navigation channel does not require special dredged material management measures or use of a USACE confined disposal facility due to chemical contamination.[1]

> [1]*As has always been the case, dredging activities outside of the federal navigation channel will be required to follow the current or future NYSDEC/U.S. Army Corps of Engineers/U.S. Environmental Protection Agency permitting processes and meet the associated standards.*

The removal criteria only apply to the federally maintained navigation channel and not privately owned marinas, boat slips, or other depositional areas outside of the navigation channel that may require dredging for any reason and special dredged material provisions or restrictions.

The footnote included in the criteria states that areas outside of the federal navigation channel will follow all required permitting processes. Permitting requirements guarantee that a consistent and comprehensive permitting process is implemented for all in-water projects, including dredging activities. The controls put in place within the permit and the regulatory process of obtaining the permit ensures that all projects are protective to the environment and incorporates best management practices for all the stages of the project. The footnote acknowledges that proposed dredging within any area of the AOC will be properly permitted before any action can be taken.

3. Assessments and Management Actions Supporting BUI Removal

Since publication of the Stage II RAP in 1989, a significant amount of work has been completed to address AOC impairments, including the *Restrictions on Dredging Activities* BUI and to better understand and restore sediment quality. Figure 2 below summarizes some of these efforts.

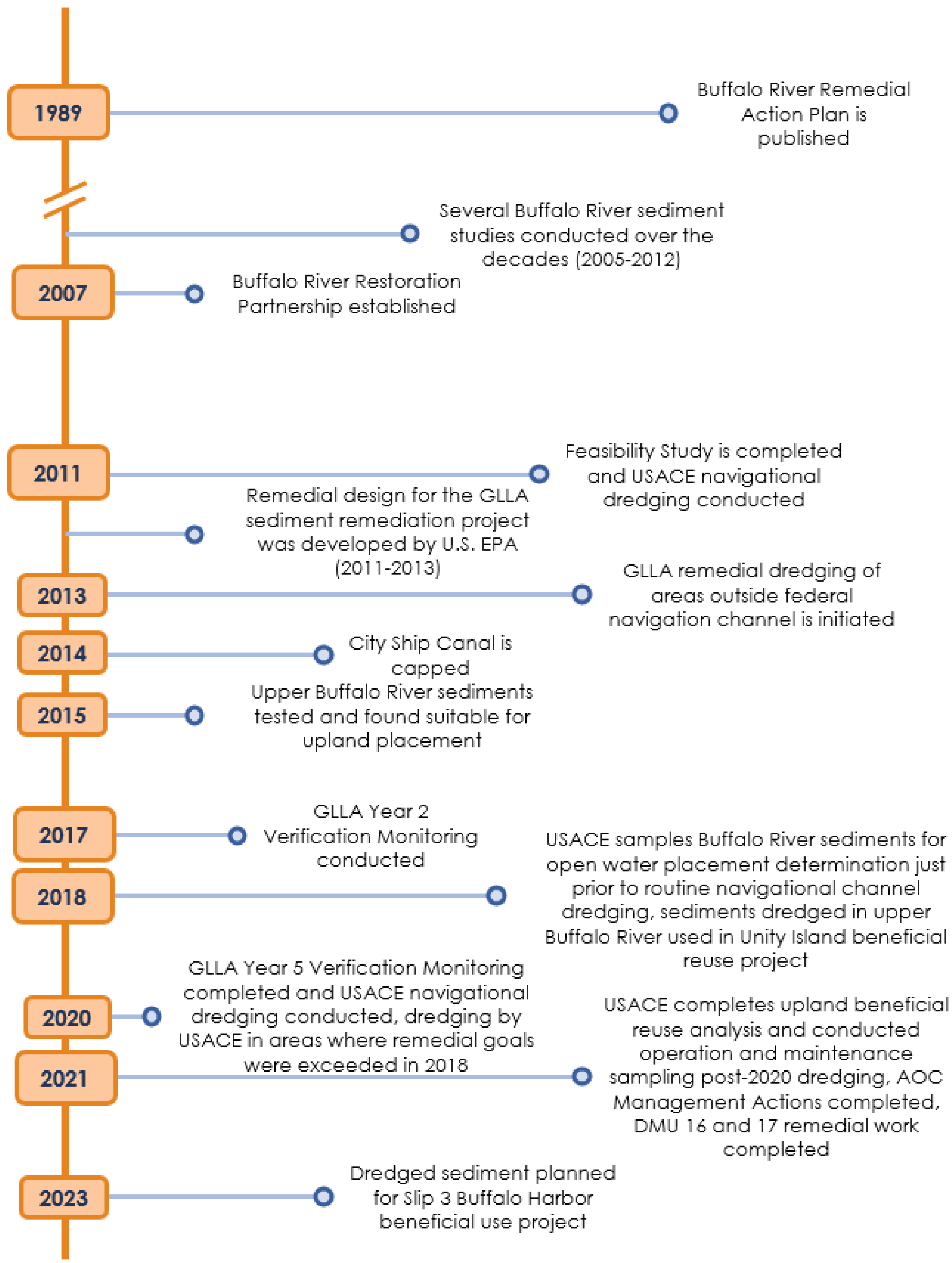

Figure 2: Timeline of AOC Activities

3.1 Assessing and Remediating Contaminated Sediment

Since publication of the Stage I/II RAP in 1989, additional studies have been conducted to characterize the Buffalo River sediments and the extent of contamination. One major effort was the development of the Assessment and Remediation of Contaminated Sediments (ARCS) Report in the Buffalo River AOC in 1995. This report presented data from two surveys performed in 1989 and 1990 where sediment grab and core samples were analyzed for PAHs, PCBs, chlorinated pesticides, and heavy metals. New guidelines developed in the early 1990s were used in the data analysis. These were the Long and Morgan 1990 and EPA 1993 equilibrium partitioning approach (ARCS 1995). The ARCS report found that the metals posing the highest risk for biota were lead and zinc, followed by mercury, chromium, and nickel. Organic pollutants that posed concern were PCBs and PAHs. The contaminants exceeded the updated guidelines; therefore, the *Restrictions on Dredging Activities* was still in place requiring confined disposal of dredged sediment. The most cost-effective and environmentally acceptable disposal option has been to place the material in the USACE CDF.

In 2002, the Great Lakes Legacy Act (GLLA) was passed by Congress for the purpose of accelerating cleanup of contaminated sediment within the Great Lakes Areas of Concern. This boosted further Buffalo River AOC studies to be conducted on the extent of contamination in the sediments and prompted remediation alternatives to be assessed. The sediment studies carried out from 2005 to 2012 intended to model sediment movement, baseline conditions, and assess whether point sources continued to contribute pollutant loadings. One key sampling effort was led by NYSDEC and EPA Great Lakes National Program Office (GLNPO), conducted in 2005, 2007, and 2008 to further characterize four indicator chemicals: PAHs, PCBs, lead and mercury. These chemicals were chosen because they would address the risks of the full set of comingled COCs and later would be used as the remedial criteria for sediments in the Buffalo River. The data in the study was also intended to assess remedial alternatives and determine the potential for recontamination of sediments within the navigation channel from sediments outside of the navigation channel. Surface sediment samples and sediment cores were collected in 17 locations predetermined by NYSDEC, EPA GLNPO, Buffalo Niagara Waterkeeper (BNW), and USACE based on highest potential for human contact and potential habitat areas. Interpretation of sample results was not within the scope of the report, rather the study was intended to collect baseline information that could be presented in various additional studies and reports to evaluate the effects the sediments had on the Buffalo River ecosystem. This data was also used to define distinct dredge management units (DMUs) to manage the sediment remediation in the future (USEPA 2013).

The Buffalo River Restoration Partnership (PCT), formed in 2007, led coordination and planning efforts to address the contaminated bottom sediments within the AOC. This group consisted of USEPA, NYSDEC, BNW, USACE, the City of Buffalo, and Honeywell, Inc. Each organization was a key partner in progressing the restoration of the Buffalo River. Information collected over the years led to the development of a feasibility study that would determine the best course of action to effectively manage potential ecological and human health risks associated with elevated sediment contaminant concentrations, and ultimately allow for the removal of the *Restrictions on Dredging Activities* BUI. A more complete summary of studies completed between 2005 to 2008 is provided in the Feasibility Study for the Buffalo River prepared by environmental consultants for Honeywell (ENVIRON 2011).

The study identified site specific remedial goals (RGs) for four indicator chemicals using multiple lines of evidence, listed the remedial action objectives (RAOs) which define the basis for evaluating sediment remedy options, and provided remedial alternatives to address contaminants in the bottom sediments. The RAO's are listed as follows:

- **RAO 1**: Reduce human exposures for direct sediment contact and fish consumption from the Buffalo River by reducing the availability and/or concentration of COCs in sediment
- **RAO 2**: Reduce the exposure of wildlife populations and the aquatic community to sediment COC concentrations that are above protective levels
- **RAO 3**: Reduce or otherwise address legacy sediment COC concentrations to improve the likelihood that future dredged sediments (for routine navigational, commercial, and recreational purposes) will not require confined disposal
- **RAO 4**: Implement a remedy that is compatible with the Buffalo River Remedial Advisory Committee's goal of protecting and restoring habitat and supporting wildlife

Table 1 presents the remedial goals for PAHs, PCBs, lead, and mercury. The remedial goal for total PAHs is based on point concentrations, whereas the remedial goals for the other chemicals are based on surface-weighted average concentrations (SWACs) from multiple samples collected over 1/3-mile segments of the river (bank to bank). These numerical values were determined to be protective of environmental resources and were developed using multiple lines of site-specific evidence using USACE toxicity tests and comprehensive analyses performed by a sub-group of the PCT. Further information on the development of the RGs can be found in Section 3 of the Feasibility Study (ENVIRON 2011). The RAOs were determined as priority goals to make progress towards BUI removal. The third RAO specifically addresses the *Restrictions on Dredging Activities* BUI, aiming to achieve open lake placement or beneficial use of dredged sediment and is directly in line with the BUI criteria. The Feasibility Study proposed five remedial alternatives ranging from natural recovery to various efforts of remedial dredging and capping. Remedial Alternative 5, "Alternative 5: Enhanced Protectiveness Dredging", was the study's recommended alternative and consisted of a combination of strategic sediment removal and engineered capping as it would provide the effective and efficient risk reduction goals in both the surface and subsurface sediments while minimizing short-term impacts to the biotic community.

Table 1: Established GLLA Remedial Goals

Chemical	Remedial Goal
Total PAHs	1 toxicity unit (16 mg/kg)
Lead	90 mg/kg SWAC
Mercury	0.44 mg/kg SWAC
Total PCBs	0.20 mg/kg SWAC
Notes: mg/kg - milligram(s) per kilogram.	

The project partners made the decision to implement Remedial Alternative 5 for remediating contaminated bottom sediments in the Buffalo River AOC based on the RAOs stated in the Feasibility Study Report. In March of 2013, EPA published the *Final Basis of Design Report* which described the plans of the remedial project.

Under the GLLA program, the USEPA and Honeywell funded $48.5 million to remove approximately 453,000 cubic yards of contaminated sediment from areas outside of and below the federal navigation channel within the Buffalo River AOC. The DMUs, shown in Figure 3, were developed to manage dredging activities. The river mile stations are shown in 1/3-mile increments that correspond to the determination of the GLLA site-specific remedial goals.

Figure 3: Buffalo River AOC GLLA DMUs

Most of the sediment was disposed in the Buffalo Harbor CDF. A small volume of sediment was classified as hazardous waste due to elevated PCB concentrations and was disposed of in a licensed landfill. The funding also included the capping of a 4.75-acre section of the City Ship canal with 5.5 feet of clean sediment, isolating the chemical contamination, and subsequent habitat restoration in this area. The GLLA work completed the bulk of remedial dredging required to remove contaminated sediments. Figure 4 maps the GLLA project area (Ramboll & Anchor QEA 2018).

Figure 4:Buffalo River GLLA Remediation and Restoration Areas

As part of the GLLA project, verification monitoring was performed at year 2 and year 5 following completion of the remedial dredging activities to evaluate environmental conditions and determine if the remedial goals of the project have been achieved. The verification monitoring was performed by Ramboll and Anchor QEA, on behalf of Honeywell, Inc. Year 2 monitoring was conducted in 2017 and Year 5 verification monitoring was completed in 2020. Verification monitoring components included bathymetric surveys, surface sediment chemistry analysis, biological community surveys, and habitat surveys. For the purposes of this report, the bathymetric surveys and sediment chemistry analysis portion of the monitoring effort will be discussed.

Bathymetric surveys were conducted to evaluate the integrity of the City Ship Canal cap, monitor the cap status of several DMUs, and estimate sedimentation rates in remedial areas. Figure 3 presents the locations of all DMUs within the Buffalo River AOC (Ramboll & Anchor QEA 2018). It was determined the City Ship Canal cap surface has been subjected to slight sediment deposition and no instances of cap failure were observed during both monitoring events in 2017 and 2020. Three DMUs in the Buffalo River were monitored for cap stability: DMUs 9, 10, and 44e as these were the only areas to be capped. These areas, outside of the federal navigation channel, were dredged in 2015 and were backfilled to retain shoreline stability. Based on the bathymetric surveys, there is no evidence of cap instability.

Year 2 (2017) and Year 5 (2020) verification monitoring provided a means to evaluate the success of the sediment remediation relative to the remedial goals and provides a snapshot of trends in contaminant concentrations within the Buffalo River AOC over time, following the completion of remedial dredging. In 2017, 73% of the 234 discrete samples collected for PAH evaluation met the PAH remedial goal of 16 mg/kg (Ramboll & Anchor QEA 2018). Locations in which remedial goals were not met were tested again in 2020 and 79% of the 77 samples collected met the remedial goal for PAHs (Ramboll & Anchor QEA 2021). Samples collected from sixteen locations did not meet PAH remedial goals, most of which were isolated, and surrounded by samples that did achieve remedial goals. Three of these exceedances were located in DMUs 16 and 17 where wooden bulkheads, debris, and pilings made dredging of contaminated sediments impracticable. As part of the GLLA project, Honeywell carried out additional remediation measures in 2021 to address DMUs 16 and 17 (described more fully in the Year 5 discussion below). The PAH concentrations at the remaining 13 sample locations outside of DMUs 16 and 17 were projected to decrease over time due to natural sedimentation, therefore did not require further remediation or monitoring. In addition, these elevated PAH sample sites were isolated and surrounded by samples that did achieve the PAH remedial goal therefore are not part of a continuous deposit of elevated PAH concentrations. Overall, 94% of the original 260 PAH sediment sample locations met the remedial goals by the Year 5 monitoring, demonstrating the success of the remedial dredging and ongoing natural recovery of the Buffalo River.

To address the PAH contaminants in DMU 16 and 17, which could not be remediated during the initial GLLA dredging project, a subsequent remedial alternative was developed by the GLLA project partners and implemented in 2021. Unique challenges were faced in addressing the contaminated sediment in these DMUs due to the timber pilings and shoreline slope instability. The upland property is owned by CSX and currently has working rail lines where trains transport goods regularly along the rail lines adjacent to the river. A geotechnical engineering analysis was performed by Anchor QEA to determine the slope stability and slope factor of safety. The slope factor of safety was calculated to be between 0.9 and 1.2 which is less than the USACE guidelines of 1.3 for short-term slope stability and 1.5 for long term slope stability (Anchor QEA July 2021). The slope instability of the CSX property is evident by the sloped timber pilings, indicating historical movement of the soil around the piles in a downslope direction, and several tension cracks at the top of the slope of the riverbank (Anchor QEA April 2021). The alternative chosen to remediate DMUs 16 and 17 was to dredge 1 foot down within the federal navigation channel of DMU 16 and installing a cover in areas outside of the navigation channel in both DMUs 16 and 17. The cover was designed to consist of two layers, first, a 6-inch layer of amended sand and granulated activated carbon (GAC), followed by a 6-inch layer of sand. The GAC layer will further reduce PAH concentrations in the underlying sediment. Bathymetric surveys have shown DMUs 16 and 17 are depositional, therefore the cover should stay intact and increase in thickness over time. Over 95% of sample sites within the AOC meet remedial goals after the completion of partial dredge and cover at DMUs 16 and 17 (Ramboll & Anchor QEA 2021).

During the Year 2 verification monitoring sampling event, one composite sample was collected from each of 11 composite areas within the Buffalo River AOC. Each composite sample consisted of 40 discrete surface sediment samples from the respective composite areas. The composite samples were tested for three parameters: total PCBs, lead, and mercury, yielding a total of 33 contaminant results. Lab analysis of the samples indicated that 15 of the 33 results met the remedial goals, the remaining 18 results exceeded the remedial goals. Three composite areas met remedial goals for all three COCs, while the other eight areas all exhibited at least one COC exceeding the remedial goal. A more detailed summary of the Year 2 results is provided in the associated monitoring report (Ramboll & Anchor QEA 2018).

Year 5 monitoring consisted of resampling for all eight Year 2 composite areas where one or more COC concentrations exceeded project remedial goals. One composite sample, each consisting of at least 30 discrete surface sediment samples, was collected from each of these eight areas. Each composite sample was only analyzed for those COCs that exceeded the remedial goals in the Year 2 monitoring for the respective area. These analyses yielded a total of 17 contaminant results. Less samples were collected in 2020 than 2017 due to insufficient sample recovery. Eleven of the 17 contaminant results met the remedial goals for the respective COC. Although six results exceeded the remedial goal, the concentrations of these COCs had decreased compared to Year 2 data. The results demonstrate the natural recovery process ongoing in the Buffalo River AOC.

Three of the six exceedances (1 for PCBs, 2 for mercury) located in the Buffalo River portion of the AOC (excludes City Ship Canal) were only marginally above the remedial goal. The other three results are from samples collected in two composite areas within the City Ship Canal (2 for mercury, 1 for lead). These areas are located just south of South Michigan Avenue adjacent to a submerged City of Buffalo water utility line. Dredging within these areas was not feasible due to the proximity of utility lines.

For all six areas with exceedances of remedial goals, the Year 5 Verification Monitoring Report concluded natural recovery will reduce contaminant concentrations in surface sediment. The verification monitoring report had concluded remedial dredging was successful in removing the majority of contaminated sediments and RGs were met.

3.2 Inactive Hazardous Waste Site Remediation

Four of the five primary contributors to historical contaminant inputs along the shoreline of the Buffalo River AOC have been designated as inactive hazardous waste sites in the last 40 years. NYSDEC issues different classifications for waste sites based on the nature and extent of the site-specific contamination, as well as the potential impacts to human health and the environment. To address contamination at inactive hazardous waste sites, there are numerous programs in New York State which include the state Superfund program, the Brownfields Cleanup Program, and the Voluntary Cleanup Program. Sites identified in the Buffalo River watershed were subsequently entered into appropriate state programs to facilitate remediation of site-specific contamination. The fifth primary historical contributor is still an active industrial facility and is required to comply with all applicable regulatory requirements that may exist to control contaminant releases.

Remedial investigations and, where it was determined necessary, remedial actions at all designated inactive hazardous waste sites in the vicinity of the Buffalo River AOC have been completed as of 2021. Information about hazardous waste sites within the vicinity of the Buffalo River AOC can be found on NYSDEC's DECinfo Locator. Remedial measures completed include components to prevent the migration of contaminants off-site, and to mitigate potential human health and environmental impacts and are further detailed in their monitoring plans. Currently there are no known continuing sources of unacceptable concentrations of contaminants entering the Buffalo River, as was first identified in the Stage I/Stage II RAP as being linked to multiple BUIs, including the *Restrictions on Dredging Activities*.

3.3 Routine Navigational Dredging

The federal navigation channel in the Buffalo River is maintained by the USACE to an authorized depth of 22 feet below low water datum and is typically dredged every couple of years. The USACE conducted routine dredging in the years 2011, 2015, 2018, and 2020. Routine dredging to address the backlog of contaminated sediment that remained in the federal navigation channel began in 2011. The USACE used $4.6 million of Great Lakes Restoration Initiative (GLRI) funds and $1.3 million of USACE's operations and maintenance funds to remove approximately 508,000 cubic yards of contaminated sediment from the federal navigation channel in the river. In the following year, USACE removed approximately 40,000 cubic yards of sediment and shoals from the lower reaches of the Buffalo River within the federal navigation channel. Sediment from these dredging activities was placed into the CDF located adjacent to the former Bethlehem Steel site. During routine dredging activities, sediments were removed from the river and also placed into the CDF. While this practice remains in place today due to the cost-effectiveness and proximity of the CDF located in the Buffalo Harbor, declining sediment contaminant concentrations as discussed above have allowed USACE to also pursue beneficial re-use of sediment dredged from the river, as described in Section 3.5.

3.4 Buffalo Harbor Sediment Evaluation

The USACE conducts periodic sampling to evaluate the sediment quality within the federal navigation channel. In 2018, USACE conducted sediment sampling within the Buffalo River federal navigation channel to further analyze suitability for potential open water placement areas in Lake Erie and would establish whether the *Restrictions on Dredging Activities* BUI continued to be impaired. The purpose of this work was to determine whether the sediments from the federal navigation channel would meet the Clean Water Act (CWA) Section 404(b)(1) Guidelines for open water placement, including potential beneficial reuse in aquatic environments. Meeting the CWA guidelines indicate that dredged sediments would not require special management for disposal and therefore that the BUI removal criteria have been met. This was the first evaluation of sediments within and outside the federal navigation channel since the GLLA remedial dredging activities were substantially completed in 2015.

Sediments were analyzed for a series of contaminants including the Buffalo River AOC COCs, all of which are listed in the original report, *Buffalo Harbor Dredged Sediment Evaluation* (USACE 2019). There were

30 locations sampled within the Buffalo River Channel and 5 locations sampled within the City Ship Canal. In the Buffalo River navigation channel, 12 sediment core samples and 18 sediment surface grab samples were collected. Grab samples were collected in locations where project depth was less than 3 feet, due to insufficient soil volumes for sediment core sampling. Sediment samples collected in the City Ship Canal were surface grab samples.

The sediment evaluation was conducted in accordance with *The Great Lakes Material Testing and Evaluation Manual* (1998b), and *Evaluation of Dredged Material for Discharge in Waters of the U.S.* (1998a). Results from the 2018 USACE sampling efforts show that sediments from 25 sites in the Buffalo River and the 5 sites within the City Ship Canal meet the "contaminant determination" part of the CWA Section 404(b)(1) Guidelines for open-water placement, which included an evaluation of sediment contaminant concentrations against the project criteria (i.e., remediation goals as previously defined in this report). Only 5 sample sites out of the 30 within the Buffalo River Channel required further evaluation as they did not meet the project criteria, exhibiting exceedances for at least one of the COCs.

USACE conducted additional dredging in 2020 of those areas where sample contaminant concentrations exceeded project criteria in 2018. Operation and maintenance sampling was conducted post-dredging as part of USACE federal navigation channel activities in 2021. The sampling verified that sediments exhibiting contaminant concentrations exceeding criteria in 2018 were removed during the 2020 dredging (USACE 2022). Sediment in the federal navigation channel meets the criteria for open water placement and aquatic beneficial reuse based on data analyzed for select areas in 2018 and the remainder of locations in 2020. The results indicate that the criteria developed to remove the *Restrictions on Dredging Activities* BUI have been met, and the 'impaired' designation can be removed.

3.5 Beneficial Reuse

Several beneficial reuse analyses were conducted for sediments dredged within the Buffalo River AOC. Sediments in the upstream portion of the Buffalo River are situated upstream from the inactive hazardous waste sites and were not dredged in 2011 and 2012. Sediment from the upper Buffalo River was analyzed in 2015 for aquatic and upland beneficial reuse and it was determined to be environmentally suitable for wetland restoration projects. The sediments were subsequently dredged and used for a wetland habitat enhancement project at Unity Island (within the Niagara River AOC) as part of USACE's Section 204 project in 2018 (USACE 2021).

Sediments in the lower Buffalo River AOC were evaluated for beneficial reuse in both aquatic and upland environments using the USACE 2018 and 2021 data. For aquatic placement beneficial reuse, sediment must meet the CWA Section 404(b)(1) Guidelines for open-water placement as described in Section 3.4. The five sites that exceeded project criteria for COCs in 2018 were dredged again in 2020 and follow-up sampling conducted in 2021 indicated that COC concentrations in all five sites were below project criteria. The analysis for aquatic beneficial reuse concluded sediment would not be expected to cause unacceptable, adverse, contaminant related impacts.

The 2018 data set (excluding the five sites which exceeded project criteria mentioned in the paragraph above) was used to perform an upland beneficial reuse analysis in 2021. For determining the suitability of sediments for upland beneficial use placement, dredged material is reviewed in accordance with NYSDEC's Solid Waste Management Facilities Regulations, 6 NYCRR Part 360, Section 360.12(e). Soil Cleanup Objectives (SCOs) are incorporated into the regulation to evaluate soils and soil-like material such as dredged material for soil-like uses. Dredged material within the Buffalo River federal navigation channel requires evaluation for case-specific beneficial use determination (BUD). The dredged material was compared to Table 375-6.8(b) Residential Use and Protection of Groundwater SCOs as part of 6 NYCRR Part 360 Section 360.12(e) to determine whether contaminant concentrations were below SCO values. The evaluation was based in part on the results from seven composite sediment samples, which included PCBs, PAHs, metals, and pesticides. The results from samples collected from 30 discrete locations were also included in the evaluation. The evaluation, which is provided in Appendix B, concluded that the maximum concentrations of the majority of analytes (32 of 35 total parameters) were below their respective residential and groundwater SCOs, and the average concentrations of all constituents within each of the 6 river DMUs and the City Ship Canal were below their SCOs. Individual discrete sample exceedances of the SCOs were observed only for 2 metals (arsenic and total chromium) and 1 PAH (benzo(b)fluoranthene) in three discrete samples. These three samples were collected at or below authorized channel depth, and thus do not represent sediments that would be maintenance dredged. No samples within the bounds of the federal navigation channel exceeded relevant SCOs for Residential Use or Protection of Groundwater. The evaluation indicates sediment in the Buffalo River federal navigation channel meets criteria set in the NYSDEC BUD process for upland beneficial reuse.

Additionally, future plans are in place to use sediments dredged from the federal navigation channel for the multi-year Buffalo Harbor Slip 3 habitat project. The sediments from the next three USACE routine dredging cycles will be used as aquatic fill to create wetland and aquatic habitat.

Buffalo River sediments have the potential to be used for beneficial reuse. This supports the removal criteria because the sediment has been tested and determined to be suitable for habitat restoration/enhancement projects. Sediment that was once causing ecological impairment is now able to build and restore habitat areas both aquatic and upland.

4. Analysis

The *Restrictions on Dredging Activities* BUI was originally listed as Impaired in the 1989 RAP due to contaminants in the sediments restricted open lake disposal and required that dredged sediment to be disposed of in the CDF. Since then, a series of remedial activities have been completed to address contaminants and prevent further loading in the Buffalo River, within and outside of the federal navigation channel. Upland loading sources have been remediated or are monitored as work is being completed to address sources of contamination and cleaner upstream sediments depositing in the AOC area contribute towards natural attenuation of the bottom sediment. The Buffalo River and City Ship Canal have been extensively dredged of sediments that exceeded remedial goals. The sediment analyses conducted by USACE (USACE 2019, 2022, and Appendix B) demonstrate the removal criteria has been met. The actions and initiatives of the various programs have been successful in addressing root causes of contamination, restoring the river sediments, and mitigating ecological impairments.

The removal criteria states that special management measures for handling dredged sediment should not be required due to chemical contamination. The term "special management measures" can be defined as any management measure of dredged sediments that requires sediments to be contained due to chemical contamination such as placing in the USACE CDF, for example. Based on results presented in this report, Buffalo River sediment is not restricted to disposal in the CDF due to chemical contamination.

It has also been demonstrated that the sediments dredged from the federal navigation channel meet the criteria for open lake placement and beneficial reuse in aquatic and upland environments. While the 2018 USACE report included potential open water placement areas identified and evaluated for suitability, the report concluded further study for open placement areas is needed. Establishing an open water placement area is an ongoing process led by USACE. Until such time that a location is identified, sediments dredged may still be placed in the CDF but not due to contamination and therefore the BUI removal criteria have been met.

5. Public Outreach

NYSDEC, in partnership with BNW, Erie County Department of Environment and Planning, USEPA, and the Buffalo River RAC, hosted a virtual public meeting on ____, 2022 to present the case for removing the "Restrictions on Dredging Activities" BUI to local stakeholders. The meeting kicked off a 30-day period during which public was invited to review and provide input on a draft version of this BUI removal report, which was hosted on the BNW website.

During the virtual public meeting, NYSDEC responded to questions asked by attendees in real time. No additional input was received following the virtual public meeting. BNW has prepared a summary of the public meeting comments reflecting the public's general desire to understand a very complicated topic and acceptance of the RAC/DEC conclusions without any opposition noted. This summary is included as **Appendix C**.

6. Conclusions

6.1 BUI Removal Steps

	Completed	*Date*	*Step Taken*
1.	√	11/1989	BUI first designated as "impaired" in Stage I/II RAP.
2.	√	12/17/2021	Final BUI removal criteria established with RAC consensus.
3.	√	12/17/2021	RAC agreed to proceed with BUI removal.
	√	7/8/2022	Initial Draft BUIRR provided to USEPA for review by Technical Review Lead.
5.	√	7/19/2022	Receive comments from USEPA/Technical Review Lead and revise removal report accordingly.
6.			Hold public outreach meeting to present BUI removal rationale to local stakeholders (including a 30-day public outreach period).
7.			NYSDEC completes final modifications to the *Restrictions on Dredging Activities* BUI removal document, based on public input received.
8.			Coordinate the formal transmittal of the BUI removal report with USEPA GLNPO.
9.			Communicate results to RAC for appropriate recognition and follow-up.

6.2 Removal Statement

In the Stage I/II RAP for the Buffalo River AOC, the *Restrictions on Dredging Activities* BUI was originally listed as Impaired due to contaminated sediments within the federal navigation channel exceeding criteria for open lake placement and required confined disposal during USACE routine dredging.

In order to assess the status of the *Restrictions on Dredging Activities* BUI, sediment characterization studies were conducted leading to the development of the Feasibility Study which identified the best course of action for remediating contaminated sediments. Major remedial dredging efforts removed contaminated sediments from the federal navigation channel and areas outside the navigation channel. Capping some areas within the AOC that could not be dredged also isolated contaminants left in place. Sediments were collected by USACE in 2018 and 2021 and analysis of the samples concluded the sediments within the navigation channel meet the criteria for open water placement and beneficial use in upland and aquatic environments and do not require any special management measures or confined disposal for dredged sediments.

The NYSDEC has determined the *Restrictions on Dredging Activities* BUI can be removed from the list of designated impairments for the Buffalo River AOC in accordance with EPA guidance and the GLWQA. The Buffalo River RAC fully supports the removal of this BUI.

6.3 Post-Removal Responsibilities

6.3.1 New York State Department of Environmental Conservation

NYSDEC will evaluate all future beneficial reuse projects involving the use of Buffalo River dredged sediments through the Beneficial Use Determination protocol pursuant to 6 NYCRR Part 360.12 and Water Quality certification under Section 401. Additionally, NYSDEC will continue to provide regulatory oversight for inactive hazardous waste site within the Buffalo River watershed that have not yet completed remedial activities and process permits for any future dredging projects.

6.3.2 United States Army Corps of Engineers

The USACE will continue to use *The Great Lakes Material Testing and Evaluation Manual* as a technical guidance resource in the assessment of dredging projects in the Buffalo River AOC. USACE will continue to perform routine navigational dredging in the Buffalo River and process permits for any future dredging projects. USACE will do so in accordance with all applicable procedures, standards, and guidance.

6.3.3 United States Environmental Protection Agency

The USEPA will continue to provide funding for RAP/RAC Coordination and technical resources to the extent resources are available to support the removal of remaining BUIs and ultimately the delisting of the AOC.

6.3.4 Buffalo Niagara Waterkeeper

BNW will continue to serve as the RAP coordinator for the Buffalo River AOC until EPA/GLRI grant funding expires. As RAP coordinator, BNW facilitates RAC meetings, provides technical and administrative assistance for AOC documentation, serves as the primary point of contact for the AOC, and coordinates the overall implementation of the RAP for the Buffalo River AOC.

6.3.5 Erie County Department of Environment and Planning

Erie County Department of Environment and Planning will continue to partner with BNW in implementing responsibilities associated with the Buffalo River RAP until EPA/GLRI grant funding expires. Erie County staff participate in RAC meetings, provide feedback on AOC-related documentation and progress reports, and capacity support for the Buffalo River AOC.

6.3.6 City of Buffalo

Environmental Deed Restrictions were developed for multiple areas within the Buffalo River AOC after the completion of remedial activities and was signed by City of Buffalo. This institutional control authorizes the City of Buffalo to provide long-term monitoring and routine assessments of the following sites:

- DMU 16 & 17
- Buffalo Color Peninsula
- City Ship Canal
- Katherine Street
- Ohio Street
- Riverbend
- DMU 8b Natural Cap Area
- DMU 9 & 10 submerged knee wall
- DMU 44e Deadman's Creek

6.3.7 Remedial Advisory Committee

The RAC will continue to forward the objectives of the RAP by evaluating, supporting, and documenting the restoration of the Buffalo River AOC, until all the Beneficial Use Impairments are restored and the long-term goal of delisting the AOC can be achieved.

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APPENDIX A

Appendix A

List of Subcommittee Members

Name	Organization
Margaux Valenti	Buffalo Niagara Waterkeeper
Lauren Darcy	Buffalo Niagara Waterkeeper
Jill Singer	Buffalo State College
Nolan Skipper	City of Buffalo
Tyler Hamilton	Erie County
Stephany Tatarevich	NYS Department of Environmental Conservation
Dave Gianturco	RAC Chair
Andrew Lenox	U.S Army Corps of Engineers
Bryan Hinterberger	U.S Army Corps of Engineers
Karen Keil	U.S Army Corps of Engineers
Christopher Seslar	U.S Environmental Protection Agency
Mary Beth Giancarlo	U.S Environmental Protection Agency
Amy Roe	U.S Fish & Wildlife

APPENDIX B

US Army Corps of Engineers

Buffalo River and Harbor Dredged Material Risk-Based Screening for Upland Beneficial Use Determination Buffalo, New York

February 2022

Contents

Buffalo River and Harbor Dredged Material
Risk-Based Screening for Upland Beneficial Use Determination
Buffalo, NY

INTRODUCTION

Sediment from the federal navigation channel of the Buffalo River and Harbor in Buffalo, New York was evaluated in order to determine whether it may be suitable for potential beneficial uses following future maintenance dredging operations. Results from sediment samples collected and analyzed in 2018 were used for the contaminant determination per Clean Water Act (CWA) Section 404(b)(1) Guidelines regarding the open-water placement of dredged sediment (USACE 2019), which also may be informative for other aquatic beneficial use placements. Those sample results were re-evaluated with respect to criteria for determining suitability for potential upland beneficial use placement (USACE 2021). This report provides the details of that upland beneficial use determination.

METHODS

Data Set - Sampling Protocol and Laboratory Analyses

The sampling locations and laboratory analysis are described in detail in USACE 2019. The same data set that was used to evaluate the suitability of the material for open-water placement (e.g., the contaminant determination of the CWA Section 404(b)(1)) was used in this evaluation. Sediment from the six dredged material management units (DMMUs) in the Buffalo River and the one DMMU in the City Ship Canal were evaluated, with a total of 35 discrete samples and 7 composite samples (one per DMMU) (Figure 1).

Sample Results Excluded from this Beneficial Use Determination

Five of the sediment sampling locations were excluded from this upland beneficial use determination, because these locations were subjected to additional dredging in 2020. The sediment sampling results from 2018 would not be reflective of current conditions in the river. These locations include BR-7, BR-11, BR-16, BR-26, and BR-28 (Figure 1). Sediment from the Buffalo Harbor was not included in this analysis because the Harbor is outside the AOC boundary.

NYSDEC's Beneficial Use Determination Protocol

NYSDEC's solid waste regulations apply to management of dredged materials, including disposal or beneficial use. An exclusion exists in 6 NYCRR Part 360.2(a)(3)(xi) for dredged materials which are managed under a NYSDEC Dredging Permit or Clean Water Act 404 Water Quality Certification. However, most upland placement of dredged material is not managed under dredging permits but rather through beneficial use determinations (BUDs) granted pursuant to 6 NYCRR 360.12(e).

For determining the suitability of materials for upland beneficial use placement, dredged materials are usually reviewed in accordance with NYSDEC's Solid Waste Management Facilities Regulations, 6 NYCRR Part 360-369, specifically for beneficial use of any material: Subdivision 360.12(e). Once reviewed pursuant to these regulations, if suitable for upland beneficial use, the dredged material in question will be granted a BUD (NYSDEC BUD). The BUD may specify use of the dredged material at a specific location as fill, cover, topsoil, or aggregate, or may allow its general sale or distribution in one or more of these uses. Note that two pre-determined beneficial uses (no review required by NYSDEC) can be found in Subdivision 360.12(c); one is for coarse dredged materials with low organic carbon; the other is for excavated clay, till or rock that may be dug or blasted to deepen channels on some projects, provided these materials are kept separate from overlying sediment. The material from the Buffalo River does not meet these definitions.

Recent revisions to beneficial use regulations in Sections 360.12 and 360.13, incorporate soil cleanup objectives (SCOs) in 6 NYCRR Part 375, Environmental Remediation Programs Regulations, to evaluate soils and soil-like materials such as dredged material in soil-like uses, especially as fill and cover or topsoil. Dredged materials are evaluated on a case-specific basis, but if meeting new "General Fill" criteria, i.e., Public Health-Residential Land Use and Groundwater Protection SCOs, the BUD may allow general sale or distribution of dewatered dredged material in place of fill, cover or topsoil.

Recent communication with the NYSDEC indicated that the sediments dredged from the Buffalo River and Harbor federal navigation channel could be evaluated to determine potential suitability for upland beneficial use placement by applying for a case-specific BUD permit (Forgette 2021). According to 360.12(e)(3) Case Specific beneficial use determinations- navigational dredge materials: For use as general fill cover, the dredged material must not contain pollutants above the concentrations indicated in Table 375-6.8(b) for Residential Use AND Protection of Groundwater, unless the dredged material will meet criteria for or will be used in the same manner as Restricted Use (i.e. engineered use for embankments or subgrade in transportation corridors) or Limited Use Fill (under foundations or pavement). The dredged material cannot be used in ecologically sensitive areas.

BUD Screening Criteria – Soil Cleanup Objectives

Residential land use SCOs consider exposure via soil ingestion, particulate and vapor inhalation, dermal contact, and home-grown vegetable consumption. However, this exposure scenario excludes raising livestock and consuming home-produced animal products, such as meat, eggs, and milk. These exposure pathways were evaluated for both adult and child receptors. SCOs were developed with a target excess cancer risk of one in one million or a target noncarcinogenic hazard index of one. The final human health risk-based residential SCO is the lowest of all the SCOs calculated for chronic exposure, acute soil ingestion, and irritant contact dermatitis.

Groundwater SCOs were established to prevent contamination from leachate. The maximum allowable concentration of a parameter was back-calculated using a not-to-be-exceeded groundwater or drinking water standard and a parameter-specific partition coefficient between water and soil. This calculation assumes that the organic carbon content in soil is 1%. To account for mechanisms that occur during transport (i.e. volatilization, transformation, degradation), a correction factor or dilution attenuation factor of 100 was used to establish the SCOs.

As appropriate, rural soil background concentrations (RSBCs) are used as SCOs for certain parameters. The NYSDEC and NYSDOH conducted a statewide rural surface soil survey, in which the background concentration ranges were specified for 179 parameters. The RSBC set for each parameter is the approximated 98^{th} percentile concentration from available data. The RSBCs are used if they exceed the risk-based screening levels or the groundwater protection SCOs (NYSDEC 2006).

Screening Protocol

Data were evaluated within each DMMU. To supplement the data collected in 2018, an arithmetic mean concentration was calculated for each parameter using the five discrete data points in each DMMU. The five locations that were subject to additional dredging in 2020 (BR-7, BR-11, BR-16, BR-26, and BR-28) were excluded from the calculations of average concentrations. Any value qualified as an estimated value (e.g., with a “J” flag) or not reported above detection limits (e.g., with a “U” flag) was used at face value in the calculation of the average. If concentration measurements were only available for less than three discrete samples in a DMMU, an average was not calculated for that parameter. Subsequently, the five discrete samples, the average concentration of the discrete samples, and the composite samples were all screened against the residential and groundwater NYSDEC SCOs (Tables 1-4). If SCOs were unavailable for parameters that were measured in sediment samples, then those parameters were excluded from this evaluation, but the results for these parameters are available elsewhere (USACE 2019). Sediment screening was conducted for 13 metals, 16 polycyclic aromatic hydrocarbons (PAHs), 13 pesticides, and total polychlorinated biphenyls (PCBs).

Data were also evaluated site-wide across the Buffalo River. Site-wide average concentrations (including data from all seven DMMUs) were calculated for each parameter and compared to data collected in 2011 (USACE 2012) from the upper reach of the Buffalo River (Table 5).

RESULTS

Metals

Two discrete samples had concentrations of metals that exceeded one or both of the residential and groundwater SCOs. One discrete sample, City Ship Canal-3, had a concentration of arsenic (17 mg/kg) that exceeded both the residential SCO (16 mg/kg) and the groundwater SCO (16 mg/kg) (Table 1). The total chromium concentration from the same sample location, City Ship Canal-3, was 48 mg/kg, which exceeded the residential SCO (36 mg/kg), while a groundwater SCO is not specified in the NYSDEC criteria. Similarly, the total chromium concentration in Upper Buffalo River Channel-23 (54 mg/kg) exceeded the residential SCO (36 mg/kg). Notably, NYSDEC criteria are outlined for hexavalent and trivalent chromium, but not total chromium. However, sediment samples were evaluated for total chromium in the 2019 report. The total chromium concentrations were compared to the SCO for trivalent chromium, as that is expected to be the predominant species in anoxic environments.

All composite samples had concentrations below screening levels for metals, except for one DMMU. BR-DMMU-2 in the Lower Buffalo River Channel had a concentration of mercury (0.8 mg/kg) that exceeded the groundwater SCO (0.73 mg/kg), but not the residential SCO (0.81 mg/kg). BR-DMMU-2 also had a concentration of total chromium (67 mg/kg) that exceeded the residential SCO (36 mg/kg), while the groundwater SCO is unspecified in the NYSDEC criteria. The BR-DMMU-2 composite sample no longer represents current sediment conditions of the river (see discussion section below).

While some concentrations of metals in the discrete and composite samples exceeded relevant SCOs, the average concentrations of all metals in all DMMUs were lower than the screening criteria.

Polycyclic Aromatic Hydrocarbons

There were two discrete locations from the City Ship Canal where concentrations of PAHs exceeded screening criteria (Table 2). The concentrations of benzo(b)fluoranthene in City Ship Canal-2 (1.3 mg/kg) and in City Ship Canal-3 (1.4 mg/kg) exceeded the residential SCO of 1 mg/kg but not the groundwater SCO of 1.7 mg/kg.

While two discrete samples had concentrations of benzo(b)fluoranthene that exceeded relevant criteria, both the composite and average concentrations of PAHs were below both the residential and groundwater SCOs for all DMMUs.

Pesticides

Concentrations of pesticides in discrete and composite samples were below both the residential and groundwater SCOs (Table 3). Calculated average concentrations of pesticides for all DMMUs were also below the screening criteria.

Polychlorinated Biphenyls

Concentrations of PCBs in discrete and composite samples were below both the residential and groundwater SCOs (Table 4). Calculated average concentrations of PCBs for all DMMUs were also below both residential and groundwater SCOs. Average concentrations were only calculated for four of the seven DMMUs, as none of the PCB aroclors were reported above detection limits in three of the DMMUs (BR-DMMU-1, BR-DMMU-4, and BR-DMMU-6) (Table 4).

DISCUSSION

The maximum concentrations of the majority of analytes (32 of 35 total parameters) were below the SCOs. Overall, individual discrete sample exceedances of the SCOs were observed only for 2 metals (arsenic and total chromium) and 1 PAH (benzo(b)fluoranthene). Composite sample exceedances were solely observed for metals (mercury and total chromium) in one DMMU, BR-DMMU-2 in the Lower Buffalo River Channel, but this composite sample includes one sediment sampling location which was later removed (dredged) from the river and no longer represents current sediment conditions (see discussion below). No average concentrations exceeded relevant screening criteria. Note that “U” flagged values were incorporated at face value when calculating the mean concentrations, which is a conservative approach for estimating a concentration.

While evaluating discrete exceedances can provide in-depth information on the sediment conditions location by location, sediment is not stationary by nature. The Buffalo River is subject to seiches from Lake Erie, which can result in the mobilization of sediment. Additionally, the process of dredging mixes sediment. As such, composite and average samples are more representative of the material that would be dredged and subsequently utilized for an upland beneficial use determination project.

While the average concentrations account for current river conditions by removing locations that were subjected to additional dredging in 2020, the composite samples included all discrete locations within a specified DMMU. In BR-DMMU-2, mercury and total chromium concentrations in the composite sample exceeded the groundwater and residential SCOs, respectively. This composite sample included sediment from a discrete location that was scheduled to be dredged in 2020 (BR-7). The composite sample exceedance of the SCOs can likely be attributed to concentrations found at BR-7, as the concentration of chromium (147 mg/kg) was 4.9 times greater than the next highest concentration of chromium (30 mg/kg) within the DMMU. Similarly, the concentration of mercury at BR-7 (1.8 mg/kg) was 6.7 times greater than the next highest concentration of mercury (0.27 mg/kg) within BR-DMMU-2. Because parameter concentrations in BR-7 (and thus BR-DMMU-2) are not representative of current sediment conditions due to recent dredging activity, the average concentration likely provides a better estimate of current sediment quality. The average concentrations of total chromium (25 mg/kg) and total mercury (0.18 mg/kg) are below the screening criteria that the composite sample exceeded (the residential SCO for total chromium (36 mg/kg) and groundwater SCO for total mercury (0.73 mg/kg), respectively).

In addition to comparing sediment results within each DMMU, the river-wide and BR-DMMU-6 specific average and maximum concentrations for each parameter were compared to sample results obtained in 2011 (Table 5). The 2011 samples were collected from the upper reach of the Buffalo River in an area which overlaps with and extends upstream of the 2018 BR-DMMU-6.

Similar to the river-wide 2018 dataset, the maximum concentrations of arsenic and benzo(b)fluoranthene in sediment collected in the upstream reach of the river sampled in 2011 exceeded the SCOs. However, concentrations of arsenic and benzo(b)fluoranthene were below SCOs in samples collected in 2018 from BR-DMMU-6.

The maximum concentrations of arsenic measured in samples obtained in 2011 (22.2 mg/kg) and in 2018 from throughout the river (17.1 mg/kg) exceeded both the residential (16 mg/kg) and groundwater (16 mg/kg) SCOs. The arsenic SCO value, 16 mg/kg, is the RSBC, which is the 98th percentile concentration in New York State rural soils. The SCO for a parameter is modified from human health carcinogenic screening criteria (1E-06 risk) and noncancer screening criteria (hazard index=1) if the background soil concentration exceeds these risk-based screening levels. In the establishment of the RSBC, data from multiple surveys indicated that an “RSBC of 14.1 to 17.7 [ppm] is reasonable for arsenic” (NYSDEC 2006). Data from 2018 are below the upper end of this background range used to select the RSBC. Interestingly, the regional arsenic background concentration in sediments in the Erie-Ontario Lake Plain of northeastern Ohio is 25 mg/kg, which exceeds the New York soil RSBC of 16 mg/kg. Samples were collected from reference areas in Ohio that were thought to be representative of the least impacted (uncontaminated) conditions in an ecoregion (Ohio EPA 2018). Ultimately, the average concentrations of arsenic from the 2011 dataset (7.6 mg/kg) and the 2018 dataset (9.8 mg/kg) were below both of the SCOs, indicating that the arsenic concentrations in the river are commensurate with rural background soil concentrations in New York State.

Similar to arsenic, the maximum concentrations of benzo(b)fluoranthene in the 2011 and 2018 river-wide datasets (1.11 mg/kg and 1.4 mg/kg, respectively) exceeded the residential SCO (1 mg/kg). The residential SCO for benzo(b)fluoranthene is the RSBC for soils in New York State. The RSBC was selected considering both near source and source distant data in order to better reflect human exposure. Guidance indicates that an RSBC value between two different 98th percentile values generated, 640 ppb and 1200 ppb, is reasonable. Thus, the value selected was 1000 ppb or 1 mg/kg. Background concentrations reported in the guidance range from 0.018 mg/kg to 4.6 mg/kg (NYSDEC 2006). Overall, the average concentrations for the 2011 and 2018 datasets (0.294 mg/kg and 0.551 mg/kg, respectively) were below both the residential and groundwater SCOs, indicating that the benzo(b)fluoranthene concentrations in the river are within the range of benzo(b)fluoranthene concentrations in rural background soil in New York State.

Concentrations of constituents targeted for sediment remediation under the Great Lakes Legacy Act (e.g., the indicator compounds lead, mercury, total PAHs, and total PCBs) have all decreased in the upper reach of the river since 2011 (represented by 2018 BR-DMMU-6 sampling results) (Table 5).

CONCLUSIONS

The maximum concentrations of the majority of analytes (32 of 35 total parameters) were below their respective residential and groundwater SCOs, and the average concentrations of all constituents within each of the 6 river DMMUs were below their SCOs. Individual discrete sample exceedances of the SCOs were observed only for 2 metals (arsenic and total chromium) and 1 PAH (benzo(b)fluoranthene). Available data indicate that the current sediment quality in the Buffalo River meets criteria set in the NYSDEC BUD process for upland beneficial use.

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FIGURES

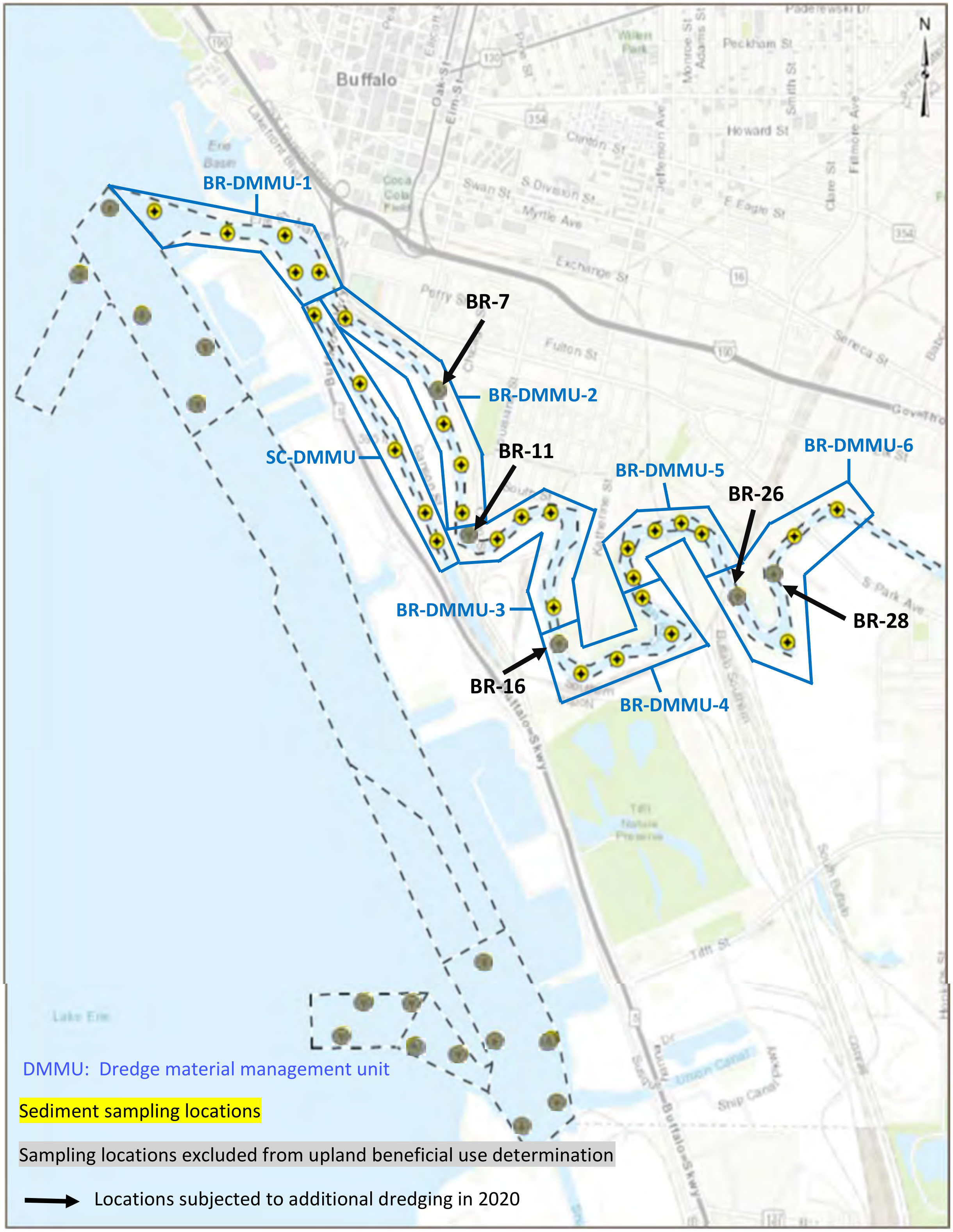

Figure 1. Sediment sampling locations in the Buffalo River (USACE 2019).

TABLES

Table 1. Screening of Metal Concentrations in Buffalo River Sediment against NYSDEC Soil Cleanup Objectives

Metals	Residential SCOs	Groundwater SCOs	City Ship Canal						
			SC-01	SC-02	SC-03	SC-04	SC-05	SC-DMMU Composite	SC-DMMU Average
Arsenic	16	16	10	11	17	5	4	10	9.46
Barium	350	820	116	111	122	53	51	97	90.46
Beryllium	14	47	0.8	0.9	1.0	0.4	0.4	0.8	0.692
Cadmium	2.5	7.5	0.82 J	0.79 J	1.8	0.32 J	0.23 J	0.72 J	0.792
Chromium, total*	36	NS	30	34	48	17	13	29	28.36
Copper	270	1720	45	53	61	23	18	42	39.9
Lead	400	450	59	64	131	24	15	43	58.6
Manganese	2000	2,000	715	585	668	262	220	512	490
Total Mercury	0.81	0.73	0.190 J	0.460 J	0.520 J	0.120 J	0.081 J	0.220 J	0.27
Nickel	140	130	37	37	42	18	15	33	29.7
Selenium	36	4	U 1.3	U 1.2	U 1.4	U 0.89	U 0.93	U 1.1	1.14
Silver	36	8.3	U 0.33	U 0.33	U 0.36	U 0.23	U 0.24	U 0.28	0.30
Zinc	2200	2480	165	194	334	98	70	168	172.12

Metals	Residential SCOs	Groundwater SCOs	Lower Buffalo River Channel																				
			BR-DMMU-1							BR-DMMU-2							BR-DMMU-3						
			BR-1	BR-2	BR-3	BR-4	BR-5	BR-DMMU-1 Composite	BR-DMMU-1 Average	BR-6	BR-7	BR-8	BR-9	BR-10	BR-DMMU-2 Composite	BR-DMMU-2 Average	BR-11	BR-12	BR-13	BR-14	BR-15	BR-DMMU-3 Composite	BR-DMMU-3 Average
Arsenic	16	16	9	11	10	10	9	9	9.6	10	31	10	8	9	16	9.13	2	9	10	10	11	10	9.8
Barium	350	820	92	99	99	102	95	87	97	97	114	115	86	90	101	97	22	86	120	110	100	110	104
Beryllium	14	47	0.6	0.7	0.7	0.6	0.6	0.6	0.65	0.7	0.8	0.8	0.6	0.7	0.8	0.69	0.2	0.7	0.9	0.8	0.8	0.8	0.79
Cadmium	2.5	7.5	0.38 J	0.35 J	0.33 J	0.3 J	0.29 J	0.39 J	0.33	0.4 J	5.6	0.49 J	0.5 J	0.45 J	2.3	0.46	U 0.12	U 0.13	U 0.13	U 0.10	U 0.11	U 0.11	0.1175
Chromium, total*	36	NS	21	20	20	18	19	20	20	24	147	30	24	22	67	25	7	21	30	25	24	31	25
Copper	270	1720	32	33	34	32	31	31	32	34	154	40	34	32	74	35	8	28	45	38	37	55	37
Lead	400	450	26	26	25	24	30	24	26	29	241	37	36	40	102	35	10	20	34	28	22	38	26
Manganese	2000	2,000	638	739	594	627	655	575	651	611	496	585	442	518	534	539	100	440	620	620	710	630	598
Total Mercury	0.81	0.73	0.10	0.073	0.087	0.068	0.07	0.072	0.08	0.12	1.8	0.18	0.27	0.13	0.8	0.18	0.29	0.15	0.14	0.066	0.049	0.21	0.10
Nickel	140	130	29	31	32	29	29	30	30	33	43	36	28	31	36	32	6.2	32	44	39	39	42	39
Selenium	36	4	U 1.2	U 1.1	U 1.2	U 1.1	U 1.1	U 1.2	1.14	U 1.1	1.6 J	U 1.2	U 1	U 1.1	1.1 J	1.10	0.99	0.88	1.0	1.1	0.98	1.1	0.99
Silver	36	8.3	U 0.32	U 0.28	U 0.31	U 0.3	U 0.29	U 0.32	0.30	U 0.29	U 0.32	U 0.32	U 0.27	U 0.29	0.6 J	0.29	U 0.59	0.19	U 0.64	0.23	0.10	0.23	0.29
Zinc	2200	2480	112	112	111	105	101	109	108	130	645	156	143	131	311	140	47	120	170	150	140	180	145

Metals	Residential SCOs	Groundwater SCOs	Upper Buffalo River Channel																				
			BR-DMMU-4							BR-DMMU-5							BR-DMMU-6						
			BR-16	BR-17	BR-18	BR-19	BR-20	BR-DMMU-4 Composite	BR-DMMU-4 Average	BR-21	BR-22	BR-23	BR-24	BR-25	BR-DMMU-5 Composite	BR-DMMU-5 Average	BR-26	BR-27	BR-28	BR-29	BR-30	BR-DMMU-6 Composite	BR-DMMU-6 Average
Arsenic	16	16	12	10	10	11	5	10	9	10	U 12	U 14	13	U 11	8	12	16	10	U 14	U 9.8	9	11	9
Barium	350	820	100	110	110	120	48	100	97	120	120	120	140	95	110	119	110	130	120	93	110	110	111
Beryllium	14	47	0.7	0.8	0.8	0.9	0.4	0.8	0.7	0.9	0.9	0.9	0.9	0.7	0.7	0.83	0.7	0.8	0.8	0.6	0.6	0.7	0.70
Cadmium	2.5	7.5	U 0.12	U 0.11	U 0.10	U 0.10	U 0.097	U 0.10	0.10	0.69	0.66	1.2	0.65	0.52	0.79	0.744	0.88	0.6	0.47	0.38	0.36	0.49	0.45
Chromium, total*	36	NS	41	29	30	29	10	25	25	29	28	53	29	21	35	32	54	29	26	21	21	25	24
Copper	270	1720	61	41	35	44	16	35	34	39	35	54	34	30	40	38	53	35	29	27	25	29	29
Lead	400	450	61	36	28	30	9	29	26	28	26	65	34	23	41	35	61	26	20	18	16	24	20
Manganese	2000	2,000	490	670	790	670	260	600	598	630	690	630	830	610	710	678	670	800	570	540	600	710	647
Total Mercury	0.81	0.73	0.30	0.087	0.15	0.077	0.062	0.10	0.09	0.096	0.095	0.53	0.066	0.045	0.31	0.17	1.8	0.064	0.040	0.033	0.038	0.13	0.05
Nickel	140	130	37	42	39	43	17	37	35	39	37	40	39	31	34	37	45	41	36	30	29	31	33
Selenium	36	4	1.1	0.91	0.88	0.99	0.41	0.88	0.80	0.96	0.94	0.99	0.99	0.75	0.85	0.93	0.98	1.2	0.9	0.71	0.63	0.8	0.85
Silver	36	8.3	0.15	0.39	0.21	0.34	U 0.49	U 0.51	0.36	U 0.50	0.25	U 0.64	U 0.63	U 0.51	U 0.50	0.51	0.18	U 0.52	U 0.64	U 0.45	U 0.53	U 0.52	0.50
Zinc	2200	2480	220	160	160	160	71	160	138	120	120	240	130	97	160	141	170	130	110	92	87	110	103

Data from USACE 2019
All units in mg/kg
DMMU: Dredged material management unit
SCO: Soil cleanup objective
U Not detected above the quantitation limit
J The reported concentration is an estimated value
* Total chromium concentrations measured in sediment samples were compared to screening criteria for trivalent chromium

Exceedance of Residential *or* Groundwater SCO
Exceedance of Residential *and* Groundwater SCO
One of the 5 locations representing sediments which were subsequently dredged and therefore excluded from the average concentration calculations

Table 2. Screening of PAH Concentrations in Buffalo River Sediment to NYSDEC Soil Cleanup Objectives

PAHs	Residential SCOs	Groundwater SCOs	City Ship Canal						
			SC-01	SC-02	SC-03	SC-04	SC-05	SC-DMMU Composite	SC-DMMU Average
Acenaphthene	100000	98000	50	58	69	34	29	46	48
Acenapthylene	100000	107000	35	47	79	34	34	52	45.8
Anthracene	100000	1,000,000	180	230	320	61	100	190	178.2
Benz(a)anthracene	1000	1000	260	600	710	130	200	460	380
Benzo(a)pyrene	1000	22000	300	710	830	140	200	520	436
Benzo(b)fluoranthene	1000	1700	580	1,300	1,400	250	350	980	776
Benzo(g,h,i)perylene	100000	1,000,000	U 9.9	260	300	53	U 7.6	230	126
Benzo(k)fluoranthene	1000	1700	85	420	590	88	140	380	264.6
Chrysene	1000	1000	360	800	1,000	180	250	550	518
Dibenz(a,h)anthracene	330	1,000,000	8	68	77	U 7.8	U 7.6	55	33.66
Fluoranthene	100000	1,000,000	710	1,500	1,700	300	530	1,100	948
Fluorene	100000	386000	67	100	110	45	69	75	78.2
Indeno(1,2,3-cd)pyrene	500	8200	3	220	260	51	64	190	119.66
Naphthalene	100000	12000	41	89	76	250	130	55	117.2
Phenanthrene	100000	1,000,000	430	570	580	130	390	430	420
Pyrene	100000	1,000,000	680	1,500	1,700	290	470	1,000	928

PAHs	Residential SCOs	Groundwater SCOs	Lower Buffalo River Channel																				
			BR-DMMU-1							BR-DMMU-2							BR-DMMU-3						
			BR-1	BR-2	BR-3	BR-4	BR-5	BR-DMMU-1 Composite	BR-DMMU-1 Average	BR-6	BR-7	BR-8	BR-9	BR-10	BR-DMMU-2 Composite	BR-DMMU-2 Average	BR-11	BR-12	BR-13	BR-14	BR-15	BR-DMMU-3 Composite	BR-DMMU-3 Average
Acenaphthene	100000	98000	26	17	22	24	84	26	34.6	29	230	90	32	44	70	48.75	97	25	16	76	U 27	110	36
Acenapthylene	100000	107000	30	24	37	31	31	28	30.6	29	140	25	40	33	52	31.75	68	29	20	28	25	51	25.5
Anthracene	100000	1,000,000	79	48	76	78	190	81	94.2	110	1,200	260	120	99	280	147.25	280	280	50	170	63	370	140.75
Benz(a)anthracene	1000	1000	250	190	240	230	430	250	268	260	780	580	340	260	430	360	420	220	130	350	180	420	220
Benzo(a)pyrene	1000	22000	350	250	320	300	500	330	344	360	790	690	450	320	540	455	490	250	150	390	230	450	255
Benzo(b)fluoranthene	1000	1700	530	420	520	510	720	510	540	600	1,000	960	690	490	820	685	780	460	260	670	430	690	455
Benzo(g,h,i)perylene	100000	1,000,000	190	150	180	180	220	160	184	170	400	370	260	190	230	247.5	170	98	60	150	89	160	99.25
Benzo(k)fluoranthene	1000	1700	220	150	190	200	320	200	216	170	400	310	220	190	280	222.5	310	140	120	230	120	300	152.5
Chrysene	1000	1000	400	300	380	370	580	370	406	410	890	720	480	360	580	492.5	580	310	190	510	300	580	327.5
Dibenz(a,h)anthracene	330	1,000,000	55	41	48	51	58	43	50.6	48	110	100	64	42	64	63.5	17	27	16	10	U 27	47	20
Fluoranthene	100000	1,000,000	660	490	670	650	1,200	660	734	770	2,100	1,500	880	650	1,200	950	1,100	590	340	1,000	500	1,100	607.5
Fluorene	100000	386000	34	26	41	38	120	38	51.8	44	330	110	45	52	100	62.75	110	94	22	100	33	110	62.25
Indeno(1,2,3-cd)pyrene	500	8200	180	140	160	170	190	150	168	160	300	310	210	160	190	210	170	120	82	140	110	170	113
Naphthalene	100000	12000	39	45	24	22	100	30	46	35	210	110	45	28	95	54.5	78	35	24	120	20	95	49.75
Phenanthrene	100000	1,000,000	280	200	310	320	820	310	386	340	1,500	980	360	310	670	497.5	690	290	150	700	250	750	347.5
Pyrene	100000	1,000,000	560	400	550	530	960	550	600	640	1,900	1,300	790	570	1,000	825	990	490	290	860	410	1,100	512.5

PAHs	Residential SCOs	Groundwater SCOs	Upper Buffalo River Channel																				
			BR-DMMU-4							BR-DMMU-5							BR-DMMU-6						
			BR-16	BR-17	BR-18	BR-19	BR-20	BR-DMMU-4 Composite	BR-DMMU-4 Average	BR-21	BR-22	BR-23	BR-24	BR-25	BR-DMMU-5 Composite	BR-DMMU-5 Average	BR-26	BR-27	BR-28	BR-29	BR-30	BR-DMMU-6 Composite	BR-DMMU-6 Average
Acenaphthene	100000	98000	310	79	86	20	18	46	50.75	74	65	390	73	15	150	123.4	1,400	20	70	32	9	400	20.3
Acenapthylene	100000	107000	110	75	20	22	19	37	34	31	37	88	44	20	34	44	130	20	27	33	18	46	23.7
Anthracene	100000	1,000,000	1,200	230	250	60	47	170	146.75	180	190	690	240	44	230	268.8	1,500	62	120	77	32	410	57.0
Benz(a)anthracene	1000	1000	570	470	180	170	130	270	237.5	270	340	550	410	140	230	342	840	200	230	290	120	320	203.3
Benzo(a)pyrene	1000	22000	510	530	150	270	150	270	275	290	350	460	430	150	200	336	770	280	270	360	150	320	263.3
Benzo(b)fluoranthene	1000	1700	750	720	250	400	230	370	400	420	570	630	680	220	290	504	1,000	510	430	510	250	490	423.3
Benzo(g,h,i)perylene	100000	1,000,000	210	230	82	200	81	260	148.25	200	230	210	240	80	100	192	300	170	130	190	82	170	147.3
Benzo(k)fluoranthene	1000	1700	250	240	98	160	88	160	146.5	160	170	220	210	94	120	170.8	380	140	150	150	100	180	130.0
Chrysene	1000	1000	700	570	230	280	180	310	315	390	470	670	570	190	280	458	970	350	330	400	190	440	313.3
Dibenz(a,h)anthracene	330	1,000,000	58	70	25	65	23	54	45.75	44	49	57	61	16	28	45.4	73	U 28	31	42	U 27	38	32.3
Fluoranthene	100000	1,000,000	1,700	1,000	560	470	340	830	592.5	790	970	1,600	1,200	380	650	988	2,900	590	680	730	320	1,100	546.7
Fluorene	100000	386000	990	200	260	38	U 24	130	130.5	160	150	820	150	33	U 28	262.6	1,100	39	78	55	25	340	39.7
Indeno(1,2,3-cd)pyrene	500	8200	200	220	96	180	93	200	147.25	180	210	200	200	91	110	176.2	260	150	140	170	91	150	137.0
Naphthalene	100000	12000	270	100	48	17	18	35	45.75	82	130	240	77	16	100	109	360	31	280	63	13	130	35.7
Phenanthrene	100000	1,000,000	1,900	570	500	240	200	540	377.5	540	660	1,600	720	220	630	748	3,500	280	480	370	180	1,200	276.7
Pyrene	100000	1,000,000	1,600	970	500	410	290	680	542.5	680	840	1,400	1,000	330	570	850	2,300	510	560	620	260	840	463.3

Data from USACE 2019
All units in µg/kg
DMMU: Dredged material management unit
SCO: Soil cleanup objective
U Not detected above the quantitation limit

Exceedance of Residential *or* Groundwater SCO
Exceedance of Residential *and* Groundwater SCO
One of the 5 locations representing sediments which were subsequently dredged and therefore excluded from the average concentration calculations

Table 3. Screening of Pesticide Concentrations in Buffalo River Sediment against NYSDEC Soil Cleanup Objectives

Pesticides	Residential SCOs	Groundwater SCOs	City Ship Canal						
			SC-01	SC-02	SC-03	SC-04	SC-05	SC-DMMU Composite	SC-DMMU Average
Aldrin	19	190	U 1.3	U 1.3	U 1.4	U 1	U 1	U 1.2	1.2
alpha-BHC	97	20	U 1.3	U 1.3	U 1.4	U 1	U 1	U 1.2	1.2
Chlordane (alpha)	910	2900	U 1.3	U 1.3	U 1.4	U 1	U 1	U 1.2	1.2
beta-BHC	72	90	U 1.3	U 1.3	U 1.4	U 1	U 1	U 1.2	1.2
4,4'-DDD	2600	14000	U 1.3	3.9	1.9 J	U 1	U 1	2.2 J	1.82
4,4'-DDE	1800	17000	2.3	3.7	3.0	1.2 J	0.99 J	3.7	2.238
4,4'-DDT	1700	136000	2.2 J	4.5	1.9 J	0.98 J	0.82 J	2.5 J	2.08
delta-BHC	100000	250	U 1.3	U 1.3	U 1.4	U 1	U 1	U 1.2	1.2
Dieldrin	39	100	U 1.3	U 1.3	U 1.4	U 1	U 1	U 1.2	1.2
Endosulfan sulfate	4800	1,000,000	U 1.3	U 1.3	U 1.4	U 1	U 1	U 1.2	1.2
Endrin	2200	60	U 6.6	U 6.6	U 6.9	U 5.2	U 5.1	U 5.9	6.08
Lindane	280	100	U 1.3	U 1.3	U 1.4	U 1	U 1	U 1.2	1.2
Heptachlor	420	380	U 1.3	U 1.3	U 1.4	U 1	U 1	U 1.2	1.2

Pesticides	Residential SCOs	Groundwater SCOs	Lower Buffalo River Channel																				
			BR-DMMU-1							BR-DMMU-2							BR-DMMU-3						
			BR-1	BR-2	BR-3	BR-4	BR-5	BR-DMMU-1 Composite	BR-DMMU-1 Average	BR-6	BR-7	BR-8	BR-9	BR-10	BR-DMMU-2 Composite	BR-DMMU-2 Average	BR-11	BR-12	BR-13	BR-14	BR-15	BR-DMMU-3 Composite	BR-DMMU-3 Average
Aldrin	19	190	U 0.66	U 0.63	U 0.63	U 0.62	U 0.61	U 0.64	0.63	U 0.62	U 0.59	U 0.6	U 0.64	U 0.62	U 0.6	0.62	U 1.2	U 1.4	U 1.3	U 1.2	U 1.2	U 1.2	1.275
alpha-BHC	97	20	U 0.57	U 0.54	U 0.55	U 0.54	U 0.53	U 0.55	0.546	U 0.54	U 0.51	U 0.52	U 0.56	U 0.54	U 0.52	0.54	U 1.2	U 1.4	U 1.3	U 1.2	U 1.2	U 1.2	1.275
Chlordane (alpha)	910	2900	U 0.73	U 0.69	U 0.7	U 0.69	U 0.67	U 0.71	0.696	U 0.69	U 0.66	U 0.66	U 0.71	U 0.69	U 0.66	0.6875	U 1.2	U 1.4	U 1.3	U 1.2	U 1.2	U 1.2	1.275
beta-BHC	72	90	U 0.7	U 0.66	U 0.67	U 0.66	U 0.64	U 0.68	0.666	U 0.66	U 0.63	U 0.64	U 0.68	U 0.66	U 0.64	0.66	U 1.2	U 1.4	U 1.3	U 1.2	U 1.2	U 1.2	1.275
4,4'-DDD	2600	14000	U 1.1	U 1	U 1	U 1	U 0.98	U 1	1.016	U 1	U 0.95	U 0.97	1.2 J	U 1	U 0.97	1.0425	1.2 J	U 1.4	1.7 J	2.8 J	U 1.2	1.6 J	1.775
4,4'-DDE	1800	17000	0.82 J	0.87 J	1.2 J	1.6	1.6	1.1 J	1.218	1.9	11	1.8	2.8	2.5	1.4 J	2.25	3.3	2.5	4	2.7	1.4 J	3.8	2.65
4,4'-DDT	1700	136000	U 0.69	1.1 J	0.98 J	1.1 J	1.5 J	1.3 J	1.074	1.5 J	16 J	1.8 J	3.3 J	2.1 J	U 0.63	2.175	U 1.2	U 1.4	2.1 J	U 1.2	1 J	U 1.2	1.425
delta-BHC	100000	250	U 0.57	U 0.54	U 0.55	U 0.54	U 0.53	U 0.55	0.546	U 0.54	U 0.51	U 0.52	U 0.56	U 0.54	U 0.52	0.54	U 1.2	U 1.4	U 1.3	U 1.2	U 1.2	U 1.2	1.275
Dieldrin	39	100	U 0.71	U 0.67	U 0.68	U 0.67	U 0.65	U 0.68	0.676	0.84 J	3.2 J	U 0.64	0.69 J	U 0.66	U 0.64	0.7075	U 1.2	U 1.4	U 1.3	U 1.2	U 1.2	U 1.2	1.275
Endosulfan sulfate	4800	1,000,000	U 0.74	U 0.7	U 0.7	U 0.69	U 0.68	U 0.71	0.702	U 0.69	U 0.66	U 0.67	U 0.71	U 0.69	U 0.67	0.69	U 1.2	U 1.4	U 1.3	U 1.2	U 1.2	U 1.2	1.275
Endrin	2200	60	U 0.75	U 0.71	U 0.72	U 0.71	U 0.69	U 0.73	0.716	U 0.71	U 0.67	U 0.68	0.81 J	U 0.71	U 0.68	0.7275	0.71 J	U 1.4	U 1.3	U 1.2	U 1.2	U 1.2	1.275
Lindane	280	100	U 0.6	U 0.56	U 0.57	U 0.56	U 0.55	U 0.58	0.568	U 0.56	U 0.54	U 0.54	U 0.58	U 0.56	U 0.54	0.56	U 1.2	U 1.4	U 1.3	U 1.2	U 1.2	U 1.2	1.275
Heptachlor	420	380	U 0.72	U 0.68	U 0.69	U 0.68	U 0.66	U 0.69	0.686	U 0.68	U 0.64	U 0.65	U 0.7	U 0.67	U 0.65	0.675	U 1.2	U 1.4	U 1.3	U 1.2	U 1.2	U 1.2	1.275

PAHs	Residential SCOs	Groundwater SCOs	Upper Buffalo River Channel																				
			BR-DMMU-4							BR-DMMU-5							BR-DMMU-6						
			BR-16	BR-17	BR-18	BR-19	BR-20	BR-DMMU-4 Composite	BR-DMMU-4 Average	BR-21	BR-22	BR-23	BR-24	BR-25	BR-DMMU-5 Composite	BR-DMMU-5 Average	BR-26	BR-27	BR-28	BR-29	BR-30	BR-DMMU-6 Composite	BR-DMMU-6 Average
Aldrin	19	190	U 1.3	U 1.2	U 1.2	U 1.1	U 1.1	U 1.1	1.15	U 1.1	U 1.2	U 1.2	U 1.4	U 1.1	U 1.3	1.2	U 1.2	U 1.2	U 1.2	U 1.2	U 1.2	U 1.2	1.2
alpha-BHC	97	20	U 1.3	U 1.2	U 1.2	U 1.1	U 1.1	U 1.1	1.15	U 1.1	U 1.2	U 1.2	U 1.4	U 1.1	U 1.3	1.2	U 1.2	U 1.2	U 1.2	U 1.2	U 1.2	U 1.2	1.2
Chlordane (alpha)	910	2900	U 1.3	0.93 J	U 1.2	U 1.1	U 1.1	U 1.1	1.0825	U 1.1	U 1.2	U 1.2	U 1.4	U 1.1	U 1.3	1.2	U 1.2	U 1.2	U 1.2	U 1.2	U 1.2	U 1.2	1.2
beta-BHC	72	90	U 1.3	U 1.2	U 1.2	U 1.1	U 1.1	U 1.1	1.15	U 1.1	U 1.2	U 1.2	U 1.4	U 1.1	U 1.3	1.2	U 1.2	U 1.2	U 1.2	U 1.2	U 1.2	U 1.2	1.2
4,4'-DDD	2600	14000	4.4	2.1 J	U 1.2	U 1.1	U 1.1	U 1.1	1.375	U 1.1	U 1.2	U 1.2	U 1.4	U 1.1	U 1.3	1.2	U 1.2	U 1.2	U 1.2	U 1.2	U 1.2	U 1.2	1.2
4,4'-DDE	1800	17000	8.4	7.3	1.1 J	0.74 J	1.3 J	2.2	2.61	1.1 J	1.2 J	2.2	1.4 J	0.78 J	3.4 J	1.336	2.8	1.8	0.88 J	1.4 J	1.5 J	1.7	1.6
4,4'-DDT	1700	136000	9.7 J	2.2 J	0.95 J	0.63 J	0.86 J	2 J	1.16	1.1 J	1.2 J	U 1.2	1.7 J	U 1.1	U 1.3	1.26	3.3 J	1.3 J	U 1.2	1 J	0.92 J	2.4 J	1.1
delta-BHC	100000	250	U 1.3	U 1.2	U 1.2	U 1.1	U 1.1	U 1.1	1.15	U 1.1	U 1.2	U 1.2	U 1.4	U 1.1	U 1.3	1.2	U 1.2	U 1.2	U 1.2	U 1.2	U 1.2	U 1.2	1.2
Dieldrin	39	100	2 J	U 1.2	U 1.2	U 1.1	U 1.1	U 1.1	1.15	U 1.1	0.63 J	0.75 J	U 1.4	U 1.1	0.87 J	0.996	1.7 J	U 1.2	1.2 J	U 1.2	U 1.2	U 1.2	1.2
Endosulfan sulfate	4800	1,000,000	U 1.3	U 1.2	U 1.2	U 1.1	U 1.1	U 1.1	1.15	U 1.1	U 1.2	U 1.2	U 1.4	U 1.1	U 1.3	1.2	U 1.2	U 1.2	U 1.2	U 1.2	U 1.2	U 1.2	1.2
Endrin	2200	60	2.4 J	U 1.2	U 1.2	U 1.1	U 1.1	U 1.1	1.15	U 1.1	U 1.2	**0.77 J**	U 1.4	U 1.1	**1.3 J**	1.114	0.85 J	U 1.2	0.94 J	U 1.2	U 1.2	U 1.2	1.2
Lindane	280	100	1.7	U 1.2	U 1.2	U 1.1	U 1.1	U 1.1	1.15	U 1.1	U 1.2	U 1.2	U 1.4	U 1.1	U 1.3	1.2	U 1.2	U 1.2	U 1.2	U 1.2	U 1.2	U 1.2	1.2
Heptachlor	420	380	U 1.3	U 1.2	U 1.2	U 1.1	U 1.1	U 1.1	1.15	U 1.1	U 1.2	U 1.2	U 1.4	U 1.1	U 1.3	1.2	U 1.2	U 1.2	U 1.2	U 1.2	U 1.2	U 1.2	1.2

Data from USACE 2019
All units in µg/kg
DMMU: Dredged material management unit
SCO: Soil cleanup objective
U Not detected above the quantitation limit
J The reported concentration is an estimated value

Exceedance of Residential *or* Groundwater SCO
Exceedance of Residential *and* Groundwater SCO
One of the 5 locations representing sediments which were subsequently dredged and therefore excluded from the average concentration calculations

Table 4. Screening of PCB Concentrations in Buffalo River Sediment against NYSDEC Soil Cleanup Objectives

PCBs	Residential SCOs	Groundwater SCOs	City Ship Canal						
			SC-01	SC-02	SC-03	SC-04	SC-05	SC-DMMU Composite	SC-DMMU Average
Total Polychlorinated Biphenyls	1000	3200	43	43	28	ND	ND	50	38

PCBs	Residential SCOs	Groundwater SCOs	Lower Buffalo River Channel																				
			BR-DMMU-1							BR-DMMU-2							BR-DMMU-3						
			BR-1	BR-2	BR-3	BR-4	BR-5	BR-DMMU-1 Composite	BR-DMMU-1 Average	BR-6	BR-7	BR-8	BR-9	BR-10	BR-DMMU-2 Composite	BR-DMMU-2 Average	BR-11	BR-12	BR-13	BR-14	BR-15	BR-DMMU-3 Composite	BR-DMMU-3 Average
Total Polychlorinated Biphenyls	1000	3200	ND	ND	ND	ND	17	--	--	16	850	60	131	68	37	72	164	121	54	27	ND	107	67

PCBs	Residential SCOs	Groundwater SCOs	Upper Buffalo River Channel																				
			BR-DMMU-4							BR-DMMU-5							BR-DMMU-6						
			BR-16	BR-17	BR-18	BR-19	BR-20	BR-DMMU-4 Composite	BR-DMMU-4 Average	BR-21	BR-22	BR-23	BR-24	BR-25	BR-DMMU-5 Composite	BR-DMMU-5 Average	BR-26	BR-27	BR-28	BR-29	BR-30	BR-DMMU-6 Composite	BR-DMMU-6 Average
Total Polychlorinated Biphenyls	1000	3200	680	75	24	ND	ND	64	--	23	28	146	61	ND	209	64.5	167	13	208	ND	ND	182	--

All units in µg/kg
DMMU: Dredged material management unit
SCO: Soil cleanup objective
ND none of the individual aroclors were reported above detection limits, therefore no total PCB concentration was calculated (USACE 2019).

Exceedance of Residential *or* Groundwater SCO
Exceedance of Residential *and* Groundwater SCO
One of the 5 locations representing sediments which were subsequently dredged and therefore excluded from the average concentration calculations

Table 5. Comparison of 2011 to 2018 sediment results

Chemical	NYSDEC SCOs		2011 Sediment Concentrations*		2018 BR-DMMU-6 Sediment Concentrations		2018 River-Wide Sediment Concentrations	
	Residential	Groundwater	Average	Maximum	Average	Maximum	Average	Maximum
Metals								
Arsenic	16	16	7.6	22.2	9.5	10	9.8	17.1
Barium	350	820	79.3	110	111.0	130	102.0	140
Beryllium	14	47	0.434	0.541	0.70	0.84	0.7	0.95
Cadmium	2.5	7.5	0.481	1.3	0.45	0.6	0.4	1.8
Chromium, total	36	NS	16.1	31	23.7	29	25.6	53
Copper	270	1720	30.1	51.9	29.0	35	35.5	60.5
Lead	400	450	28.2	82	20.0	26	33.6	131
Manganese	2000	2,000	512	644	646.7	800	599.0	830
Total Mercury	0.81	0.73	0.07	0.521	0.045	0.064	0.1	0.53
Nickel	140	130	24.4	28.9	33.3	41	33.6	44
Selenium	36	4	0.802	2.1	0.85	1.2	1.0	1.4
Silver	36	8.3	0.276	0.742	0.50	0.53	0.4	0.64
Zinc	2200	2480	109	168	103.0	130	137.0	334
PAHs								
Acenaphthene	100	98	0.0482	0.716	0.0203	0.032	0.054	0.390
Acenapthylene	100	107	0.0327	0.149	0.0237	0.033	0.035	0.088
Anthracene	100	1,000	0.0371	0.744	0.057	0.077	0.154	0.690
Benz(a)anthracene	1	1	0.126	0.76	0.203	0.29	0.294	0.710
Benzo(a)pyrene	1	22	0.191	0.78	0.263	0.36	0.344	0.830
Benzo(b)fluoranthene	1	1.7	0.294	1.11	0.423	0.51	0.551	1.400
Benzo(g,h,i)perylene	100	1,000	0.0538	0.19	0.1473	0.19	0.164	0.370
Benzo(k)fluoranthene	1	1.7	0.148	0.85	0.130	0.15	0.191	0.590
Chrysene	1	1	0.225	0.99	0.313	0.4	0.413	1.000
Dibenz(a,h)anthracene	0.33	1,000	0.037	0.074	0.032	0.042	0.042	0.100
Fluoranthene	100	1,000	0.426	2.4	0.546	0.73	0.786	1.700
Fluorene	100	386	0.0426	0.971	0.0397	0.055	0.103	0.820
Indeno(1,2,3-cd)pyrene	0.5	8.2	0.0627	0.19	0.137	0.17	0.154	0.310
Naphthalene	100	12	0.0435	0.00759	0.0357	0.063	0.069	0.250
Phenanthrene	100	1,000	0.221	3.19	0.277	0.37	0.450	1.600
Pyrene	100	1,000	0.472	2.17	0.463	0.62	0.693	1.700
Pesticides								
4,4'-DDD	2.6	14	0.00187	0.0116	0.0012	0.0012	0.001352	0.0039
4,4'-DDE	1.8	17	0.0022	0.00884	0.0016	0.0018	0.001957	0.0073
4,4'-DDT	1.7	136	0.00188	0.00984	0.0011	0.0013	0.001478	0.0045
delta-BHC	100	0.25	0.0000797	0.0033	0.0012	0.0012	0.001006	0.0014
Dieldrin	0.039	0.1	0.000112	0.00266	0.0012	0.0012	0.001016	0.0014
PCBs								
Total PCBs	1	3.2	0.0227	0.065	--	0.013	0.052688	0.146

All units are mg/kg
DMMU: Dredged material management unit
SCO: Soil cleanup objective
* Area sampled in 2011 overlaps with and extends upstream of BR-DMMU-6

Exceedance of Residential *or* Groundwater SCO
Exceedance of Residential *and* Groundwater SCO

APPENDIX C

[Public Comment Summary to be added]

APPENDIX D

[RAC Letter of Support to be added]