SDMS DocID 105189

RECORD OF DECISION

Operable Unit 2 of the Geddes Brook/Ninemile Creek Site Operable Unit of the Onondaga Lake Bottom Subsite Onondaga Lake Superfund Site

Onondaga County, New York

NYSDEC

USEPA Region 2

OCTOBER 2009

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
ALBANY, NEW YORK

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
NEW YORK, NEW YORK

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DECLARATION FOR THE RECORD OF DECISION

SITE NAME AND LOCATION

Operable Unit 2 of the Geddes Brook/Ninemile Creek Site[1]
Operable Unit of the Onondaga Lake Bottom Subsite/Onondaga Lake Superfund Site
Onondaga County, New York

Superfund Site Identification Number: NYD986913580
Operable Unit 24

STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) documents the New York State Department of Environmental Conservation (NYSDEC) and U.S. Environmental Protection Agency's (EPA's) selection of a remedy for Operable Unit 2 (OU2) of the Geddes Brook/Ninemile Creek Site (Site), an operable unit of the Onondaga Lake Bottom subsite of the Onondaga Lake Superfund site. The selected remedy is chosen in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA), 42 US Code (USC) §9601, *et seq*., and the National Oil and Hazardous Substances Pollution Contingency Plan, 40 Code of Federal Regulations Part 300. This decision document explains the factual and legal basis for selecting the remedy for this Site. The attached index (see Appendix III) identifies the items that comprise the Administrative Record upon which the selection of the remedy is based.

The New York State Department of Health was consulted on the proposed remedy in accordance with CERCLA Section 121(f), 42 USC §9621(f), and it concurs with the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from the Site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

The selected remedy consists of the dredging/excavation and removal of an estimated 58,000 cubic yards (cy) (44,000 cubic meters [m^3]) of contaminated channel sediments and floodplain soils/sediments over approximately 15.5 acres (6.3 hectares) in Reach AB of lower Ninemile Creek[2].

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1 This is also being tracked in EPA's CERCLIS data base as Operable Unit #24 of the Onondaga Lake National Priorities List (NPL) Site.

2 The stretch of Ninemile Creek downstream of the area just above the confluence with Geddes Brook has been designated as "lower Ninemile Creek." Lower Ninemile Creek has been further subdivided into three reaches (AB, BC, and CD).

As part of the selected remedy, clean materials will be placed in the dredged/excavated areas throughout the Site. Depending on their location, these materials will consist of backfill (if needed) and a habitat layer. The habitat layer will consist of clean material designed to provide the proper conditions for animal and plant communities to grow. This layer will be a minimum of 2 feet (ft)(60 centimeters [cm]) thick, unless otherwise noted, and may consist of clean gravel in the stream bed and clean topsoil in wetland/floodplain areas. Backfill will consist of soils used to bring the sediment or ground surface to an appropriate elevation below the habitat layer.

The areal "footprint" of the Site remedy is bounded by steep banks within the floodplain which limited the extent of sediment/soil contamination. The selected remedy will address all of the remediation goals (RGs)[3] with a combination of removal, backfilling, and habitat layer placement technologies.

In the Reach AB channel of Ninemile Creek, the selected remedy includes the removal of approximately 16,000 cy (12,000 m^3) of contaminated sediments overlying the native marl layer (where present) or to a depth of approximately 2.5 ft (75 cm) to allow for the installation of a habitat layer (2 ft [60 cm]) and a sand base layer (0.5 ft [15 cm]). This depth of removal is expected to eliminate the need for an isolation cap[4] below the habitat layer and would allow for the passage of flood flows under existing upstream infrastructure and protection of floodplain areas in accordance with applicable requirements, and provide sufficient water depth for fish passage and canoe access during low flows. The sand base layer will be installed below the habitat layer to provide support for it and to prevent clay or silt particles from migrating into it. The base layer will also provide the added benefit of attenuating any residual contamination that may remain after dredging. The removal of channel sediments is expected to reduce mercury concentrations to approximately 0.3 milligrams per kilogram (mg/kg) or less.

In the Reach AB floodplain portion of Ninemile Creek, the selected remedy includes the removal of approximately 42,000 cy (32,000 m^3) of floodplain soils/sediments to depths ranging from approximately 1 to 4 ft (0.3 to 1.2 m) (depending on the level of contamination and the presence of structural stone/gravel at depth) and the placement of 1 to 3 ft (30 to 90 cm) of backfill (where needed) and habitat layer material. The removal of floodplain soils/sediments is expected to reduce concentrations of mercury to 0.5 mg/kg or less following removal.

The selected remedy for the Site will result in the removal of about 640 pounds (290 kilograms [kg]) of mercury in the channel and floodplain of Reach AB (92 percent of the total mass of mercury found in this reach) and the residual that will remain (generally less than about 0.5 mg/kg of mercury) would typically be significantly lower than the maximum concentration currently found within Reach AB (77 mg/kg).

Contaminated sediments and soils removed from the creek and floodplains will be disposed of at Honeywell's Linden Chemicals and Plastics (LCP) Bridge Street subsite containment system, which was constructed (and is being monitored) pursuant to the requirements of a September 2000 ROD or the Sediment Consolidation Area (SCA) that will be constructed at Wastebed 13 as part of the

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3 Preliminary Remediation Goals identified in the Proposed Plan are referred to as "Remediation Goals" (RGs) in this document except in the selected remedy section where quantitative RGs for soil, sediment and surface water are referred to as "cleanup levels".

4 Based on available data related to lithology and the concentrations of contaminants at the Site, removal of sediments to a depth of 2.5 ft (75 cm) or into the marl could be conducted in one dredging pass and would result in sediment concentrations that are generally less than 0.3 mg/kg of mercury.

Onondaga Lake Bottom subsite remedy pursuant to the requirements of a July 2005 ROD. A decision as to the specific disposal location(s) will be made during the design phase. This decision will consider various factors including the design and construction schedules for Site remedy as well as the SCA so that remediation of Ninemile Creek is not delayed.

Treatment of water generated by dredging and excavating sediments and soils and corresponding sediment/soil dewatering will be conducted at a location in the vicinity of the Site. The actual location of the treatment plant, discharge requirements, and point of discharge will be determined as part of the remedial design.

It is estimated that the dredging/excavating, backfilling, and habitat layer placement components of the selected remedy, along with dewatering, water treatment, and transport/disposal of sediments and soils at the LCP Bridge Street subsite and/or the SCA, will take one year.

Following sediment and soil removal, restoration of the stream bed and banks, floodplains, wetlands (including forested areas), and habitats will include placement of a sand base layer and backfill, where needed, and placement of a habitat layer with appropriate substrate types and thicknesses as well as planting of appropriate species of wetland and upland vegetation. Habitat restoration is an integral part of the remediation and the details of habitat restoration will be included in a habitat restoration plan that will be developed during remedial design. The goals of the habitat restoration plan will include, but will not be limited to, providing connectivity of the stream with the surrounding floodplain/wetland, the establishment of diverse habitats and native vegetation (*e.g.*, vernal pools, forested floodplains), and no net loss of wetland areas following remediation. Natural stream restoration techniques will be used in designing both the channel remedy and the habitat layer with the goal of creating a diversity of stream and near-stream habitats and minimizing hardening of the channel and banks, to the extent feasible. Additionally, the specific thickness(es), type(s) of substrate material, and specifications for vegetation to be used for the habitat layer will be developed in the restoration plan.

The environmental benefits of the selected remedy may be enhanced by consideration, during remedial design, of technologies and practices that are sustainable in accordance with EPA Region 2's Clean and Green policy[5]. This will include consideration of green remediation technologies and practices.

The selected remedy for this Site, combined with the remedy selected for OU1 of the Geddes Brook/Ninemile Creek site in an April 2009 ROD (NYSDEC and EPA, 2009), will result in a long-term reduction in the toxicity, mobility, and volume of the contaminants of concern in Geddes Brook and Ninemile Creek, namely, mercury, arsenic, lead, hexachlorobenzene, phenol, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, and polychlorinated dibenzo-*p*-dioxins/polychlorinated dibenzofurans.

The selected remedy will address all areas of this Site such that the top 2 ft (60 cm) of sediments and soils will be replaced with clean material. The goal for the concentrations of this clean material for mercury, other chemical parameters of interest, and other constituents will be NYSDEC's sediment criteria (including the lowest effects level of 0.15 mg/kg for mercury) in sediments and 6 NYCRR Part 375 unrestricted use soil cleanup objectives (including the objective of 0.18 mg/kg for mercury) in soils. Clean soil will include imported fill materials from off-Site sources. The selected remedy will also attain a 0.8 mg/kg site-specific bioaccumulation-based sediment quality value (BSQV) for mercury in sediments for protection of wildlife consumption of fish and 0.6 mg/kg

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5 See http://epa.gov/region2/superfund/green_remediation.

site-specific BSQV for mercury in floodplain soils for protection of wildlife consumption of terrestrial invertebrates. The selected remedy is also intended to achieve fish tissue mercury concentrations ranging from 0.1 mg/kg wet weight (ww), which is for protection of ecological receptors, to 0.3 mg/kg ww, which is based on EPA's methylmercury National Recommended Water Quality criterion for the protection of human health from elevated risks due to consumption of organisms.

DECLARATION OF STATUTORY DETERMINATIONS

The selected remedy meets the requirements for remedial actions set forth in CERCLA Section 121, 42 USC §9621, because it: 1) is protective of human health and the environment; 2) meets a level or standard of control of the hazardous substances, pollutants, and contaminants, which attains the legally applicable or relevant and appropriate requirements under federal and state laws; 3) is cost effective; 4) utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable; and 5) satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as their principal element.

Because this remedy will result in contaminants remaining on-Site above levels that would allow for unlimited use and unrestricted exposure to Site media, CERCLA requires that the Site be reviewed at least once every five years. If justified by the review, additional remedial actions may be selected and implemented to remove, treat, or contain the contaminated sediments and soils.

ROD DATA CERTIFICATION CHECKLIST

This ROD contains the remedy selection information noted below. More details may be found in the Administrative Record file for this Site.

- Contaminants of concern and their respective concentrations (see ROD, pages 18 to 27).

- Baseline risk represented by the contaminants of concern (see ROD, pages 28 to 34).

- Cleanup levels established for contaminants of concern and the basis for these levels (see ROD text boxes "Toxicity-Based Sediment Effect Concentrations Selected as RGs for Mercury and Other Inorganics" [page 38] and "Toxicity-Based Sediment Effect Concentrations Selected as RGs for Organic Contaminants" [page 39]).

- Manner of addressing source materials constituting principal threats (see ROD, page 77).

- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of surface water used in the baseline risk assessment and ROD (see ROD, page 27).

- Potential land and surface water use that will be available at the Site as a result of the selected remedy (see ROD, page 27).

- Estimated capital, annual operation and maintenance, and present-worth costs; discount rate; and the number of years over which the remedy cost estimates are projected (see ROD, pages 76 and 88).

- Key factors used in selecting the remedy (*e.g.*, how the selected remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision) (see ROD, pages 77 to 79).

AUTHORIZING SIGNATURES

Dale A. Desnoyers, Director
Division of Environmental Remediation
NYSDEC

Oct. 1, 2009
Date

Walter E. Mugdan, Director
Emergency and Remedial Response Division
EPA, Region 2

Oct. 1, 2009
Date

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RECORD OF DECISION FACT SHEET
EPA REGION 2

Site

Site name:	Operable Unit 2 of the Geddes Brook/Ninemile Creek Site, an operable unit of the Onondaga Lake Bottom subsite, Onondaga Lake Superfund Site
Site location:	Onondaga County, New York
HRS score:	50
Listed on the NPL:	December 16, 1994

Record of Decision

Date signed:	October 1, 2009
Selected remedy:	Dredging/excavation and disposal of contaminated channel sediments and floodplain soils/sediments followed by backfilling the dredged/excavated area.
Capital cost:	$15,100,000
Operation and maintenance cost:	$110,000 per year
Present-worth cost:	$16,500,000

Lead	NYSDEC
Primary Contact:	Timothy Larson, P.E., Project Manager, NYSDEC, (518) 402-9676
Secondary Contact:	Donald Hesler, Section Chief, NYSDEC, (518) 402-9676

Main PRP	Honeywell International, Inc.

Waste

Waste type:	Mercury and other metals (*e.g.*, lead, arsenic); semi-volatile organic compounds; dioxins/furans; polychlorinated biphenyls; dieldrin
Waste origin:	Discharges from the LCP Bridge Street subsite to the streams and floodplain
Contaminated media:	Sediment, floodplain soil/sediment, surface water, and biota

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DECISION SUMMARY

Operable Unit 2 of the
Geddes Brook/Ninemile Creek Site
Operable Unit of the Onondaga Lake Bottom Subsite
Onondaga Lake Superfund Site

Onondaga County, New York

October 2009

New York State Department of Environmental Conservation
Albany, New York

United States Environmental Protection Agency
Region 2
New York, New York

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LIST OF ACRONYMS AND ABBREVIATIONS USED IN ROD AND RESPONSIVENESS SUMMARY

AMSL	Above Mean Sea Level
ARAR	Applicable or Relevant and Appropriate Requirement
BALCT	Benthic Aquatic Life Chronic Toxicity criteria
BERA	Baseline Ecological Risk Assessment
BSAF	Biota-Sediment Accumulation Factor
BSQV	Bioaccumulation-based Sediment Quality Value
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeter
COC	Chemical (or Contaminant) of Concern
CPOI	Chemical Parameter of Interest
CSF	Carcinogenic Slope Factor
CT	Central Tendency
CWA	Clean Water Act
cy	cubic yard
DO	Dissolved Oxygen
ECL	Environmental Conservation Law
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
ER-L	Effects Range-Low
ER-M	Effects Range-Median
FS	Feasibility Study
ft	feet/foot
GAC	Granular Activated Carbon
gal/min	gallons per minute
GM	General Motors
HEC-RAS	Hydrologic Engineering Centers River Analysis System
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
IFG	Inland Fisher Guide (GM Subsite)
IRM	Interim Remedial Measure
kg	kilogram
km	kilometer

LCP	Linden Chemicals and Plastics
LEL	Lowest Effect Level
LOAEL	Lowest Observed Adverse Effect Level
m	meter
Metro	Metropolitan Syracuse Sewage Treatment Plant
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mi	mile
MNR	Monitored Natural Recovery
NAPL	Non-Aqueous-Phase Liquid
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ng/L	nanograms per liter
NOAEL	No Observed Adverse Effect Level
NPL	National Priorities List
NYCRR	New York Code of Rules and Regulations
NYNHP	New York Natural Heritage Program
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
O&M	Operation and Maintenance
OU1/OU2	Operable Unit 1/Operable Unit 2
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCDD/PCDF	Polychlorinated Dibenzo-p-Dioxin/Polychlorinated Dibenzofuran
PDI	Pre-Design Investigation
PRP	Potentially Responsible Party
PSA	Preliminary Site Assessment
RAO	Remedial Action Objective
RfD	Reference Dose
RG	Remediation Goal
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SCA	Sediment Consolidation Area
SCO	Soil Cleanup Objective
SEC	Sediment Effect Concentration
SEL	Severe Effect Level
SQS	Sediment Quality Standard
SOC	Stressor of Concern
SSLC	Species Screening Level Concentration
SVOC	Semi-volatile Organic Compound
SWAC	Surface-Weighted Average Concentration
SYW	Syracuse West (from U.S. Geological Survey quadrant sheet; used to identify New York State wetlands)

TBC	to-be-considered
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TSS	Total Suspended Solids
µg/kg	micrograms per kilogram
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	Volatile Organic Compound
ww	wet weight
YOY	Young-of-Year

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SITE NAME, LOCATION, AND DESCRIPTION

On June 23, 1989, the Onondaga Lake site was added to the New York State Registry of Inactive Hazardous Waste disposal sites. On December 16, 1994, Onondaga Lake and its tributaries and the upland hazardous waste sites which have contributed or are contributing contamination to the lake (sub-sites) were added to EPA's NPL. This NPL listing means that the lake system is among the nation's highest priorities for remedial evaluation and response under the federal Superfund law for sites where there have been a release of hazardous substances, pollutants, or contaminants.

Geddes Brook and Ninemile Creek are located southwest of Onondaga Lake (Figure 1). Ninemile Creek, a Class C stream below the former Honeywell water intake and a class C and trout stream upstream, originates at Otisco Lake and flows approximately 16 mi (26 km) northeast to its mouth at Onondaga Lake. Ninemile Creek receives surface inflow from Beaver Meadow Brook and Geddes Brook at approximately 2.8 mi (4.5 km) and 1.3 mi (2.1 km), respectively, upstream from Onondaga Lake (Figure 2). Between Amboy Dam and Onondaga Lake, Ninemile Creek flows adjacent to Solvay Wastebeds 1 through 8, 9 through 11, and 12 through 15. During the time that Honeywell utilized the Solvay process for the production of soda ash (1881 to 1986), wastes from this process were disposed of in numerous wastebeds along the lake and Ninemile Creek. Wastebeds 1 through 8 were used until 1944 and Wastebeds 9 through 15 were used from 1944 until 1986. Upstream of the dam, Ninemile Creek flows through woodlands, farmlands, and some light industrial/commercial areas. Ground surface elevations range from approximately 400 ft (122 m) above mean sea level (AMSL) at the most upstream section of Ninemile Creek addressed in this study, to approximately 363 ft (111 m) AMSL where the stream enters Onondaga Lake.

The Geddes Brook/Ninemile Creek site is defined as the channel sediments, floodplain soils/sediments, and surface water of Geddes Brook and Ninemile Creek that have been impacted or have the potential to be impacted by the disposal of hazardous and industrial wastes by Honeywell. This definition was based on the understanding at the time of the remedial investigation and feasibility study (RI/FS) work plan (1998) that contaminants from Honeywell sites (*e.g.*, LCP Bridge Street, Solvay Wastebeds) were discharged (directly or indirectly) to Geddes Brook and Ninemile Creek, where they settled into the stream beds, banks, and floodplains.

This ROD focuses only on the Operable Unit (OU) 2 portion of the Geddes Brook/Ninemile Creek site (lower Ninemile Creek channel sediments, surface water, and floodplain soils and sediments).

The stretch of Ninemile Creek downstream of the area just above the confluence with Geddes Brook has been designated as "lower Ninemile Creek," which has been further subdivided into three reaches (AB, BC, and CD). Major physical features within and near the Site, the approximate limits of the respective operable units, and the approximate limits of lower Ninemile Creek Reaches AB, BC, and CD are shown in the aerial photograph presented in Figure 2 and in Figure 3.

SITE HISTORY AND ENFORCEMENT ACTIVITIES

Honeywell Facilities and Disposal Areas Near Geddes Brook/Ninemile Creek

This section summarizes the industrial pollution of Geddes Brook/Ninemile Creek and key historical information regarding Honeywell International and its predecessor companies' manufacturing operations (*e.g.*, Allied Chemical Corporation), and is based on the RI/FS reports. For clarity, and as stated in the text box entitled "What is a Potentially Responsible Party" (page 2), "Honeywell" is used throughout this ROD to refer to Honeywell International, Inc. and its predecessor companies. Honeywell has been named a PRP as a major contributor of contamination to this Site and Onondaga Lake. Honeywell consented to investigate this Site and the lake pursuant to the terms of a Consent Decree 89-CV-815 (U.S. District Court, Northern District of New York)("Consent Decree").

> **What is a "Potentially Responsible Party?"**
>
> A potentially responsible party (PRP) is an entity that is potentially responsible for the contamination, and therefore the cleanup, of a contaminated site. In the case of the Geddes Brook/Ninemile Creek site, Honeywell International has been named as a (PRP) as a major contributor of contamination to the lake. Honeywell agreed to investigate contamination at this Site pursuant to the terms of a Consent Decree. Honeywell International, Inc., and its predecessor companies, operated manufacturing facilities in Solvay, New York, from 1881 until 1986. When Honeywell merged (December 1, 1999) with its predecessor companies (shown below), it became liable for the contamination those companies introduced into the environment. "Honeywell" represents Honeywell International, as well as its predecessor companies which include:
>
> Allied Chemical and Dye Corp. (incorporated December 17, 1920)
> *General Chemical*
> *Barrett Company*
> *National Aniline and Chemical Company*
> *Solvay Process Company*
> *Semet Solvay Company*
> ⇓
> Allied Chemical Corporation (April 28, 1958)
> ⇓
> Allied Corporation (April 27, 1981)
> ⇓
> AlliedSignal, Inc. (September 18, 1985)
> ⇓
> Honeywell International (Present)

The availability of natural deposits of salt and limestone in greater Onondaga County was the primary reason for locating the Solvay Process Company in Solvay, New York. Founded in 1881, the company initially used brine collected locally, but, in 1889, it started utilizing the salt formations in the Tully Valley about 20 mi (33 km) away. The Solvay Process Company used the ammonia soda process (subsequently known as the Solvay Process) to produce soda ash, a product used to manufacture neutralizing agents, detergent, industrial chemicals, and glass. Honeywell subsequently expanded its operation to three locations – the Main Plant, the Willis Avenue plant, and the Bridge Street plant – which were collectively known as the Syracuse Works. The locations of these and other sites discussed in the RI report are shown in Figure 5. These processes resulted in releases of mercury as well as organic contamination and Solvay Waste (see the text boxes entitled "What is Mercury?" [page 3] and "What are Organic Contaminants in the Geddes Brook/Ninemile Creek Site?" [page 5]).

The Main Plant at the Syracuse Works manufactured soda ash and related products from 1884 to 1986 and benzene, toluene, xylenes, and naphthalene from 1917 to 1970. The Willis Avenue plant manufactured chlorinated benzenes and chlor-alkali products from 1918 to 1977. Chlor-alkali production by the diaphragm cell process was in operation at the Willis Avenue plant from 1918 until 1977. The mercury cell process was used at the Willis Avenue plant for chlor-alkali production

What is Mercury?

One of the main contaminants at the Geddes Brook/Ninemile Creek site is mercury. Honeywell used mercury in the production of chlorine and caustic soda at the mercury-cell chlor-alkali plants.

Most of the mercury in water, sediments, plants, and animals is in the form of inorganic mercury salts and organic forms of mercury (*e.g.*, methylmercury). Methylation of mercury is a key step in the entrance of mercury into food chains. The biotransformation of inorganic mercury to methylated organic forms in water bodies can occur in the sediments and the water column.

Mercury accumulates in the food chain up to the top of the aquatic food web. Nearly all of the mercury that accumulates in fish tissue is methylmercury. Inorganic mercury, which is less efficiently absorbed and more readily eliminated from the body than methylmercury, does not tend to bioaccumulate. Accordingly, mercury exposure and accumulation is of particular concern for animals at the highest trophic levels in aquatic food webs and for animals and humans that feed on these organisms.

Mercury is a known human and ecological toxicant. Methylmercury-induced neurotoxicity is the effect of greatest concern when exposure occurs to the developing fetus. Dietary methylmercury is almost completely absorbed into the blood and distributed to all tissues including the brain; it also readily passes through the placenta to the fetus and fetal brain. Neurotoxic effects include subtle decrements in motor skills and sensory ability at comparatively low doses to tremors, inability to walk, convulsions, and death at extremely high exposures. Other adverse effects of mercury include reduced reproductive success, impaired growth and development, and behavioral abnormalities.

Mercury is known to adversely affect aquatic organisms through inhibition of reproduction, reduction in growth rate, increased frequency of tissue histopathology, impairment in ability to capture prey and olfactory receptor function, alterations in blood chemistry and enzyme activities, disruption of thyroid function, chloride secretion, and other metabolic and biochemical functions. In general, the accumulation of mercury by aquatic biota is rapid and depuration is slow. It is emphasized that organomercury compounds, especially methylmercury, are significantly more effective than inorganic mercury compounds in producing adverse effects and accumulation.

from approximately 1947 (or possibly earlier) until 1977. Starting in 1953, the Bridge Street plant produced chlor-alkali products, as well as hydrogen peroxide, using the mercury cell electrolytic process. Diaphragm cells were added to the Bridge Street operation in 1968. The plant was sold to LCP of New York in 1979 and operated until 1988.

Pursuant to the 1992 Consent Decree noted above, Honeywell commenced an RI/FS associated with the Geddes Brook/Ninemile Creek site. This culminated in the completion of an RI report by NYSDEC in July 2003 (TAMS/Earth Tech, 2003a,b,c). After the completion of a draft FS report (Parsons, 2005), it was determined that additional investigation was necessary. Additional investigative work was conducted by Honeywell in 2007 and 2008 and a Supplemental FS report for OU1 (Parsons, 2008a) was completed in November 2008 and a Supplemental FS report for OU2 (Parsons, 2009) was completed in May 2009.

LCP Bridge Street Subsite

The LCP Bridge Street subsite, which includes the West Flume, was a source of mercury and other contaminants to Geddes Brook. Geddes Brook receives discharges from the West Flume, a drainage ditch that passes through the LCP Bridge Street facility. The remediation of the LCP Bridge Street subsite included the removal of contaminated sediments from the West Flume.

The LCP Bridge Street subsite consists of 20 acres (8 hectare) of land used for various industrial activities (including a chlor-alkali production facility that operated from 1953 to 1988). The wastes from the LCP Bridge Street plant were discharged into the West Flume. A ROD was issued in September 2000 to address the LCP Bridge Street subsite. The buildings at the subsite were demolished as part of two IRMs. The LCP Bridge Street subsite remediation was substantially completed in 2007 (described below in the section entitled “Scope and Role of Response Action”). This effort included the construction of a temporary cap which will be replaced with a final cap following the placement of material from the remediation of Geddes Brook and possibly Ninemile Creek.

What are Organic Contaminants in the Geddes Brook/Ninemile Creek Site?

Honeywell released the major organic contaminants found at the Geddes Brook/Ninemile Creek site from its Syracuse facilities. Releases of hexachlorobenzene, phenol, and polycyclic aromatic hydrocarbons (PAHs) began at least as early as 1918, and polychlorinated biphenyls (PCBs) and mercury were used in the 1940s and possibly even the late 1930s. (Mercury is an inorganic contaminant and is discussed in the text box entitled "What is Mercury?") Although the Willis Avenue and Main Plant sites are not located in the Geddes Brook/Ninemile Creek watershed, wastes from these facilities were disposed of in the wastebeds within the Geddes Brook/Ninemile Creek watershed. Wastewater from the Main Plant was discharged to the West Flume, which runs through the LCP Bridge Street subsite and discharges to Geddes Brook.

Hexachlorobenzene: Hexachlorobenzene is a hazardous substance that is part of the chlorinated benzenes group. Chlorinated benzenes were produced by Honeywell's Willis Avenue Plant, which was in operation from 1918 until 1977. Hexachlorobenzene was widely used as a pesticide and fungicide for onions and wheat and other grains until 1965, and it was also used in the manufacture of fireworks, ammunition, electrodes, dye, and synthetic rubber, and as a wood preservative. Hexachlorobenzene is resistant to chemical and biological degradation and tends to accumulate in the fat-containing tissues of animals and humans. Studies in animals show that chronic ingestion of hexachlorobenzene can damage the liver, thyroid, nervous system, bones, kidneys, blood, and immune and endocrine systems. Chlorinated benzenes such as hexachlorobenzene can bioaccumulate in humans and cause adverse health effects, and maternal chronic exposure has led to teratogenic effects including cleft palate, changes in rib development, and kidney malformation.

Phenol: Phenol is a manufactured substance found in a number of consumer products. A side product of the BTEX process at Honeywell, phenol was also produced as a saleable product during the 1940s. Phenol is generally not persistent in the environment, but large or repeated releases can remain in the air, water, and soil for long periods of time. Phenol is highly toxic to fish, frogs, and other aquatic organisms. With respect to animals, effects reported in short-term studies include neurotoxicity, liver and kidney damage, respiratory effects, and growth retardation. Human exposure to high levels of phenol has resulted in liver damage, diarrhea, dark urine, and hemolytic anemia.

Polycyclic Aromatic Hydrocarbons: PAHs is the general term applied to a group of compounds, including naphthalene, comprised of several hundred organic substances with two or more benzene rings. They are released to the environment mainly as a result of incomplete combustion of organic matter and are major constituents of petroleum and its derivatives. Naphthalene and other PAHs were produced by Honeywell in conjunction with the benzene, toluene, and xylenes product line and other industrial activities. PAHs, in particular naphthalene, were also part of Honeywell's waste streams, were released to the environment by Honeywell, and are hazardous substances. Exposure to PAHs may result in a wide range of effects on biological organisms. While some PAHs are known to be carcinogenic, others display little or no carcinogenic, mutagenic, or teratogenic activity. Several PAHs exhibit low levels of toxicity to terrestrial life forms, yet are highly toxic to aquatic organisms.

Polychlorinated Biphenyls: PCBs are mixtures of up to 209 different compounds (referred to as "congeners") that include a biphenyl and from one to 10 chlorine atoms. They have been used commercially since 1930 as dielectric and heat-exchange fluids and in a variety of other applications. PCBs have been used at and released to the environment from the Honeywell facilities. They are persistent and accumulate in food webs. PCBs bioaccumulate in the fatty tissues of humans and other animals. PCBs are considered probable human carcinogens and are linked to other adverse health effects such as developmental effects, reduced birth weights, and reduced ability to fight infection.

Polychlorinated dibenzo-*p*-dioxins/polychlorinated dibenzofurans: PCDD/PCDFs are composed of a triple-ring structure consisting of two benzene rings connected to each other by either two (dioxins) or one (furans) oxygen atoms. Dioxins and furans are byproducts of chemical manufacturing or the result of incomplete combustion of materials containing chlorine atoms and organic compounds. Based on evidence collected by Honeywell from their sites, PCDD/PCDFs were apparently generated as the result of a fire in the chlorination building at the Willis Avenue Plant in the 1930s and as trace contaminants during the various manufacturing operations and thus were released into the environment. PCDD/PCDFs tend to be very insoluble in water; adsorb strongly onto soils, sediments, and airborne particulates; and bioaccumulate in biological tissues. These substances have been associated with a wide variety of toxic effects in animals, including acute toxicity, enzyme activation, tissue damage, developmental abnormalities, and cancer.

Solvay Wastebeds

The primary method of waste disposal at the Syracuse Works was to pump wastes to wastebeds located along the lake shore and along Ninemile Creek. The wastes, which were primarily made up of Solvay waste from the manufacturing of soda ash, were pumped in a slurry of about 5 percent solids. These solids settled out in the beds, and the remaining wastewater overflowed into the lake or Ninemile Creek. Wastebeds 1 through 15 are located along Ninemile Creek (see Figure 5) and were utilized as follows:

- From the 1920s to 1944, Wastebeds 1 through 8 were used to dispose of Honeywell's wastes. The mouth of Ninemile Creek was re-routed to allow for the construction of these wastebeds. The ownership of Wastebeds 1 through 8 was subsequently transferred by Allied to New York State and Onondaga County. Groundwater from Wastebeds 1 through 8 discharges predominantly into Onondaga Lake.

- From 1944 to 1986, wastes were disposed of in Wastebeds 9 through 11 and 12 through 15. Ninemile Creek was re-routed to allow for the construction of these wastebeds. Groundwater, leachate seeps, and surface water from Wastebeds 9 through 15 discharge to Ninemile Creek and serves as a migration pathway for wastebed constituents.

- Other uses were as landfills for slag and wastewater treatment sludges from the Crucible Materials Corporation (a portion of Wastebed 5); for Metropolitan Syracuse Sewage Treatment Plant (Metro) sewage sludge disposal (portions of Wastebeds 5 and 12 through 15); and as sites for construction of parking lots for the New York State Fairgrounds (portions of Wastebeds 5, 7, and 8). In addition, I-690 and Route 695 were constructed over portions of Wastebeds 7 and 8.

Honeywell is currently performing an RI/FS for Wastebeds 1 through 8 under the direction of NYSDEC. Closure of Wastebeds 9 through 15 is currently being evaluated by NYSDEC's Solid Waste Program. The sources and potential sources of contaminants influencing the Site, including these wastebeds, are discussed in more detail below in the section entitled "Results of the Remedial Investigation."

HIGHLIGHTS OF COMMUNITY PARTICIPATION

The RI, FS and OU2 Supplemental FS reports describe the nature and extent of the contamination at and emanating from the Site and evaluate remedial alternatives to address this contamination. The May 2009 Proposed Plan identified NYSDEC's and EPA's preferred remedy and the basis for that preference. These documents were made available to the public in both the Administrative Record and information repositories maintained at the NYSDEC Region 7 Office, 615 Erie Boulevard West, Syracuse, New York; NYSDEC Central Office, 625 Broadway, Albany, New York; Onondaga County Public Library Syracuse Branch at the Galleries, 447 South Salina Street, Syracuse, New York; and Atlantic States Legal Foundation, 658 West Onondaga Street, Syracuse, New York.

A notice of the commencement of the public comment period related to the preferred remedy, the public meeting date, contact information, and the availability of the above-referenced documents was published in the *Syracuse Post-Standard* on May 19, 2009. The public comment period opened on May 19, 2009. NYSDEC held a formal public meeting on June 11, 2009 at the Martha Eddy Room in the Art and Home Center of the New York State Fairgrounds to present the findings of the RI, FS, and OU2 Supplemental FS reports and Proposed Plan and to answer questions from the public about the Site and the remedial alternatives under consideration. Approximately 40 people, including residents, environmental groups, and local business people attended the public meeting. The public comment period was closed on July 3, 2009.

The Proposed Plan called for the disposal of the contaminated sediments and soils removed from the creek and floodplains at the LCP Bridge Street subsite containment system, which was constructed (and is being monitored) pursuant to the requirements of a September 2000 ROD or the Sediment Consolidation Area (SCA) that will be constructed at Wastebed 13 as part of the Onondaga Lake Bottom subsite remedy pursuant to the requirements of a July 2005 ROD. A decision as to the specific disposal location will be made during the design phase. This decision will consider various factors, including the design and construction schedules for the Ninemile Creek OU2 remedy, as well as the design and construction schedules for the SCA, so that the remediation of Ninemile Creek is not delayed.

Responses to the written comments received during the public comment period and to comments received at the public meeting are included in the Responsiveness Summary portion of this ROD (see Appendix V).

The draft Proposed Plan was provided to the Onondaga Nation for comment with an offer to meet in order to discuss such comments. The Onondaga Nation provided written comments during the public comment period, responses to which are included in the attached Responsiveness Summary.

SCOPE AND ROLE OF OPERABLE UNITS

Operable Units within the Geddes Brook/Ninemile Creek Site

Since many Superfund sites are complex and have multiple contamination problems and/or areas, they are often divided into several operable units for the purpose of managing the Site-wide response actions. Section 300.5 of the National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR Part 300 (NCP) defines an operable unit as "a discrete action that comprises an incremental step toward comprehensively addressing site problems. This discrete portion of a remedial response manages migration, or eliminates or mitigates a release, threat of a release, or pathway of exposure. The cleanup of a site can be divided into a number of operable units, depending on the complexity of the problems associated with the Site. Operable units may address geographical portions of a site, specific site problems, or initial phases of an action, or may consist of any set of actions performed over time or any actions that are concurrent but located in different parts of a site."

NYSDEC and EPA have, to date, organized the work for the Onondaga Lake NPL site into eight subsites. These subsites are also considered by EPA to be OUs of the NPL site. The Geddes Brook/Ninemile Creek site is an OU of the Onondaga Lake Bottom subsite.

The stretch of Ninemile Creek downstream of the area just above the confluence with Geddes Brook has been designated as "lower Ninemile Creek," which has been subdivided into three reaches (AB, BC, and CD). Major physical features within and near the Geddes Brook/Ninemile Creek site, the approximate limits of the respective operable units, and the approximate limits of lower Ninemile Creek Reaches AB, BC, and CD are shown in the aerial photograph presented as Figure 2 and in Figure 3, respectively.

OU1 of the Geddes Brook/Ninemile Creek site includes the channel sediments, surface water, and floodplain soils/sediments of lower Geddes Brook downstream from the discharge point of the West Flume, which is part of Honeywell's LCP Bridge Street subsite, and lower Ninemile Creek from approximately 600 ft (180 m) upstream of the discharge point of Geddes Brook to just downstream of the I-690 overpass near the Wastebeds 1 through 8 site. A ROD for OU1 was issued on April 29, 2009. The remedy for OU1 will result in clean sediment/soil existing at the surface in Reaches BC and CD of lower Ninemile Creek (including both channel sediment and floodplain soil/sediment). Specifically, the remedy consists of the dredging/excavation and removal of an estimated 59,000 cy (45,000 m^3) of contaminated channel sediments and floodplain soils/sediments over approximately 15 acres (6 hectares). For the remainder of OU1, approximately 67,000 cy (51,000 m^3) of contaminated sediments and floodplain soils/sediments will be removed over approximately 16 acres (6.5 hectares) from lower Geddes Brook under an Interim Remedial Measure (IRM) [6]. A Response Action Document was issued by NYSDEC and EPA on April 29, 2009. That document selected the LCP Bridge Street subsite containment system as the disposal location for contaminated channel sediment and floodplain soil/sediment that will be removed under the IRM.

When the OU1 remedy's removal of approximately 535 pounds (242 kg) of mercury mass from the channel and floodplain of Ninemile Creek Reaches BC and CD is combined with the IRM's removal of approximately 1,000 pounds (450 kg) of mercury mass from lower Geddes Brook channel and floodplain, it is estimated that greater than 90 percent of the total mercury mass within OU1 will be removed. Residual mercury contamination will be isolated beneath a clean habitat layer underlain by an engineered cap in the Ninemile Creek Reach BC channel and, if needed, Reach CD channel and beneath a clean habitat layer in the floodplain of these reaches.

OU2 includes the channel sediments, surface water, and floodplain soils/sediments of the section of lower Ninemile Creek from the downstream end of OU1 to Onondaga Lake. This section of lower Ninemile Creek (Reach AB) flows adjacent to the western edge of the Wastebeds 1 through 8 site (see Figures 2 and 3). A source of groundwater contamination containing elevated levels of benzene, toluene, ethylbenzene, and xylenes has been located on the Wastebeds 1 through 8 site below (beneath) the Solvay waste. Based on these conditions and the ongoing RI/FS for the Wastebeds 1 through 8 site, the remediation of groundwater and surficial soils/waste will be evaluated for the Wastebeds 1 through 8 site in a separate remedial decision.

Pursuant to an RI/FS work plan for Wastebeds 1 through 8 (O'Brien & Gere, 2006), and based on an ongoing RI, Honeywell has initiated a focused FS study to evaluate remedial alternatives for Wastebeds 1 through 8. The Geddes Brook/Ninemile Creek OU2 Supplemental FS (Parsons, 2009), Geddes Brook/Ninemile Creek OU2 Proposed Plan and this ROD have been prepared with the understanding that any remedial measures, if required for Wastebeds 1 through 8, would not require significant modification to the Ninemile Creek OU2 site channel or floodplain, and, therefore, would not significantly impact remedy selection for Ninemile Creek OU2. However, any active remedial measures along the western edge of the Wastebeds 1 through 8 site, which may

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6 An IRM is a discrete set of planned actions for both emergency and non-emergency situations that provide a quick solution to a defined problem, and is designed to be a permanent part of the final remedy.

be needed to address contamination from and/or erosion of the Wastebeds 1 through 8 site, would be coordinated with the remediation of Reach AB of lower Ninemile Creek.

As discussed below in the "Summary of Site Risks" section of this ROD, the human health risk assessment (HHRA) and baseline ecological risk assessment (BERA) for the Site indicated unacceptable risks associated with the Site for human and ecological receptors. Although both risk assessments were conducted for the Geddes Brook/Ninemile Creek site as a whole, the exposure assessments utilized varying subareas of the Geddes Brook/Ninemile Creek site, depending on the route of exposure and the receptor being assessed. The HHRA and BERA are applicable to both Geddes Brook/Ninemile Creek OUs 1 and 2 because the separation of the Geddes Brook/Ninemile Creek site into operable units, which was done after the completion of the Geddes Brook/Ninemile Creek RI and risk assessments, are based on similar cleanup strategies and criteria for the protection of human health and the environment.

Status of Other Onondaga Lake NPL Site Operable Units

The primary objective of this response action is to address the risks to human health and the environment due to mercury and other chemical parameters of interest (CPOIs) in the contaminated channel sediments, surface water, and floodplain soils/sediments within Reach AB of lower Ninemile Creek.

NYSDEC and EPA have to date identified eight subsites, as shown in Figure 9, which comprise the Onondaga Lake NPL site. These subsites are also considered to be operable units of the NPL site by EPA and actions at these subsites have and will need to meet all CERCLA requirements. The Site is an operable unit of the Onondaga Lake Bottom subsite. The status of the subsites is discussed below.

Onondaga Lake Bottom Subsite

In July 2005, NYSDEC and EPA issued a ROD for the Onondaga Lake Bottom subsite of the Onondaga Lake NPL site. The selected remedy includes dredging an estimated 2.65 million cubic yards (2 million cubic meters) of contaminated sediments and isolation capping of an estimated 425 acres (172 hectares) in the littoral zone (water depths ranging from 0 to 30 ft [0 to 9 m]), thin-layer capping of an estimated 154 acres (62 hectares) in the profundal zone (water depths exceeding 30 ft [9 m]), an oxygenation pilot study (of the water near the lake bottom) which will be followed by full-scale oxygenation if supported by the pilot study, and monitored natural recovery (MNR) in the profundal zone. It is anticipated that the most highly contaminated materials would be treated and/or disposed of off-site. The balance of the dredged sediment would be placed in the SCA at Wastebed 13. Wastewater generated by the dredging/sediment handling processes as a result of dewatering of the sediments at the SCA would be treated prior to being discharged back to the lake. An Explanation of Significant Differences which describes a change to a portion of the remedy required by the Lake Bottom Subsite ROD in the southwest portion of the lake was issued by NYSDEC and EPA in December 2006. The change was necessary to ensure the stability of the adjacent causeway and the adjacent area which includes a portion of I-690, and was supported by recent, more extensive sampling of the area which indicates that the pure chemical contamination is significantly less extensive in this area than estimated in the Lake Bottom Subsite ROD. In January 2007, Honeywell entered into a consent decree with the State of New York whereby Honeywell committed to implement the remedy at the Onondaga Lake Bottom subsite. Extensive pre-design investigations (PDI) commenced in September 2005 and are ongoing, along with remedial design activities (Parsons, 2008c). Dredging in the lake is scheduled to begin in May 2012.

LCP Bridge Street Subsite

In September 2000, NYSDEC issued a ROD for the LCP Bridge Street Subsite of the Onondaga Lake NPL site. In March 2002, Honeywell entered into an administrative consent order (Order on Consent by Honeywell International, Inc., D7-0001-00-12 [State of New York: Department of Environmental Conservation]) whereby Honeywell committed to implement the remedy at the LCP Bridge Street subsite. The remediation of the LCP Bridge Street subsite was substantially completed in 2007. Remedial construction included removal of contaminated sediments from the West Flume, on-Site ditches, and wetlands; restoration of wetlands; installation of a low-permeability cutoff wall around the Site; installation of an interim low-permeability cap[7]; and capture of contaminated groundwater inside the cutoff wall. Remediation of the LCP Bridge Street subsite has controlled discharges of mercury and other CPOIs to the West Flume, some of which ultimately migrated to Onondaga Lake through Geddes Brook and Ninemile Creek. Maintenance and monitoring activities are ongoing.

Other Subsites

The Ley Creek PCB Dredgings Subsite ROD was issued in 1997 and remedial construction activities were completed in 2001.

The Semet Residue Ponds Subsite ROD was issued in 2002. Construction activities associated with a portion (lakeshore barrier wall/collection system for the shallow and intermediate zones) of the groundwater remedy component were completed in 2007. Design of the remaining portion (groundwater collection system adjacent to Tributary 5A) is underway. NYSDEC and EPA are evaluating a potential modification to the portion of the remedy that addresses the pond residues.

The Town of Salina Landfill Subsite ROD was issued in 2007 and the design is currently underway. It is anticipated that the design will be completed in 2010.

RI/FSs are underway for the General Motors Former Inland Fisher Guide, Wastebed B/Harbor Brook, and Willis Avenue subsites. Construction activities associated with the Willis Avenue lakeshore barrier wall/collection system are underway.

SUMMARY OF SITE CHARACTERISTICS

Description of Historic Channel Modifications

Prior to 1926, most of the Geddes Brook and Ninemile Creek watershed was primarily rural and bordered by farms. Since that time, the stream channels have been impacted and modified by commercial and industrial development. These impacts and modifications included discharges from Honeywell (formerly Allied Chemical/AlliedSignal) operations (*e.g.*, the LCP Bridge Street facility) and re-routing of the streams. A brief history of the streams and their modifications is presented by reach below. The original streambed is shown in Figure 4 along with the current channel locations and designation of the reaches used in this ROD.

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7 A temporary cap was installed. It will be replaced with a final cap following the placement of material from the remediation of Geddes Brook and possibly Ninemile Creek.

Lower Ninemile Creek

For the purpose of the RI/FS for the Geddes Brook/Ninemile Creek site and this ROD, the stretch of Ninemile Creek downstream of the area just above the confluence with Geddes Brook has been designated as “lower Ninemile Creek,” which has been further subdivided into three reaches.

Reach AB

In 1926, the lowest reach of Ninemile Creek (*i.e.*, Reach AB) was re-routed to accommodate Wastebeds 1 through 8. At this time, the outlet to Onondaga Lake was moved to its current location, as shown in Figure 4, about 1,600 ft (500 m) west of its original location.

In the late 1960s, sediments in Onondaga Lake near the mouth of Ninemile Creek were dredged to remove a portion of a delta that had built up over the years. Based on sediment probing in Ninemile Creek adjacent to Wastebeds 1 through 8, it is likely that the dredging continued up Ninemile Creek as far as just downstream of the second major bend in the stream (*i.e.*, nearly the entire length of Reach AB). The dredging at the delta of Ninemile Creek was part of a larger project along the northwest shore of the lake to fill the marshland to establish parkland and to ease the flow of water from Ninemile Creek to Onondaga Lake. These dredge spoil areas, located west of Wetland SYW-10 and the Reach AB portion of the Site, underwent a preliminary investigation in 2000 during the Onondaga Lake RI (TAMS/Earth Tech, 2002) and a preliminary Site assessment (PSA) was conducted by Honeywell under a consent order with NYSDEC.

Reach BC

Between approximately 1940 and 1951, Reach BC, south of State Fair Boulevard, appears to have been straightened or re-channelized. This portion of lower Ninemile Creek consisted of two channels – a western channel located very close to the foot of Wastebed 9 and an eastern channel.

The downstream section of Reach BC was slightly relocated in 1954 during the construction of I-690. The area from approximately 50 ft (15 m) north of the northbound lane to about 100 ft (30 m) south of the southbound lane of I-690 was straightened and the banks were relocated approximately 6 to 10 ft (2 to 3 m) either east or west in several locations.

In the late 1960s, Reach BC of Ninemile Creek was excavated and/or re-routed to accommodate the construction of State Highway Route 695. The new (current) channel was located approximately 100 ft (30 m) west of the former eastern channel. The western channel (*i.e.*, the channel nearest Wastebeds 9 through 11) was eliminated.

Reach CD

In contrast to Reaches AB and BC, Reach CD of lower Ninemile Creek has remained essentially unaltered since at least the 1930s (*e.g.*, two channels remain separated by islands).

Upper Ninemile Creek

Upper Ninemile Creek includes the area of the stream just upstream of its confluence with Geddes Brook to Amboy Dam. Around 1944, a portion of upper Ninemile Creek was re-routed to accommodate the construction of Wastebeds 9 through 11.

Upper and Lower Geddes Brook

The upper Geddes Brook portion of the Geddes Brook/Ninemile Creek site extends from the confluence with the West Flume to a point approximately 2,500 ft (760 m) upstream of Gerelock Road. Part of Geddes Brook experienced re-routing to accommodate the construction of Route 695 in the late 1960s. The first 200 ft (60 m) of Geddes Brook above the confluence of the West Flume was re-routed approximately 200 ft (60 m) east to its current location some time between 1967 and 1978 during the construction of Route 695. At some time in the past, lower Geddes Brook (reach downstream of the West Flume) was likely artificially modified, given the straight and deeply-cut channel. Although no record of this original channelization is available, it is believed that this stretch was dredged between 1959 and 1966, resulting in the mounds of dredge spoils alongside the lower portion of the brook.

Site Geology/Hydrogeology

Most of the Onondaga Lake drainage basin, including Geddes Brook and Ninemile Creek, is located in the Limestone Belt of central New York State. Exposed surfaces in some areas of the Limestone Belt consist of glacial till and lacustrine deposits, and in other areas they consist of outcrops of limestone (particularly Onondaga Limestone) and alkaline shales. Because of this geologic influence, concentrations of calcium, magnesium, bicarbonate, and alkalinity are higher in streams and lakes influenced by the Limestone Belt than in those influenced by the Northern Allegheny Plateau to the south and the Ontario-Oneida-Champlain Lake Plain to the north.

The bedrock geology beneath the Site consists of 500 to 600 ft (150 to 180 m) of sedimentary rocks of the Vernon Shale formation. The Vernon Shale consists of soft and erodible mudstones with some localized, discontinuous gypsum seams. In the upper reaches of Geddes Brook, the Upper Silurian Syracuse Formation overlays the older Vernon Formation. The Syracuse formation is approximately 600 ft (180 m) thick and consists of shales, dolostones, and salt.

The sedimentary geology at the Site is primarily a result of glaciation that deposited a thin layer of glacial till over the bedrock surface. The glacial till consists of a poorly sorted mixture of clays, silts, sands, and boulders. The glacial till is generally 10 to 15 ft (3 to 5 m) thick and is overlain by glaciolacustrine deposits. The glaciolacustrine deposits were formed in lake waters which were formed from glacial meltwater several thousand years ago, and consist of marl, clays, silts, and sands with gravels present at increasing depth.

Regional groundwater flow in the area is from south to north. In the vicinity of the Site, groundwater flow occurs both in the bedrock and unconsolidated Ninemile Creek valley fill deposits, with movement between the two strata. The unconsolidated valley fill deposits are generally heterogeneous, with a relatively less permeable layer close to the ground surface. As described in detail below, groundwater recharge to the subsurface occurs primarily along the Ninemile Creek valley walls. However, in the lower reaches of the valley near Onondaga Lake, the deeper bedrock flow system discharges into the overlying material in the center of the valley. Discharge from the bedrock flow system is limited to areas with little overlying glacial till.

Bedrock underlying the Ninemile Creek area consists of Vernon Shale, which underlies most of the valley fill in the study area. The formation produces water fairly consistently, with yields ranging from one to 450 gallons per minute (gal/min) with a median of 12 gal/min. Water flow in this formation is largely through voids and channels created by groundwater that has dissolved various salts commonly found in this formation.

Groundwater flow tends to follow the elevation of the ground surface in the Ninemile Creek valley fill deposits. Two distinct groundwater flow systems in the valley fill deposits (*i.e.*, shallow and deep) have been identified. Groundwater migration in the shallow flow system is generally towards the stream, however, in the vicinity of the wastebeds, the groundwater is mounded (higher in elevation). The mounding is attributed to the height and the relatively low permeability of the wastebed materials, and causes groundwater to flow away from the wastebeds in all directions. Groundwater migration in the deeper flow system heads northeast, which is more consistent with the orientation of the valley.

Concentrations of total dissolved solids (TDS) in Ninemile Creek above Amboy Dam (*i.e.*, above the area of influence of the wastebeds and former Honeywell operations) range from 720 to 809 milligrams per liter (mg/L), and exceed the state surface water quality standard of 500 mg/L for a Class C water body. As discussed in the RI report, discharge from Wastebeds 9 through 11 is evident in Ninemile Creek by the increase of ionic loading downstream of the wastebeds. Between Station NM3 (located near the upstream limit of Wastebed 11) and Station NM4 (located near Wastebeds 9 and 10), TDS increased from 1,430 to 2,810 mg/L, total chloride increased from 288 to 674 mg/L, and calcium increased from 216 to 354 mg/L in samples from July 1998. Wastebeds 1 through 8 are located along Onondaga Lake southeast of the mouth of Ninemile Creek, with only Wastebed 5 directly bordering Ninemile Creek. Compared to Wastebeds 9 through 15, Wastebeds 1 through 8 are considered a minor source of groundwater to Ninemile Creek, based on relatively small increases in TDS in this section of the stream from upstream to downstream.

Groundwater in the vicinity of the Site is designated as Class GA groundwater under 6 NYCRR Part 701.15. However, groundwater is not and has not been used for potable water supply purposes. High concentrations of chloride and TDS in the surface aquifer preclude its use as potable water.

Surface Water Hydrology

Geddes Brook and Ninemile Creek are the major surface water features at the Geddes Brook/Ninemile Creek site and also serve as major drainage features in the region. Ninemile Creek empties into Onondaga Lake north of the New York State Fairgrounds. Geddes Brook is the largest tributary to Ninemile Creek. Beaver Meadow Brook is a minor tributary that joins Ninemile Creek across from Wastebed 13. The West Flume which flows through the LCP Bridge Street subsite, and an unnamed tributary which carries drainage from Wastebeds 12 through 15, are minor contributors of flow to Geddes Brook. These three minor tributaries (Beaver Meadow Brook, West Flume, and the unnamed tributary) are not part of the Site.

The State of New York has classified the lower reaches of Geddes Brook, Beaver Meadow Brook, and Ninemile Creek from Otisco Lake (where it originates) to Onondaga Lake as Class C water. According to 6 NYCRR Part 701.8, the best usage of Class C waters is "fishing. These waters shall be suitable for fish propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes."

The designation of C(T) standards apply to Geddes Brook, upstream of the Old Erie Canal, and Ninemile Creek, upstream of the former Honeywell water intake location (0.6 mi [1 km] upstream of Airport Road). This designation indicates that, in addition to Class C uses, these waters are trout waters and that the dissolved oxygen (DO) specification for trout waters apply (6 NYCRR Part 895). Streams and small water bodies located in the course of a stream that have the classification or standard designation of C(T) or higher *(i.e.*, C[TS], B, or A) are collectively referred to as "protected streams," and are subject to the disturbance of protected streams provisions of the Protection of Waters regulations (6 NYCRR Part 608.2).

Flow rates in Ninemile Creek range from 50 cubic feet per second (cfs) to over 1,000 cfs, with an annual mean stream flow of 154 cfs for the years 1980 to 2000. Flow rates increase dramatically during storm events. The U.S. Geological Survey (USGS) gauges that collect daily flow data are located on Ninemile Creek upstream of the Site in the town of Camillus and within the Reach BC portion of the Site at Lakeland, approximately 2,500 ft (760 m) upstream of the mouth of the stream. Honeywell collects quarterly flow data from lower Geddes Brook.

Annual mean stream flow in Ninemile Creek dropped from 264 cfs in the 1970s to 154 cfs from 1980 to 2000. This drop in flow coincided with the diversion of former Honeywell discharges to other receiving waters, and then closure of their facilities. The total suspended solids (TSS) load has also decreased by approximately 30 percent since the closure of former Honeywell operations. These reductions in flow and sediment load have contributed to changes in the hydraulic regime and may have affected patterns of deposition and erosion.

The maximum areal extent of surface water at the Site was estimated in the FS by the use of the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Centers River Analysis System (HEC-RAS) flood model Version 3.1 and updated in the OU1 and OU2 Supplemental FS reports (see text box entitled “Flood Flow Model” on page 53).

The modeled floodplain footprints for flood events of various sizes as well as the approximate boundaries of OU1 and OU2 are shown in Figure 3. The footprint of the 50-year floodplain (*i.e.*, from a storm event which has a 2 percent chance of occurring in any given year), determined through the modeling effort, is comparable to the extent of the historical high water mark from 1972. As discussed in the RI report, the 1972 flood caused by Hurricane Agnes was the largest historically recorded flood event in central New York. The limits of that estimated flood event at the Site are generally well constrained by rapid changes in elevation of the land surrounding the stream (breaks in grade), which generally coincide with the limits of areas warranting remediation.

The floodplain portion of OU2 contains wetland SYW-10, which is directly connected to the lower reach of Ninemile Creek (see Figure 2). Wetland SYW-10 is a 27.2-acre (11-hectare) Class I wetland [8]. This wetland is divided by I-690. On the lake side of I-690, the wetland is dominated by emergent vegetation and floodplain forest. This portion of the wetland, which is part of the OU2 portion of the Site, has been recently delineated using both federal and NY State wetland delineation methodologies. The extent of the field-delineated wetland within the limits of OU2 is shown in Figure 10. The wetland section on the western side of I-690 was historically a salt marsh; however, the saline inputs appear to be gone and the wetland is now dominated by typical emergent vegetation.

Sediment Transport and Characteristics

For the ROD, the stream channel is defined as those areas below the mean high-water level, while the floodplain is defined as those areas above the mean water level to the highest extent of flooding during the period of Honeywell operations, which is constrained by steep banks present along the Site (see discussion above in the “Site Name, Location, and Description” section). Sediment transport is dependent on flow conditions, with the water velocities controlling the

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8 NYSDEC classifies and regulates wetlands in New York State pursuant to 6 NYCRR Parts 663 and 664. Four classes of wetlands have been established and are ranked according to their ability to perform wetland functions and provide wetland benefits. Class I wetlands provide the most critical functions and benefits, while Class IV wetlands provide fewer functions and benefits.

erosional or depositional character of Ninemile Creek and Geddes Brook. At low (base) flow with low water velocities, the suspended sediment load is limited to small, easily transported particles. At high (flood) flow with high water velocities, additional sediment from the stream bed can be resuspended and transported downstream. Inputs of sediment during high flow, however, come from erosion of the channel bank. When water flows over the stream banks and onto the floodplain, water velocities over the floodplain are slowed by the topography and by the vegetation. This results in depositional floodplain areas that accumulate sediment.

In natural systems, these types of erosion variations cause streams to curve or meander; the meanders are the bends in the river. Meanders are common features of rivers caused by the erosion and deposition of bank materials. The current in a river flows most quickly near the outer edge of a meander and most slowly near the inner edge. Since erosion increases as current speed increases, and deposition increases as current speed drops, rivers erode material on the outside of meanders and deposit sediment on the inside. Typically, over time, the meanders gradually migrate downstream.

However, the lower reaches of Geddes Brook and Ninemile Creek have not been naturally meandering, as they have been artificially and permanently restricted to a large degree by large immobile constructed features. In Reach AB, I-690 restricts movement to the west for most of the reach, and Solvay Wastebeds 1 through 8 restrict movement to the east. There is some opportunity for the stream to meander near its mouth, although even in this section, it would be limited by the deeply entrenched channel and the heavily wooded bank on the west.

Based on observations made during the RI, Reach AB of Ninemile Creek is currently depositional during low-flow conditions; modeling performed as part of the FS indicates that it would be erosional at high flows. The current distribution of sediments in Reach AB is the result of historical depositional and erosional patterns, historical anthropomorphic modifications to the stream, and the current depositional and erosional regime. Overall, the historical discharges by Honeywell have resulted in two effects:

- The large amounts of solids discharged into the streams, along with the potential for the dissolved solids to precipitate out, caused much more of lower Geddes Brook and lower Ninemile Creek to be depositional during Honeywell's operations than is currently the case.

- Deposition rates during Honeywell's operations were much greater than those currently experienced, as evidenced by the accumulation of several feet of Solvay waste.

The re-routing of the streams produced different hydrologic conditions with respect to width, depth, and gradient. In addition, the alteration of the stream bed by various activities impacted the contaminant deposition patterns that would be typically seen in stream systems. Typically, the highest concentrations of a contaminant are seen in the sediments and floodplain near the source and then gradually decline farther from the source. At this Site, the source of mercury contamination was determined to be the Honeywell LCP Bridge Street plant which started using mercury in 1953, discharging it through the West Flume into Geddes Brook. Downstream of the culverts in lower Geddes Brook, the highest mercury concentrations within the Geddes Brook/Ninemile Creek site are found in the Ninemile Creek Reach CD channel and floodplain south of the large island. The mercury concentrations in the stream channel of Geddes Brook, while elevated, are lower than in Ninemile Creek Reach CD and lower than in the Geddes Brook floodplain. This is likely because the lower Geddes Brook channel was dredged in, or just prior to, 1966 (four years before pollution controls were installed at Honeywell's LCP Bridge Street plant in 1970) and the spoils were placed in the floodplain (now seen as mounds along the channel).

The mercury levels in the Reach BC channel, while elevated, are lower than both Reach CD, as expected, and Reach AB, which being downstream of Reach BC would be expected to have lower concentrations. However, Reach BC of Ninemile Creek was relocated to the east in the late 1960s. The former channel was located approximately where the ramp for Route 695 is now. Therefore, both the channel and floodplain of Reach BC contain mercury concentrations somewhat lower than might be expected, although still elevated. In Reach AB, the mercury concentrations in the floodplain tend to be much higher than the concentrations in the channel. This is because much, although not all, of the contaminated sediments in the Reach AB channel were dredged in 1968 and the spoils placed in the nearby dredge spoils area site and/or along the channel bank. The contaminated floodplain of Reach AB still contains high concentrations of mercury, but the channel sediments in this reach are lower than in the floodplain. Thus, although the pattern of the mercury distribution is not typical, an understanding of the history of the Site ensures that the source of mercury contamination was properly identified and addressed in this and other remedial programs. Although these modifications to the streams impacted the historic distribution of mercury and other contaminants, levels remain throughout the Site that warrant remediation, as discussed later in the ROD, and remedial alternatives are based on the current distribution of mercury and other CPOIs.

Additional information on sediment transport and stream channel characteristics can be found in the RI report and in the "Summary of Site Characteristics" section of this ROD.

Soil Characteristics

The soils of the Onondaga Lake watershed include soils formed during glacial times, and soils of more recent origin. Deposits of glacial origin, include till, outwash, alluvial, and glaciolacustrine sediments. The soils tend to be medium-textured, well drained, and high in lime.

The soils overlying bedrock and glacial material in the study area include alluvial deposits along Geddes Brook and Ninemile Creek, organic-rich sediments and peat deposited in post-glacial marshes and swamps, and lacustrine deposits in the Onondaga Lake basin. The lacustrine deposits are composed primarily of marl with varying amounts of silts and fine sand. Fill deposits composed of cinders, ash, and Solvay waste are located above the native soils in many upland areas near the Site.

Within the Ninemile Creek valley, large amounts of Solvay Process wastes were placed in Wastebeds 1 through 15, both north (Wastebeds 1 through 8 and 9 through 11) and south (Wastebeds 12 through 15) of adjacent reaches of Ninemile Creek. The Wastebeds 1 through 8 site occupies approximately 315 acres (127 hectares) and ranges in thickness from approximately 20 to 67 ft (6 to 20 m). Wastebeds 9 through 15 occupy approximately 662 acres (268 hectares) and range in thickness from approximately 3 to 69 ft (1 to 21 m). As noted above, Ninemile Creek was historically diverted to accommodate accumulations of these wastes. Wastebeds 9 and 10 are separated from Wastebed 11 by a low interbed area that is the original ground surface prior to construction of the wastebeds. Remnants of the original Ninemile Creek channel are present within this interbed area.

Biota

Aquatic Species

The major aquatic communities sampled during the RI at the Geddes Brook/Ninemile Creek site include benthic macroinvertebrates (the insects, worms, and other animals which inhabit the stream bottom) and fishes. Benthic macroinvertebrate communities were sampled in these water bodies by Honeywell at 24 stations in 1990 and at eight stations in 1998. More than 80 taxa (types of organisms) were identified in the samples. Soft-substrate macroinvertebrates included amphipods, chironomids, and non-tubificid and tubificid oligochaetes. Hard-substrate macroinvertebrates included amphipods, chironomids, caddisflies, mayflies, and non-tubificid oligochaetes. Nocturnally drifting invertebrates included amphipods, chironomids, caddisflies, mayflies, and non-tubificid oligochaetes.

The fish communities in Geddes Brook and Ninemile Creek were evaluated in 1973 by independent researchers, and in 1990 and 1998 by Honeywell. Over 25 fish species from 11 families were found during surveys at the Geddes Brook/Ninemile Creek site in 1973, 1990, and 1998. The most numerous species included longnose dace (*Rhinichthys cataractae*), creek chub (*Semotilus aromaculatus*), alewife *(Alosa pseudoharengus*), tessellated darter (*Etheostoma olmstedi*), white sucker (*Catostomus commersoni*), pumpkinseed (*Lepomis gibbosus*), and bluegill (*Lepomis macrochirus*). In 2002, TAMS/Earth Tech (for NYSDEC) sampled young-of-year (YOY) fish at three stations in lower Ninemile Creek downstream of Geddes Brook. The following species were collected: bluegill, killifish (*Fundulus diaphanous*), largemouth bass (*Micropterus salmoides*), tessellated darter, blacknose dace (*Rhinichthys atratulus*), and white sucker.

Historic studies conducted during Honeywell's period of operation showed heavily impacted communities throughout the Geddes Brook/Ninemile Creek site. As noted in a 1974 NYSDEC report (Cooper et al., 1974), based on a field study conducted in 1973, "the water [of Ninemile Creek] was turbid and light brown in color. The odor of chlorine was very noticeable. Only one specimen of a fly maggot (*Diptera*) was found in the Surber sample. No other organisms were found while making fairly intensive dip-net sampling. The stream bottom for all practical purposes was sterile. No fish life was observed and probably did not exist. Station 9 was grossly polluted by toxic wastes."

Terrestrial Species

Over 60 bird species have been observed near Onondaga Lake and the Geddes Brook/Ninemile Creek site, including double-crested cormorants (*Phalac rocorax*), herons (*e.g.*, great blue heron [*Ardea herodias*]), ducks (*e.g.*, mallard [*Anas platyrhynchos*]), swallows (*e.g.*, tree swallow [*Tachycineta bicolor*]), blue jays (*Cyanocitta crisata*), American crows (*Corvus brachyrhynchos*), American robins (*Turdus migratorius*), and sparrows (*e.g.*, song sparrow [*Melospiza melodia*]). Vegetation along Ninemile Creek provide nesting areas and foraging habitat for waterfowl, ring-necked pheasants (*Phasianus colchicus*), owls (*e.g.*, barred owl [*Strix varia*]), and hawks (*e.g.*, red-tailed hawk [*Buteo jamaicensis*]).

Over 25 mammalian species have been observed near Onondaga Lake and the Geddes Brook/Ninemile Creek site, including opossums (*Didelphis virginiana*), Northern short-tailed shrews (*Blarina brevicauda*), Eastern cottontails (*Sylvilagus floridanus*), Eastern chipmunks (*Tamias striatus*), woodchucks (*Marmota monax*), squirrels (*e.g.*, gray squirrel [*Sciurus carolinensis*]), mice (*e.g.*, deer mouse [*Peromyscus maniculatus*]), meadow voles (*Microtus pennsylvanicus*), muskrats (*Ondatra zibethicus*), raccoons (*Procyon lotor*), striped skunks (*Mephitis mephitis*), moles (*e.g.*, starnosed mole [*Condviura cristata*]), foxes (*e.g.*, red fox [*Vulpes fulva*]), and white-tailed deer (*Odocoileus virginianus*). Periodic sightings of river otter (*Lutra canadensis*) have been made in the Ninemile Creek area.

Rare, Threatened, and Endangered Species

According to the databases maintained by the New York Natural Heritage Program (NYNHP) and the U.S. Fish and Wildlife Service (USFWS), and based also on field observations made during the RI field effort, 12 state-listed rare, threatened, or endangered species have been observed near Geddes Brook and Ninemile Creek, including three plant species, eight bird species, and one mammal. The plants include three species known only from historical records: Sartwell's sedge (*Carex sartewellii*), little-leaf tick-trefoil (*Desmodium ciliare*), and red pigweed (*Chenopodium rubrum*). Eight state-listed bird species, including the common loon (*Gavia immer*), common nighthawk (*Chordeiles minor*), sharp-shinned hawk (*Accipiter striatus*), osprey (*Pandion haliaetus*), horned lark (*Eremophila alpestris*), red-headed woodpecker (*Melanerpes erythrocephalus*), common tern (*Sterna hirundo*), and bald eagle (*Haliaeetus leucocephalus*) have been recorded near Geddes Brook and Ninemile Creek. The federal and state-listed endangered Indiana bat (*Myotis sodalis*) is the only listed mammalian species that has been observed in the area.

Areas of Archaeological or Historical Significance

The Onondaga Nation has asserted that Onondaga Lake lies within its aboriginal territory and that Onondaga villages were located on the shores of the lake. The Nation has indicated that it relied heavily on the lake and its tributaries in the past for fishing, gathering of plants for medicinal and nutritional needs, and for recreation. In the late 1800s and early 1900s, Onondaga Lake supported a thriving resort industry based upon the recreational utilization of the lake, including swimming and recreational fishing. The lake also had a plentiful cold-water fishery, which supported a commercial fishing industry until the late 1800s. However, from the late 1800s to the present, Onondaga Lake has been a receptacle for both industrial and municipal wastes.

A Phase 1A Cultural Resource Assessment for various areas, including the Geddes Brook/Ninemile Creek site, was completed by Honeywell in 2003. Based on the results of the Phase 1A assessment, Phase 1B cultural resources work would be conducted in appropriate areas of Geddes Brook and Ninemile Creek prior to remediation.

Results of the Remedial Investigation

The Geddes Brook/Ninemile Creek site was the subject of multiple investigations conducted by Honeywell from 1992 to 2002, with additional investigation of YOY fish by NYSDEC in 2002. The investigations conducted by Honeywell in 1992 and 1995 were part of the Onondaga Lake Bottom subsite's RI and focused on quantifying loads of contaminants (especially mercury) from the Geddes Brook/Ninemile Creek site to the lake. Geddes Brook/Ninemile Creek site-specific RI field work was conducted by Honeywell in 1998 (Geddes Brook/Ninemile Creek RI/FS Phase 1 sampling), 2001 (Geddes Brook/Ninemile Creek supplemental RI/IRM sampling), and 2002 (Ninemile Creek supplemental RI floodplain sampling and Geddes Brook IRM pre-design sediment and floodplain soil sampling). Results of these three investigations were presented in the Geddes Brook/Ninemile Creek RI report (TAMS/Earth Tech, 2003c). Additional floodplain and channel data were collected by Honeywell in 2007 and 2008, respectively. These data are presented in the OU1 Supplemental FS report (Parsons, 2008a) and the OU2 Supplemental FS report (Parsons, 2009), respectively. The HHRA report (TAMS/Earth Tech, 2003a) and BERA report (TAMS/Earth Tech, 2003b) were completed by NYSDEC as part of the RI process. These risk assessments are discussed in the "Summary of Site Risks" section of this ROD. The RI, HHRA, and BERA were issued by NYSDEC in July 2003.

As a result of the RI studies and risk assessments, numerous contaminants were identified as CPOIs (see Tables 1 and 2 and the text box entitled "What are Chemical Parameters of Interest?" [page 20]), including:

- Mercury and other metals.
- Volatile organic compounds (VOCs).
- Semivolatile organic compounds (SVOCs).
- Pesticides.
- PCBs.
- PCDD/PCDFs.
- Ionic waste constituents.

Both total mercury and methylmercury were analyzed during the RI. In this ROD, total mercury is generally referred to as "mercury." Total mercury encompasses all mercury species present in a sample, including inorganic species such as ionic mercury and organic species such as methylmercury. Methylmercury is the most toxic and most bioaccumulative form of mercury, with over 95 percent of total mercury in fish tissue present as methylmercury.

Data summaries for Geddes Brook and Ninemile Creek channel sediments, floodplain soils/sediments, surface water, and fish are presented in Tables 3 through 6 in this ROD. These tables present data from the RI, unless otherwise noted. Maps showing the extent of mercury contamination within the Site at depths up to 3 ft (90 cm) in channel sediments and floodplain soils/sediments of Reach AB are presented in this ROD as Figures 6a through 6c. These figures also show mercury floodplain data collected in 2007 and channel sediment data collected in 2008. Additional maps for mercury and other CPOIs can be found in Chapter 5 of the Geddes Brook/Ninemile Creek site RI report (TAMS/Earth Tech, 2003c) and Chapter 2 and Appendix C of the FS report (Parsons, 2005). The floodplain data collected in 2007 are presented in Appendix B of the Geddes Brook/Ninemile Creek site OU1 Supplemental FS report (Parsons, 2008a). The channel sediment data collected from the lower portion of Reach AB in 2008 (including data below 3 ft) are presented in Appendix B of the OU2 Supplemental FS report (Parsons, 2009).

Channel Sediments

Mercury

Mercury concentrations in stream channel sediments based on data collected through 2002 generally reflected the input and transport of mercury from the West Flume to Geddes Brook and from Geddes Brook to Ninemile Creek. Sediment concentrations were also affected by the stream channel geomorphology and historical changes to the stream channel. Mercury concentrations were highest in Geddes Brook downstream of the West Flume, and in Ninemile Creek downstream of the Geddes Brook confluence. The ranges of total mercury concentrations in surface sediments (0 to 15 cm) in the upper and lower Ninemile Creek portions of the Geddes Brook/Ninemile Creek site were 0.06 to 0.15 mg/kg[9] and 0.01 to 21.1 mg/kg, respectively. Within lower Ninemile Creek,

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9 This range of concentrations in the upper Ninemile Creek portion of the Geddes Brook/Ninemile Creek site from Amboy Dam to just upstream of Geddes Brook is based on two surface sediment samples collected in 1998 as part of the RI. An additional eight surface sediment samples were collected in 1998 and 2001 as part of the RI in Ninemile Creek upstream of Amboy Dam with mercury

What are Chemical Parameters of Interest?

The **chemical parameters of interest**, or **CPOIs**, for the Geddes Brook/Ninemile Creek RI/FS are defined as those elements or compounds that were selected as **contaminants of potential concern (COPCs)**, **chemicals of concern (COCs)**, or **stressors of concern (SOCs)**. The major classes of CPOIs at the Site include mercury and other metals, SVOCs (including PAHs, hexachlorobenzene, and phenol), PCBs, PCDD/PCDFs, and calcite.

COPCs: COPCs are used in human health risk assessments (HHRAs) to determine contaminants that may be harmful to humans. An HHRA for the Geddes Brook/Ninemile Creek site was performed as part of the RI. COPCs were developed using available contaminant concentration data for fish (fillets only; limited to species likely to be consumed by humans), channel sediments, floodplain soils/sediments, and surface water. A total of about 40 individual COPCs in one or more Geddes Brook/Ninemile Creek site media were identified in the HHRA that fall into the classes identified above plus other SVOCs and pesticides. (See attached Table 1 entitled "Contaminants of Potential Concern for the Geddes Brook/Ninemile Creek HHRA.")

COCs: COCs are used in baseline ecological risk assessments (BERAs) to determine chemicals that may be harmful to the environment. A BERA for the Geddes Brook/Ninemile Creek site was performed as part of the RI. COCs were developed using toxicity values to establish conservative thresholds for adverse effects to ecology (surface water, channel surface sediments, floodplain surface soils/sediments, plants, fish, and wildlife). As presented in the BERA, numerous toxic chemicals were detected at elevated concentrations in various Geddes Brook/Ninemile Creek site media. A total of 28 COCs in one or more Geddes Brook/Ninemile Creek site media were identified in the BERA that fall into the classes identified above plus select VOCs, other SVOCs, and pesticides. (See attached Table 2 entitled "Contaminants and Stressors of Concern Selected for Geddes Brook/Ninemile Creek Site Media in the BERA.")

SOCs: SOCs are used in BERAs to determine those chemical contaminants which may not be addressed as hazardous wastes or hazardous substances, but which may cause effects or conditions that are harmful to the environment. The SOCs identified in the BERA include calcite in channel sediments, and chloride, sodium, and total dissolved solids in surface water. (See attached Table 2 entitled "Contaminants and Stressors of Concern Selected for Geddes Brook/Ninemile Creek Site Media in the BERA.")

the highest concentrations were found in Reach CD and in Reach AB near the mouth of the stream where it enters Onondaga Lake.

Sediments in Reach AB of Ninemile Creek were generally characterized by elevated surficial mercury concentrations that declined with depth. This could have been a result of the previous dredging of the channel. This reach is currently depositional and contains relatively deep sediments (*i.e.*, 5 to 10 ft [1.5 to 3 m]) based on available sediment probing results. In the downstream portion of the Reach AB channel, a marl layer is generally present at depths of less than 1 ft (30 cm) to about 2 ft (60 cm) below the stream bottom (sediment-water interface).

Patterns of methylmercury (a highly toxic and bioaccumulative form) were similar to those of mercury, with higher concentrations in the lower reaches of the streams than in the upper reaches. For Ninemile Creek site sediment locations and depths where both total mercury and

concentrations ranging from 0.08 to 1.4 mg/kg. In addition, four surface sediment samples were collected by NYSDEC in upper Ninemile Creek with mercury concentrations ranging from less than 0.05 to 0.18 mg/kg. The average mercury concentration of all 14 samples in upper Ninemile Creek, upstream of Reach CD, was 0.33 mg/kg (if the highest value is removed, this average would be 0.25 mg/kg).

methylmercury have been measured, concentrations of methylmercury are generally less than 1 percent of total mercury (average of about 0.3 percent).

Other CPOIs

Other CPOIs detected in stream sediments included metals (*e.g.*, arsenic and lead) other than mercury and organic compounds. Other inorganic CPOIs (*e.g.*, arsenic, lead, and sodium) were detected throughout Ninemile Creek sediments.

Patterns of contaminant distribution showed a significant increase in sodium from upper Ninemile Creek to lower Ninemile Creek. Higher concentrations of lead and arsenic (*i.e.*, greater than the NYSDEC severe effects levels [SELs] for arsenic [33 mg/kg] and lead [110 mg/kg]) were found only in lower Ninemile Creek, and not in the upper reaches of the stream. These higher concentrations of arsenic and lead were found in the same areas as elevated concentrations of mercury.

Organic CPOIs detected in sediments of lower Ninemile Creek which exceeded NYSDEC's sediment screening criteria included hexachlorobenzene, various individual PAHs, phenol, PCBs, and PCDD/PCDFs.

Calcite (*i.e.*, calcium carbonate) was identified as a SOC in the BERA. Calcium concentrations were higher in sediments in the lower reaches of Ninemile Creek than in the upper reaches.

Floodplain Soils/Sediments

Mercury

The patterns of mercury concentrations in floodplain soils/sediments (including the islands and wetland portions of the floodplains) were similar to those found in channel sediments. In Reach AB, the highest mercury concentrations were found near the mouth of Ninemile Creek and generally decrease with depth. However, there are some locations adjacent to the stream in this reach where mercury concentrations remain elevated at a depth of 3 ft (90 cm), which is the maximum depth of the RI floodplain data.

Methylmercury was only analyzed for a subset of the 1998 surface (0 to 15-cm-deep) soil/sediment samples. Higher concentrations were found in lower Geddes Brook and in Reach CD than in other reaches. Methylmercury concentrations in the floodplain soils/sediments in all reaches ranged from 0.11 to 27.5 µg/kg. With the exception of Station NM9 at the upstream end of Reach AB (with methylmercury concentrations up to 1.2 µg/kg), methylmercury data were not collected in the floodplain/wetlands of Reach AB during the RI. For Ninemile Creek floodplain locations and depths where both total mercury and methylmercury have been measured, concentrations of methylmercury are generally less than 1 percent of total mercury (average of about 0.6 percent).

Other CPOIs

Various metals (*e.g.*, arsenic and lead) were identified as CPOIs for floodplain soils and wetland sediments in the risk assessments. For these metal CPOIs, there was generally little difference in average concentrations between the upper and lower reaches of Ninemile Creek.

Organic CPOIs identified in the initial screening of the risk assessments based on exceedances of the screening criteria included hexachlorobenzene, PAHs, phenol, PCBs, and PCDD/PCDFs. Concentrations of hexachlorobenzene, total PAHs, PCB Aroclor 1254, PCB Aroclor 1268, and

PCDD/PCDFs were generally higher in floodplain soils/sediments along Ninemile Creek Reach CD than in Reach AB, and were co-located with elevated mercury concentrations.

As with channel sediments, calcium concentrations in floodplain soils/sediments were higher in the lower reaches of Ninemile Creek than in the upper reaches.

Surface Water

Mercury

In the surface water, total mercury concentrations reflected the input of mercury from the West Flume to Geddes Brook and from Geddes Brook to Ninemile Creek. In 1998, the average detected unfiltered total mercury concentrations were 2.1 and 22.3 nanograms per liter (ng/L) in upper and lower Geddes Brook, respectively. In upper and lower Ninemile Creek, the average detected unfiltered total mercury concentrations were 1.8 and 9.2 ng/L, respectively, in 1998. Samples collected at the mouth of the West Flume had the highest concentrations of unfiltered total mercury (815 and 1,090 ng/L in July and September of 1998, respectively). Dissolved total mercury was detected only in the West Flume (56.8 ng/L in July and 41.4 ng/L in September) and Geddes Brook below the West Flume (1.33 ng/L and 1.41 ng/L in a duplicate sample in July). These concentrations of dissolved mercury exceeded the lowest New York State surface water standard for dissolved mercury (0.7 ng/L). See also discussion below under "RG 4."

The average detected dissolved methylmercury concentrations from July and September 1998 were 0.029 and 0.037 ng/L in upper and lower Geddes Brook, respectively, and 0.041 and 0.021 ng/L in upper and lower Ninemile Creek, respectively. Samples collected at the mouth of the West Flume had the highest concentrations of dissolved methylmercury (1.14 ng/L in July and 1.26 ng/L in September of 1998). There was little change in dissolved methylmercury concentrations along the length of Ninemile Creek.

The concentration of total mercury on suspended sediments (*i.e.*, total mercury concentration on particles carried in the water) was calculated from the 1998 data under base-flow (*i.e.*, low water) conditions. Suspended sediments from the West Flume had the highest concentrations of mercury (30 and 58 mg/kg in July and September), followed by lower Geddes Brook samples (6.8 and 2.7 mg/kg) and the September sample from the most downstream Ninemile Creek station (2.0 mg/kg). All other suspended sediment samples contained less than 1 mg/kg total mercury. Most of the mercury amounts (*i.e.*, 75 to 99 percent) in surface water samples were associated with particles.

Comparison of the 1998 RI data to previous investigations in 1990 and 1992 indicated that mercury concentrations in surface water from the West Flume, lower Geddes Brook, and lower Ninemile Creek, sampled at low flow, were between 77 and 90 percent lower in 1998 than in 1990 and 1992. The most recent high flow sampling conducted in 1995 found considerably higher mercury concentrations than at low flow, indicating that different sources and transport processes may be important during high flow. During high-flow events in 1995, total mercury concentrations were 1.34 to 11.1 ng/L in upper Ninemile Creek (just above the Geddes Brook confluence), 27.6 to 455 ng/L in lower Ninemile Creek (at State Fair Boulevard), and 169 to 615 ng/L in lower Geddes Brook.

Other CPOIs

Select metals other than mercury (*e.g.*, lead) and one group of organic compounds (PCDD/PCDFs) were retained in the HHRA as human health CPOIs in surface water. Select metals other than mercury (*e.g.*, barium, lead, and manganese) and one organic compound (chlorobenzene) were retained in the BERA as ecological CPOIs in surface water.

Organic CPOIs were only detected sporadically in the surface water of Geddes Brook and Ninemile Creek. PCDD/PCDFs and chlorobenzene were detected in the 1998 sampling.

Four conventional parameters (total chloride, calcium, sodium, and TDS) were identified as SOCs in the BERA. The highest concentrations of these parameters in Geddes Brook were found at stations located downstream of the unnamed tributary which carries drainage from Wastebeds 12 through 15. Concentrations of these parameters in Ninemile Creek roughly doubled as the stream flowed past Wastebeds 9 through 11. In Ninemile Creek, concentrations of sodium were higher in lower reaches than in upper reaches by approximately 1.2 to 3 times. See the "Site Geology/Hydrogeology" section of this Propose Plan for discussion of chloride, calcium, and TDS results.

Fish

Adult fish were collected for chemical analysis in Ninemile Creek in 1990, 1998, and 2000, and YOY fish were collected in 1990, 1998, 2000, and 2002. Because adult fish move between the streams and lake, the source of mercury in these fish (*i.e.*, stream, lake, or both) is unclear. For these reasons, YOY fish were also collected since they tend to reside within a small area, and provide a clearer understanding of where these fish acquire mercury in their tissue.

Fish sampled in 1990 had mercury concentrations ranging from 0.13 to 2.5 mg/kg ww in fillets collected from the Geddes Brook/Ninemile Creek site, which exceeded EPA's methylmercury in fish criterion of 0.3 mg/kg for protection of human health. See also discussion below under "RG 3."

Mercury concentrations in adult fish collected in 1998 ranged from 0.07 to 1.5 mg/kg ww in fillets, which exceeded EPA's methylmercury in fish criterion of 0.3 mg/kg for protection of human health, and from 0.01 to 1.0 mg/kg ww in remainder tissues (the rest of the fish after the fillets are removed). The lowest concentrations were found in samples from the most upstream (above Amboy Dam) locations in Ninemile Creek. The highest concentrations were found in Ninemile Creek just downstream of the Geddes Brook confluence (Reach CD). In 2000, fish were only collected at the mouth of Ninemile Creek, and mercury in those adult fish ranged from 0.5 to 0.9 mg/kg ww in fillets, which exceeded EPA's methylmercury in fish criterion of 0.3 mg/kg for protection of human health, and 0.4 to 0.7 mg/kg ww in remainder tissue.

In YOY fish, mercury concentrations were higher in samples collected below the Geddes Brook confluence (Reach CD) and at the mouth of Ninemile Creek than in samples collected in upper Ninemile Creek. Mercury was detected in YOY fish at concentrations ranging from 0.02 to 0.05 mg/kg ww in 1998 in upper Ninemile Creek (Honeywell was unable to collect YOY fish samples in lower Ninemile Creek in 1998) and 0.14 to 0.22 mg/kg ww in 2000 at the mouth of Ninemile Creek. In 2002, mercury was detected in YOY fish at concentrations ranging from 0.18 to 0.85 mg/kg ww at Ninemile Creek stations downstream of Geddes Brook.

In addition to mercury, other CPOIs were detected in both adult and YOY fish. The BERA retained arsenic, selenium, zinc, DDT and metabolites, total PCBs, and PCDD/PCDFs as chemicals of concern for fish. Hexachlorobenzene, dieldrin, DDT and metabolites, heptachlor epoxide, PCBs, and PCDD/PCDFs exceeded human health screening criteria for fish consumption in the HHRA.

Impacts to Fish and Wildlife Resources

The contamination in the media described above has contributed to negative effects on the fish and wildlife resources at the Geddes Brook/Ninemile Creek site in a number of ways, including:

- Chloride loadings to Geddes Brook and Ninemile Creek from Solvay waste.
- Decreased value of habitat due to calcite crust formation and excessive turbidity.
- Expected acute and chronic toxic impacts to biota within the streams, wetlands, and floodplains.
- Increased dominance of benthic macroinvertebrate communities by pollution-tolerant taxa.
- Impoverished fish communities in Ninemile Creek.
- Bioaccumulation of mercury and other contaminants in fish and likely bioaccumulation in other biota.

Historical studies documented that waste discharges into Ninemile Creek during plant operations adversely affected the fish community to the extent that Ninemile Creek was considered unsuitable to support fish (New York State Conservation Department, 1946, 1947). A study conducted by CDR Environmental Specialists in 1990 for Honeywell found that the fish fauna in the slow, deep channels of Ninemile Creek, which constitute about 70 percent of the stream length, were generally impoverished in comparison to fish fauna at other habitats in the study area (CDR, 1991).

Additional information on impacts to fish and wildlife resources can be found in the BERA report and in the “Summary of Site Risks” section of this ROD.

A detailed evaluation of the nature and extent of contamination, including contaminant distribution maps, can be found in Chapter 5 of the Geddes Brook/Ninemile Creek RI report.

Groundwater

Groundwater at the Geddes Brook/Ninemile Creek site is not considered to be a medium requiring remediation, since both Geddes Brook and Ninemile Creek below Amboy Dam are gaining streams (*i.e.*, groundwater flows upward, discharging into these water bodies). Any groundwater contamination beneath or near the Site would be from upland sites, which are and/or will be investigated separately, as appropriate.

Transport and Fate of Contaminants

Transport and fate refers to the movement of CPOIs in the environment, their transformation, and their ultimate destination. The movement is largely a function of deposition, suspension, and redeposition of CPOIs that are bound to the sediments. These processes are critical to understanding the relative importance of contaminant sources and the outcome of proposed remedial actions. Transport and fate processes, therefore, need to be characterized at a level sufficient to support evaluation of remedial alternatives.

The analysis of transport and fate of CPOIs in the Site is complicated by two factors. First, flow conditions and discharges to the Site have changed significantly over time. Flows in Ninemile Creek dropped significantly from the 1970s to the 1980s as former Honeywell discharges were diverted from the West Flume and the wastebeds. Similarly, concentrations of TSS, TDS, and mercury in Ninemile Creek have been declining over the years since former Honeywell operations and active discharges ceased. Second, high flow events are expected to play a dominant role in mobilizing CPOIs from sediments and floodplain soils, yet data collection during such events has been limited. The peak flow rates were generally recorded during the snowmelt or spring runoff period; however, no chemical concentration data were available from this period. The load analysis presented in the RI report for conditions during high flow is based on samples taken during one high-flow event in October 1995.

Mercury

The transport and fate of mercury are strongly influenced by the tendency of mercury to associate with sediment/soil particles and, therefore, the tendency of particles to be resuspended or eroded and transported during high flow events. During base flow when transport of particles is low, the primary source of mercury to the Site has been the LCP Bridge Street subsite, which contributed mercury to the Site via the West Flume. Total unfiltered mercury concentrations in surface water increased in Geddes Brook downstream of the West Flume and in Ninemile Creek downstream of Geddes Brook. Methylmercury concentrations increased in Geddes Brook downstream of the West Flume but did not increase in Ninemile Creek downstream of Geddes Brook (possibly because methylmercury is rapidly oxidized in surface water).

Analysis of the mercury load carried in the Ninemile Creek water column during base flow (based on four sampling events in 1990 and 1998) suggests that Geddes Brook supplied 15 to 43 percent (mean of 33 percent) and upper Ninemile Creek supplied approximately 20 percent of the mercury load carried in lower Ninemile Creek (Figures 7 and 8). The remainder of the mercury load (mean of 47 percent of total load) carried in lower Ninemile Creek is presumed to come from internal sources (*e.g.*, from the sediments in the stream) within lower Ninemile Creek.

For Geddes Brook, load analysis at base flow (based on four sampling events in 1990 and 1998) suggested that the West Flume supplied 50 to 70 percent of the total mercury load in lower Geddes Brook. The remainder of the mercury load in lower Geddes Brook is presumed to come from internal sources (*e.g.*, sediment) within lower Geddes Brook. However, on at least one occasion, lower Geddes Brook appeared to have been a sink for mercury (*i.e.*, more mercury entered the brook from the West Flume than was carried to the lower reaches).

Estimation of loads during high flow was based on a single event with a flow of 500 cfs, during which the load of mercury increased by a factor of ten over the load at base flow. As discussed in the RI report, during the one high-flow event for which data are available (October 21 and 22, 1995), Geddes Brook contributed 14 percent of the total mercury load carried in lower Ninemile Creek (compared to 33 percent at base flow). The majority of the total mercury load in lower Ninemile Creek (82 percent) during this high-flow event was, therefore, attributed to erosion and transport of streambed sediments and bank sediment/floodplain soils within lower Ninemile Creek. There was considerable uncertainty associated with the load estimates for this event and with the implication of these estimates on annual loads to the lake. Nevertheless, the analysis strongly suggested that internal sources within lower Ninemile Creek likely contribute to the mercury load carried to Onondaga Lake.

The main source of internal loads in lower Ninemile Creek is likely streambed sediments and stream bank sediments/floodplain soils in Reach CD. Reach CD contains the highest concentrations of mercury and other CPOIs in Ninemile Creek. The high concentrations of mercury in this reach reflects historical patterns of transport and deposition and the fact that this reach has remained unaltered since the 1930s, while other reaches have been re-routed and/or dredged.

Sediments can be resuspended and transported downstream. Based on general hydrologic principals and quantitative modeling, the largest inputs of sediment during high flow, however, come from erosion of the channel bank. During even higher flows, when water flows over the channel banks and onto the floodplain, bank erosion is still the major source of particles. (See further discussion below under “RG 1.”)

In addition to the transport and fate of mercury on particles from the Geddes Brook/Ninemile Creek channel and floodplain, the production of methylmercury (*i.e.*, methylation of inorganic mercury) is an important process because of methylmercury's potential toxicity and tendency to bioaccumulate. Methylmercury is formed naturally by bacteria in the environment in the absence of oxygen, such as in anoxic sediment. In aquatic environments, methylmercury formed in sediment enters the food web through both benthic (*i.e.*, sediment-associated) and water column-associated pathways. Organisms at the top of the food chain (*e.g.*, wildlife that consume fish) receive the highest methylmercury exposure.

In terrestrial environments, anoxic conditions are more limited and methylmercury production is therefore limited. Methylmercury in terrestrial environments is potentially available to receptors such as the shrew that consume terrestrial invertebrates (*e.g.*, earthworms [*Lubricus terrestris*]) that are exposed to methylmercury in soil.

Other Metal CPOIs

Filtered and unfiltered surface water sampling results indicated that the concentration of metals (other than mercury) associated with particles did not vary significantly within the Site. Sediment sampling results were similar. Metals were generally found at higher concentrations in floodplain soils/sediments than in channel sediments, suggesting preferential settling of fine-grained material in floodplain soils/sediments or dilution in the streambed.

The ultimate fate of soluble and sediment-associated metal CPOIs is eventual transport to Onondaga Lake.

Organic CPOIs

Most of the organic CPOIs are highly persistent and remain associated with sediments. Like mercury, the organic CPOIs (*e.g.*, hexachlorobenzene, PCBs, PAHs, and PCDD/PCDFs) appear to be primarily associated with depositional zones downstream of the LCP Bridge Street subsite and the West Flume. As such, the organic CPOIs tend to be co-located with elevated mercury concentrations in Reach CD of Ninemile Creek, where the stream has remained unaltered since at least the 1930s. As with mercury and other metals, sediments containing organic CPOIs can be transported downstream if resuspended. Based on data from Onondaga Lake sediments near the mouth of Ninemile Creek, the Site is a possible source of some organic CPOIs to the lake. These organic CPOIs include hexachlorobenzene, PCBs, PAHs, and PCDD/PCDFs.

Ionic Waste Constituents

Ionic waste constituents, including calcium, sodium, chloride, and carbonates, can enter into and impact the streams in either dissolved or solid forms.

With regard to dissolved ionic waste constituents, the concentration of TDS, which includes ionic waste constituents, exceeds the New York State surface water quality standard (500 mg/L) under base-flow conditions (*i.e.*, when groundwater contributions to the system are most obvious) in

Ninemile Creek above the wastebeds (four samples at two locations in the 1998 sampling range from 720 to 809 mg/L), and further increases as the stream flows past Wastebeds 9 through 15 (concentration ranges from 1,430 to 2,810 mg/L). The ionic waste constituents in this segment enter the stream from groundwater and surface runoff associated with Wastebeds 9 through 15 and are predominantly in the form of dissolved calcium chloride and sodium chloride.

In regards to solid ionic waste constituents, calcite deposits (*i.e.*, solid calcium carbonate) are found adjacent to the wastebeds in upper Ninemile Creek and in various locations in lower Ninemile Creek (particularly in Reach CD). Under high-flow conditions, erosion of the calcite deposits results in transport of particulate calcite downstream, eventually to Onondaga Lake. TSS loads, which are assumed to be approximately 50 percent calcite based on sediment analysis in Onondaga Lake, increase significantly during storm-related high-flow events, due primarily to stream bank erosion. Analysis of TSS loads during the one high-flow event for which data are available shows that lower Ninemile Creek is a major source of TSS to the load carried by the stream. The New York State standard for TSS, which is "none from sewage, industrial wastes or other wastes that will cause deposition or impair the waters for their best usages," would be considered exceeded during high-flow conditions.

CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

The State of New York, Onondaga County, and the City of Syracuse have jointly sponsored the preparation of a land-use master plan to guide future development of the Onondaga Lake area (Syracuse-Onondaga County Planning Agency, 1998).The primary objective of land-use planning efforts is to enhance the quality of the Onondaga Lake area for recreational and commercial uses. Anticipated recreational uses of the lake and Geddes Brook/Ninemile Creek area include fishing without consumption restrictions and swimming.

Land Use

In general, the northwest upland of the lake, which includes the Site area, is primarily residential, with interspersed urban structures and several undeveloped areas. Solvay wastebeds cover much of the western lakeshore and areas of the Site. Land around much of the lake is recreational, providing hiking and biking trails, picnicking, sports, and other recreational activities.

Surface Water Use

Approximately the northern two-thirds of Onondaga Lake is classified by the State of New York as Class B water (best usages defined as "primary and secondary contact recreation and fishing. These waters shall be suitable for fish propagation and survival" [6 NYCRR Part 701.7]). The southern third of Onondaga Lake and the area at the mouth of Ninemile Creek are classified as Class C water (best usage defined as "fishing. These waters shall be suitable for fish propagation and survival. The water quality shall be suitable for primary and secondary contact recreation, although other factors may limit the use for these purposes" [6 NYCRR Part 701. 8]). Ninemile Creek is a Class C stream below the former Honeywell water intake and C(T) upstream. Geddes Brook is a Class C stream below the Old Erie Canal and C(T) upstream. No permitted swimming beaches or sanctioned swimming areas exist at the Site (NYSDOH, 1995).

Fishing occurs, but the NYSDOH has a specific, restrictive consumption advisory for Onondaga Lake including its tributaries which warns against eating walleye (*Stizostedion vitreum*), largemouth bass (*Micropterus salmoides*), and smallmouth bass (*Micropterus dolomieui*) larger than 15 inches, with consumption of all other species limited to no more than once per month (NYSDOH, 2008).

The specific advisory also stipulates that infants, children under 15, and women of childbearing age should eat no fish from the lake and its tributaries. The more general, statewide advisory for the state's fresh waters advises that consumption be limited to no more than one meal per week. Onondaga Lake and the associated tributaries do not serve as potable-water sources (Syracuse Department of Water, 2000).

SUMMARY OF SITE RISKS

As part of the RI process, baseline risk assessments were conducted for the Site to estimate the risks to human health and the environment. The baseline risk assessments, consisting of an HHRA, which evaluated risks to people, and a BERA, which evaluated risks to the environment, analyzed the potential for adverse effects both under current conditions and if no actions are taken to control or reduce exposure to hazardous substances at the Site. As indicated below, based upon the results of the RI and the risk assessments, NYSDEC and EPA have determined that active remediation is necessary to protect public health or welfare and the environment from actual and threatened releases of hazardous substances into the environment. In addition, the control of contamination migrating from Geddes Brook and Ninemile Creek into Onondaga Lake is an integral part of the overall remediation of Onondaga Lake.

Human Health Risk Assessment

A Site-specific HHRA was performed to quantitatively evaluate both cancer risks and noncancer health hazards associated with potential current and/or future exposures to chemicals present in Geddes Brook and Ninemile Creek surface water, floodplain soils/sediments, channel sediments, and fish in the absence of any action to control or mitigate those chemicals. The HHRA is used to determine whether the risks associated with the Site justify remedial action; however, the HHRA does not identify specific remedial goals. The HHRA was prepared to evaluate potential risks associated with exposure to elevated concentrations of mercury, lead, PCDD/PCDFs, and other COPCs in surface water; mercury, lead, arsenic, hexachlorobenzene, PAHs, PCBs, PCDD/PCDFs, and other COPCs in channel sediments; mercury, lead, arsenic, hexachlorobenzene, PAHs, PCBs, PCDD/PCDFs, and other COPCs in floodplain soils/sediments; and mercury, arsenic, hexachlorobenzene, PCBs, PCDD/PCDFs, and other COPCs in fish.

Hazard Identification

In addition to mercury (including methylmercury), approximately 40 other chemicals were identified as COPCs in one or more Site media using a screening process that compared measured concentrations to risk-based target concentrations. Risks were calculated for these COPCs in the HHRA.

Exposure Assessment

Geddes Brook and Ninemile Creek are surrounded by lands used for industrial, commercial, and recreational purposes. No residential property directly abuts the Geddes Brook/Ninemile Creek site. People who consume fish from Geddes Brook and Ninemile Creek and recreational visitors exposed to Geddes Brook and Ninemile Creek sediments, surface water, and floodplain and wetland soils/sediments are the receptors or individuals with the greatest potential for exposure to COPCs. Cancer risks and noncancer health hazards were evaluated for young children (less than 6 years old), older children (6 to less than 18 years old), and adults (18 and over) who consume fish from Geddes Brook and Ninemile Creek. Cancer risks and noncancer health hazards were also evaluated for older children and adults who are exposed to sediments, surface water, and floodplain and wetland soils/sediments within the Geddes Brook/Ninemile Creek site during recreational activities. Under current conditions, potential exposures for recreational visitors to the Geddes Brook/Ninemile Creek site are limited by the lack of public swimming areas. The exposure point concentrations for the COCs, along with the detection frequencies for these contaminants, are presented in Table 7.

The NYSDOH has also issued specific, restrictive fish consumption advisories for Onondaga Lake and its tributaries, including Geddes Brook and Ninemile Creek, which currently advises that women of childbearing age, infants, and children under the age of 15 should not eat any fish from Onondaga Lake and its tributaries, and all others should eat no more than one meal per month of any species, with no walleye and bass larger than 15 inches to be eaten at all. However, because the HHRA addresses future conditions, it was assumed that the public would consume fish caught in Geddes Brook and Ninemile Creek, and that recreational visitors would be exposed to sediments, surface water, and floodplain and wetland soils/sediments of the Geddes Brook/Ninemile Creek site.

The HHRA assesses risk under both current and future use scenarios. Potential future uses are evaluated under the assumption that there are no restrictions, advisories, or limitations in place, although it was assumed that there would continue to be no residential exposure to sediments and soils since the Site consists of open channel and floodplain/wetland areas that are unlikely to be developed in the future. Thus, since no occupied structures currently exist on-Site and none are likely to built on-Site in the future, a residential scenario was not evaluated in the HHRA. Exposure pathways evaluated quantitatively include consumption of fish from Geddes Brook and Ninemile Creek, incidental ingestion of and dermal contact with surface and subsurface channel sediments, incidental ingestion of and dermal contact with surface and subsurface floodplain soils/sediments, and incidental ingestion of and dermal contact with surface water.

In addition to exposures attributable to fish consumption and direct exposures to contaminated media by recreational visitors, the HHRA also evaluated potential exposures to construction workers who may contact contaminated media (*i.e.*, channel sediments, floodplain soils/sediments, and surface water) during work on the Site.

Because risk assessments are designed to be conservative so that risk management strategies can be protective of human health, as well as consistent with EPA requirements, two types of exposure scenarios were analyzed in the HHRA to assess a range of potential risk: the reasonable maximum exposure (RME), which portrays the highest level of human exposure that could reasonably be expected to occur, and the central tendency (CT, or "typical") scenarios. Cancer risks and non-cancer health hazards were assessed for exposures attributable to fish consumption and direct exposures to contaminated media by recreational visitors and construction workers at the Site under both these scenarios.

Toxicity Assessment

Risk estimates for all COPCs were based on use of toxicity values, using carcinogenic slope factors (CSFs) to assess potential carcinogenic effects and reference doses (RfDs) to assess potential noncancer effects. These measures were primarily derived and published by EPA. The three COPCs (or COPC groups) responsible for a majority of estimated Site risks are methylmercury, PCBs, and PCDD/PCDFs, as described below.

- Methylmercury is a toxic chemical with which a number of adverse health effects have been associated in both human and animal studies (see the text box entitled "What is Mercury?" [page 3]). With respect to the adverse effects of methylmercury, the largest amount of data exists on neurotoxicity, particularly in developing organisms.

- PCBs cause cancer in animals and probably cause cancer in humans, based on evidence in laboratory animals (see the text box entitled "What are Organic Contaminants in the Geddes Brook/Ninemile Creek Site?" [page 5]). In addition, serious noncancer health effects have been observed in animals exposed to PCBs. Studies of Rhesus monkeys exposed to PCBs indicate a reduced ability to fight infection and reduced birth weight in offspring exposed in utero.

- PCDD/PCDFs probably cause cancer in humans, based on evidence in laboratory animals (see the text box entitled "What are Organic Contaminants in the Geddes Brook/Ninemile Creek Site?" [page 5]). They have also been associated with a wide variety of toxic effects in animals, including acute toxicity, enzyme activation, tissue damage, and developmental abnormalities.

A summary of the toxicity information for both noncancer health effects as well as cancer endpoints is presented in Tables 8 and 9, respectively.

Risk Characterization

Contamination at the Site presents risks to human health that are above applicable EPA guidelines, particularly as a result of fish consumption. The primary sources of cancer risks and noncancer health hazards are mercury, PCBs, and PCDD/PCDFs.

- **Cancer risks (fish consumption and recreational scenarios):** The calculated RME cancer risks (ranging from 2.9×10^{-5} for young children to 9.3×10^{-5} for adults) associated with fish consumption exceeded the low end of the target cancer risk range (1×10^{-6}) by more than an order of magnitude, but were less than the high end of the target risk range (1×10^{-4}).[10] The calculated CT cancer risks for fish consumption were slightly greater than 1×10^{-6}, ranging from 1.2×10^{-6} to 1.3×10^{-6}. PCBs and PCDD/PCDFs contributed the bulk of the cancer risk associated with fish consumption.

  RME cancer risk estimates associated with several other exposure pathways related to channel sediments, floodplain soils/sediments, and

10 In an HHRA, exposures are evaluated based on the potential risk of developing cancer and the potential for non-cancer health hazards. The likelihood of an individual developing cancer is expressed as a probability. For example, a 10^{-4} cancer risk means a "one-in-ten-thousand excess cancer risk," or one additional cancer may be seen in a population of 10,000 people as a result of exposure to Site contaminants under the conditions explained in the Exposure Assessment of the HHRA. Current federal Superfund guidelines for acceptable exposures are "generally concentration levels that represent an excess upper bound cancer to an individual of between 10^{-4} to 10^{-6}" (40 CFR § 300.430[e][2][A][2]) (corresponding to a one-in-ten-thousand to a one-in-a-million excess cancer risk). The 10^{-6} risk is used as the point of departure for determining remediation goals.

surface water in recreational scenarios were greater than 1 × 10^{-6} but lower than 1 × 10^{-4}. CT risk estimates for only two of these pathways (exposure to surface sediments and surface water in upper Geddes Brook) slightly exceeded the low end of the target risk range (1 × 10^{-6}). However, for these routes of exposure there was no increase in calculated risks from the upper to the lower reaches, and the chemicals presenting the highest risks are typical of urban runoff. The cancer risk estimates for the COCs for the RME scenario are presented in Table 10.

- **Noncancer health hazards (fish consumption and recreational scenarios):** The RME noncancer hazard indices (HIs) for the recreational angler fish consumption pathway (ranging from 4.1 to 6.4) exceeded the target hazard index of 1.0.[11] The CT HIs (ranging from about 0.3 to 0.5) were below 1.0. The elevated HIs for the fish consumption pathways were primarily related to PCBs (highly chlorinated Aroclors, assessed as Aroclor 1254), methylmercury, and, to a lesser extent, dieldrin. RME and CT HIs for all pathways other than fish ingestion were less than 1.0. The non-cancer hazard quotients and indices for the COCs for the RME scenario are presented in Table 11.

- **Cancer risks (construction worker scenario):** RME cancer risks (1.2 × 10^{-6}) for exposure to upper Geddes Brook sediments for future construction workers slightly exceeded the low end of the target risk range of 1 × 10^{-6}. All other RME and CT risks for future construction workers were less than the target range.

- **Noncancer health hazards (construction worker scenario):** None of the calculated noncancer hazards (for both RME and CT scenarios) for future construction workers and recreational visitors associated with pathways other than fish consumption exceeded the target threshold of 1.0, indicating that exposure to COPCs from all pathways except fish consumption are not predicted to result in adverse noncancer effects.

In addition, the potential risks and hazards to subsistence fishers were evaluated in the uncertainty section of the HHRA. Although the RME and CT exposures were used to quantify risks and hazards from the Geddes Brook/Ninemile Creek site, the uncertainty section examines additional factors which could influence risk characterization, such as the higher consumption rates from a subsistence life style. As discussed in the Geddes Brook/Ninemile Creek HHRA report (see Section 7.3.3 thereof), the potential risks and hazards to a subsistence fisherman, which would be greater than the risks and hazards calculated for the adult recreational angler by a factor of seven for the RME and nine for CT scenarios, are also above applicable EPA guidelines.

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11 For non-cancer health effects, a "hazard quotient" (HQ) is calculated for each contaminant. An HQ represents the ratio of the estimated exposure to the corresponding reference doses (RfDs). The sum of the HQs is termed the "hazard index" (HI). The key concept for a non-cancer HI is that a "threshold level" (measured as an HQ or HI of 1) exists, below which non-cancer health effects are not expected to occur.

Baseline Ecological Risk Assessment

The BERA evaluated the likelihood that adverse ecological effects are occurring or may occur as a result of exposure to one or more chemicals or stressors. The BERA was prepared to evaluate potential risks associated with exposure to elevated concentrations of mercury, lead, and other contaminants of concern (COCs) and stressors in surface water; mercury, arsenic, lead, hexachlorobenzene, phenol, PAHs, PCBs, and other COCs and stressors in channel sediments; mercury, arsenic, lead, hexachlorobenzene, phenol, PAHs, PCBs, PCDD/PCDFs, and other COCs and stressors in floodplain soils/sediments; and mercury, arsenic, PCBs, PCDD/PCDFs, and other COCs in fish. The framework used for assessing Site-related ecological risks is similar to that used for HHRAs and consists of problem formulation, ecological exposure assessment, ecological effects assessment, and risk characterization.

Problem Formulation

Problem formulation identifies the major factors to be considered in a BERA, including COC and SOC (*e.g.*, ionic waste) characteristics, ecosystems and/or species potentially at risk, and ecological effects to be evaluated. It establishes the goals, breadth, and focus of the assessment, develops a conceptual model, and selects assessment endpoints, which are explicit expressions of the environmental value that is to be protected. In an HHRA, only one species (humans) is evaluated and the cancer and noncancer effects are typically the assessment endpoints. In contrast, a BERA involves multiple species that are likely to be exposed to differing degrees and respond differently to the same contaminant. Assessment endpoints focus the risk assessment on particular components of the ecosystem that could be adversely affected by contaminants from the Site.

Assessment endpoints selected for the Geddes Brook/Ninemile Creek BERA are based on the sustainability of plant and animal communities and populations. “Sustainability” relates to survival, growth, and reproduction. The assessment endpoints include:

- Sustainability of a terrestrial plant community that can serve as a shelter and food source for local invertebrates and wildlife.
- Sustainability of a benthic invertebrate community that can serve as a food source for local fish and wildlife.
- Sustainability of local fish populations.
- Sustainability of local amphibian and reptile populations.
- Sustainability of local insectivorous, piscivorous (fish-eating), and carnivorous bird populations.
- Sustainability of local insectivorous and piscivorous mammal populations.

Detailed quantitative assessments of the sustainability of selected fish and wildlife populations were conducted by selecting individual species representative of various feeding preferences, predatory levels, and habitats. Receptors selected to represent the Geddes Brook/Ninemile Creek ecological community for the BERA included benthic macroinvertebrates, four species of fish (bluegill, brook trout [*Salvelinus fontinalis*], smallmouth bass [*Micropterus dolomieu*], and white sucker), four species of birds (tree swallow, belted kingfisher [*Ceryle alcyon*], great blue heron, and red-tailed hawk), and four species of mammals (little brown bat [*Myotis lucifigus*], short-tailed shrew, mink, and river otter). The remaining receptors (*i.e.*, terrestrial plants, amphibians, reptiles) were evaluated qualitatively.

Ecological Exposure Assessment

The assumptions and models used to predict the potential exposure of plants and animals to COCs associated with the Site are addressed in this component. Exposure parameters (*e.g.*, body weight, prey ingestion rate, home range) of wildlife species selected as representative receptors and Site-specific fish, channel sediments, floodplain soils/sediments, and water COC concentrations, were used to calculate the exposure concentrations or dietary doses using food-web models.

Ecological Effects Assessment

Mercury and numerous other potentially toxic chemicals, including metals, PCBs, PAHs, hexachlorobenzene, and PCDD/PCDFs, were detected at concentrations above ecological screening levels in various Site media.

Measures of toxicological effects were selected based on lowest-observed-adverse-effect levels (LOAELs) and no-observed-adverse-effect levels (NOAELs) from studies reported in the scientific literature. Reproductive effects (*e.g.*, egg maturation, egg hatchability, and survival of juveniles) were generally the most sensitive endpoints.

Risk Characterization

Multiple lines of evidence, based on various measurement endpoints (measures of effect), were used to evaluate major components of the Geddes Brook/Ninemile Creek ecosystem to determine if contamination has adversely affected plants and animals at the Site. Almost all lines of evidence indicate that inputs of chemicals to Geddes Brook and Ninemile Creek and their associated floodplains/wetlands in the lower reaches have produced adverse ecological effects at all trophic levels (levels of the food chain) examined. Ionic wastes have also impacted the Site, reducing habitat value for aquatic macrophytes, benthic invertebrates, and fish that use the stream for feeding or spawning.

As discussed in the BERA, mercury and possibly other chemicals have bioaccumulated in most organisms serving as a food source for biota in the Site, resulting in risks to fish and wildlife above acceptable levels. Comparisons of measured tissue concentrations and modeled doses of chemicals to measures of toxicological effects show exceedances of hazard quotients for chemicals at the Site. Many of the chemicals at the Site are persistent (*i.e.*, they remain in the same chemical state without breaking down); therefore, the risks associated with these chemicals are unlikely to decrease significantly unless remediation is performed.

Exceedances of toxicity-based sediment effects concentrations from the literature suggest that adverse effects to invertebrates due to contact with surface channel sediments and floodplain soils/sediments will frequently occur in lower Geddes Brook and lower Ninemile Creek. This is confirmed by sediment toxicity testing that was conducted in Geddes Brook and Ninemile Creek. These tests indicate that sediment toxicity appears to occur in both streams in those areas downstream of and directly influenced by the discharges of the West Flume from the LCP Bridge Street subsite.

Summary of Human Health and Ecological Risks

Key results of the HHRA include the finding that contamination at the Site presents risks to human health that are above EPA guidelines, particularly as a result of fish consumption. The primary sources of these cancer risks and noncancer health hazards are methylmercury, PCBs, and PCDD/PCDFs.

Key results of the BERA indicate that comparisons of measured tissue concentrations and modeled doses of chemicals to toxicity reference values show exceedances of hazard quotients for Site-related chemicals. Many of the contaminants at the Site are persistent and, therefore, the risks associated with these contaminants are unlikely to decrease significantly in the absence of remediation. On the basis of these comparisons, it has been determined through the BERA that all receptors of concern are at risk. Contaminants and stressors at the Site have either impacted or potentially impacted every trophic level examined in the BERA.

Based upon the results of the RI and the risk assessments, NYSDEC and EPA have determined that active remediation is necessary to protect public health or welfare and the environment from actual and threatened releases of hazardous substances into the environment.

Basis for Action

Actual or threatened releases of hazardous substances from the Site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

The documents that form the basis of NYSDEC and EPA's selection of a remedy are included in the Administrative Record Index (see Appendix III) and include the final Geddes Brook/Ninemile Creek RI report, BERA, and HHRA (all dated July 2003), the draft final Geddes Brook/Ninemile Creek FS report (dated May 2005), the Ninemile Creek OU2 Supplemental FS report (dated May 2009), the Geddes Brook/Ninemile Creek OU1 ROD (dated April 29, 2009), the OU2 Proposed Plan (dated May 18, 2009), the comments on the above documents and the Geddes Brook/Ninemile Creek OU2 Proposed Plan received from the public during the comment period, and this ROD (which includes the Responsiveness Summary).

REMEDIAL ACTION OBJECTIVES AND REMEDIATION GOALS

Remedial action objectives (RAOs) are specific goals to protect human health and the environment. These objectives are based on available information and standards, such as applicable or relevant and appropriate requirements (ARARs), to-be-considered guidance (TBCs), and risk-based levels. There are no federal or New York State sediment cleanup standards for mercury or the other CPOIs found in Geddes Brook and Ninemile Creek channel and wetland sediments. However, as discussed below, NYSDEC's (1999) sediment screening criteria have been used as TBC criteria to develop remedial alternatives for the channel and floodplain.

Since completion of the Geddes Brook/Ninemile Creek FS Report (Parsons, 2005) in May 2005, NYSDEC issued soil cleanup objectives (SCOs) for inactive hazardous waste sites (6 NYCRR Part 375.6). Because the majority of the floodplain portion of the Site is a regulated wetland with soils more characteristic of sediments than upland soils, the Part 375 SCOs were not considered in this ROD to determine areas warranting remediation. However, as discussed below in the "Description of Alternatives" section, the unrestricted use SCOs (6 NYCRR 375-6.8[a]) are goals that will be used to determine clean soil acceptable for use as suitable habitat layer material.

Although the channel sediments and floodplain soils/sediments are the primary focus of the remediation, the degrees of attainment of New York State's surface water standards and guidance values and Site-specific fish target concentrations were also evaluated in this ROD.

The RAOs for this Site are based on Site-specific information including the nature and extent of CPOIs, the transport and fate of mercury and other CPOIs, and the baseline human health and ecological risk assessments. The RAOs were developed as goals for controlling CPOIs within the Site and protecting human health and the environment. The RAOs for this Site are:

- **RAO 1**: To eliminate or reduce, to the extent practicable, further transport of sediments and soils, containing mercury and other CPOIs, from the channel and floodplain of lower Geddes Brook and lower Ninemile Creek to Geddes Brook, Ninemile Creek, and, ultimately, Onondaga Lake.

- **RAO 2**: To eliminate or reduce, to the extent practicable, existing and potential future adverse ecological effects on fish and wildlife resources, as well as potential risks to humans.

- **RAO 3**: To eliminate or reduce, to the extent practicable, levels of mercury and other CPOIs in surface water in order to meet surface water quality standards.

In order to achieve these RAOs, remediation goals (RGs) were established to provide additional information with which remedial alternatives can be developed and selected. The Site contains four primary media that have been impacted by CPOIs: channel sediments, floodplain soils/sediments, biological tissue, and surface water. The following four RGs have been developed to address each of the affected media:

- **RG 1**: Reduce, contain, or control, to the extent practicable, mercury and other CPOI concentrations in erodible channel sediments and in erodible floodplain soils/sediments within the Site.

- **RG 2**: Achieve CPOI concentrations, to the extent practicable, in channel sediments and floodplain soils/sediments that are protective of human health and fish and wildlife resources. This RG covers a range of risk levels for mercury and other CPOIs.

- **RG 3**: Achieve CPOI concentrations, to the extent practicable, in fish tissue that are protective of humans and wildlife that consume fish.

- **RG 4**: Achieve, to the extent practicable, aqueous CPOI concentrations to meet surface water quality standards.

RG 1 – Erodible Channel Sediments and Erodible Floodplain Soils/Sediments

RG 1: Reduce, contain, or control, to the extent practicable, mercury and other CPOI concentrations in erodible channel sediments and in erodible floodplain soils/sediments within the Site.

Since the spread of mercury and most other key CPOIs (arsenic, lead, hexachlorobenzene, PCBs, PCDD/PCDFs, and PAHs) is primarily associated with the transport of soils and sediment particles, minimization of transport of sediments and soils from the streambed and floodplains of lower Geddes Brook and lower Ninemile Creek also would minimize the transport of these contaminants. This can be best addressed by targeting those CPOI-containing sediments and floodplain soils/sediments that are prone to erosion, resuspension, and transport through surface water. Therefore, RG 1 focuses on the erodible sediments and floodplain soils/sediments along lower Geddes Brook and lower Ninemile Creek to achieve reduction of transport of streambed sediments and floodplain soils/sediments.

As part of the RI report (see its Appendix H), a qualitative and quantitative assessment was conducted to determine which sections of the Geddes Brook and Ninemile Creek stream channels are erosional or depositional at low flows. This issue was further investigated in the FS report (see FS Figures 1-17 to 1-24, and its Appendix A) and in the Geddes Brook/Ninemile Creek OU1 Supplemental FS report (see its Appendix D). Using a quantitative model (*i.e.*, USACE's Hydrologic Engineering Centers River Analysis System [HEC-RAS] model), the erosion potential of the lower Geddes Brook and lower Ninemile Creek channels and floodplains was determined for a range of flows, up to and including the 500-year flood event. Results from these evaluations indicate that the streams and the banks within the floodplain are erosive at almost all locations during major storm events, while the floodplain overbank areas are depositional under all storm conditions. Thus, to address this RG, those areas subject to stream erosion (*i.e.*, all channel deposits and stream banks) are included in the remedial alternatives.

Applicability to RAOs

RG 1 addresses RAOs 1 through 3 to varying degrees, as follows:

- RAO 1: The reduction, containment, or control of mercury and other CPOI concentrations in erodible channel sediments and in erodible floodplain soils/sediments would directly address further transport of mercury and other CPOIs from channel sediments and from floodplain soils/sediments.

- RAO 2: Reducing the concentrations of mercury and other CPOIs on erodible channel sediments and floodplain soils/sediments would reduce the further transport of contaminants from the streambeds and floodplains, thus reducing adverse ecological effects to the benthic and terrestrial community. In addition, reductions of CPOI concentrations would reduce adverse effects associated with direct exposure of humans, fish, and wildlife to sediments and soils, as well as adverse effects associated with bioaccumulation of CPOIs.

- RAO 3: Reducing the transport of CPOIs from erosion of the streambeds and floodplains into the water column would help to address RAO 3 by reducing the levels of mercury and other CPOIs in surface water in order to meet surface water quality standards.

RG 2 – Channel Sediments and Floodplain Soils/Sediments

RG 2: Achieve CPOI concentrations, to the extent practicable, in channel sediments and floodplain soils/sediments that are protective of human health and fish and wildlife resources. This RG covers a range of risk levels for mercury and other CPOIs.

Toxicity

Target sediment concentrations that address direct contact toxicity to benthic organisms are considered "not-to-exceed" levels at individual locations. As directed by the NYSDEC (1999) Technical Guidance for Screening Contaminated Sediments, Site-specific sediment toxicity testing was conducted which confirmed sediment toxicity at the Site. However, this work did not produce sufficient data for the derivation of Site-specific toxicity-based sediment effect concentrations. Therefore, literature-based values were used in the BERA and in development of remedial alternatives which is common practice. The target concentrations considered for this Site include criteria/guidelines for sediment toxicity to benthic macroinvertebrates from New York State, as well as the Province of Ontario and Washington State. These literature values are based on studies of a wide variety of freshwater and marine aquatic systems. Each literature-based value is defined with a differing level of expected effects at each concentration. (See text boxes called "Toxicity-Based Sediment Effect Concentrations Selected as RGs for Mercury and Other Inorganics" [page 38] and "Toxicity-Based Sediment Effect Concentrations Selected as RGs for Organic Contaminants" [page 39].)

Toxicity-Based Sediment Effect Concentrations Selected as Remediation Goals for Mercury and Other Inorganics

To evaluate sediment quality at the Site, channel sediment and floodplain sediment/soil concentrations were compared to statewide criteria for sediment toxicity to benthic macroinvertebrates. These criteria are literature values that are based on studies of a wide variety of aquatic systems. The literature values used in developing this ROD were based on the following methods.

Effects Range-Low (ER-L) – The concentration that represents the lowest 10th percentile of the concentrations at which toxic effects were observed. At concentrations below the ER-L, toxic effects are rarely expected (Long and Morgan, 1990).

Effects Range-Median (ER-M) – The concentration that represents the 50th percentile (median) at which toxic effects were observed. At concentrations above the ER-M, toxic effects are likely to occur (Long and Morgan, 1990).

Lowest Effect Level (LEL) – The level of sediment contamination that can be tolerated by the majority (95 percent) of benthic organisms but still causes toxicity to a few (5 percent) species. It is derived in a two-step process in which the 90th percentile of the concentrations tolerated by a single species is determined (species screening level or SSLC). The 5th percentile concentration of the SSLCs considered represents the LEL (Persaud et al., 1993).

Severe Effect Level (SEL) – The level of sediment contamination that can causes toxicity to the majority (95 percent) of benthic organisms. It is derived in a two-step process in which the 90th percentile of the concentrations tolerated by a single species is determined (species screening level or SSLC). The 95th percentile concentration of the SSLCs considered represents the SEL (Persaud et al., 1993).

Sediment Quality Standard (SQS) – This concentration was derived for the Washington State Department of Ecology (Avocet and Science Applications International Corporation, 2002 and Avocet, 2003) by first assessing the strength of the relationship between individual contaminants and toxicity. For those contaminants which have a relationship with toxicity, an iterative statistical process is employed which provides the concentrations which are the most reliable predictors of toxic effects. The SQS for mercury cited in this ROD represents a concentration that is discernable from control samples with a change in mortality of 10 percent from the controls. Above this concentration, minor adverse effects may occur.

NYSDEC developed two levels of risk for metals contamination in sediment (NYSDEC, 1999). These are:

NYSDEC LEL – NYSDEC defines the LEL as the lowest of either the Persaud et al. (1993) LEL or the Long and Morgan (1990) ER-L.

NYSDEC SEL – NYSDEC defines the SEL as the lowest of either the Persaud et al. (1993) SEL or the Long and Morgan (1990) ER-M.

For **mercury**, which is the primary contaminant of concern at this Site, the following sediment RGs were used to develop and/or evaluate remedial alternatives: 0.15 mg/kg, which is the NYSDEC (1999) LEL; 0.5 mg/kg, which is the SQS from Washington State (Avocet, 2003); 1.3 mg/kg, which is the NYSDEC (1999) SEL; and 2.0 mg/kg, which is the Persaud et al. (1993) SEL.

Lead and arsenic are the other two inorganics that were determined to be potential risk drivers. For **lead**, the NYSDEC (1999) SEL of 110 mg/kg was used in developing the remedial alternatives while the LEL of 31 mg/kg was used for the comparative analysis. For **arsenic**, the NYSDEC (1999) SEL of 33 mg/kg was used in developing the remedial alternatives while the LEL of 6 mg/kg was used for the comparative analysis.

Toxicity-Based Sediment Effect Concentrations Selected as Remediation Goals for Organic Contaminants

For the organic contaminants that presented a potential impact to benthic toxicity, including hexachlorobenzene, PCBs, and phenol, NYSDEC's **Benthic Aquatic Life Chronic Toxicity (BALCT)** criteria, which are on an organic-carbon-normalized basis, were used to develop and/or evaluate each remedial alternative (NYSDEC, 1999). For purposes of the FS and this ROD, the Site-wide average for total organic carbon (TOC) in sediment of 2.1 percent was used to convert the BALCT criteria to a dry-weight basis for determining exceedances of the RGs. During the remedial design, additional TOC data would be obtained along with the chemical data for determining final areas of remediation.

For PCBs, the NYSDEC BALCT criterion of 19.3 μg/g organic carbon was used (19.3 μg/g organic carbon x 2.1% / 100) to derive a sediment RG of 0.405 mg/kg.

For hexachlorobenzene, the NYSDEC BALCT criterion of 5,570 μg/g organic carbon was used (5,570 μg/g organic carbon x 2.1% / 100) to derive a sediment RG of 117 mg/kg.

For phenol, 50 times the NYSDEC BALCT criterion of 0.5 μg/g organic carbon was used (50 x 0.5 μg/g organic carbon x 2.1% / 100) to derive a sediment RG of 0.53 mg/kg. The factor of 50 was applied to phenol because, as stated in the NYSDEC Technical Guidance for Screening Contaminated Sediments (NYSDEC, 1999) "for non-polar organic contaminants, exceedance of sediment criteria based on aquatic life chronic toxicity by a factor of 50 in a significantly large area indicates that biota are probably impaired and to achieve restoration of the ecosystem will require remediation of organic contaminants present."

For total PAHs, the ER-M of 35 mg/kg was used in the development of each remedial alternative while the ER-L of 4 mg/kg was used for the comparative analysis.

In addition to channel sediments, the toxicity RGs are also considered to be relevant for floodplain sediments since a majority of the floodplain consists of sediments associated with delineated federal and state wetlands. The physical and chemical characteristics of the channel sediments and the wetland sediments that predominantly comprise the floodplain are very similar. Thus, the same set of toxicity RGs are used for both floodplain sediments and channel sediments.

Bioaccumulation

Target sediment and soil concentrations that address bioaccumulation are designed to protect humans, fish, and wildlife resources from bioaccumulation and are derived from the human health and ecological risk assessments for the Site. Site-specific target fish tissue concentrations to protect human health and wildlife (*e.g.*, river otter, mink) against bioaccumulation were back-calculated from the HHRA risk models and BERA food web models. (See the text boxes on RGs in fish tissue to protect human health and ecological receptors [pages 41 and 42].) Then, target sediment concentrations for bioaccumulation of CPOIs from sediments to fish tissue were developed through the application of a biota-sediment accumulation factor (BSAF). Also, a target soil concentration was calculated for the protection of wildlife (*e.g.*, short-tailed shrew) that consume terrestrial invertebrates. (See the text boxes on sediment quality values for channel sediments and floodplain soils/sediments to protect against bioaccumulation and direct contact [pages 44 and 45].) The Site-specific bioaccumulation-based sediment/soil quality values (BSQVs) calculated for mercury are 0.8 mg/kg for channel sediments and 0.6 mg/kg for soils.

Concentrations of PCBs and PCDD/PCDFs in fish tissue and hexachlorobenzene in invertebrates (modeled) were also determined to be risk drivers for human health and wildlife. PCBs, hexachlorobenzene, and PCDD/PCDFs are not widespread in Geddes Brook and Ninemile Creek and are found primarily in a few specific areas of the streams. The NYSDEC sediment screening criteria for protection of wildlife and humans from bioaccumulation were used as the comparison values for these three CPOIs. Therefore, Site-specific BSQVs were not developed for these CPOIs. The areas where these CPOIs are elevated are generally co-located with areas that would be addressed under the remedial alternatives evaluated in this ROD.

Target sediment and soil concentrations that address bioaccumulation are considered on a surface area-weighted average basis, since fish and wildlife integrate soils/sediments exposure over a larger area than benthic invertebrates. Therefore, residual (*i.e.*, post-remediation) CPOI concentrations in channel sediments and floodplain soils/sediments on a surface area-weighted average basis reflect the concentrations at which bioaccumulating receptors are exposed. Additional information on how the remedial alternatives address these CPOIs can be found in the Geddes Brook/Ninemile Creek site OU2 Supplemental FS report (*e.g.*, Tables 3-3 and 3-4; Parsons, 2009).

Applicability to RAOs

RG 2 addresses RAOs 1 and 2 to varying degrees, as follows:

- **RAO 1**: Reducing the concentration of CPOIs in the channel sediments and floodplain soils/sediments would limit the amount of contaminants available for further transport.

- **RAO 2**: Reducing channel sediment and floodplain soil/sediment concentrations would directly reduce adverse ecological effects to the benthic community. In addition, reductions of CPOI concentrations would reduce adverse effects associated with direct exposure of humans, fish, and wildlife to sediments and soils, as well as adverse effects associated with bioaccumulation of CPOIs.

RG 3 – Fish Tissue

RG 3: Achieve CPOI concentrations, to the extent practicable, in fish tissue that are protective of humans and wildlife that consume fish.

RG 3 directly addresses RAO 2 by eliminating or reducing existing and potential future adverse ecological effects on fish and wildlife resources, as well as potential risks to humans. Quantitative fish tissue target concentrations were developed to protect wildlife and human health. It is expected that the achievement of these fish target concentrations will allow for individuals to consume fish at a higher rate than what is currently recommended under NYSDOH's fish consumption advisory for Onondaga Lake and its tributaries. (See text boxes on RGs in fish tissue to protect human health and ecological receptors [pages 41 and 42].) Site-specific BSQVs or NYSDEC sediment screening criteria to protect wildlife and humans from bioaccumulation were used as estimates of the concentrations in surface sediments and floodplain soils/sediments needed to reach acceptable target concentrations in fish tissue. (See text boxes on sediment quality values for channel sediments and floodplain soils/sediments to protect against bioaccumulation and direct contact [pages 44 and 45].)

Remediation Goals in Fish Tissue to Protect Ecological Receptors

Methylmercury was calculated to pose potential risks (*i.e.*, hazard quotients above 1) to piscivorous birds and mammals consuming fish from Geddes Brook and Ninemile Creek. RGs for mercury (as methylmercury) in fish tissue were developed for Geddes Brook and Ninemile Creek using risk-based methods, as there are no federal or New York State cleanup standards for mercury in fish to protect fish or wildlife.

The concentrations of methylmercury for the RGs for fish were calculated based on a hazard quotient of 1 for ecological receptors. The hazard quotients for ecological receptors were based on both the no-observed-adverse-effect level (NOAEL), representing the highest CPOI concentration at which no adverse effects are seen, and the lowest-observed-adverse-effect level (LOAEL), representing the lowest CPOI concentration shown to produce adverse effects. The RGs were calculated using the same exposure assumptions and toxicity values as the BERA.

Mercury fish tissue RGs range from 0.009 to 0.35 mg/kg ww, depending on the receptor species and whether the NOAEL or LOAEL is used to set the target hazard quotient. If only the LOAELs are used, the fish tissue RGs range from approximately 0.1 to 0.3 mg/kg ww.

The calculations for these values are presented in Section I.2 of Appendix I of the FS report.

Remediation Goals in Fish Tissue to Protect Human Health

Methylmercury and PCBs are bioaccumulative contaminants calculated to pose potential risks (*i.e.*, hazard quotients above 1) to humans consuming fish from Geddes Brook and Ninemile Creek. RGs for mercury (as methylmercury) and PCBs in fish tissue were developed for Geddes Brook and Ninemile Creek using risk-based methods. There are no federal or New York State human health cleanup standards for mercury or PCBs in fish.

The concentrations of methylmercury for the human health RGs for fish were calculated based on a hazard quotient of 1 for noncancer risk for humans (see the "Summary of Site Risks" section of this ROD). The human health hazard quotient of 1 for individual CPOIs indicates the "threshold level" below which noncancer effects are not expected to occur. The RGs were calculated using the same exposure assumptions and toxicity values as the HHRA.

Human health mercury target fish tissue concentrations range from 0.6 to 0.9 mg/kg ww for the reasonable maximum exposure (RME) scenario with the lower end of the range based on young children and the upper end of the range based on adults.

PCB target fish tissue concentrations based on cancer risk targets of 1×10^{-5} and 1×10^{-4} range from 0.11 to 1.1 mg/kg ww, respectively, for the RME scenario for adults. The target range for children (0.35 to 3.5 mg/kg ww) is slightly higher. The fish tissue target concentrations corresponding to a risk of 1×10^{-6} (0.011 mg/kg ww for adults to 0.035 mg/kg ww for children) may not be achievable since they are much lower than the mean background fish concentration (0.04 mg/kg) in U.S. waters. The target tissue concentrations for the RME scenario based on noncancer effects of PCBs (0.12 mg/kg ww for children to 0.19 mg/kg ww for adults) are within the range based on a cancer risk target of 1×10^{-5} (0.11 to 0.35 mg/kg ww).

Concentrations of PCDD/PCDFs for human health RGs for fish were also calculated based on cancer risks. RGs for noncancer effects could not be developed (see HHRA). PCDD/PCDF target fish tissue concentrations based on cancer risk targets of 1×10^{-5} and 1×10^{-4} range from 1×10^{-6} to 1×10^{-5} mg/kg ww, respectively, for the RME scenario for adults. The target range for children (5×10^{-6} to 5×10^{-5} mg/kg ww) is slightly higher. The fish tissue target concentrations corresponding to a risk of 1×10^{-6} (1×10^{-7} mg/kg ww for adults to 5×10^{-7} mg/kg ww for children) may not be achievable since they are much lower than the mean background fish concentration (8×10^{-7} mg/kg) in U.S. waters.

These concentrations assume that only a fraction of the fish consumed by an individual comes from Geddes Brook or Ninemile Creek due to the limited carrying capacity of these water bodies. The calculations for these values are presented in Section I.3 of Appendix I of the Geddes Brook/Ninemile Creek FS report (Parsons, 2005) and in Attachment A-2 of Appendix A of the OU1 Supplemental FS report (Parsons, 2008a).

It should be noted that EPA's National Recommended Water Quality Criterion for methylmercury, as measured in fish tissue, is 0.3 mg/kg. When both wildlife and human health fish tissue RGs for Geddes Brook/Ninemile Creek are considered, the overall range of Site-specific fish tissue RGs for mercury (*i.e.*, about 0.1 to 0.6 mg/kg using the LOAEL for wildlife and the RME for human health) encompasses the EPA criterion[12]. Fish tissue target concentrations for PCBs and PCDD/PCDFs are presented in the RGs in fish tissue to protect human health text box on page 42.

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12 The target fish tissue concentrations for mercury (0.1 and 0.3 mg/kg) are similar to the mean background concentration of mercury in fish of U.S. lakes and reservoirs (approximately 0.2 mg/kg; see Appendix G, page G-6 and Table G.1 of the Onondaga Lake FS [Parsons, 2004] and supplemental data through 2003 [EPA, 2005]). Target fish tissue concentrations based on the subsistence fisher consumption rate evaluated in the uncertainty section of the HHRA are not included since these concentrations would not likely be achievable without a reduction in background sources of mercury and would not be a representative measure of the effectiveness of Site remedial actions.

RG 4 – Surface Water

RG 4: Achieve, to the extent practicable, aqueous CPOI concentrations to meet surface water quality standards.

RG 4 directly addresses RAO 3 by eliminating or reducing levels of mercury and other CPOIs in surface water to meet surface water quality standards. Geddes Brook and Ninemile Creek currently meet most New York State surface water quality standards and guidelines (6 NYCRR Part 703). Numeric state surface water quality standards that are consistently not met in Geddes Brook and/or Ninemile Creek are those for aluminum, iron, mercury, and dissolved solids. The two lowest numeric state water quality standards for mercury are also periodically exceeded. The lowest standard, 0.7 ng/L as dissolved mercury for protection of human health via fish consumption, was exceeded in four of 29 surface water samples collected for the RI in 1998. These exceedances occurred in samples from two locations, one in lower Geddes Brook and one in the West Flume near the confluence with Geddes Brook. The samples collected from lower Geddes Brook (a sample and a field duplicate) had dissolved mercury concentrations of 1.3 and 1.4 ng/L. The two samples collected from the mouth of the West Flume had concentrations of 41.4 and 56.8 ng/L. The water quality standard to protect wildlife from exposure to mercury, 2.6 ng/L as dissolved mercury, was exceeded in only the two samples collected from the West Flume. It should be noted that the West Flume, which was sampled during the Geddes Brook/Ninemile Creek RI, has been remediated by Honeywell as part of the cleanup of the LCP Bridge Street subsite.

Narrative water quality standards for turbidity and suspended solids are periodically exceeded in both streams, and sporadic exceedances have been observed for several other CPOIs including thallium and chlorobenzene. For these constituents and other CPOIs, the reduction of CPOIs in Site-related contributions from contaminated sediments and soils is expected to result in the achievement of the New York State water quality standards. In addition, closure of the wastebeds would help to achieve narrative water quality standards, including the prohibitions for turbidity and for suspended, colloidal, or settleable solids.

Summary

The goals of the selected remedy are to achieve the RAOs and RGs as defined in this ROD. Per the NCP, the success or failure of the Geddes Brook/Ninemile Creek remedial program, as assessed every five years, will be based on the attainment of all RGs and cleanup levels.

Because of the importance of the Geddes Brook/Ninemile Creek ecosystem as a natural resource, the protection of habitat through remediation and corresponding restoration has been an important consideration in the development of the various dredging/excavation and capping alternatives. The goal of restoring productive aquatic and terrestrial (wetland) habitats in the Site has been considered throughout the analysis of the various alternatives, along with the need to provide an effective remedy. A Site-wide habitat restoration plan will be prepared during the remedial design.

Sediment Quality Values for Channel Sediments to Protect from Bioaccumulation and Direct Contact

Since a variety of dynamic factors affect contaminant levels in fish, bioaccumulation-based sediment quality values (BSQVs) were developed for Geddes Brook and Ninemile Creek to estimate the mercury concentrations in sediments associated with the fish tissue RGs. These BSQVs were derived to be protective of human health and the environment by reducing the potential for bioaccumulation from the sediments into fish. The first step entailed calculating site-specific biota-sediment accumulation factors (BSAFs) for fish fillets consumed by people and for whole fish consumed by wildlife using Geddes Brook and Ninemile Creek fish and surface sediment data. BSAFs for mercury were calculated by dividing the average contaminant concentration in fish tissue by the average contaminant concentration in sediments of lower Ninemile Creek.

The mercury RGs for fish based on human and wildlife fish consumption were divided by the BSAF to calculate the target concentration of mercury in sediments. The human health sediment target concentrations of mercury were calculated to be between 2.1 and 3.2 mg/kg for the RME scenario, depending on the receptor used (*i.e*., adult, older child, young child).

Mercury wildlife sediment RGs range from 0.08 to 2.0 mg/kg, depending on the receptor species and whether the NOAEL or LOAEL is used. Avian mercury target levels range from 0.1 to 2.0 mg/kg and mammalian target levels range from 0.08 to 0.8 mg/kg. The most sensitive ecological receptors, the mink and river otter, were used to calculate a LOAEL-based sediment target of 0.8 mg/kg. As this ecological-based target level was less than the low end of the human health target concentration range of 2.1 to 3.2 mg/kg (*i.e*., also protective of human health), 0.8 mg/kg was selected as the target BSQV for mercury to compare to post-remediation surface-weighted average sediment concentrations (SWACs). The bioaccumulation-based targets are applied on an area-weighted basis (*i.e*., by reach rather than point-to-point) since animals, such as fish, that bioaccumulate mercury and other bioaccumulative contaminants are not limited to a specific location of the Site.

A Site-specific BSQV was not calculated for PCBs, as discussed in Appendix A of the Supplemental FS (Parsons, 2008a). As discussed in the text of the ROD, NYSDEC's bioaccumulation-based sediment screening criteria (NYSDEC, 1999) were used for evaluation purposes. The NYSDEC wildlife bioaccumulation screening value for PCBs is 0.03 mg/kg based on 2.1% total organic carbon (TOC). The NYSDEC screening value for human health bioaccumulation for PCBs is below the detection limit at the Site and was therefore not used for evaluation purposes.

A Site-specific BSQV was also not developed for hexachlorobenzene since the NYSDEC sediment screening criterion (NYSDEC, 1999) to protect wildlife from bioaccumulation was used as the comparison value for hexachlorobenzene. This value is 0.25 mg/kg based on 2.1% TOC. PCDD/PCDFs exceeded NYSDEC bioaccumulation screening criteria at only three of the 194 locations sampled. These locations would be remediated based on concentrations of other contaminants (*e.g.*, mercury) detected. Therefore, RGs for PCDD/PCDFs in sediments were not developed.

Target concentrations for dermal exposure pathways were derived by adjusting concentrations of the CPOIs identified to result in a cumulative risk estimate of 1×10^{-5} (specifically, 1.49×10^{-5}) for all CPOIs. In these calculations for human health-based sediment concentrations for direct contact, a cumulative risk target of 1×10^{-5} (which is the midpoint of the risk range considered in CERCLA HHRAs) was applied. The remaining CPOIs were conservatively assumed to remain unchanged, although remedial methods to address any given CPOI would likely reduce concentrations of all chemicals present. Within the project area, benzo(a)pyrene had the largest contribution to the risk estimates. Remedial methods that address benzo(a)pyrene would also be expected to be effective with additional co-located PAHs. The RG to protect from direct exposure to sediments/soils is 1.3 mg/kg of benzo(a)pyrene.

The calculations for these values are presented in Sections I.4 and I.5 of Appendix I of the FS report and in Attachment A-2 of Appendix A of the OU1 Supplemental FS report (Parsons, 2008a).

Sediment Quality Values for Floodplain Soils/Sediments to Protect from Bioaccumulation and Direct Contact

BSQVs that are protective of human health and the environment were also developed for mercury, benzo(a)pyrene (representing PAHs), and hexachlorobenzene in Geddes Brook/Ninemile Creek floodplain soils/sediments.

To protect wildlife that consume terrestrial invertebrates, the first step of BSQV development entailed modeling rates of mercury accumulation in terrestrial invertebrates based on a transfer factor derived from the literature. The target concentration was then calculated using receptor-specific data and toxicity values. The LOAEL-based mercury RG to protect the most sensitive ecological receptor, the short-tailed shrew, was calculated to be 0.6 mg/kg.

A target concentration of 0.25 mg/kg was established for hexachlorobenzene to be protective of wildlife based on NYSDEC's bioaccumulation-based sediment screening criterion. See text box above entitled "Sediment Quality Values for Channel Sediments to Protect from Bioaccumulation and Direct Contact."

To protect recreational visitors that may contact sediments, the benzo(a)pyrene direct contact-based value of 1.3 mg/kg calculated for channel sediments was also selected for floodplain soils/sediments, as the exposure assumptions were the same for both media.

The calculations for these values are presented in Sections I.4 and I.5 of Appendix I of the FS report and in Attachment A-2 of Appendix A of the OU1 Supplemental FS report (Parsons, 2008a).

DESCRIPTION OF REMEDIAL ALTERNATIVES

General

CERCLA §121(b)(1), 42 U.S.C. §9621(b)(1), mandates that remedial actions must be protective of human health and the environment, comply with ARARs, be cost-effective, and utilize permanent solutions, alternative treatment technologies, and resource recovery alternatives to the maximum extent practicable. Section 121(b)(1) also establishes a preference for remedial actions which employ, as a principal element, treatment to permanently and significantly reduce the volume, toxicity, or mobility of the hazardous substances, pollutants, and contaminants at a site. CERCLA §121(d), 42 U.S.C. §9621(d), further specifies that a remedial action must attain a level or standard of control of the hazardous substances, pollutants, and contaminants, which at least attains ARARs under federal and state laws, unless a waiver can be justified pursuant to CERCLA §121(d)(4), 42 U.S.C. §9621(d)(4) (see the nine evaluation criteria listed below in the "Comparative Analysis of Disposal Options and Remedial Alternatives" section of this ROD).

The media of concern for remediation at the Site are channel sediments and surface water, and floodplain soils/sediments. Alternatives that specifically address these media were developed in the Geddes Brook/Ninemile Creek FS report (Parsons, 2005) and Geddes Brook/Ninemile Creek OU2 Supplemental FS report (Parsons, 2009). Specific areas of the Site which exhibit different characteristics that are important to the development of remedial alternatives are presented in Figure 10. This figure also shows the station markers for lower Ninemile Creek. The channel sediments between Stations 0+00 and 3+00 (lower 300 ft [90 m]), which are downstream of Reach AB, are being addressed under the Onondaga Lake remedy.

The Geddes Brook/Ninemile Creek FS report evaluated a variety of remedial alternatives for both channel sediments and floodplain soils/sediments, using combinations of removal to various depths, isolation capping, backfilling, and habitat layer placement, to meet a range of PRGs. Permutations of the channel and floodplain alternatives were then further combined to assemble Site-wide alternatives. As described in the Geddes Brook/Ninemile Creek OU1 and OU2 Supplemental FS reports, a number of Site investigations and assessments have been conducted since the submittal of the FS report, which have resulted in a better understanding of Site features and physical and ecological conditions. In consideration of the recent investigations and assessments, and to facilitate a more focused evaluation of alternatives, the OU2 Supplemental FS report and this ROD evaluate four alternatives: three representative alternatives from the FS report (updated to reflect the recent Site information) and a new alternative (based on the recent Site information). Also, while the FS report presented and evaluated alternatives separately for channel and floodplain areas, the alternatives in the OU2 Supplemental FS report and this ROD reflect coordinated activities for channel and floodplain areas to facilitate a focused evaluation.

With the exception of the “no action” alternative, all of the alternatives included in this ROD involve some combination of the following remedial technologies, which are described on the following pages:

- Dredging/excavation to remove contaminated channel sediments.
- Excavation to remove contaminated floodplain soils/sediments.
- Consolidation and disposal in the containment area at Honeywell’s LCP Bridge Street subsite and/or the SCA that will be constructed at Wastebed 13 as part of the remediation of the Onondaga Lake Bottom subsite. The FS report and OU2 Supplemental FS report also evaluated disposal at a New York State commercial landfill which is not in the vicinity of Onondaga Lake (see discussion below).
- Water treatment.
- Isolation capping of channel sediments.
- Backfilling.
- Installation of habitat layer.

Each of the action alternatives also includes wetland and stream restoration. Any wetland habitat that is disturbed as a result of remedial action would be restored. In instances where restoration is not feasible, actions such as wetland mitigation would be required. The design and construction of restoration elements must be consistent with the substantive requirements for permits associated with disturbance to state- and federal-regulated wetlands (*e.g.*, 6 NYCRR Part 663, Freshwater Wetlands Permit Requirements) and navigable waters (*e.g.*, 6 NYCRR Part 608, Use and Protection of Waters). The details would be developed during the remedial design, as part of a habitat restoration plan for the Site.

The alternatives proposed for the Site are based on a variety of and, in some cases, a combination of technologies. Therefore, the section on technologies (below) is presented before the “Description of Geddes Brook/Ninemile Creek Operable Unit 2 Remedial Alternatives” section so that the alternatives may be clearly understood.

Technologies

Removal of Contaminated Channel Sediments (Dredging/Excavation) and Floodplain Soils/Sediments (Excavation)

Channel Sediments (Dredging/Excavation)

Removal of channel sediments can be accomplished in a submerged aqueous environment using hydraulic and/or mechanical dredging equipment or in a “dry” environment using more conventional upland construction equipment to excavate sediments after water has been drained and diverted.

Dredging and/or excavation at the Site would involve removal of contaminated channel sediments from lower Ninemile Creek to a depth that achieves a specified residual contaminant concentration (less than RGs) or enables installation of a cap and habitat layer. It should be noted that lower Geddes Brook sediments will be excavated down to the underlying clay layer as part of the Geddes Brook IRM (for a detailed discussion of the Geddes Brook IRM, see the “Honeywell Facilities and Disposal Areas near Geddes Brook/Ninemile Creek” section of the OU1 ROD).

Sediments can be dredged hydraulically, mechanically, or by a combination of the two. Mechanical dredging was selected as the representative process for detailed evaluation in the FS report for estimating costs; however, the actual dredging and excavation methods would be determined during design. The type of dredging/excavation to be performed would likely depend on the Site-specific area and stream reach conditions. Any requisite stream bank removal (for cap construction or contaminant excavation) would be performed using on-shore mechanical excavation.

The remedial design will need to evaluate appropriate roadway and bridge structural stability and safety-related considerations. These considerations may impose limitations on the depths and footprints of removal in the vicinity of transportation structures.

Floodplain Soils/Sediments (Excavation)

Excavation at the Site would involve removal of floodplain soils/sediments from along lower Ninemile Creek to various depths. As discussed below, after removal, backfilling and placement of a habitat layer would occur to appropriate ground elevations to provide terrestrial or wetland habitat, as part of a habitat restoration plan for the Site. It was assumed for the FS report and this ROD that floodplain soils/sediments would be removed using standard construction techniques such as backhoes and excavators.

Disposal

Sediment dredging and soil excavation projects require land areas for operations support and materials management (which includes dewatering, water treatment, solids staging and loading, and final disposal) of the dredged/excavated sediment and soil. Typically, the dredged/excavated material from a remediation project is either consolidated in an on-site disposal location (with treatment, if required) if sufficient land area is available or is transported off-site for treatment or disposal.

The assessment of various land disposal options included consolidating excavated materials within the containment system at Honeywell’s nearby LCP Bridge Street subsite and/or the SCA that will be constructed at Wastebed 13 as part of the remediation of the Onondaga Lake Bottom subsite, and disposing of excavated materials at an existing permitted landfill in the Rochester, New York, area. The estimated costs for these disposal options are included in the descriptions of alternatives below.

Water Treatment

Dredging/excavating, dewatering, and sediments handling can generate significant volumes of water. Transport and off-Site treatment of this water was evaluated for each of the remedial alternatives in the FS report. However, the OU2 Supplemental FS report demonstrated that on-Site treatment, at a location in the vicinity of the Site, and discharge of water would be more cost-effective and efficient. The actual location of treatment would be determined as part of the remedial design. On-Site treatment and discharge of waters generated by the excavation of contaminated sediments and soils is assumed, for the purpose of the OU2 Supplemental FS report, to be similar to the temporary treatment system used at the LCP Bridge Street subsite, which consisted of pH adjustment equipment, a clarifier tank, bag filters, sand filters, and a granular activated carbon (GAC) and/or sulfur-impregnated GAC filtration system. Estimated equipment and operating costs for the temporary system are based on the system used at LCP. The treated water may be released back to the Geddes Brook/Ninemile Creek watershed in accordance with discharge requirements to be determined by NYSDEC, or managed in another way determined to be acceptable to NYSDEC.

Placement of Clean Materials (Channel and Floodplain)

The placement of clean material is included in all of the action alternatives developed for the Site. There are several purposes for placing clean materials over the Site, including to restore the natural elevations in the floodplain, to prevent potential adverse exposure to residual contaminated channel sediments and floodplain soils/sediments by human and ecological receptors, to provide habitat for wetland and upland species (*e.g.*, through vegetative cover), and to provide stable slopes and stream banks.

Depending on location, as described further in this ROD, these clean materials would consist of one or more of the following layers, from the surface down:

- Habitat Layer: Clean material designed to provide the proper conditions for animal and plant communities to grow. This layer is assumed in this ROD to be a minimum of 2-ft (60-cm) thick, unless otherwise noted. The type of substrate would be determined during design and might include a variety of materials in the stream and floodplain.

- Backfill: Soils used to bring the sediment or ground surface to an appropriate elevation below the habitat layer but not necessarily proper material for habitat (*e.g.*, inappropriate grain size, or organic content).

- Isolation Cap: Clean sand or other suitable clean material designed to isolate the habitat layer from underlying residual contamination in areas where contaminant transport via sediment porewater is a concern (*i.e.*, the stream channel or wetlands).

- Sand Base Layer: Where an isolation cap is not needed, a sand base layer (called a mixing layer if under an isolation cap), which is a relatively thin layer of sand, would be placed on top of the underlying sediments (or backfill) prior to placement of the habitat layer. A sand layer would prevent clay or silt particles from migrating into the habitat layer above it, and would provide the added benefit of attenuating residual contamination that may remain after dredging.

Where dredging/excavating results in removal of all significant contamination in the stream or floodplain, the area would be backfilled to bring the sediment or ground surface up to the designed elevation, if needed, and a habitat layer would be placed.

In floodplain areas, the area would be backfilled to bring the ground surface up to the designed elevation, if needed, and a habitat layer would be placed on top of the backfill. Unlike the channel areas where residual contamination could migrate upward due to diffusion and advection of porewater, a separate isolation cap may not be needed to isolate residual contamination at depth if residual contamination remains below the depth of removal within the floodplain.

In the development of the floodplain alternatives, the potential for CPOI upwelling in the floodplain was determined not to be significant since groundwater is typically at a depth of 6 inches (15 cm) or more below the ground surface in the SYW-10 wetland. In addition, portions of this wetland area are inundated at times from high lake and stream levels. However, due to limited available data, additional data would be obtained during the remedial design to assist with determining if upwelling is a significant concern in the floodplains. If it is determined during design that there is upwelling in certain areas of the wetlands or floodplains, then deeper removal of contaminated soils/sediments (beyond that required in the alternative selected) and/or placement of an isolation cap may be needed prior to placement of the habitat layer to prevent unacceptable migration of contamination by groundwater.

The use of clean materials for the purposes of isolation capping, habitat restoration, and backfilling is discussed further below.

Isolation Capping of Channel Sediments

Isolation capping involves placement of an engineered cap on top of post-excavation, residual contaminated sediments to meet the following objectives:

- Provide physical isolation of the contaminated sediments from benthic organisms and other animals and human contact.
- Physically stabilize the sediments to prevent resuspension, contaminant mobilization, and sediment transport.
- Provide chemical isolation of contaminated sediments from advective or diffusive flux into the overlying surface waters.

Specific factors that would be evaluated as part of the design of the engineered cap include erosion, groundwater upwelling, bioturbation, chemical isolation, habitat protection, settlement, static and seismic stability, and placement techniques. The Geddes Brook/Ninemile Creek FS and Geddes Brook/Ninemile Creek OU1 and OU2 Supplemental FS reports included preliminary evaluations of many of these factors.

The isolation cap, if included as a component of the selected remedy, would be constructed following removal of contaminated sediments and would consist of as many as three layers, each of which would serve a specific purpose; a mixing layer, a chemical isolation layer, and an armor (erosion) layer. A habitat layer would be placed above the isolation cap as well as in areas dredged/excavated where an isolation cap would not be needed.

Mixing Layer

The first layer of the engineered cap on top of residual contaminated sediments that remain following removal is referred to as the mixing layer, which accounts for mixing of the cap material with the underlying sediments and uneven application during cap placement. A layer of substrate would be placed as a mixing layer where required. The actual thickness of the mixing layer, if an isolation cap is necessary, would be determined during design.

Chemical Isolation Layer

Above the mixing layer is the chemical isolation layer which "isolates" contaminants in the sediments below the cap. The chemical isolation layer would be a minimum of 1-foot (30-cm) thick. The thickness of the chemical isolation layer is determined based on computer modeling, such that concentrations of contaminants within the sediments beneath the cap do not result in unacceptable levels of exposure to aquatic life at the surface of the cap (which assumes that the cap thickness does not decrease over time [*i.e.*, does not erode]). During the design phase (if isolation capping is part of the selected remedy), the isolation capping model would be rerun as needed based on additional field data to be collected and cap thicknesses and/or removal depths would be revised as appropriate. However, based on practical considerations of constructing an engineered cap in a stream environment and for long-term effectiveness, the thickness of the isolation layer would be designed to be no less than 1 ft (30 cm).

Modeling for chemical isolation performed during the FS and OU2 Supplemental FS was used to calculate the maximum allowable CPOI sediment concentrations that can remain beneath the isolation layer of the cap without resulting in unacceptable levels at the base of the habitat (surface) layer of the cap at 1,000 years or steady state[13] (whichever happens first), from chemical upwelling, diffusion, or other transport processes (see the text box entitled "Isolation Capping Model" on page 51). The point of compliance being at the base of the habitat layer is intended to ensure that the isolation portion of the cap is effective in preventing unacceptable concentrations of contaminants (*i.e.*, concentrations greater than the lowest RG for mercury of 0.15 mg/kg and RGs for other CPOIs) from entering the habitat restoration layer.

[13] Steady state is the point at which the chemical concentrations within the isolation layer would reach their maximum predicted values. The period of time to achieve steady state could be less than or greater than 1,000 years.

Isolation Capping Model

A model was developed to assess the effectiveness of in-situ isolation capping of the channel sediments of Ninemile Creek OU2 and to estimate the maximum CPOI concentrations that can remain in the sediments beneath the cap without resulting in an exceedance of the RG concentrations at the top of the cap due to chemical upwelling, diffusion, or other transport processes. In-situ capping involves placement of an engineered cap over contaminated sediment to prevent or limit the movement of contaminated porewater from the sediment into the water column and minimize exposure of benthic organisms to the contaminated sediments. The placement of an isolation cap, if needed, would include the following:

1. A mixing layer, designed to address the mixing of underlying sediments with the cap material during placement, as well as uneven placement.
2. An isolation layer, designed to prevent or limit vertical chemical migration.
3. An armor layer, designed to protect the isolation layer from erosional processes such as channel flow and ice scour.
4. A habitat layer, designed to provide habitat for fish and benthic macroinvertebrates and allow for bioturbation processes without exposure to contaminated sediment or disruption of the isolation layer material.

This model assumes that the cap is armored, so that erosion of the cap is minimal and does not provide the primary means of contaminant migration.

During the FS, a steady-state cap model was run using an iterative approach to estimate maximum allowable sediment concentrations for key CPOIs for a range of isolation layer thicknesses up to 2 ft (60 cm). These sediment concentrations were then used in each alternative to identify deeper remediation areas necessary for cap effectiveness. The model is discussed in detail in Appendix H of the Geddes Brook/Ninemile Creek FS report.

During the OU2 Supplemental FS, a transient cap model was run at 1,000 years to estimate an appropriate isolation layer thickness assuming varying sediment concentrations for mercury, PCBs, hexachlorobenzene, benzo(a)pyrene, and phenol. As discussed in the OU2 Supplemental FS, an upwelling velocity of 100 cm/yr was assumed for Reach AB. Detailed modeling results are provided in Appendix E of the OU2 Supplemental FS report, and the results are summarized below.

- Within Reach AB, an isolation layer thickness of 1.25 ft (38 cm) would result in attainment of the RGs for mercury, PCBs, hexachlorobenzene, benzo(a)pyrene, and phenol.

A preliminary estimate of the groundwater upwelling velocity in Reach AB (*i.e.*, 100 cm/year) was used in the isolation capping model. Preliminary modeling indicates that the isolation cap, if required in Reach AB, would need to be 1.25 ft (38 cm) thick. If isolation capping is part of the selected remedy, during the design phase, additional field data would be collected to verify the estimated groundwater upwelling velocity, and the isolation capping model would be rerun as needed (should isolation capping be a component of the selected remedy) and cap thicknesses and/or removal depths would be revised as appropriate.

As discussed in the OU2 Supplemental FS report, a final determination of model applications and input assumptions would be made during the design based on available data and the selected remedial approach for the Site. In general, chemical isolation layer designs should be based on an appropriate level of conservatism in the selection of design parameters to address uncertainties. A buffer (or safety) layer is also an approach that can be used to address uncertainties surrounding selection of design parameters. The need for a buffer layer would be determined during design based on the selected remedial approach and on an assessment of the design investigation data.

Armor (Erosion) Layer

An armor or erosion control layer (*e.g.*, gravel) would be included in the cap design/construction above the chemical isolation layer. Erosion mechanisms can be classified into two distinct categories based on sediment bed properties, cohesive sediments (fine-grained with clay particles which tend to bind the sediment particles together) and non-cohesive (larger particles such as sand or gravel which do not interact with each other). Cohesive sediments (*e.g.*, the silts and Solvay wastes in the stream) tend to resist erosion better than would be predicted from their size alone because of their binding action, but once the channel flow reaches the critical water velocity, deposits of cohesive sediments tend to erode out quickly and completely. The particles of sand in non-cohesive sediments (*e.g.*, the sand that would be used in the isolation layer of the cap) would be eroded out of the stream bed as individual particles at their critical water velocities, with the water removing the smaller particles first and leaving larger particles behind. Each deposit of non-cohesive sediments would erode until a layer of larger stone is either encountered or is produced by the current removing smaller grains until only particles larger than the critical size remain. Such a layer would then effectively guard (armor) the sediments below it from any further erosion.

In order to assess the potential for erosion, the USACE's HEC-RAS flood velocity model was run by Honeywell for lower Ninemile Creek, with results indicating that much of the channel is erosional under high-flow conditions and that an armor layer would be required to prevent erosion of the underlying chemical isolation layer under base flow and flood events (see text box entitled "Flood Flow Model" on page 53). An armor layer would be placed beneath the habitat layer, where necessary, to further protect the underlying chemical isolation layer of the cap against erosion from high flows and ice scour. Specific details of the cap configuration, including the thicknesses of each layer, would be determined during the remedial design. It was assumed for the FS report (Parsons, 2005) that the sediment cap would include a 0.5-ft (15-cm) thick erosion protection layer. For the OU2 Supplemental FS report (Parsons, 2009), the combined thickness of the armor layer and habitat layer (see below) was assumed to be 2 ft (60 cm). A determination of the final thickness of the armor layer and whether a portion of the armor layer could be incorporated into the habitat layer would be made during design.

Habitat Layer

A habitat layer would be placed throughout the remediated area whether or not an isolation cap is present.

Where an isolation cap is required, the habitat layer would be placed above the chemical isolation and armor layers. In the aquatic areas (streams and wetlands), the overlying habitat layer would be designed to be compatible with local benthic and other aquatic life forms and would provide suitable substrate to establish aquatic vegetation, where appropriate. In the floodplain areas, the habitat layer would be of sufficient thickness to protect burrowing animals from being exposed to contaminated soils/sediments at depth.

A minimum of 2 ft (60 cm) of clean soil or other suitable material, as determined during design, would be used as the habitat layer in channel and floodplain areas of lower Ninemile Creek where CPOIs exceeding the RGs remain in the residual soils/sediments. The goal for the concentrations of this clean material for mercury, other CPOIs, and other constituents would be NYSDEC's sediment criteria (including the LEL of 0.15 mg/kg for mercury) in sediments and 6 NYCRR Part 375 unrestricted use soil cleanup objectives (including the objective of 0.18 mg/kg for mercury) in soil. Clean soil would include imported fill materials from off-Site sources.

Flood Flow Model

The HEC-RAS flood model Version 3.1 was used to evaluate hydraulic effects of the remedial alternatives. Model simulations were conducted to provide data on the extent of flooding within the Geddes Brook and Ninemile Creek channels and floodplains and flow velocities, depths, and shear stresses associated with various storm events. These data were then used to evaluate the stability of various substrates (with different thicknesses and sediment type) and channel alignments.

The term "erosion" refers to the ability of the channel sediment to be eroded or moved by flowing water. Sediments will erode when the stream velocity exceeds the critical velocity for moving or eroding sediment particles. The size of the material used as the armoring layer (if required above the isolation layer) must be able to withstand erosive forces associated with the 100-year storm event. In addition, the habitat layer should be able to withstand certain storm conditions, although some of this layer may erode and become re-deposited, which is natural in streams.

The model included lower Ninemile Creek from Onondaga Lake to the confluence with Geddes Brook, and lower Geddes Brook from the confluence with Ninemile Creek to the confluence with the West Flume. Based on results, the material used for the armoring layer could be comprised of either graded gravel or riprap. The modeling effort is discussed in detail in Appendix D of the OU1 and OU2 Supplemental FS reports.

The HEC-RAS model would be updated during design based on detailed bathymetric and topographic surveys to be conducted throughout the Site. This updated model would be used during remedial design to ensure that the remedy is protective and stable and meets requirements for protection of existing infrastructure and floodplain areas (*i.e.*, no adverse increase in water elevations or extent of flooding as compared to existing conditions).

The actual make up of the habitat layer would be determined during the design. The intention of the habitat layer is to provide the substrate necessary for the restoration of a diversity of habitats throughout the stream corridor. The habitat layer will consist of clean materials, the contents of which will depend on the final habitat goals for the section of the Site. The substrate organic content, grain size and distribution, thickness, and placement may vary depending on the location within the Site. The expected forces of any erosional events on the habitat layer will have to be considered during design. The habitat layer may also be influenced by the species of biota that will be expected in the area after remediation. The placement of large habitat or stream structures, such as boulders, woody debris, or flow diversions, would be considered in the design of the habitat layer.

Overall, natural stream restoration techniques would be used in designing both the channel remedy and the habitat layer with the goal of creating a diversity of stream and near-stream habitats and minimizing hardening of the channel and banks, to the extent feasible. To the greatest extent possible and if applicable, the existing pool and riffle habitats would be restored within the stream. The details of the habitat layer would have to meet the substantive requirements of 6 NYCRR Part 608.

A habitat restoration plan would be developed as part of the remedial design, and would include a determination of the final thickness and substrate of the habitat layer as well as planting plans and specifications, including the species composition of any plantings or seed mixes (*e.g.*, species native to floodplain forests of the northeast).

Backfilling in Removal Areas

There are several potential reasons for backfilling in the remedial area without the need for a fully engineered isolation cap, including restoration of surface topography after removal, stabilizing slopes, and creating desirable habitat features. Backfilling would include the use of soils to bring the sediment or ground surface to an appropriate elevation below the habitat layer, but these soils would not necessarily consist of appropriate material for habitat (*e.g.*, inappropriate grain size, or organic content).

GEDDES BROOK/NINEMILE CREEK OPERABLE UNIT 2 REMEDIAL ALTERNATIVES

For the action alternatives, the cleanup criteria are based on the RGs developed for the Site (see the "Remedial Action Objectives and Remediation Goals" section of this ROD). As discussed therein, screening of CPOIs identified in the RI report, which included COCs and COPCs from the BERA and HHRA, was conducted in the FS, and based on those results, quantitative PRGs were developed for the following CPOIs: mercury, arsenic, lead, total PAHs, benzo(a)pyrene, PCBs, hexachlorobenzene, and phenol. These PRGs address both direct toxicity and bioaccumulation impacts on human health and the environment, including fish tissue and surface water exposure pathways. For mercury, the sediment toxicity RG concentrations ranged from 0.15 to 2 mg/kg. For this ROD, these PRGs are selected as the RGs. RG concentrations for mercury and the other CPOIs are presented in the text boxes in the "Remedial Action Objectives and Remediation Goals" section of this ROD. Calcite was also determined to be a stressor of concern in the BERA. Alternatives in the OU2 Supplemental FS report and this ROD do not explicitly include the removal of visible calcite (ionic waste), but all of the action alternatives would improve the benthic substrate as a by-product of removal (based on CPOIs) and/or placement of a clean habitat layer above sediments/soils within the remedial areas.

The OU2 Supplemental FS report and this ROD evaluate four alternatives for Reach AB of Ninemile Creek. One of these alternatives (Alternative 1) calls for no action and the other three alternatives call for varying amounts of excavation, backfilling, and placement of a clean habitat layer within the stream channel and floodplains. Table 12 presents a summary of the four alternatives. Detailed descriptions of each of the four alternatives follow:

Alternative 1 – "No Action"

The Superfund program requires that the "no action" alternative be considered as a baseline for comparison with the other alternatives. The "no action" remedial alternative for channel sediments and floodplain soils/sediments does not include any physical remedial measures that address the contamination at the Site.

Because this alternative would result in contaminants remaining on-Site above levels that allow for unlimited use and unrestricted exposure to Site media, CERCLA requires that the Site be reviewed at least once every five years. If justified by the review, remedial actions may be implemented to remove, treat, or contain the contaminated sediments and floodplain soils/sediments.

Alternative 1 (Ninemile Creek Reach AB)

Dredged/Excavated Volume (cy):	0
Mercury Mass Removed (pounds):	0
Capital Cost:	$0
Average Operation and Maintenance (O&M) Annual Costs:	$0
Present-Worth O&M Costs:	$0
Present-Worth Cost:	$0
Construction Time:	0 years

Alternative 2 – Removal of contaminated Ninemile Creek channel sediments in Reach AB to a depth to meet criteria (1.3 mg/kg mercury and RGs for other CPOIs) in the channel and removal of contaminated floodplain soils/sediments where concentrations exceed 1.3 mg/kg mercury (and RGs for other CPOIs) to a depth of 2 ft (60 cm) in the floodplain, followed by placement of backfill and a habitat layer in the channel and floodplain

The specific components of this alternative, as shown in Figure 11, include:

- **Ninemile Creek Channel:** Remove channel sediments with mercury concentrations exceeding 1.3 mg/kg and other non-mercury CPOIs exceeding RGs. It is anticipated that the removal, where needed, would average 2 ft (60 cm), with a maximum depth of about 3 ft (90 cm). Backfill areas of removal and place a 2-ft (60 cm) habitat layer. A 0.5-ft (15 cm) sand base layer would be installed below the habitat layer to provide support for it and to prevent clay or silt particles from migrating into it. The base layer would also provide the added benefit of attenuating residuals that may remain after dredging. Removal of channel sediments and restoration of the stream would allow for passage of flood flows under existing upstream infrastructure (*e.g.*, bridges) and ensure no adverse increases in water elevations, extent of flooding, and erosion potential in accordance with applicable requirements, and would provide sufficient water depth for fish passage and canoe access. Based on available data, it is not anticipated that a chemical isolation layer would be needed following this removal since mercury concentrations are less than 1.3 mg/kg at depths below 3 ft in the Reach AB channel. If additional data are collected during design that are not consistent with this current understanding of the Site, a chemical isolation layer may be required following this removal.

- **Ninemile Creek Floodplain:** Remove up to 2 ft (60 cm) of floodplain soil/sediment with mercury concentrations exceeding 1.3 mg/kg and other non-mercury CPOIs exceeding RGs. Place up to 2 ft (60 cm) of vegetated habitat layer in areas where soil/sediment had been removed and restore delineated wetlands and other habitats. For the portion of the floodplain adjacent to I-690, restore the area with trees and shrubs as feasible, based on the presence of the structural stone, to create a riparian buffer and to screen recreational users of the stream from I-690. In the portion of the floodplain adjacent to the Wastebeds 1 through 8 site, restore the area with trees and shrubs as feasible to create a riparian buffer.

This alternative includes the removal of an estimated 23,000 cy (18,000 m^3) of contaminated sediment and soil over an area of approximately 10.8 acres (4.4 hectares) within and along Reach AB. It is estimated that this dredging and excavation would result in the removal of about 430 pounds (195 kg) of mercury from Ninemile Creek (or about 63 percent of the estimated total mercury mass in Reach AB).

Removal areas for Alternative 2 are shown in Figure 14 for channel areas and Figure 15 for floodplain areas.

The contaminated sediments and soils that are removed from the stream and floodplains would be disposed of in the containment area at the LCP Bridge Street Subsite containment system and/or the SCA (Option A) or an existing permitted landfill in the Rochester, New York, area (Option B).

It is estimated that the dredging/excavating, backfilling, and habitat layer placement components of this alternative, along with dewatering, water treatment, and transport/disposal of sediments and soils would take one year.

If residual contamination remains beneath the habitat layer in any areas following the implementation of this alternative at levels above that which would allow for unlimited use or unrestricted exposure, an institutional control, such as an environmental easement or some other appropriate mechanism which would include restrictions on dredging/excavating in these areas, would be needed.

Under this alternative, it would be certified on an annual basis that O&M is being performed. If an institutional control is implemented under this alternative, it would be certified on an annual basis that the institutional control is in place.

Because this alternative would result in contaminants remaining on-Site above levels that would permit unlimited use and unrestricted exposure to Site media, CERCLA requires that the Site be reviewed at least once every five years. If justified by the review, additional remedial actions may be implemented to remove, treat, or contain the contaminated sediments and floodplain soils/sediments.

Alternative 2 (Ninemile Creek Reach AB)

Dredged/Excavated Volume for Disposal (cy):	23,000
Mercury Mass Removed (pounds):	430
Capital Cost:	$8,600,000
Average O&M and Periodic Annual Costs:	$105,000
Present-Worth O&M and Periodic Costs:	$1,300,000
Present-Worth Cost:	$9,900,000
Construction Time:	1 year

Note: For cost estimating purposes, the costs above are based on disposal in the containment area at the LCP Bridge Street subsite (Option A). The costs for disposal at the SCA are likely to be similar. For disposal at a facility not in the vicinity of Onondaga Lake (Option B), the costs are based upon utilizing a facility in the Rochester, New York area. The estimated cost for this disposal is $12.6 million.

Alternative 3 – Removal of Ninemile Creek channel sediments and floodplain soils/sediments in Reach AB to various depths and placement of backfill and habitat layer

This alternative provides for more removal of contaminated channel sediments and floodplain soils/sediments at generally a greater depth, and a greater footprint than Alternative 2, based on limits defined by physical features (*e.g.*, horizontally to breaks in grade or wetland boundaries; vertically to stone where present on the banks or marl where present in the channel). Within the remedy footprint, this alternative would address the RAOs and RGs for mercury and other CPOIs.

Specific components of this alternative, as shown in Figure 12, are summarized below. Because Alternative 3 tailors the remedial approach to specific areas of the Site, the summary below includes separate discussions corresponding to specific areas of the Ninemile Creek channel and floodplain.

Channel Areas

- **Ninemile Creek Reach AB Channel Lower 1,600 ft (500 m)** (*i.e.*, station 3+00 to station 19+00 [see Figure 10 for the location of these stations]): In this portion of Reach AB, a natural formation of uncontaminated marl (with mercury concentrations typically less than 0.15 mg/kg) is present. For the full area of the channel in this portion of Reach AB (*i.e.*, bank-to-bank), remove sediment overlying the native marl layer and a portion of the marl, as necessary, to eliminate the need for an isolation cap and to allow for restoration of the stream, including the installation of a sand base layer (0.5 ft [15 cm]) and habitat layer (2 ft [60cm]).

- **Ninemile Creek Reach AB Channel Upper 1,100 ft (340 m)** (*i.e.*, station 19+00 to station 30+00 [see Figure 10 for the location of these stations]): For the full area of the channel in this portion of Reach AB (*i.e.*, bank-to-bank), remove approximately 2.5 ft (75 cm) of sediment to eliminate the need for an isolation cap and to allow for restoration of the stream, including the installation of a sand base layer (0.5 ft [15 cm]) and habitat layer (2 ft [60 cm]).

For both sections of the Reach AB channel, removal of channel sediments and restoration of the stream would allow for passage of flood flows under existing upstream infrastructure (*e.g.*, bridges) and ensure no adverse increases in water elevations, extent of flooding, and erosion potential in accordance with applicable requirements, and would provide sufficient water depth for fish passage and canoe access.

The sand base layer noted above would be installed below the habitat layer to provide support for it and to prevent clay or silt particles from migrating into it. The base layer would also provide the added benefit of attenuating residuals that may remain after dredging. Based on available data related to lithology and the concentrations of contaminants at the Site, removal of sediments to a depth of 2.5 ft (75 cm) or into marl could be conducted in one dredging pass and would result in concentrations of residuals (generally less than 0.3 mg/kg of mercury; see Appendix C of the OU2 Supplemental FS) that would not require a chemical isolation layer[14].

The final channel restoration plan and profile would be determined during design, and would include microtopography and other features to the extent feasible, to restore in-stream habitat under varying flow conditions.

Floodplain Areas

- **Ninemile Creek Floodplain Adjacent to I-690:** Remove all floodplain soil/sediment (1 ft [30 cm] typical) overlying structural stone between the Ninemile Creek waterline and the break in grade at the top of the bank. Restore removal areas with approximately 1 ft (30 cm) of vegetated habitat layer from the waterline to the break in grade and restore the vegetation in the area including trees and shrubs, as feasible, based on the presence of structural stone, to create a riparian buffer.

- **Ninemile Creek Floodplain Adjacent to Wastebeds 1 through 8:** Remove floodplain soil/sediment to approximately 2 ft (60 cm) below existing grade between the Ninemile Creek waterline and the break in grade associated with the toe of the wastebeds, which

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[14] One of the design goals for this portion of Ninemile Creek will be to minimize, via sediment removal, the areal extent of stream channel where an isolation layer will be required. Based on the available data, it appears that the vertical distribution of mercury (that would warrant an isolation cap) in Reach AB is generally limited to the top 2 to 3 ft of stream sediments. A Pre-Design Investigation (PDI) will be performed to gather additional channel sediment data from Reach AB. The data will be reviewed during design to determine the appropriate depth of sediment removal. This will include an evaluation of the vertical and areal distribution of mercury, potential post-removal residual concentrations, the potential thickness and type of backfill materials that will be placed over remaining sediments and forming the base for the habitat layer, potential sheeting and dewatering requirements associated with differing removal depths, and potential stability concerns during construction. The evaluation will determine whether or not an isolation layer will be needed beneath the habitat layer in any portion or portions of this reach in lieu of additional sediment removal. It would not be considered feasible to substitute additional sediment removal depth for an isolation layer in a specific area if the additional removal would require or cause: disproportionate additional equipment use or infrastructure (*e.g.*, sheeting, water management equipment, materials); or a major extension to the overall construction schedule. It also would not be considered feasible if the required depth of removal would exceed 2 ft (60 cm) beyond that needed to otherwise remove sediments for the purpose of: placing the isolation layer, erosion protection layer, and habitat layer, and to reconstruct reconstructing the stream channel with the appropriate depths and slopes for maintaining stream flows and appropriate habitats.

generally corresponds to the 370-ft contour. Place approximately 2 ft (60 cm) of vegetated habitat layer along the portion of the floodplain adjacent to Wastebeds 1 through 8 from the waterline to the break in grade. Restore vegetation in the area including trees and shrubs as feasible to create a riparian buffer.

- **Ninemile Creek Floodplain in Wetland SYW-10 Area:** The remedial approach for Alternative 3 in this portion of the Site is divided into different areas based on existing physical features and degrees of mercury contamination[15]. The removal (to various depths specified below) are expected to reduce concentrations of mercury to 0.5 mg/kg or less following removal. However, the engineering feasibility as noted above for channel sediments would also be considered during design to determine the final depths of removal. These areas are described below and are shown in Figure 12:

    - *Wetland SYW-10 Spit Areas*[16]: Remove floodplain soil/sediment to approximately 3 ft (90 cm) below existing grade at the western spit and approximately 4 ft (1.2 m) below grade at the eastern spit, backfill with clean substrate, install habitat layer, and restore wetland conditions. The actual depth of removal and backfill thickness would be determined during design based on the results of a pre-design investigation and the thickness of the habitat layer would be as specified in the habitat restoration plan being developed for the Onondaga Lake Bottom subsite.

    - *Upland Adjacent to Eastern SYW-10 Spit Area:* Remove 2 ft (60 cm) of soil/sediment from the edge of the SYW-10 spit area to the break in grade associated with the toe of the wastebeds, which generally corresponds to the 370 ft contour. Place approximately 2 ft (60 cm) of vegetated habitat layer.

    - *Wetland SYW-10 Forested Wetland:* Remove approximately 2 ft (60 cm) of soil/sediment within the wetland. Place a minimum of 2 ft (60 cm) of suitable habitat layer with the intent to restore the forested wetland and current topography. The actual extent and depth of removal would be confirmed during design based on the results of a pre-design investigation.

    - *Area Adjacent to I-690:* Remove approximately 2 ft (60 cm) of floodplain soil in the area adjacent to I-690. Place approximately 2 ft (60 cm) of vegetated habitat layer on the floodplain in removal areas. The actual depth of removal would be confirmed during design based on the results of a pre-design investigation. The remedial work would be coordinated with the bike trail that is currently being planned for the area.

    - *Upland Between SYW-10 Forested Wetland and Ninemile Creek:* Remove

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15 As discussed in the RI report, the CPOIs other than mercury have the same general distribution as mercury, although the degree to which they are elevated over upstream conditions, and the extent to which they are found are less than for mercury. Therefore, mercury represents the best measure of the extent of contamination attributable to the LCP Bridge Street subsite. In addition, only mercury presents areas of contiguous sample locations which contain concentrations much (*i.e.*, a factor of ten or more) greater than the concentrations in the surrounding area (*i.e.*, hot spots which are present in the wetlands in this area). Sampling during the pre-design investigation would include the other CPOIs (as well as mercury) to ensure that the remedy is protective for all CPOIs.

16 The spit areas referred to in this ROD are small peninsulas extending out on both sides of the mouth of Ninemile Creek into Onondaga Lake. These areas are also part of Wetland SYW-10. See Figure 10.

floodplain soil/sediment to approximately 3 ft (90 cm) below existing grade. Provide approximately 2 ft (60 cm) of habitat layer in areas where soil/sediment had been removed, resulting in a lower overall elevation, with the intent to establish a forested wetland. The actual depth of removal would be determined during design based on the results of a pre-design investigation.

This alternative includes the removal of an estimated 58,000 cy (44,000 m^3) of contaminated sediment and soil over an area of approximately 15.5 acres (6.3 hectares) within and along Reach AB. It is estimated that this dredging and excavation would result in the removal of about 640 pounds (290 kg) of mercury from the Ninemile Creek channel and floodplain (or about 92 percent of the estimated total mercury mass in the Reach AB channel and floodplain).

Removal areas for Alternative 3 are shown in Figure 16 for channel areas and Figure 17 for floodplain areas.

As is discussed above, remedial limits for Alternative 3 are based on physical features which would have confined the possible extent of contamination carried by Ninemile Creek. As shown in Figures 12 and 17, the northwest remedial limit for Alternative 3 is the northwest edge of the delineated SYW-10 forested wetland, which is separated from the forested floodplain (non-wetland) by a rise in ground surface elevation. Since the forested portion of SYW-10 is a valuable Class I wetland that is limited along the shores of Onondaga Lake, a portion of SYW-10 may be identified during the remedial design for exclusion from remediation so that area can continue to provide valuable forested wetland functions. During design a focused study will take place to evaluate criteria such as contaminant concentrations, habitat value, size, location within SYW-10, and engineering considerations would be used to determine what portion of SYW-10 would be remediated. In areas of the wetland requiring remediation, remedial activity would be phased to allow portions of the forested wetland to remain intact while the remediated portion is disturbed and restored. However, for the purposes of this ROD, the remedial areas, masses, volumes, and costs for this alternative are based on the full extent of the delineated SYW-10 wetland within Reach AB and are therefore upper-end estimates.

The contaminated sediments and soils that would be removed from the stream and floodplains would be disposed of at the LCP Bridge Street subsite containment system and/or the SCA that will be constructed at Wastebed 13 as part of the remediation of the Onondaga Lake Bottom subsite (Option A) or at an existing permitted landfill in the Rochester, New York, area (Option B).

It is estimated that the dredging/excavating, backfilling, and habitat layer placement components of this alternative, along with dewatering, water treatment, and transport/disposal of sediments and soils in the containment area at the LCP Bridge Street subsite or the SCA, would take one year.

If residual contamination remains beneath the habitat layer in any areas following the implementation of this alternative at levels above that which would allow for unlimited use or unrestricted exposure, an institutional control, such as an environmental easement or some other appropriate mechanism which would include restrictions on dredging/excavating in these areas, would be needed.

Under this alternative, it would be certified on an annual basis that O&M is being performed. If an institutional control is implemented under this alternative, it would be certified on an annual basis that the institutional control is in place.

Because this alternative would result in contaminants remaining on-Site above levels that allow for unlimited use and unrestricted exposure to Site media, CERCLA requires that the Site be reviewed at least once every five years. If justified by the review, additional remedial actions may be implemented to remove, treat, or contain the contaminated sediments and floodplain soils/sediments.

Alternative 3 (Ninemile Creek Reach AB)

Dredged/Excavated Volume for Disposal (cy):	58,000
Mercury Mass Removed (pounds):	640
Capital Cost:	$15,100,000
Average O&M and Periodic Annual Costs:	$110,000
Present-Worth O&M and Periodic Costs:	$1,400,000
Present-Worth Cost:	$16,500,000
Construction Time:	1 year

Note: For cost estimating purposes, the costs above are based on disposal in the containment area at the LCP Bridge Street subsite (Option A). The costs for disposal at the SCA are likely to be similar. For disposal at a facility not in the vicinity of Onondaga Lake (Option B), the costs are based upon utilizing a facility in the Rochester, New York area. The estimated cost for this disposal is $23.9 million.

Alternative 4 – Full removal of Ninemile Creek channel sediments and floodplain soils/sediments in Reach AB to a depth to meet criteria (0.15 mg/kg mercury and RGs for other CPOIs) and placement of backfill and habitat layer

The specific components of this alternative, as shown in Figure 13, include:

- **Ninemile Creek Channel:** Remove sediment with mercury concentrations exceeding 0.15 mg/kg and other non-mercury CPOIs exceeding RGs. It is anticipated that the removal would average 3 ft (90 cm), with a maximum of 8 ft (2.4 m). Backfill areas of removal and place a habitat layer with clean soil at the surface.

- **Ninemile Creek Floodplain:** Remove floodplain soil/sediment with mercury concentrations exceeding 0.15 mg/kg and other non-mercury CPOIs exceeding RGs. It is anticipated that the removal would range in depths from approximately 1 to 4 ft (0.3 to 1.2 m) and average 3 ft (0.9 m). Backfill the removal areas and place a habitat layer with clean soil to previous ground surface or a shallower depth to provide terrestrial or wetland habitat. As discussed above for Alternatives 2 and 3, removal in the floodplain along I-690 would be limited to soils above the structural armor stone.

This alternative includes the removal of an estimated 70,000 cy (54,000 m^3) of contaminated sediment and soil, over an area of approximately 16.4 acres (6.6 hectares) within and along Reach AB. It is estimated that this dredging and excavation would result in the removal of about 690 pounds (313 kg) of mercury from Ninemile Creek (or 100 percent of the estimated total mercury mass in Reach AB based on the lowest RG for mercury).

Removal areas for Alternative 4 are shown in Figure 18 for channel areas and Figure 19 for floodplain areas.

Alternative 4 includes a remedial footprint area that is 1 acre larger than Alternative 3. This additional area is a forested floodplain (non-wetland) located west of the western boundary of the delineated SYW-10 (see Figures 12 and 13). This area is included under this alternative because two of the four locations sampled in this additional area exhibit mercury concentrations of 0.2 mg/kg, which is slightly above the lowest mercury RG of 0.15 mg/kg.

The contaminated sediments and soils that are removed from the stream and floodplains would be disposed of in the containment area at the LCP Bridge Street subsite containment system and/or the SCA that will be constructed at Wastebed 13 as part of the remediation of the Onondaga Lake Bottom subsite (Option A) or at an existing permitted landfill in the Rochester, New York, area (Option B).

It is estimated that the dredging/excavating, backfilling, and habitat layer placement components of this alternative, along with dewatering, water treatment, and transport/disposal of sediments and soils in the containment area at the LCP Bridge Street subsite or the SCA, would take two years.

Institutional controls are not envisioned being necessary for Alternative 4.

Alternative 4 (Ninemile Creek Reach AB)

Dredged/Excavated Volume for Disposal (cy):	70,000
Mercury Mass Removed (pounds):	690
Capital Cost:	$20,000,000
Average O&M and Periodic Annual Costs:	$90,000
Present-Worth O&M and Periodic Costs:	$1,100,000
Present-Worth Cost:	$21,100,000
Construction Time:	2 years

Note: For cost estimating purposes, the costs above are based on disposal in the containment area at the LCP Bridge Street subsite (Option A). The costs for disposal at the SCA are likely to be similar. For disposal not in the vicinity of Onondaga Lake (Option B), the costs are based upon utilizing a facility in the Rochester, New York area. The estimated cost for disposal is $29.3 million.

COMPARATIVE ANALYSIS OF DISPOSAL OPTIONS AND REMEDIAL ALTERNATIVES

During the detailed evaluation of remedial alternatives, each alternative is assessed against nine evaluation criteria: overall protection of human health and the environment; compliance with ARARs or TBCs; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; cost; support agency acceptance; and community acceptance. The evaluation criteria are described below. A comparative analysis of the disposal options and remedial alternatives was performed, based on these nine criteria, and is presented in this section of the ROD.

The following ***"threshold criteria"*** are the most important and must be satisfied by any alternative in order to be eligible for selection:

1. ***Overall protection of human health and the environment*** addresses whether or not a remedy provides adequate protection and describes how risks posed through each exposure pathway (based on a reasonable maximum exposure scenario) are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

2. ***Compliance with ARARs*** addresses whether or not a remedy would meet all of the applicable or relevant and appropriate requirements of federal and state environmental statutes and regulations or provide grounds for invoking a waiver. Other federal or state advisories, criteria or guidance are TBCs. TBCs are not required by the NCP, but may be very useful in determining what is protective of a site or how to carry out certain actions or requirements.

The following ***"primary balancing criteria"*** are used to make comparisons and to identify the major tradeoffs among alternatives:

3. ***Long-term effectiveness and permanence*** refers to the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup goals have been met. It also addresses the magnitude and effectiveness of the measures that may be required to manage the risk posed by treatment residuals and/or untreated wastes.

4. ***Reduction of toxicity, mobility, or volume through treatment*** is the anticipated performance of the treatment technologies a remedy may employ, with respect to these parameters.

5. ***Short-term effectiveness*** addresses the period of time needed to achieve protection from any adverse impacts on human health and the environment that may be posed during the construction and implementation period until cleanup goals are achieved.

6. ***Implementability*** is the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

7. ***Cost*** includes estimated capital, operation and maintenance (O&M), and present-worth costs. Present-worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.

The following ***"modifying criteria"*** are used in the final evaluation of the remedial alternatives after the formal comment period, and may prompt modification of the preferred remedy that was presented in the Proposed Plan:

8. ***Support agency acceptance*** indicates whether, based on its review of the RI/FS reports, Proposed Plan, and ROD, NYSDOH concurs with, opposes, or has no comments on the selected remedy.

9. ***Community acceptance*** refers to the public's general response to the alternatives

described in the RI/FS reports and Proposed Plan.

A comparative analysis of the disposal options and the alternatives based upon the evaluation criteria noted above follows.

DISPOSAL OPTIONS

Disposal options for the excavated contaminated channel sediments and floodplain soils/sediments include consolidation within the containment system at Honeywell's nearby LCP Bridge Street subsite (Option A)[17] and disposing of contaminated channel sediments and floodplain soils/sediments at a permitted landfill which is not in the vicinity of Onondaga Lake such as in the Rochester, New York, area (Option B).

Criterion 1: Overall Protection of Human Health and the Environment

Both disposal options would provide similar and adequate overall protection of human health and the environment by containing contaminated sediments and soils under a low-permeability cap and reducing or eliminating risks associated with direct contact with contaminated material.

Criterion 2: Compliance with ARARs

Both disposal options would be equally compliant with location-specific and action-specific ARARs.

Criterion 3: Long-Term Effectiveness and Permanence

Both disposal options would provide similar levels of acceptable long-term effectiveness and permanence. Consolidation of the removed material at the LCP Bridge Street subsite containment system, at the SCA, or at an approved commercial facility would result in the permanent containment of contaminated channel sediments and floodplain soils/sediments. For the disposal option at the LCP Bridge Street subsite, the contaminated channel sediments and floodplain soils/sediments would provide needed fill material for site closure.

Criterion 4: Reduction of Toxicity, Mobility, or Volume through Treatment

Consolidation within the containment system at the LCP Bridge Street subsite, at the SCA, or removal to a commercial facility would reduce the mobility of mercury and other CPOIs, although not through treatment. The reduction in mobility would be the same for consolidation at the LCP Bridge Street subsite, at the SCA, and removal to an approved commercial facility. Containment at either of the facilities would not reduce the toxicity or volume of mercury or other CPOIs in the removed channel sediments and floodplain soils/sediments.

Criterion 5: Short-Term Effectiveness

Consolidation and containment at the LCP Bridge Street subsite or the SCA would provide the highest level of short-term effectiveness. The dominant short-term impact of disposal of excavated sediments and soils from Ninemile Creek at a facility which is not in the vicinity of Onondaga Lake is truck traffic, which presents potential issues for noise, dust/exhaust, traffic congestion, and safety

[17] For cost estimating purposes, the costs are based on disposal in the containment area at the LCP Bridge Street subsite. The costs for disposal at the SCA are likely to be similar.

concerns for the local community. For consolidation and containment locally, truck traffic would be routed approximately one to two miles from the location of the dredging/excavation activities at the Site (depending on the reach where the soils/sediments are being removed) via easily accessible non-residential roads suitable for truck traffic. Therefore, this disposal option would have limited direct impact on the local community since the haul route is short and no residential roads would be used.

For disposal at a landfill which is not in the vicinity of Onondaga Lake (assumed to be in the Rochester area, approximately 75 miles [120 km] away), the heavy truck traffic would have to use public roadways to transport the excavated sediments and soils. The remedial alternatives for Reach AB of Ninemile Creek would involve the disposal of 23,000 cy (18,000 m^3) of sediments and soils for Alternative 2, 58,000 cy (44,000 m^3) for Alternative 3, and 70,000 cy (54,000 m^3) for Alternative 4. Assuming 15 cy (11 m^3) per truckload, and the need for two trips (loaded and empty), the three action alternatives would require approximately 3,000 (Alternative 2), 7,700 (Alternative 3), and 9,300 (Alternative 4) truck trips through the community.

Criterion 6: Implementability

Both options are readily implementable technically and administratively. However, due to the shorter travel distances involved, consolidation at the containment system at the LCP Bridge Street subsite or the SCA is slightly more implementable than consolidation at a commercial facility in the Rochester area, such as the High Acres Landfill or the Ontario County Landfill.

Criterion 7: Cost

As shown in the tables in the "Geddes Brook/Ninemile Creek Operable Unit 2 Remedial Alternatives" section above, the total present-worth costs for the disposal option for a facility which is not in the vicinity of Onondaga Lake for all of the action alternatives evaluated in this ROD are approximately 27 to 45 percent greater than the costs for disposal within the containment system at the LCP Bridge Street subsite containment system (*i.e.*, \$12.6 million versus \$9.9 million for Alternative 2, \$23.9 million versus \$16.5 million for Alternative 3, and \$29.3 million versus \$21.1 million for Alternative 4)[18]. As presented in Appendix F of the OU2 Supplemental FS report, the unit cost (*i.e.*, price per cubic yard) for disposal at a landfill which is not in the vicinity of Onondaga Lake (\$146/cy) is approximately four times higher than for consolidation and disposal at the LCP Bridge Street subsite (\$36/cy).

Criterion 8: Support Agency Acceptance

NYSDOH concurs with the selected disposal option.

Criterion 9: Community Acceptance

Comments received during the public comment period indicate that the public generally supports the selected disposal option. The public's comments are summarized and addressed in the Responsiveness Summary, which is attached as Appendix V to this document.

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18 For cost estimating purposes, the costs are based on disposal in the containment area at the LCP Bridge Street subsite. The costs for disposal at the SCA are likely to be similar. For disposal at a location not in the vicinity of Onondaga Lake, the costs are based upon utilizing a facility in the Rochester, New York area.

Selected Disposal Option

Based upon the above analysis, Option A, consolidation and containment at the LCP Bridge Street subsite and/or at the SCA is the selected sediment management option. This decision is based on consideration of the primary and balancing criteria and the cost disparity between consolidation locally and consolidation at a Rochester area commercial facility. Management at the existing LCP Bridge Street subsite containment system or the SCA would be a proven and reliable technology for sediment and waste management.

If the consolidated sediments and soils are contained at the LCP Bridge Street subsite, it would be beneath a 6 NYCRR Part 360 equivalent low-permeability cap covering approximately 18 acres (7 hectares). The area is surrounded by a subsurface barrier (slurry) wall to contain contaminated groundwater that would be collected and treated. Additional information on the cap and containment/collection system can be found in the ROD and the remedial design documents for the LCP Bridge Street subsite.

As discussed in the Onondaga Lake remedial design work plan (Parsons, 2008c), the SCA will be designed, constructed, operated, and maintained in accordance with the substantive requirements of NYSDEC Part 360, Section 2.14(a) (industrial monofills) and will include an impermeable liner, leachate collection system, and cover. The decision of whether the sediments and soils would be consolidated at the SCA will consider various factors, including the design and construction schedules for the Ninemile Creek OU2 remedy as well as the SCA so that remediation of Ninemile Creek is not unnecessarily delayed.

If the excavated soils and sediments are disposed of at the LCP Bridge Street subsite containment system, they would not negatively impact the property's future development potential. The LCP Bridge Street subsite cap area would be maintained and monitored in the same manner whether or not it contains contaminated materials from the Site. As discussed above, management of the dredged/excavated channel sediments and floodplain soils/sediments in a containment system at the LCP Bridge Street subsite and/or at the SCA would also be more cost-effective than disposal at a facility for the removal volumes needed and would involve fewer impacts on the community (*e.g.*, less truck traffic, lower potential for risks of an accident or spill during transport).

Based upon the evaluation of the disposal options above, the following comparison of the remedial alternatives against the evaluation criteria assumes that the dredged/excavated channel sediments and floodplain soils/sediments would be disposed of at the LCP Bridge Street subsite containment system or the SCA.

REMEDIAL ALTERNATIVES

Criterion 1: Overall Protection of Human Health and the Environment

Alternative 1, the "no action" alternative, would not actively address risks to human health and the environment posed by contaminated sediments, soils, water, and biota in Ninemile Creek because it would not reduce or control risk to receptors or the further transport of CPOIs at the Site. The RAOs and RGs would not be met under this alternative.

All of the alternatives, with the exception of Alternative 1, would achieve the RAOs established for the Site. However, Alternative 2 would not achieve all of the RGs. The three action alternatives (Alternatives 2 through 4) would be protective of human health and the environment because they would reduce or eliminate existing and potential future adverse ecological effects on fish and wildlife resources and potential risks to humans (RAO 2); achieve, to varying degrees, CPOI concentrations in fish tissue that are protective of humans and wildlife that consume fish (RG 3); achieve, to varying degrees, CPOI concentrations in channel sediments that are protective of human health and fish and wildlife resources (RG 2); and reduce, contain, or control CPOI concentrations in erodible channel sediments (RAO 1 and RG 1). The remediation of sediments and soils under these alternatives is expected to achieve surface water quality standards for CPOIs (RAO 3 and RG 4).

All three action alternatives would meet all SWAC-based sediment targets for protection of bioaccumulation and direct contact (by humans). Alternatives 2, 3, and 4 are all also expected to result in reduced mercury concentrations in fish and, consequently, reduced risk to humans and ecological receptors from fish consumption.

Alternatives 2 through 4 would be protective of human health potentially impacted by consumption of fish containing PCBs and PCDD/PCDFs. PCBs and PCDD/PCDFs are not widespread in Ninemile Creek sediments and the areas where these CPOIs are elevated are generally located within the areas addressed under these alternatives. The reduction in PCB and PCDD/PCDF concentrations in sediment as a result of these alternatives is expected to result in reduced fish tissue concentrations over time, to the extent that Geddes Brook/Ninemile Creek sediments contribute to the body burden of these contaminants in fish tissue.

In the Reach AB portion of the Ninemile Creek channel, Alternative 2 provides protectiveness by removal of material with concentrations that exceed 1.3 mg/kg mercury and targets for all other CPOIs and replacement with a habitat layer. This alternative would also address 56 percent of the Ninemile Creek channel surface that exceeds both 0.5 and 0.15 mg/kg mercury (resulting from exceedances of RGs for other CPOIs).

Alternative 3 through a combination of removal, backfilling, and/or habitat layer placement addresses all of the sediment targets for mercury in the stream channel. Alternative 4 also addresses all of the sediment target values for mercury in the channel via removal of all sediment to achieve a residual of less than 0.15 mg/kg mercury (*i.e.*, essentially to concentrations near or below background).

In the Reach AB portion of the Ninemile Creek floodplain, Alternative 2 provides a degree of protectiveness by removal of up to 2 ft (60 cm) of material with concentrations that exceed 1.3 mg/kg mercury and/or targets for other CPOIs and replacement with up to 2 ft (60 cm) of clean soil. This alternative would also address 77 percent and 57percent of the floodplain that exceeds 0.5 and 0.15 mg/kg mercury, respectively (resulting from exceedances of RGs for other CPOIs).

Following removal and placement of a clean habitat layer, Alternative 3, compared to Alternative 4, addresses 100 percent and 93 percent of the floodplain that exceeds the two lowest mercury RGs of 0.5 and 0.15 mg/kg mercury, respectively. Alternative 4 addresses all of the surficial floodplain exceeding each of the sediment targets. Note that the difference between Alternatives 3 and 4 is due to the additional 1 acre area to be remediated under Alternative 4.

Although not targets, NYSDEC's LEL sediment screening criteria for arsenic (6 mg/kg), lead (31 mg/kg) and total PAHs (4 mg/kg) were considered during this comparative evaluation. For the top 2 ft (60 cm) of soil/sediment, Alternative 2 is not as effective as Alternatives 3 and 4 in addressing these screening criteria. Alternative 2 would address 100 percent, 100 percent, and 95 percent of the Ninemile Creek channel and 82, 97, and 90 percent of the floodplain exceeding these three criteria, respectively. Alternative 3 would address 100 percent of the area exceeding each of these criteria in the Ninemile Creek channel and 90 percent, 100 percent, and 95 percent of the area exceeding these three criteria in the floodplain. Alternative 4 would address 100 percent of the area exceeding these three criteria in the Ninemile Creek channel and floodplain. Note that this difference between Alternatives 3 and 4 (similar to mercury) is due to the additional remedial area under Alternative 4 that is just west of the western border of the delineated wetland SYW-10. As discussed in Appendix A of the OU1 Supplemental FS report, concentrations as low as these screening criteria may not be achievable in the long-term because they are influenced by sources other than just the Site.

Certain institutional controls may be needed for Alternative 2 and possibly Alternative 3 to ensure that any future construction or other activities do not remove or disrupt any residual contamination beneath the habitat layers in the channels and floodplain. Institutional controls would likely not be needed for Alternative 4.

As stated above, Alternatives 2 and 3 would achieve the RAOs established for the Site; however, Alternative 2 would not meet all of the RGs for mercury. Alternative 3 would be protective of benthic macroinvertebrates, because for the top 2 ft (60 cm) of channel sediment and floodplain soil/sediment, it would meet all sediment toxicity targets for mercury in all channel and wetland areas of Reach AB. As previously discussed, the goal is that the concentrations of the clean material used for the habitat layer within the top 2 ft (60 cm) would meet the lowest RG for mercury in channel sediment areas (0.15 mg/kg) and the Part 375 unrestricted use soil cleanup objectives for floodplain areas. This alternative would also meet the sediment toxicity targets for arsenic, lead, total PAHs, PCBs, hexachlorobenzene, and phenol within the habitat layer.

Alternative 4 would achieve the RAOs established for the Site. Implementation of Alternative 4 would be expected to remove all of the contamination from the Site, to the extent feasible. Following the removal, channel and floodplain areas would be backfilled and a habitat layer with clean soil placed. Similar to Alternative 3, Alternative 4 would be protective of benthic macroinvertebrates because for the top 2 ft (60 cm) of soil/sediment, the goal is to meet all four sediment toxicity targets for mercury and meet sediment toxicity targets for arsenic, lead, total PAHs, PCBs, hexachlorobenzene, and phenol.

Criterion 2: Compliance with ARARs

As there are currently no federal or state promulgated standards for contaminant levels in sediments, the sediment RGs would be used as TBC criteria. For soils, New York State has issued soil cleanup objectives for remedial programs (6 NYCRR Part 375.6). The unrestricted use soil cleanup objectives represent the concentration of a contaminant in soil which, when achieved at a site, would require no use restrictions on the site for the protection of public health, groundwater and ecological resources due to the presence of contaminants in the soil. For surface water, New York State has promulgated standards which are enforceable standards for various surface water contaminants.

In general, Alternatives 2 to 4 would be expected to comply with the designated chemical-specific ARARs to the extent practicable, while Alternative 1 (no action) would not, since there would be no active remediation associated with the sediments or soils.

As discussed above, narrative water quality standards for turbidity and suspended solids are periodically exceeded in both streams, and sporadic exceedances have been observed for several other CPOIs including thallium and chlorobenzene. For these constituents and other CPOIs, the reduction of CPOIs in Site-related contributions from contaminated sediments and soils is expected to result in the achievement of the New York State water quality standards. In addition, closure of the wastebeds would help to achieve narrative water quality standards, including the prohibitions for turbidity and for suspended, colloidal, or settleable solids. It is also expected that closure of the wastebeds would significantly reduce TDS concentrations in Ninemile Creek. As noted in the "Site Geology/Hydrogeology" and "Results of the Remedial Investigation" sections above, TDS has been detected in Ninemile Creek at concentrations exceeding the State surface water quality standard of 500 mg/L for a Class C water body. The presence of TDS at these concentrations has been determined to be primarily from upgradient sources of ionic substances (*e.g.*, Wastebeds 9 through 11), which are unrelated to the conditions to be addressed by the OU2 portion of this Site. For this reason, attainment of the surface water quality standard of 500 mg/L in Ninemile Creek is not a performance standard for the action alternatives considered in this ROD, and it is anticipated that the conditions causing or contributing to these exceedances would be addressed in a subsequent action or actions to address the upgradient sources.

As discussed in the RI/FS, for surface water, two of the four New York State water quality standards for mercury (based on dissolved total mercury) for Class B/C waters were exceeded in lower Geddes Brook and the West Flume, but not in Ninemile Creek. The New York State surface water quality standards for mercury for protection of wildlife is 2.6 ng/L dissolved mercury and the standard for protection of human health (via fish consumption) is 0.7 ng/L dissolved mercury. As discussed previously, dissolved total mercury was not detected in lower Ninemile Creek and was detected at 1.4 ng/L in lower Geddes Brook and up to 57 ng/L in the West Flume during low-flow conditions in 1998. In conjunction with the selected remedy for Geddes Brook/Ninemile Creek OU1, implementation of Alternatives 2, 3, or 4 would be expected to enable Ninemile Creek Reach AB to comply with the applicable water quality standards for mercury.

During implementation of Alternatives 2, 3, or 4, any short-term exceedances of surface water ARARs in Ninemile Creek due to dredging/excavation or capping would be expected to be limited to the area in the vicinity of the work zone. Sufficient engineering controls would be utilized during dredging/excavation and capping to prevent or minimize exceedances of surface water ARARs outside of the work zone. Furthermore, compliance with the discharge limits (to be established by NYSDEC if needed) should ensure that there are no exceedances of surface water ARARs caused by the discharge from on-Site water treatment.

The primary location-specific ARARs applicable to the remediation are ECL Article 24 Freshwater Wetlands, ECL Article 15 Use and Protection of Waters, and Clean Water Act (CWA) Section 404. For freshwater wetlands, 6 NYCRR Part 663 regulates activities conducted in or adjacent to regulated wetlands. Article 15 is implemented by 6 NYCRR Part 608 which regulates alterations to beds and banks of streams such as dredging and filling.

CWA Section 404 includes requirements related to the discharge of dredged or fill material into navigable waters of the U.S. and prohibits activities which adversely affect an aquatic ecosystem, including wetlands. In addition, Superfund actions must meet EPA's 1985 Policy on Floodplains and Wetland Assessments for CERCLA Actions, and EPA's Protection of Wetlands Executive Order 11990. The policy memorandum discusses situations that require preparation of a floodplains or wetlands assessment, and the factors that should be considered in preparing an assessment, for response actions taken pursuant to Section 104 or 106 of CERCLA. Executive Order 11990 addresses long- and short-term adverse impacts associated with the destruction or modification of wetlands and seeks to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative.

Since all of the alternatives except the "no action" alternative include dredging/excavation and/or backfilling, and habitat layer placement within the stream, the final design of the remedy must meet the substantive requirements of the applicable regulations. Alternatives that restore appropriate habitat and function, do not result in unacceptable changes in water depth or the loss of stream surface area, and do not diminish natural resource values throughout the stream would more readily meet the requirements. All of the alternatives except the "no action" alternative are expected to comply with all of the designated location-specific and action-specific ARARs, to varying degrees. Compliance with Articles 15 and 24 would be achieved under Alternatives, 2, 3, or 4 via development and implementation of a habitat restoration plan. The habitat restoration plan would address bathymetry and other related habitat aspects for each impacted stream reach.

Although there are no chemical-specific ARARs for sediment, the two lowest RGs for mercury in sediments (0.15 and 0.5 mg/kg) would not be met in portions of the Site under Alternative 2. Since the entire area of the Site within the well-defined steep banks and within the delineated wetlands would be remediated under Alternatives 3 and 4, with use of clean soils in both channel and floodplain areas at the surface (excluding the non-wetland floodplain forest west of the forested wetlands), the goal of concentrations within the top 2 ft (60 cm) would be less than the lowest mercury RG of 0.15 mg/kg within the entire remedial area of each of the Alternatives 3 and 4.

The NYSDEC Part 375 unrestricted use soil cleanup objective of 0.18 mg/kg for mercury would apply to clean surface soil being placed in those areas of the floodplain not expected to be wetland (*i.e.*, upland). Alternative 1 ("no action") would not comply with the Part 375 unrestricted use soil cleanup objective in the floodplain soils, since there would be no active remediation. Under Alternative 2, the NYSDEC Part 375 unrestricted use soil cleanup objective of 0.18 mg/kg for mercury would not be met in areas not being remediated (*i.e.*, areas having mercury concentrations between 0.18 and 1.3 mg/kg at the floodplain surface). For Alternatives 3 and 4, it would be expected that all ARARs and RGs (TBCs) for CPOIs, would be met.

Sediment removal, handling, dewatering, and consolidation, as well as the installation of the channel and floodplain habitat layer, are expected to meet action-specific and location-specific ARARs. Appropriate regulatory approvals or permits would be obtained prior to initiating the alternatives.

Criterion 3: Long-Term Effectiveness and Permanence

Alternative 1 would be neither effective in the long-term nor permanent because the potential for further transport of mercury and other CPOIs, and the associated risks to human health and ecological receptors, would not be controlled or eliminated. Some amount of natural recovery would be anticipated due to the planned remediation of upstream and external sources; however, it is unlikely that the RAOs and RGs would be met within the foreseeable future.

Alternatives 2, 3, and 4 all provide long-term effectiveness and permanence. The sand base layer (or residual cap, if needed) used in Alternatives 2 and 3 would be designed to attenuate any residuals that may remain after dredging and excavating. Adequate engineering controls are readily available and can be used during the removal of sediment and during placement/installation of the habitat layer to provide for the long-term effectiveness of the remedy. Proven techniques are available to provide for the adequacy and reliability of the remedy through its design and construction, and implementation of a long-term operation and maintenance program.

A discussion of additional factors related to this evaluation criterion is provided below.

Permanence and Adequacy and Reliability of Controls

Alternative 4 provides the greatest reliability by removing more of the sediments and soils that exceed toxicity-based cleanup criteria than the other alternatives. Alternatives 2 and 3 incorporate removal of contaminated sediments and soils prior to covering with clean material. Alternative 3 would remove more than twice as much contaminated sediment and soil as Alternative 2, and approximately 20 percent less than Alternative 4. Alternative 3 would remove about 50 percent more mercury than Alternative 2, and about 8 percent less mercury than Alternative 4. Alternative 3 includes removal of contaminated floodplain and wetland soils to depths up to 4 ft (1.2 m) whereas Alternative 2 is limited to 2 ft (60 cm) removal in the floodplain and wetlands.

As the volume of removal decreases relative to Alternatives 4, 3, and 2, the relative degree of reliability of the given alternative also decreases. Therefore, Alternative 4, which would attempt to remove the maximum amount of contaminated sediments and soils is regarded as the most reliable. However, insofar as the extent of mercury residuals beneath the habitat layers under Alternative 3 may be very limited (*i.e.*, residual concentrations of mercury less than 0.5 mg/kg based on available data), there is no significant difference in degree of reliability between Alternatives 3 and 4. Alternative 2, which addresses a much smaller portion of the Site based on one of the higher RGs for mercury (1.3 mg/kg), is clearly less reliable than Alternatives 3 and 4.

For any contaminated sediments and soils that would be left at the Site under Alternatives 2 and 3, the sand base layer (or residual cap, if needed) would attenuate any residuals that may remain after dredging and excavating. There would be development and implementation of a monitoring and maintenance program to ensure that the integrity and effectiveness of the habitat layer and cap, if needed, are maintained. Therefore, although complete removal of contaminated sediments, to the extent practicable, would be most permanent, covering any low-level residual contaminated sediments with a habitat layer and sand base layer (or residual cap, as needed), would still achieve a high degree of permanence.

Reduction of Residual Risk

Residual risk in Ninemile Creek can be evaluated on the basis of direct toxicity, bioaccumulation, and potential for recontamination. Since Alternative 1 would involve no active remedial measures, it would not effectively reduce residual risk.

At the point of exposure (top 2 ft [60 cm]), Alternative 2 would remediate all areas which exceed the mercury RG of 1.3 mg/kg, leaving some areas below 1.3 mg/kg unremediated. At the point of exposure (top 2 ft [60 cm]), Alternatives 3 and 4 would address all areas exceeding the lowest mercury RG of 0.15 mg/kg within all channel areas and within the well-defined steep banks of the floodplain or delineated wetlands. Alternative 4 would also address a 1-acre area with mercury concentrations marginally above the mercury RG of 0.15 mg/kg in a non-wetland floodplain area. Reduction of residual risk is greatest for Alternative 4 since this alternative removes the greatest volume of contaminated soils/sediments. Alternative 3 provides for a greater reduction of residual risk than Alternative 2 since Alternative 3 removes a greater volume and addresses a larger area than Alternative 2.

The cleanup criteria address sediment toxicity to benthic macroinvertebrates. For those areas that are remediated, concentrations of CPOIs in the clean habitat layer overlying any residual contamination are expected to remain low enough to reduce toxicity. Based on this criterion of direct toxicity, all three action alternatives would be protective. However, Alternatives 3 and 4 are similar in that they would provide a greater degree of confidence in the protectiveness of the alternative, as compared to Alternative 2.

Alternatives 2, 3 and 4 would meet the bioaccumulation-based RGs for mercury and other CPOIs. Mercury concentration goals in sediments of 0.8 mg/kg and in soil of 0.6 mg/kg were developed for the Site to address bioaccumulation concerns (see the text boxes entitled “Sediment Quality Values for Channel Sediments and Floodplain Soils/Sediments to Protect from Bioaccumulation and Direct Contact” [pages 44 and 45]). To determine whether the alternatives (which were developed based on direct toxicity goals) meet the bioaccumulation goals for mercury, the estimated post-remediation SWAC for each alternative was compared to the 0.8 mg/kg or 0.6 mg/kg goals. This was done on an area-weighted basis (*i.e.*, by reach rather than point-to-point) since animals that bioaccumulate mercury, such as fish, are not limited to a specific location of the Site. For Alternative 2 (which is the only action alternative that does not include remediation of the full Site or delineated wetland), the predicted post-remediation SWACs (0.4 mg/kg mercury in the channel and 0.2 mg/kg mercury in the floodplain) would meet these goals in both the channel and floodplain portions of Reach AB. The post-remediation SWACs for Alternatives 3 and 4 would also meet these criteria since only new clean material (0.15 mg/kg mercury) would be at the surface of the entire remedial area. Bioaccumulation-based RGs, based on NYSDEC sediment screening criteria, were also evaluated for PCBs (0.03 mg/kg) and hexachlorobenzene (0.25 mg/kg) in channel sediments. A direct contact-based RG for benzo(a)pyrene (1.3 mg/kg) was also evaluated. The predicted post-remediation SWACs for these non-mercury CPOIs would also be less than the bioaccumulation-based RGs for Alternatives 2, 3 and 4.

Criterion 4: Reduction of Toxicity, Mobility, or Volume through Treatment

No treatment would be performed under Alternative 1; therefore, there would be no reduction of toxicity, mobility, or volume through treatment.

As discussed in the “Description of Alternatives” section, there would be on-Site treatment of water generated from excavated sediment and soil using a temporary treatment system for the action alternatives. However, this treatment is not expected to reduce the concentrations of mercury and other CPOIs within the sediments and soils.

Implementation of Alternative 2 would result in the removal of approximately 23,000 cy (18,000 m^3) of contaminated sediments and soils and approximately 430 pounds (195 kg) of mercury from Reach AB of Ninemile Creek (approximately 63 percent of the total mercury mass in Reach AB channel and floodplains), significantly reducing the toxicity, mobility, and volume of contaminated sediments and soils. The habitat layer and sand base layer (residual cap, if needed), installed following the removal, would reduce the mobility of residual concentrations in sediments and soils, although the reduction of toxicity, mobility, and volume at the point of exposure is achieved through removal and containment rather than treatment.

Implementation of Alternative 3 would result in the removal of approximately 58,000 cy (44,000 m^3) of contaminated sediments and soils and approximately 640 pounds (290 kg) of mercury from Reach AB of Ninemile Creek (approximately 92 percent of the total mercury mass in Reach AB channel and floodplains), significantly reducing the toxicity, mobility, and volume of contaminated sediments and soils.

For Alternative 3, the residuals that would remain following removal in Reach AB (expected to be less than about 0.5 mg/kg) would typically be about two orders-of-magnitude lower than the maximum concentrations currently found at the Site (77 mg/kg). The habitat layer, installed following the removal, would comprehensively cover the Site (with the exception of a small non-wetland floodplain forested area with mercury concentrations at or below 0.2 mg/kg) and reduce the mobility of residual concentrations in sediments and soils, although the reduction of toxicity, mobility, and volume at the point of exposure is achieved through removal and containment rather than treatment.

Implementation of Alternative 4 would result in the removal of approximately 70,000 cy (54,000 m^3) of contaminated sediments and soils and approximately 690 pounds (313 kg) of mercury from Reach AB of Ninemile Creek (100 percent of the mercury mass in Reach AB channel and floodplains above the lowest RG), significantly reducing the toxicity, mobility, and volume of contaminated sediments and soils, although the reduction of toxicity, mobility, and volume at the point of exposure is achieved through removal and containment rather than treatment.

Alternative 3 would remove more than twice as much contaminated sediment and soil as Alternative 2, and approximately 20 percent less than Alternative 4 (58,000 cy [44,000 m^3] compared to 70,000 cy [54,000 m^3]). Alternative 3 would remove about 50 percent more mercury than Alternative 2, and about 8 percent less mercury than Alternative 4. Thus, on the basis of the amount of contaminated sediment and soil removed and placed in a secure facility, Alternative 2 would result in much less reduction in mobility and toxicity than Alternatives 3 and 4, while Alternative 3 would result in a slightly lower reduction in mobility and toxicity than Alternative 4.

EPA's Preference for Treatment

The NCP states that EPA expects to use treatment to address the principal threats posed by a site wherever practicable (NCP Section 300.430 [a][1][iii][A]). The "principal threat" concept is applied to the characterization of "source materials" at a Superfund site. A source material is material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for the migration of contamination to groundwater, surface water, or air, or acts as a source for direct exposure. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to human health or the environment should exposure occur.

As noted above, the contaminated sediments and soils within the Site contain hazardous substances, pollutants, or contaminants that have migrated from the LCP Bridge Street subsite. Although contaminated sediments/soils are present at the Site, the concentrations are generally lower than the levels found on the LCP Bridge Street subsite. Thus, these contaminated sediments and soils would not be considered "source materials" or "principal threat wastes."

Criterion 5: Short-Term Effectiveness

Environmental Impacts

Alternative 1 ("no action") does not include any active remediation and, therefore, would not present any potential adverse impacts to on-Site workers, the environment, or the community as a result of its implementation. However, as previously noted, unacceptable risks to human health and the environment posed by contaminated sediments and soils, water, and fish in the stream would continue to occur.

In general, short-term effectiveness risks are proportional to the volume of materials excavated and the duration of work. Thus, these impacts are least for Alternative 2 and greatest for Alternative 4. The estimated volumes of materials to be excavated from the Reach AB portion of Ninemile Creek for Alternatives 2, 3, and 4 are approximately 23,000 cy (18,000 m^3), 58,000 cy (44,000 m^3), and

70,000 cy (54,000 m^3), respectively. The estimated remedial construction durations for Alternatives 2, 3, and 4 are approximately one, one, and two years, respectively.

For all of the action alternatives, potential short-term risks associated with sediment dredging and related activities in the channel include resuspension of channel sediment, related potential impacts to water quality, and temporary loss of aquatic and upland habitats within and near work areas. For Alternatives 2, 3, and 4, the durations of sediment dredging and associated installation and removal of sheet piling, where needed, for Ninemile Creek Reaches AB are estimated to be approximately 26 weeks, 41 weeks (one construction season), and 82 weeks (two construction seasons), respectively. Additional information on construction scheduling for these alternatives can be found in Appendix F of the OU2 Supplemental FS report.

As a result of its deeper removal (up to a depth of 8 ft [2.5 m] into the sediments), Alternative 4 would require installation and removal of significantly (greater than ten times) more sheet pile than Alternatives 2 and 3, which contributes added short-term risks of potential adverse water quality impacts relative to Alternatives 2 and 3. Under each action alternative, the short-term risks of water quality impacts would be mitigated through the use of best management dredge practices (*e.g.*, the use of environmental buckets where feasible), silt curtains placed downstream from the dredge site, and potentially other resuspension controls.

Other short-term risks associated with sediment dredging, floodplain soil/sediment excavation, and installation of a habitat layer, include those associated with erosion of floodplain soil/sediment, air emissions from stockpiles and equipment, noise and light from construction equipment, and truck traffic to the upland sediment/soil consolidation area. These types of risks, however, are common to many remedial and heavy construction projects and would be mitigated to the extent feasible.

The sediment and soil removals under the action alternatives would also temporarily impact the existing benthic macroinvertebrate and terrestrial species in the area, and indirect effects may be experienced by fish that forage in the affected area due to temporary disruption of the benthic food web. However, the negative ecological effects would be temporary and offset by the positive long-term effects of significantly less contaminated benthic habitat via remediation.

Alternatives 3 and 4 would involve remediation (*i.e.*, removal of soils to various depths) of the entire 4.1-acre forested wetland of SYW-10 within the Reach AB portion of the Site, and Alternative 4 would, in addition, also remediate the 1-acre forested floodplain (non-wetland) to the west of this area. While the alternatives would include restoring SYW-10 as a forested wetland/floodplain, even with the planting of large trees, it would be decades before the mature forested wetland would be restored. Thus, the potential long-term environmental impact would be greater for Alternative 4 than Alternative 3, since Alternative 4 would remove approximately a 1-acre larger area of mature trees in a non-wetland area with relatively low concentrations of mercury (*i.e.*, about 0.2 mg/kg or less). In addition, as discussed in the "Description of Alternatives" section, a stated objective of Alternative 3 is to preserve a portion of the existing forested wetland of SYW-10 during the initial phase of the remediation, thereby presenting less environmental impact than Alternative 4 in this area.

Community and On-Site Worker Impacts

Alternatives 2, 3, and 4 could present some limited adverse impacts to on-Site workers through dermal contact and inhalation related to dredging activities. Noise from the dredging/excavation work processes could present some limited adverse impacts to on-Site workers and nearby residents, although the nearest residents are over half-a-mile away and would likely not be affected. In addition, post-dredging sampling activities may pose some risk to on-Site workers. Another potential adverse impact associated with dredging would be odors associated with the dredged sediments. The risks to on-Site workers and nearby residents under all of the alternatives could be mitigated by following appropriate health and safety protocols, exercising sound engineering practices, and utilizing proper protective equipment.

Alternatives 2, 3, and 4 would require the transport of increasing amounts of material, including backfill, which may involve use of local roadways and would cause increased traffic. For transport of dredged/excavated sediments from Reach AB of Ninemile Creek to the LCP Bridge Street subsite containment system or the SCA, it is anticipated that only non-residential roads suitable for truck traffic would be used. During remedial design, various means would be evaluated to minimize potential adverse impacts (*e.g.*, traffic, odors associated with dredged sediments) on the community.

The public would be excluded from the work areas of Ninemile Creek during remediation, with the duration of this impact estimated as one year for Alternatives 2 and 3, and two years for Alternative 4.

Criterion 6: Implementability

No remedial actions would be implemented in Ninemile Creek under Alternative 1.

Sediment dredging, floodplain soil excavation, and placing clean materials on floodplains and through surface water have been implemented at other sites. Construction of temporary haul roads, removal of floodplain soil/sediment, construction and operation of sediment dewatering piles, construction and operation of a temporary water treatment system, and upland confinement of contaminated sediment is routine work for environmental remediation contractors. Removal of contaminated sediment in Ninemile Creek would be done by dredging with the use of shore-based excavators or cranes. A portion of the removal along the lakeshore may need to be performed using barge-mounted dredges since the soils in and along the wetlands spits are not expected to support heavy equipment. The dredging would be moderately difficult to implement due to the challenges of accurate removal and mitigating re-suspension of sediment and potential impacts to water quality. However, accurate dredge cuts can be made using modern dredging/excavation equipment. In addition, resuspension of sediment and potential impacts to water quality would be mitigated by use of best-management dredge practices (*e.g.*, the use of environmental buckets where feasible), silt curtains downstream from the dredge site, and potentially other resuspension controls, including temporary stream diversions.

For Alternative 2, it is not anticipated that sheet pile would be required to remove sediment and install the habitat layer except for a short (*i.e.*, 300 ft [90 m]) section at the upper end of Reach AB, which would include removal generally less than 4 ft (1.2 m). The implementability of Alternative 3 would be similar to Alternative 2.

For Alternative 4, removal of contaminated sediment from Ninemile Creek to reach the RGs would require removal to depths averaging 3 ft (0.9 m), and up to 8 ft (2.5 m). Removal to such depths would likely require structural support to prevent failure of the stream banks. A total of about 3,500 ft (1.1 km) of 40-ft (12 m) deep sheet pile would be required under this alternative. Thus, Alternative 4 would be more difficult to implement than Alternatives 2 and 3.

Criterion 7: Cost

The cost estimates for both channel sediments and floodplain soils/sediments presented in this ROD are based upon capital (construction) costs and the present-worth of the annual O&M costs calculated using a discount rate of 7 percent and a 30-year time interval. The actual costs would vary depending on the specifications contained in the detailed remedial design. Further, the actual costs would also vary because the cost estimates provided are developed conservatively and have an accuracy of +50 percent to -30 percent, to comply with the 1988 EPA guidance document, "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA."

In general, the cost of each alternative increases with increases in the footprint of the remediated area and with the volumes and depths of sediments and soils removed, as follows:

- There is no cost associated with Alternative 1, the "no action" alternative.

- The estimated present-worth cost for Ninemile Creek Reach AB for Alternative 2, which includes partial removal of contaminated channel sediments and floodplain soils/sediments and construction of a habitat system, is $9,900,000.

- The estimated present-worth cost for Ninemile Creek Reach AB for Alternative 3, which includes a greater volume of removal of contaminated channel sediments and floodplain soils/sediments as compared to Alternative 2 and a larger remedial footprint (but nearly the same as Alternative 4), is $16,500,000.

- The estimated present-worth cost for Ninemile Creek Reach AB for Alternative 4, which includes full removal to meet all RGs (versus partial removal) of contaminated channel sediments and floodplain soils/sediments, is $21,100,000.

Costs for Alternatives – Ninemile Creek Reach AB

Alternative	Capital Cost	Average O&M and Periodic Annual Cost	Present-Worth O&M and Periodic Cost	Present-Worth Cost
1	$0	$0	$0	$0
2	$8,600,000	$105,000	$1,300,000	$9,900,000
3	$15,100,000	$110,000	$1,400,000	$16,500,000
4	$20,000,000	$90,000	$1,100,000	$21,100,000

Criterion 8: Support Agency Acceptance

NYSDOH concurs with the selected remedy.

Criterion 9: Community Acceptance

Comments received during the public comment period indicate that the public generally supports the selected remedy. The public's comments are summarized and addressed in the Responsiveness Summary, which is attached as Appendix V to this document.

PRINCIPAL THREAT WASTE

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a site wherever practicable (NCP Section 300.430 (a)(1)(iii)(A)). The "principal threat" concept is applied to the characterization of "source materials" at a Superfund Site. A source material is material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for the migration of contamination to groundwater, surface water, or air, or acts as a source for direct exposure. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to human health or the environment should exposure occur. The decision to treat principal threat wastes is made as provided in the Principal Threat Waste Guidance, OSWER Directive No. 9380.3-06FS,'A Guide to Principal Threat and Low Level Threat Wastes' and additionally pursuant to Site-specific concerns. As noted above, the contaminated sediments and soils within the Site contain hazardous substances, pollutants, or contaminants that have migrated from the LCP Bridge Street subsite. Thus, these contaminated sediments and soils would not be considered "source materials" or "principal threat wastes."

SELECTED REMEDY

Summary of the Rationale for the Selected Remedy

Based upon consideration of the requirements of CERCLA, the detailed analysis of the alternatives, and public comments, NYSDEC and EPA have determined that Alternative 3, removal of Ninemile Creek channel sediments and floodplain soils/sediments in Reach AB and placement of backfill and a habitat layer, best satisfies the requirements of CERCLA Section 121, 42 USC §9621, and provides the best balance of tradeoffs among the remedial alternatives with respect to the NCP's nine evaluation criteria, 40 CFR Section 300.430(e)(9).

Alternative 3 addresses the RAOs, RGs and cleanup levels for mercury and other CPOIs and will result in a long-term reduction in the toxicity, mobility, and volume of the key contaminants, namely, mercury, arsenic, lead, hexachlorobenzene, phenol, PAHs, PCBs, and dioxins/furans. Alternative 3 is preferred over Alternative 4 because it provides the same overall protection of human health and the environment and compliance with ARARs as Alternative 4, but at significantly less cost ($16.5 million versus $21.1 million), presents less short-term impact, and is more implementable than Alternative 4.

Alternative 3 will be protective of benthic macroinvertebrates, because, with the exception of a small non-wetland floodplain forested area with mercury concentrations at or below 0.2 mg/kg, the top 2 ft (60 cm) of channel sediment and floodplain soil/sediment would meet all of the sediment toxicity targets for mercury. This alternative would also meet the sediment toxicity targets for arsenic, lead, total PAHs, PCBs, hexachlorobenzene, and phenol.

Alternatives 3 and 4 would address all ARARs, RGs, and cleanup levels. Alternative 2 would not address NYSDEC's Part 375 unrestricted use soil cleanup objective of 0.18 mg/kg for mercury in portions of the floodplain with concentrations between 0.18 and 1.3 mg/kg.

Alternatives 2 through 4 address the RGs and cleanup levels for mercury and other contaminants through removal, to various extents. Alternative 3 is more protective than Alternative 2, since it addresses potentially contaminated surface soils/sediments throughout the entire remedial area (15.5 acres [6.3 hectares]) since this alternative is based on physical limitations to the extent of potential contamination and limits of delineated wetlands. Alternative 2, which is based on one of the less stringent mercury cleanup levels (1.3 mg/kg) to define the areal extent of remediation, addresses a smaller portion of the remedial area (10.8 acres [4.4 hectares]). Alternative 4, which is based on the lowest of the mercury cleanup levels (0.15 mg/kg), addresses a slightly larger (16.4 acres [6.6 hectares]) remedial area than Alternative 3.

Alternative 3 would be more protective than Alternative 2. Alternative 3 addresses all of the potential mercury cleanup levels at the point of exposure in the surface (top 2 ft [60 cm]) soils/sediments (with the exception of a small non-wetland floodplain forested area with mercury concentrations at or below 0.2 mg/kg), while Alternative 2 does not fully address the two most stringent mercury cleanup levels (0.15 and 0.5 mg/kg). Alternative 4, which is based on the most stringent of the mercury cleanup levels, also addresses the same cleanup levels as Alternative 3 at the point of exposure.

As discussed in the “Toxicity-Based Sediment Effect Concentrations Selected as Remediation Goals for Mercury and Other Inorganics” text box (page 38), the mercury cleanup levels of 0.15 mg/kg and 1.3 mg/kg are based on the LEL and SEL, respectively, of the NYSDEC sediment screening values (NYSDEC, 1999), which are in turn based on Long and Morgan’s (1990) ER-L and ER-M values. The ER-L (0.15 mg/kg) represents a concentration below which toxic effects are rarely expected, and the ER-M (1.3 mg/kg) represents a concentration above which toxic effects are likely to occur. By meeting the LEL under Alternative 3, an added measure of protectiveness for the benthic community (*i.e.*, the base of the food chain) over the SEL (used for Alternative 2) is provided.

Alternatives 2, 3, and 4 would meet all SWAC-based sediment targets for protection of bioaccumulation and direct contact (by humans) in Reach AB.

All three alternatives remove a majority of the mercury mass in Reach AB. Alternative 3 removes about 640 pounds [290 kg] of mercury (92 percent of the total found in this reach), which is significantly more than Alternative 2 (430 pounds [195 kg], or 63 percent of the total), but less than Alternative 4 (690 pounds [313 kg] or 100 percent of the total above the lowest RG). For Alternative 3, the residuals that would remain following removal (generally less than 0.5 mg/kg of mercury) would typically be about two orders-of-magnitude lower than the maximum concentrations currently found at the Site (77 mg/kg). Furthermore, under Alternative 3, all residuals would be covered. The residuals for Alternative 2 would remain at higher concentrations than for Alternative 3.

Alternative 3 would remove more than twice as much soil/sediment (58,000 cy [44,000 m^3]) as Alternative 2 (23,000 cy [18,000 m^3]), and about 20 percent less than Alternative 4 (70,000 cy [54,000 m^3]). All of these alternatives include disposal of these soils and sediments at Honeywell’s LCP Bridge Street subsite under the landfill cap or at the SCA. Disposal at the LCP Bridge Street site and/or the SCA would eliminate the need for large volumes of heavy truck traffic to pass through nearby communities on public roads.

Both Alternatives 2 and 3 utilize a sand base layer under the habitat layer to attenuate any residual contamination left after removal. These layers can be designed to be reliable and protective of the low concentrations of contamination left as residuals. Alternative 4 would be slightly more reliable than Alternative 3, since about 20 percent more material (8 percent more mercury) would be sent to the secure containment system at the LCP Bridge Street subsite or the SCA.

Alternatives 2, 3, and 4 would disrupt the benthic community of Ninemile Creek, as well as prevent access by the public during remedial construction. Alternative 2 would cause disruption for less than one year, Alternative 3 for one year, and Alternative 4 for two years. There is a potential risk of resuspension of contaminated sediments being washed downstream into Onondaga Lake during dredging/excavation. While it is expected that releases of this type would be controlled, this potential risk is most pronounced for Alternative 4 due to the larger amount of sheet piling that would be required in a portion of the channel for the deeper removal to reach the RG of 0.15 mg/kg mercury at depth. For this reason, Alternative 4 would be more difficult to implement than Alternatives 2 and 3.

Alternatives 3 would involve remediation of a portion of the forested wetland of SYW-10, the extent of which which would be determined during the remedial design. Alternative 4 would involve remediation (*i.e.*, removal of soils to various depths) of the entire forested wetland of SYW-10 within the Reach AB portion of the Site and remediate the forested floodplain (non-wetland) to the west of this area, which is approximately 1 acre in size. While the alternatives would include restoring SYW-10 as a forested wetland/floodplain, even with the planting of larger trees, it would be decades before the mature forested wetland would be restored. Thus, the potential long-term environmental impact is greater for Alternative 4 than Alternative 3, since Alternative 4 would remove approximately a larger area consisting of at least a 1-acre larger area of mature trees in a non-wetland area with relatively low concentrations of mercury (*i.e.*, about 0.2 mg/kg or less).

In addition to providing long-term effectiveness and permanence, the remedial action under all three action alternatives would meet requirements for protection of existing infrastructure and floodplain areas (*i.e.*, no adverse increase in water elevations or extent of flooding as compared to existing conditions).

Alternative 3 will remove more than twice as much sediment and soil as Alternative 2, and approximately 20 percent less than Alternative 4. Alternative 3 will remove about 50 percent more mercury than Alternative 2, and only about 8 percent less mercury than Alternative 4.Thus, on the basis of the amount of contaminated sediment and soil removed and placed in a secure facility, Alternative 2 would result in much less reduction in mobility and toxicity than Alternatives 3 and 4, while Alternative 3 will result in a slightly lower reduction in mobility and toxicity than Alternative 4. However, the costs and difficulty of implementation are significantly greater for Alternative 4 than Alternative 3. The cost of Alternative 4 is about 30 percent greater than Alternative 3. In addition, Alternative 3 includes measures to potentially limit the loss of mature forested areas with low levels of soil contamination.

Summary

NYSDEC and EPA selected Alternative 3 because it provides the same overall protection of human health and the environment and compliance with ARARs as Alternative 4, but at significantly less cost ($16.5 million versus $21.1 million). Alternative 3 also presents less short-term risk and is more implementable than Alternative 4. Under Alternative 1 none of the threats to human health and the environment would be abated. Alternative 2 would be less protective, would not comply with all ARARs and affords less reduction of toxicity, mobility, and volume than Alternative 3. In addition there are more significant short-term risk and implementation issues associated with Alternative 4.

Description of the Selected Remedy

The selected remedy for this Site is Alternative 3. This alternative addresses the RAOs and cleanup levels for mercury and other CPOIs and will result in a long-term reduction in the toxicity, mobility, and volume of the key contaminants, namely, mercury, arsenic, lead, hexachlorobenzene, phenol, PAHs, PCBs, and dioxins/furans.

The selected remedy addresses all areas of this Site, as described in this ROD, such that the top 2 ft (60 cm) of sediments and soils will be replaced with clean material. The goal for the concentrations of this clean material for mercury, other CPOIs, and other constituents will be NYSDEC's sediment criteria (including the LEL of 0.15 mg/kg for mercury) in sediments and 6 NYCRR Part 375 unrestricted use soil cleanup objectives (including the objective of 0.18 mg/kg for mercury) in soils. Clean soil will include imported fill materials from off-Site sources. The selected remedy will also attain a 0.8 mg/kg Site-specific BSQV for mercury in sediments for protection of wildlife consumption of fish and 0.6 mg/kg Site-specific BSQV for mercury in floodplain soils for protection of wildlife consumption of terrestrial invertebrates. The selected remedy is also intended to achieve fish tissue mercury concentrations ranging from 0.1 mg/kg, which is for protection of ecological receptors, to 0.3 mg/kg, which is based on EPA's methylmercury National Recommended Water Quality criterion for the protection of human health from elevated risks due to consumption of organisms.

Specific components of the selected remedy, as shown in Figure 12, are summarized below.

Channel Areas

- **Ninemile Creek Reach AB Channel Lower 1,600 ft (500 m)** (*i.e.*, station 3+00 to station 19+00 [see Figure 10 for the location of these stations][19]): In this portion of Reach AB, a natural formation of uncontaminated marl (with mercury concentrations typically less than 0.15 mg/kg) is present. For the full area of the channel in this portion of Reach AB (*i.e.*, bank-to-bank), sediment overlying the native marl layer and a portion of the marl, as necessary, will be removed to eliminate the need for an isolation cap and to allow for restoration of the stream, including the installation of a sand base layer (0.5 ft [15 cm]) and habitat layer (2 ft [60cm]).

- **Ninemile Creek Reach AB Channel Upper 1,100 ft (340 m)** (*i.e.*, station 19+00 to station 30+00 [see Figure 10 for the location of these stations]): For the full area of the channel in this portion of Reach AB (*i.e.*, bank-to-bank), approximately 2.5 ft (75 cm) of sediment will be removed to eliminate the need for an isolation cap and to allow for restoration of the stream, including the installation of a sand base layer (0.5 ft [15 cm]) and habitat layer (2 ft [60 cm]).

For both sections of the Reach AB channel, removal of channel sediments and restoration of the

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[19] The channel sediments between Stations 0+00 and 3+00 (lower 300 ft [90 m]), which are downstream of Reach AB, are being addressed under the Onondaga Lake Bottom subsite remedy. In this lower 300-ft reach, the concentrations of mercury in the sediments and the depth to marl are significantly greater (see data for Stations NMC-SED-70 through NMC-SED-74 in Appendix B of the OU2 Supplemental FS; note that these data are not shown in Figures 6a through 6c of this ROD since they are downstream of Reach AB). The depth of removal in this lower 300 ft downstream of Reach AB is expected to be greater than 2.5 ft (75 cm) and will be developed as part of the dredge/cap designs for Sediment Management Unit (SMU) 4 of the lake.

stream will allow for passage of flood flows under existing upstream infrastructure (*e.g.*, bridges), and this will ensure no adverse increases in water elevations, limit the extent of flooding, and reduce erosion potential in accordance with applicable requirements, and it will provide sufficient water depth for fish passage and canoe access.

The sand base layer noted above will be installed below the habitat layer to provide support for it and to prevent clay or silt particles from migrating into it. The base layer will also provide the added benefit of attenuating residuals that may remain after dredging. Based on available data related to lithology and the concentrations of contaminants at the Site, it is anticipated that removal of sediments to a depth of 2.5 ft (75 cm) or into marl could be conducted in one dredging pass and will result in concentrations of residuals (generally less than 0.3 mg/kg of mercury; see Appendix C of the OU2 Supplemental FS) that will not require a chemical isolation layer[20].

The final channel restoration plan and profile will be determined during design, and will include microtopography and other features to the extent feasible, to restore in-stream habitat under varying flow conditions.

Floodplain Areas

- **Ninemile Creek Floodplain Adjacent to I-690:** Remove all floodplain soil/sediment (1 ft [30 cm] typical) overlying structural stone between the Ninemile Creek waterline and the break in grade at the top of the bank. Restore removal areas with approximately 1 ft (30 cm) of vegetated habitat layer from the waterline to the break in grade and restore the vegetation in the area including trees and shrubs, as feasible, based on the presence of structural stone, to create a riparian buffer.

- **Ninemile Creek Floodplain Adjacent to Wastebeds 1 through 8:** Remove floodplain soil/sediment to approximately 2 ft (60 cm) below existing grade between the Ninemile Creek waterline and the break in grade associated with the toe of the wastebeds, which generally corresponds to the 370 ft contour. Place approximately 2 ft (60 cm) of vegetated

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[20] One of the design goals for this portion of Ninemile Creek will be to minimize, via sediment removal, the areal extent of stream channel where an isolation layer will be required. Based on the available data, it appears that the vertical distribution of mercury (that would warrant an isolation cap) in Reach AB is generally limited to the top 2 to 3 ft of stream sediments. A Pre-Design Investigation (PDI) will be performed to gather additional channel sediment data from Reach AB. The data will be reviewed during design to determine the appropriate depth of sediment removal. This will include an evaluation of the vertical and areal distribution of mercury, potential post-removal residual concentrations, the potential thickness and type of backfill materials that will be placed over remaining sediments and forming the base for the habitat layer, potential sheeting and dewatering requirements associated with differing removal depths, and potential stability concerns during construction. The evaluation will determine whether or not an isolation layer will be needed beneath the habitat layer in any portion or portions of this reach in lieu of additional sediment removal. It will not be considered feasible to substitute additional sediment removal depth for an isolation layer in a specific area if the additional removal will require or cause: disproportionate additional equipment use or infrastructure (*e.g.*, sheeting, water management equipment, materials); or a major extension to the overall construction schedule. It also will not be considered feasible if the required depth of removal would exceed 2 ft (60 cm) beyond that needed to otherwise remove sediments for the purpose of: placing the isolation layer, erosion protection layer, and habitat layer; and to reconstruct the stream channel with the appropriate depths and slopes for maintaining stream flows and appropriate habitats.

habitat layer along the portion of the floodplain adjacent to Wastebeds 1 through 8 from the waterline to the break in grade. Restore vegetation in the area including trees and shrubs as feasible to create a riparian buffer.

- **Ninemile Creek Floodplain in Wetland SYW-10 Area:** The remedial approach for the remedy for this portion of the Site is divided into different areas based on existing physical features and degrees of mercury contamination[21]. The removal (to various depths specified below) are expected to reduce concentrations of mercury to 0.5 mg/kg or less following removal. However, the engineering feasibility as noted above for channel sediments will also be considered during design to determine the final depths of removal. These areas are described below and are shown in Figure 12:

    - *Wetland SYW-10 Spit Areas*[22]: Remove floodplain soil/sediment to approximately 3 ft (90 cm) below existing grade at the western spit and approximately 4 ft (1.2 m) below grade at the eastern spit, backfill with clean substrate, install habitat layer, and restore wetland conditions. The actual depth of removal and backfill thickness will be determined during design based on the results of a pre-design investigation and the thickness of the habitat layer will be as specified in the habitat restoration plan being developed for the Onondaga Lake Bottom subsite.

    - *Upland Adjacent to Eastern SYW-10 Spit Area:* Remove 2 ft (60 cm) of soil/sediment from the edge of the SYW-10 spit area to the break in grade associated with the toe of the wastebeds, which generally corresponds to the 370 ft contour. Place approximately 2 ft (60 cm) of vegetated habitat layer.

    - *Wetland SYW-10 Forested Wetland:* Remove approximately 2 ft (60 cm) of soil/sediment within the wetland. Place a minimum of 2 ft (60 cm) of suitable habitat layer with the intent to restore the forested wetland and current topography. The actual depth of removal will be confirmed during design based on the results of a pre-design investigation.

    - *Area Adjacent to I-690:* Remove approximately 2 ft (60 cm) of floodplain soil in the area adjacent to I-690. Place approximately 2 ft (60 cm) of vegetated habitat layer on the floodplain in removal areas. The actual depth of removal will be confirmed during design based on the results of a pre-design investigation. The remedial work will be coordinated with the bike trail that is currently being planned for the area.

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21 As discussed in the Geddes Brook/Ninemile Creek RI report, the CPOIs other than mercury have the same general distribution as mercury, although the degree to which they are elevated over upstream conditions, and the extent to which they are found are less than for mercury. Therefore, mercury represents the best measure of the extent of contamination attributable to the LCP Bridge Street subsite. In addition, only mercury presents areas of contiguous sample locations which contain concentrations much greater (*i.e.*, a factor of ten or more) greater than the concentrations in the surrounding area (*i.e.*, hot spots which are present in the wetlands in this area). Sampling during the pre-design investigation would include the other CPOIs (as well as mercury) to ensure that the remedy is protective for all CPOIs.

22 The spit areas referred to in this ROD are small peninsulas extending out on both sides of the mouth of Ninemile Creek into Onondaga Lake. These areas are also part of Wetland SYW-10. See Figure 10.

- *Upland Between SYW-10 Forested Wetland and Ninemile Creek:* Remove floodplain soil/sediment to approximately 3 ft (90 cm) below existing grade. Provide approximately 2 ft (60 cm) of habitat layer in areas where soil/sediment had been removed, resulting in a lower overall elevation, with the intent to establish a forested wetland. The actual depth of removal will be determined during design based on the results of a pre-design investigation.

The selected remedy will encompass the removal of an estimated 58,000 cy (44,000 m^3) of contaminated sediment and soil over an area of approximately 15.5 acres (6.3 hectares) within and along Reach AB. It is estimated that this dredging and excavation will result in the removal of about 640 pounds (290 kg) of mercury from the Ninemile Creek channel and floodplain (or about 92 percent of the estimated total mercury mass in the Reach AB channel and floodplains).

Removal areas for the selected remedy are shown in Figure 16 for channel areas and Figure 17 for floodplain areas.

As discussed above, the remedial limits for the selected remedy are based on physical features which would have confined the possible extent of contamination carried by Ninemile Creek. As shown in Figures 12 and 17, the northwest remedial limit is the northwest edge of the delineated SYW-10 forested wetland, which is separated from the forested floodplain (non-wetland) by a rise in ground surface elevation. The forested portion of SYW-10 is a valuable Class I wetland which is limited along the shores of Onondaga Lake. Therefore, during remedial design a focused study will take place to evaluate criteria such as contaminant concentrations, habitat value, size, location within SYW-10, and engineering considerations to determine what portions of SYW-10 would require remediation. The details of this focused study will be developed during design. Based on the outcome of this study it may be determined that a portion of SYW-10 is appropriate to be excluded from remediation so that area can continue to provide valuable forested wetland functions. In areas of the wetland requiring remediation, remedial activity will be phased to allow portions of the forested wetland to remain intact while the remediated portion is disturbed and restored. However, for the purposes of this ROD, the remedial areas, masses, volumes, and costs for the selected remedy are based on the full extent of the delineated SYW-10 wetland within Reach AB and are therefore upper-end estimates.

Contaminated sediments and soils removed from the stream and floodplain will be disposed of at the LCP Bridge Street subsite containment system, which was designed and constructed, and is being monitored pursuant to the requirements of a September 2000 ROD and/or the SCA that will be constructed at Wastebed 13 as part of the remediation of the Onondaga Lake Bottom subsite. A decision as to the specific disposal location will be made during the design phase. This decision will consider various factors including the design and construction schedules for this Site remedy as well as the SCA so that remediation of Geddes Brook/Ninemile Creek is not unnecessarily delayed.

Consolidation and disposal in this manner is a proven and reliable technology for management of contaminated sediments, soils, and wastes to protect human health and the environment. The consolidated sediments and soils will either be contained at the LCP Bridge Street subsite beneath a 6 NYCRR Part 360 equivalent low-permeability cap covering approximately 18 acres (7 hectares) or at the SCA at Wastebed 13 which will include an impermeable liner and leachate collection/treatment. The containment area at the LCP Bridge Street subsite is surrounded by a subsurface barrier (slurry) wall to contain contaminated groundwater that will be collected and treated.

Treatment of water generated by dredging and excavating sediments and soils and corresponding sediment/soil dewatering will be conducted at a location in the vicinity of the Site. The actual location of the treatment plant, discharge requirements, and point of discharge will be determined as part of the remedial design.

The design and construction of the remedy, including habitat restoration, will need to meet the substantive requirements for permits associated with the disturbance to state and federal regulated wetlands (*e.g.*, 6 NYCRR Part 663, Freshwater Wetlands Permit Requirements) and navigable waters (*e.g.*, 6NYCRR Part 608, Use and Protection of Waters).

Restoration of the stream bed and banks, floodplains, wetlands (including forested areas), and habitats will be performed following sediment and soil removal and placement of a sand base layer and backfill, where needed, and placement of a habitat layer with appropriate substrate types and thicknesses as well as planting of appropriate species of wetland and upland vegetation. Habitat restoration is an integral part of the remediation and the details of habitat restoration will be included in a habitat restoration plan that will be developed during remedial design. The goals of the habitat restoration plan will include, but will not be limited to, providing connectivity of the stream with the surrounding floodplain/wetland, the establishment of diverse habitats and native vegetation (*e.g.*, vernal pools, forested floodplains), and no net loss of wetland areas following remediation. Natural stream restoration techniques will be used in designing both the channel remedy and the habitat layer with the goal of creating a diversity of stream and near-stream habitats and minimizing hardening of the channel and banks, to the extent feasible. Additionally, the specific thickness(es), type(s) of substrate material, and specifications for vegetation to be used for the habitat layer will be developed in the restoration plan.

A comprehensive wetlands and floodplains assessment, as described under EPA's Policy on "Floodplains & Wetlands Assessments for CERCLA Actions" (1985) will be conducted during remedial design.

A long-term monitoring program will be developed during remedial design. It will be implemented to assess the remedy's achievement of the RAOs, RGs, and cleanup levels, monitor habitat restoration success, and to ensure that the remedial technologies are performing as specified in the remedial design. The monitoring program could encompass the stream, floodplains and wetlands before, during and after remedy implementation. Types of monitoring could include biological tissue sampling (*e.g.*, fish, invertebrates), success of vegetation establishment, environmental effect measurements (*e.g.*, community analysis), surface water and sediment sampling, and containment system monitoring (*e.g.*, groundwater) to determine its chemical and structural integrity.

A long-term operations and maintenance program will be developed and implemented to include the inspection of the various components of the remedy, and the performance of any repairs (*e.g.*, bank stabilization, replacement of the habitat layer) that might be necessary to ensure the effectiveness of the remediation. In addition, if an isolation cap is installed as part of the remedy for this Site, the effectiveness of the isolation cap will be monitored in accordance with a monitoring and maintenance program. The scope of the program would be determined during remedial design.

The remedial design will include the collection of additional Site data (*e.g.*, sediment cores, soil borings) to delineate in detail the various areas in which remedial activities will be performed consistent with the requirements of the selected remedy, including the final determination of dredging/excavation areas and volumes. The specific types of dredging and excavation methods will be determined during design. Also, treatability studies (*e.g.*, water treatment) will be performed if necessary.

The design and construction of the remedy will also need to meet all applicable requirements and regulations regarding water flow and flooding as well as protection of federal and state-listed threatened and endangered species.

A Phase 1A Cultural Resource Assessment for various areas, including the Site, was completed by Honeywell in 2003. Based on the results of the Phase 1A assessment, Phase 1B cultural resources work will be conducted in appropriate areas of lower Ninemile Creek prior to remediation.

If residual contamination remains beneath the habitat layer in any areas following the implementation of the selected remedy at levels above that which would allow for unlimited use or unrestricted exposure, an institutional control, such as an environmental easement or some other appropriate mechanism which would include restrictions on dredging/excavating in these areas, will be needed. As part of the selected remedy, it will be certified on an annual basis that remedy-related O&M is being performed. If an institutional control is implemented under the selected remedy, it will be certified on an annual basis that the institutional control is in place. In addition, although they are voluntary, and so are not considered true institutional controls, the New York State Department of Health fish consumption advisories for Onondaga Lake and its tributaries, including Geddes Brook and Ninemile Creek, will continue.

The environmental benefits of the selected remedy may be enhanced by consideration, during remedial design, of technologies and practices that are sustainable in accordance with EPA Region 2's Clean and Green policy. This will include consideration of green remediation technologies and practices.

It is estimated that the dredging/excavating, backfilling, and habitat layer placement components of the selected remedy along with dewatering, water treatment, and transport/disposal of sediments and soils at the containment system at the LCP Bridge Street subsite or the SCA will take approximately one year.

Because this selected remedy will result in contaminants remaining on-Site above levels that allow for unlimited use and unrestricted exposure to Site media, CERCLA requires that the Site be reviewed at least once every five years. The five-year review will evaluate the results from monitoring programs established as part of this remedy to ensure that the remedy remains protective of human health and the environment. If justified by the review, additional remedial actions may be implemented to remove, treat, or contain the contaminated sediments and floodplain soils/sediments.

Summary of the Estimated Remedy Costs

The estimated cost of the selected remedy for Reach AB of lower Ninemile Creek is $16,500,000. This total cost estimate is comprised of a capital cost of $15,100,000[23] and annual O&M and periodic costs of $110,000 per year (or $1,400,000 in present-worth cost).

The cost estimates presented in this ROD are based upon capital (construction) costs and the present-worth of the annual O&M costs calculated using a discount rate of 7 percent and a 30-year

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23 For cost estimating purposes, the capital cost is based on disposal in the containment area at the LCP Bridge Street subsite.

time interval. The actual costs will vary depending on the specifications contained in the detailed remedial design. Further, the actual costs will also vary because the cost estimates provided are developed conservatively and have an accuracy of +50 percent to -30 percent, to comply with the 1988 EPA guidance document, "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA."

Table 13 provides details of the estimated cost of the selected remedy.

Expected Outcomes of the Selected Remedy

The results of the HHRA indicate that the Site, if left unremediated, presents an unacceptable noncancer hazard and an increased cancer risk to recreational users of Ninemile Creek due to consumption of contaminated fish. The results of the BERA indicate that comparisons of measured tissue concentrations and modeled doses of chemicals to toxicity reference values show exceedances of hazard quotients for Site-related chemicals throughout the range of the point estimates of risk. Site-specific sediment toxicity data indicate sediments are toxic to benthic macroinvertebrates on both an acute and chronic basis.

The State of New York, Onondaga County, and the City of Syracuse have jointly sponsored the preparation of a land-use master plan to guide future development of the Onondaga Lake area (Syracuse-Onondaga County Planning Agency, 1998). The primary objective of land-use planning efforts is to enhance the quality of the Onondaga Lake area for recreational and commercial uses. Implementation of the remedy will aid this long-term planning effort by reducing or eliminating concerns related to human exposure to contaminated sediments, soils, and surface water.

Under the selected remedy, it is estimated that concentrations of contaminants in fish will be reduced following completion of remedial activities. Potential risks to humans who consume fish and existing and potential future adverse ecological effects on fish and wildlife resources will be eliminated or reduced as contaminant levels fall. Fish tissue data from post-remedial monitoring can be used to document improvements in the streams, and to support reevaluation of the NYSDOH fish consumption advisory.

STATUTORY DETERMINATIONS

Under CERCLA Section 121 and the NCP, remedies must be selected that are protective of human health and the environment, comply with ARARs (unless a statutory waiver is justified), are cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Section 121(b)(1) also establishes a preference for remedial actions which employ treatment to permanently and significantly reduce the volume, toxicity, or mobility of the hazardous substances, pollutants, or contaminants at a site.

For the reasons discussed below, NYSDEC and EPA have determined that the selected remedy meets these statutory requirements.

Protection of Human Health and the Environment

The selected remedy will be protective of human health and the environment in that all RAOs, RGs, and cleanup levels will be met through the implementation of this remedy. The predicted reductions of mercury and other contaminant inventories are expected to reduce the exposures and uptake of contaminants in humans and wildlife. BSQVs were developed for Geddes Brook/Ninemile Creek to provide a conservative total mercury concentration in sediments and soils below which bioaccumulation is expected to be low enough to result in mercury concentrations in fish and terrestrial organisms that are protective for human and wildlife consumption. BSQVs of 0.8 mg/kg and 0.6 mg/kg for mercury in sediments and soils, respectively, based on the most sensitive receptors (*i.e.*, the river otter and short-tailed shrew), are considered protective of all adult human and ecological receptors modeled in the Geddes Brook/Ninemile Creek risk assessments. Following implementation of the selected remedy, mercury concentrations in the habitat layer of the channel and floodplain will be less than the BSQVs of 0.8 mg/kg and 0.6 mg/kg, respectively.

The implementation of the selected remedy will not pose unacceptable short-term risks or cross-media impacts that cannot possibly be mitigated.

Compliance with ARARs and Other Environmental Criteria

Since there are currently no federal or state promulgated standards for contaminant levels in sediments, the literature-based sediment screening criteria were used as "To-Be-Considered" criteria. A summary of action-specific, chemical-specific, and location-specific ARARs, as well as TBCs, which will be complied with during implementation of the selected remedy, is presented below.

Action-Specific ARARs:

- National Emissions Standards for Hazardous Air Pollutants (40 CFR Parts 51, 52, and 60)
- 6 NYCRR Part 257, Air Quality Standards
- 6 NYCRR Part 200, New York State Regulations for Prevention and Control of Air Contamination and Air Pollution
- 6 NYCRR Part 375-1,-2, Environmental Remediation Programs
- 6 NYCRR Part 376, Land Disposal Restrictions
- Resource Conservation and Recovery Act (42 U.S.C. § 6901, *et seq*.)
- Clean Water Act Sections 301-304 and 307
- Clean Water Act Section 404
- Rivers and Harbors Act Section 10
- Fish and Wildlife Coordination Act, 16 USC § 662

Chemical-Specific ARARs:

- Safe Drinking Water Act (SDWA) MCLs and nonzero MCL Goals (40 CFR Part 141)
- 6 NYCRR Parts 700-705 Groundwater and Surface Water Quality Regulations
- 6 NYCRR Part 703, New York State Surface Water Quality Standards

Location-Specific ARARs:

- Fish and Wildlife Coordination Act, 16 U.S.C. 661
- New York State Environmental Conservation Law, Article 24, Freshwater Wetlands
- 6 NYCRR Part 663, Freshwater Wetlands Permit Requirements Regulations
- New York State Environmental Conservation Law, Article 15, Use and Protection of Waters
- 6 NYCRR Part 608, Use and Protection of Waters
- National Historic Preservation Act

Other Criteria, Advisories, or Guidance TBCs:

- New York Guidelines for Soil Erosion and Sediment Control
- New York State Air Cleanup Criteria, January 1990

- SDWA Proposed MCLs and nonzero MCL Goals
- NYSDEC Technical and Operational Guidance Series 1.1.1, June 1998
- NYSDEC Guidelines for the Control of Toxic Ambient Air Contaminants, DAR-1, November 12, 1997
- NYSDEC Technical Guidance for Screening Contaminated Sediments, January 1999
- EPA Region 2's Clean and Green Policy, March 2009
- EPA's 1985 Policy on Floodplains and Wetland Assessments for CERCLA Actions
- EPA's Protection of Wetlands Executive Order 11990
- EPA's Floodplain Management Executive Order 11988

A summary of the action-specific, chemical-specific, and location-specific ARARs and TBCs is presented in Tables 14 through 19.

Cost-Effectiveness

A cost-effective remedy is one whose costs are proportional to its overall effectiveness (NCP §300.430(f)(1)(ii)(D)). Overall effectiveness is based on the evaluations of: long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness. Based on the comparison of overall effectiveness (discussed above) to cost, the selected remedy meets the statutory requirement that Superfund remedies be cost-effective in that for a reasonable increase in cost, it affords a greater degree of permanence and reliability than does the lower-cost action alternatives, and it will achieve the remediation goals in a reasonable time frame.

Each of the alternatives has undergone a detailed cost analysis. In that analysis, capital and annual O&M costs have been estimated and used to develop present-worth costs. The cost estimates presented in this ROD are based upon capital (construction) costs and the present-worth of the annual O&M costs calculated using a discount rate of 7 percent and a 30-year time interval.

Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

NYSDEC and EPA have determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the Site. Of the alternatives that are protective of human health and the environment and comply with ARARs, NYSDEC and EPA have determined that the selected remedy provides the best balance of tradeoffs in terms of the five balancing criteria set forth in NCP §300.430(f)(1)(i)(B), while also considering the statutory preference for treatment as a principal element and the bias against off-Site disposal without treatment and further considering support agency and community acceptance.

Implementation of the selected remedy will greatly reduce the mass of mercury and other CPOIs in the sediments and soils and lower the contaminant concentrations in surface sediments and soils, which in turn will reduce contaminant levels in the water column and fish and other biota, thereby reducing the level of risk to humans and ecological receptors.

Preference for Treatment as a Principal Element

EPA's statutory preference for treatment of principal threat materials has been considered as part of this remedy.

As noted above in the “Principal Threat Waste” section, the contaminated sediments and soils within the Site contain hazardous substances, pollutants, or contaminants that have migrated from the LCP Bridge Street subsite. Although contaminated sediments/soils are present at the Site, the concentrations are generally lower than the levels found on the LCP Bridge Street subsite. Thus, these contaminated sediments and soils would not be considered “source materials” or “principal threat wastes.”

Five-Year Review Requirements

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on Site above levels that allow for unlimited use and unrestricted exposure to Site media, a statutory review will be conducted within five years after initiation of remedial action. The five-year review will evaluate the results from monitoring programs established as part of this remedy to ensure that the remedy remains protective of human health and the environment.

DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan identified Alternative 3 (removal, backfill, and placement of a habitat layer) as the preferred remedy. Based upon the review of the written and oral comments submitted during the public comment period, NYSDEC and EPA determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

LIST OF REFERENCES USED IN RECORD OF DECISION AND RESPONSIVENESS SUMMARY

Avocet and Science Applications International Corporation 2002. Development of Freshwater Sediment Quality Values for use in Washington State – Phase I Task 6: Final Report. Prepared for Washington State Department of Ecology, Sediment Management Unit. September 2002. Publication Number 02-09-050. http://www.ecy.wa.gov/biblio/0209050.html.

Avocet. 2003. Development of Freshwater Sediment Quality Values for use in Washington State – Phase II, Development and Recommendations of SQVs for Freshwater Sediments in Washington State. Prepared for Washington State Department of Ecology, Toxics Cleanup Program, Sediment Management Unit under contract to Science Applications International Corporation. September. Publication Number 03-09-088. http://www.ecy.wa.gov/biblio/ 0309088.html.

BBL. 1999. Supplemental Site Investigation Report, Wastebeds 9 to 15, Onondaga County, New York. Prepared for AlliedSignal, Inc., Syracuse, NY by BB&L Engineers and Scientists, Syracuse, NY. August.

CDR Environmental Specialists (CDR). 1991. Environmental Assessment of Lower Reaches of Ninemile Creek and Geddes Brook, Oswego Watershed, New York. Prepared for AlliedSignal, Solvay, NY by CDR Environmental Specialists, Stow, MA. July.

Cooper, A.L., M.J. Tracy, and G.N. Neuderfer. 1974. A Macroinvertebrate Study of Ninemile Creek. New York State Department of Environmental Conservation Divisions of Fish and Wildlife and Water Management Planning. July.

Long, E.R. and L.G. Morgan. 1990. The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. NOAA Technical Memorandum, NOS OMA 64. National Oceanic and Atmospheric Administration, Seattle, WA.

New York State Conservation Department (NYSCD). 1946. Onondaga Lake Survey 1946, a Study of Onondaga Lake and Tributary Waters to Determine Chemical and Pollutional Characteristics. File reference: Onondaga L. (12-12-66) Oswego Watershed.

NYSCD. 1947. A Supplementary Report to the Survey of Onondaga Lake and Tributary Streams in 1946 and 1947. File reference: Onondaga L. (12-12-66) Oswego Watershed.

New York State Department of Environmental Conservation (NYSDEC). 1999. Technical Guidance for Screening Contaminated Sediments. NYSDEC Division of Fish, Wildlife, and Marine Resources. Albany, NY. January.

NYSDEC. 2002. Order on Consent with Honeywell for the Geddes Brook IRM. Index No. D7-0003-01-09. April 16.

NYSDEC and EPA. 2009. Record of Decision, Operable Unit 1 of the Geddes Brook/Ninemile Creek Site Operable Unit of the Onondaga Lake Bottom Subsite of the Onondaga Lake Superfund Site. NYSDEC, Albany, NY and EPA Region 2, New York, NY. April.

NYSDEC and EPA. 2005. Record of Decision Volume 1, Onondaga Lake Bottom Subsite of the Onondaga Lake Superfund Site. NYSDEC, Albany, NY and EPA Region 2, New York, NY. July.

New York State Department of Health (NYSDOH). 2008. Chemicals in Sportfish and Game, 2008-09 Health Advisories. NYSDOH, Albany, NY. April.

NYSDOH. 1995. Public Health Assessment. Onondaga Lake, City of Syracuse, Towns of Salina and Geddes, Onondaga County, New York. New York State Department of Health, Albany, NY.

O'Brien & Gere. 2006. Revised Work Plan, Remedial Investigation/Feasibility Study Wastebeds 1 through 8, Geddes, New York. Prepared for Honeywell. November.

Parsons. 2009. Geddes Brook/Ninemile Creek Operable Unit 2 Supplemental Feasibility Study Report. Draft Final. Prepared by Parsons, Liverpool, NY in association with Exponent and Anchor QEA for Honeywell, East Syracuse, NY. May.

Parsons. 2008a. Geddes Brook/Ninemile Creek Operable Unit 1 Supplemental Feasibility Study Report. Draft Final. Prepared by Parsons, Liverpool, NY in association with Exponent and QEA for Honeywell, East Syracuse, NY. November.

Parsons. 2008b. Engineering Evaluation/Cost Analysis Geddes Brook Interim Remedial Measure. Draft Final. Prepared by Parsons, Liverpool, NY for Honeywell, East Syracuse, NY. November.

Parsons. 2008c. Remedial Design Work Plan for the Onondaga Lake Bottom Subsite. Draft. Prepared by Parsons, Liverpool, NY for Honeywell, East Syracuse, NY. October.

Parsons. 2005. Geddes Brook/Ninemile Creek Feasibility Study Report. Draft Final. Prepared by Parsons, Liverpool, NY in association with Exponent, Albany, NY for Honeywell, Morristown, NJ. May.

Parsons. 2004. Onondaga Lake Feasibility Study Report. Draft Final. Prepared by Parsons, Liverpool, NY in association with Exponent and QEA for Honeywell, Morristown, NJ. November.

Parsons. 2003. Preliminary (50%) Design Report for the Geddes Brook Site, Geddes, New York. Prepared by Parsons, Liverpool, NY for Honeywell, Morristown, NJ. August.

Parsons. 2002. Interim Remedial Measure Work Plan for the Geddes Brook Site, Geddes, New York. Prepared by Parsons, Liverpool, NY for Honeywell, Morristown, NJ. November.

Persaud, D., R. Jaagumagi, and A. Hayton. 1993. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of the Environment, Water Resources Branch.

PTI. 1996. Onondaga Lake RI/FS West Flume Mercury Investigation and Supplemental Sampling and Ninemile Creek Supplemental Sampling Data Report. Prepared for AlliedSignal, Inc, Syracuse, NY by PTI Environmental Services, Bellevue, WA.

Syracuse Department of Water (SDW), City of Syracuse. 2000. Water newsletter home page. Web site: www.syracuse.ny.us/syrmayor/Services/Departments/waterreport.html. Accessed May.

Syracuse-Onondaga County Planning Agency. 1998. 2010 Development Guide for Onondaga County. 1100 Civic Center, 421 Montgomery Street, Syracuse, NY 13202. June.

TAMS/Earth Tech. 2003a. Geddes Brook/Ninemile Creek Human Health Risk Assessment. Original document prepared for Honeywell, East Syracuse, NY by Exponent, Bellevue, WA. Revision prepared for New York State Department of Environmental Conservation, Albany, NY by TAMS/Earth Tech, New York, NY and YEC, Valley Cottage, NY. July.

TAMS/Earth Tech. 2003b. Geddes Brook/Ninemile Creek Baseline Ecological Risk Assessment. Original document prepared for Honeywell, East Syracuse, NY by Exponent, Bellevue, WA. Revision prepared for New York State Department of Environmental Conservation, Albany, NY by TAMS/Earth Tech, New York, NY and YEC, Valley Cottage, NY. July.

TAMS/Earth Tech. 2003c. Geddes Brook/Ninemile Creek Remedial Investigation Report. Original document prepared for Honeywell, East Syracuse, NY by Exponent, Bellevue, WA. Revision prepared for New York State Department of Environmental Conservation, Albany, New York by TAMS/Earth Tech, New York, NY and YEC, Valley Cottage, NY. July.

TAMS/Earth Tech. 2002. Onondaga Lake Remedial Investigation Report. Original document prepared by Exponent, Bellevue, Washington, for Honeywell, East Syracuse, New York. Revision prepared by TAMS/Earth Tech, New York, New York and YEC, Valley Cottage, New York, for New York State Department of Environmental Conservation, Albany, New York. December.

USEPA. 2005. The National Study of Chemical Residues in Lake Fish Tissue. Fact Sheet: 2005 Update and Years 1 through 4 Data. EPA-823-F-05-012. October.

USEPA. 1993. Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA. OSWER Directive 9360.0-32. December.

USEPA. 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA. PB89-184626. October.

USEPA. 1973. Report of Mercury Source Investigation, Onondaga Lake, New York and Allied Chemical Corporation, Solvay, New York. Prepared by National Field Investigations Center Cincinnati and USEPA Region II, New York. USEPA Office of Enforcement and General Counsel. April.