4. SOURCES AND POTENTIAL SOURCES OF CHEMICAL PARAMETERS OF INTEREST TO ONONDAGA LAKE

Based on data acquired during the Onondaga Lake remedial investigation (RI), as well as investigations from other Honeywell and non-Honeywell sites, this chapter describes external sources and potential sources of mercury and other chemical parameters of interest (CPOIs) to Onondaga Lake. Some of the more prevalent CPOIs or classes of CPOIs are listed below:

- Mercury and other metals.
- Benzene, toluene, ethylbenzene, and xylene (BTEX).
- Chlorinated benzenes.
- Polycyclic aromatic hydrocarbons (PAHs).
- Polychlorinated biphenyls (PCBs).
- Dioxins/furans (PCDD/PCDFs).
- Calcite.

The nature and extent of all CPOIs within Onondaga Lake and the fate and transport of numerous CPOIs within the lake system are discussed in Chapters 5 and 6, respectively.

This chapter provides information on past and present sources and potential sources of mercury and other CPOIs to Onondaga Lake to support the analysis of contaminant fate and transport in this RI, as well as the analysis of remedial alternatives in a feasibility study (FS). Available information on sources and potential sources of mercury and other CPOIs to the lake from upland sites, areas of concern, and tributaries have been summarized. The various sites and areas of concern consist of Honeywell and non-Honeywell sources and potential sources. Several of these sites have been listed as "subsites" of the Onondaga Lake National Priorities List (NPL) site. As of December 2002, the subsites include, in addition to the lake itself, Honeywell LCP Bridge Street, Honeywell Semet Residue Ponds, Honeywell Wastebed B/Harbor Brook, Honeywell Willis Avenue, the Town of Salina Landfill, General Motors – former Inland Fisher Guide facility (GM – IFG) and Ley Creek Deferred Media, the GM – Ley Creek Dredgings, and the Maestri 2 sites. Chapter 1, Table 1-1 provides a listing and description of the Honeywell upland sites and corresponding consent orders, to date. The Honeywell sites are shown in Figure 4-1, except for the Solvay Wastebeds, which are presented in Chapter 1, Figure 1-7.

The Honeywell sources and potential sources and non-Honeywell sources and potential sources in the area between Ninemile Creek and Harbor Brook, discussed in Sections 4.1 through 4.5 of this chapter, are located in the following five areas:

- West Flume/Geddes Brook/Ninemile Creek area.
- Honeywell lakeshore area.
- Solvay Wastebeds area.
- Dredge spoils area.
- Honeywell in-lake waste deposit area.

Note that while the Honeywell in-lake waste deposit is not actually an external or upland source to the lake, it is considered so here. This reflects the fact that the deposit is waste material and not the result of natural deposition.

Non-Honeywell sources and potential sources around the lake, discussed in Section 4.6 of this chapter, are located in the following five areas:

- Ley Creek area.
- Onondaga Creek area.
- Oil City area.
- Metropolitan Syracuse Sewage Treatment Plant (Metro).
- Bloody Brook area.

A map showing the location of the referenced non-Honeywell sites in the vicinity of Onondaga Lake is also presented in Section 4.6 (see Figure 4-15).

While there are numerous contaminated sites with preferential pathways, CPOIs generally are released to Onondaga Lake through either groundwater discharges or tributaries, except for the CPOIs in the in-lake waste deposit, which can directly enter the lake system.

Based on the most recent information available (i.e., through November 2002), this chapter also takes into consideration ongoing or planned remedial activities. For example, some of Honeywell's sites are being actively remediated or may be in the near future; thus, continuing loads from these sources may change significantly relative to historical conditions. Furthermore, while external sources of mercury and other CPOIs are summarized here, a more complete description of contaminant loads, both external and internal, can be found in Chapter 6.

As discussed previously in this report (Chapter 1, Section 1.3), the manufacturing/disposal operations of Honeywell's predecessors represent one of the most important historical sources of CPOIs to Onondaga Lake. For example, USEPA (1973) cites an AlliedChemical letter of July 21, 1970 to the New York Department of Health stating that, "prior to May 9, 1970, the mercury discharged to Geddes Brook (tributary to Ninemile Creek) averaged 22 pounds per day." This estimate does not take into account other large amounts of mercury discharged or lost to the environment, such as the large amounts of separate-phase elemental mercury at, and in the vicinity of, the mercury cell buildings at both the LCP Bridge Street and Willis Avenue plant sites, as well as that discharged directly to Onondaga Lake. It is not possible to fully account for the mass of mercury historically discharged, as Honeywell asserts (PTI, 1992d) that no records of spills or discharges were kept for most of the plants' operational histories.

4.1 West Flume/Geddes Brook/Ninemile Creek Area

This area includes the following sites:

- LCP Bridge Street site (Operable Units 1 and 2 [OU-1 and OU-2]).
- Geddes Brook/Ninemile Creek site.
- Mathews Avenue Landfill site.
- Maestri 2 site.
- Doring Property site.

The first two sites are discussed together in Section 4.1.1 below, as the LCP Bridge Street site is the major source of mercury to Geddes Brook and Ninemile Creek. The remaining three sites, which are in the proximity of the Ninemile Creek system and are potential sources of CPOIs to Ninemile Creek, are discussed in Section 4.1.2.

4.1.1 LCP Bridge Street and Geddes Brook/Ninemile Creek Sites

The LCP Bridge Street site, which includes the West Flume, is a source of mercury and other CPOIs to Geddes Brook, a tributary of Ninemile Creek. Geddes Brook and Ninemile Creek are located southwest of Onondaga Lake (see Figure 4-1). Ninemile Creek begins at Otisco Lake and enters Onondaga Lake at the village of Solvay, New York, and flows adjacent to Wastebeds 9 through 15 and 5, 6, and 8 before entering the lake. Geddes Brook flows through the town of Geddes and enters Ninemile Creek approximately 1 mile (mi) (1.6 kilometers [km]) upstream from Onondaga Lake. Geddes Brook receives discharge from the West Flume (formerly referred to as the "West Sewer" by AlliedChemical [New York State Department of Health {NYSDOH}, 1951]), a drainage ditch that passes through the LCP Bridge Street facility (see Figure 4-1).

The LCP Bridge Street site consists of 20 acres (8 hectares) of land used for various industrial activities (including a mercury and diaphragm cell chlor-alkali production facility that operated from 1953 to 1988). The RI and risk assessments, based on data collected by Honeywell and NYSDEC, were completed by NYSDEC and TAMS in 1998. The FS for the site (Gradient and Parsons, 1999) was reviewed by NYSDEC, which issued a record of decision (ROD) in September 2000. The buildings at the site were demolished as part of two interim remedial measures (IRMs). Remediation (described below) will commence pending completion and NYSDEC approval of the remedial design, which is being carried out under the terms of the NYSDEC-approved remedial design work plan (Parsons, 2002c). Current sources of mercury to the West Flume from the LCP Bridge Street facility include:

- Direct discharge of contaminated groundwater.
- Discharge from a ponded area at the site.
- Particulate mercury from surface runoff (NYSDEC/TAMS, 1998c).

A potential major source of mercury to groundwater at the LCP Bridge Street site is a zone of residual elemental liquid mercury (i.e., dense non aqueous phase liquid [DNAPL]), which is entrained in both the lower and upper aquifers and is located north of the former mercury cell building (NYSDEC/TAMS, 1998c). PCBs are found in site soils at concentrations as high as 76 mg/kg, and the site may have been a historic source of PCBs to the Ninemile Creek system (NYSDEC/TAMS, 1998c). The ROD (September 2000) requires that the site remediation include the following:

- Cleaning the manhole structures and catch basins and filling the sewer system located downgradient of the former mercury and diaphragm cell buildings.
- Encapsulation of the site with a slurry wall and cap.
- Removal of sediment in the West Flume and the wetland area adjacent to the site. The wetland area, which is part of New York State Wetland SYW-14, will be remediated to background mercury concentrations (0.2 mg/kg), based on sediments upstream of the site, in order to prevent downstream contamination by sediments scoured during high flows.
- Excavation and on-site capping of brine muds.
- Excavation of shallow soils with high concentrations (including DNAPL) of mercury in the upper aquifer zone, followed by treatment and/or disposal.
- Excavation of soils with PCB concentrations above 1 mg/kg in surface soils and above 10 mg/kg in subsurface soils.
- Long-term monitoring.
- Placement of a site deed restriction.
- The ROD also states that if monitoring results from deep borings in the vicinity of the mercury cell building area and groundwater monitoring wells indicate that elemental mercury is mobile and that it would not be effectively contained by the cap and barrier wall system, mercury DNAPL recovery wells or other treatment methods will be considered.

In addition to the ROD for the LCP Bridge Street site, Honeywell has agreed to implement an IRM for Geddes Brook (D. Hesler, pers. comm., 2002). The scope of the IRM includes full bank-to-bank sediment removal from Geddes Brook, beginning at the confluence with the West Flume and ending at the confluence with Ninemile Creek, an estimated 4,200 cubic yards of sediment. Contaminated floodplain soils along Geddes Brook will also be addressed as part of this IRM. A draft Geddes Brook IRM work plan (Parsons, 2002a) is currently under review by NYSDEC.

4.1.1.1 Sources and Migration Pathways of Mercury

Two primary sources of mercury to Onondaga Lake have been identified in the Geddes Brook/Ninemile Creek system:

- Dissolved and particulate mercury loading from the LCP Bridge Street site (NYSDEC/TAMS, 1998c).

- Episodic loading that occurs when mercury-contaminated sediments in the creeks and floodplains are mobilized during high-flow periods (NYSDEC/TAMS, 1998b).

Analysis of surface water, sediment, and floodplain soils indicate that the West Flume is the main conduit, both currently and historically, of mercury contamination in the Ninemile Creek watershed. Chapter 6 provides loading estimates based on a statistical analysis of the available data.

4.1.1.2 Sources and Migration Pathways of Non-Mercury Chemical Parameters of Interest

The LCP Bridge Street site RI report (NYSDEC/TAMS, 1998c) concluded that non-mercury contamination in groundwater in the area to the south of the West Flume is benign in terms of migration to the lake system. A groundwater plume of chlorinated solvents (vinyl chloride, chloroethane, methylene chloride, 1,1-dichloroethane, 1,2-dichloroethene, and 1,1,1-trichloroethane) and benzene that exists east of the site and south of the West Flume originates from an upgradient, off-site source and dissipates over a short distance on-site and before the groundwater reaches the ponded area of the LCP Bridge Street site (NYSDEC/TAMS, 1998c). Furthermore, Honeywell is currently performing an RI/FS at OU-2 of the LCP Bridge Street site to assess groundwater contaminated with xylenes and other CPOIs in the area of the former hydrogen peroxide plant north of the West Flume (Parsons Engineering Science, 2001).

There appear to be two source areas for PAHs within Geddes Brook and Ninemile Creek: one far upstream in Geddes Brook (Station GB1; Exponent, 2001d, currently under revision by NYSDEC), and one in Ninemile Creek, less than a kilometer upstream of Onondaga Lake (Station NM9; Exponent 2001d, currently under revision by NYSDEC). Sediments in both of these areas had elevated concentrations of PAHs, including anthracene, benzo[g,h,i]perylene, chrysene, fluoranthene, phenanthrene, and pyrene.

A potential source of non-mercury CPOIs to upper Geddes Brook (Station GB1) is runoff from residential areas. The low concentrations (mostly below detection) in recent surface water analyses indicate that an ongoing source of organic contaminants to Geddes Brook and Ninemile Creek via surface water is unlikely. Because most of the organic contaminants have relatively long half-lives in sediment (e.g., PCBs and PAHs), they may reflect past loadings to the sediments of lower Ninemile Creek.

Groundwater, and probably surface runoff, from Wastebeds 9 through 15 yield increased concentrations of calcium, chloride ions, iron, magnesium, manganese, potassium, sodium, and total dissolved solids in

Ninemile Creek above its confluence with Geddes Brook (i.e., between Stations NM2 and NM4; Exponent, 2001d; currently under revision by NYSDEC). For more discussion of these wastebeds, see Section 4.3.

In summary, non-mercury CPOIs were detected in sediment and floodplain soils of Geddes Brook/ Ninemile Creek (Exponent, 2001d, currently under revision by NYSDEC). The presence of non-mercury CPOIs in the sediments of the West Flume, Geddes Brook, and Ninemile Creek indicates that historical discharges of these compounds have occurred, with the lake as the likely final recipient, as is evidenced by their occurrence in lake sediments.

4.1.2 Other Potential Industrial Sources to Ninemile Creek

Honeywell's Mathews Avenue Landfill is no longer in operation and was a construction/demolition debris disposal site used by the Syracuse Works. The site is bordered by the Old Erie Canal on the north and Geddes Brook to the west (Figure 4-1). Honeywell entered into an Order on Consent in September 2002 for implementation of a Preliminary Site Assessment (PSA) and, if warranted, an RI/FS (NYS index # D-7-0007-01-01). Honeywell is currently performing the PSA at the site.

The Maestri 2 site consists of a 10-acre area in a wetland that was filled with mill scale and other wastes from the Crucible Materials Corporation facility and automotive wastes from the Val's Dodge car dealership. The wetland adjacent to the site drains into Ninemile Creek. An RI performed by the potentially responsible parties (PRPs) is underway at the site.

The Doring Property site is a fill area within a wetland that also received mill scale from the Crucible Materials Corporation facility. Surface water in an adjacent wetland flows to Ninemile Creek. A PSA performed by the PRPs is ongoing.

4.2 Honeywell Lakeshore Area

This area between Tributary 5A and Harbor Brook includes the following Honeywell sites:

- Semet Residue Ponds site.
- Willis Avenue Plant site.
- Willis Avenue Ballfield site.
- Wastebed B/Harbor Brook site.

In addition to these Honeywell sites (discussed below), the Crucible Materials Corporation (Crucible) plant and disposal area near the mouth of Tributary 5A are potential sources of contaminants to the lake. According to Crucible (1984), approximately 52.5 tons of caustic-coated mill scale containing hexavalent chromium (D002) were disposed of at the Crucible Lake Pump Station disposal area site by Crucible from 1961 through 1967. In addition, grinding dust, slag, boiler ash, coolant sludge, and construction and demolition debris (all considered as non-hazardous wastes) may have been disposed of there. This disposal

area is located on the shoreline of Onondaga Lake adjacent to the mouth of Tributary 5A. Groundwater beneath the site discharges directly to Onondaga Lake. In October 1990, four soil samples were collected by NYSDEC at a depth of approximately 4 inches at the disposal area. Laboratory results for the samples indicate that site soils are highly contaminated with chromium. These results are supported by Crucible's ongoing PSA, which indicates that elevated chromium levels are present in surface and subsurface soil samples (C&S, 2002).

Contamination of various types has been documented at the Honeywell sites along the southwest shore of Onondaga Lake, several of which have historically discharged waste directly to the lake. In addition, wastes or waste constituents have also been discharged to Onondaga Lake via small nearby streams and drainage ditches. Data indicate that some of these sites are currently contributing CPOIs to the lake via contaminated groundwater (and potentially NAPLs).

Honeywell owns the shoreline areas from Tributary 5A to Harbor Brook, as well as the land extending a significant distance inland from the shore (see Figure 4-1). These properties are bisected by I-690 and other roads or railroad rights-of-way. Honeywell has entered into an order on consent (Index #D7-0004-01-09) with NYSDEC to implement an IRM (O'Brien & Gere, 2002d) for the lakeshore area between Tributary 5A and the East Flume, which will include a groundwater and DNAPL collection system and a vertical barrier along the entire shoreline. An IRM for enhanced collection of DNAPL in a portion of this area is being implemented by Honeywell, as described in Section 4.2.2.1.

In the following discussions, each of the major Honeywell sites is described, along with its CPOIs. In addition, the contributions via individual streams and drainage ditches are also addressed. These water bodies serve to transport ongoing releases from the various sites, as well as the re-release of CPOIs from the sediment resulting from historical discharges. Figures 4-2 and 4-3 are maps of the Honeywell lakeshore area illustrating the sites and local tributaries to the lake.

4.2.1 Semet Residue Ponds

The Semet Residue Ponds site is located in the town of Geddes, Onondaga County, New York (see Figure 4-2). The site is next to the lakeshore and adjacent to the Willis Avenue Plant site. The Semet Residue Ponds site consists of:

- Five ponds approximately 400 ft (120 m) south of Onondaga Lake and I-690, in the western half of Solvay Wastebed A. The ponds have an average depth of 20 ft (6.1 m) and contain approximately 80 million gallons (300 million liters) of residual material.

- Two small containment areas to the south and west of the ponds (O'Brien & Gere, 1991).

Tributary 5A originates from natural springs south of the site, and flows along the south and west sides of the site before discharging into Onondaga Lake. The area surrounding the site is highly industrialized. Crucible Materials Corporation, the former Honeywell Willis Avenue facility, and an industrial complex (the former Honeywell Main Plant) border the site to the west, east, and south, respectively. The FS report for the Semet Residue Ponds (O'Brien & Gere, 1999a) was submitted to NYSDEC, and the ROD was issued by NYSDEC and USEPA in March 2002. The ROD provides for various remedial activities, including the removal and chemical processing of the Semet residue for conversion into RT-12 (an ingredient of driveway sealer) and other saleable products, groundwater capture along the lakeshore and Tributary 5A, and on-site groundwater treatment.

Prior to construction of the Semet Residue Ponds, the area containing the site (i.e., Wastebed A) was used as a settling basin for the disposal of Solvay Process waste from the Main Plant site just south of this location. The ponds were constructed by dragline and bulldozer excavation, and were confined by dikes made of rubble, ashes, and debris (e.g., electrolytic cell parts, bricks, and stone) (O'Brien & Gere, 1991). Between 1917 and 1970, the Semet-Solvay Division of Allied Chemical & Dye used the ponds as depositories for organic-based residue (PTI, 1992d). This residue was generated by the acid-washing of coke light oil at the benzene, toluene, and xylenes facility at the Main Plant site in preparation for fractionation. The site also received coarse ash and cinders from stoker-fired boilers at the Syracuse Works, and material contaminated with high levels of calcium carbonate from a former ammonium chloride operation (O'Brien & Gere, 1991).

The CPOIs associated with the Semet Residue Ponds include BTEX, naphthalene and other PAHs, and mercury. Berms surround the ponds and prevent pond surface water from migrating off-site, and surface water would be expected to infiltrate the soils. However, the Semet waste material has been observed seeping out of the basins along the slope adjacent to the railroad tracks near Tributary 5A and CPOIs have been detected in this water body. Groundwater migration (as discussed below) and the presence of the seeps may both contribute to this contamination. The seeps are the subject of an ongoing IRM (O'Brien & Gere, 2002h).

Area groundwater is affected by pond residue and site groundwater acts as a source of CPOIs to the lake. In particular, high levels of CPOIs, including benzene and naphthalene, are found in site groundwater. This groundwater transports these CPOIs to Tributary 5A and to the lake both directly (the Semet residue lies below the water table and groundwater migrates toward the lake and Tributary 5A in this location) and via the I-690 storm drains, which collect some contaminated groundwater in this area. In fact, monitoring data obtained for Tributary 5A document the transport of mercury, benzene, toluene, and xylenes, and other metals from the vicinity of the Semet Residue Ponds site. The mercury is believed to have migrated from the Willis Avenue and/or Semet Residue Ponds sites. The organic compounds are believed to have originated from the Semet Residue Ponds site, and other metals (e.g., chromium, copper, and nickel) may have originated from the Crucible Materials Corporation plant.

In summary, CPOIs on the Semet Residue Ponds site have several documented pathways to reach Onondaga Lake. Both Tributary 5A and groundwater migration deliver contaminants to the lake. Among

the most important CPOIs originating from the Semet Residue Ponds site are mercury, benzene, toluene, and xylenes, and naphthalene. Further discussion on these CPOIs in Tributary 5A and groundwater can be found in Chapters 5 and 6.

4.2.2 Willis Avenue Area Sites

The Willis Avenue site is a former chlor-alkali and chlorinated benzene plant in the town of Geddes, Onondaga County, New York (see Figure 4-2). The site has a long history of operation and is one of two major sources of mercury, as well as a major source of chlorinated compounds, to Onondaga Lake. (The other major source of mercury to the lake is the LCP Bridge Street site.) Honeywell discharged waste streams from the site to the lake (e.g., via the East Flume; see Section 4.5.1). Currently, both groundwater and surface runoff (via the East Flume) transport CPOIs to the lake.

The chlor-alkali plant operated from 1918 until 1977, producing chlorine and other chemicals. The plant utilized both diaphragm and mercury cells for chlorine production. The 102 mercury cells originally part of this operation were designed in the 1930s and started with sodium chloride brine. In 1947 and 1948, the plant was redeveloped and a new process was installed. The number of mercury cells was reduced to 59, and the plant converted to potassium chloride brine (O'Brien & Gere, 1990). The area has been the subject of an RI that began in 1991. The following discussion of CPOI transport from the Willis Avenue site to Onondaga Lake has been derived primarily from the Willis Avenue site RI report (O'Brien & Gere, 2002e), which is under review by NYSDEC. More detailed information on the history and potential CPOI loads associated with the Willis Avenue facilities is included in the Onondaga Lake Site History Report (PTI, 1992d) and in the History of the Willis Avenue Plant report (O'Brien & Gere, 1990). Chlorinated benzenes were produced at the facility from 1918 to 1977. The following discussion is divided into the Willis Avenue Plant site/Lakeshore Area property, and areas associated with the Willis Avenue Plant that are located near the site on Main Plant property (e.g., the Petroleum Storage and Chlorobenzene Hot Spots areas).

4.2.2.1 Former Willis Avenue Plant Area – Lakeshore Property

The location of the former plant site proper is at the corner of Willis Avenue and State Fair Boulevard, although plant operations, such as the loading and unloading of material, also took place on the lakeshore. Also, operations associated with the Willis Avenue Plant site, such as distillation of coal and oil to produce benzene, took place at the Main Plant site. The potential for CPOI transport to Onondaga Lake via groundwater, surface water, and underground utilities in the Willis Avenue Plant area (e.g., Plant Area sewers) and lakeshore property was assessed by O'Brien & Gere (2002e). CPOIs associated with groundwater enter the lake directly, since this site borders the lake. Except for the I-690 drains, CPOIs associated with the underground utilities do not appear to directly enter the lake, but may be conveyed via groundwater into the East Flume or Tributary 5A (O'Brien & Gere, 2002e). The I-690 drains do discharge directly into the lake; however, they are not a separate source of mercury and other CPOIs but, rather, collect groundwater within the influence of the drain. Their loads are discussed in Chapter 6 of this report as part of the groundwater loading estimates.

The CPOIs in soil and groundwater at the Willis Avenue site included chlorinated benzenes, BTEX, mercury, PAHs, PCBs, and dioxins/furans. Most of the observed contamination is consistent with previous industrial activities, which included production of chlorinated benzene products in the plant area; storage and fractionation of petroleum to produce benzene, toluene, and ethylbenzene and naphthalene in the Petroleum Storage Area; and production of chlorine in mercury and diaphragm cells (O'Brien & Gere, 2002e).

Mercury is found in groundwater wells (WA-1, WA-2, WA-3) along the lakeshore at concentrations as high as 8,900 ng/L. However, the I-690 storm drains (see Section 4.2.2.6) that collected groundwater near the lakeshore on the Willis Avenue site contained mercury at concentrations that averaged approximately 15,000 ng/L and ran as high as 20,000 ng/L. IRMs performed by Honeywell which consisted of sewer rehabilitation have resulted in a reduction of the loading of CPOIs to the lake from the sewer system, but have not addressed the movement of groundwater into the lake. However, elevated concentrations of CPOIs are still entering the sewer system (O'Brien & Gere, 2002b). A supplemental IRM to be implemented by Honeywell to address the underdrain flow to the system (O'Brien & Gere, 2002b) has been approved.

DNAPL containing chlorinated benzenes is found at the shore of Onondaga Lake in the intermediate groundwater aquifer immediately adjacent to the concrete causeway previously used by Honeywell for loading and unloading materials. DNAPL is being pumped from recovery wells for disposal (O'Brien & Gere, 2002i). Between installation in 1993 and October 2002, 20,189 gallons of free-phase chlorinated benzenes were collected by the treatment system (A. Labuz, pers. comm., 2002). Chlorobenzene (mono) was evident in groundwater measured with in-lake piezometers and monitoring wells in October 1992 (see Figure 4-4), with the highest concentrations of chlorobenzene in the fill zone at 25,000 µg/L. In groundwater sampling events during the Willis Avenue RI (O'Brien & Gere, 2002e), higher concentrations of chlorobenzene at 87,000 µg/L, 1,4-dichlorobenzene at 72,000 µg/L, benzene at 55,000 µg/L, and toluene at 80,000 µg/L were detected in the lakeshore area in wells screened in the marl where the DNAPL occurs. Chlorobenzene was also detected in the lake surface water in this area during the supplemental lake water sampling in 1999.

Overland runoff from the Willis Avenue site is not expected to be a significant pathway for CPOI migration to Onondaga Lake. CPOI transport from soils to surface water bodies via surface water runoff is limited by the extensive coverage of concrete, asphalt, and fill materials at the plant area. Isolated areas where CPOIs were detected at elevated concentrations in surface soils (the northwest ditch, Semet Residue Ponds ditch, drainage ditches near Outfalls 004 and 006, and the former Chlorination Building) are porous, rarely receive surface flow, are located a "considerable distance" from surface water bodies, and are, therefore, not expected to significantly affect surface waters in the vicinity (O'Brien & Gere, 2002e).

4.2.2.2 Main Plant

The Honeywell Main Plant was located south of the Willis Avenue Plant and Tributary 5A. The major products of this facility included soda ash produced by the Solvay process and related products, although

numerous other processes also took place here (PTI, 1992d). The Honeywell Main Plant was the source of the Solvay waste found in numerous locations in the area.

The Petroleum Storage Area and Chlorobenzene Hot Spot Area are locations on the Main Plant site (see Figure 4-2) that have been found to have contamination associated with the Willis Avenue Plant operations. The Petroleum Storage and Chlorobenzene Hot Spots Areas are being addressed as part of the RI/FS for the Willis Avenue site. The Petroleum Storage Area, located southwest of the former Willis Avenue Plant on the northern edge of the former Main Plant near Tributary 5A, operated from 1915 to 1970, fractionally distilling coke light oil to produce benzene, toluene, xylenes, and naphthalene. Benzene produced at this site was pumped to the Willis Avenue Plant area for use in the manufacture of chlorinated benzene products. The facility was demolished in 1973. Most recently, No. 2 fuel oil was stored in the Petroleum Storage Area. The storage tanks were dismantled during closure of the Honeywell facility, and subsequent investigations found no evidence of No. 2 fuel oil in groundwater in the area. However, BTEX and naphthalene were detected in the groundwater at elevated levels.

The Chlorobenzene Hot Spot Area is a location on the former Main Plant site where a pipeline that had carried chlorobenzene residual wastes to the Main Plant grounds had leaked. Benzene and chlorobenzene have been detected in monitoring wells in this area (O'Brien & Gere, 2002e).

NYSDEC is evaluating the data available for the former Main Plant to determine what, if any, future activities are appropriate.

4.2.2.3 Willis Avenue Ballfield Site

Across Willis Avenue from the Willis Avenue Plant site is another area, the Willis Avenue Ballfield site, that was the subject of a PSA (O'Brien & Gere, 2000a) and is being further addressed in an ongoing RI/FS (O'Brien & Gere, 2002c). The Willis Avenue Ballfield site is located on the northwest and central portion of Wastebed C (see Figure 4-3), is partially occupied by Butler Fence Company, and was used as a baseball field in the 1960s and 1970s (O'Brien & Gere, 2002c). Honeywell waste, including Allen-Moore diaphragm cell bodies and related graphite, laboratory vials and flasks, construction and demolition debris, miscellaneous metal debris, and boiler slag (O'Brien & Gere, 2002c), was disposed of on the site prior to its use as a ballfield. No site-specific estimates of CPOI transport from the site are currently available. However, any site-related contamination would migrate through the Willis Avenue or Wastebed B/Harbor Brook sites to reach the lake. Thus, CPOI loadings from the Ballfield site would be accounted for in the calculation of the loading from the neighboring sites.

The preliminary findings of the PSA indicate elevated levels of chlorinated benzenes, xylenes, naphthalene, and PAHs in soils, as well as total PCBs at concentrations up to 580 mg/kg. The PSA found mercury up to 1,760 mg/kg in soils collected from test pits, as well as elevated levels of mercury (up to 91.9 mg/kg) in surface soils. Intermediate groundwater within the southwestern portion of the site exhibited elevated levels of mercury as high as 31,300 ng/L, and shallow groundwater within the north end of the site was

found to have mercury concentrations as high as 14,300 ng/L. Additional sampling of the site will be performed as part of the Willis Avenue Ballfield site RI.

4.2.2.4 East Flume

The East Flume was originally an excavated drainage ditch that carried a combined (Solvay, sanitary, mercury, and organic) waste stream from the Main Plant and the Willis Avenue Plant into Onondaga Lake (see Section 4.5.1).

As such, it was one of the major discharge locations for mercury to the lake. As a result of these discharges, the sediments of the lower East Flume are contaminated with mercury at concentrations from 1.8 to 7 mg/kg, which continue to recontaminate the water that currently passes through the flume. Other historical discharges to the East Flume are summarized in the History of the Willis Avenue Plant report (O'Brien & Gere, 1990). Stormwater from the village of Solvay, Trigen Syracuse Energy Corporation (formerly Salt City Energy Ventures), General Chemical Corporation, Solvay Paperboard/Fibertec, and Landis Plastics also flows into the East Flume, as does some permitted process water from Trigen Syracuse Energy Corporation.

The East Flume, formerly part of the Willis Avenue site, is currently part of the Wastebed B/Harbor Brook site. Data collected in the East Flume during the Willis Avenue RI are being addressed as part of the Wastebed B/Harbor Brook RI. Honeywell has agreed to implement an IRM (Order on Consent Index # D7-0002-01-09) that will include the removal of the East Flume, including sediments, and redirection of the existing discharges directly to the lake (O'Brien & Gere, 2002g).

4.2.2.5 Tributary 5A

Tributary 5A originates from a culvert north of the railroad tracks on the west side of Willis Avenue, then runs parallel to the tracks until a point west of the Semet Residue Ponds fence line, where it turns northeast toward Onondaga Lake (see Figure 4-2). Permitted discharges from 12 outfalls from the active Crucible Materials Corporation facility flow into Tributary 5A, as do surface water runoff and shallow groundwater discharge from the Honeywell sites (Semet Residue Ponds, Willis Avenue, and former Main Plant) and the Church and Dwight facility.

CPOIs associated with Crucible Materials Corporation include metals (iron, chromium, nickel, vanadium, and cobalt), oils, and possibly PCBs (Stearns & Wheler, 2001). Caustic-coated mill scale wastes from Crucible were disposed of in the immediate area of Tributary 5A at the Lake Pump Station disposal site (the small peninsula just north of Tributary 5A). CPOIs associated with the Honeywell facilities in the vicinity of Tributary 5A include mercury, PAHs, BTEX, PCBs, and dioxins/furans. Tributary 5A, formerly part of the Semet Residue Ponds site investigation, is part of the Willis Avenue site investigation. Data collected in Tributary 5A have been incorporated into the revised Willis Avenue RI report.

4.2.2.6 I-690 Storm Drainage System

I-690 runs north of the Willis Avenue Plant and Semet Residue Ponds sites and south of Onondaga Lake. The storm drains, which were built to collect the runoff from the highway, run parallel to the highway. There are two outfalls for these storm drains, which effectively divide the drain system into a western system (in front of the Semet Residue Ponds) and eastern system (in front of the Willis Avenue Plant site). These systems apparently were constructed at least partly below the water table, and leaks in the pipes allowed groundwater to collect in the pipes and drain to the lake. In addition, an underdrain system that collects shallow groundwater also discharges to the drainage system.

Preliminary investigations identified BTEX, chlorinated benzenes, PCB Aroclor 1254, and mercury in sediment and water associated with the I-690 drainage system. These observations resulted in an IRM Consent Order between Honeywell and NYSDEC with the objectives of investigating, cleaning, rehabilitating, and subsequently monitoring the drainage system (O'Brien & Gere, 2002b). The construction activities associated with the initial phases of the IRM were completed in 1999. Additional IRM activities are underway to further address the underdrain flow to the system (O'Brien & Gere, 2002b).

4.2.3 Wastebed B/Harbor Brook

Harbor Brook is a tributary to Onondaga Lake that flows through the town of Geddes and enters Onondaga Lake in its southernmost corner (see Figures 4-1 and 4-3). Data on Harbor Brook and lake sediments at the mouth of Harbor Brook show extensive contamination, suggesting contaminant transport via this tributary. Also, Wastebed B forms the western bank of Harbor Brook just downstream of the I-690 crossing and is a source of CPOIs to the brook and Onondaga Lake.

A PSA was conducted by Honeywell at the Wastebed B/Harbor Brook site, based on an approved work plan (O'Brien & Gere, 2000b). The site is being further addressed in an ongoing RI/FS (O'Brien & Gere, 2002a). An RI/FS Work Plan for the Wastebed B/Harbor Brook site (O'Brien & Gere, 2002a) has been approved. The RI/FS for this site will incorporate data from previous investigations (i.e., Willis Avenue RI sampling in the East Flume, Harbor Brook IRM sampling data) and the PSA data, in addition to the data to be collected during the RI.

The Wastebed B/Harbor Brook site is divided into the following four areas (see Figure 4-3):

- Lakeshore Area (including the upper and lower East Flume and Dredge Spoils Areas 1 and 2).
- Penn-Can property.
- CSX Railroad Area.
- The lower reaches of Harbor Brook itself.

Historical use of these areas is described in the Harbor Brook Preliminary Site Assessment Work Plan (O'Brien & Gere, 2000b), the Harbor Brook Site Remedial Investigation/Feasibility Study Work Plan (O'Brien & Gere, 2002a). A brief overview of each of the four Wastebed B/Harbor Brook site areas is provided below.

4.2.3.1 Lakeshore Area

The Lakeshore Area was used for the disposal of Solvay waste from approximately 1908 to 1926 (Blasland & Bouck, 1989), and was designated as Wastebed B. Honeywell also disposed of other wastes to this area via the East Flume and other means after 1926. Honeywell has indicated that between 1959 and 1966 the city of Syracuse used the southeast end of the wastebed for sewage sludge disposal. The Wastebed B area also contains Dredge Spoils Areas 1 and 2, which are the disposal areas from the construction and maintenance dredging of the East Flume, and the installation of the thermal diffuser pipe in the lake, respectively.

In addition to the known solids disposal, the Wastebed B area has been subject to direct disposal or on-site migration of organic contaminants. Two DNAPL plumes can be found within the Wastebed B area. The northern end of the wastebed near the East Flume contains a chlorinated benzene DNAPL plume that resulted from Willis Avenue operations.

At the southern end of Wastebed B at Harbor Brook is a large DNAPL plume, consisting largely of naphthalene, BTEX, and lesser amounts of other PAHs. This plume is likely present due to releases from the former Barrett Paving facility (O'Brien & Gere, 2002a).

4.2.3.2 Penn-Can Property

The Penn-Can property, located south of the Lakeshore Area and south of I-690 (see Figure 4-3), has been used for the production and storage of asphalt products from 1919 to the present. In 1919, the Barrett Division of the Semet-Solvay Chemical Company began a paving-material production facility, which was operated by AlliedSignal and its subsidiaries until 1983, when it was sold to the Penn-Can Corporation. In 1978, prior to the sale to Penn-Can, approximately 750 to 1,000 cubic yards of asphalt tank-bottoms were buried on-site by AlliedSignal in a pit with dimensions of 40 ft wide by 165 ft long by 7 ft (12 m wide by 50 m long by 2 m) deep. The tank bottoms were covered with 2 ft (0.6 m) of glacial till, a geotextile, and 2 ft (0.6 m) of fill. The Penn-Can site, which is approximately 1,600 ft (490 m) (east-west) by 450 ft (140 m) (north-south), today consists of buildings, aboveground storage tanks, and a gravel parking lot, with limited vegetation around the periphery of the area. Based on the initial investigation, the Penn-Can property appears to be an ongoing source of naphthalene DNAPL to the Wastebed B area and Harbor Brook, and possibly to the lake.

4.2.3.3 CSX Railroad Area

The CSX Railroad Area, owned by Conrail, is situated to the south of the Penn-Can property and is bounded to the north, south, and east by railroad tracks (see Figure 4-3). The site area is approximately 1,400 ft (430 m) wide (east-west) and 400 ft (120 m) deep (north-south), and the covertype is classified as "successional scrubland" in the southern portion and "urban-structure interior" in the northern portion. Historical uses of the CSX Railroad Area are not known, although it is believed to have been controlled by the railroad from at least 1900 until the present.

4.2.3.4 Harbor Brook – Lower Reaches

The portion of Harbor Brook currently under investigation begins at Hiawatha Boulevard and continues downstream to the confluence with Onondaga Lake. Before entering Onondaga Lake, Harbor Brook flows adjacent to the CSX Railroad Area, the Penn-Can site, and the Lakeshore Area. Ongoing contribution of constituents to Harbor Brook sediment is suspected via groundwater/seeps and ditches located at the former Wastebed B site (O'Brien & Gere, 2002a). Surface water samples from Harbor Brook were obtained by Honeywell in 1992, 1996, and 2001 and NYSDEC in 1996 and 1997. These samples indicated the presence of mercury, chlorinated benzenes, BTEX, and PAHs. NYSDEC and Honeywell also performed sediment sampling in Harbor Brook. These samples also documented the presence of several contaminants and significant quantities of DNAPL in the sediment and underlying soil of Harbor Brook. The interpretation of these data is still ongoing as part of the Wastebed B/Harbor Brook RI.

As part of the PSA investigation of the Wastebed B/Harbor Brook site, sampling was performed on the Lakeshore Area, the Penn-Can property, and the CSX Railroad Area in conformance with the Harbor Brook Preliminary Site Assessment Work Plan (O'Brien & Gere, 2000b). Soil (surface at 0 to 2 inches, and subsurface at varying depths), surface water, groundwater, and drainage swale sediment samples (0 to 6 inches) were collected as part of the PSA.

The soil investigation included the collection of samples from test pit excavations, Geoprobe borings, and soil borings. DNAPL was observed in the southeastern portion of the Lakeshore Area and the Penn-Can property and the northeastern portion of the CSX Railroad Area. These areas also exhibited elevated concentrations of volatile organic compounds (VOCs) (e.g., BTEX) and semivolatile organic compounds (SVOCs) (PAHs, including naphthalene and phenols). The highest concentrations were observed near the East Flume in the northwest portion of the site and in areas where DNAPL is present in the eastern portion of the site. Surface soil/sediment samples in wetlands along the lakeshore and near the mouth of Harbor Brook also exhibited elevated concentrations of CPOIs (see Chapter 5). Groundwater in the Lakeshore Area exhibited mercury concentrations up to 30,000 ng/L.

The Wastebed B/Harbor Brook RI/FS Work Plan (O'Brien & Gere, 2002a), includes additional sampling to delineate the source and extent of DNAPL migration within the Wastebed B/Harbor Brook site. Investigations will be performed during the RI in two additional areas of study east of Harbor Brook (see Figure 4-3) to address the prior observations of DNAPLs east of the brook.

4.2.3.5 Summary of Chemical Parameters of Interest Migration from Wastebed B/Harbor Brook

In summary, contaminants found on the Wastebed B/Harbor Brook site (e.g., mercury, chlorinated benzenes, BTEX, PAHs, and phenols) in the groundwater appear to be migrating to Onondaga Lake either directly or via the East Flume and Harbor Brook. Both groundwater transport and DNAPL migration appear to be important routes for transport to the lake. The magnitude of the loadings of these CPOIs to the lake is discussed as part of the estimation of the shoreline groundwater loadings, or tributary loadings, presented in Chapter 6 of this RI.

4.3 Solvay Wastebeds Area

The Solvay Wastebeds associated with Onondaga Lake are located in the towns of Camillus and Geddes, and in the city of Syracuse, in Onondaga County, New York (see Figure 4-5). The wastebeds are surrounded by commercial and industrial areas, as well as some residential neighborhoods and agricultural areas. These uncontained, unlined wastebeds represent the primary means of disposal for the wastes produced by the Solvay operations (i.e., landfilling). Initial Solvay waste disposal practices consisted of filling low-lying land adjacent to Onondaga Lake. Later, unlined wastebeds designed specifically for Solvay waste disposal were built using containment dikes constructed of native soils, Solvay waste, and cinders, or by using bulkheads made with timber along the lakeshore (BBL, 1990). As discussed in Chapter 1, the Solvay Process created sodium carbonate from brine (sodium chloride in water), limestone, and ammonia (PTI, 1992d). The ammonia and part of the carbon dioxide used in the process were recovered during the chemical reactions and reused (PTI, 1992d). However, the fact that the ammonia concentration in lower Ninemile Creek (below the Solvay Wastebeds) is significantly elevated (a factor of 7.6) above the concentration in upper Ninemile Creek (at Amboy) (Effler and Whitehead, 1996) indicates that significant amounts of ammonia were disposed of in the beds.

4.3.1 Description of the Wastebeds

The wastebeds are grouped into four different areas (i.e., Wastebeds A to M, 1 to 8, 9 to 11, and 12 to 15) so as to best classify the contaminant type and means of transport to the lake (Figure 4-5). In total, these wastebeds cover an area of approximately 8.1 sq km (2,000 acres) (Effler and Harnett, 1996).

4.3.1.1 Wastebeds A to M

Several areas near the southern end of Onondaga Lake (i.e., Areas A to H) contain evidence of Solvay waste disposal (Blasland & Bouck, 1989). Solvay waste disposal activities at Wastebeds A to E, which occupy a total of approximately 132 acres, ceased by 1926, although some of the wastebeds also received other materials (e.g., tar residues, sewage sludge) in later years. Areas F to M, covering approximately 910 acres, are now occupied by numerous industrial and commercial structures. Of these, Areas F to H appear to have served as Solvay wastebeds; material identified in Areas I to M is probably other types of fill related to road construction (Blasland & Bouck, 1989).

4.3.1.2 Wastebeds 1 to 8

Wastebeds 1 to 8, occupying approximately 315 acres of the former Geddes Marsh on the southwest side of Onondaga Lake, were used for Solvay Process waste disposal from 1926 until 1944. Wastebeds 1 to 4 were in use by 1926, prior to the use of Wastebeds 5 and 6. Wastebeds 5 and 6 were constructed after the diversion of Ninemile Creek to the north of Wastebed 6. Disposal in Wastebeds 7 and 8, southwest of Wastebeds 1 to 6, did not begin until after 1939 and continued until 1944.

Disposal of Solvay Process waste into Wastebeds 1 to 8 was discontinued after a containment dike failed in 1944. Wastebeds 1 to 8 contain an estimated 19.4 million m^3 of material (BBL, 1990). Sampling of the groundwater and seeps at Wastebeds 1 to 8 (TAMS, 1995) indicated high concentrations of BTEX (up to 15,700 µg/L), PAHs (up to 3,600 µg/L total PAHs), and phenols (up to 3,200 µg/L). Elevated concentrations of mercury were also detected in groundwater (up to 2,400 ng/L); however, these samples also contained high turbidity values, making the significance of these mercury results unclear. Wastebeds 1 through 5 show evidence of active erosion directly into Onondaga Lake. USEPA has concurred with NYSDEC's recent determination that a PSA is required at the Wastebeds 1 to 8 site. NYSDEC has initiated the negotiation of an administrative consent order with Honeywell.

4.3.1.3 Wastebeds 9 to 11

Ninemile Creek was again diverted in 1944 for the construction of Wastebeds 9 to 11, and the remaining abandoned creek bed was filled with natural materials. Waste disposal in Wastebeds 9 to 11 began in 1944 and continued until 1968, and included the disposal of brine purification sediments and boiler water purification wastes, as well as Solvay Process waste. Wastebeds 9 to 11 occupy approximately 126 acres, and contain an estimated 6.3 million m^3 of waste material (BBL, 1990).

4.3.1.4 Wastebeds 12 to 15

Waste disposal in Wastebeds 12 to 15 began in the 1940s and continued until 1986. The location of Wastebed 13 was originally a municipal airport. In addition to Solvay Process waste, Wastebeds 12 to 15 received brine purification sediments, treated mercury cell wastewater, boiler water purification wastes, and boiler bottom and fly ash. During 1986, the Onondaga County Department of Drainage and Sanitation (OCDDS) disposed of liquid sludge (3 to 5 percent solids) and dewatered sludge from Metro in Wastebeds 15 and 12, respectively. Between 1981 and 1986, Metro used wastebed overflow as a chemical reagent for phosphorus precipitation and thereby likely introduced wastebed contaminants into Metro and from there into the lake. Honeywell's Wastebeds 12 to 15 occupy approximately 536 acres and contain an estimated 37 million m^3 of waste material (BBL, 1990). Chlorinated benzenes were found in the area of Wastebed 15, but appear to be associated with fill in the bed of the former Erie Canal (BBL, 1999).

4.3.2 Summary of Chemical Parameter of Interest Migration from the Solvay Wastebeds

The four wastebed groups discussed in the previous sections are addressed below in terms of contaminant types and means of transport to the lake. Proceeding directionally from west to east, as shown on Figure 4-5, the wastebeds are summarized as follows:

- **Wastebeds 9 to 15** are a source of ionic constituents (calcium, sodium, and chloride ions), as well as chlorobenzene. Contaminants in groundwater are discharged to Ninemile Creek.

- **Wastebeds 1 to 8** contain groundwater contaminated with BTEX, PAHs, phenols, and mercury, as well as the ionic waste constituents. Because of the proximity of these wastebeds to Onondaga Lake, these contaminants enter the lake directly as groundwater seepage to the lake. Some contaminated groundwater also discharges to Ninemile Creek.

- **Wastebeds A to E** contribute ionic constituents as well as organic contaminants both directly to the lake via groundwater discharge, and indirectly via groundwater discharge to Onondaga Lake tributaries (e.g., Tributary 5A, Harbor Brook). These wastebeds contain a mixture of contaminants that were placed in the wastebed areas as part of the original Solvay waste disposal operations, as well as contaminants introduced during subsequent disposal practices or during industrial operations, primarily by Honeywell, on top of the wastebeds. Wastebeds A, B, and C have been used in this manner, with resulting DNAPL plumes of chlorinated benzenes (Willis Avenue site) and naphthalene (Wastebed B/Harbor Brook site), as well as extensive levels of mercury contamination (Section 4.2). Groundwater seepage from Wastebeds A, B, and C is the main route of transport to the lake for these beds, while groundwater at Wastebeds D and E most likely discharges to Harbor Brook.

- **Wastebeds F to M** have a less extensive data set than the other wastebed areas. Wastebeds F to H are comprised primarily of Solvay wastes. These beds appear to be sources of ionic constituents, much like Wastebeds A to C. Wastebeds I to M are believed to be primarily comprised of materials related to road construction.

Overall, the wastebed areas are readily identified as an ongoing source of ionic constituents to Onondaga Lake. In addition, some of the wastebeds are ongoing sources of organic constituents, as well as mercury, to Onondaga Lake. Some of these contaminants were placed in the wastebed areas as part of the original Solvay waste disposal operations, while others were the result of subsequent waste disposal or industrial activities on top of an existing wastebed. Due to the extensive volume of waste material (over 90 million cubic meters) in Wastebeds 1 to 15 alone (BBL, 1990), it is anticipated that the load or discharge of contaminants to Onondaga Lake will continue into the foreseeable future. To some extent, discharges from

the wastebeds are limited due to the low permeability of the waste material. Nonetheless, the sheer volume of the wastebeds is sufficient to yield a substantive source of ionic constituents, and in some cases, organic compounds and mercury to the lake.

4.4 Dredge Spoils Area

The dredge spoils area is located along the northwestern shoreline of Onondaga Lake, northwest of the mouth of Ninemile Creek (see Figure 4-1). The area includes up to 19 basins constructed between 1966 and 1968 by Honeywell and Onondaga County in a joint project (USEPA, 1973) to contain dredged material from the mouth of Ninemile Creek and from the lake shoreline. Review of the base map for construction of the basins, newspaper articles from the time of the dredging operations, and aerial photographs of the area indicates that dredged material from the Ninemile Creek delta was placed in Basins 1 to 3 during three separate dredging operations (A. Labuz, pers. comm., 2000). The basins were created by filling in wetlands along the edge of the lake.

Samples collected in 2000 during Phase 2A of the Onondaga Lake RI in Basins 1 to 4 indicated that CPOIs associated with the dredged sediments include mercury and PAHs down to approximately 10 ft (3 m) below grade. Mercury in the soil ranged from 0.02 to 98.8 mg/kg, and the individual PAHs ranged up to about 20 mg/kg. The contaminated spoils were apparently covered with cleaner soils, largely isolating them from surface runoff and human contact, but not from rainwater infiltration and groundwater. A further discussion of the data collected in this area can be found in Chapter 5.

The dredged material disposal area has been naturally revegetated and there is little opportunity for overland surface runoff. However, groundwater transport to the lake is likely and installation of groundwater monitoring wells in the area will be necessary to evaluate this pathway. It is expected that additional investigations of this area, including groundwater sampling, will be performed as part of a separate site investigation. At this time, no quantitative estimate of loading of CPOIs from the dredge spoils area can be made.

4.5 Honeywell In-Lake Waste Deposit Area

The materials that form the lake bottom in the southwestern corner of Onondaga Lake are comprised of a mixture of Honeywell waste materials, as well as lake sediments (see Chapter 1, Figure 1-3). In particular, a portion of the shoreline area is believed to consist almost entirely of Honeywell waste materials. The location of this deposit of wastes is adjacent to the shore in the area between the causeway and just east of the mouth of Harbor Brook (indicated as Area A of in-lake waste in Chapter 3, Figure 3-9 of this RI). As discussed below, these wastes are believed to have been disposed of by discharging a combination of cooling water, sanitary waste, Solvay waste, mercury wastes, and organic wastes into the lake (e.g., via the East Flume), where they settled out, forming a large delta.

The large horizontal extent of the waste material is, in part, the result of the frequent relocation of the discharge point (e.g., the East Flume). The point of discharge appears to have been steadily moved from

west to east (see Figure 3-9) as deposits built up around the discharge, restricting flow. Because of this history, it is believed that wastes from Honeywell were initially discharged directly to the lake, and then eventually through what became known as the East Flume. In subsequent discussions in this RI, these discharges will be referred to as having come "via the East Flume" regardless of the exact configuration of the flume over the years.

4.5.1 History from Aerial Photographs

The history of the discharge of the Solvay wastes through the East Flume is clearly seen in a series of aerial photographs (Figures 4-6 to 4-12).

In the 1926 photograph (Figure 4-6), there is no apparent discharge to the lake in the area of the Honeywell shoreline. Neither the structures associated with the causeway/docking facility nor the East Flume have been constructed. There are buildings at the visible portion of the Willis Avenue Plant (the poor quality of the photograph obscures some of the plant site). Wastebed B is covered with a white material, indicating that the disposal of Solvay waste was very recent or still ongoing. There is some construction activity on the western side of Wastebed A, west of the Willis Avenue Plant; perhaps the construction of the Semet Residue Ponds.

In the September 1938 photograph (Figure 4-7), there is an obvious plume of waste (which appears to be Solvay waste) entering the lake east of the causeway, near the western end of Wastebed B. There is already a delta of Solvay waste in the lake outside of the bermed areas of Wastebed B, suggesting that in-lake disposal had been occurring before this photograph was taken.

In the October 1951 photograph (Figure 4-8), the plume of Solvay waste has greatly expanded, suggesting that the disposal had increased since 1938. The delta of Solvay waste is extended at least 1,000 ft (300 m) into the lake and beyond (to the east of) the mouth of Harbor Brook. This roughly corresponds to the area indicated as Area A in Figure 3-9, and also corresponds to the relatively shallow (3 to 10 ft [1 to 3 m] water depth) area in Figure 3-1. Honeywell has extended the outlet of the East Flume to roughly the midpoint of Wastebed B.

In the June 1959 photograph (Figure 4-9), it appears that the discharge of Solvay waste has stopped or been greatly reduced. However, the delta of waste materials is still very obvious, and waves can be seen breaking along the edge of the delta. The East Flume has apparently cut a meandering channel to discharge to the lake at a location slightly east of that shown in the 1951 photograph.

In the June 1966 photograph (Figure 4-10), a flow of water, but no apparent Solvay waste, can be seen emanating from the mouth of the East Flume. The East Flume has apparently continued to cut a meandering channel to discharge to the lake somewhat farther east than shown in the 1959 photograph, and the area of the lake east of the mouth of Harbor Brook has been filled. The extent of the delta is now less obvious in the photograph; the delta may have settled or eroded so that the water is deep enough to hide its extent. Some of the delta along the shoreline now appears as dry land that did not exist prior to 1959.

In the April 1967 and September 1978 photographs (Figures 4-11 and 4-12), flow from the East Flume and the conditions of the waste deposit delta have not changed significantly from the 1966 photograph.

4.5.2 History from Written Documentation

The disposal of waste materials in the lake was also documented in several government reports, which were written at a time when the discharge could have been witnessed by the authors.

The 1948 City of Syracuse Engineers report, "Pollution Survey of Onondaga Lake and its Tributaries," identified an area of Solvay waste deposits near the East Flume (Figure 4-13). This identified area approximates the delta seen in the 1938 aerial photograph. Four water samples were collected in 1948 from Station 10 (shown on Figure 4-13); however, there is some language in the associated text which suggests that these samples could have been collected in the East Flume itself. These samples averaged 1,100 mg/L of total suspended solids (TSS) and pH of 10.2, suggesting that Solvay waste was being discharged into the lake, regardless of the exact location of the sample collections.

The Water Pollution Control Board/New York State Department of Health produced a report in 1951 entitled "The Onondaga Lake Drainage Basin – Recommended Classifications and Assignments of Standards of Quality and Purity for Designated Waters of New York State." This report contains several passages that describe the waste disposal in the lake as follows:

> "The Solvay Process Division, Allied Chemical and Dye Corporation, discharges industrial wastes through a rough flume to Onondaga Lake. With this industrial waste is mixed the untreated sanitary sewage of the Village of Solvay. The discharge is located in the southwest corner of the lake and its exact point of discharge is changed from time to time." (p. 15)
>
> "A flume carrying some of the industrial wastes and sanitary wastes of the Solvay Process Company and Solvay Village discharges to Onondaga Lake on the southwest shore near the intersection of State Fair Boulevard and Willis Avenue. These combined wastes have a great quantity of suspended and dissolved material, are usually grey-white or grey-green in color and intermittently cause surface film." (p. 19)
>
> "A portion of the (Allied) plant industrial waste, together with the plant sanitary wastes and the sanitary waste from the Village of Solvay is collected and piped to the shore of Onondaga Lake where it enters a flume and is conducted to the lake proper. The final point of discharge from this flume is changed at intervals presumably in an effort to control the formation of the delta which is being built up by the suspended solids." (p. 25)

"Industrial wastes and sanitary sewage from the Village of Solvay and industrial wastes and sanitary sewage from Solvay Process Company are discharged to Onondaga Lake in a rough flume arrangement after mixing of wastes has been accomplished. This flume is located on the lake shore in the general vicinity of the intersection of State Fair Boulevard and Willis Avenue in Solvay. Sludge deposits extend into the lake from the end of the flume. Discoloration of the lake is readily apparent and surface films were noted intermittently." (p. 60)

An August 30, 1966 letter from the Allied Chemical Corporation, referring to a 1966 report prepared by the Federal Water Pollution Control Administration (FWPCA), quotes certain passages from that report, including one stating that "...vast deposits of both organic and inorganic sediments were found in the lake in 1965. Cores of the deposits revealed varying layers of black sludge and white clayey material. The result of many years of discharge of calcium and sodium carbonates by Solvay and partially treated wastes by Syracuse, these deposits ranged up to ten feet in depth..." (Allied Chemical Corporation, 1966).

4.5.3 Review of Physical Description of the In-Lake Waste Deposit

A review of historical and recent coring logs, and chemical analysis of the sediments in the lake, provides further confirmation of this disposal and documents the present location of the wastes.

In 1976, the Allied Chemical Corporation conducted a series of borings in the area of the East Flume in anticipation of upgrading the flume with, among other things, the installation of a diffuser pipe extending into the lake. There were two borings in the lake, as indicated on Figure 4-14. Although surveyed locations are not available, the borings were performed along the line of the diffuser pipe (seen in the Onondaga Lake Remedial Investigation/Feasibility Study Geophysical Survey [PTI, 1992a] report) in 1 m (core B2) and 4.6 m (core B1) of water and extending 39.5 m (core B2) and 42 m (core B1) into the sediment. The logs for these deep borings (included in Appendix F2) indicate "white and gray Chemical Waste, chemical odor, calcareous" from the sediment surface down to approximately 14.6 m (core B2) and 12.2 m (core B1) into the sediment.

In 2000, Honeywell collected 23 cores from the lake, which were intended to be about 8 m deep into the sediment (see Chapter 2, Figure 2-18). A review of the coring logs (see Appendix F1) revealed that six of these cores contain a formation described as "Calcareous Material." The 8 m cores with deposits of "Calcareous Material" are in the immediate area of the 1951 Honeywell waste delta (cores S309, S310, S311, and S312) and in the Ninemile Creek delta (cores S304 and S305). These are both areas of the lake where there is historical information of disposal of Solvay wastes; i.e., the Ninemile Creek delta having received runoff from Honeywell Solvay Wastebeds 1 through 15, and the in-lake disposal from the East Flume discussed above. The cores in the Honeywell wastes (cores S309 to S312) do not penetrate through the "Calcareous Material" and have accumulated little, if any, material (0 to 0.6 m) above this formation, which is consistent with the 1976 borings in the lake.

Figure 1-3 of this report illustrates the Honeywell in-lake waste deposit, which covers about 65 acres. Based on the 1976 coring evidence (waste material thicknesses of 14.6 m [core B2] and 12.2 m [core B1]) and the observation that many of the 8 m cores obtained in 2000 did not extend to the bottom of the waste material, it appears that the waste deposit is on the order of over 33 ft (10 m) thick. If the waste deposit is 33 ft (10 m) thick, then this suggests that the deposit contains about 2.6 million m^3 (3.4 million yd^3) of material.

4.5.4 Review of Chemical Contamination of the In-Lake Waste Deposit

While the extent of Solvay waste can be based on the physical description from the coring logs, the nature and extent of other wastes is documented by the results of chemical analysis.

As further discussed in Chapter 5 of this report, the Honeywell in-lake waste deposit contains some of the highest concentrations in the lake of numerous CPOIs, including mercury, BTEX, chlorinated benzenes, PAHs (including naphthalene), PCBs, and dioxins/furans. All of these CPOIs are associated with Honeywell waste streams. It is noteworthy that sediment at core S312 off the mouth of the East Flume failed Toxicity Characteristic Leachate Procedure (TCLP) testing (see Chapter 5, Section 5.2.3, and Figure 5-28).

In addition to these CPOIs, there are two additional compounds which were found in the waste deposit: PTE (1-phenyl-1-[4-methylphenyl]-ethane, or PhenylTolyEthane) and PXE (1-phenyl-1-[2,4-dimethylphenyl]-ethane, or PhenylXylylEthane). PTE and PXE were formed during the Semet Process for producing benzene (Hassett, 1994; Hassett and Hubbard, 1995). The presence of these compounds is likely a positive confirmation of Honeywell waste from the Semet industrial process. These results are further discussed in Chapter 5 of this report.

The presence of the Honeywell CPOIs, including PTE and PXE, confirm that the in-lake waste deposit is of Honeywell origin and contains numerous waste streams, not just Solvay waste. The vertical extent of contamination in the cores collected from the waste area is quite deep (over 8 m in some instances), and well beyond the rate of deposition anticipated in this area of the lake. Specifically, deposition in the shallow areas of the lake is expected to occur slowly, less than a centimeter per year. Thus, a 100-year period of deposition would yield less than 100 cm, or 1 m, of sediment, yet contamination extends over 8 m, indicating that this area primarily consists of almost pure waste material and not naturally occurring sediment.

4.5.5 Source of Contamination

The extensive accumulation of waste material deposited off the East Flume occurred in a rapid manner, under atypical conditions for a stream delta in the lake (a much higher deposition rate in a non-depositional area). As a result, these materials cannot be expected to be permanently sequestered in the lake bed. In fact, there is evidence that the Honeywell waste deposit is a source of contamination to the water column and to the biota, which is further discussed in Chapters 5 and 6. Hassett (1994) and Hassett and Hubbard

(1995) identified a major source of organics (especially PTE and PXE and naphthalene) to the water column in the area of the Honeywell waste deposit. Surface water samples collected in 1999 and 2001 in the area of the Honeywell waste deposit contained mercury concentrations of 10 to 103 ng/L, elevated significantly above the concentrations seen in the rest of the lake (5 to 6 ng/L). Sediment porewater from this area (Stations S344, S402, and S405) also exhibited mercury concentrations significantly higher (up to 49,300 ng/L dissolved) than porewater samples from other areas of the lake (<70 ng/L dissolved). Several of the macroinvertebrate samples (Stations S406, S404, and S344) collected in 2000 from this area exhibited mercury concentrations significantly higher (3.7 to 7.5 mg/kg wet) than the samples from other areas of the lake (<0.8 mg/kg). Additional discussion and presentation of the extent of contamination is included in Chapter 5 of this report.

The relatively rapid creation of the waste material deposit in the shallow area of the lake has placed a significant source of contamination in a potentially unstable setting. These materials are subject to wind-driven resuspension, bioturbation, groundwater percolation, and ice scour, all of which are mechanisms that can serve to re-release the contaminants to the lake. As documented by the data described above and in Chapter 5, these materials continue to act as a source of contaminants to the lake. As will be discussed in Chapter 6 of this report, the flux from this area represents a significant contribution to the overall loading to the lake for several major contaminants.

4.6 Other Tributaries/Source Areas

Figure 4-15 shows various Honeywell and non-Honeywell sites and areas of concern. Evidence of tributary sources includes a combination of contaminant measurements made within each tributary, data from the known potential sources in the local watershed of each tributary, and the expression of the tributary contribution in the lake sediments proximal to the tributary mouths. To the extent that the contamination from these or yet-to-be-determined sites impact the lake, the contamination is discussed in this RI. As documented in Chapter 5, the highest concentration of CPOIs in the lake nearshore area occurs between Ninemile Creek and Ley Creek. This evidence suggests that the remaining tributaries are less significant contributors to lake contamination, although these tributaries have localized contaminant sources.

The tributaries that appear less likely to have received direct discharges of Honeywell wastes (i.e., Onondaga Creek, Ley Creek, Bloody Brook, and Sawmill Creek) have lake sediment contamination in the immediate vicinity of their mouths, which is indicative of local input. The sources within the watersheds of these tributaries are discussed below.

4.6.1 Ley Creek Area

This area includes the following sites:

- GM – Former Inland Fisher Guide Facility and Ley Creek Deferred Media site.
- GM – Ley Creek Dredgings site.

- Town of Salina Landfill.
- GM – Old Ley Creek Channel site.

Ley Creek flows through a relatively urbanized/commercial area of the city of Syracuse and village of East Syracuse. Some industries have discharged wastes to Ley Creek and its branches, and many of them could have contributed CPOIs to Onondaga Lake.

The GM – former Inland Fisher Guide facility, located adjacent to Ley Creek, conducted plating, buffing, forming, and finishing of metal auto parts, and the manufacture and painting of plastic auto parts. Wastes from the plant were formerly discharged to Ley Creek. Confirmed hazardous wastes at the site included PCBs, solvents, copper, nickel, and chromium (NYSDEC, 2001). This site and the adjacent reach of Ley Creek are the subject of an RI (O'Brien & Gere, 1999b) and remedial program. An RI/FS is underway at the site.

The Ley Creek Dredgings site includes areas along the banks of Ley Creek where PCB-contaminated dredge spoils removed from the creek were placed. An RI/FS was completed by GM for the site and a ROD was issued by NYSDEC in March 1997. A 4,000-ft (1,200-m) stretch of Ley Creek stream bank containing the dredge spoils has been remediated. Remedial activities included the excavation of hot spot materials and site capping.

The Town of Salina Landfill, which borders Ley Creek, received domestic, commercial, and industrial wastes from the 1950s to 1970s. There is documentation that paint sludges and PCBs from the GM plant were disposed of in the landfill, and sampling has confirmed that PCBs are migrating from the site (NYSDEC, 2001). An RI/FS is nearing completion at the site.

Ley Creek, below Route 11 near the Town of Salina Landfill, was rerouted in the 1970s. Due to this rerouting, a section of Ley Creek became cut off from the Ley Creek flow (the Old Ley Creek Channel). The sediments and banks of this channel are contaminated with PCBs and metals (e.g., chromium, cadmium, copper, lead, zinc, and nickel). This site is listed as a Class 2 New York State Inactive Hazardous Waste site, and an RI/FS order is being negotiated with GM.

An aerial photograph (Figure 4-10) indicates that Wetland SYW-12, which is at the mouth of Ley Creek and which was sampled as part of this RI, was disturbed during the 1960s. This suggests that disposal activities could have occurred here. A discussion of the results of soil and sediment sampling conducted in this wetland and in the lake near this wetland is included in Chapter 5.

The information listed above indicates that Ley Creek has received a wide range of CPOIs, principally in the form of heavy metals and PCBs. These CPOIs are also found in the sediments around the mouth of Ley Creek, indicating a potential contribution from this tributary.

4.6.2 Onondaga Creek Area

This area includes the following sites:

- Niagara Mohawk – Erie Boulevard Manufactured Gas Plant (MGP) site.
- Niagara Mohawk – Hiawatha Boulevard MGP site.
- Roth Steel site.
- American Bag and Metal site.

The Niagara Mohawk – Erie Boulevard MGP site is located in the city of Syracuse and is approximately 10 acres in size. Of these 10 acres, approximately 7 acres were occupied by the former MGP, which was a coal gas plant from 1849 to 1916 and a water gas plant from 1896 to 1933. The area of the former MGP is now covered by paved parking lots and roads, with the remainder of the site occupied by five office buildings and surrounded by a chain-link fence with restricted access points.

The Erie Boulevard MGP site is adjacent to Onondaga Creek, approximately 9,000 ft upstream from Onondaga Lake. Soils and groundwater on site contain various contaminants, including PAHs and VOCs (e.g., BTEX), the likely sources of which were a tar well, cistern, and gas holders, which are no longer extant aboveground but may exist below the surface. A DNAPL plume of PAHs exists approximately 65 ft (20 m) below the ground surface at a location about 200 ft (60 m) south of West Genesee Street and extends north towards Onondaga Lake. An RI/FS is underway at the site.

The Niagara Mohawk – Hiawatha Boulevard MGP site, approximately 20 acres in size, is located south of the Barge Canal on West Hiawatha Boulevard, and borders Onondaga Lake and Onondaga Creek. The Barge Canal is part of Onondaga Creek. The MGP operated from 1925 to 1958. In the mid-1970s, a 16-acre parcel of the site was used in the expansion of the Metro plant. The remaining 4 acres have been acquired by Onondaga County for the recent expansion of Metro. The MGP facility used coal from 1925 to 1947, and partially switched to a carbureted water gas process in 1941. Manufactured gas production ceased in 1958. Wastes associated with the MGP include: clinker waste containing heavy metals; coal tar, which contains PAHs, BTEX, and phenols; oil sludge; and purifier waste, which contains cyanides.

In 1995 and 1998, sampling was performed as part of an NYSDEC PSA. Sampling results indicate that contaminants (e.g., VOCs, PAHs and cyanide) are present in site soils and groundwater. In addition, a PAH DNAPL layer was found in groundwater along Hiawatha Boulevard. Groundwater flows toward the Barge Canal (Onondaga Creek) and the lake. A soil removal IRM was conducted in 2001 and 2002 in support of the Metro plant expansion for ammonia/phosphorus treatment. An RI/FS is underway at the site.

The Roth Steel site is a scrap recycling facility that has been in operation since 1967. The site is located approximately 500 ft (150 m) from Onondaga Lake between the Barge Canal (Onondaga Creek) Terminal and Harbor Brook. Groundwater beneath the site likely discharges to Onondaga Lake. The site was originally used as a municipal solid waste landfill by the city of Syracuse (dates not available). The site was

subsequently used by the Solvay Process Company as a disposal site for Solvay waste. This disposal occurred prior to 1926, and the disposal areas are designated as Wastebeds F and G.

Roth Steel operated two automobile shredder fluff disposal areas on site, between the facility and Onondaga Lake. The two areas are located adjacent to each other, separated by a drainage ditch that runs toward Onondaga Lake. Each disposal area contains an estimated 60,000 cubic feet of shredder fluff, covering approximately one-third of an acre. Waste sampling done by Roth Steel indicates that the shredder fluff waste contains levels of PCBs greater than 50 ppm. Additional investigations, including a PSA and possibly an RI, will be performed at the site.

American Bag and Metal is a scrap yard where various materials are sorted for eventual recycling. On-site operations are believed to have resulted in the release of contaminants, primarily PCBs. Buried paint wastes and associated contaminated groundwater are also present on-site. The property is bisected by Onondaga Creek, a tributary to Onondaga Lake. American Bag and Metal conducted a PSA at the facility in 1997. S&W Redevelopment conducted an investigation under NYSDEC's Voluntary Cleanup Program in 2002.

Prior to 1993, Onondaga Creek provided slightly more than 50 percent of the annual external sediment loading to Onondaga Lake, and the source of much of this sediment is the Tully Mudboils (Effler and Whitehead, 1996). Since 1996, significant reduction of this sediment load has been accomplished through various actions implemented by the United States Geological Survey (USGS). In addition to this sediment load, the creek runs through the city of Syracuse and receives contaminants associated with urban runoff.

4.6.3 Oil City Area

The property situated between Onondaga Creek, I-81, and the railroad tracks adjacent to Wetland SYW-12 has been referred to as "Oil City." Oil City was used as a bulk storage and transfer facility for numerous industries since 1926. All bulk storage and transfer in Oil City has been discontinued. Industrial compounds utilized and stored in the area included the bulk storage of fuel-related hydrocarbons and the storage of synthetic organic chemicals and PCBs (NYSDEC, 1989). Part of the Oil City area, the Clark property, included a disposal site where very high concentrations of chlorinated hydrocarbons (768 mg/L) and non-chlorinated hydrocarbons (227 mg/L) were found in groundwater (NYSDEC, 2001). The Clark property has been remediated under a 1994 ROD that included the installation of a groundwater collection and treatment system and the construction of a containment cell.

Sediment samples collected offshore of Oil City contain high levels of PAHs, with a pattern that is distinct relative to the naphthalene-dominated pattern at and near the Honeywell sites. This observation suggests that the historical operations from the Oil City area were a potential source of this contamination in the area of Onondaga Creek. A further discussion of the PAH patterns in the lake and their likely sources is provided in Chapter 6.

4.6.4 Metro Plant

Metro, the sewage treatment plant serving the city of Syracuse and certain suburbs, is located on the shore of Onondaga Lake between Onondaga Creek and Harbor Brook and discharges its effluent to the lake at an average rate of approximately 3 m^3/s (70 million gallons per day). This discharge supplies an average of 18.9 percent of the total surface water inflow to the lake, ranging from 12 to 28 percent of the total inflow, making Metro the third largest source of water to the lake (Effler and Whitehead, 1996).

Historically, the Metro facility used wastewater from the Honeywell facilities in order to control phosphorous discharges. (It is possible that these waste waters conveyed mercury contamination to the Metro facility, making the Metro discharge an indirect source of mercury to the lake.) Samples of the Metro effluent collected in 1992 indicated total mercury concentrations of 9.5 to 104 ng/L. Samples collected by OCDDS in 1999 and 2000 indicated average total mercury concentrations 30 percent lower than the samples collected in 1992, and methylmercury concentrations 90 percent lower than in 1992, indicating that current contributions of mercury from Metro tend to be reduced, relative to historical levels.

4.6.5 Bloody Brook Area

Bloody Brook, at its upstream reach, runs through the industrial complex (Electronics Park) currently operated by Lockheed Martin, and from there through a suburban area and some major transportation rights-of-way. The historic discharges from this industrial complex are believed to have contaminated Bloody Brook with cadmium. A significant portion of the contaminated sediments were removed by Lockheed Martin in April 1997. Additional sediments and floodplain areas are to be addressed by Lockheed Martin pursuant to the Voluntary Cleanup Program.

4.7 Summary

Onondaga Lake has been the recipient of over 100 years of Honeywell-related wastes, as well as industrial and municipal sewage discharges from the municipal sewer system. Other industries in the area have contributed contamination as well. Current loads to the lake are primarily derived from Honeywell sites on the lake perimeter as well as in its vicinity, with surface water and groundwater pathways delivering much of the associated contamination to the lake. DNAPL plumes at the Willis Avenue and Wastebed B/Harbor Brook sites also convey CPOIs to the lake. Empirical evidence for the Honeywell contributions can be found in water, sediment, and biota of the lake and sediment of select wetlands, indicating the dominance of these sources to current and historical lake contamination.

CPOIs being transported to the lake from the Honeywell facilities include, among others, mercury, BTEX compounds, chlorinated benzenes, naphthalene and other PAHs, and ionic wastes. Historically, the contaminants included a greater assortment at generally higher concentrations, as documented in the lake sediments and historical monitoring reports.

Besides the Honeywell upland facilities on the lake perimeter and in the Ninemile Creek basin, recent and historical evidence documents the presence of Honeywell wastes within the lake itself, which resulted from historical waste discharges to the lake (e.g., via the East Flume). This in-lake waste deposit is estimated to be over 10 m thick, with a maximum reported thickness of 14.6 m, representing over 3 million cubic yards of material. This material represents some of the most contaminated "sediment" contained within the lake. Evidence indicates ongoing re-release of contamination from the area, suggesting that contaminants contained in the deposit are not sequestered from the lake. Its location in the littoral zone is considered to be relatively unstable, with the material subject to wind-driven resuspension and bioturbation, among other re-release processes.

Other contaminant sources to the lake include the Metro facility, Ley Creek, the Crucible Materials Corporation plant (via Tributary 5A), and Oil City. More quantitative discussion of fluxes to the lake can be found in Chapter 6 of this report.