St. Lawrence River Environment Natural Resource Damage Assessment: Restoration and Compensation Determination Plan and Environmental Assessment: Appendices

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prepared by:

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APPENDIX A: SITE HISTORY AND REMEDIAL DETAIL

EXHIBIT A-1 ALCOA WEST SITE TIMELINE

DATE	ACTION
1903	Alcoa's aluminum manufacturing facility on the Grasse River commenced in 1903 includes a fabricating area, ingot extrusion area, and a smelter. Aluminum is produced from alumina using the pre-baked anode method.
1957	Alcoa begins use of polychlorinated biphenyls (PCBs) in hydraulic fluid and electrical equipment.
1980	SRMT settles with Alcoa for $464,000 after agreeing not to sue for damages to cattle and vegetation for 10 years.
January 1985	NYSDEC enters into Consent Order with Alcoa to investigate and remediate industrial waste areas at the facility.
1985	MCA settles with Alcoa and Reynolds for $650,000 for damages to cattle and vegetation from emissions. The suit claimed that emissions from both Alcoa and Reynolds caused damages to the health of the St. Regis Mohawks residing on Cornwall Island and also damaged their cattle and other vegetation crops. The health aspects of the suit were dropped after a fluoride exposure assessment was conducted. The amount of $430,000 was subtracted from the settlement for legal fees.
August 1987	Alcoa completes a Remedial Investigation Report (Volumes I and II) for the uplands.
February 1989	NYSDEC issues draft SPDES permit modifications to Alcoa requiring non-detectable levels of PCBs using Method 680 with a detection limit of 0.065 ug/l.
September 1989	EPA issues Unilateral Administrative Order (UAO) to Alcoa for the investigation and remediation of lower Grasse River sediments.
Fall 1989	Alcoa installs a leachate collection system, as an interim measure, at the General Refuse Landfill, to intercept contaminant migration to the East Marsh.
Fall 1990	Alcoa excavates contaminated sediment from West Marsh (8000 cy) and the first 400 feet of the Unnamed Tributary (1500 cy) and ships it off-site.
October 1990	A revised Consent Order is issued by NYSDEC to guide remaining remedial investigations, design, and remedy implementation.
November 1990	Alcoa finalizes Feasibility Study (FS) for nine plant site areas.
December 1990	Alcoa stops dumping wastes in the General Refuse Landfill and installs an interim cap.
1991-1994	Alcoa performed Phase I and Phase II of the River and Sediment Investigations (RSI). The Phase I study concluded that PCBs were the major contaminant of concern (COC).
February 1991	Alcoa completes FS for remaining plant sites.
March 1991	NYSDEC issues ROD to address eight sites on Alcoa property. Remedy includes removal, treatment, and containment of contaminated material. The eight sites comprised the Potliner Disposal Site "A", Potliner Disposal Site "I", Dennison Road, Soluble Oil Lagoon, Primary Lagoon and Dredge Spoils Area, Oily Waste Landfill, West Marsh and the Unnamed Tributary.

DATE	ACTION
June 1991	Alcoa installs carbon treatment at one outfall.
July 1991	Alcoa pays $7.5 million in criminal fines and civil penalties to NYS for SPDES permit wastewater discharge violations and illegal storage, shipping and disposal of hazardous waste.
August 1991	Alcoa enters into Consent Order with NYSDEC to reduce PCB discharges and to settle February 1989 SPDES permit action.
December 1991	Alcoa replaces wet air pollution control wet system with dry scrubbers and implements other waste control actions to reduce wastewater discharges from the Alcoa facility from 12 to 6 million gals (mgal) per day.
January 1992	NYSDEC issues second ROD to address six sites on Alcoa property. Remedy includes leachate collection, groundwater treatment, and removal and treatment of soils and sediments. The six sites comprise the General Refuse Landfill, Waste Lubricating Oil Lagoon, 60-Acre Lagoon, Sanitary Lagoon, East Marsh, and the Landfill Annex.
March 1992	Alcoa installs carbon treatment on second outfall.
June 1992	Alcoa pays $2250 fine for violating TSCA when two capacitors are found on-site that were supposed to have been disposed off-site.
1993	EPA produces the Revised Risk Assessment Aluminum Company of America Study Area.
	An Amendment to the Administrative Order Index No. II-CERCLA-90229 allows for the NTCRA.
June – October 1995	Alcoa conducts the Non-Time Critical Removal Action (NTCRA) removing ~2600 cy PCB-contaminated sediment and 400 cy PCB-contaminated debris/boulders from Alcoa's 001 Outfall. Highest concentrations at outfall were 11,000 ppm. Approximately 85% reduction PCBs achieved from this removal action. .
1996 - Ongoing	Alcoa initiates Supplemental Remedial Studies (SRS) including annual water and fish sampling in the lower Grasse River. Studies indicate sediments an important source of PCBs in fish.
August 1996	NYSDEC issues ROD for the Storage Tank No. 51.
December 1996	Alcoa submits a draft Analysis of Alternatives Report (A of A) to EPA.
October 1997	The New York State Department of Environmental Conservation (DEC), in a letter dated October 10, 1997, notified Alcoa that its Massena, New York facility allegedly is in violation of certain air pollution control requirements. The allegations included operation of certain emission sources without permits, non-compliance with permitting and control standards for sulfur dioxide, carbon monoxide and carbonyl sulfide and violation of requirements related to the deposition of fluoride on vegetation.
1998	In early March 1998, the Company agreed to an Order on Consent with the DEC. Alcoa pays fine of $57,500 to settle dispute with NYSDEC surrounding Alcoa's adherence to Consent Order that allowed more fluoride to be released than permitted.
March 1998	NYSDEC issues ROD for the HPM Press Area.
June 1998	NYSDEC issues ROD for the Unpaved Plant Roads.
1999	Alcoa excavated contaminated sediments from the RCP pipe and the Unnamed Tributary pursuant to March 1991 ROD.
August 1999	Alcoa submitted the 1999 Draft Comprehensive Characterization of the Lower Grasse River (CCLGR) Report to EPA.

DATE	ACTION
December 1999	Alcoa submits an Analysis of Alternatives Report to EPA.
March 2000	NYSDEC issues a ROD for the West Fill Area.
2001	Alcoa conducted the Capping Pilot Study (CPS) screening a variety of cap material and placement methods in a 750 ft stretch of PCB-contaminated river sediments (7-acres). The primary cap consisted of a foot of 1:1 sand:topsoil (6-12 in). Other cap combinations included Aquablok only (3-4 in), and bentonite only (2 in) or in combination with 1:1 sand:topsoil (12 in).
April 2001	Alcoa submitted the amended 2001 CCLGR to EPA. Cleanup of the Soluble Oil Lagoon completed.
June 2001	Cleanup of the 60-Acre Lagoon and the West Fill Area completed.
October 2001	Cleanup of the Unpaved Plant Roads completed.
June –August 2002	Alcoa submitted the Analysis of Alternatives Report dated 6/12/02 and it was subsequently approved by EPA.
July 1, 2002	Alcoa submits updated Human Health Risk Assessment.
April-May 2002	EPA's National Remedy Review Board (NRRB) reviews proposed remedial action for the Lower Grasse River and issues its recommendations.
April 2003	EPA Region 2 responds to NRRB memorandum recommendations on Alcoa's Grasse River Study Area.
Spring 2003	Ice jam scoured ~ 1 foot of cap and ~3.8 feet of sediment below some parts of the capping pilot study, along with other areas of scouring.
2005	Alcoa performed the Remedial Options Pilot Study (ROPS) to assess remedial effectiveness of potential alternatives for the river. Dredging (~25,000 cy), armored capping (~1 acre) and thin-layered capping (~0.5 acres) were implemented in the lower Grasse River. Dredged material placed in on-site landfill.
September-October 2006	Alcoa conducted the Activated Carbon Pilot Study (ACPS) in ~0.5 acre area of the lower Grasse River to assess the effectiveness of granulated activated carbon (GAC) in reducing the bioavailability of PCBs. Laboratory and field studies accompanied the field application.
Winter 2006	Alcoa tests flume and physical models at USACE Cold Region Research and Engineering Laboratory (CRREL) to aid in design of an Ice Control Structure at T6.5.
2006-Present	Alcoa partially funding Massena Electric's Department proposed 26 ft head dam on Grasse River to deal with ice jams/ice scour of PCB-contaminated sediments.
March 2007	Alcoa conducted an Ice Breaking Demonstration Project in the lower ~7 miles of the Grasse River to evaluate mechanical ice breaking to mitigate ice jams as an interim measure.
2009-2011	Alcoa's Revised Analysis of Alternatives Report under review by EPA.
April 2009	Alcoa submits Addendum to the Comprehensive Characterization of the Lower Grasse River Report to EPA.
February 2010	EPA issues updated Ecological Risk Assessment, per NRRB comment.
Aug-Sept 2010	Alcoa conducts sampling of nearshore sediments to support Alternatives of Analysis Report.
2012	Proposed Plan/ROD tentatively scheduled.
Sources: Alcoa (2006, 2004, 2002, 2001a, 2001b, 1999a, 1999b, 1998), Maytal (2004), NYSDEC (1998, 1995, 1985), CDM (1999), EPA (Undated, 2010).	

EXHIBIT A-2 ALCOA EAST (FORMERLY REYNOLDS METALS CORPORATION) SITE TIMELINE

DATE	ACTION
1958	RMC was constructed to produce aluminum from alumina using the Soderberg process. Starting in the late 1950s, polychlorinated biphenyls (PCBs) were used at the plant in hydraulic fluid and electrical equipment. Various outfalls discharged PCBs and other contaminants (PAHs, dibenzofuran, fluoride, metals) into the St. Lawrence River. One of the main sources of PCBs & PAHs in the St. Lawrence River was from the Heat Transfer Medium (HTM) used to pump the carbon pitch from the North Yard storage to the potlines. Releases of HTM fluid and liquid pitch were due to bad housekeeping, and leaks in the HTM system.
1980	SRMT settles with Alcoa for $464,000 after agreeing not to sue for damages to cattle and vegetation for 10 years.
1985	MCA settles with Alcoa and Reynolds for $650,000 for damages to cattle and vegetation from emissions. The suit claimed that emissions from both Alcoa and Reynolds caused damages to the health of the St. Regis Mohawks residing on Cornwall Island and also damaged their cattle and other vegetation crops. The health aspects of the suit were dropped after a fluoride exposure assessment was conducted. The amount of $430,000 was subtracted from the settlement for legal fees.
September 1987	New York State Department of Environmental Conservation (NYSDEC) enters into Consent Order with RMC to investigate and remediate industrial waste areas at the facility. RMC placed on the NYSDEC Registry of Inactive Hazardous Waste Sites.
August 1988	Interim remedial measures include removal of contaminated sediments and capping of the North Yard drainage ditch (Outfall 004). Capping and fencing of other contaminated areas.
July 1988	RMC adds carbon adsorption treatment to one of its outfalls.
January 1989	RMC completed an initial study of sediment contamination in the St. Lawrence River adjacent to the RMC facility.
February 1989	NYSDEC issues draft SPDES permit modifications to RMC requiring non-detectable levels of PCBs using Method 680 with a detection limit of 0.065 ug/l.
September1989	EPA issues Unilateral Administrative Order (UAO) to RMC to investigate and clean up contamination in the river system surrounding the RMC facility, referred to as the "Reynolds Study Area."
July 1990	Remedial Investigation Report completed.
November 1990	The Clean Air Act Amendments of 1990 require air discharges to comply with Maximum Achievable Control Technology (MACT) limits which address hazardous air pollutants.
1990	Approximately 2,875 cy of contaminated material is excavated from the 002 Outfall ditch and disposed off-site.
February 1991	Construction is completed to permanently divert the 004 Outfall on the St. Lawrence River to an activated carbon treatment system. A shallow groundwater collection system is also completed and the North Yard treatment system is installed.

DATE	ACTION
August 1991	The Feasibility Study Report is completed.
January 1992	NYSDEC issues ROD to remediate RMC property. Remedy includes removal and/or treatment of contaminated sediments and soils, and upgrading of the groundwater, surface water and leachate collection and treatment systems.
March 1992	Reynolds issues draft Analysis of Alternatives Report. Reynolds agrees to a Consent Order that includes non-detectable PCBs in discharges, bioaccumulation monitoring, and continued on-site remediation. This settles the February 1989 SPDES permit action. Consent Order results in a $420,000 penalty and corrective action projects to remediate PCBs. Besides the legal fees and penalties, other payments included: $120,000 to support the Akwesasne Aquaculture Project and related monitoring; $30,000 to support PCB study in the Area of Concern; and $25,000 to support American Clean Water biological studies between the City of Ogdensburg and Village of Massena.
1993	Reynolds releases a revised Analysis of Alternatives Report to address the contamination of the St. Lawrence River.
March 1993	NYSDEC issues a Consent Order requiring RMC to implement remedial design and remedial actions at the Black Mud Pond, Industrial Landfill, Wetlands, Potliner Storage Pad, North Yard and Miscellaneous Areas. Remedies included source removal, capping, groundwater/leachate collection and treatment.
September 1993	EPA issues ROD for the RMC study area requiring dredging of the contaminated sediments of the St. Lawrence River, on-site thermal desorption of dredged sediments with PCB concentrations greater than 25 ppm, and consolidation and capping of the untreated dredged sediments containing between 1 and 25 ppm PCBs with the treated dredged sediments in Black Mud Pond (an on-site disposal pit). Cleanup goals 1 ppm PCBs, 10 ppm PAHs, and 1 ppb dibenzofuran.
October 1993	Remedial action implemented at the Miscellaneous Area north of Haverstock Road.
1994	Land based remediation continues.
June 1995	NYSDEC issues ROD amendment allowing on-site disposal of sediment and soil <50 ppm PCB and off-site disposal where >50 ppm PCB.
1995	NYSDEC negotiates Memorandum of Understanding with Reynolds for air emissions, including building hoods, modernizing cells, installing air pollution equipment, and using best management practices. RMC installed a new fume control system including wet and dry scrubbers to control air emissions from the plant. Compliance demonstrated in October 1999.
December 1997	Reynolds pays $19,000 in fines under an enforcement action for violation of TSCA when stripping oil and oily waste water contaminated with PCBs were shipped off-site as nonhazardous waste.
1995-2002	Action to remediate contaminated sediments of the St. Lawrence River postponed until 2001. Land based remediation continues on schedule. Black Mud Pond: PCB and cyanide disposal area. A dewatering system was

DATE	ACTION
	installed in 1995 and a hazardous waste closure cap installed the following year. As of February 2000, ~1.7 million galls of leachate was extracted and treated. Landfill/Former Potliner Storage Area: PCB wastes disposal area. Closure cap design approved in Dec 1996. Landfill cap construction finalized December 2002. North Yard: Remediation of PCB-contaminated soils has been completed per the Nov 1998 completion report. Potliner Pad: Excavation of PCB and PAH contaminated soils completed in July 1997. A total of 17,539 cy soils disposed at on-site landfill and 172 cy were transported off-site. Wetlands: Excavated material placed in on-site landfill. Open water (2-acres) at toe of landfill converted to upland. Excavated wetland replaced and an additional 8-acre open water wetland area created. Rectifier Yard: Soils (2,524 cy) contaminated with PCBs and PAHs were excavated and either placed in the on-site landfill or disposed off-site at a licensed facility.
July 1998	EPA issues Proposed Plan specifying changes to disposal of dredged sediments and eliminating treatment of dredged sediments. Off-site disposal proposed for material contaminated with PCBs above 50 ppm and on-site disposal for material below 50 ppm but greater than 1 ppm.
September 1998	EPA issues ROD amendment modifying disposal and treatment requirements as follows: Off-site treatment and disposal of dredged sediments greater than 500 ppm, off-site disposal of dredged PCB sediments between 50 and 500 ppm PCB and on-site disposal and capping of dredged sediments less than 50 ppm PCB in the Industrial Landfill. Allowed for capping after dredging to ensure attainment of cleanup goals.
February 2000	Alcoa issues Final Work Plan dredging contaminated sediments from the St. Lawrence River.
May 2000	Alcoa purchases Reynolds. RMC site renamed Alcoa East.
April-November 2001	Alcoa dredges about 85,655 cy of St. Lawrence River sediments from 21.8 acres contaminated with PCB, PAH, and dibenzofuran (TDBF) from within sheet pile wall. About 20,200 lbs PCBs were removed. A 98.6% reduction in PCBs levels was achieved associated with a post-remediation site-wide average of 0.8 ppm PCBs. Thirty of the 32 tested cells achieved the 1 ppb TDBF cleanup goal. Two hundred fifty-six of the 268 cells met the 1 ppm PCB cleanup goal. The remaining 12 cells were below 10 ppm. Post-dredging sample results from 96 cells showed numerous cells with PAHs above the 10 mg/kg cleanup goal, indicating that the PAHs were not co-located with the PCBs and the TDBFs. A 0.75 acre interim 12-inch gravel cap was installed just prior to demobilization to address PCBs above 1 ppm in 12 cells as insufficient time remained in the construction season to install the engineered 3-layer cap. Interim cap thickness ranged from ~1-7 ft.

DATE	ACTION
March 2002	Alcoa releases a Draft Interim Completion Report for the St. Lawrence River Remediation Project.
2002-2003	Alcoa discharges excess fluoride in Oct 2002. NYSDEC issues Consent Order and Alcoa pays $20,000 fine for air violations in November 2003.
2002-2006	Alcoa tests remaining cells to determine if PAHs exceed sediment cleanup goal. EPA concludes that seventy-six of the 268 cells contained PAH levels above the cleanup goal. Fifty-three cells were documented with PAHs above 20 mg/kg.
November 2005	Alcoa pays fine of $40,000 for air violation recorded in April exceeding state minimum of 2.4 pounds of aluminum emitted per ton produced.
August 2006	Alcoa agrees to Consent Order with NYSDEC requiring company to pay $143,000 penalty to resolve violations of its permitted monthly fluoride emission for Mar, Apr, and June 2006. Corrective actions were required by the end of December 2006 and a stipulated penalty schedule resulted in additional penalty of $73,000 for fluoride emissions exceeding the CO threshold in July and August 2006.
December 2008	EPA issued Explanation of Significant Difference (ESD) that allows for the capping of residual and inventory PAH in 50 cells and excavation of 3 nearshore cells. The PAH cap will consist of a 6-inch sand layer topped by a 6-inch armor layer. In addition, a 6-inch habitat layer will be placed over the armor layer of the PCB and PAH capped cells. The habitat material will fill in the spaces between the armor stone and provide a base for submerged aquatic vegetation (SAV) to root and benthic organisms to colonize. In the nearshore area, the habitat layer will fill in the spaces between the armor stone to avoid exceeding original bathymetry. Long-term monitoring will include the physical condition of the capped cells, sediment, benthic community, fish, and SAV.
May 2009	Alcoa East may be idled for 2 years. Implement modernization plan. Switch over from Soderberg to pre-baked anode production process.
Summer 2009	Supplemental remediation of St Lawrence River completed. Final 1.9 acre PCB cap (mid 6-inch sand layer overlain by 12 inch armor layer) installed on top of the 2001 interim cap (6 inch gravel layer - 15 cells). Fifty cells > 20 ppm PAH capped. This 3.5 acre PAH cap consists of 6 inches of sand and 6 inches of armor. A habitat layer is installed as described in the ESD description, above.
2010	Long-term physical, chemical and biological monitoring of remediated area begins.
Sources: Tames (2009), Waite (2009), EPA (2008, 2006), Lieber (2005), Maytal (2004), Bechtel (2002), NYSDEC (1995, 1985), Alcoa (2011).	

EXHIBIT A-3 GENERAL MOTORS SUPERFUND SITE TIMELINE

DATE	ACTION
1959	General Motors begins manufacturing aluminum cylinder heads for automobile engines using the die-casting method. Polychlorinated biphenyls (PCBs) were used in hydraulic fluid in die-casting equipment and in electrical equipment.
1968-1980	GM periodically landfills sludge containing PCBs and other hazardous substances on-site under the Toxic Substances Control Act (TSCA).
1970	PCB-contaminated site soil disposed of on the north bank of the Raquette River.
1975	The containment berm surrounding the East Disposal Area (EDA) fails resulting in transport of wastewater treatment sludges and other materials onto St. Regis Mohawk tribal lands.
1980	GM stops on-site disposal of PCB-contaminated material and submits closure plans for the EDA and North Disposal Area (NDA).
September 1984	GM site is placed on Superfund National Priorities List (NPL).
Mid-1980s	GM ceases die casting switching over to the lost foam method for casting aluminum.
1985	GM pays EPA a penalty of $395,000 to settle the 1983 case.
April 1985	EPA and GM enter into Administrative Order of Consent to conduct RI/FS.
Summer 1985	GM fences off the Industrial Landfill (ILF).
May 1986	GM submits Draft Remedial Investigation and Feasibility Study (RI/FS) to EPA.
Summer 1987-1988	GM implements interim remedial measures, including the closing, grading, and temporary capping of the ILFI.
1988	Stormwater discharges to the Raquette River through the storm sewer line redirected to the 10-million gallon lagoon. Sewer line sealed near GM plant.
February 1989	GM performs additional river sampling. NYSDEC issues draft State Pollution Discharge and Elimination System (SPDES) permit modifications to GM requiring non-detectable levels of PCBs using Method 608 with a detection limit of 0.065 ug/L.
May 1989	GM submits Final Phase 2 RI reports to EPA. GM submits report to EPA on samples taken from St. Lawrence and Raquette Rivers.
June 1989	EPA approves RI, Phase 2 RI, and Sediment Sampling reports for GM site. RI report outlines those areas in need of remediation
November 1989	GM submits FS report to EPA

DATE	ACTION
December 1990	The EPA issues a Record of Decision (ROD) for the first operable unit (OU1) that includes sediment, soil, and sludge excavation and treatment, as well as groundwater recovery and treatment.
1992	Design of ILF commences.
March 1992	The EPA issues a ROD for a second operable unit (OU2) that includes a mix of treatment and containment of soils (including remediation of EDA and IFL) and contaminated groundwater below the EDA and ILF. The EPA also issues a UAO compelling implementation of OU1.
April 1992	The EPA issues a UAO compelling implementation of OU1 remedial actions.
August 1992	The EPA issues a UAO compelling implementation of OU2 remedial actions.
August1993	GM performs additional sampling for design and implementation of a remediation plan.
Mid-1990s	GM begins casting iron using the lost foam method.
1994	St. Lawrence River dredging postponed due to redesign of engineering controls once it was determined that currents too strong for effective operation of silt curtains.
June–November 1995	Dredging is implemented within sheet-piled remediation area. Over 13,000 cubic yards (cy) of contaminated material is removed from approximately 10 acres in the St. Lawrence River. Greater than 99% of the PCBs removed. Post-dredging, residual PCBs in a 2-acre area in the vicinity of GM Outfall 001 was capped to reduce surface concentrations to <1 ppm PCBs. The remaining 8 acres were left uncapped and averaged ~3 ppm PCBs. The multilayer cap is inspected and monitored annually. GM also excavated ~7,000 cy of contaminated soils around the south side of the GM plant. Soils above 10 ppm PCBs were removed and stockpiled in EDA. The soils in the area of the EDA were re-contoured and re-vegetated directing any surface waters to a newly constructed 1.5 million gallon storm-water lagoon and treatment system. Remediation of Turtle Cove contaminated sediments was planned but postponed because access was prohibited.
June 1995	GM received approval from NYSDEC to remediate the Mineral Processing site. GM was instructed to haul away soils over 10 ppm PCBs to an off-site secure landfill, place two feet of clean fill over the area, dismantle and ship the building off site, and monitor the groundwater at this site. The EPA issues an OU1 Post-Decision Proposed Plan calling for on-site treatment using thermal extraction for materials with PCBs above 500 ppm and on-site containment of materials with PCB concentrations less than 500 ppm. EPA issued a Proposed ROD amendment to change the treatment level for OU1 ROD soils and sediments from 10 ppm to 500 ppm to be consistent with OU2 ROD treatment levels. The public expressed strong opposition and EPA rescinded the proposed plan.

DATE	ACTION
1997-2001	Spottail shiner monitoring program implemented to assess cap effectiveness in sequestering PCBs.
January 1998	Monitoring studies show that a portion of the sediment cap that was placed near GM Outfall 001 to cover contaminated materials was defective. The sediment cap was repaired.
Summer 1998	EPA considers a Revised OU1 Post Decision Plan calling for off-site disposal of contaminated St. Lawrence and Raquette River sediments rather than therma1 treatment.
March 1999	ROD amendment issued allowing off-site disposal of sediments rather than treatment.
Summer 1999	GM delineates the Raquette River sediments and bank soils for PCBs.
Fall I999	Previously dredged St. Lawrence River sediments disposed of off-site. GM takes soil borings of the Industrial Landfill to better characterize the waste pile. GM begins the Subsurface Investigation and Stability Analysis Study of the Industrial Landfill. This study, when finished, will help design the cutoff walls around the Industrial Landfill
April 2000	EPA issued an Explanation of Significant Differences (ESD) for OU1 that allowed off-site disposal of certain materials after on-site treatment via solidification, rather than thermal desorption.
July 2000	GM abandoned 33 wells and samples 50 wells.
July 2000-August 2004	Contaminated sludge and soil associated with the 1.5 million gal and 350,000 gal lagoons are excavated and disposed off-site.
2001	GM solidified the sludge in the Northern Aeration and Southern Aeration Basins. All cracks and leaks in the Basins were repaired before they were placed back into service.
October 2001	NYS Attorney General's Office Fund a study that determined that Contaminant Cove is still being impacted by the GM Industrial Landfill.
June 2002	GM started the Subsurface Investigation of the Area Northeast of the Industrial Landfill. Ten soil borings were collected to delineate an area of known contamination between the Industrial Landfill and Turtle Cove.
August 2002-September 2003	GM began the Raquette River Bank and Sediment removal work. Steel sheet pile walls enclosed the river sediments into two separate areas. The areas were dewatered and excavated in the dry. By December 2002, GM completed the river work. Bank work was completed by Fall 2003. Over 10,000 cy of soils were excavated from the river banks with ~7,420 cy shipped to an off-site disposal facility. Approximately 1,440 cy of sediments were dredged from the Raquette River. Red osier dogwoods were planted along the banks in the Fall 2003.
May 2003 – December 2004	GM eliminated a pathway of known contamination between the Industrial Landfill and Turtle Cove. An area of contaminated soils called

DATE	ACTION
	Area Northeast of the Industrial Landfill was isolated with steel sheeting and 5,050 cy were excavated and placed in storage Cell One located on GM property.
September-November 2003	GM restarted Inactive Lagoon work by removing the oily stained soils, which were left behind in 2001. The location of utilities prevented total cleanup of lagoon. An under-drain system was installed to control remaining contaminants. The lagoon was lined and placed back into service.
Fall 2003	GM completes remediation of toe of the Industrial Landfill.
December 2003	GM collects groundwater samples from all of their existing monitoring wells. Information gathered will help determine the current condition of groundwater contamination.
July 2004	GM performed a subsurface investigation of the area around Turtle Cove. Its purpose is to help define the limits of excavation when the Cove is remediated in the near future.
October 2004-March 2005	GM remediated an SRMT property with soils greater than Tribal standard of 1 ppm PCBs. Remediation access still needed for 2 other tribal properties. GM excavated contaminated sediments above Tribal cleanup standard (0.1 ppm PCBs) from dewatered Turtle Cove. Approximately 18,240 cy of soils and sediments with PCB concentrations greater than 10 mg/kg and 15,300 cy of soils and sediments with PCB concentrations less than 10 mg/kg were removed during the excavation of the Cove and upland soils. Sediments remain on-site and are part of the landfill talks. Groundwater in the vicinity of the ILF is pumped to GM's wastewater treatment system through installation of an automated sump system.
April 2005	EPA conducts five-year review inspection.
July 2005	GM samples certain downstream areas located on Tribal land to determine if there were any downstream impacts to the Raquette River.
2005	EPA issues a 5-year review recommending that access restrictions be implemented for the East and North Disposal Areas to prevent exposure to contaminated surfaces soils.
July 2006	GM initiates soil sample collection on Tribal property bordering the GM facility. Its purpose is to help define the limits of PCB contamination at Akwesasne.
October 2006	GM installed 20 new groundwater monitoring wells. Two were placed on Tribal property. These wells have been added to GM's existing Groundwater Monitoring Network of 54 wells. All the wells in the network have been sampled for PCB, VOCs, and phenols. Additional groundwater sampling will continue in the future. The information gathered by this work will help define the sources of contamination at GM.
November 2006	GM collects a round of ground water samples from their new and existing monitoring wells. Wells on one of the Thompson family properties were not sampled.

DATE	ACTION
December 2006	GM modified the 002 Outfall at the Raquette River. An HDPE liner was inserted inside the existing cement discharge pipe. This was GM's corrective measure to address the residual PCBs in old cement piping. Low level PCBs had been detected during periodic sampling of outfall.
May 2007	GM collects a round of ground water samples from their new and existing monitoring wells. Wells on one of the Thompson family properties were not sampled.
October 2007	GM submits Interim Groundwater Characterization Sampling and Analysis Report evaluating the current condition of the Groundwater at the site.
August 2007	GM remediated a portion of Tribal soils upland from Turtle Cove delineated in July 2006. Access roads were built on reservation property to haul out the PCB-contaminated soils to GM's EDA. Approximately 815 cy of material were disposed of at the EDA.
2007	Spottail shiner monitoring program reinstated.
April 2008	GM installs willow whips along the shoreline of the Raquette River at request of natural resource agencies to minimize shoreline erosion.
June 2008	Fish sampling and analysis conducted to re-evaluate fish consumption advisories.
December 2008	GM report issued summarizing results of fish collection activities evaluating fish consumption advisory in Turtle Cove. Observed general decrease in average PCBs compared to 1988 values but concentrations were higher than in fish in surround areas collected in 1988.
February 2009	St. Lawrence River 2008 Monitoring and Maintenance Annual Inspection Report. About 10%-15% of the St. Lawrence River cap supports SAV. The dredged areas that were not capped have thicker growth of SAV.
2009	Remediation of the ILF, EDA, NDA, and tribal soils has not been completed.
June 2009	GM enters into Chapter 11 bankruptcy.
October 2009	Motors Liquidation Company (MLC or "Old GM") submits Mohawk Uplands Soil/ Sediment Sampling Work Plan.
November 2009	DOJ enters proof of claim on behalf of Trustees for NRD liability and EPA for response costs.
2010	MLC collects subsurface soil samples beneath the GM plant.
October 2010	Court approves bankruptcy settlement with EPA, 14 States, and the SRMT. Settlement includes $120,860,604 to manage and fund cleanup of the GM facility in Massena, NY.
June 2011	Court approves NRD Consent Decree and settlement agreement that provides for general unsecured claim of $9.5M in GM stock for the GM Massena site.
Sources: Arcadis (2009), CDM and BBL (2007), NOAA (2006), EPA (2011, 2005, 1992, 1991), CDM (1998), NYSDEC (1995), Anon (1985), ATSDR (Undated).	

APPENDIX A REFERENCES

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Soil is a trust natural resource that has been exposed to contamination from the Facilities. This assessment focused on the potential injury to soils within Akwesasne due to PCBs.

INJURY TO SOIL RESOURCES

Soil is a geologic resource, defined in the in the DOI regulations as:

Those elements of the earth's crust such as soils, sediment, rocks, and minerals…that are not included in the definitions of ground and surface water resources (43 C.F.R. §11.14 (s)).

Soil resources exposed to contaminants discharged directly to the assessment area or remobilized or re-released from the soils (e.g., erosion or bioturbation) include soils within Akwesasne.

Injury to soil has occurred when:

Concentrations in the soil of substances sufficient to cause a toxic response to soil invertebrates (43 C.F.R. §11.62(e)(9));

Concentrations in the soil of substances sufficient to cause a phytotoxic response such as retardation of plant growth (43 C.F.R. §11.62(e)(10)); or

Concentrations of substance sufficient to have caused injury as defined in paragraphs (b), (c), (d), or (f), of this section to surface water, groundwater, air, or biological resources when exposed to the substances ((43 C.F.R. §11.62(e)11)).

To assess the potential for injury to soil within Akwesasne, PCB concentrations in soil are compared to published soil toxicity screening levels and thresholds.

COMPARISON OF ASSESSMENT AREA SEDIMENT PCB CONCENTRATIONS TO SEDIMENT QUALITY GUIDELINES

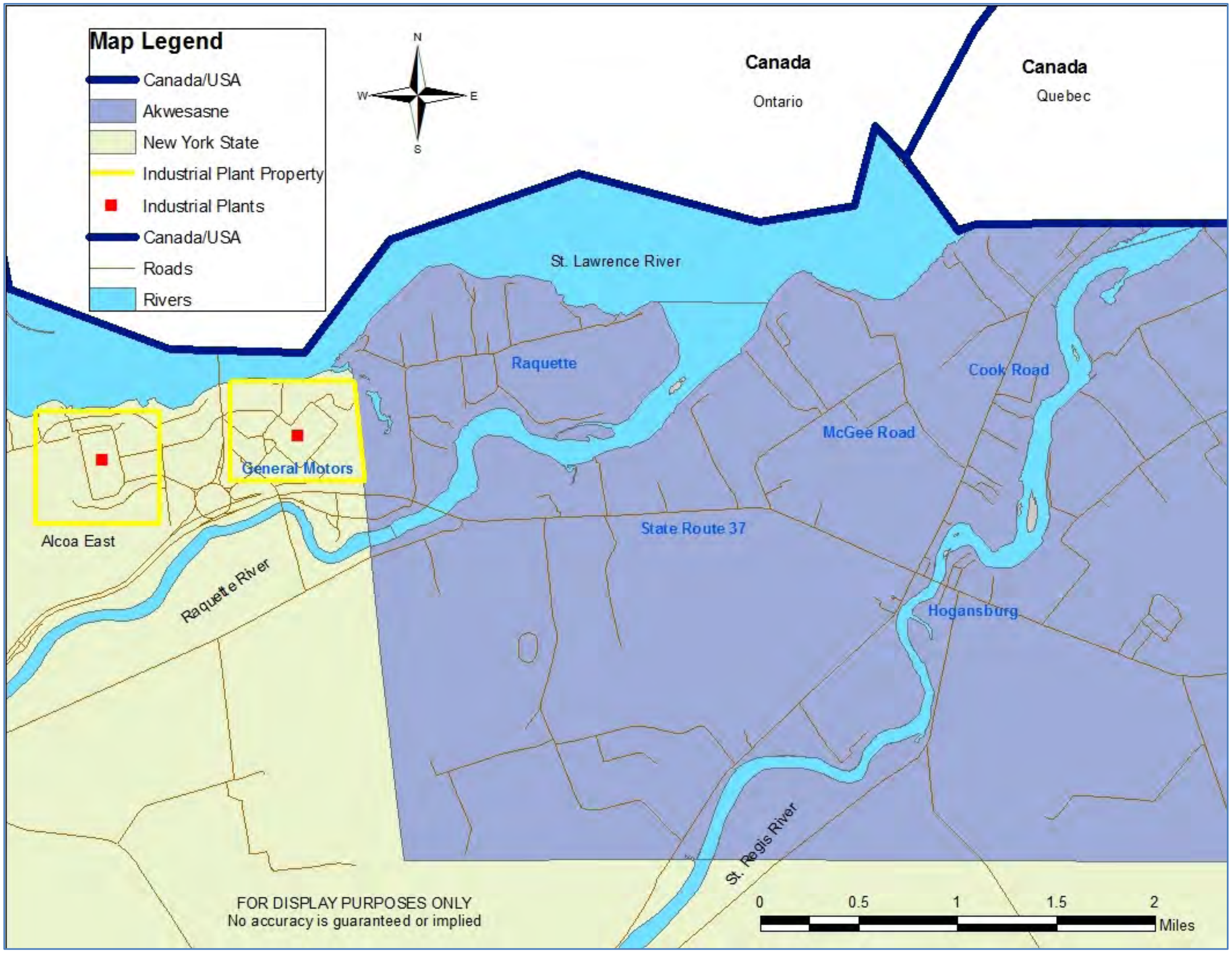
Data on PCB concentrations in soil have been recorded within the assessment area at various times between 1985 and 2005. These data are summarized in Exhibit B-1. A map of general sampling locations is provided in Exhibit B-2.

EXHIBIT B-1 AVERAGE SOIL PCB CONCENTRATIONS IN AND AROUND ASSESSMENT AREA

AREA	NUMBER OF SAMPLES	YEAR	AVERAGE SOIL PCB CONCENTRATION (PPM)
Adjacent to GM Property	4	1985	2.09
	7	1986	0.15
	2	1987	0.30
	6	2001	6.28
Akwesasne - Route 37	6	1986	0.002
	3	2005	0.005
Raquette (Including Raquette Point)	2	1986	0.05
	1	1987	0.02
	3	1994	0.32
	3	2005	0.003
	38	2006	ND
St. Regis	2	1986	ND
	1	1994	0.08
	3	2001	ND
	6	1994	0.04
Snye Marsh	2	1994	0.07
	7	1994	0.03
	1	2005	0.004
Cornwall Island	1	1987	ND
	22	1994	0.06
	4	2005	0.003
Cook Road	1	1994	0.61
McGee Road	1	1994	0.20
	1	2005	0.002
Hamilton Island	1	1994	0.03
Hogansburg	1	2005	0.004

Notes:
ND indicates non-detect.
Data source: Thompson 2007.

EXHIBIT B-2 MAP OF GENERAL SOIL SAMPLING LOCATIONS IN AND AROUND ASSESSMENT AREA



Although no promulgated criteria for contaminant concentrations in soil exist, there are two published soil quality thresholds below which adverse (i.e., toxic) effects to soil invertebrates and plants are unlikely to occur. In addition, a few literature studies report soil PCB concentrations below which adverse effects on plants and earthworm predators are unlikely to occur. These thresholds are summarized in Exhibit B-3.

EXHIBIT B-3 EFFECTS THRESHOLDS FOR PCBS IN SOIL

PCB CONCENTRATION (PPM)	THRESHOLD	SOURCE
0.5	Soil Quality Guideline for adverse effects on agricultural land.	EC 2005
10	No effect on height, water use, or fresh shoot weight o terrestrial plants.	Efroymson et al. 1997
40	Screening benchmark for toxic effects on terrestrial plants.	Efroymson et al. 1997
500	Lowest Observed Effect Level for adverse effects on reproduction in oldfield mice*	Wooten 2008, Sample et al. 1996, EPA 1999
670	Lethal or serious sub-lethal effects on wildlife consumers of earthworms in soil contaminated with PCBs.	Beyer and Stafford 1993

Note:
Calculated using a Lowest Observable Effects Level (LOEL) of 5 ppm in food (Linzey 1987 in Sample et al. 1996; diet is mainly vegetation and seeds, Wooten 2008) and soil-to-plant bioconcentration factor of 0.01 (EPA 1999).

Comparison of average yearly PCB concentrations in Akwesasne soil with published effects thresholds indicate that injury to soil (i.e., organisms exposed to soil or consuming invertebrates living in soil) is unlikely to have occurred due to PCBs. Although average PCB concentrations in soil adjacent to GM property exceeded the Soil Quality Guideline for agricultural soil in 1985 and 2001, concentrations did not exceed the lowest ecological threshold for effects on terrestrial plants or oldfield mice (oldfield mice are more sensitive to PCBs than white-footed mice; EPA 1999). Because this area is not used for agricultural purposes, it is unlikely that PCB concentrations in soil have caused a loss in ecological services.

APPENDIX B REFERENCES

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Groundwater is a trust natural resource that has been exposed to contamination from the Facilities. This assessment focused on the potential injury to groundwater within Akwesasne due to PCBs.

INJURY TO GROUNDWATER RESOURCES

Groundwater resources are defined in the in the DOI regulations as:

Water in a saturated zone or stratum beneath the surface of land or water and the rocks or sediments through which ground water moves. It includes ground water resources that meet the definition of drinking water supplies (43 C.F.R. §11.14 (t)).

Groundwater resources exposed to contaminants discharged from the facilities include groundwater within Akwesasne.

Injury to groundwater has occurred when:

Concentrations of substances [are] in excess of drinking water standards, established by sections 1411-1416 of the Safe Drinking Water Act (SDWA), or by other Federal or State laws or regulations that establish such standards for drinking water, in ground water that was potable before the discharge or release (43 C.F.R. §11.62 (c)(i));

Concentrations of substances [are] In excess of water quality criteria, established by section 1401(1)(d) of the SDWA, or by other Federal or State laws or regulations that establish such criteria for public water supplies, in ground water that before the discharge or release meet the criteria and is a committed use, as the phrase is used in this part, as a public water supply (43 C.F.R. §11.62 (c)(ii));

Concentrations of substances [are] in excess of applicable water quality criteria established by section 304(a)(1) of the Clean Water Act (CWA), or by other Federal or State laws or regulations that establish such criteria for domestic water supplies, in ground water that before the discharge or release meet the criteria and is a committed use as that phrase is used in this part, as a domestic water supply (43 C.F.R. §11.62 (c)(iii)); or

Concentrations of substances [are] sufficient to have caused injury as defined in paragraphs (b), (d), (e), of (f) of this section to surface water, air, geologic, or biological resources when exposed to groundwater (43 C.F.R. §11.62 (c)(iv)).

To assess the potential for injury to groundwater within Akwesasne, PCB concentrations in groundwater were reviewed. All samples collected from locations within Akwesasne, including Raquette Point, Snye Marsh, and Cornwall Island were non-detect for PCBs

(Exhibits C-1, C-2). Therefore, it is unlikely that injury to groundwater resources has occurred.

EXHIBIT C-1 PCB CONCENTRATIONS IN GROUNDWATER WITHIN AKWESASNE

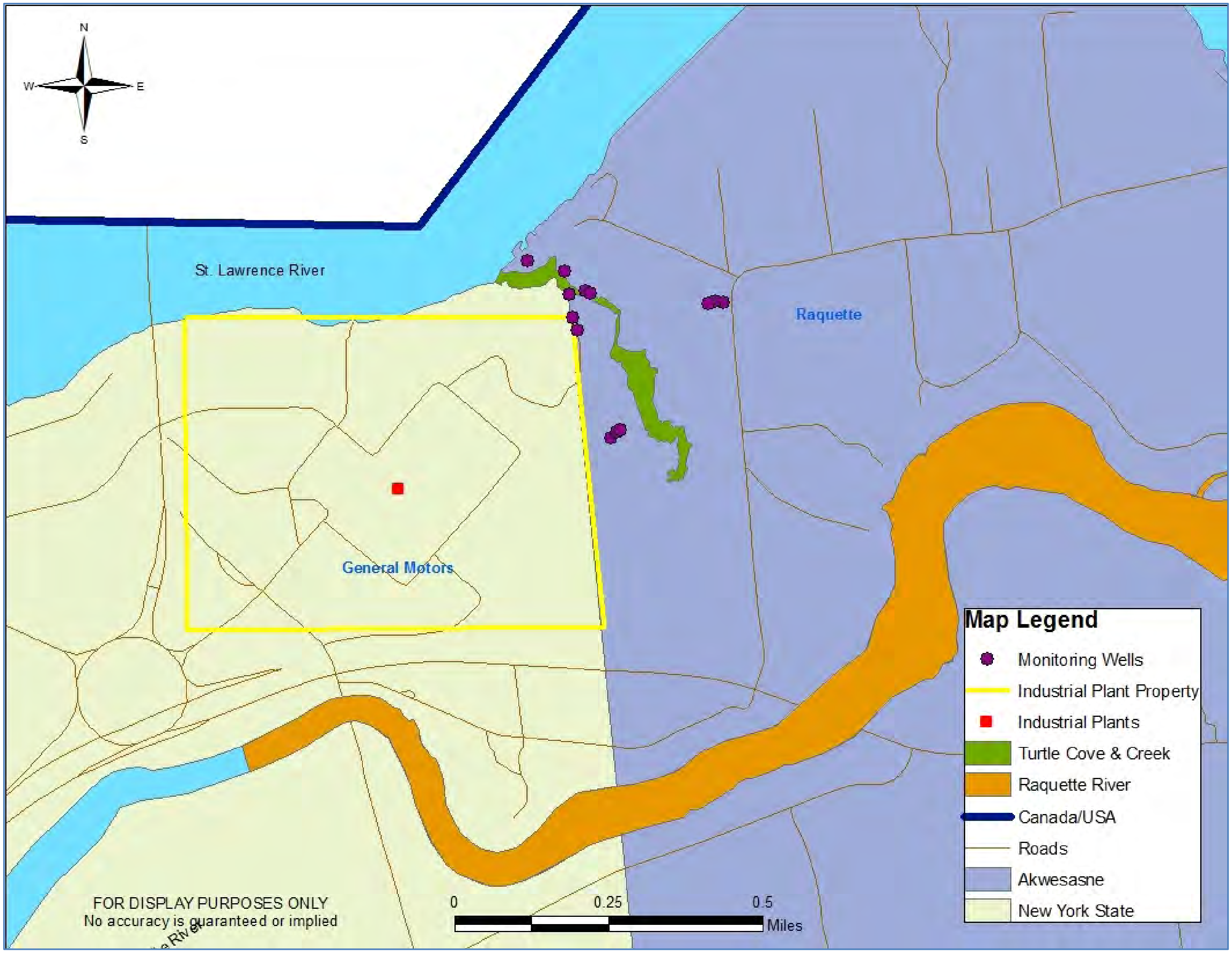
AREA	# OF SAMPLES	YEAR	MIN (PPM)	MAX (PPM)
Raquette Point (Akwesasne)	6	1985	Unavailable	Unavailable
	6	1986	Unavailable	Unavailable
	14	1987	ND (0.5)	ND (0.5)
	4	1988	ND (0.5)	ND (0.5)
	4	1988	ND (0.5)	ND (0.5)
	4	1988	ND (0.5)	ND (0.5)
	4	1988	ND (0.5)	ND (0.5)
	4	1988	ND (0.5)	ND (0.5)
	9	2000	ND (0.5)	ND (0.5)
	1	2003	ND (0.1)	ND (0.1)
	3	2004	ND (0.02)	ND (0.05)
	1	2006	ND (0.065)	ND (0.065)
	1	2007	ND (0.065)	ND (0.065)
Snye Area	4	1994	ND (0.000001)	ND (0.000001)
Cornwall Island	16	1994	ND (0.000001)	0.0000044

Sources:

Interim Groundwater Characterization Sampling and Analysis" General Motors (GM) Corporation in Massena, NY. October 2007.

SRMT Environmental Contaminants Database. Provided by A. LaFrance March 2009.

EXHIBIT C-2 MAP OF GENERAL GROUNDWATER SAMPLING LOCATIONS IN AND AROUND ASSESSMENT AREA



APPENDIX D: EVALUATION OF EXPOSURE AND TOXICITY OF ALUMINUM, CADMIUM, CYANIDE, DIOXINS/FURANS, FLUORIDE, LEAD, MERCURY, AND PAHS TO NATURAL RESOURCES WITHIN THE ASSESSMENT AREA

ST. LAWRENCE ENVIRONMENT NATURAL RESOURCE DAMAGE ASSESSMENT

Evaluation of Exposure and Toxicity of Aluminum, Cadmium, Cyanide, Dioxins/Furans, Fluoride, Lead, Mercury, and PAHs to Natural Resources within the Assessment Area

Final Report December 2011

Prepared by:

St. Lawrence Environmental Trustee Council

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INTRODUCTION

As part of the natural resource damage assessment (NRDA) for the St. Lawrence Environment, the U.S. Department of the Interior Fish and Wildlife Service, the U.S. Department of Commerce National Oceanic and Atmospheric Administration, the State of New York Department of Environmental Conservation, and the St. Regis Mohawk Tribe (collectively known as the Trustees) evaluated the effects of eight contaminants other than polychlorinated biphenyls (PCBs) on sediment and fish within the assessment area.[1,2] These contaminants include polycylic aromatic hydrocarbons (PAHs), aluminum (Al), cadmium (Cd), cyanide (Cn), dioxins/furans (PCDD/PCDF), fluoride (F), lead (Pb), and mercury (Hg).[3] The effects of dioxins/furans on birds were also evaluated. Each contaminant was reviewed in terms of available concentration and exposure data within the assessment area, toxicity information, and source (i.e., whether or not the contaminant is likely from Alcoa, Reynolds and/or General Motors (together, the Site)). This report contains the following sections:

- Summary of results;
- Assessment area;
- Contaminants quantitatively assessed (PAHs, fluoride);
- Contaminants qualitatively assessed (aluminum, cyanide);
- Contaminants removed from consideration (cadmium, dioxins/furans, lead, mercury); and
- Overall conclusion.

SUMMARY OF RESULTS

Sediment and fish data for eight contaminants and bird data for one contaminant were assessed to determine whether these contaminants are Site-related and, if so, if they have caused injury to Trust resources within the assessment area. Where possible, injury due to relevant contaminants was quantified (i.e., PAHs and fluoride in sediment). If data indicate injury was likely but were insufficient to quantify impacts, losses will be addressed qualitatively within the context of restoration (i.e., aluminum and cadmium in sediment; and PAHs, fluoride, aluminum, and cyanide in fish). For contaminants that are not Site-related or where no impacts to Trust resources are expected, no further investigation is recommended (i.e., cadmium, dioxins/furans, lead, and mercury). Results are summarized in Exhibit 1.

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[1] PCBs are addressed under separate cover.

[2] Data on other contaminant concentrations in biological resources such as amphibians and mammals are extremely limited. Where data are sufficient to evaluate potential injury (i.e., fluoride injury to mammals), such assessment is addressed under separate cover.

[3] Styrenes, including octochlorostyrene (OCS), are described in the St. Lawrence NRDA Plan as a contaminant of concern in air and are therefore not addressed in detail here. Note that site-specific OCS concentrations in fish, birds, and reptiles and corresponding effects information are extremely limited, and are insufficient to evaluate the potential for injury to these resources.

EXHIBIT 1 SUMMARY OF ASSESSMENT RESULTS

CONTAMINANT	RESOURCE	QUANTITATIVE	QUALITATIVE	NO FURTHER ASSESSMENT
Aluminum	Sediment	--	X	--
	Fish	--	X	--
Cadmium	Sediment	--	--	X
	Fish	--	--	X
Cyanide	Sediment	--	--	X
	Fish	--	X	--
Dioxins/Furans	Sediment	--	--	X
	Fish	--	--	X
	Birds	--	--	X
Fluoride [1]	Sediment	2,768 DSAYs	--	--
	Fish	--	X	--
Lead	Sediment	--	--	X
	Fish	--	--	X
Mercury	Sediment	--	--	X
	Fish	--	--	X
PAHs [2]	Sediment	5,361 DSAYs	--	--
	Fish	--	X	--

Notes:
-- = Not applicable
X = Analysis for corresponding resource/contaminant
DSAY = Discount service acre-years (present value of loss)
[1] Does not include DSAYs for injury to mammals from fluoride exposure, as this was assessed under separate cover.
[2] Does not include DSAYs for GM and RMC remediation areas, as these areas were already assumed to have sustained 100 percent service loss.

ASSESSMENT AREA

The assessment area for the St. Lawrence Environment NRDA includes the U.S. waters of the St. Lawrence River from the Moses Saunders Dam, Long Sault Dam, and upstream of the Wiley-Dondero Canal downstream to the mouth of the St. Regis River, a suite of tributaries to the St. Lawrence River, aquatic and terrestrial areas on-site at the Facilities, and Akwesasne. This area has been divided into sub-sections based on differences in hydrology, bathymetry, geographic relationship to contaminant sources, and remedial activities. Subsections are depicted in Figures 1-3 and are listed below:

- Moses Saunders to Polly's Gut (Moses Saunders dam downstream along the western edge of Cornwall Island through Polly's Gut in U.S. waters),
- GM Remediation Area,
- Around GM (St. Lawrence River immediately adjacent to the GM Remediation Area in U.S. waters, including the Ship Channel),

- RMC Remediation Area,
- Around RMC (St. Lawrence River immediately adjacent to the RMC Remediation Area in U.S. waters, including the Ship Channel),
- Grasse River (confluence with the Power Canal downstream to the St. Lawrence River),
- Raquette River (Route 37 Bridge downstream to the St. Lawrence River),
- St. Regis River (dam at Hogansburg downstream to St. Lawrence River),
- Turtle Cove / Creek,
- Unnamed Tributary,
- Robinson Creek, and
- Downstream of Robinson Creek (Wiley Dondero Canal).

CONTAMINANTS ASSESSED QUANTITATIVELY

PAHS

Concentration Data - Sediment

Total PAHs were reported for 687 (421 detected) surface and subsurface sediment samples (NOAA 2007). The mean of the detected surface and subsurface sediment concentrations for all assessment areas is 67.97 parts per million dry weight (ppm dw). Concentrations ranged from 0.034 – 2,502.7 ppm dw. There are 266 non-detected sediment samples. Using one half the detection limit, the area-wide average PAH concentration is 41.9 ppm dw.

Total sediment PAH concentrations are available in the database for the assessment areas listed in Exhibit 2. Where minimum or maximum values are below the detection limit (indicated by "U") in Exhibit 2, the detection limit is presented; however, means were calculated using one half the detection limit.

EXHIBIT 2 **SEDIMENT PAH CONCENTRATIONS IN THE ST. LAWRENCE ENVIRONMENT ASSESSMENT AREA (PPM DW) [A]**

AREA	NUMBER OF SAMPLES DETECTED (TOTAL)	MINIMUM	MAXIMUM	MEAN
Grasse River – subsurface and surface	97(97)	0.054	1905.3	68
Grasse River – surface sediments only	40(40)	0.22	647.9	47
Grasse River Background [B]	0(3)	0.5U	0.540U	0.523U
Power Canal – subsurface and surface	12 (12)	0.362	64.71	19.46
Power Canal – surface sediments only	9(9)	0.362	40.3	11.2

AREA	NUMBER OF SAMPLES DETECTED (TOTAL)	MINIMUM	MAXIMUM	MEAN
Robinson Creek	26(29)	0.034	6.78	1.12
RMC Remediation Area – pre and post remediation	258(370)	0.067	2502.7	45.41
RMC to Ship Channel	3(9)	0.42U	16.83	2.7
SLR around RMC	3(6)	1.8U	5.3	2.6
GMC Remediation Area [C]	2(2)	19.62	21.85	20.74
Moses Saunders to Polly's Gut [D]	0(4)	1.1U	0.2	0.68
Raquette River Background	1(11)	0.4U	1.9	0.48
Unnamed Tributary [E]	4(67)	0.3U	32.37	1.04

Notes:

[A] Pre- and post-remediation concentrations were averaged across all depths, except where indicated, including those of clean native sediment.

[B] Grasse River background location upstream of the confluence of the Grasse River and the Power Canal.

[C] Data from RI/FS stations SL-18 and SL-19 pre-remedy (1985).

[D] Data from Moses Saunders to Polly's Gut are included here for completeness, but sediment injury due to PAHs is not assessed in this areas because the direction of river flow likely precludes PAH contamination from the GM, ALCOA, or RMC facilities in that area.

[E] PAH concentration data in Unnamed Tributary are not available. Remedial goals were based on concentrations in 60-inch RCP pipe that connects the Unnamed Tributary to the facility. Therefore, post-remedial data from the 60-inch RCP pipe is used to assess injury in the Unnamed Tributary.

U = non-detected.

Few data points were available to calculate a background concentration of total PAHs in sediment. Grasse River background had three non-detect concentrations and Raquette River had one detected out of 11 total samples. Using one half the detection limit of the 14 non-detects, the average background concentration using all 18 records is 0.42 ppm dw.

In addition to total PAH concentrations, individual PAH data in sediment exist for 18 PAHs, and most have between 270-276 records. Although for purposes of this analysis injury was not assessed using individual PAHs, we note that individual PAH concentrations may exceed a sediment quality guideline in an area where the total PAH concentration is below the sediment quality guideline.

Concentration Data - Fish

Due to the ability of fish to metabolize and excrete PAHs, tissue concentrations of PAHs are not good indicators of chronic exposure to or toxic effects on fish (e.g., Eisler 2000). However, alternate types of data (e.g., prevalence of deformities, eroded fins, lesions, and tumors (DELT anomalies) which are more closely linked to PAH exposure (e.g., Hickey 1993, Black 1983) are not available from all assessment areas. For completeness, existing PAH data are summarized below (NOAA 2007):

- Six of the 53 St. Lawrence River fish samples had total PAH concentrations above detection limits with a minimum concentration of 0.250 ppm wet weight (ww), a maximum of 0.510 ppm ww, and an average of 0.36 ppm ww.[4]
- Nineteen fish were collected from the Reynolds Remediation Area; primarily fillets of white sucker and yellow perch. PAHs were not detected in any of the samples.
- Four fish samples were collected by the GM Remediation area. PAHs were detected in one sample (longnose dace). However, the detection limit for the three other samples was higher than the concentration reported in the longnose dace sample.
- Four samples were collected within the Grasse River, one each of four species (smallmouth bass, channel catfish, walleye and emerald shiner). Three samples were carcass, one was whole body. Only the whole body shiner had detectable PAHs.
- In the Raquette River, six species (bluntnose minnow, lake sturgeon, yellow perch, smallmouth bass, emerald shiner, walleye) were analyzed for PAHs. PAHs were detected in whole body shiners and minnows. All other samples were carcasses where PAHs were not detected but the detection limits were higher than the concentrations detected in other fish samples.
- PAHs were not detected in either yellow perch or smallmouth bass carcass samples in the St. Regis River.

Although no studies were conducted by the Trustees or Companies to evaluate whether fish experienced histopathological lesions, parasitic infections, or tumors specifically associated with contamination, two studies recorded the presence of external irregularities in sampled fish. First, fish anomalies were noted in 1993 during the River and Sediment Phase II field investigation (BBL 1994). Second, during the Supplemental Remedial Studies between 1996 and 2004, external anomalies were recorded in Grasse River smallmouth bass and brown bullhead (BBL 2004). Reported anomalies included black spotting, ulcerations; clipped, missing, or eroded spines and fins; short snout or spine; missing barbell, damaged or eroded maxillary, torn jaw, damaged operculum; damaged, missing or abnormal eye; scar tissue, malnourishment, and scrapping (infections/lesions).

Toxicological Information – Sediment

Site-specific toxicity of PAHs on sediment-dwelling organisms and the effects of PAHs on benthic communities are available. For example, in one study, the freshwater midge, *Chironomus tentans,* was exposed to contaminated sediment collected near the outfalls of ALCOA, GM, and RMC for 12 days. Although the original purpose of the study was to assess bioaccumulation patterns of both PCBs and PAHs, the toxicity of the contaminants was sufficient to cause substantial mortality to the test organisms (Wood et al. 1997,

[4] Summary statistics are presented only for these six samples, excluding all non-detect samples.

O'Keefe 2002). Experimental chambers containing 100 percent facility sediment required dilution in order to obtain sufficient tissue mass for the bioaccumulation study because at the full dose of Reynolds sediment, all *Chironomus* died. Sediments were then serially diluted using control sediment (upper reach of the Hudson River). Freshwater midge survival (control-adjusted) was significantly reduced during exposure to diluted and undiluted sediments from all three facilities. Dilution factor, PAH concentration, and resulting mortality are summarized in Exhibit 3.

EXHIBIT 3 MORTALITY OF *CHIRONOMOUS* EXPOSED TO GM, ALCOA, AND RMC SEDIMENT [A]

FACILITY	PERCENT ORIGINAL SEDIMENT	PAH CONCENTRATION (PPM DW)	AVERAGE MORTALITY [B]
GM	100%	1.4	44%
ALCOA	33%	18	7%
	66%	47	15%
	100%	78	23%
RMC	3%	75	65%
	100%	3,200	100%

Notes:
[A] Source: Wood et al. (1997) and O'Keefe (2002).
[B] Tetra-Min control-adjusted.

As part of the Remedial Investigation at Reynolds, PAH and PCB concentrations in St. Lawrence River and Raquette River sediment were reported along with benthic community assessments (Woodward-Clyde 1991). The benthic community analysis showed differences in composition between the two rivers and among stations within a river.[5] The authors state "[B]ased on sediment chemistry data collected, the density and distribution of these communities are also closely related to concentrations of PAHs measured in the sediments. The benthic density and taxa richness decline as PAH concentrations increase."

General data which demonstrate PAH-associated toxicity to benthic invertebrates is available in peer-reviewed literature. For example, Ferraro and Cole (2002) collected PAH-contaminated sediment from a creosote Superfund site in Elliott Bay, WA. Ferraro and Cole (2002) calculated total PAH toxic units (TU_{PAH}) according to Swartz et al.

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[5] The taxa recorded from the station located near the Reynolds outfall 001 (SL-3) were *Annelida* (*Oligochaeta*, *Tubificidae*, *Lumbriculidae*), *Diptera* (*Chironomidae*), *Amphipoda* (*Gammaridae*), and *Gastropoda* (*Physidae*, *Lymnaeidae*). Snails comprised 90 percent of the biota recovered from SL-3. The following taxa were not found at Station SL-3 and SL-4 (near Reynolds outfall 002/003): *Tubellaria*, *Nematoda*, *Ephemeroptera*, *Nemerta*, *Odonata*, *Isopoda*, *Hemiptera*, *Polychaeta*, *Tricoptera*, *Lepidoptera*, *Coleoptera*, and *Hirudinea Pelecypoda* and *Coleoptera*. *Isopoda*, *Polychaeta*, *Oligochaeta*, and *Ephemeroptera* were not collected from SL-5 (located downstream of Reynolds Outfalls 002/003). Raquette River stations RR-1 (station upstream of confluence with Reynolds drainage ditch) and RR-2 (located downstream of ditch) were dominated by *Sphaeridae* and *Tubifidae* but RR-2 exhibited 30 percent lower density and richness than RR-1.

(1995), and conducted ten-day toxicity tests using marine amphipods *Rhepoxynius abronius* and *Leptochirus plumulosus*. Ferraro and Cole (2002) also performed benthic macrofauna community assessments at each station and computed seven community metrics. Total PAH toxic units were strongly correlated to survival of the two marine amphipods and five of the macrofauna community metrics (number of species, numerical abundance, total biomass, Swartz's dominance index, and Brillouin's index) – that is, higher TU_{PAH} corresponded to decreased survival of amphipods and decreased quality and quantity of the benthic community. They concluded that PAHs, quantified as TU_{PAH}, was an "important causal agent of changes in the field endpoints … [and] in the laboratory toxicity test endpoints, and both the field and lab endpoints were similarly sensitive to TU_{PAH}" (Ferraro and Cole 2002).

A number of sediment quality guidelines (SQGs) have also been developed for total PAHs (Exhibit 4). Thresholds below which adverse effects are rare range from 0.02 to 4.02 ppm dw. Thresholds above which adverse effects are predicted to be frequently observed range from 3.4 to 100 ppm dw.

Uncertainties in these SQGs include the unquantified effects of UV radiation, weathering, alkylation, and carbon type (e.g., soot, coal tar pitch, charcoal) on PAH bioavailability and toxicity. In addition, SQGs empirically derived from paired toxicity and chemistry data are correlative in nature, and not definitively causative. Despite these uncertainties, SQGs are commonly applied in a variety of assessments, including NRDA.

EXHIBIT 4 SUMMARY OF SEDIMENT QUALITY GUIDELINES FOR TOTAL PAHS (PPM DW)

SQG	GUIDELINE			REFERENCE
Marine and estuarine acute and chronic	**ERL** 4.02		**ERM** 44.79	Long and McDonald 1992
Consensus freshwater based on statistical analysis of multiple SQGs	**TEC** 1.6 **TEL-HA28** 0.26		**PEC** 22.8 **PEL-HA28** 3.4	MacDonald et al. 2000
Florida coastal water and inland water	**TEL** 1.684		**PEL** 16.77	MacDonald 1994, MacDonald et al. 2003
Aquatic sediment effects level for toxic effects	**LEL** 4.0		**SEL** 10ppm x OC or 100 (assuming 1% OC)	Persaud et al. 1993 as cited in MacDonald et al. 2000
Consensus estuarine, marine based on statistical analysis of multiple SQGs	**TEC** 0.29	**MEC** 1.8	**EEC** 10	Swartz 1999
Equilibrium Partitioning – Final Chronic Value for the protection of	**EqP** 0.211			Swartz 1999

SQG	GUIDELINE			REFERENCE
benthic organisms				
Logistic regression modeling: predicted marine amphipod mortality	**T20** 0.69	**T50** 5.8	**T80** 48.0	Field pers. comm. 2004
Oak Ridge National Lab evaluation of suite of SECs	**TEC-HA14** 3.553		**PEC-CR14** 13.66	ARCS EPA 1996 as cited in Jones et al. 1997
Field-derived SSD marine, sensitivity of mollusks> crustaceans> polychaetes	**Sensitive species HC_5** 0.02 (.004-.031)	**TEL** Community HC_5 0.294 (0.164-0.41)	**PEL** Community HC_{10} 14.78 (3.93-21.45)	Leung et al. 2005

Notes:
ERL = Effects Range-Low
ERM = Effects Range-Median
TEC = Threshold Effects Concentration
PEC = Probable Effects Concentration
HAXX = Effects to *Hyalella azteca* in 14 or 28 day exposure
TEL = Threshold Effects Level
PEL = Probable Effects Level
LEL = Lowest Effects Level
SEL = Severe Effects Level
OC = Organic carbon
EqP = Equilibrium Partitioning (OC-normalized concentration in sediment in equilibrium with interstitial water equal to the US EPA Water Quality Criterion Final Chronic Value. The EqP value was derived by Swartz 1999 to represent total PAHs on the basis that mixtures of PAHs are more toxic than individual PAHs. EqP were derived originally for 3 individual PAHs by EPA for the protection of benthic organisms to chronic exposure.)
TXX = Concentration corresponding to an XX percent proportion of samples causing amphipod mortality
SEC = Sediment effects concentrations
CR14 = Effects to *Chironomus riparius* in 14 day exposure
SSD = Species Sensitivity Distribution
HC_x – Hazardous Concentration for x% of the species.

Toxicological Information – Fish

As mentioned above, PAH concentrations in fish tissue were generally inappropriate to indicate exposure or severity of adverse effect (e.g., Eisler 2000). Potential adverse impacts to fish from PAH exposure are discussed below within the context of sediment PAH concentrations and potential PAH-associated abnormalities in fish.

Some studies report concentrations of PAHs in sediment above which adverse effects in fish have been documented. For example, Johnson et al. (2002) developed a threshold effect concentration of 1.0 ppm dw total PAHs in sediment to be protective of endangered salmon in their work in Puget Sound, Washington. Johnson et al. (2002) state, “As yet we do not have sufficient data to estimate threshold sediment PAH concentrations associated with reduced growth or suppressed immune function in juvenile salmonids. However, we can say that these effects have been observed in fish collected from sites with sediment total PAH levels in the 5.0 – 10.0 ppm range (Arkoosh et al. 1998; Johnson et al. 2002). Similarly, Heintz et al. (1999) report increased mortality in pink salmon embryos exposed to oiled gravel with total PAH concentrations in the 3.8 – 4.6 ppm range." Horness et al. (1998) used hockey stick regression analysis from other researchers' field survey data to relate PAH sediment concentrations to biological effects in English sole. These studies indicate effects to fish may begin in the low ppm (concentration in sediment) range.

Toxicological effects data from studies in several different geographic areas were available. For example, a number of surveys on brown bullhead measured high frequencies of liver tumors and attributed the absence of age six- and seven-year old fish to the presence of PAHs from a steel facility and coking plant in the Black River in Ohio. After remedial dredging, a dramatic decline in fish liver tumors and an improved age class structure was observed as compared to pre-remediation (Baumann et al. 1990, Baumann and Harshbarger 1995, Baumann 1998, Baumann et al. 2001). Total PAH concentrations prior to remediation reached 1,100 ppm.

Discussion

Data were sufficient to quantify injury to benthos from sediment PAH contamination for the assessment areas where sediment PAH concentrations have been documented. Injury was quantified by estimating the percentage of ecological services lost for a given PAH concentration or concentration range. Losses to sediment-dwelling organisms were estimated based on the following information and are summarized in Exhibit 5:

1. Based on Persaud et al. (1993) and EPA's Assessment and Remediation of Contaminated Sediments (ARCS) database, the trustees are not assigning ecological service losses below sediment PAH concentrations of four ppm dw. Injury may occur below this concentration, but will not be quantified for this assessment.

2. Between four and 25 ppm dw PAHs, the Trustees relied primarily on Leung et al. (2005) to estimate a ten percent service loss. Leung et al. (2005) calculate a field-derived species sensitivity distribution that predicts an adverse effect on ten percent of the benthos at concentrations ranging from four to 22 ppm dw. Other studies listed below show higher effects in this concentration range, but for the purposes of settlement the Trustees apply the lower percentage.

    - Swartz (1999) reports 34 percent mortality and seven percent incidence of sub-lethal toxicity to amphipods at PAH concentrations between 2.9 and 18.0 ppm (total reported incidence of toxic effects at that range is 43 percent).

    - MacDonald et al. (1996) report an approximately 20 percent incidence of toxic effects between 1.7 and 16.8 ppm PAHs.

3. Between 25-50 ppm and 50-100 ppm PAHs, the Trustees relied on the following information to estimate 25 and 50 percent service losses, respectively.

- ❖ Site-specific data indicates that at 47 ppm PAHs (and 11 ppm PCBs as noted above), *Chironomous* experienced an average of 15 percent mortality and survivors a 13 percent decrease in biomass.
- ❖ Swartz (1999) reports approximately 38 percent mortality and 12 percent incidence of adverse effects between 18 and 100 ppm PAHs (total reported incidence of toxic effects at that range is 50 percent).
- ❖ MacDonald et al. (2000) report a severe effect level of 100 ppm, "above which harmful effects are likely to be observed."
- ❖ Swartz (1999) reports 100 percent incidence of toxicity and almost 100 percent amphipod mortality at greater than 100 ppm PAHs.

4. Site-specific data indicated severe adverse effects to the benthic community (e.g., species richness; Woodward-Clyde 1992) and mortality (e.g., Metcalfe-Smith 1996, Swartz 1999) at PAH levels greater than 100 ppm ml/dw.

EXHIBIT 5 SEDIMENT TOXICITY REFERENCE VALUES AND PERCENTAGE SERVICE LOSS - PAHS

TOTAL PAH SEDIMENT CONCENTRATION (PPM DW)	PERCENTAGE SERVICE LOSS
<4	0
4-25	10
25-50	25
50-100	50
>100	100

Injury to sediment-dwelling organisms was determined by comparing mean PAH sediment concentrations with the PAH toxicological information summarized in Exhibit 5. Sediments in the RMC remediation area, GM remediation area, Grasse River, and the Power Canal have mean PAH concentrations greater than the threshold effects level of four ppm. The RMC and GM remediation areas were already considered to have lost 100 percent of ecological services for sediment due to extremely high concentrations of several contaminants, primarily PCBs and PAHs, so no additional loss calculations were required. For the Grasse River and the Power Canal, sediment injury was quantified by assigning the percentage service loss associated with the respective mean sediment PAH concentration. The average surface PAH concentration in the Grasse River is 47 ppm dw. Because this falls near the boundary of the 25 and 50 percent service loss categories, losses were estimated to be 37.5 percent (i.e., the midpoint). The mean surface sediment concentration in the Power Canal (11.2 ppm dw) correlates to a ten percent service loss to sediment-dwelling organisms.

Losses were estimated from 1981 (promulgation of CERCLA) through 2106. Service losses for each area were assumed to be the same each year from 1981-2009 because data are insufficient to estimate a trend. Losses are then assumed to linearly attenuate to zero in just under 100 years (2106), as PAHs are persistent compounds and no remediation for the Grasse River or Power Canal is currently planned. Using a three percent discount rate, present value (2010) losses to sediment in the Grasse River and Power Canal were approximately 5,361 discount service acre-years (DSAYs; Exhibit 6, Figure 2).[6]

EXHIBIT 6 LOST DSAYS DUE TO SEDIMENT PAH CONTAMINATION

AREA	ACRES	DSAYS (1981-2106)
Grasse River	417	4,804
Power Canal	93	557
RMC Remediation Area	32	No additional DSAYs calculated because service losses are already estimated as 100 percent.
GM Remediation Area	9	
Total		**5,361**

Notes:
DSAY = Discount service acre-year.
Lost present value in 2010.
Totals may not sum due to rounding.

In terms of injury to fish from PAH exposure, the RMC and GM remediation areas were considered to have lost 100 percent of ecological services due to extremely high concentrations of several contaminants, primarily PCBs and PAHs, so no additional loss calculations were required. Available data were insufficient to quantify injury to fish from PAHs in other areas, but based on sediment PAH concentrations injury to fish is likely.

Conclusion

Sediment injury due to PAHs was quantified for the Grasse River and Power Canal, indicating approximately 5,361 lost DSAYs. Although fish tissue data were insufficient to calculate injury to fish, some degree of injury to fish was assumed based on sediment

[6] Note that percentage service losses are calculated based on the services remaining after injury due to other contaminants is quantified. For example, if injury due to PAHs is 25 percent and injury due to fluoride is ten percent, the ten percent loss is multiplied by the 75 percent of services remaining. That is, service losses for multiple contaminants are not additive in the absolute sense.

concentrations. Therefore, fish service losses due to PAH exposure will be addressed in the context of restoration.

FLUORIDE

Concentration Data – Sediment and Fish

Over 240 samples from the assessment area were analyzed for fluoride: 214 sediment samples and 33 fish samples (Exponent 2006, NOAA 2007). Sediment and fish data are summarized in Exhibits 7 and 8. Although ten assessment areas were sampled, the number of samples per area varied substantially. The RMC remediation area has the highest mean and maximum concentrations of sediment fluoride relative to the other assessment areas by one to three orders of magnitude. According to Metcalfe-Smith et al. (1996) fluoride co-occurred with PCBs, PAHs, aluminum, cyanide and dibenzofurans. In addition, note that injury was evaluated in Moses Saunders to Polly's Gut area and in some areas considered background for contaminants with an aquatic pathway (e.g., PCBs, PAHs) because fluoride is an airborne contaminant.

EXHIBIT 7 SEDIMENT FLUORIDE CONCENTRATIONS IN THE ST. LAWRENCE ENVIRONMENT ASSESSMENT AREA (PPM DW) [A]

AREA	NUMBER OF SAMPLES	MINIMUM	MAXIMUM	MEAN
Grasse River	127	49	12,000 [B]	377
Grasse River Background	14	90	160	122
Power Canal	17	170	490	328
Unnamed Tributary	4	340	600	475
Robinson Creek	28	100	1,100	448
RMC Remediation Area	10	6	123,800	11,669
RMC to Ship Channel	2	7	293	150
Raquette River Background	2	300	325	313
Moses Saunders to Polly's Gut	1	515	515	515
Downstream of Robinson Creek	1	395	395	395

Notes:
[A] Summary is for all depths. Note that limiting the summary data to only surface samples does not significantly affect the mean for each sub-area. Fluoride was detected in all samples.
[B] This sample, collected about a mile downstream of the Unnamed Tributary, is an order of magnitude higher than all other Grasse River samples (although still an order of magnitude lower than the highest fluoride concentration reported for the RMC Remediation Area). Eliminating this data point from the analysis does not affect our conclusions regarding injury to sediment in the Grasse River due to fluoride, as the mean concentration (284 ppm) is still sufficient to cause a loss in sediment services.

EXHIBIT 8 FISH FLUORIDE CONCENTRATIONS IN THE ST. LAWRENCE ENVIRONMENT ASSESSMENT AREA (PPM WW) [A]

AREA	NUMBER OF SAMPLES	MINIMUM	MAXIMUM	MEAN
RMC Remediation Area	18	1.19	29.70	7.84
RMC to Ship Channel	5	1.06	5.27	2.74
Moses Saunders to Polly's Gut	10	1.36	34.80	18.98
Note: [A] Fish samples are fillets of white sucker or yellow perch.				

Concentration Data – Mussels

WCC (1992) presents fluoride concentrations in freshwater mussel tissue collected from the St. Lawrence (*Elliptio complanata*, *Lampsilis silicoidea*) and Raquette Rivers (*Elliptio complanata)*. Fluoride dry weight concentrations were similar by species for the reference and RMC-specific station in the St. Lawrence River. Concentrations were higher in *Elliptio* collected downstream of RMC's influence in the Raquette River (39.7 ppm) compared to those collected upstream (23.5 ppm) of RMC sources. However, no difference was observed between mussels collected in the St. Lawrence River in the vicinity of Reynolds and at an upstream reference location. This may be due to localized transport, possibly through atmospheric deposition.

Toxicological Information - General

Camargo (2003) reviewed the fluoride toxicity literature for aquatic organisms. Fluoride inhibits enzyme activity and interrupts metabolic processes. Toxicity increases with increasing fluoride concentration, exposure period, and water temperature and decreasing body size and chloride concentration in the water. The most sensitive species appear to be web-spinning caddis flies and salmonids. Fingernail clams were considered more sensitive than rainbow trout and caddis flies by Metcalfe-Smith et al. (2003) and Wallis et al. (1996). Metcalfe-Smith et al. (2001) and Wallis et al. (1996) discuss the synergy of fluoride and other contaminants, including aluminum and copper.

Toxicological Information - Sediment

Two site-specific studies regarding the effect of fluoride on sediment-dwelling organisms were reviewed. Metcalfe-Smith et al. (2003, 1996) conducted tests on the toxicity of fluoride to several species of sediment-dwelling organisms, including *Hyalella azteca*, *Chironomus tentans*, and *Hexagenia limbata* (Exhibit 7). Organisms were exposed to fluoride-contaminated sediment for ten and 28 days. Test endpoints were growth and survival. Results indicate that *Hyalella* is the most sensitive of the three species and has an IC25 (Inhibiting concentration causing 25 percent impairment) for growth at 290 ppm fluoride in sediment (dw). *Hexagenia* is the least sensitive, with an IC25 for growth at 1,221 ppm fluoride. LC50s (median lethal concentration) range from 1,115 ppm fluoride for *Hyalella* to over 5,600 ppm for *Chironomus* (Exhibit 9).

The average IC25 and LC50 for the three benthic species were compared to the average fluoride concentration in assessment area sediment. The mean concentrations of sediment fluoride in all assessment areas but two (Grasse River Background, RMC to Ship Channel) were elevated above the IC25 for *Hyalella azteca* growth (most sensitive of the three invertebrate species tested). The mean for the RMC Remediation Area was greater than the average IC25 for growth for the three species (724 ppm dw) and the LC50 for survival for the three species (2,789 ppm dw). Metcalfe-Smith et al. (2001, 2003) also reported that *Hexagenia limbata* avoided fluoride-contaminated sediments from the Reynolds Metals study area. The mayflies did not burrow into sediments containing 891 to 1,680 ppm fluoride.

No sediment quality guidelines or toxicity thresholds were available for fluoride in sediment.

EXHIBIT 9 TOXICITY OF SEDIMENT-ASSOCIATED FLUORIDE

SPECIES	EXPOSURE	CONCENTRATION (ppm dw)	SURVIVAL	GROWTH
H. azteca	10-28 Days	290	--	IC25
C. tentans		661	--	IC25
H. limbata		1,221	--	IC25
Average		724	--	IC25
H. azteca	10-28 Days	1,115	LC50	--
H. limbata		1,652	LC50	--
C. tentans		5,600	NS	--
Average		2,789	LC50	--
P. Promelas (Juvenile)	21 Days	110	NS	NS
		500	NS	NS
		1,100	NS	NS
		700-5,600	NS	NS

Notes:
NS = Not significantly different from control
IC = Inhibition Concentration
LC = Lethal Concentration
-- = No data
Sources:
Metcalfe-Smith et al. 2003, 1996.

Freshwater mussel tissue data were limited to samples in the St. Lawrence River by Polly's Gut and RMC, and in the Raquette River. Mussels are sensitive to the effects of fluoride (based on water exposure; Camargo 2003, Keller and Augspurger 2005); however, we did not specifically quantify injury to mussels since we located no literature on either tissue-based or sediment-based effects of fluoride.

Toxicological Information - Fish

Although data regarding fish tissue concentrations of fluoride in the assessment area were sparse (Exhibit 8), four papers describing fluoride toxicity in fish are summarized here as examples of potential toxicity at site-specific concentrations.

- Julshamn et al. (2004) fed adult Atlantic salmon commercial feed formulated with krill ranging in fluoride content from 18 to 358 ppm dry weight for 12 weeks. Bone concentrations of fluoride were about an order of magnitude higher than muscle concentrations. Control and krill diets resulted in similar fluoride concentrations in muscle, bone, and whole fish; there was no dose-dependent increase in fluoride tissue concentrations. No significant effects on mortality, growth, hepatosomatic index, or feed conversion ratio were reported at whole body concentrations up to 4.7 ± 1.4 ppm.
- Weirich et al. (2005) fed channel catfish fry hatchery diets with and without fluoride-contaminated krill supplements for 10 days. They report that at fluoride body burdens of 38.0 ± 4.8 to 40.4 ± 5.2 ppm, fry experienced no significant effect on weight but exhibited significant increases in mortality (46 percent to 75 percent) compared to controls where fluoride was reported as non-detect. Mortality was first observed on day six. Fry fed the krill-supplemented diets exhibited lethargy, anorexia, hypoexcitability, violent aimless movement, equilibrium loss, tetany, and death. All of these responses are also associated with exposure to high concentrations of aqueous fluoride.
- Damkaer and Dey (1989) demonstrated that fluoride discharges in the Columbia River from an aluminum plant had significant negative effects on radio-tagged upstream-migrating adult Pacific salmon survival and passage time between dams. Mortality was greater than 50 percent and passage time was greater than 150 hours. When fluoride discharges decreased, survival increased (>95 percent) and time to passage decreased (28 hours). In behavioral experiments, 72 percent of upstream migrating chinook and 66 percent of coho selected the non-fluoride side of the flume. Significantly more chinook salmon did not move upstream when exposed to fluoride compared to the control condition ($p<0.001$). Similar findings were obtained with adult chum salmon. These bioassays suggested that approximately 0.5 mg/l fluoride adversely affects migrating salmon and that 0.2 mg/l fluoride is at or below the threshold for chinook and below the threshold for coho salmon.
- Neuhold and Sigler (1960) developed fluoride LC50s for two fish species at varying life stages. Fluoride LC50s ranged between 2.7 – 4.7 ppm for adult rainbow trout (4 – 8 inches long) and 75 – 91 ppm for carp (4 – 14 inches long)

during a 480 hour (20 day) experiment. Rainbow trout eggs were exposed to aqueous sodium fluoride concentrations of 0-25 ppm. Resulting LC50s for rainbow trout eggs ranged from 222 ppm to 281 ppm fluoride depending on temperature for up to 424 hours. Rainbow trout embryos and fry had LC50 values between 61 – 85.3 ppm fluoride when exposed for 825 hours. Muscle tissue residues ranged from 2.95 ppm for fish exposed to low concentrations and 20.83 ppm for fish exposed to high concentrations.

In addition to fish body burdens, site-specific sediment fluoride concentrations also provided a perspective on the potential for adverse effects on fish. Metcalfe-Smith et al. (1996) conducted toxicity tests exposing juvenile fathead minnows to site-specific sediment in 21-day growth and survival tests using Lake Erie sediments spiked with sodium fluoride. Test concentrations ranged from five ppm (control) to 1,100 ppm fluoride (dry weight (dw)) in sediment. No significant difference in survival or weight change between any treatment and the control was observed In contrast, bioassays using RMC sediments containing fluoride up to 1,190 ppm resulted in up to 28 percent mortality of fathead minnows. Fathead minnows also exhibited reductions in growth associated with RMC sediment exposure relative to the controls.

The Metcalfe-Smith et al. (2001) study evaluated the impact of simulated dredging on survival and growth of two species of fish. The authors reported that juvenile fathead minnow and rainbow trout experienced increased mortality from undisturbed RMC-contaminated sediment (891 to 1,150 ppm fluoride). Survival for the minnow and trout was 68 and 73 percent, respectively, compared to control survival of 98 and 95 percent.

Metcalfe-Smith et al. (2001, 2003) observed fathead minnows avoiding fluoride-contaminated sediments from the Reynolds Metals study area and failing to forage in sediments containing 891 to 1,680 ppm fluoride. However, both studies reported no effect of sediment-associated fluoride on juvenile fathead minnows up to a concentration of 5,600 ppm dw in 21-day growth and survival tests. (For fathead minnows, an LC50 and IC25 greater than 5,600 ppm fluoride was developed from fluoride-spiked control sediments (concentrations greater than 5,600 ppm F have been documented in the Grasse River, Robinson Creek and the RMC area).)

Fathead minnows are a less sensitive species than many other fish and studies have shown greater sensitivity to fluoride for salmonids than for other fish (e.g., Camargo 2003).

Discussion

Mean concentrations of sediment fluoride in all assessment area units were at or above the IC25 for *Hyalella* (290 ppm dw). Mean and maximum concentrations at Reynolds exceeded all of the IC25 and LC50s summarized in Exhibit 7. This indicates that *H. azteca*, the most sensitive of the three invertebrate species, would likely experience adverse effects on growth throughout the majority of the assessment area.

To quantify injury to sediment-dwelling organisms from fluoride, site-specific exceedences of the IC25 concentration were reviewed. Because growth is a sublethal effect, and because the majority of the assessment area only exceeds the IC25 for the most sensitive species measured, the 25 percent reduction in growth was assumed to cause less than a 25 percent loss in ecological services to benthos. For purposes of this analysis, we estimated an approximate ten percent service loss to benthic invertebrates from fluoride in the following assessment units: Grasse River,[7] Power Canal, Robinson Creek, and Downstream of Robinson Creek. Elevated levels of fluoride in Robinson Creek sediments contribute to the fluoride transported and deposited into the Downstream of Robinson Creek assessment area. Although only one sampling location (3 sediment intervals) is available for this area, it is likely that additional sampling Downstream of Robinson Creek would reveal widespread contamination in that area. However, due to limited data, injury was applied only to a portion of this sub-area in the western basin proximate to the mouth of Robinson Creek. This represents the estimated depositional area of elevated fluoride based on bathymetry and excludes the navigation channel and areas to the north of the channel (Figure 4).[8]

Injury to the Moses-Saunders Dam to Polly's Gut area and the Raquette River Background area was not assessed because of the paucity of data ($n \leq 2$) and the uncertainty regarding deposition of fluoride in these sub-sections. The RMC Remediation Area has already been determined to be 100 percent injured and therefore no additional service losses due to fluoride are assigned. In addition, due to PCB, PAH, fluoride, and cyanide (discussed below) contamination and resulting remedial actions, we assumed that the Unnamed Tributary sustained a 100 percent loss in services prior to completion of the remedy. However, because the acreage of the Unnamed Tributary is so small (approximately five acres) and the resulting DSAYs would be minimal compared to overall quantified losses for the entire assessment area, we have not calculated these additional lost DSAYs.

Losses were estimated from 1981 (promulgation of CERCLA) through 2106. For each area, service losses were assumed to be the same each year from 1981-2009 because data are insufficient to estimate a trend. Losses are then assumed to linearly attenuate to zero in just under 100 years (2106), as fluoride is a persistent compound and no remediation for the Grasse River, Power Canal, Robinson Creek, or Downstream of Robinson Creek is currently planned. Using a three percent discount rate, present value (2010) losses are approximately 2,768 DSAYs (Exhibit 10, Figure 2).[9]

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[7] As noted in Exhibit 7, estimated benthic service losses due to fluoride in Grasse River sediment are similar whether or not the 12,000 ppm data point is included in the analysis.

[8] This sub-section of Downstream of Robinson Creek is located on the western basin of the Wiley-Dondero Canal south of the 27-ft deep shipping channel. This is a depositional area approximately two to 12-feet deep fed by Robinson Creek.

[9] Percentage service losses are calculated based on the services remaining after injury due to other contaminants has been quantified. For example, if injury due to PAHs is 25 percent and injury due to fluoride is ten percent, the ten percent loss is multiplied by the 75 percent of services remaining. That is, service losses for multiple contaminants are not additive in the absolute sense.

EXHIBIT 10 LOST DSAYS DUE TO SEDIMENT FLUORIDE CONTAMINATION

AREA	ACRES	DSAYS (1981-2106) [C]
Grasse River	417	588
Power Canal	93	614
Robinson Creek	25	158
Downstream of Robinson Creek Depositional Area [A]	85	1406
RMC Remediation Area [B]	32	No additional DSAYs calculated because service losses are already estimated as 100 percent.
Unnamed Tributary	5	Losses are estimated at 100 percent prior to completion of the remedy, but DSAYs were not quantified because they are minimal compared to overall losses in the entire assessment area.
Total [C]		**2,768**

Notes:
DSAY = Discounted service acre-year.
Lost present value in 2010.
[A] Western basin only based on bathymetry (approximately two to 12-foot depth near mouth of Robinson Creek).
[B] Losses are assumed to be 100 percent due to PCBs, PAHs, fluoride, and cyanide.
[C] Totals may not sum due to rounding.

In addition, it is possible that fish in the RMC Remediation Area have experienced adverse effects due to fluoride exposure, such as enzyme inhibition, interruption of metabolic processes, and increased mortality. Concentrations of fluoride in fish fillets from the assessment area are within the range of tissue concentrations associated with the adverse effects described above, including mortality for trout and other salmonids. Although these species are typically more sensitive to fluoride than non-salmonids (Camargo 2003), salmonids are a component of the assessment area fish community. While no fish were analyzed for fluoride outside the Reynolds area, sediment concentrations were sufficiently elevated to cause injury to fish in these areas as well.

Conclusion

Fluoride concentrations in sediment and fish from the assessment area have been recorded at levels associated with adverse effects to benthic invertebrates and fish. Sediment fluoride concentrations from the Reynolds area were orders of magnitude higher than the other sub-areas and in excess of known adverse effect levels. Fluoride contributes to the overall injury to benthic organisms from exposure to Reynolds remediation area sediments, but service losses were not quantified as the Trustees and Companies have agreed that this area has incurred 100 percent service loss due to the presence of PCBs, PAHs, fluoride and cyanide. Mean sediment fluoride concentrations were at or above the IC25 (290 ppm dw, based on growth of *Hyalella azteca*) for seven other assessment areas. This includes the Raquette River upstream of GM and Moses Saunders Dam to Polly's Gut upstream of all facilities, suggesting atmospheric deposition is responsible for contamination. As shown in Exhibit 7, only the Grasse River background and the RMC to Ship Channel areas were below the IC25. Injury due to sediment fluoride concentrations was quantified by applying a service loss of 10 percent to the Grasse River, Power Canal, Robinson Creek, and Downstream of Robinson Creek, resulting in approximately 2,768 lost DSAYs.

Fish data were limited to the vicinity of Reynolds, and tissue data were insufficient to quantify potential injuries to fish in the remaining assessment areas. However, available information indicated injury to fish due to fluoride exposure is likely. These potential losses will be addressed in the context of restoration.

CONTAMINANTS ASSESSED QUALITATIVELY

ALUMINUM

Contaminant Data – Sediment and Fish

Within the assessment area, 352 samples were analyzed for aluminum: 293 sediment samples and 59 fish samples (NOAA 2007). These data are summarized in Exhibits 11 and 12.

EXHIBIT 11 SEDIMENT ALUMINUM CONCENTRATIONS IN THE ST. LAWRENCE ENVIRONMENT ASSESSMENT AREA (PPM DW)

AREA	NUMBER OF SAMPLES [A]	MINIMUM	MAXIMUM	MEAN
Grasse River	128	811	34,900	9,208
Grasse River Background	20	1,620	7,390	2,676
Power Canal	17	2,940	27,400	15,066
Robinson Creek	28	5,500	24,800	16,658
Downstream of Robinson Creek	3	14,700	19,600	16,600
Unnamed Tributary	4	9,110	30,900	18,628
Raquette River	14	2,700	26,900	11,286
RMC Remediation Area	52	4,140	170,000	29,074
RMC to Ship Chanel	9	2,680	57,300	12,035
SLR around RMC	5	4,370	22,300	9,562
Moses-Saunders to Polly's Gut	4	1,900	10,600	4,560

AREA	NUMBER OF SAMPLES [A]	MINIMUM	MAXIMUM	MEAN
GM Remediation Area [B]	6	2,810	9,560	6,735
Turtle Cove [B]	3	7,330	18,600	11,450

Notes:
[A] Includes surface and sub-surface samples.
[B] Samples collected pre-remediation.

EXHIBIT 12 FISH ALUMINUM CONCENTRATIONS IN THE ST. LAWRENCE ENVIRONMENT ASSESSMENT AREA (PPM WW)

AREA	NUMBER OF SAMPLES	MINIMUM	MAXIMUM	MEAN
Grasse River	43	0.42	2.9	0.99
Grasse River Background	9	0.69	13.2	2.65
Power Canal	2	1.00	3.1	1.8
Moses Saunders to Polly's Gut	2	2.35	2.56	2.5
RMC Remediation Area	3	1.92U	1.98U	1.96U

Note:
U = Non-detect.

Contaminant Data – Mussels

WCC (1992) reported concentrations of aluminum in freshwater mussel tissue collected from the St. Lawrence (*Elliptio complanata*, *Lampsilis silicoidea*) and Raquette Rivers (*Elliptio complanata)*. Aluminum dry weight concentrations, based on an average of three replicates per station, ranged from 368 ppm near Polly's Gut to 523 ppm near RMC in the St. Lawrence River and 357 ppm upstream of RMC drainage to 722 ppm downstream of area receiving RMC drainage in the Raquette River.

Water Quality Data – pH

Metcalfe-Smith et al. (1996) reported pH of 8.1 to 8.9 in surface water in the vicinity of Reynolds. Grasse River pH ranged from 6.2 to 9.0 for the period 1995 to 1998 (QEA 1998). Raquette River pH was reported as 8.18 (WCC 1992).

Toxicological Information - General

Most of the toxicity literature reported effects in terms of the concentration of aluminum in water rather than in sediment or fish tissue and originated out of acid rain research. Biota-sediment accumulation factors (BSAFs) could be used to back-calculate sediment concentrations from fish tissue concentrations but were not done due to the complex relationship between toxic response and pH and water hardness**.** In general, fish are considered more sensitive to aluminum toxicity than invertebrates (Sparling et al. 1997, Gensemer and Playle 1999).

Toxicological Information - Sediment

Few sediment quality guidelines exist for aluminum. The Threshold Effect Level (TEL) and Probable Effect Level (PEL) for *Hyalella azteca* are 25,519 ppm and 59,572 ppm, respectively (Ingersoll et al. 1996). The freshwater swan mussel, *Anodonta cygneai,* exhibited significantly reduced shell gape duration ($p<0.05$) after exposure to 0.5 mg/l aluminum at neutral pH compared to no effect from 0.25 mg/l concentrations. This response was irreversible over the 15-day experimental recovery period. Higher aluminum concentrations in gills, digestive glands, and kidney tissue were measured in the mussels exposed to the lower concentrations of the metal as a result of this reduced filtering (Kadar et al. 2001).

Toxicological Information - Fish

Aluminum is a toxicant to adult fish via the gills. The toxic effect is ionoregulatory and/ or respiratory where the degree of the effect depends upon water chemistry (Gensemer and Playle 1999). However, Al-associated gill damage may impair bioaccumulation of aluminum; studies with trout have shown increasing then decreasing tissue concentrations with continuous exposure over the dosing period (Cleveland et al. 1991). Striped bass and brook trout have been reported as two of the most sensitive fish species to aquatic concentrations of aluminum (Gostomski 1990).

There are several studies that report fish tissue concentrations associated with toxic effects of aluminum. For example:

- Newly hatched Atlantic salmon alevin exposed to aluminum at low pH (~5) exhibited less than 20 percent mortality at mean aluminum tissue concentrations of <40 ppm (dw) (Peterson et al. 1989). Mortality increased (<40 percent to >95 percent) and median survival time decreased for alevin with aluminum tissue concentrations ranging from 40 to 100 ppm (dw).
- Atlantic salmon exhibited significant adverse effects from Al at pH 5.5 compared to fish tested at pH 7.2: reduced survival at 23.5 ppm (ww), reduced growth at 3.3 ppm (ww) and decreased swimming and feeding activity at 2.5 ppm (ww) (Buckler et al. 1995).
- Brook trout growth and mortality were evaluated from exposure to different aqueous concentrations of aluminum at a range of pH (5, 6, 7.2) (Cleveland et al. 1991). Tissue concentrations of 3.8 ppm to 12.8 ppm aluminum did not result in significant mortality at a pH of 7.2. Tissue concentrations of 16.6 ppm to 46.4 ppm aluminum elicited increased mortality at pH of 5.3 and 6.1. Brook trout weight was significantly decreased for the two lower pH treatments compared to the neutral pH treatment.

Discussion

Average sediment concentrations in all assessment areas except the RMC Remediation Area were below the TEL for *H. azteca*. Maximum sediment concentrations exceeded the TEL for seven of the assessment areas and the PEL at the RMC Remediation Area. Localized hotspots were evidenced by the maximum concentration reported for St.

Lawrence River sediments adjacent to RMC where aluminum was more than six times higher than the TEL and almost three times the PEL.

Freshwater mussel data were limited to a few samples in the St. Lawrence River by Polly's Gut and RMC, and in the Raquette River. Highest concentrations were observed closest to the facilities source (i.e., the main source of aluminum), but results also suggest potential aerial transport. Because the literature on the effects of aluminum on fish was confounded by changes in organism behavior and water chemistry, we could not readily utilize published papers to quantify injury.

Tissue data were temporally and spatially limited, which presents a substantial data gap. Aluminum concentrations in fish tissue were constrained to 1991 sample collections from four locations; but primarily from the Grasse River. Minimum and average concentrations were similar across all stations. Concentrations were highest upstream of Alcoa on the Grasse River potentially suggesting atmospheric deposition or movement of fish exposed to higher levels of contamination further downstream. While tissue concentrations of aluminum were within the range where adverse effects have been reported for salmonids, water chemistry data were insufficient to allow for a determination of these effects.

Conclusion

Aluminum is Site-related (i.e., concentrations are higher in areas closer to the facilities and two of the three facilities are active aluminum production plants). Based on a comparison of sediment concentrations to aluminum benchmarks, it is possible that some level of injury such as changes in filtration rates, bioenergetics and growth may have occurred to sediment-dwelling invertebrates due to aluminum exposure, but available data were generally insufficient to quantify this injury in most assessment areas. A determination of 100 percent sediment injury at RMC and the Unnamed Tributary (as discussed in the Fluoride section) from contaminants including PCBs and PAHs prior to remediation obviated the need to quantify injury to sediment-dwelling organisms from aluminum at these locations. Sediment benthic injury from aluminum will be considered qualitatively for the Grasse River, Power Canal, Raquette River, and RMC to Ship Channel. While area-wide averages for some of these assessment sub-areas were below the TEL, smaller spatial scale analysis suggests TELs were exceeded and therefore injury may have occurred.

Site-specific data regarding aluminum concentrations in fish were available, but it was difficult to tease out the tissue-burden effects from the corresponding influence of pH and water chemistry. Aluminum concentrations in sediment were similar in several assessment areas (Exhibit 11). Grasse River fish were documented with aluminum concentrations above effects-based levels. While there were limited fish tissue data from other assessment areas, mean sediment concentrations reported in several other assessment areas were higher than mean sediment concentrations in the Grasse River. Fish in these other assessment areas may have experienced effects from aluminum exposure, but available data were insufficient to quantify this injury.

Therefore, injury to sediment and fish from aluminum contamination will be addressed within the context of restoration.

CYANIDE

Concentration Data – Sediment and Fish

Results of cyanide analysis were available for 408 samples within the assessment area: 377 sediment samples and 31 fish samples (Exponent 2006, NOAA 2007). These data are summarized in Exhibits 13 and 14.

EXHIBIT 13 SEDIMENT CYANIDE CONCENTRATIONS IN THE ST. LAWRENCE ENVIRONMENT ASSESSMENT AREA (PPM DW)

AREA [A]	NUMBER OF SAMPLES [B]	MINIMUM [C]	MAXIMUM [C]	MEAN [C]
Grasse River	125	ND (0.5)	21.9	1.36
Grasse River Background	20	ND (1.0)	ND (1.0)	ND (1.0)
Power Canal	17	ND (1.0)	ND (1.0)	ND (1.0)
Robinson Creek	30	ND (0.65)	14.6	2.08
Raquette River	14	ND (0.05)	(2.5)	0.47
RMC Remediation Area	52	ND (0.14)	33.9	4.03
SLR Background	9	ND (0.05)	ND (0.3)	ND (0.19)
RMC to Ship Chanel, SLR around RMC, Moses-Saunders to Polly's Gut	18	ND (0.05)	1.31	ND (0.44)
GM Remediation Area	6	ND (2.5)	ND (2.5)	ND (2.5)
Unnamed Tributary [D]	86	ND (0.5)	ND (2.5)	2.11

Notes:
[A] Summary is for samples of all depths. Note that limiting the summary data to only surface samples does not significantly affect the mean for each polygon.
[B] Cyanide concentrations in the majority of samples were below detection limits.
[C] ND = Non-detect. Value in ( ) is 1/2 the detection limit.
[D] Note that the Unnamed Tributary had a clean-up goal of 8.0 ppm cyanide in sediment (CDM 1998). Data reported here are post-remedy.

EXHIBIT 14 FISH CYANIDE CONCENTRATIONS IN THE ST. LAWRENCE ENVIRONMENT ASSESSMENT AREA (PPM WW)

AREA	NUMBER OF SAMPLES	NUMBER OF DETECTED SAMPLES [A]	DETECTION LIMIT	DETECTED CONCENTRATION
RMC Remediation Area, RMC to Ship Channel, SLR around RMC, Moses - Saunders to Polly's Gut [B]	31	1	0.1	0.232

Notes:

[A] All samples were below detection limit of 1.0 ppm except sample at 0.232 ppm at RMC Remediation Area.

[B] Includes one sample from Polly's Gut. Fish samples are fillets of white sucker and yellow perch.

Source: Woodward-Clyde (1991).

Concentration Data - Mussels

WCC (1992) reported concentrations of cyanide in freshwater mussel tissue collected from the St.Lawrence (*Elliptio complanata*, *Lampsilis silicoidea*) and Raquette Rivers (*Elliptio complanata)*. Average cyanide dry weight concentrations ranged from 1.6 ppm near Polly's Gut to 7.6 ppm in the St. Lawrence River and 2.09 ppm (upstream of RMC) to 2.38 ppm (near RMC) in the Raquette River.

Forms of Cyanide

Two of the forms of cyanide most commonly found in water are free cyanide and complex cyanide. Free cyanide consists of HCN and CN^-, and is the primary toxic agent in the aquatic environment (Eisler 1991). Complex cyanides are compounds in which the cyanide anion is incorporated into a complex with other elements. These complexes are generally not directly toxic. Instead, their toxicity in an aqueous solution is typically related to their ability to release cyanide anions (Eisler 1991). Data presented in Exhibits 11 and 12 reflect measurements of total cyanide, which includes all cyanide-containing compounds in a sample (e.g., free cyanide and cyanide complexes).

Toxicological Information - Sediment

Ecologically-based sediment quality guidelines or toxicity thresholds for cyanide intended to be protective of aquatic invertebrates could not be located but general sediment benchmarks were available. These include:

- Proposed Great Lakes cyanide criteria designate sediments containing less than 0.1 ppm as not polluted, those with between 0.1 and 0.25 ppm cyanide as moderately polluted, and those contaminated with greater than 0.25 ppm cyanide as heavily polluted. The 0.1 ppm cyanide benchmark is also used by Oak Ridge National Labs as a level unlikely to result in an ecological risk (Irwin et al. 1997).
- Persaud et al. (1993) reports a 0.1 ppm threshold for cyanide in sediment for unrestricted open water disposal of sediments. This threshold was "designed

exclusively for the evaluation of dredged material for open-water disposal and only incidentally provide[s] general guidance on environmental protection."

- The Dutch Ministry reports thresholds for cyanide in sediment. However, the "Dutch Ministry standards (MHSPE 1994) for sediment are the same as those for soil. Because the chemistry and structure of sediment and soil can differ, sediment benchmarks based on the Ministry should be used with caution" (Friday 1998). These soil-based cyanide target thresholds range from 1.0 ppm to 5.0 ppm, depending on whether the cyanide is free cyanide or a cyanide complex.

Literature regarding the toxicity of cyanide to benthic invertebrates exists, but toxicity is described in terms of the concentration of cyanide in water rather than sediment.

Toxicological Information - Fish

Currently, there is very limited toxicological information available for cyanide in fish tissue. The preponderance of literature regarding the toxicity of cyanide to fish focuses on water-column exposure. Effects range from impaired osmoregulation, reproduction, and hepatic function to lethality (Eisler 1991, Irwin et al. 1997). Cyanide concentrations in gills of up to 0.05 ppm ww are unlikely to cause adverse effects.

Discussion

Cyanide is a Site-related contaminant (e.g., SPDES permits required monitoring for cyanide and sediment concentrations in the St. Lawrence near RMC exceed example thresholds. Although the majority of sediment samples were non-detect for cyanide, detection limits were five ppm or greater for 132 samples. Areas where cyanide was detected include Robinson Creek, near the mouth of the Unnamed Tributary in the Grasse River, and the RMC Remediation Area.

Although average cyanide concentrations exceeded general sediment thresholds for highly polluted systems in the Grasse River, Robinson Creek, RMC remediation area, and the Unnamed Tributary, these thresholds do not directly indicate injury. If cyanide concentrations are compared to the remedial goal of eight ppm in sediment for the Unnamed Tributary (CDM 1998), mean concentrations in all areas are below this level, and maximum concentrations exceed eight ppm only in the Grasse River, Robinson Creek, and the RMC remediation area. In addition, any evaluation of the toxicity of the above data should consider the proportion of toxic free cyanide in each site-specific sample. Assuming total cyanide is 100 percent free cyanide, some sediment dwelling organisms may have experienced adverse effects from cyanide exposure, but this is likely to overestimate injury.

Fish data samples were limited both spatially and temporally and only one sample had detectable levels of cyanide that was within the range of concentrations reported in the literature to negatively affect salmonids.

Conclusion

Concentrations of cyanide were highest in sediments collected from the RMC remediation area. This assessment unit has already been assigned a 100 percent loss in ecological service due to PCBs and PAHs and therefore no additional service losses due to cyanide are assigned. Because the Record of Decision for the Unnamed Tributary set a cleanup goal of eight ppm cyanide in sediment, indicating that pre-remedy concentrations were greater than eight ppm, injury to sediments in the Unnamed Tributary due to cyanide is likely. However, these losses were not quantified because results would have had a negligible effect on the total damage claim. Although it is possible that injury has occurred in the other assessment units, the above data and benchmarks were insufficient to determine or quantify injury to sediment.

Cyanide was detected in one out of 33 fish fillets at a concentration above which effects were observed in salmonids (based on gill concentrations). Although it is possible that injury has occurred, the above data and benchmarks were insufficient to quantify injury to fish within the assessment area.

For areas with cyanide concentrations sufficient to cause injury that are not already considered 100 percent injured (i.e., due to PCBs and PAHs), potential losses will be addressed within the context of restoration.

CONTAMINANTS REMOVED FROM CONSIDERATION

CADMIUM

Contaminant Data – Sediment and Fish

Sediment concentrations of cadmium were available for 190 samples within the assessment area (Exponent 2006, NOAA 2007). These data are summarized in Exhibit 15. Concentrations of cadmium in fish tissue were analyzed in 54 samples, all from a 1991 study from the Grasse River and the Power Canal. All values except three were reported as non-detect (detection limit was one ppm). The three reported values are 0.03, 0.03, 0.04 ppm wet weight.

EXHIBIT 15 SEDIMENT CADMIUM CONCENTRATIONS IN THE ST. LAWRENCE ENVIRONMENT ASSESSMENT AREA (PPM DW)

AREA	NUMBER OF SAMPLES	MINIMUM	MAXIMUM	MEAN
Grasse River	122	ND	6.8	1.2
Grasse River Background	20	ND	1.7	0.8
Power Canal	10	ND	3.9	0.9
Robinson Creek	28	ND	1.3	0.5
Raquette River	2	ND	ND	0.5
RMC Remediation Area	2	1.1	2.1	1.6
GM Remediation Area	6	ND	ND	ND (1.0)

Notes:
ND = Non-detect.
( ) indicates half detection limit.

Toxicological Information – Sediment and Fish

Sediment Quality Guidelines for cadmium exist, such as the Threshold Effects Concentration (TEC; 0.99 ppm) and Probable Effects Concentration (PEC; 4.98 ppm) (MacDonald et al. 2000).

Toxicological information for fish was not reviewed as fish tissue concentration data are extremely limited and are mainly non-detects, however we note that the detection limit is relatively high (one ppm).

Discussion

Cadmium may be Site-related since cadmium is listed in the ALCOA West State Pollution Discharge Elimination System (SPDES) permit, although downstream concentrations only slightly exceed background concentrations. Two sections of the assessment area have average sediment cadmium concentrations slightly above the TEC (i.e., Grasse River and two samples in RMC remediation area), and no sections have average concentrations greater than the PEC. One station downstream of the Unnamed Tributary in the Grasse River had cadmium concentrations above the PEC in surface and subsurface sediments. No concentrations above the detection limit of one ppm in fish were reported upstream of the facilities, or in the Power Canal.

Conclusion

Injury from cadmium in sediment was not quantified due to relatively low cadmium concentrations in the assessment areas closest to the facilities compared to background concentrations and no data in assessment units further removed from the source. Injury to fish from cadmium cannot be quantified due to an absence of data in all assessment units. Therefore, the Trustees are not conducting further investigation of injury to benthic organisms and fish due to cadmium at this time.

DIOXINS/FURANS

Contaminant Data – Sediment and Fish

Dioxin-like effects in biota can be attributed to dioxins, furans and planar PCBs. These three contaminants are all components of toxic equivalency calculations that evaluate adverse effects on biota. However, this document focuses on effects from contaminants other than PCBs. Therefore, dioxins and furans are addressed below, and the potential effects of planar PCBs will be described in a separate document that summarizes the effects of all forms of PCBs.

Dioxin and furan data are summarized in Exhibits 16 and 17. Sediment data include 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in 31 samples (all were non-detect) and 2,3,7,8-tetrachlorodibenzo-p-furan (TCDF) in 71 samples. Fish data include dioxin/furan concentrations in 28 samples (Exponent 2006, NOAA 2007).

EXHIBIT 16 SEDIMENT DIOXIN/FURAN CONCENTRATIONS IN THE ST. LAWRENCE ENVIRONMENT ASSESSMENT AREA (PPTR DW)

AREA	NUMBER OF SAMPLES TCDD (TCDF)	TCDD RANGE	TCDF RANGE (MEAN)
Grasse River	7 (15)	0.5U - 4.4U	0.7 - 594 (104.0)
Grasse River Background	8 (7)	0.3U – 2.2U	0.7U - 1.7U (1.1U)
RMC Remediation Area	7 (44)	1000U	0.2 – 4900 (329.7)
RMC to Ship Channel	1 (1)	1000U	1000U
Power Canal	4 (3)	0.4U - 1.1U	0.7U - 4.5U (2.0U)
Moses-Saunders to Polly's Gut	1 (1)	1000U	1000U
Robinson Creek	3	0.8U - 1.5U	-

Note:
U = Non-detect

EXHIBIT 17 FISH DIOXIN/FURAN CONCENTRATIONS IN THE ST. LAWRENCE ENVIRONMENT ASSESSMENT AREA (PPTR WW)

AREA	NUMBER OF SAMPLES	MEAN TOTAL DIOXIN CONCENTRATION	MEAN TOTAL FURAN CONCENTRATION
RMC Remediation Area	1	U	5.9
Raquette River	7	7.0	8.5
SLR around RMC	3	14.0	9.4
SLR around GM [A]	6	5.3	33.7
SLR Downstream – Upper [A]	6	18.5	7.9
SLR Background	6	5.2	6.9
St. Regis River	3	5.9	3.1
St. Regis Background	3	4.4	2.7

Notes:
[A] Data were converted from fillet to whole body concentrations using a conversion factor for lipophilic substances of 1.35 (EPA 1998).
[B] Data are reported for total dioxins/furans because only one measurement for 2,3,7,8-TCDD and –TCDF are available in the database.

Toxicological Information - Sediment

Sediment benchmarks for dioxins and furans for the protection of benthic invertebrates were limited. An Upper Effects Threshold (UET), the threshold above which adverse biological effects is expected to occur, was reported as 5.1 ppm in sediment for dibenzofuran and 8.8 parts per trillion (pptr) dw for TCDD in sediment based on *Hyalella* *azteca* bioassays assuming one percent sediment total organic carbon (TOC; Cubbage et al. 1997).

Most benchmarks have been developed to protect fish and wildlife. For example, Ianuzzi et al. (1995) discussed the potential for developing sediment quality guidelines for 2,3,7,8-TCDD and tabulated proposed benchmarks but none were specific to protecting sediment infauna. The Canadian government has identified sediment quality guidelines for dioxins and furans (EC 2005) for the protection of fish, and NYSDEC (1999) lists TCDD sediment criteria for protection of wildlife from bioaccumulation but no level is designated to protect benthic aquatic life. A sediment preliminary remediation goal (PRG) of 3.18 pptr dw was derived using BSAF and target tissue residues for oyster (Kubiak et al. 2007).

Toxicological Information - Oysters

Wintermeyer and Cooper (2003) showed reductions in American oyster (*Crassostrea virginica*), egg fertilization and veliger larval development compared to the controls from exposure to two pptr aqueous TCDD. Subsequently, Wintermeyer and Cooper (2007) demonstrated that a dose of two to ten pptr TCDD (injection) resulted in abnormal gametogenesis in male and female oysters.

Toxicological Information - Fish

In contrast to sediment-dwelling organisms, the literature provided a suite of information regarding exposure levels and corresponding effects of dioxins/furans on fish. Adverse effects have been observed on the reproductive, developmental, and endocrine systems. Induction of cytochrome P4501A (CYP1A), increased early life stage mortality, reduced body weight (wasting) and feed consumption, and an increase in epithelial and lymphomyeloid lesions are associated with exposure to PCDDs/PCDFs and related compounds (Sijm and Opperhuizen 1996). Examples are summarized in Exhibit 18, and in the Lower Passaic Preassessment Screen (NJDEP et al. 2004), the Hudson River Ecological Risk Assessment (EPA 2000) and the Fox River Fish Injury Report (Stratus 1999).

EXHIBIT 18 EXAMPLE EFFECTS CONCENTRATIONS FOR DIOXINS/FURANS AND FISH

DIOXIN/FURAN RANGE	SOURCE
<0.3 – 55 pptr lowest sublethal-lethal effects in early life stages (eggs) <54 – 800 pptr lowest sublethal-lethal effects in older fish	Cited in Sijm and Opperhuizen 1996 [A]
AHH activity increased and other sublethal effects at body burden conc of 23 – 260 pptr TCDD and TCDF (white sucker)	Hodson et al. 1992

DIOXIN/FURAN RANGE	SOURCE
34 pptr TCDD no effect on survival (lake trout) 55 pptr TCDD some deaths (lake trout) 65 pptr TCDD 50 percent dead by swim-up (lake trout) 78 pptr TCDD reproduction inhibited (lake trout)	Cited in Sijm & Opperhuizen 1996, Eisler 2000
5 pptr TCDD-TEQ NOAEL egg (lake trout) 50 pptr egg TCDD-TEQ 100 percent sac fry mortality (lake trout)	Cook et al. 2003
0.057 to 0.699 pptr TCDD-TEQ/ lipid to protect 99 and 90 percent fish species, respectively	Stevens et al. 2005

Note:
[A] The authors noted that for field populations, 50 percent of wild fish have dioxin/furan concentrations less than 40 pptr, and 90 percent of wild fish have dioxin/furan concentrations less than 100 pptr.

Contaminant and Toxicological Data - Birds

Site-specific exposure data and literature-based toxicological data regarding the effect of dioxins and furans on birds were sparse. Within the St. Lawrence watershed, Martinovic et al. (2003) found the highest concentrations of total PCDD in Grasse River tree swallow nestlings (19.3 – 79.5 ppt), followed by Upper Canada Sanctuary (34.6 ppt), Cornwall Sewage Treatment Plant (13.6 – 20.4 ppt) and Turtle Creek (8.2 – 15.2 ppt), suggesting a potential Grasse River dioxin source (although this trend is not mirrored in the sediment data). In terms of effects information, dioxin concentrations in tree swallow nestlings were positively correlated with the ratio of renal retinol:retinyl palmitate. The significance of this finding on the vitamin A pathway is not understood, although disruption of the vitamin A pathway can contribute to delayed growth, ocular discharge, or lack of coordination (Martinovic et al. 2003).

Discussion

Dioxins in sediment were detected only in Robinson Creek and are below the UET for TCDD. Furans are present in sediment in the Grasse River and the RMC remediation area, where they appear substantially elevated. Because the RMC remediation area is estimated to have sustained a 100 percent loss in ecological services due to other contaminants, and because insufficient toxicological data were available to determine injury to Grasse River sediments due to furans, for purposes of this analysis, we do not recommend further analysis (qualitative or quantitative) of sediment injury.

Dioxin concentrations in fish in the assessment area were not significantly greater than background concentrations, and overall, the concentrations of dioxins/furans in fish were not at levels associated with effects in fish. Although a few samples exceed the 50 ppb TCDD threshold associated with 100 percent lake trout sac fry mortality, average concentrations in fish in each sub-area were well below this threshold. Therefore, we do not recommend further analysis (qualitative or quantitative) of fish injury due to dioxins and furans.

Available data on dioxins and furans in tree swallows and the types of endpoints described were not adequate to qualitatively or quantitatively assess injury to birds from dioxins at this time.

Conclusion

The Trustees are not conducting further investigation of injury to benthic organisms, fish, or birds due to exposure to dioxins and furans at this time. Although injury to birds due to these contaminants may have occurred, data were insufficient for an assessment of this potential injury.

LEAD

Contaminant Data – Sediment and Fish

A total of 193 samples from the assessment area were analyzed for lead. Concentrations ranged from 1.1 to 182 ppm (mean of 24.5 ppm), with the highest concentrations located in the RMC Remediation Area (Exhibit 19). Lead concentrations were analyzed in 91 fish tissue samples. Fifty-eight samples resulted in non-detectable lead concentrations. The remaining 33 samples had detected lead concentrations ranging from 0.04 to 0.25.ppm in muscle or carcass with an average of 0.1 ppm (Exponent 2006, NOAA 2007).

Toxicological Information – Sediment and Fish

Sediment quality criteria for lead included the TEC (35.8 ppm) and PEC (128 ppm) (MacDonald et al. 2000). No tissue guidelines were available for lead.

Discussion

Lead may be Site-related since lead is listed in the ALCOA West SPDES permit, and elevated lead was detected in the sludge of GM on-site lagoons (NYSDOH and ATSDR 1999). There were also major sources of lead on the Canadian side of the St. Lawrence River. Sediment lead concentrations in the sub-areas were below the PEC, except for subsurface sediment samples at three stations in the Grasse River. Sediment concentrations between the TEC and PEC occur in the Power Canal, Grasse River, RMC remediation area, and St. Lawrence River near GM and RMC. No lead concentrations in fish were reported for the assessment area.

EXHIBIT 19 SEDIMENT LEAD CONCENTRATIONS IN THE ST. LAWRENCE ENVIRONMENT ASSESSMENT AREA (PPM DW) [A]

AREA	NUMBER OF SAMPLES	MINIMUM	MAXIMUM	MEAN
Power Canal	17	4.7	103	24.75
Grasse River Background	17	1.1	35.6	7.74

AREA	NUMBER OF SAMPLES	MINIMUM	MAXIMUM	MEAN
Grasse River	104	1.3	182	28.4
Robinson Creek	10	10.6	35.3	17.1
Downstream of Robinson Creek	3	5.4	23.5	12.03
RMC Remediation Area	7	11.2	70.1	38.01
GM Remediation Area	6	ND (20)	35	24.5
Turtle Cove/Creek	12	ND (20)	ND (20)	ND (10)
SLR Background	4	18.0	19.0	18.5
Downstream SLR - Downstream	8	13.0	65.0	44.0

Notes:
[A] Includes surface and subsurface samples.
ND = Non-detect.
( ) in Minimum/Maximum columns indicates detection limit.
( ) in Mean column indicates half detection limit.

Conclusion

The Trustees are not conducting further investigation of injury to benthic organisms and fish due to lead at this time.

MERCURY

Contaminant data – Sediment and Fish

A total of 841 samples from the assessment area were analyzed for mercury: 25 sediment samples and 369 fish tissue samples (Exponent 2006, NOAA 2007). Data are summarized in Exhibits 20 and 21.

EXHIBIT 20 SEDIMENT MERCURY CONCENTRATIONS IN THE ST. LAWRENCE ENVIRONMENT ASSESSMENT AREA (PPM DW)

AREA	NUMBER OF SAMPLES	MINIMUM	MAXIMUM	MEAN
Moses Saunders to Polly's Gut	1	ND (0.1)	--	--
Raquette River Background	2	0.1	0.2	0.15
Turtle Cove	1	0.12	--	--
RMC Remediation Area	9	0.04	ND(0.2)	0.11
GM Remediation Area	6	0.12	0.22	0.16
St. Lawrence Background	6	0.09	0.13	0.11

Notes: ND = Non-detect. ( ) in Minimum/Maximum columns indicates detection limit. ( ) in Mean column indicates half detection limit.

EXHIBIT 21 FISH MERCURY CONCENTRATIONS IN THE ST. LAWRENCE ENVIRONMENT ASSESSMENT AREA (PPM WW)

AREA	NUMBER OF SAMPLES	MINIMUM	MAXIMUM	MEAN
Grasse River Background	5	0.027	0.52	0.24
Grasse River	1	0.004U	-	-
Power Canal	5	0.16	0.42	0.26
RMC Remediation Area	2	0.032	0.19	0.1
GM Remediation Area	1	.004	-	-
SLR around GM	78	0.05	0.94	0.37
Moses Saunders to Polly's Gut	37	0.004	1.96	0.51
SLR Background	69	0.004	2.06	0.42
Raquette River	89	0.035	1.1	0.36
St. Regis River	50	0.13	0.91	0.40
St. Regis River – Background	32	0.06	1.04	0.44
U = Non-detect.				

Toxicological Information – Sediment and Fish

Sediment quality criteria for mercury included the TEC (0.18 ppm) and PEC (1.06 ppm) (MacDonald et al. 2000).

Toxicological data for fish was not explored because it is unclear whether mercury contamination is directly related to the GM and ALCOA facilities.

Discussion

The Waste Site Investigation and Public Health Assessment for ALCOA indicated that mercury is a potential contaminant of concern on-site (NYSDOH and ATSDR 1999, Engineering Science 1991). However, mercury is not included in facility SPDES permits, and the limited data on concentrations of mercury in assessment area sediment and fish indicate that injury to Trust resources due to mercury from the facility is unlikely.

Conclusion

Mercury has been removed from consideration based on our analysis.

OVERALL CONCLUSION

Sediment and fish data for eight contaminants and bird data for one contaminant were assessed to determine whether these contaminants are Site-related and, if so, if they have caused injury to Trust resources within the assessment area. Where possible, injury due to relevant contaminants was quantified (i.e., PAHs and fluoride in sediment). If data indicate injury is likely but are insufficient to quantify impacts, losses will be addressed qualitatively within the context of restoration (i.e., aluminum in sediment; and PAHs, fluoride, aluminum, and cyanide in fish). For contaminants that are not Site-related or where no impacts to Trust resources are expected, no further investigation is recommended (i.e., cadmium, dioxins/furans, lead, and mercury).

Due to extremely high concentrations of PAHs, PCBs, and other contaminants in sediment and fish, the RMC and GM remediation areas previously were considered 100 percent injured, and therefore no additional injury quantification efforts were necessary. Losses to sediment benthos in the Grasse River and Power Canal due to PAHs were approximately 5,361 DSAYs. Sediment losses in the Grasse River, Power Canal, Robinson Creek, and Downstream of Robinson Creek areas due to fluoride were approximately 2,768 DSAYs.

We noted that there are uncertainties associated with this assessment. Variables contributing to uncertainty included: insufficient data, uneven spatial and temporal sampling, form of contaminant measured, bioavailability, and high detection limits for some samples. The toxicity of the mixture of the various contaminants also is unknown. Interpretation of Site-related data was also limited by availability of toxicological data. These variables could lead to either an over- or underestimation of injury.

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FIGURE 1: MAP OF THE ASSESSMENT AREA

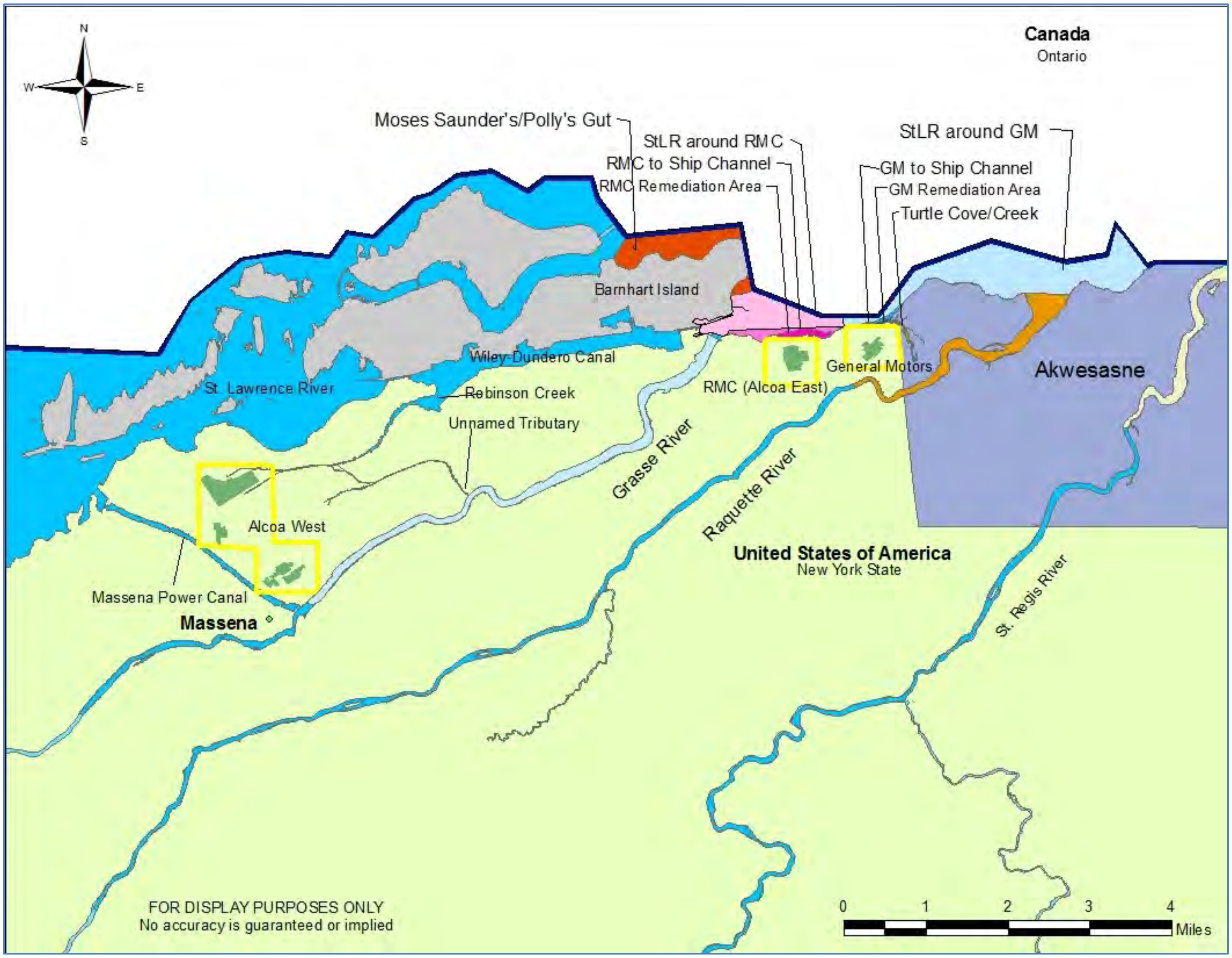


FIGURE 2: MAP OF THE ASSESSMENT AREA NEAR THE FACILITIES

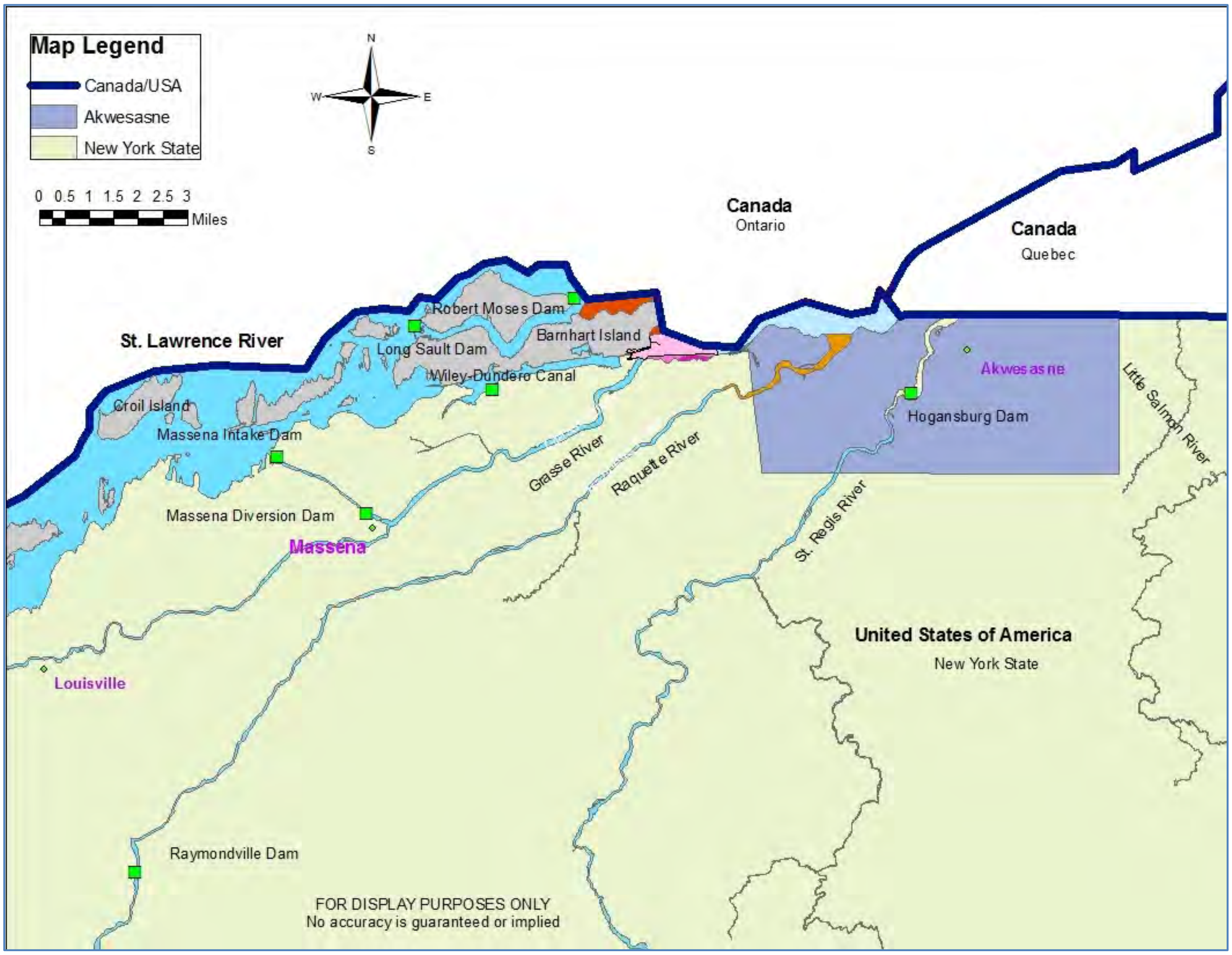


FIGURE 3: MAP OF RMC AND GM REMEDIATION AREAS

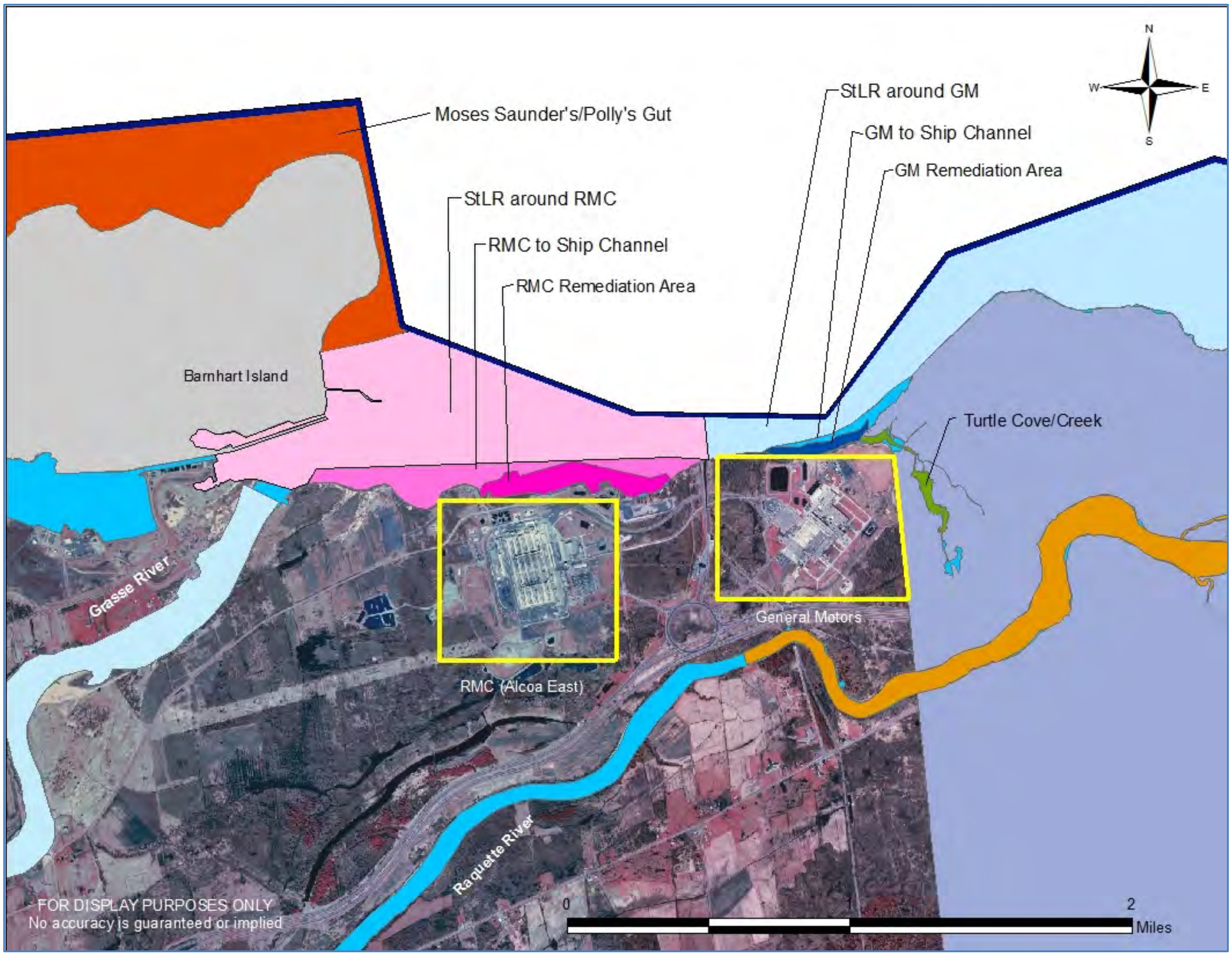
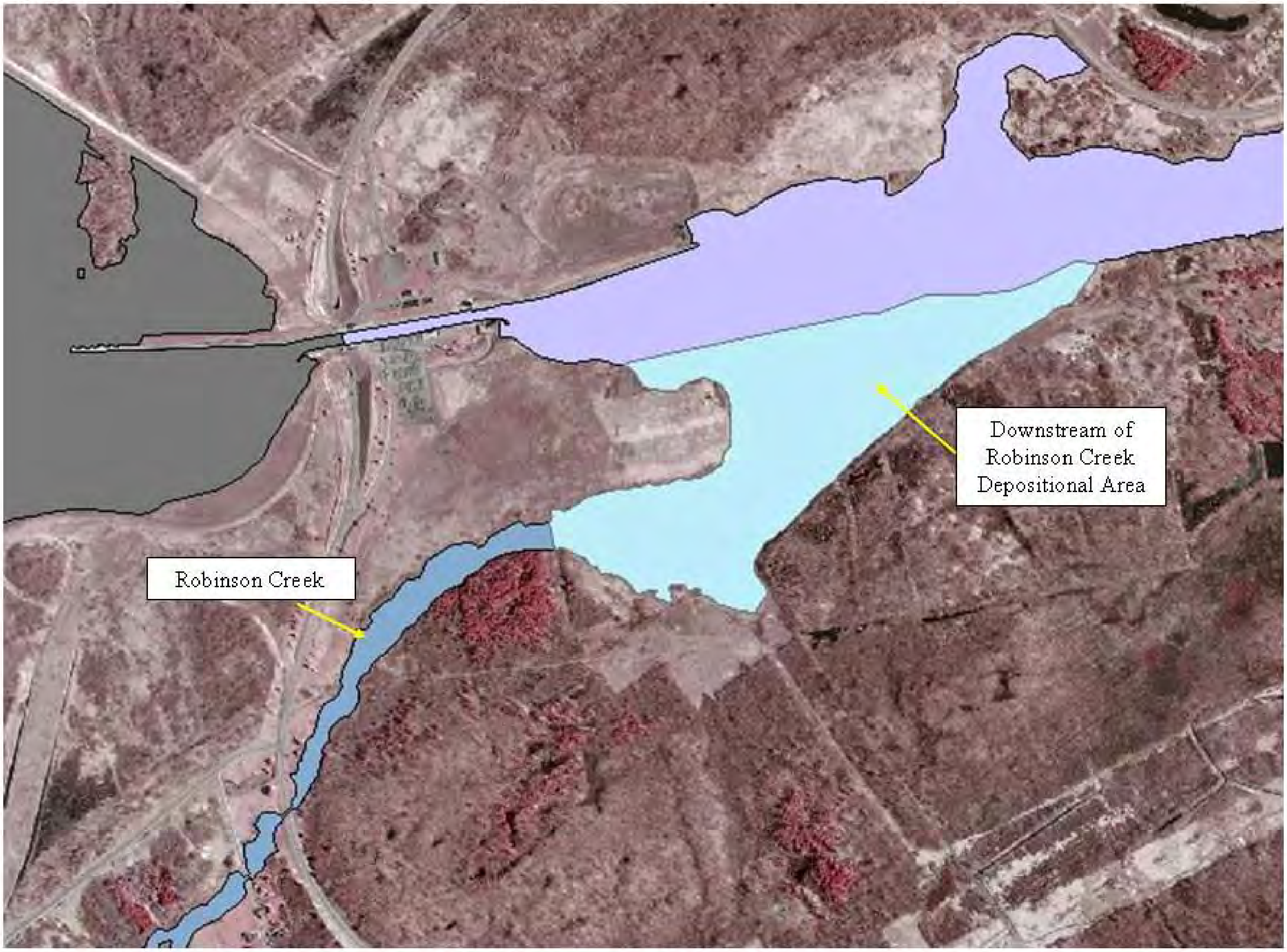


FIGURE 4: MAP OF DOWNSTREAM OF ROBINSON CREEK DEPOSITIONAL AREA



APPENDIX E: ST. LAWRENCE ENVIRONMENT NATURAL RESOURCE DAMAGE ASSESSMENT: QUALITATIVE ASSESSMENT OF EFFECTS OF POLYCHLORINATED BIPHENYLS (PCBS) ON REPTILES AND AMPHIBIANS IN THE ST. LAWRENCE ENVIRONMENT

INTRODUCTION

The purpose of this document is to: 1) summarize information on PCBs in reptiles and amphibians in and around the St. Lawrence Environment Assessment Area, 2) compare area data with site-specific and literature-based adverse effects information, and 3) make preliminary recommendations with respect to assessing injury to these species groups as part of the St. Lawrence Environment Natural Resource Damage Assessment.

TURTLES

Of the approximately 20 species of turtles in New York State, at least seven species are expected to occur in the St. Lawrence River watershed. Some of these species are linked to contaminated habitats in the St. Lawrence Environment through various life history characteristics such as using wetland or riverine habitat for nesting and/or feeding areas. There are no Federally listed turtles in the assessment area, but a number of State listed species may occur there. According to the New York State Amphibian and Reptile Atlas Project (NYSARAP 1999), there are occurrences of the State threatened Blandings turtle (*Emydoidea blandingii*) and State special concern wood turtle *(Clemmys insculpta*) in the assessment area or the vicinity of the assessment area. Environment Canada=s Biodiversity Portrait of the St. Lawrence River indicates that the Eastern spiny softshell (*Apalone s. spinifera*) and spotted turtle (*Clemmys guttata*) (State species of special concern) have been recorded along the St. Lawrence River downstream of Montreal (Environment Canada 2004). Common turtle species in the assessment area include the map turtle (*Graptemys geographica*), painted turtle (*Chrysemys picta picta*), and snapping turtle (*Chelydra serpentina serpentina*).

The Blandings turtle prefers slow moving, shallow water with a muddy bottom. This species is omnivorous (eating crustaceans, insects, frogs, plant material) and nests at dry upland sites (NYSARAP 1999). The wood turtle is omnivorous (eating fruits, fungi, insects, snails and worms) and is often associated with moving water, although they tend to forage in terrestrial areas during the warmer months (WIDNR). The spotted turtle is semi-aquatic, preferring bogs, swampy streams in woodland or meadow areas, ponds, and ditches. It is a carnivore, feeding on insects, larvae, and invertebrates (NYSARAP 1999). The Eastern spiny softshell feeds on insects, crustaceans, and occasionally fish. This species inhabits various freshwater systems such as rivers, lakes, marshes, and farm ponds, as well as bays of the Great Lakes. The Eastern spiny softshell prefers open habitats with a small amount of vegetation and a sandy or muddy bottom and requires sandy raised nesting areas close to water (NYSARAP 1999).

The only extensive PCB concentration data available in the published literature are for the snapping turtle, a species found in the assessment area, as noted above. This species is omnivorous, feeding on vegetation, carrion, invertebrates, fish, amphibians, and small mammals. Snapping turtles prefer water bodies with muddy bottoms and abundant vegetation.

Strong evidence exists that the snapping turtle can accumulate significant concentrations of PCBs. For example, PCB concentrations of 3,608 and 7,900 mg/kg lipid weight (lw) were reported in the fat of Hudson River snapping turtles (Stone et al. 1980). Data from locations along the St. Lawrence River also indicate bioaccumulation of organochlorine contaminants in snapping turtle eggs and body tissue. Snapping turtle eggs collected from four sites at Akwesasne had concentrations of PCBs ranging from 2.4 mg/kg wet weight (ww) at Snye Marsh to 737 mg/kg ww at Turtle Creek (deSolla et al. 2001). Struger et al. (1993) collected snapping turtle eggs from a number of locations around the Great Lakes, including the St. Lawrence River (Morrisburg, Ingleside - upstream of Akwesasne; Loon Island - downstream of Akwesasne). The highest PCB concentrations were detected in eggs from Hamilton Harbour on Lake Ontario (as high as 12 mg/kg ww), with concentrations at Morrisburg, Ingleside, and Loon Island at 2.2, 1.3, and 3.03 mg/kg ww, respectively.

The St. Lawrence Cooperative Database provides data for three turtle species - the painted turtle, map turtle, and snapping turtle (Exponent 2003). Painted turtles collected at Snye Marsh contained between 0.1 and 0.86 mg/kg PCB ww in fat, liver or muscle. Painted turtles from the Alcoa site contained 22 mg/kg PCB in fat, 0.6 mg/kg in liver and 0.1 mg/kg PCB in muscle. Map turtles from along the St. Lawrence River downstream of Turtle Creek contained 0.1 - 0.85 mg/kg ww (tissue unknown). Other map turtles collected along the St. Lawrence River between the mouth of Turtle Creek and the Raquette River contained between 0.1 and 186 mg/kg ww in fat; 0.1 and 14.8 mg/kg ww in muscle; 0.1 and 68.1 mg/kg ww in liver. Map turtles collected along the Raquette River about halfway between General Motors and the river mouth contained concentrations up to 1.32 mg/kg PCB ww (tissue unknown).

The St. Lawrence database contains a considerable amount of PCB concentration data in snapping turtles, some of which are summarized here. Snapping turtles collected in Turtle Creek at Akwesasne contained 0.1 – 233.9 mg/kg ww PCB in liver, 0.1 – 2.98 mg/kg ww PCB in muscle, and 0.1 – 1346.6 mg/kg ww PCB in fat. Snye Marsh snapping turtles contained 0.1 – 56.3 mg/kg PCB ww in fat and 0.1 – 51 mg/kg PCB ww in liver. Along the Grasse River, liver PCB concentrations ranged from 3.56 – 94.7 mg/kg ww, with fat PCB concentrations between 9.2 - 812 mg/kg ww. Snapping turtles collected along the lower Raquette River contained 0.97 – 22.6 mg/kg PCB ww in fat and 0.1 – 2.8 mg/kg PCB ww in liver. Snapping turtle eggs collected presumably along the Raquette River (RR-STEG sample ID) contained 2.3 – 8.9 mg/kg PCB ww. Snapping turtle eggs collected as part of the NYSDEC 90B survey (location unknown) contained up to 1.1 mg/kg PCB ww. Other snapping turtle eggs (SM-STEG, SRR-STEG, TC-STEG) contained PCB concentrations ranging from 2.6 mg/kg PCB ww to 738 mg/kg PCB ww (See Exhibit E-1 for a Data Summary).

There is limited information on the effects of PCBs and similar compounds on turtles (Exhibit E-2). Bergeron et al. (1994) observed that PCB metabolites topically applied to eggs altered sex ratios in red-eared slider turtles (*Trachemys scripta elegans*). Willingham and Crews (1999) recorded significant sex reversal (greater than 70 percent) in red-eared sliders when eggs were exposed to “environmentally relevant” concentrations of Aroclor 1242.

De Solla et al. (1998) found that altered secondary sexual characteristics occurred in Great Lakes snapping turtles at a greater frequency than reference area turtles. The authors hypothesized that these effects were related to organochlorine contaminants (organochlorine levels in the serum of adult males were higher in turtles from contaminated sites). Studies by Bishop et al. (1991, 1998) reported weak correlations between rates of developmental abnormalities in snapping turtles and concentrations of compounds such as PCBs, PCDDs, and PCDFs. The Akwesasne snapping turtle eggs from Bishop et al. (1998) exhibited an abnormality rate of 14.4 percent, compared with a rate of 7.4% in reference area snapping turtles. These Akwesasne eggs appeared to have been collected along the Raquette and St. Regis Rivers. The mean PCB concentration of the Akwesasne eggs was 3.9 mg/kg. Deformity rates were higher at sites such as Hamilton Harbour (43.1%) and Lynde Creek (37.5%) than Akwesasne, corresponding to total PCB concentrations in eggs of 2.08 - 3.6 mg/kg and 1.4 mg/kg, respectively. These authors concluded that PCDDs/PCDFs or individual PCB congeners may be more important contributors to egg toxicity than total PCBs or dioxin equivalents (TEQs). Ashpole et al. (2001) found the number of deformities per individual hatchling to be higher at PCB-contaminated sites (including Akwesasne) than reference sites.

Patnode et al. (1998), as cited in Sparling (2000), collected snapping turtle eggs from along the Sheboygan River (MI) in 1996 and 1997. Hatching success was reduced in clutches with PCB concentrations greater than 15 mg/kg that were incubated at male-producing temperatures, but not female-producing temperatures. Patnode et al. (1998) also found that the righting response of hatchling snapping turtles was inversely related to PCB exposure. PCBs were not associated with deformities or hatchling weight.

For snapping turtles, there may be a relationship between hatchling deformities and PCBs and similar compounds. It is unclear whether PCBs, individual PCB congeners, or PCDDs/PCDFs are more directly associated with deformities. The available data do not clearly suggest at which level of PCB/PCDD/PCDF contamination these abnormalities may become significant. Patnode et al. (1998) presented a threshold of 15 mg/kg in snapping turtle eggs at which hatching success was affected under certain conditions. Some snapping turtle eggs from the assessment area have exceeded this 15 mg/kg concentration. It is, therefore, possible that PCB concentrations in some of the more contaminated reaches of the Grasse, Raquette, and St. Lawrence Rivers may contribute to deformities and other physiological effects in resident turtles, but without additional controlled studies, it is difficult to establish toxicity thresholds and associated percent service loss.

Based on the above information regarding contaminant body burdens, specifically PCBs, and associated adverse effects recorded in turtles in the St. Lawrence Environment, the

Trustees believe that these reptiles may have been or may be injured by PCBs and similar compounds.

SALAMANDERS

A number of salamander species may be found in the assessment area. These include the mudpuppy (*Necturus maculosus*), considered to be the only exclusively aquatic amphibian in the St. Lawrence River basin. There are no Federally listed salamanders in the assessment area, but the State special concern Jefferson salamander *(Ambystoma jeffersonianum*) and blue-spotted salamander (*Ambystoma laterale*) are reported in the New York State Amphibian and Reptile Atlas Project (NYSARAP 1999) as occurring in the vicinity of Massena. These species have been known to hybridize with each other. The Jefferson and blue-spotted salamanders prefer moist woodlands, spending much of their life underground, but breeding in ponds in early spring. They feed on insects, earthworms, other amphibians, and small mice (Ohio History Central).

In general, salamanders are potentially highly exposed to contaminants. They are carnivorous, accumulating contaminants from their prey, and they spend much of their time in moist sediments and soils, where incidental ingestion of contaminated soil is probable. However, the only salamander species for which PCB toxicological data exist is the mudpuppy. In addition to having a carnivorous diet, the mudpuppy is long-lived (25+ years), lives in close association with sediment, and is believed to be relatively sedentary (Gendron et al. 1994). These factors make it a potentially suitable organism for monitoring sediment contamination.

Site-specific data regarding contaminant concentrations in mudpuppies are available for the St. Lawrence watershed. Mudpuppies were taken as by-catches by anglers in 1998 and 2000 along the St. Lawrence and Ottawa Rivers (Bonin et al. 1995). Specimens were analyzed for organochlorine pesticides and 39 PCB congeners. Total PCB concentrations in whole body pooled mudpuppy samples ranged from 0.113 mg/kg ww in the Ottawa River to 1.082 mg/kg ww in the St. Lawrence River at Port Lewis (downstream of the St. Regis River). The authors found that mudpuppies contained PCB concentrations that were approximately three-quarters of the concentrations found in fish from similar areas.

Mudpuppies sampled along the St. Lawrence and Ottawa Rivers in 1992 and 1993 accumulated PCBs in eggs as high as 58.2 mg/kg ww (at Akwesasne) (Gendron et al. 1994, 1995). A high prevalence of skeletal deformities was found in the most contaminated sections of the St. Lawrence River. At Akwesasne, adult mudpuppies were 6.71 times more likely to develop a limb defect than at the reference site; 58.33% of mudpuppies from Akwesasne exhibited a limb defect compared with 8.69% at Batiscan (Ottawa River), 29.17% at Paix (near the mouth of the Ottawa River), and 34.86% at Moulin (near the mouth of the Ottawa River) (Gendron et al. 1994, 1995). The frequencies of terata were positively correlated with the concentrations of chemicals in gonads, including PCBs and pesticides. There were no among-site differences in other parameters, such as circulating steroids (17β-estradiol, testosterone), fecundity and egg diameters (Gendron et al. 1994, 1995). The authors of the above study also noted shifts in age structure among sampling sites, with the shift most apparent at the Akwesasne site, manifest as a reduction in younger animals, particularly females. The authors suggested that this may indicate a higher prevalence of reproductive failure at this site. However, because these are field studies in which a variety of external influences were not controlled, it is possible that other contaminants/ factors may have contributed to the terata and age structure shift observed at Akwesasne.

Based on the above information regarding contaminant levels and adverse effects on the mudpuppy, the Trustees believe that mudpuppies, and potentially other salamander species, in the St. Lawrence Environment may have been or may be injured as a result of exposure to PCBs and potentially other contaminants.

FROGS

A number of frog and toad species occur in New York State and are expected to occur in the St. Lawrence assessment area. These include the American toad (*Bufo americanus*), bullfrog *(Rana catesbeiana*), green frog (*R. clamitans*), northern leopard frog (*R. pipiens*), gray tree frog (*Hyla versicolor*), spring peeper (*Hyla crucifer crucifer*), wood frog (*R. sylvatica sylvatica*), and pickerel frog (*R. palustris*). No Federal or State listed species of frogs are known to occur in the assessment area.

Various frog species are likely to be exposed to assessment area contaminants. Although most tadpoles are herbivores, many adult frogs and toads are carnivores, potentially exposing them to high levels of PCBs and other contaminants through ingestion of contaminated prey. Some frogs spend much of their life cycle in close contact with sediments and moist soils and are exposed to contaminants through incidental ingestion of sediment/soil and dermal absorption (Savage 2002). Frogs, like other amphibians, may be sensitive to environmental contaminants because of the rapid growth of larvae, poikolothermy and permeable eggs, gills and skin (Sparling 2000; Gutleb et al. 2000).

The St. Lawrence Cooperative Database contains limited PCB data on bullfrogs, green frogs, leopard frogs, and Atadpoles.@ Bullfrogs from Akwesasne contained PCBs from 0.1 to 7.18 mg/kg ww (up to 13,715 mg/kg lw) in unspecified tissues. The higher PCB concentrations are presumed to be associated with bullfrogs collected at the mouth of Turtle Creek. A bullfrog collected along the Grasse River contained 0.24 mg/kg PCB ww and 188 mg/kg lw (tissue unknown). Bullfrog samples from the Raquette River contained 0.1 mg/kg (tissue unknown). Bullfrogs from Alcoa contained 0.07 – 5.6 mg/kg PCB ww (82 – 807 mg/kg lw) in muscle or carcass. Green frogs collected at or near Contaminant Cove contained total PCBs as high as 1,390 mg/kg ww and 1,495 mg/kg lw (tissue unknown). Raquette River green frogs had 0.1 mg/kg PCB ww. Alcoa site green frogs contained between 0.32 and 4.54 mg/kg PCBs ww (47 – 1,390 mg/kg lw) (tissue unknown). Tadpoles (unspecified Ranid) from Alcoa contained concentrations of PCBs ranging from 0.32 – 1.54 mg/kg ww (127 – 161 1w). A leopard frog from Contaminant Cove contained 2,319 mg/kg PCBs ww and leopard frogs collected at Alcoa ranged in PCB concentration from ND to 15.2 mg/kg ww (444 mg/kg lw), with most Alcoa leopard frogs with less than 1 mg/kg PCBs ww.

Although information on the effects of PCBs and other contaminants on frogs and toads is limited, adverse effects in response to contaminant exposure have been documented for various species. Some studies measured the sensitivity of frogs and toads to contaminants relative to fish sensitivity. For example, in 96-hour acute toxicity tests, leopard frogs were found to be less sensitive to PCBs than rainbow trout (*Oncorhynchus mykiss*) and redear sunfish (*Lepomis microlophus*), but more sensitive than channel catfish (*Ictalurus punctatus*) (Birge et al. 1978, as cited in Sparling 2000). In that same study, hatchling frogs and toads appeared to be more tolerant of PCBs than older larvae. Jung and Walker (1997), as cited in Sparling (2000) concluded that American toads, green frogs, and northern leopard frogs were less sensitive to dioxins than most early life-stage fishes.

Other studies have documented adverse effects on frogs from exposure to contaminated sediment. For example, USEPA (2003) exposed northern leopard frogs to Housatonic River or PCB-spiked sediments and reported lower rates of egg maturation, poor egg mass fertilization, larval malformations, delayed metamorphosis and sperm head abnormalities at sediment concentrations within the range of 4.3 to 160 mg/kg PCB. In this study, reference area leopard frog tadpoles took 13 days to reach Gosner Stage 24, compared with 91 and 105 days to reach the same Gosner stage when exposed to mean PCB sediment concentrations of 42 and 17 mg/kg, respectively (USEPA 2003).

Savage et al. (2002) exposed wood frog tadpoles to sediment collected from a riverine marsh at Akwesasne containing 325 mg/kg PCBs (possibly the Turtle Creek area). Tadpoles were exposed either by direct contact or non-direct contact to 20 grams or 40 grams of PCB-contaminated sediment. Direct sediment contact resulted in higher tadpole mortality than if tadpoles were suspended over the sediment. The PCB-exposed tadpoles also exhibited reduced activity levels and swimming speed compared to reference tadpoles. Tissue concentrations in PCB-exposed tadpoles that exhibited effects ranged from 6 – 128 mg/kg (Savage 2002).

The USEPA evaluated wood frog reproduction and development in vernal pools in the Housatonic River floodplain (USEPA 2003). They did not demonstrate PCB-related effects for endpoints such as egg mass viability, larval survival or metamorphosis. They did demonstrate a relationship between PCB concentrations and (1) larval malformations and (2) skewed sex ratios. Sediment PCB concentrations of approximately 24.6 and 32.3 mg/kg were associated with malformations in wood frog metamorphs, with a weaker relationship between malformations in metamorphs and a sediment concentration of 4.9 mg/kg PCB (USEPA 2003). Concentrations of PCBs in wood frog metamorph tissue representing an EC_{50} (4.15 mg/kg) and an EC_{20} (0.68 mg/kg) for skewed sex ratios were proposed (USEPA 2003).

Exposure of frogs to levels of PCB 126 in the water column caused adverse effects in green and leopard frogs. Jofre et al. (2000) documented reductions in survival and incidences of edema in green and leopard frogs exposed to water concentrations of 50 mg/L PCB 126, but not at the lower concentrations used. Tadpoles in that study also grew more slowly when exposed to PCB 126. PCB 126 concentrations in tadpoles at the end of the experiment ranged from 0.0012 - 9.6 mg/kg (Jofre et al. 2000).

In a study of cricket frogs (*Acris crepitans*) in Illinois, a significant relationship was demonstrated between sex ratio reversal and contamination with PCBs and PCDFs (Reeder et al. 1998). Sediment PCB concentrations at the contaminated sites ranged from 0.9 – 260 mg/kg. European common frog (*Rana temporaria*) tadpoles exhibited a dose-dependent increase in mortality as a result of long-term oral exposure to a PCB-spiked diet (Gutleb et al. 2000). Approximately 50 days after long term oral exposure, the common frog tadpoles experienced 32% mortality when fed a 2 mg/kg Clophen A50 diet, compared with 47 % mortality when fed a 200 mg/kg Clophen A50 diet, with no mortality among tadpoles fed a control diet. In addition, body weight of the PCB-dosed tadpoles was altered and the duration of larval period increased (Gutleb et al. 2000).

Based on the above information regarding contaminant levels and adverse effects on frogs and toads, the Trustees believe that these amphibians in the St. Lawrence environment may have been or may be injured due to exposure to PCBs. Although the limited nature of these studies does not enable us to definitively estimate threshold effects concentrations for PCBs in frog tissue or sediment, the Trustees can conservatively state that sediment concentrations potentially as low as 4.3 mg/kg and 25 mg/kg PCB have been associated with adverse effects in northern leopard frogs and/or wood frogs, respectively (USEPA 2003). Sediment PCB concentrations exceed these concentrations throughout the assessment area, including at the Alcoa site, off-shore of Reynolds and GM, and in large areas of the Grasse River. PCB concentrations in frog tissue from various locations within the assessment area also exceed tissue levels (4.15, 6 mg/kg) shown by USEPA (2003) and Savage (2002) to be associated with adverse effects in wood frogs. Therefore, it is probable that sufficiently high concentrations of PCBs are present in these areas to adversely affect survival, reproduction, development, and/or behavior of these and other frog species.

CONCLUSION

Based on the above information, the Trustees expect that injury to turtles, salamanders, and frogs as a result of exposure to PCBs (and potentially other contaminants) in the assessment area has occurred. Contaminant concentrations, specifically PCBs, recorded in assessment area reptiles and amphibians are greater than concentrations shown to cause adverse effects. However, currently available information is insufficient to quantify these injuries. Therefore, for purposes of settlement negotiations, the Trustees propose a qualitative discussion of potential injury to turtles, salamanders, and frogs in the St. Lawrence Environment as part of the Natural Resource Damage Assessment. The Trustees suggest that benefits to St. Lawrence Environment amphibians and reptiles be considered during the evaluation of restoration alternatives proposed as compensation for other injuries.

EXHIBIT E-1 SUMMARY OF PCB DATA IN AMPHIBIANS AND REPTILES FROM IN AND AROUND THE THE ASSESSMENT AREA

SPECIES	MATRIX	LOCATION	CONCENTRATION
TURTLES			
Snapping turtle	eggs	Morrisburg	2.2 mg/kg ww[2]
Snapping turtle	eggs	Ingleside	1.3 mg/kg ww[2]
Snapping turtle	eggs	Loon Island	3.03 mg/kg ww[2]
Snapping turtle	eggs	Akwesasne	1.1-737 mg/kg ww[1,3]
Snapping turtle	fat/liver/muscle	Akwesasne	0.1–1347 / 0.1–53.5 / 0.1–3 mg/kg ww[1]
Snapping turtle	fat/liver/muscle	Raquette River	0.97–22.6 / 0.1–2.8 / 0.1 mg/kg ww[1]
Snapping turtle	fat/liver/muscle	Grasse River	9.2–812 / 3.6–94.7 / 0.8–1.6 mg/kg ww[1]
Painted turtle	various tissues	Snye Marsh	0.1-0.86 mg/kg ww[1]
Map turtle	fat/liver/muscle	St. Lawrence R.	0.1–186 / 0.1–68.1 / 0.1 mg/kg ww[1]
Map turtle	tissue	Raquette River	1.32 mg/kg ww[1]
SALAMANDERS			
Mudpuppy	whole body	SLR @ Port Lewis	1.08 mg/kg ww[4]
Mudpuppy	eggs	Akwesasne	58.2 mg/kg ww[5,6]
Mudpuppy	liver	Akwesasne	37 mg/kg ww[5,6]
FROGS			
Bullfrog	tissue	Akwesasne	7.18 ww <13,715 mg/kg lw[1]
Bullfrog	tissue	Grasse River	0.24 mg/kg ww 188 mg/kg lw[1]
Bullfrog	tissue	Raquette River	0.1 mg/kg ww[1]
Bullfrog	tissue	Alcoa	0.07–5.6 mg/kg ww 82-807 mg/kg lw[1]
Bullfrog	tissue	Snye Marsh	0.1 mg/kg ww[1]
Leopard frog	tissue	Turtle Creek	2,319 mg/kg ww[1]
Leopard frog	tissue	Alcoa	ND- 15.2 mg/kg ww <444 mg/kg lw[1]
Leopard frog	tissue	Power Canal	0.05-3.3 mg/kg ww[1]
Green frog	tissue	Turtle Creek	1,390 mg/kg ww/ 1,495 mg/kg lw[1]

SPECIES	MATRIX	LOCATION	CONCENTRATION
Green frog	tissue	Raquette River	0.1 mg/kg ww[1]
Green frog	tissue	Alcoa	0.32–4.54 mg/kg ww/ 47–1,390 mg/kg lw[1]
Tadpole	tissue	Alcoa	0.05-127 mg/kg ww[1]

Notes:
[1] Exponent (2003).
[2] Struger et al. (1993).
[3] DeSolla et al. (2001).
[4] Bonin et al. (1995).
[5] Gendron et al. (1995).
[6] Gendron et al. (1994).
mg/kg = milligrams per kilogram
ww = wet weight
lw = lipid weight

EXHIBIT E-2 PCB CONCENTRATIONS ASSOCIATED WITH EFFECTS IN REPTILES AND AMPHIBIANS

SPECIES/MATRIX	PCB CONCENTRATION	EFFECT	CITATIONS
Snapping turtle/Egg	15 mg/kg ww	Hatching Success	Patnode et al. 1998
Mudpuppy/Eggs	58 mg/kg ww	Limb Deformities*	Gendron et al. 1994,1995
Leopard Frog/Sediment	4.3 – 160 mg/kg	Development; Reproduction	USEPA 2003
Wood Frog Tadpoles/Tissue	6 – 128 mg/kg ww	Mortality; Altered Behavior	Savage et al. 2002
Wood Frog Metamorphs/Tissue	0.68 mg/kg (EC_{20}); 4.15 mg/kg (EC_{50})	Skewed Sex Ratios	USEPA 2003
Wood Frog Metamorphs/ Sediment	24.6 – 32.3 mg/kg	Malformations; Skewed Sex Ratios	USEPA 2003

Notes:
* 58 mg/kg PCB ww in mudpuppy eggs from Akwesasne; limb deformities at 58.33%, compared with 29.17% at Paix (PCB=1.9mg/kg); 34.86% at Moulin (PCB=1.3 mg/kg); 8.69% at Batiscan (PCB=0.4 mg/kg). Other contaminants were also present.
mg/kg = milligrams per kilogram
ww = wet weight
EC20 (EC50) = concentration at which 20 (50) percent of the experimental population showed an effect.

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APPENDIX F: ST. LAWRENCE ENVIRONMENT NATURAL RESOURCE DAMAGE ASSESSMENT PRELIMINARY ASSESSMENT OF EFFECTS OF POLYCHLORINATED BIPHENYLS (PCBS) ON MAMMALS IN THE ST. LAWRENCE ENVIRONMENT

INTRODUCTION

The purpose of this document is to: 1) summarize information on PCBs in mammals in and around the St. Lawrence Environment Assessment Area,[10] 2) compare these data with literature-based adverse effects information, and 3) make preliminary recommendations with respect to assessing injury to mammals as part of the St. Lawrence Environment Natural Resource Damage Assessment.

In order to complete this analysis, the following approach was implemented:

- Determine which mammals are found in the assessment area.
- Collect, review, and summarize data regarding contaminant concentrations in assessment area mammals.
- Conduct a literature search for relevant toxicological information regarding the effect of PCBs on mammal species relevant to the assessment area.
- Develop toxicity reference values for PCBs in mammals.
- Compare site-specific PCB levels in mammals to corresponding toxicity reference values (measured and modeled) and determine exceedences.

SUMMARY OF RESULTS

Data regarding contaminant concentrations in mammals in and around the assessment area reflect the PCB body burden of small terrestrial, large terrestrial, and semi-aquatic mammals. These data indicate exposure and bioaccumulation of PCBs by relevant species, and therefore the potential for injury. Although extensive toxicity information for mink exists, site-specific data regarding PCB body burden in mink are lacking. In addition, toxicity information on the effects of PCBs, measured as body burden concentrations, on the remainder of assessment area mammal species is insufficient to compare with site specific data and determine injury. Therefore, for purposes of settlement negotiations, the Trustees propose a qualitative discussion of potential mammal injury due to PCBs in the St. Lawrence Environment as part of the NRDA, and suggest that concrete and significant benefits to St. Lawrence Environment mammals be required as part of the evaluation of restoration alternatives proposed as compensation for other injuries.

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[10] Marine mammals are not included in this assessment.

MAMMALS IN AND AROUND THE ASSESSMENT AREA

Over 40 species of mammals have been recorded in the St. Lawrence assessment area (Appendix F-A). Utilizing aquatic, floodplain, and terrestrial habitats, these species rely on the area's natural resources for all life history characteristics. For example, mink feed in the river and the floodplain, and rely on floodplain and upland areas for breeding and denning. Short-tailed shrews prey on earthworms in the floodplain, and deer access the river for water while spending the rest of their time in upland areas. None of the mammals found in the assessment area are listed as Federally Threatened or Endangered. All are classified as either Unprotected or Game species under New York State law. Note, however, that a number of species are of special significance to members of the St. Regis Mohawk Tribe (Appendix F-A).

TOXICOLOGICAL INFORMATION - PCBS

Although PCBs rarely cause acute toxicity in mammals, exposure to PCBs can cause mortality as a result of reproductive effects, as well as sub-lethal, chronic effects. The physical and chemical characteristics of PCBs allow them to persist in the environment (i.e., resist degradation), and accumulate throughout the food web (Ma and Talmage 2000). Within each organism, PCBs accumulate in lipid, and can adversely affect the central nervous system, liver, and reproductive organs (Sheffield et al. 2000). To determine whether injury to mammals in the St. Lawrence Environment has occurred due to PCBs, published toxicological information was reviewed for comparison with site-specific data. No formal toxicological standards related to either dietary intake or body burden for PCBs in mammals exist,[11] and no site-specific toxicity data are currently available. Therefore, this review focuses on toxicity information in peer-reviewed literature. Literature is considered appropriate and relevant for this analysis if it meets the following criteria:

Study focuses on a mammal species found in the assessment area, or a mammal species closely related to one found in the assessment area.

Study focuses on the effect of PCBs (in the form of total PCBs or Aroclors).

Study documents a body burden or dose/intake value and a corresponding adverse effect (measured or extrapolated from empirical studies on test species).

Study focuses on adverse effects considered biologically relevant, including physiological changes, growth, reproduction, and mortality.

INJURY ASSESSMENT

For purposes of this assessment, mammals are divided into three main groups: small mammals (e.g., shrews, mice, voles), large mammals (e.g., moose, deer) and semi-aquatic mammals (e.g., mink, otter). For each species group, site-specific PCB data and relevant

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[11] No formal toxicological standards exist for any biota.

adverse effects information are summarized. These groupings were chosen based on similarities in physiology and contaminant exposure, allowing for comparison of contaminant data for multiple species to a single set of adverse effect thresholds.[12]

In this case, however, the assessment of injury to mammals in the St. Lawrence Environment is complicated by the fact that site-specific PCB data are not always directly comparable with literature-based toxicity information. For example, published toxicity information does not exist for all species for which PCB data are available or for tissues analyzed, and available toxicity information does not always reflect biologically-relevant endpoints (e.g., reproduction or survival). In these cases, a weight-of-evidence approach is used to establish the contaminant levels, either in tissue or in the diet, that are likely to cause injury.

SMALL TERRESTRIAL MAMMALS

Small terrestrial mammals in the St. Lawrence Environment occupy all consumer niches in the floodplain and upland habitats. Herbivores (e.g., rabbit, hare, squirrels, porcupines, voles) consume plants, grasses, flowers, nuts, seeds, tree bark, and leaves. Carnivores (e.g., striped skunk) typically consume soil invertebrates and other small mammals. Insectivores, such as shrews and bats, prey on earthworms, snails, insects, and other soil-dwelling invertebrates. Omnivores, such as mice, are opportunistic feeders and consume seeds, insects, green vegetation, roots, nuts, and fruit as available.

Although food habitats vary, each of these species types is exposed to contaminants in the St. Lawrence Environment through their consumption of contaminated food and water and incidental consumption of contaminated soil.

SITE-SPECIFIC DATA

To determine available site-specific data regarding PCB concentrations in small mammals, the St. Lawrence Environment Cooperative Database (Exponent 2003) was reviewed. Data on PCBs in small mammal tissue are available for the following species:

- meadow vole (*Microtus pennsylvanicus*),
- deer mouse (*Peromyscus maniculatus*),
- cottontail rabbit (*Sylvilagus floridanus*),
- red squirrel (*Tamiasciurus hudsonicus*),
- gray squirrel (Sciurus *carolinensis),*
- snowshoe hare (*Lepus americanus*),
- masked shrew (*Sorex cinereus*),
- short-tailed shrew (*Blarina brevicauda*),
- pygmy shrew (*Sorex hoyi*),

[12] Species may have different ingestion rates and basal metabolism, but these may be accounted for in modeled toxicity reference values.

- woodland jumping mouse (*Napaeozapus insignis*),
- striped skunk (*Mephitis mephitis*), and
- Eastern cottontail (*Sylvilagus floridanus*).

These data indicate bioaccumulation of PCBs by small terrestrial mammals in and around the assessment area (Exhibit F-1 and Appendix F-B). The highest PCB levels were found in masked shrews collected from sites adjacent to GM property, where maximum concentrations in whole body/carcass were 40 mg/kg wet weight (ww) and 11,522 mg/kg lipid weight (lw). PCB levels in the carcasses of other species of shrews, such as short-tailed and pygmy shrews, range from 1.17-2.1 mg/kg whole body/carcass ww and 11.7-45 mg/kg lw. These high levels of PCBs in shrews are directly related to the foraging habits and diet of shrews (i.e., consumption of soil invertebrates and significant contact with soil), and their consumption of more food per unit body mass than other small terrestrial mammals (Ma and Talmage 2001, Sample et al. 1996).

PCBs have also been detected in other small terrestrial mammals from the assessment area (Exhibit F-1 and Appendix F-B). For example, eastern cottontails were found with concentrations as high as 10 mg/kg whole body ww. The PCB body burden of snowshoe hares from the study is 0.1 mg/kg whole body/carcass ww (non-detect) and 8 mg/kg lw. Deer mouse samples from the Alcoa property near Sanitary Lagoon were found to have PCB concentrations of 0.1 (non-detect) mg/kg whole body/carcass ww (2.0 mg/kg lw), and tissue samples from a woodland jumping mouse carcass showed PCB levels at 0.4 mg/kg ww (7 mg/kg lw). PCB concentrations analyzed in other tissue types are summarized in Appendix F-B.

ADVERSE EFFECTS THRESHOLDS

Body-burden toxicity data for small terrestrial mammals were found in relatively few studies. Most of these data are for laboratory rats, species commonly used in toxicity tests. Body burdens of 0.028-12.36 mg/kg whole body ww correspond to decreased reproductive activity and immune suppression in rats (Exhibit F-2). Note that the detection limit for PCBs can be as high as 0.1 mg/kg, a value much higher than the lowest adverse effect threshold determined in laboratory studies.

In contrast to the scarcity of body-burden toxicity data for small mammals, information on dietary- or dose-related effects levels (i.e. No Observed Adverse Effects Level (NOAEL) and Lowest Observed Adverse Effects Level (LOAEL)) exists. Dose-related toxicity thresholds are summarized in Exhibit F-3 (a more detailed table of values is presented in Appendix F-C). Values were derived either from laboratory testing of sensitivity to administered doses, or from models based on exposure rates and physiology (See text box "Modeling Adverse Effects Thresholds"). Dietary effects levels vary from 0.009 mg/kg/d (LOAEL for little brown bat; Sample et al. 1996) to 50 mg/kg/d (LOAEL for physiological effects in the raccoon; Meyers and Schiller 1986). This variability is attributed to a number of factors, including differences in species' ability to metabolize PCBs; primary sites of action; age, growth rate, biomass and lipid content of the species; dose rate and duration of exposure; and congeners tested (Eisler 2000).

INJURY

Comparison of PCB concentrations in small terrestrial mammals in the assessment area to literature-based toxicity information suggests possible exceedences of adverse effects thresholds. These body burden-based thresholds, however, are based mainly on the toxicity of PCBs to rats; thresholds for site-specific small mammal species are not currently available. Alternatively, comparison of estimated dietary exposure for St. Lawrence mammals with published dose-effects information may provide sufficient information to predict injury to small mammals in the assessment area.

EXHIBIT F-1 TOTAL PCBS IN SMALL TERRESTRIAL MAMMALS (WHOLE BODY/CARCASS MG/KG)[A,B]

SPECIES	WET WEIGHT [C]		LIPID WEIGHT	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
Deer mouse	ND	ND	2	2
Eastern cottontail	ND	10	5	5
Indiana bat	1.45	1.45	--	--
Masked shrew	2.7	40	11.2	11,522
Meadow vole	0.03	0.03	1.2	1.2
Pygmy shrew	1.17	1.17	11.7	11.7
Short-tailed shrew	2.1	2.1	45	45
Snowshoe hare	ND	ND	8	8
Woodland jumping mouse	0.4	0.4	7	7

Notes:

[a] Source: Exponent (2003).

[b] PCB concentrations measured in other tissues are listed in Appendix F-B.

[c] ND = non-detect at a detection limit of 0.1 mg/kg.

MODELING ADVERSE EFFECTS THRESHOLDS

Some adverse toxicity thresholds (e.g., those of Sample et al. 1996) are estimated using a model that incorporates experimentally derived NOAELs or LOAELs (i.e., those derived for laboratory rats, mice, or other animals) and adjustments for differences in species body size and dietary habits. Sample et al. (1996) use this model to derive NOAEL and LOAEL-based benchmarks for 20 widely-distributed wildlife species. Although originally developed for use in ecological risk assessment, these benchmarks can be applied to estimate the potential toxicity of contaminant levels within the context of natural resource damage assessment.

In the model developed by Sample et al. (1996), NOAELs and LOAELs are normalized to the body weight of the animal. This consideration for differences in body size allows for comparisons across different tests and species, and is based on the premise that a number of physiological factors, including metabolic rate and responses to toxic chemicals, are a function of body size. Contaminant concentrations in the wildlife species' food or drinking water that would be equivalent to the NOAEL for that species were then estimated based on rate of food consumption and water intake. The result is an estimate of the NOAEL and/or LOAEL in terms of daily dose levels normalized to the body weight of the animal.

For mammals, the relationship between body size and metabolic rate (and therefore the response to toxic chemicals) is best expressed as body weight raised to the ¾ power. Therefore, the model is derived as outlined below.

Given a toxic dose tested in the laboratory and expressed in terms of unit body weight (i.e. mg/kg), the metabolic rate-based dose D is:

$$D = d*bw / bw^{(3/4)} = d * bw^{(1/4)}$$

Assuming that the dose per body surface area for species "a" and "b" would be equal:

$$d_{(a)} * bw_{(a)}^{1/4} = d_{(b)} * bw_{(b)}^{1/4}$$

Then, if the body weights of the two species and the dose $d_{(b)}$ producing an adverse effect in the test species are known, the dose $d_{(a)}$ that would produce the same effect in the wildlife species (species a) can be determined by :

$$d_{(a)} = d_{(b)} * bw_{(b)}^{1/4} / bw_{(a)}^{1/4} = d_{(b)} *(bw_{(b)}/bw_{(a)})^{1/4}$$

This last equation was used along with data on toxic effects of Aroclors in laboratory animals to derive NOAELs and LOAELs in wildlife species. Note that uncertainty in modeled values is typically higher than in values derived from dose-response experiments on the species of interest.

EXHIBIT F-2 ADVERSE EFFECTS THRESHOLDS FOR TISSUE RESIDUE LEVELS OF PCBS IN SMALL TERRESTRIAL MAMMALS

SPECIES	EFFECT MEASURED	BODY BURDEN	REFERENCE
Hispid Cotton Rat	NOEL Chromosome damage	12.36 mg/kg whole body	Shaw-Allen & McBee, 1993
Rat (spp. not given)	LOAEL Decreased sperm count in offspring	0.028 mg/kg ww maternal whole body	Gray et al. 1997
	LOAEL Immune suppression in offspring	0.05 mg/kg ww maternal whole body	Gehrs et al. 1997; Gehrs and Smialowicz, 1999
	LOAEL Increased genital malformations in offspring	0.073 mg/kg ww maternal whole body	Gray et al. 1997

EXHIBIT F-3 DOSE-RELATED EFFECT LEVELS FOR PCBS IN SMALL TERRESTRIAL MAMMALS

SPECIES	EFFECT MEASURED	MEDIAN DOSE (MG/KG/D)	PCB	REFERENCE
Mouse/Rat	NOAEL Reproduction LOAEL Reproduction (Mouse) LOAEL Reproduction (Rat)	0.14 mg/kg/d 1.79 mg/kg/d 6.85 mg/kg/d	Multiple Aroclors	Sample et al. 1996, Meyers and Schiller 1986, Collins and Capen 1980. As cited in Sample et al. 1996: Sanders and Kirkpatrick 1975, McCoy et al. 1995, Linder et al. 1974, NCI 1978, ATSDR 1993
	LOAEL Weight	0.55 mg/kg/d	Commercial grade PCBs of 41-60% chlorine	Golub et al. 1991
Rabbit	NOAEL Fetotoxicity FEL Fetotoxicity	10.0 mg/kg 12.5 mg/kg	Aroclor 1254	Villeneuve et al. 1971
	LOAEL Weight loss	10 mg/kg (12 wk)[a]	Aroclor 1254	Meyers and Schiller, 1986
	NOAEL Reproduction LOAEL Reproduction	0.04 mg/kg/d [b] 0.44 mg/kg/d	Multiple Aroclors	Sample et al. 1996
Ferret	NOAEL Reproduction LOAEL Reproduction	20 mg/kg (9 mo.) [a]	Multiple Aroclors	Meyers and Schiller 1986
Raccoon	LOAEL Physiology	50 mg/kg (8 d) [a]	Aroclor 1254	Meyers and Schiller 1986
Short-tailed shrew	NOAEL Reproduction LOAEL Reproduction	0.20 mg/kg/d [b] 1.97 mg/kg/d	Multiple Aroclors	Sample et al. 1996
Meadow Vole	NOAEL Reproduction LOAEL Reproduction	0.10 mg/kg/d [b] 1.01 mg/kg/d	Multiple Aroclors	Sample et al. 1996

Notes:

[a] Estimated value based on toxicity data for related species (from Table C1 in Sample et al. 1996; see text box "Modeling Adverse Effects Thresholds")

[b] Estimated value based on toxicity data for related species (from Table 12, Appendix D in Sample et al. 1996; see text box "Modeling Adverse Effects Thresholds").

SEMI-AQUATIC MAMMALS

Semi-aquatic mammals in the assessment area include muskrat (*Ondatra zibethica*), beaver (*Castor canadensis*), mink (*Mustela vison*), and river otter (*Lutra canadensis*; Hagler Bailly Services Inc. 1998). These mammals are exposed to PCBs through consumption of contaminated food and incidental ingestion of contaminated water and sediment. Muskrats feed on a host of aquatic plants including cattails, pondweed, swamp loosestrife, as well as insects, crayfish, freshwater clams, snails, mussels, frogs, reptiles, young turtles, small fish, young birds, and carrion (Godin 1977). Beavers consume leaves, grasses, ferns, woody material, and the occasional fish (BWW 2002). A mink's diet consists of approximately 65 percent fish and 35 percent benthic invertebrates, and river otters consume approximately 70-90 percent fish; the remainder of the otter's diet is composed of crayfish, mollusks, eels, amphibians, rodents, birds, eggs, and small reptiles (EPA 1993). Piscivores (i.e., fish-eaters) such as mink and otter have been shown to bioaccumulate PCBs at levels that far exceed food source concentrations when fed PCB-laden fish (Aulerich et al. 1973, Foley et al. 1988, Eisler 2000).

SITE-SPECIFIC DATA

To evaluate whether aquatic mammals in the assessment area have accumulated PCBs, data from the St. Lawrence Environment Cooperative Database (Exponent 2003) were reviewed. Data are available for beaver and muskrat, and indicate bioaccumulation of PCBs by both species in the assessment area (Exhibit F-4 and Appendix F-B). Data show PCB concentrations in beaver muscle tissue of 0.1 mg/kg (non-detect) ww and 57 mg/kg lw. Muskrat carcasses collected from the assessment area had PCB concentrations of approximately 0.2 mg/kg ww and 17-18 mg/kg lw. The accumulation of PCBs in muskrat lipid specifically is notable, as muskrat are not known to rapidly accumulate PCBs (Mayak, personal communication, 2004). PCB concentrations analyzed in other tissue types are summarized in Appendix F-B.

EXHIBIT F-4 TOTAL PCBS IN AQUATIC MAMMALS (MG/KG)[A,B]

SPECIES	TISSUE	WET WEIGHT [C]		LIPID WEIGHT	
		MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
Beaver	Muscle	ND	ND	57	57
Muskrat	Whole Body/Carcass	0.2	0.21	17	18

Notes:
[a] Source: Exponent (2003).
[b] PCB concentrations measured in other tissues are listed in Appendix F-B.
[c] ND = non-detect at a detection limit of 0.1 mg/kg.

No site-specific contaminant data are currently available for mink or otter in the assessment area.

ADVERSE EFFECTS THRESHOLDS

Literature reporting the adverse effects of PCBs on aquatic mammals is available mainly for mink, with fewer studies available for otter. No literature is currently available on the effects of PCBs on beaver or muskrat.

MINK

Research on the harmful effects of PCBs on mink began in the 1960's, when mink ranchers noted that animals fed Coho salmon from the Great Lakes were not reproducing. This prompted a series of studies on the effects of contaminants on mink (Aulerich et al. 1973, 1977; Platonow and Karstad 1973; Hornshaw et al. 1983, 1986; Kamrin and Ringer, 1996). Laboratory experiments, most of them dose-response studies, confirmed the adverse effects of dietary intake of PCBs on reproduction in ranched mink, and provided a more complete picture of the mechanisms underlying the effects of PCBs. Adverse effects of PCBs on mink include reduced litter size, kit weight, and whelping. Epidemiological studies established the inverse relationship between piscivore (mink and otter) populations and PCB levels in the environment (Kruuk and Conroy 1985, O'Connor and Neilsen 1981, Roos et al. 2001).

The few studies that have measured PCB tissue concentrations in relation to adverse effects in mink were reviewed (Exhibit F-5 and Appendix F-D). One of the most sensitive mammals to PCBs, mink experience adverse effects when exposed to PCB levels as low as 0.25 mg/kg in the diet (Restum et al. 1998). Hornshaw (1983) showed reduced reproduction and no kit survival at 13.3 mg/kg whole body ww in female mink. Significant kit mortality was recorded at PCB concentrations of 2.0 mg/kg liver (Kihlstrom et al. 1992, Wren et al. 1987a), and death was observed at a PCB levels of 4.2 mg/kg liver (Aulerich et al. 1973).

Much of the information on the effects of PCBs on mink comes from dose-response studies reported in the literature, in which mink were fed PCB-contaminated fish or other PCB-laden food. These studies (summarized in Exhibit F-5, Appendix F-E) include findings of adverse effects on kit growth and survival with PCB concentrations as low 0.015 mg/kg in food (Heaton et al. 1995a,b). Other studies, however, have suggested adverse reproductive effects that only begin to occur at higher levels. For example, Sample et al. (1996) determined a LOAEL for reproductive effects on mink at 10-20 mg/kg depending on the Aroclor group (Meyers and Schiller 1986). Note, however, that the thresholds developed by Sample et al. (1996) are based on empirical models (see text box "Modeling Adverse Effects Thresholds").

EXHIBIT F-5 ADVERSE EFFECTS THRESHOLDS FOR TISSUE RESIDUE LEVELS OF PCBS IN MINK

SPECIES	EFFECT MEASURED	TISSUE CONCENTRATION	REFERENCE
Mink	NOEL female reproduction LOEL Kit growth and survival (kits nursed by above females)	2.0 mg/kg liver 1.75 mg/kg fat in kits	Wren et al. 1987a
	EC_{50} litter size EC_{50} kit survival	1.2 mg/kg whole body 2.36 mg/kg whole body	Leonards et al. 1995

SPECIES	EFFECT MEASURED	TISSUE CONCENTRATION	REFERENCE
	Reduced reproduction	0.4-13.3 mg/kg lipid 11.23 mg/kg liver	Hornshaw et al. 1983, Platonow and Karstad, 1973
	Mortality	2.0-11.99 mg/kg liver 11.0 mg/kg fat	Aulerich et al. 1973, Platonow and Karstad, 1973, Kihlstrom et al. 1992

OTTER

Although some literature on the effects of PCBs in otter exists, the majority examines the link between elevated levels of PCBs in the environment and the decline of natural otter populations (Kruuk and Conroy 1995, Murk et al. 1998, Roos et al. 2001, Wren 1991). Some authors, such as Wren (1991), argue that otter may be as sensitive to PCBs as mink, due to a similar susceptibility to other contaminants such as methylmercury (O'Connor and Nielsen 1981 as cited in Wren 1991). The difficulty in maintaining otter populations in the laboratory, however, as well as the ethical issues of doing so, have precluded thorough toxicological testing on this species. One published study associates PCB body burdens with adverse effects on otters: Henney et al. (1981; as cited in Wren 1991) associated the decline in the otter population of the lower Columbia River, Oregon with PCB concentrations of 9.3 mg/kg whole body ww in males and 3.5 mg/kg ww in females. Dietary-based adverse effect thresholds have also been estimated for physiological effects in river otter. Sample et al. (1996) estimated dietary NOAELs and LOAELs for Aroclors in otter ranging from 0.009 to 2.04 mg/kg/d, depending on the Aroclor (Exhibit F-6, Appendix F-E, text box "Modeling Adverse Effects Thresholds"). Smit et al. (1996) estimated safe (EC_1) and critical levels (EC_{90}) in otter lipid and in the diet for physiological effects in otters.

EXHIBIT F-6 ADVERSE EFFECTS THRESHOLDS FOR DIETARY EXPOSURE TO PCBS IN MINK AND OTTER

SPECIES	EFFECT MEASURED	MEDIAN DOSE (MG/KG/D)	PCB [A]	REFERENCE
Mink	NOAEL for kit production, growth and survival	0.13	NR	Heaton *et al.* (1995a,b), Jensen *et al.* (1977), Hornshaw *et al.* (1983), Aulerich and Ringer (1977)
	LOAEL Reproduction	1.0	NR	Den Boer (1984), Restum *et al.* (1998), Hornshaw *et al.* (1983), Platonow and Karstad (1973), Heaton *et al.* (1995a,b), Wren *et al.* (1987b), Aulerich and Ringer (1977), EPA (1980), Aulerich *et al.* (1987), Jensen *et al.* (1977), Bleavins (1980)
	LOAEL Reproduction [b]	20.0	Aroclor 1016 (9 mo)	Meyers and Schiller 1986
	LOAEL Reproduction [b]	5.0	Aroclor 1242 (9 mo)	Meyers and Schiller 1986
	Acute/Lethal Dose [b]	10.0	Aroclor 1242 (9 mo)	Meyers and Schiller 1986
River Otter	NOAEL [c] LOAEL [c]	0.06 0.41	Aroclors	Sample et al. 1996
	EC_1 EC_{90}	0.002 0.005	Total PCBs	Smit et al. 1996

Notes:
[a] NR = Not Reported
[b] Estimated value based on a model derived from tests on related species (from Table C1 in Sample et al. 1996). See text box "Modeling Adverse Effects Thresholds."
[c] Estimated value based on a model derived from tests on related species (from Table 12, Appendix D in Sample et al. 1996). See text box "Modeling Adverse Effects Thresholds."

INJURY

Because no information on the effects of PCBs on beavers or muskrats is currently available, injury to these species cannot be directly determined. In addition, although literature-based PCB toxicity information on mink and otter is available, there are no site-specific PCB body burden data with which to compare these adverse effect thresholds. Therefore, injury to mink and otter cannot currently be determined. Injury to aquatic mammals in the St. Lawrence Environment, however, could be determined by modeling site-specific dietary exposure to PCBs, and comparing exposure levels to literature-based dietary adverse effects thresholds (Exhibit F-6).

LARGE MAMMALS

Large terrestrial mammals in the assessment area include the *Artiodactyla*, or ungulates (e.g., moose, white-tailed deer) and carnivores (e.g., red fox, coyote). The ungulates are largely forest-edge mammals, preferring thickets alternating with open, abandoned fields, and feed and drink near rivers, ponds, and streams. Deer feed mainly on the above-ground portions of woody plants, and occasionally eat lichens or grub for roots (Godin, 1977). Moose also browse on woody plants, but their diet also includes grass, moss, lichens, mushrooms, and a variety of herbaceous and leafy plants (Godin, 1977). These species are exposed to contaminants via consumption of contaminated food and water and incidental ingestion of contaminated soil.

Large carnivorous mammals in the assessment area include coyote and fox. Both eat a variety of small mammals, including carrion. They also consume birds, snakes, frogs, lizards, turtles, fishes, crayfish and insects, and occasionally fruits, berries, and other plant material (Godin, 1977). Carnivores also are exposed to PCBs through consumption of contaminated prey and incidental ingestion of contaminated soil and water. Because they feed high on the food chain, however, carnivores tend to accumulate more PCBs than herbivores and omnivores.

SITE-SPECIFIC DATA

To determine available site-specific data regarding PCB concentrations in large mammals, the St. Lawrence Environment Cooperative Database (Exponent 2003) was reviewed. PCB concentration data are available for the white-tailed deer (*Odocoileus virginianus*). Results indicate PCBs levels at 0.1 mg/kg ww (non-detect) and 12 mg/kg lw in liver (Appendix F-B). PCB concentrations analyzed in other tissue types also are summarized in Appendix F-B.

ADVERSE EFFECTS THRESHOLDS

No published data on tissue residue-based adverse effects thresholds are available for any of the large mammals in the assessment area, but dietary effects thresholds for deer and red fox are reported in Sample et al. (1996). For white-tailed deer, the estimated dietary effects levels range from 0.005-1.25 mg/kg/d, depending on test species and PCB congener, and for red fox, estimated effects levels range from 0.01-2.36 mg/kg/d (see previous text box "Modeling Adverse Effects Thresholds").

INJURY

Although injury to large terrestrial mammals in the St. Lawrence Environment cannot be determined directly from the available information, data indicate exposure and bioaccumulation of PCBs. Alternatively, comparison of estimated dietary exposure for St. Lawrence mammals with published dose-effects information may provide sufficient information to predict injury to small mammals in the assessment area.

CONCLUSION

Based on the above information, the Trustees expect that injury to mammals in the St. Lawrence Environment has occurred. Further work, such as estimating dietary exposure, would be required to determine injury for the majority of mammal species in the assessment area. However, for purposes of settlement negotiations, the Trustees propose a qualitative discussion of potential mammal injury due to PCBs in the St. Lawrence Environment as part of the NRDA, and suggest that concrete and significant benefits to St. Lawrence Environment mammals be required as part of the evaluation of restoration alternatives proposed as compensation for other injuries.

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APPENDIX F-A MAMMALS OF THE ST. LAWRENCE ENVIRONMENT ASSESSMENT AREA*

GENUS	SPECIES	COMMON NAME	NY STATUS	TRIBAL STATUS
Alces	alces	Moose	G	Y,SS
Blarina	brevicauda	Northern Short-Tailed Shrew	U	Y
Canis	latrans	Coyote	G	Y,SS
Castor	canadensis	Beaver	G	Y,SS
Clethrionomys	gapperi	Southern Red-Backed Vole	U	Y
Condylura	cristata	Star-Nosed Mole	U	Y
Eptesicus	fuscus	Big Brown Bat	U	Y
Erethizon	dorstatum	Porcupine	U	Y,SS
Gaucomys	sabrinus	Northern Flying Squirrel	U	Y
Glaucomys	volans	Southern Flying Squirrel	U	Y
Lasionycteris	noctavagans	Silver-Haired Bat	U	Y
Lasiurus	cinereus	Hoary Bat	U	Y
Lepus	americanus	Snowshoe Hare	G	Y,SS
Lutra	canadensis	River Otter	G	Y,SS
Lynx	rufus	Bobcat	G	Y,SS
Marmota	monax	Woodchuck	U	Y,SS
Martes	pennanti	Fisher	G	Y,SS
Mephitis	mephitis	Striped Skunk	G	Y,SS
Microtus	pennsylvanicus	Meadow Vole	U	Y
Microtus	pinetorum	Woodland Vole	U	Y
Mus	musculus	House Mouse	U	Y
Mustela	erminea	Ermine	G	Y,SS
Mustela	frenata	Long-Tailed Weasel	G	Y,SS
Mustela	vison	Mink	G	Y,SS
Myotis	leibii	Small-Footed Bat	U,SC	Y,SS
Myotis	lucifugus	Little Brown Bat	U	Y
Myotis	keeni	Keen's Myotis	U	Y
Myotis	septentrionalis	Northern Long-Eared Myotis	U	Y
Myotis	sodalis	Indiana Bat	U	Y
Napaeozapus	insignis	Woodland Jumping Mouse	U	Y
Odocoileus	virginianus	White-Tailed Deer	G	Y,SS
Ondatra	zibethicus	Muskrat	G	Y,SS
Parascalops	breweri	Hairy-Tailed Mole	U	Y
Peromyscus	leucopus	White-Footed Mouse	U	Y
Peromyscus	maniculatus	Deer Mouse	U	Y

GENUS	SPECIES	COMMON NAME	NY STATUS	TRIBAL STATUS
Pipistrellus	subflavus	Eastern Pipistrelle	U	Y
Procyon	lotor	Raccoon	G	Y,SS
Rattus	norvegicus	Norway Rat	U	Y
Sciurus	carolinensis	Gray Squirrel	G	Y,SS
Sorex	cinereus	Masked Shrew	U	Y
Sroesx	fumeus	Smokey Shrew	U	Y
Sorex	hoyi	Pygmy Shrew	U	Y
Sorex	palustris	Northern Water Shrew	U	Y
Sylvilagus	floridanus	Eastern Cottontail	G	Y,SS
Synaptomys	spp.	Bog Lemming	U	Y
Tamias	striatus	Eastern Chipmunk	U	Y,SS
Tamiasciurus	hudsonicus	Red Squirrel	U	Y,SS
Urocyon	cinereo-argenteus	Gray Fox	G	Y,SS
Vulpes	vulpes	Red Fox	G	Y,SS
Zapus	hudsonius	Meadow Jumping Mouse	U	Y

* Source: Hagler Bailly Services Inc. (1998).

G = Game. Game species are any variety of ‘big game’ or ‘small game’ as stated in the NYS Environmental Conservation Law. Many normally have an open season for at least part of the year, and are protected at other times of the year.

U = Unprotected. Unprotected means that the species may be taken at any time without limit; however, a license may be required.

Y =Yes. Significant to St. Regis Mohawk Tribe

SS = Special Significance. These are species which are of special significance to the St. Regis Mohawk Tribe.

APPENDIX F-B TOTAL PCBS IN ASSESSMENT AREA MAMMALS*

SPECIES	DATE	STATION	SAMPLE	MEASUREMENT BASIS	CONCENTRATION (MG/KG)	TISSUE
Beaver	01-Jan-85	KRC_TRC	BVR.MUS2	Lipid	57	Muscle
	01-Jan-85	KRC_TRC	BVR.LIV2	Lipid	7.1	Liver
	01-Jan-85	KRC_TRC	BVR.FAT2	Lipid	1.5	Fat
	01-Jan-85	KRC_TRC	BVR.FAT1	Wet	0.1	Fat
	01-Jan-85	KRC_TRC	BVR.LIV1	Wet	0.1	Liver
	01-Jan-85	KRC_TRC	BVR.MUS1	Wet	0.1	Muscle
Deer Mouse	01-Jan-85	HR-CI	DM.CAR2	Lipid	2	Carcass
	01-Jan-85	HR-CI	DM.CAR1	Wet	0.1	Carcass
Eastern cottontail	01-Jan-85	NA17	CR.MUS2	Lipid	19	Muscle
	01-Aug-87	CR1RP	CR1RP1	Wet	10	Whole organism
	01-Jan-85	NA17	CR.CAR2	Lipid	5	Carcass
	01-Jan-85	NA17	CR.LIV2	Lipid	4.2	Liver
	08-Dec-87	AKW-CCTR	880917F	Lipid	0.4	Fat
	02-Dec-87	AKW-CCTR	880722F	Lipid	0.2	Fat
	08-Dec-87	AKW-CCTR	880917F	Wet	0.2	Fat
	01-Jan-85	NA17	CR.CAR1	Wet	0.1	Carcass
	01-Jan-85	NA17	CR.LIV1	Wet	0.1	Liver
	01-Jan-85	NA17	CR.MUS1	Wet	0.1	Muscle
	29-Oct-87	AKW-PH	877131F	Wet	0.1	Fat
	29-Oct-87	AKW-PH	877131L	Wet	0.1	Liver
	29-Oct-87	AKW-PH	877131M	Wet	0.1	Muscle
	20-Sep-87	AKW-PH	880432F	Wet	0.1	Fat
	20-Sep-87	AKW-PH	880432L	Wet	0.1	Liver
	20-Sep-87	AKW-PH	880432M	Wet	0.1	Muscle
	21-Dec-87	AKW-CFBP	880719F	Wet	0.1	Fat
	21-Dec-87	AKW-CFBP	880719L	Wet	0.1	Liver
	21-Dec-87	AKW-CFBP	880719M	Wet	0.1	Muscle
	14-Dec-87	AKW-CCTR	880720F	Wet	0.1	Fat
	14-Dec-87	AKW-CCTR	880720L	Wet	0.1	Liver
	14-Dec-87	AKW-CCTR	880720M	Wet	0.1	Muscle
	04-Dec-87	AKW-CCTR	880721F	Wet	0.1	Fat
	04-Dec-87	AKW-CCTR	880721L	Wet	0.1	Liver
	04-Dec-87	AKW-CCTR	880721M	Wet	0.1	Muscle
	02-Dec-87	AKW-CCTR	880722F	Wet	0.1	Fat
	02-Dec-87	AKW-CCTR	880722L	Wet	0.1	Liver
	02-Dec-87	AKW-CCTR	880722M	Wet	0.1	Muscle
	05-Jan-88	AKW-RP	880806F	Wet	0.1	Fat
	05-Jan-88	AKW-RP	880806L	Wet	0.1	Liver
	05-Jan-88	AKW-RP	880806M	Wet	0.1	Muscle

SPECIES	DATE	STATION	SAMPLE	MEASUREMENT BASIS	CONCENTRATION (MG/KG)	TISSUE
Eastern cottontail	01-Mar-88	AKW-RP	880915L	Wet	0.1	Liver
Eastern cottontail	01-Mar-88	AKW-RP	880915M	Wet	0.1	Muscle
Eastern cottontail	01-Mar-88	AKW-PH	880916F	Wet	0.1	Fat
Eastern cottontail	01-Mar-88	AKW-PH	880916L	Wet	0.1	Liver
Eastern cottontail	01-Mar-88	AKW-PH	880916M	Wet	0.1	Muscle
Eastern cottontail	08-Dec-87	AKW-CCTR	880917M	Wet	0.1	Muscle
Eastern cottontail	19-Mar-88	AKW-RP	882703L	Wet	0.1	Liver
Eastern cottontail	19-Mar-88	AKW-RP	882703M	Wet	0.1	Muscle
Eastern cottontail	01-Jan-85	NA17	CR.FAT2	Lipid	0.07	Fat
Eastern cottontail	01-Jan-85	NA17	CR.FAT1	Wet	0.03	Fat
Gray squirrel	01-Jan-85	NA17	GS.MUS2	Lipid	5.2	Muscle
Gray squirrel	01-Jan-85	NA17	GS.MUS1	Wet	0.1	Muscle
Indiana bat	28-Aug-79	JEFF_CO	BAT_CARC	Wet	1.45	Carcass
Masked shrew	01-Jun-85	NA45	MS1	Lipid	11522	Carcass
Masked shrew	01-Jun-85	NA45	MS2	Lipid	5033	Carcass
Masked shrew	01-Jan-85	NA46	MS.CAR2	Lipid	670	Carcass
Masked shrew	01-Jun-85	NA45	MS3	Lipid	204	Carcass
Masked shrew	01-Jun-85	NA45	MS9	Lipid	130	Carcass
Masked shrew	01-Jun-85	NA45	MS11	Lipid	69	Carcass
Masked shrew	01-Jun-85	NA45	MS4	Lipid	60	Carcass
Masked shrew	01-Jun-85	NA45	MS6	Lipid	60	Carcass
Masked shrew	01-Jun-85	NA45	MS8	Lipid	40	Carcass
Masked shrew	01-Aug-87	MS12R37	MS12R37_1	Wet	40	Whole organism
Masked shrew	01-Jun-85	NA45	MS7	Lipid	30	Carcass
Masked shrew	01-Jun-85	NA45	MS10	Lipid	16.3	Carcass
Masked shrew	01-Jun-85	NA45	MS5	Lipid	11.2	Carcass
Masked shrew	01-Jan-85	NA46	MS.CAR1	Wet	2.7	Carcass
Masked shrew	01-Jan-85	NA46	MS.FET2	Lipid	0.9	Fetus
Masked shrew	01-Jan-85	NA46	MS.FET1	Wet	0.1	Fetus
Meadow vole	01-Jan-85	NA46	MV.FET2	Lipid	10	Fetus
Meadow vole	01-Jan-85	NA46	MV.CAR2	Lipid	1.2	Carcass
Meadow vole	01-Jan-85	NA46	MV.FET1	Wet	0.1	Fetus
Meadow vole	01-Jan-85	NA46	MV.CAR1	Wet	0.03	Carcass
Muskrat	01-Aug-87	MR1UT	MR1UT2	Lipid	18	Carcass
Muskrat	01-Jan-85	NA36	MKR.CAR2	Lipid	17	Carcass
Muskrat	01-Jan-85	NA36	MKR.MUS2	Lipid	13	Muscle
Muskrat	29-Oct-87	SLR-RP	877130L	Lipid	4	Liver
Muskrat	26-Oct-87	SRR-AKW	880812F	Lipid	4	Fat
Muskrat	09-Sep-87	SLR-RP	870426F	Lipid	1.2	Fat
Muskrat	16-Sep-87	SLR-RP	877129F	Lipid	1.2	Fat

SPECIES	DATE	STATION	SAMPLE	MEASUREMENT BASIS	CONCENTRATION (MG/KG)	TISSUE
Muskrat	07-Sep-87	SLR-RP	877124F	Lipid	1	Fat
	18-Oct-87	SRR-AKW	880828F	Lipid	1	Fat
	08-Jul-87	AKW-CNWL	885705F	Lipid	0.9	Fat
	15-Sep-87	RR-BTB	877114F	Lipid	0.8	Fat
	16-Sep-87	SLR-RP	877129F	Wet	0.8	Fat
	28-Sep-87	RR-BTB	882706F	Lipid	0.7	Fat
	29-Oct-87	SLR-CC	877132L	Wet	0.7	Liver
	26-Sep-87	RR-BTB	870430F	Lipid	0.6	Fat
	10-Sep-87	SLR-RP	877116F	Lipid	0.6	Fat
	07-Sep-87	SLR-RP	877124F	Wet	0.6	Fat
	03-Sep-87	SLR-RP	877127F	Lipid	0.5	Fat
	09-Sep-87	SLR-RP	870426F	Wet	0.5	Fat
	18-Oct-87	SRR-AKW	880828F	Wet	0.5	Fat
	29-Sep-87	RR-BTB	880516F	Lipid	0.44	Fat
	26-Sep-87	RR-BTB	877105F	Lipid	0.4	Fat
	01-Feb-88	REYN	881102F	Lipid	0.4	Fat
	15-Sep-87	RR-BTB	877114F	Wet	0.4	Fat
	25-Sep-87	RR-BTB	877104F	Lipid	0.3	Fat
	10-Sep-87	SLR-RP	877116F	Wet	0.3	Fat
	26-Oct-87	SRR-AKW	880812F	Wet	0.3	Fat
	26-Oct-87	SRR-AKW	882705F	Lipid	0.28	Fat
	28-Sep-87	RR-BTB	882706F	Wet	0.28	Fat
	01-Jan-85	NA36	MKR.FAT2	Lipid	0.25	Fat
	29-Sep-87	RR-BTB	880516F	Wet	0.24	Fat
	01-Jan-85	NA36	MKR.CAR1	Wet	0.21	Carcass
	22-Sep-87	RR-BTB	877032F	Lipid	0.2	Fat
	19-Oct-87	AKW-SNYE	880221F	Lipid	0.2	Fat
	26-Oct-87	SRR-AKW	880819F	Lipid	0.2	Fat
	18-Oct-87	SRR-AKW	880823F	Lipid	0.2	Fat
	18-Oct-87	SRR-AKW	880827F	Lipid	0.2	Fat
	19-Oct-87	AKW-SNYE	880831F	Lipid	0.2	Fat
	01-Aug-87	MR1UT	MR1UT1	Wet	0.2	Carcass
	26-Sep-87	RR-BTB	870430F	Wet	0.2	Fat
	26-Sep-87	RR-BTB	877105F	Wet	0.2	Fat
	01-Feb-88	REYN	881102F	Wet	0.2	Fat
	26-Oct-87	SRR-AKW	882705F	Wet	0.18	Fat
	01-Jan-85	NA36	MKR.MUS1	Wet	0.1	Muscle
	09-Sep-87	SLR-RP	870426L	Wet	0.1	Liver
	09-Sep-87	SLR-RP	870426M	Wet	0.1	Muscle
	17-Sep-87	RR-BTB	870427F	Wet	0.1	Fat

SPECIES	DATE	STATION	SAMPLE	MEASUREMENT BASIS	CONCENTRATION (MG/KG)	TISSUE
	17-Sep-87	RR-BTB	870427L	Wet	0.1	Liver
Muskrat	17-Sep-87	RR-BTB	870427M	Wet	0.1	Muscle
	26-Sep-87	RR-BTB	870430L	Wet	0.1	Liver
	26-Sep-87	RR-BTB	870430M	Wet	0.1	Muscle
	22-Sep-87	RR-BTB	877032F	Wet	0.1	Fat
	22-Sep-87	RR-BTB	877032L	Wet	0.1	Liver
	22-Sep-87	RR-BTB	877032M	Wet	0.1	Muscle
	18-Sep-87	AKW-CFBP	877033F	Wet	0.1	Fat
	18-Sep-87	AKW-CFBP	877033L	Wet	0.1	Liver
	21-Sep-87	RR-BTB	877034F	Wet	0.1	Fat
	21-Sep-87	RR-BTB	877034L	Wet	0.1	Liver
	23-Sep-87	SLR-RP	877101AL	Wet	0.1	Liver
	23-Sep-87	SLR-RP	877101AM	Wet	0.1	Muscle
	23-Sep-87	SLR-RP	877101BF	Wet	0.1	Fat
	23-Sep-87	SLR-RP	877101BL	Wet	0.1	Liver
	23-Sep-87	SLR-RP	877101BM	Wet	0.1	Muscle
	21-Sep-87	RR-BTB	877102F	Wet	0.1	Fat
	21-Sep-87	RR-BTB	877102L	Wet	0.1	Liver
	21-Sep-87	RR-BTB	877102M	Wet	0.1	Muscle
	25-Sep-87	RR-BTB	877103F	Wet	0.1	Fat
	25-Sep-87	RR-BTB	877103L	Wet	0.1	Liver
	25-Sep-87	RR-BTB	877104F	Wet	0.1	Fat
	25-Sep-87	RR-BTB	877104L	Wet	0.1	Liver
	26-Sep-87	RR-BTB	877105L	Wet	0.1	Liver
	25-Sep-87	RR-BTB	877106F	Wet	0.1	Fat
	25-Sep-87	RR-BTB	877106L	Wet	0.1	Liver
	25-Sep-87	RR-BTB	877106M	Wet	0.1	Muscle
	15-Sep-87	AKW-CFBP	877110F	Wet	0.1	Fat
	15-Sep-87	AKW-CFBP	877110L	Wet	0.1	Liver
	20-Sep-87	AKW-CFBP	877112F	Wet	0.1	Fat
	20-Sep-87	AKW-CFBP	877112L	Wet	0.1	Liver
	21-Sep-87	RR-BTB	877113L	Wet	0.1	Liver
	15-Sep-87	RR-BTB	877114L	Wet	0.1	Liver
	10-Sep-87	SLR-RP	877116L	Wet	0.1	Liver
	10-Sep-87	SLR-RP	877116M	Wet	0.1	Muscle
	07-Sep-87	SLR-RP	877124L	Wet	0.1	Liver
	07-Sep-87	SLR-RP	877124M	Wet	0.1	Muscle
	20-Sep-87	AKW-CFBP	877125F	Wet	0.1	Fat
	20-Sep-87	AKW-CFBP	877125L	Wet	0.1	Liver
	19-Sep-87	AKW-CFBP	877126F	Wet	0.1	Fat

SPECIES	DATE	STATION	SAMPLE	MEASUREMENT BASIS	CONCENTRATION (MG/KG)	TISSUE
	19-Sep-87	AKW-CFBP	877126L	Wet	0.1	Liver
	19-Sep-87	AKW-CFBP	877126M	Wet	0.1	Muscle
Muskrat	03-Sep-87	SLR-RP	877127F	Wet	0.1	Fat
	03-Sep-87	SLR-RP	877127L	Wet	0.1	Liver
	03-Sep-87	SLR-RP	877127M	Wet	0.1	Muscle
	19-Sep-87	AKW-CFBP	877128F	Wet	0.1	Fat
	19-Sep-87	AKW-CFBP	877128L	Wet	0.1	Liver
	19-Sep-87	AKW-CFBP	877128M	Wet	0.1	Muscle
	16-Sep-87	SLR-RP	877129L	Wet	0.1	Liver
	29-Oct-87	SLR-RP	877130F	Wet	0.1	Fat
	29-Oct-87	SLR-RP	877130L	Wet	0.1	Liver
	29-Oct-87	SLR-RP	877130M	Wet	0.1	Muscle
	19-Oct-87	AKW-SNYE	880221F	Wet	0.1	Fat
	19-Oct-87	AKW-SNYE	880221L	Wet	0.1	Liver
	29-Sep-87	RR-BTB	880516L	Wet	0.1	Liver
	28-Sep-87	RR-BTB	880518AF	Wet	0.1	Fat
	28-Sep-87	RR-BTB	880518AL	Wet	0.1	Liver
	28-Sep-87	RR-BTB	880518AM	Wet	0.1	Muscle
	28-Sep-87	RR-BTB	880518BF	Wet	0.1	Fat
	28-Sep-87	RR-BTB	880518BL	Wet	0.1	Liver
	28-Sep-87	RR-BTB	880518BM	Wet	0.1	Muscle
	26-Sep-87	RR-BTB	880520L	Wet	0.1	Liver
	26-Sep-87	RR-BTB	880520M	Wet	0.1	Muscle
	28-Sep-87	RR-BTB	880522AF	Wet	0.1	Fat
	28-Sep-87	RR-BTB	880522AL	Wet	0.1	Liver
	28-Sep-87	RR-BTB	880522AM	Wet	0.1	Muscle
	28-Sep-87	RR-BTB	880522BF	Wet	0.1	Fat
	28-Sep-87	RR-BTB	880522BL	Wet	0.1	Liver
	29-Sep-87	RR-BTB	880524F	Wet	0.1	Fat
	29-Sep-87	RR-BTB	880524L	Wet	0.1	Liver
	26-Oct-87	SRR-AKW	880811F	Wet	0.1	Fat
	26-Oct-87	SRR-AKW	880811L	Wet	0.1	Liver
	26-Oct-87	SRR-AKW	880811M	Wet	0.1	Muscle
	26-Oct-87	SRR-AKW	880812L	Wet	0.1	Liver
	26-Oct-87	SRR-AKW	880813F	Wet	0.1	Fat
	26-Oct-87	SRR-AKW	880813L	Wet	0.1	Liver
	26-Oct-87	SRR-AKW	880813M	Wet	0.1	Muscle
	26-Oct-87	SRR-AKW	880814F	Wet	0.1	Fat
	26-Oct-87	SRR-AKW	880814L	Wet	0.1	Liver
	26-Oct-87	SRR-AKW	880814M	Wet	0.1	Muscle

SPECIES	DATE	STATION	SAMPLE	MEASUREMENT BASIS	CONCENTRATION (MG/KG)	TISSUE
	26-Oct-87	SRR-AKW	880815F	Wet	0.1	Fat
	26-Oct-87	SRR-AKW	880815L	Wet	0.1	Liver
	26-Oct-87	SRR-AKW	880815M	Wet	0.1	Muscle
Muskrat	26-Oct-87	SRR-AKW	880816F	Wet	0.1	Fat
	26-Oct-87	SRR-AKW	880816L	Wet	0.1	Liver
	26-Oct-87	SRR-AKW	880816M	Wet	0.1	Muscle
	26-Oct-87	SRR-AKW	880817F	Wet	0.1	Fat
	26-Oct-87	SRR-AKW	880817L	Wet	0.1	Liver
	26-Oct-87	SRR-AKW	880817M	Wet	0.1	Muscle
	26-Oct-87	SRR-AKW	880818F	Wet	0.1	Fat
	26-Oct-87	SRR-AKW	880818L	Wet	0.1	Liver
	26-Oct-87	SRR-AKW	880818M	Wet	0.1	Muscle
	26-Oct-87	SRR-AKW	880819F	Wet	0.1	Fat
	26-Oct-87	SRR-AKW	880819L	Wet	0.1	Liver
	26-Oct-87	SRR-AKW	880819M	Wet	0.1	Muscle
	19-Oct-87	AKW-SNYE	880820AL	Wet	0.1	Liver
	19-Oct-87	AKW-SNYE	880820AM	Wet	0.1	Muscle
	26-Oct-87	SRR-AKW	880820BF	Wet	0.1	Fat
	26-Oct-87	SRR-AKW	880820BL	Wet	0.1	Liver
	26-Oct-87	SRR-AKW	880820BM	Wet	0.1	Muscle
	18-Oct-87	SRR-AKW	880823F	Wet	0.1	Fat
	18-Oct-87	SRR-AKW	880823L	Wet	0.1	Liver
	18-Oct-87	SRR-AKW	880823M	Wet	0.1	Muscle
	14-Oct-87	SRR-AKW	880824F	Wet	0.1	Fat
	14-Oct-87	SRR-AKW	880824L	Wet	0.1	Liver
	14-Oct-87	SRR-AKW	880824M	Wet	0.1	Muscle
	18-Oct-87	SRR-AKW	880825F	Wet	0.1	Fat
	18-Oct-87	SRR-AKW	880825L	Wet	0.1	Liver
	18-Oct-87	SRR-AKW	880825M	Wet	0.1	Muscle
	18-Oct-87	SRR-AKW	880827F	Wet	0.1	Fat
	18-Oct-87	SRR-AKW	880827L	Wet	0.1	Liver
	18-Oct-87	SRR-AKW	880827M	Wet	0.1	Muscle
	18-Oct-87	SRR-AKW	880828L	Wet	0.1	Liver
	18-Oct-87	SRR-AKW	880828M	Wet	0.1	Muscle
	19-Oct-87	AKW-SNYE	880829F	Wet	0.1	Fat
	19-Oct-87	AKW-SNYE	880829L	Wet	0.1	Liver
	19-Oct-87	AKW-SNYE	880829M	Wet	0.1	Muscle
	19-Oct-87	AKW-SNYE	880830F	Wet	0.1	Fat
	19-Oct-87	AKW-SNYE	880830L	Wet	0.1	Liver
	19-Oct-87	AKW-SNYE	880830M	Wet	0.1	Muscle

SPECIES	DATE	STATION	SAMPLE	MEASUREMENT BASIS	CONCENTRATION (MG/KG)	TISSUE
	19-Oct-87	AKW-SNYE	880831F	Wet	0.1	Fat
	19-Oct-87	AKW-SNYE	880831L	Wet	0.1	Liver
	19-Oct-87	AKW-SNYE	880831M	Wet	0.1	Muscle
	19-Oct-87	AKW-SNYE	880832L	Wet	0.1	Liver
Muskrat	19-Oct-87	AKW-SNYE	880832M	Wet	0.1	Muscle
	19-Oct-87	AKW-SNYE	880833F	Wet	0.1	Fat
	19-Oct-87	AKW-SNYE	880833L	Wet	0.1	Liver
	19-Oct-87	AKW-SNYE	880833M	Wet	0.1	Muscle
	19-Oct-87	AKW-SNYE	880834F	Wet	0.1	Fat
	19-Oct-87	AKW-SNYE	880834L	Wet	0.1	Liver
	19-Oct-87	AKW-SNYE	880834M	Wet	0.1	Muscle
	19-Oct-87	AKW-SNYE	880901F	Wet	0.1	Fat
	19-Oct-87	AKW-SNYE	880901L	Wet	0.1	Liver
	19-Oct-87	AKW-SNYE	880901M	Wet	0.1	Muscle
	19-Oct-87	AKW-SNYE	880902F	Wet	0.1	Fat
	19-Oct-87	AKW-SNYE	880902L	Wet	0.1	Liver
	19-Oct-87	AKW-SNYE	880902M	Wet	0.1	Muscle
	30-Oct-87	SRR-AKW	880904F	Wet	0.1	Fat
	30-Oct-87	SRR-AKW	880904L	Wet	0.1	Liver
	30-Oct-87	SRR-AKW	880904M	Wet	0.1	Muscle
	30-Oct-87	SRR-AKW	880905F	Wet	0.1	Fat
	30-Oct-87	SRR-AKW	880905L	Wet	0.1	Liver
	30-Oct-87	SRR-AKW	880905M	Wet	0.1	Muscle
	30-Oct-87	SRR-AKW	880906F	Wet	0.1	Fat
	30-Oct-87	SRR-AKW	880906L	Wet	0.1	Liver
	30-Oct-87	SRR-AKW	880906M	Wet	0.1	Muscle
	30-Oct-87	SRR-AKW	880907F	Wet	0.1	Fat
	30-Oct-87	SRR-AKW	880907L	Wet	0.1	Liver
	30-Oct-87	SRR-AKW	880907M	Wet	0.1	Muscle
	01-Feb-88	REYN	881102L	Wet	0.1	Liver
	01-Feb-88	REYN	881102M	Wet	0.1	Muscle
	28-Sep-87	RR-BTB	882706L	Wet	0.1	Liver
	28-Sep-87	RR-BTB	882706M	Wet	0.1	Muscle
	28-Sep-87	RR-BTB	882707F	Wet	0.1	Fat
	28-Sep-87	RR-BTB	882707L	Wet	0.1	Liver
	08-Jul-87	AKW-CNWL	885705F	Wet	0.1	Fat
	08-Jul-87	AKW-CNWL	885705L	Wet	0.1	Liver
	08-Jul-87	AKW-CNWL	885705M	Wet	0.1	Muscle
	01-Jan-85	NA36	MKR.FAT1	Wet	0.09	Fat
	01-Jan-85	NA36	MKR.LIV2	Lipid	0.06	Liver

SPECIES	DATE	STATION	SAMPLE	MEASUREMENT BASIS	CONCENTRATION (MG/KG)	TISSUE
	01-Jan-85	NA36	MKR.LIV1	Wet	0.05	Liver
Pygmy shrew	01-Jan-85	CHBMJD	PS.CAR2	Lipid	11.7	Carcass
	01-Jan-85	CHBMJD	PS.CAR1	Wet	1.17	Carcass
Red Squirrel	01-Jan-85	BARNES	RS.MUS2	Lipid	9.7	Muscle
	01-Jan-85	BARNES	RS.LIV2	Lipid	2.8	Liver
Red Squirrel	01-Jan-85	BARNES	RS.FAT2	Lipid	0.2	Fat
	01-Jan-85	BARNES	RS.FAT1	Wet	0.1	Fat
	01-Jan-85	BARNES	RS.LIV1	Wet	0.1	Liver
	01-Jan-85	BARNES	RS.MUS1	Wet	0.1	Muscle
Short-tailed shrew	01-Jan-85	NA46	STS.CAR2	Lipid	45	Carcass
	01-Jan-85	NA46	STS.CAR1	Wet	2.1	Carcass
Snowshoe hare	01-Jan-85	RT37-CR	SSH.MUS2	Lipid	13	Muscle
	01-Jan-85	RT37-CR	SSH.CAR2	Lipid	8	Carcass
	01-Jan-85	RT37-CR	SSH.LIV2	Lipid	4	Liver
	01-Jan-85	RT37-CR	SSH.FAT2	Lipid	0.4	Fat
	01-Jan-85	RT37-CR	SSH.CAR1	Wet	0.1	Carcass
	01-Jan-85	RT37-CR	SSH.FAT1	Wet	0.1	Fat
	01-Jan-85	RT37-CR	SSH.LIV1	Wet	0.1	Liver
	01-Jan-85	RT37-CR	SSH.MUS1	Wet	0.1	Muscle
	01-Dec-87	AKW-RP	880723F	Wet	0.1	Fat
	01-Dec-87	AKW-RP	880723L	Wet	0.1	Liver
	01-Dec-87	AKW-RP	880723M	Wet	0.1	Muscle
	07-Jan-88	AKW-RP	880803L	Wet	0.1	Liver
	07-Jan-88	AKW-RP	880803M	Wet	0.1	Muscle
	07-Jan-88	AKW-RP	880804F	Wet	0.1	Fat
	07-Jan-88	AKW-RP	880804L	Wet	0.1	Liver
	07-Jan-88	AKW-RP	880804M	Wet	0.1	Muscle
	05-Jan-88	AKW-RP	880807F	Wet	0.1	Fat
	05-Jan-88	AKW-RP	880807L	Wet	0.1	Liver
	05-Jan-88	AKW-RP	880807M	Wet	0.1	Muscle
	15-Nov-87	AKW-RP	880809F	Wet	0.1	Fat
	15-Nov-87	AKW-RP	880809L	Wet	0.1	Liver
	15-Nov-87	AKW-RP	880809M	Wet	0.1	Muscle
	27-Dec-87	AKW-RP	880918F	Wet	0.1	Fat
	27-Dec-87	AKW-RP	880918L	Wet	0.1	Liver
	27-Dec-87	AKW-RP	880918M	Wet	0.1	Muscle
	26-Feb-88	AKW-RP	881033F	Wet	0.1	Fat
	26-Feb-88	AKW-RP	881033L	Wet	0.1	Liver
	26-Feb-88	AKW-RP	881033M	Wet	0.1	Muscle
	14-Dec-87	AKW-RP	882708F	Wet	0.1	Fat

SPECIES	DATE	STATION	SAMPLE	MEASUREMENT BASIS	CONCENTRATION (MG/KG)	TISSUE
	14-Dec-87	AKW-RP	882708L	Wet	0.1	Liver
	14-Dec-87	AKW-RP	882708M	Wet	0.1	Muscle
Striped skunk	01-Jan-85	CF_BP	SSK.LIV.1	Wet	1.9	Liver
	01-Jan-85	CF_BP	SSK.FAT.1	Wet	0.3	Fat
White-tailed deer	01-Jan-85	NA17	WTD.LIV2	Lipid	12	Liver
	01-Jan-85	NA17	WTD.HRT2	Lipid	4	Heart
White-tailed deer	01-Jan-85	NA17	WTD.FAT1	Wet	0.1	Fat
	01-Jan-85	NA17	WTD.HRT1	Wet	0.1	Heart
	01-Jan-85	NA17	WTD.LIV1	Wet	0.1	Liver
	26-Oct-87	AKW-RP	880810L	Wet	0.1	Liver
	11-Jun-87	AKW-RP	880914M	Wet	0.1	Muscle
	27-Nov-88	AKW-CHAP	886210L	Wet	0.1	Liver
Woodland jumping mouse	01-Jan-85	DIABLO_J	MJM.CAR.2	Lipid	7	Carcass
	01-Jan-85	DIABLO_J	MJM.CAR.1	Wet	0.4	Carcass
* Source: Exponent (2003).						

APPENDIX F-C DOSE-RELATED EFFECT LEVELS FOR PCBS IN SMALL TERRESTRIAL MAMMALS

SPECIES	EFFECT MEASURED	DOSE (MG/KG/D) AND DURATION	PCB	REFERENCE
White-footed Mouse	FEL Reproduction	62 (2-3 wk)	Aroclor 1254	Sanders and Kirkpatrick, 1975*
	LOAEL Reproduction	31 (60d)	Aroclor 1254	Merson and Kirkpatrick, 1976*
	LOAEL Reproduction	1.55 (18 mo)	Aroclor 1254	Linzey, 1987*
	LOAEL** Reproduction; Decreased pup survival	10 ppm (18 mo)	Aroclor 1254	Meyers and Schiller, 1986, as cited in Sample et al. 1996 (Table C1)
	NOAEL*** LOAEL*** (based on tox data for mink)	3.56 8.91	Aroclor 1016	Sample et al. 1996 (Table 12)
	NOAEL*** LOAEL*** (based on tox data for mink)	0.179 1.792	Aroclor 1242	Sample et al. 1996 (Table 12)
	NOAEL*** LOAEL*** (based on tox data for Rhesus monkey)	0.039 0.388	Aroclor 1248	Sample et al. 1996 (Table 12)
	LOAEL*** NOAEL*** (based on tox data from oldfield mouse)	0.061 0.607	Aroclor 1254	Sample et al. 1996 (Table 12)
Oldfield Mouse	LOAEL Reproduction	0.68 (12 mo.)	Aroclor 1254	McCoy et al. 1995*
Rat	LD_{50}	1010 mg/kg (1 d)	Aroclor 1254	Garthoff et al. 1981*
	LOAEL Fetotoxicity	4 (during gestation)	Aroclor 1254	Collins and Capen 1980
	LOAEL Reduced survival	2 (104 wk)	Aroclor 1254	NCI 1978*; ATSDR 1989a*
	FEL/LOAEL Reduced litter size	1.6 mg/kg (2 generations)	Aroclor 1254	Linder et al. 1974*
	NOAEL Reduced litter size	0.4 (2 generations)	Aroclor 1254	Linder et al. 1974*
Rats & Mice	LOAEL Postnatal weight gain	0.1	Varied (Commercial grade PCBs of 41-60% chlorine)	Golub et al. 1991 (literature review)
	LOAEL Increased estrus cycle	0.8	Varied (Commercial grade PCBs of 41-60% chlorine)	Golub et al. 1991 (literature review)
Rats & Mice	LOAEL Decreased conceptions	3.7	Varied (Commercial grade PCBs of 41-60% chlorine)	Golub et al. 1991 (literature review)

SPECIES	EFFECT MEASURED	DOSE (MG/KG/D) AND DURATION	PCB	REFERENCE
	LOAEL Lower birthweight	1.0	Varied (Commercial grade PCBs of 41-60% chlorine)	Golub et al. 1991 (literature review)
	LOAEL Reduced litter size	10.0	Varied (Commercial grade PCBs of 41-60% chlorine)	Golub et al. 1991 (literature review)
	LOAEL Decreased sperm production	20.0	Varied (Commercial grade PCBs of 41-60% chlorine)	Golub et al. 1991 (literature review)
Rabbit	NOAEL Fetotoxicity	10.0 during gestation (28 d)	Aroclor 1254	Villeneuve et al. 1971
	FEL fetal deaths	12.5 during gestation (28 d)	Aroclor 1254	Villeneuve et al. 1971
	LOAEL** Weight loss	10 (12 wk)	Aroclor 1254	Meyers and Schiller, 1986, as cited in Sample et al. 1996 (Table C1)
	NOAEL*** LOAEL*** (based on tox data for mink)	1.31 3.28	Aroclor 1016	Sample et al. 1996 (Table 12)
	NOAEL*** LOAEL*** (based on tox data for mink)	0.066 0.659	Aroclor 1242	Sample et al. 1996 (Table 12)
	NOAEL*** LOAEL*** (based on tox data for Rhesus monkey)	0.014 0.143	Aroclor 1248	Sample et al. 1996 (Table 12)
	NOAEL*** LOAEL*** (based on tox data for oldfield mouse)	0.022 0.223	Aroclor 1254	Sample et al. 1996 (Table 12)
Ferrett	NOAEL **	20 ppm (9 mo.)	Aroclor 1016	Meyers and Schiller, 1986, as cited in Sample et al. 1996 (Table C1)
	LOAEL** Reproduction	20 (9 mo)	Aroclor 1242	Meyers and Schiller, 1986, as cited in Sample et al. 1996 (Table C1)
Raccoon	LOAEL** Physiology	50 (8 d)	Aroclor 1254	Meyers and Schiller, 1986, as cited in Sample et al. 1996 (Table C1)
Short-tailed shrew	NOAEL***	3.91	Aroclor 1016	Sample et al. 1996

SPECIES	EFFECT MEASURED	DOSE (MG/KG/D) AND DURATION	PCB	REFERENCE
	LOAEL*** (both based on mink toxicity data)	9.80		
	NOAEL*** LOAEL*** (based on mink toxicity data)	0.197 1.972	Aroclor 1242	Sample et al. 1996
	NOAEL*** LOAEL*** (based on Rhesus monkey toxicity data)	0.043 0.427	Aroclor 1248	Sample et al. 1996
Meadow Vole	LOAEL*** NOAEL*** (based on tox data for mink)	2.99 7.49	Aroclor 1016	Sample et al. 1996 (Table 12)
	NOAEL*** LOAEL*** (based on tox data for mink)	0.151 1.507	Aroclor 1242	Sample et al. 1996 (Table 12)
	NOAEL*** LOAEL*** (based on tox data for Rhesus monkey)	0.033 0.326	Aroclor 1248	Sample et al. 1996 (Table 12)
	NOAEL*** LOAEL*** (based on tox data for oldfield mouse)	0.051 0.511	Aroclor 1254	Sample et al. 1996 (Table 12)
River Otter	LOAEL*** NOAEL*** (based on tox data for mink)	0.81 2.04	Aroclor 1016	Sample et al. 1996 (Table 12)
	LOAEL*** NOAEL*** (based on tox data for mink)	0.041 0.410	Aroclor 1042	Sample et al. 1996 (Table 12)
	LOAEL*** NOAEL*** (based on tox data for Rhesus monkey)	0.009 0.089	Aroclor 1048	Sample et al. 1996 (Table 12)
	LOAEL*** NOAEL*** (based on tox data for mink)	0.083 0.410	Aroclor 1054	Sample et al. 1996 (Table 12)
Little Brown Bat	LOAEL*** NOAEL*** (based on tox data for oldfield mouse)	0.009 0.085	Aroclor 1054	Sample et al. 1996 (Table 12)
	LOAEL*** NOAEL*** (based on tox data for mink)	4.66 11.66	Aroclor 1016	Sample et al. 1996 (Table 12)
	LOAEL***	0.051	Aroclor 1048	Sample et al. 1996

SPECIES	EFFECT MEASURED	DOSE (MG/KG/D) AND DURATION	PCB	REFERENCE
	NOAEL*** (based on tox data for Rhesus monkey)	0.508		(Table 12)
	LOAEL*** NOAEL*** (based on tox data for oldfield mouse)	0.079 0.795	Aroclor 1054	Sample et al. 1996 (Table 12)

* As cited in Sample et al. 1996. FEL: Frank Effects Level.
** Estimated value based on toxicity data for related species (from Table C1 in Sample et al. 1996).
*** Estimated value based on toxicity data for related species (from Table 12 in Sample et al. 1996).

APPENDIX F-D ADVERSE EFFECTS THRESHOLDS FOR TISSUE RESIDUE LEVELS OF PCBS IN AQUATIC MAMMALS

SPECIES	EFFECT MEASURED	BODY BURDEN	REFERENCE
Mink	NOEL female reproduction LOEL Kit growth and survival (kits nursed by above females)	2.0 mg/kg liver 1.75 mg/kg fat in kits	Wren et al. 1987a
	Significant kit mortality	2.0 mg/kg in liver	Kihlstrom et al. 1992
	EC_{50} litter size EC_{50} kit survival	1.2 mg/kg whole body 2.36 mg/kg whole body	Leonards et al. 1995
	Reduced reproduction	0.4-9.5 mg/kg lipid	Foley et al. 1988
	LOEL Reduced reproduction	13.3 mg/kg lipid (in adult females)	Hornshaw et al. 1983
	Death	4.3 mg/kg liver 11.0 mg/kg fat	Aulerich et al. 1973
	Impaired reproduction Death	11.23 mg/kg liver 11.99 mg/kg liver	Platonow and Karstad, 1973

APPENDIX F-E ADVERSE EFFECTS LEVELS FOR DIETARY EXPOSURE TO PCBS IN PISCIVOROUS MAMMALS

SPECIES	EFFECT MEASURED	DOSE (MG/KG/D)	PCB	REFERENCE
Mink	NOAEL for kit growth and survival (at 3 and 6 wks of age)	0.015	--	Heaton *et al.* (1995a,b)
	NOAEL for kit production, growth, and survival	0.050	--	Jensen *et al.* (1977)
	NOAEL for kit production, growth, and survival	0.210	--	Hornshaw *et al.* (1983)
	NOAEL for number of kits born alive	1.000	--	Aulerich and Ringer (1977)
	LOAEL for whelping	0.147 [a]	--	Den Boer (1984), as cited in EPA (1995)
	LOAEL for reproductive effects (delayed estrus, lower kit body weight at 3 and 6 wks. of age)	0.250	--	Restum *et al.* (1998), abstract
	LOAEL for whelping and kit survival	0.660	--	Hornshaw *et al.* (1983), p. 941
	LOAEL for kit production/survival	0.640	--	Platonow and Karstad (1973)
	LOAEL for kit growth and survival (at 3 and 6 wks of age)	0.720	--	Heaton *et al.* (1995a,b), Table 6
	LOAEL, kit growth and survival	1.000	--	Wren *et al.* (1987b)
	LOAEL for whelping and kit production	2.000	--	Aulerich and Ringer (1977), p. 286-287
	LOAEL for kit mortality at 4 wks.	2.000	--	EPA (1980), p. 5,8,9
	LOAEL for kit mortality	2.500	--	Aulerich *et al.* (1985), p. 69
	LOAEL for kit production, growth, and mortality	3.330	--	Jensen *et al.* (1977)
	LOAEL for reproduction	5.000	--	Bleavins *et al.* (1980), abstract
	LOAEL** Reproduction	20.0	Aroclor 1016 (9 mo)	Meyers and Schiller, 1986, as cited in Sample et al. 1996 (Table C1)
	LOAEL** Reproduction	5.0	Aroclor 1242 (9 mo)	Meyers and Schiller, 1986, as cited in Sample et al. 1996 (Table C1)
	Acute/Lethal Dose**	10.0	Aroclor 1242 (9 mo)	Meyers and Schiller, 1986, as cited in Sample et al. 1996 (Table C1)

SPECIES	EFFECT MEASURED	DOSE (MG/KG/D)	PCB	REFERENCE
River Otter	LOAEL*** NOAEL*** (based on tox data for mink)	0.81 2.04	Aroclor 1016	Sample et al. 1996 (Table 12)
	LOAEL*** NOAEL*** (based on tox data for mink)	0.041 0.410	Aroclor 1042	Sample et al. 1996 (Table 12)
	LOAEL*** NOAEL*** (based on tox data for Rhesus monkey)	0.009 0.089	Aroclor 1048	Sample et al. 1996 (Table 12)
	NOAEL*** LOAEL*** (based on tox data for mink)	0.083 0.410	Aroclor 1054	Sample et al. 1996 (Table 12)

** Estimated value based on toxicity data for related species (from Table C1 in Sample et al. 1996).

*** Estimated value based on toxicity data for related species (from Table 12 in Sample et al. 1996).

APPENDIX F-F EFFECT LEVELS FOR LARGE TERRESTRIAL MAMMALS*

SPECIES	EFFECT MEASURED	DOSE (MG/KG/D)
Red Fox	LOAEL*** NOAEL*** (based on tox data for mink)	0.94 Aroclor 1016 2.36 Aroclor 1016
	LOAEL*** NOAEL*** (based on tox data for mink)	0.047 Aroclor 1042 0.474 Aroclor 1042
	LOAEL*** NOAEL*** (based on tox data for Rhesus monkey)	0.010 Aroclor 1048 0.103 Aroclor 1048
	LOAEL*** NOAEL*** (based on tox data for oldfield mouse)	0.096 Aroclor 1054 0.474 Aroclor 1054
White-tailed Deer	LOAEL*** NOAEL*** (based on tox data for mink)	0.50 Aroclor 1016 1.25 Aroclor 1016
	LOAEL*** NOAEL*** (based on tox data for mink)	0.025 Aroclor 1042 0.252 Aroclor 1042
	LOAEL*** NOAEL*** (based on tox data for Rhesus monkey)	0.005 Aroclor 1048 0.055 Aroclor 1048
	LOAEL*** NOAEL*** (based on tox data for oldfield mouse)	0.009 Aroclor 1054 0.085 Aroclor 1054

* Estimated value based on toxicity data for related species (from Table 12 in Sample et al. 1996).

INJURY QUANTIFICATION

As described in Chapter 3, losses in ecological services in the assessment area due to COCs are quantified for representative species groups. Additional detail regarding the quantification of losses to sediment and macroinvertebrates, fish, and birds resulting from exposure to PCBs are presented below.

SEDIMENT AND MACROINVERTEBRATES

Sediment and macroinvertebrates are essential to the continued function and viability of aquatic habitat. Together, they provide services such as substrate for burrowing and feeding, nutrient cycling, improved water quality, and prey (e.g., as the base of the food web). PCBs have caused reductions in these services. For purposes of this assessment, mortality is considered to be directly proportional to a loss in ecological services (e.g., a ten percent increase in mortality due to contamination is equivalent to a ten percent loss in services), and sub-lethal effects such as decreased growth are estimated to cause half the equivalent service loss (e.g., a ten percent decrease in growth is considered a five percent loss in services).

Sediment losses due to PCBs were estimated using a relationship between PCB concentration in sediment and the severity and magnitude of corresponding lethal and sub-lethal effects as reported in site-specific studies and in the literature. This includes the following steps:

1. Calculate past average annual sediment PCB concentrations using measured or modeled data (1981-2009).[13]
2. Model future sediment PCB concentrations in years 2010-2106.
3. Estimate the loss in sediment services due to PCBs for each sub-section of the assessment area for each year of the analysis (1981-2106).
4. Calculate the present value of sediment losses in discount service-acre years (DSAYs) in 2010 for each sub-assessment area using a three percent discount rate.
5. Sum the DSAYs lost for the entire assessment area for the entire assessment area.

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13 Sediment data are divided into pre- and post-remedy PCB concentrations where remedial actions occurred before 2010; e.g., the GM remediation area, RMC Remediation Area, Unnamed Tributary, and Turtle Cove/Creek areas. Grasse River data includes sampling before and after removal actions, and treatability studies.

SEDIMENT PCB CONCENTRATIONS: 1981-2009

Sediment PCB concentrations are estimated using the average of all surface data (i.e., 0-20 cm) collected in a given sub-section through all years of the analysis, except for the Grasse and Raquette Rivers (discussed below). [14,15] Data in these sub-sections are inconsistent across space and time, and are either insufficient to represent an entire sub-section in a given year (e.g., few samples were collected), or do not provide sufficient spatial coverage (e.g., most samples were collected from the same location). Data are also insufficient to estimate a trend in PCB concentrations over time. Combining all data for a given sub-section provides a general picture of the average PCB concentration to which sediment-dwelling organisms have been exposed.[16] Sediment PCB concentrations for sub-sections within the St. Lawrence River are then adjusted for baseline PCB concentrations (i.e., 0.02 ppm is subtracted from the average annual PCB concentration for each sub-section within the St. Lawrence River). Losses are evaluated using these baseline-adjusted concentrations.

Where remedial actions have occurred, including the GM remediation area, RMC remediation area, Unnamed Tributary, and Turtle Cove/Creek, sediment data are divided into pre- and post-remedy PCB concentrations. This accounts for any changes in sediment PCB levels due to remedial activities. However, at the time the HEA analysis was conducted, post-remedial monitoring data were only available for the GM remediation area. Because remedial PCB goals for all of these areas are similar, post-remedy data from the GM remediation area is used to estimate post-remedy concentrations in these other areas we well (CDM 1998, EPA 1993). [17,18] Data are summarized in Exhibit G-1.

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[14] The majority of sediment-dwelling organisms are active in the upper 20 cm (eight inches) of bottom sediment (Bares and Hennes 2003, DOER 2001). For sediment samples that were collected and sliced at multiple depths, surface PCB concentrations are calculated as the length-weighted average for slices that encompass zero to 20 cm (zero to eight inches).

[15] Data are not reviewed for Moses Saunders/Polly's Gut, or the St. Regis River due to hydrology (i.e., it is unlikely that PCB contamination from the facilities has injured resources in these areas).

[16] Non-detects are included as half the detection limit, and duplicate results for a given sample are averaged.

[17] Remedial cleanup trigger for Turtle Creek/Cove was slightly lower than for other remediated areas because of the consideration of a Tribal ARAR.

[18] Remedial actions initial occurred in the RMC remediation area in 2001, but supplemental remediation was implemented in 2009 to complete the PCB cap, excavate nearshore contamination and cap cells with elevated levels of PAHs. In-river work was completed in late September 2009, shoreline mitigation conducted in October 2009.

EXHIBIT G-1 PRE- AND POST-REMEDY SEDIMENT PCB CONCENTRATIONS

ASSESSMENT AREA SUB-SECTION	YEAR REMEDY COMPLETE	TIMEFRAME RELATIVE TO REMEDY	YEARS OF DATA	NUMBER OF SAMPLES	AVERAGE PCB CONCENTRATION (PPM DW) *
Unnamed Tributary	1999	Pre	1981-1988	130	12.1
		Post	--	--	--
RMC Remediation Area	2009	Pre	1985-2001	207	35.4
		Post	**	--	--
GM Remediation Area	1995	Pre	1985-1993	30	763.5
		Post	1997-2003	7	2.0
Turtle Cove/Creek	2005	Pre	1985-2004	39	116.3
		Post	--	--	--

Notes:

* GM remediation area and RMC remediation area adjusted for baseline.

-- indicates no data. Therefore, post-remedy PCB concentrations in the Unnamed Tributary, Turtle Cove/Creek, and the RMC remediation area are assumed to equal post-remedy concentrations in the GM remediation area.

** Monitoring data became available after injury analysis conducted.

Grasse River

In contrast to the assessment area sub-sections described above, Grasse River sediment data allow for analysis of PCB concentrations both spatially and temporally. Thiessen polygon analyses were conducted using sediment PCB concentration data for 1991, 1997, 2003, and 2007 the years for which data are most spatially extensive. In addition, sediment core data are available to estimate historic surface PCB concentrations. Using an average sediment deposition rate of 2.33 cm/year based on bathymetric data, lead-210 concentrations, and the depth of the peak concentration of cesium-137, the depth of each core representing the sediment surface in 1981 and 1986 was determined (Alcoa 2004, 2001).[19,20,21] The length-weighted average of PCB concentrations in the top 20 cm was calculated for each of these years. Surface sediment PCB concentrations for interim years (i.e., years where data are insufficient to conduct a spatial analysis of PCB data) were

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[19] Cesium-137, with a half-life of 30.3 years, is a thermonuclear byproduct. Its presence is directly related to the atmospheric testing of nuclear devices during the latter half of the 1950s and early 1960s. As a result of this testing, cesium-137 can be detected in sediments. The peak concentration of cesium-137 is assumed to correspond to 1963 $\pm$ 2 years. This is then used as a "dated" horizon from which a sedimentation rate (and subsequent ages of other sediments) can be estimated (MicroAnalytica 2008).

[20] Lead-210 is typically used to date geologic materials, including sediments. Lead-210 is produced through the decay of radon, which is a gas that can escape from depositing sediments. Because the half-life of radon is known (3.8 days), scientists can determine, based on the "excess" lead-210 remaining in the sediments, how old the sediments are (MicroAnalytica 2008).

[21] PCB concentrations were estimated for 1981 because that is the first year damages are assessed, and for 1986 because 1986 is half-way between 1981 and 1991 (the first year sufficient site-specific surface sediment data are available).

estimated as the average of the two closest years with data (e.g., 1982-1985 is the average of PCB concentrations in 1981 and 1986; 1992-1996 is the average of PCB concentrations in 1991 and 1997; etc.; Exhibit G-2).

EXHIBIT G-2 PCB CONCENTRATIONS IN GRASSE RIVER SEDIMENT

YEAR	PCB CONCENTRATION (PPM)	METHOD FOR DERIVING PCB CONCENTRATION
1981	103.47	Thiessen analysis of length-weighted average of 0-20 cm of 18 cores.
1982-1985	*98.70*	Average of 1981 and 1986 Thiessen results.
1986	93.93	Thiessen analysis of length-weighted average of 0-20cm of 18 cores.
1987-1990	*52.80*	Average of 1986 and 1991 Thiessen results.
1991	11.67	Thiessen analysis of length-weighted average of 0-20 cm surface sediment.
1992-1996	*16.74*	Average of 1991 and 1997 Thiessen results.
1997	21.80	Thiessen analysis of length-weighted average of 0-20 cm surface sediment.
1998-2002	*18.15*	Average of 1997 and 2003 Thiessen results.
2003	14.50	Thiessen analysis of length-weighted average of 0-20 cm surface sediment.
2004-2006	*13.6*	Average of 2003 and 2007 Thiessen results.
2007	12.61	Thiessen analysis of length-weighted average of 0-20 cm surface sediment.
2008-2009	*12.61*	Theissen results for 2007.

Notes:
Italics indicate estimated concentration.
Sources: Exponent (2006), Alcoa (2010, 2004, 2001).

Raquette River

Over 60 sediment samples were collected from the Raquette River and analyzed for PCB concentrations between 1989 and 2004. This dataset is sufficient to conduct a spatial analysis of PCB concentrations in sediment using Thiessen polygon analysis. Results indicate the area-weighted average surface sediment PCB concentration is approximately 2.17 ppm. However, the spatial distribution of these samples does not include depositional areas (i.e., possible hot spots of contamination) downstream of the GM facility, and therefore may underestimate the PCB concentration. [22]

[22] The arithmetic mean is not used because it may not represent the river-wide average PCB concentration in sediment, as a disproportionate number of samples were collected adjacent to the GM outfall.

DATA ANALYSIS: 2010-2106

Due to the physical and chemical properties of PCBs, future PCB concentrations are likely to decline slowly without remedial actions (i.e., natural attenuation of PCBs in sediments is extremely slow (Eisler 2000)). In addition, within the assessment area, remedial activities have been completed (e.g., GM remediation area), have yet to be selected (e.g., Grasse River), or are not planned (e.g., St. Regis River).

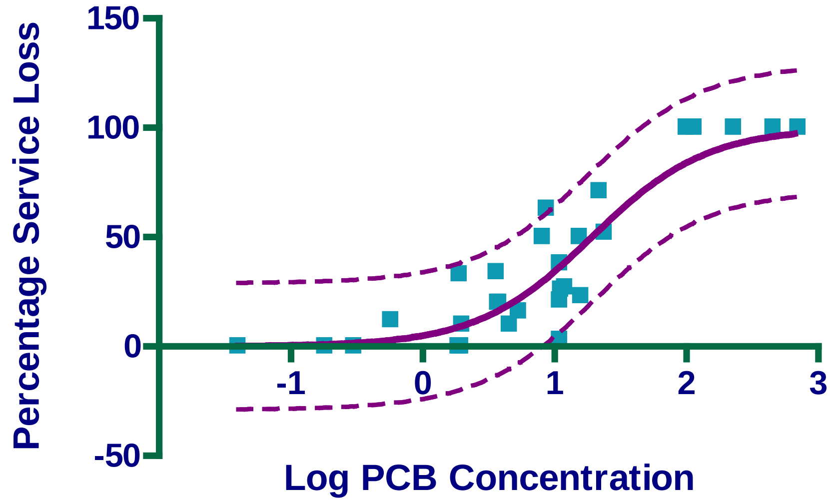
SERVICE LOSSES

To develop a relationship between PCB concentration and ecological services lost to benthic organisms, site-specific toxicity test results and data from the literature were reviewed. Studies that reported both lethal and sub-lethal effects at a given PCB sediment concentration were included in this analysis (Ingersoll et al. 2005, ACOE and EPA 2004, O'Keefe 2002, MacDonald et al. 2000, Wood et al. 1997, Metcalfe-Smith et al. 1996). The relationship between percentage service loss (the sum of service losses associated with lethal and sub-lethal effects) and PCB concentration is a dose reponse curve for log PCB concentration in sediment (Exhibit G-3).

Using the average PCB concentration, the log PCB concentration for each sub-section and each year was calculated, and using the PCB-service loss relationship equation described above, a percentage service loss for each sub-section and each year was estimated.[23] Two exceptions were the RMC remediation area and the GM remediation area, where sediment service losses are assumed to be 100 percent through the completion of remedial activities. This is due to the high concentrations of PCBs, PAHs and other contaminants in sediment.

[23] Sediment concentrations in St. Lawrence River sub-sections are baseline-adjusted.

EXHIBIT G-3 PCB CONCENTRATION AND SEDIMENT SERVICE LOSS (LETHAL AND SUB-LETHAL EFFECTS)



Notes:

The dotted lines are 95% prediction limits.

Equation: Sigmoidal dose-response Y = (100)/(1+10^(1.283-X))

X is the logarithm of concentration. Y is the response (i.e., percentage service loss).

R^2 = 0.84

Constraints: Bottom Y = 0, Top Y = 100

Because the equation is not currently constrained to 0.04ppm (0% service loss) and 100 ppm PCBs (100% service loss), this analysis artificially truncates the curve at those two concentrations.

Annual service losses for each sub-section of the assessment area except the Grasse River from 1981 through 2009 are presented in Exhibit G-4. Service losses are constant every year except for those areas with completed or on-going remedial activities. Annual service losses for sediment in the Grasse River are presented in Exhibit G-5. Future PCB-related service losses estimated for 2007 for each sub-section are assumed to attenuate through 2106.

EXHIBIT G-4 ANNUAL PERCENTAGE SEDIMENT SERVICE LOSS FOR EACH SUB-SECTION OF THE ASSESSMENT AREA EXCEPT THE GRASSE RIVER (1981-2010 UNLESS OTHERWISE NOTED)[1]

ASSESSMENT AREA SUB-SECTION	AVERAGE PCB CONCENTRATION (PPM)	ANNUAL PERCENTAGE SERVICE LOSS (1981-2010)[2]
Raquette River	2.17	10%
Power canal	0.96	5%
Unnamed Tributary – Pre-Remedy (1981-1999)	12.10	39%
Unnamed Tributary – Post-Remedy (2000-2009) [3]	1.99	9%
Robinson Creek	1.97	9%
RMC Remediation Area – Pre-Remedy (1981-2009) [4]	NA	100%
RMC Remediation Area – Post-Remedy (2010) [3]	2.17	9%
St. Lawrence River Around RMC	0.55	3%
RMC To Ship Channel	1.61	8%
GM Remediation Area – Pre-remedy (1981-1995) [4]	763.50	100%
GM Remediation Area – Post-remedy (1996-2009)	1.99	9%
St. Lawrence Around GM	0.73	4%
GM To Ship Channel	0.59	3%
Turtle Cove/Creek – Pre-remedy (1981-2005)	116.28	86%
Turtle Cove/Creek – Post-remedy (2006-2009) [3]	1.99	9%

Notes:

[1] Sediment service losses for the Grasse River are presented separately in Exhibit G-5 because service losses change over time.

[2] Annual percentage service losses are for each year from 1981 through 2010 except in areas where remedial actions have been completed or are on-going.

[3] Average annual PCB concentrations for Unnamed Tributary, RMC remediation area, and Turtle Cover/Creek post-remedy are estimated based on the post-remedy PCB concentration reported for sediments in the GM remediation area.

[4] Pre-remedy service losses for RMC and GM remediation areas assumed to be 100 percent due to PCBs, PAHs, and other COCs.

[5] Average annual PCB concentrations adjusted for baseline conditions (0.02 ppm) in the St. Lawrence River.

[6] Sub-sections upstream of the Facilities are not included.

NA – Not applicable.

Source: Exponent (2006).

EXHIBIT G-5 ANNUAL PERCENTAGE SEDIMENT SERVICE LOSS FOR THE GRASSE RIVER (1981-2010)

YEAR	ANNUAL PERCENTAGE SERVICE LOSS
1981	100%
1982	84%
1983	84%
1984	84%
1985	84%
1986	83%
1987	73%
1988	73%
1989	73%
1990	73%
1991	38%
1992	47%
1993	47%
1994	47%
1995	47%
1996	47%
1997	53%
1998	49%
1999	49%
2000	49%
2001	49%
2002	49%
2003	43%
2004	41%
2005	41%
2006	41%
2007	40%
2008	40%
2009	40%
2010	39%

The percentage service loss per year for each sub-section is multiplied by the acreage of that sub-section, and the present value in 2010 of these lost acres is calculated using a discount rate of three percent.[24] Results indicate a loss of sediment services equal to approximately 24,223 DSAYs (Exhibit G-6).

EXHIBIT G-6 LOST SEDIMENT DSAYS (1981-2106)

ASSESSMENT AREA SUB-SECTION	LOST SEDIMENT DSAYS
Raquette River	2,059
Power Canal	305
Unnamed Tributary	84
Robinson Creek	161
RMC Remediation Area	1,577
St. Lawrence River Around RMC	596
RMC To Ship Channel	301
GM Remediation Area	297
St. Lawrence Around GM	2,256
GM To Ship Channel	414
Turtle Cove/Creek	439
Grasse River	15,729
Total	**24,223**

Notes:
DSAY = Discount Service Acre-Year.
Lost DSAYs in present value 2010.
Total may not sum due to rounding.

FISH

Fish are an integral ecological component in aquatic ecosystems, and serve as a link between aquatic and semi-aquatic biota. Occupying multiple trophic levels, fish provide such ecological services as nutrient cycling, benthic community control, and food web sustainability. PCB-induced losses were estimated using a weight-of-evidence from the peer-reviewed literature that described mercury concentrations in fish and the severity and magnitude of the corresponding adverse effect.

[24] This is a standard discount rate and is typically used in NRDA (Freeman 1993, NOAA 1999).

This includes the following steps:

1. Calculate past annual average whole body fish PCB using measured or modeled data (1981-2009).
2. Model future whole body fish PCB concentrations in years 2010-2106.
3. Estimate the loss in fish services and DSAYs lost due to PCBs for each sub-section of the assessment area for each year of the analysis (1981-2106).
4. Calculate the present value of losses in 2010 for each sub-section of the assessment area.
5. Sum the present value acres lost over time to estimate the DSAYs lost for the entire assessment area.

FISH PCB CONCENTRATION: 1981-2009

Fish PCB concentrations are estimated using the average of all data collected in a given sub-section overall years of the analysis except for the Grasse River (discussed below; Exponent 2006). Data in these sub-sections are inconsistent across species, age, gender, and tissue type, as well as across space and time.

For purposes of this analysis, only tissue types that represented whole body or fillet/muscle were used: 1) the majority of assessment area fish data are reported as either whole body or fillet/muscle, 2) site-specific factors to convert fillet/muscle to whole body concentrations could be developed, and 3) the majority of adverse effect information is reported in whole body concentrations.

To develop fillet/muscle to whole body conversion factors, whole body and fillet PCB concentrations were required. Site-specific data was available. A subset of the Grasse River dataset included fillet and carcass from the same sample. Reconstituted whole body PCB concentrations were calculated using PCB concentrations and mass in fillet and carcass from 77 smallmouth bass and 102 brown bullhead (Exponent 2006). For all other fish species analyzed as fillet, a conversion factor was calculated as the average of the factors for brown bullhead and smallmouth bass. Spottail shiners records were whole body fish (Exhibit G-7).

With the exception of the Grasse River, fish tissue data are either insufficient to represent an entire sub-section in a given year (e.g., few samples were collected), or do not provide sufficient spatial coverage (e.g., samples were collected mainly from the same location). Data are also insufficient to estimate a trend in PCB concentrations over time. Therefore, all data for a given sub-section were combined to provide a general picture of the average PCB concentration in fish.[25]

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[25] Non-detects are included as half the detection limit, and duplicate results for a given sample are averaged.

EXHIBIT G-7 FILLET/MUSCLE TO WHOLE BODY CONVERSION FACTORS FOR FISH

FISH SPECIES	FILLET/MUSCLE TO WHOLE BODY CONVERSION FACTOR [1]
Smallmouth Bass[2]	3.4
Brown Bullhead[3]	2.7
All Other Species [4]	3.0

Notes:

[1] PCB concentration in fillet * Conversion Factor = PCB concentration in whole body.

[2] Calculated from 77 samples for which fillet, carcass and reconstituted whole body PCB concentrations were reported.

[3] Calculated from 102 samples for which fillet, carcass and reconstituted whole body PCB concentrations were reported.

[4] Calculated as the average of the conversion factors for smallmouth bass and brown bullhead.

No fish contaminant data are available for the GM to Ship Channel sub-section. Therefore, for purposes of this assessment, fish in this sub-section are assumed to have PCB concentrations similar to fish in the closest sub-section with fish tissue data (i.e., the St. Lawrence around GM sub-section.

Fish tissue PCB concentrations for sub-sections within the St. Lawrence River are then adjusted for baseline PCB concentrations (i.e., 0.52 ppm is subtracted from the average annual whole body PCB concentration for each sub-section within the St. Lawrence River).

Grasse River

Prior to 1991, fish data for the Grasse River are limited. Beginning in 1991 and continuing to the present, over 100 Grasse River fish samples were collected every year.[26] These data were used to hindcast and forecast fish PCB concentrations.

Because sufficient data are available for the Grasse River over time, a temporal trend could be developed to fill in data gaps (i.e., 1981-1992, 1994).[27] The most robust data set is the annual fish monitoring data for brown bullhead, smallmouth bass, and spottail shiner performed as part of the remedial investigation for the Grasse River. Advantages of this dataset include:

Data have been collected for the same three species regularly over a 15-year period.

Sample sizes and sampling locations are consistent across years.

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[26] Exceptions were 1992 (one sample) and 1994 (no samples).

[27] Although over 100 samples were collected from the Grasse River in 1991, the majority of fish were lower trophic level species and therefore not representative of the overall fish community. Therefore, modeled data for each of the three surrogate species, brown bullhead, smallmouth bass, and spottail shiner, was used for this year.

Sampling and analysis procedures and techniques are fairly consistent across sampling events.

The three species represent three different trophic levels and feeding guilds within the fish community.

Brown bullhead and smallmouth bass fillet data were converted to whole body concentrations using the conversion factors described above. Spottail shiners were analyzed on whole body samples. Exponentially-declining regressions for each species were calculated to predict temporal trends, accounting for changes in lipid content and length of fish samples over time. The average whole body PCB concentration in brown bullhead, smallmouth bass, and spottail shiner predicted by the trend analyses for each species were averaged for each year. Modeled results are applied in years where site-specific data are insufficient (Exhibit G-8).

EXHIBIT G-8 PCB CONCENTRATIONS IN GRASSE RIVER FISH

YEAR	PCB CONCENTRATION (PPM WB WW) [1,2]
1981	*44.01*
1982	*40.51*
1983	*37.33*
1984	*34.43*
1985	*31.78*
1986	*29.37*
1987	*27.17*
1988	*25.16*
1989	*23.32*
1990	*21.64*
1991[3]	*20.10*
1992	*18.69*
1993	27.79
1994	*26.15*
1995	24.51
1996	20.31
1997	13.38
1998	17.92
1999	17.14
2000	20.67
2001	17.92
2002	14.12
2003	8.03
2004	7.98

YEAR	PCB CONCENTRATION (PPM WB WW) [1,2]
2005[4]	22.66
2006	*7.54*
2007[5]	2.90
2008	3.36
2009	2.90

Notes:

WB WW = whole body wet weight

[1] Sources: Alcoa (2010), Exponent (2006).

[2] Italics indicate modeled concentration – average of brown bullhead, smallmouth bass, and spottail shiner predicted PCB concentrations.

[3] Although over 100 samples were collected from the Grasse River in 1991, the majority of fish were lower trophic level species and therefore not representative of the overall fish community. Modeled data was used for this year instead.

[4] The Remedial Options Pilot Study (ROPS) was conducted in 2005.

[5] There is some uncertainty in the post-2006 PCBs due to low lipid content.

-- indicates no data.

REMEDY

Where remedial actions have occurred, including the GM remediation area, RMC remediation area, Unnamed Tributary, and Turtle Cove/Creek, fish data are divided into pre- and post-remedy PCB concentrations. This accounts for any changes in fish PCB levels due to remedial activities. However, post-remedial fish concentration data are not available for Turtle Cove/Creek and the RMC remediation area. Because remedial goals for these areas – in terms of residual PCB sediment concentrations and corresponding exposure of fish to PCBs – are similar, post-remedial fish data from the GM remediation area is used to estimate post-remedial concentrations in these other areas as well.[28] Data are summarized in Exhibit G-9.

[28] Remedial actions in the RMC remediation area were completed in 2009, the date assumed for these analyses.

EXHIBIT G-9 PRE- AND POST-REMEDY FISH PCB CONCENTRATIONS

ASSESSMENT AREA SUB-SECTION	YEAR REMEDY COMPLETE	TIMEFRAME RELATIVE TO REMEDY	YEARS OF DATA	NUMBER OF SAMPLES	AVERAGE PCB CONCENTRATION (PPM WB WW)
Unnamed Tributary	1999	Pre	1992	11	5.44
		Post	2000-2004	30	0.79
RMC Remediation Area	2009	Pre[2]	--	--	--
		Post[3]	--	--	--
GM Remediation Area [1]	1995	Pre[2]	--	--	--
		Post	1996-2001	32	1.55
Turtle Cove/Creek	2005	Pre	1986-2002	13	65.83
		Post[3]	--	--	--

Notes:

-- indicates no data.

[1] GM remediation area adjusted for baseline.

[2] Pre-remedy conditions at the GM and RMC remediation areas are assumed to be such that fish provide no ecological services (see section below).

[3] Post-remedy PCB concentrations in Turtle Cove/Creek, and the RMC remediation area are assumed to equal post-remedy concentrations in the GM remediation area. Post-remediation spottail shiner data for RMC were first collected in 2010, after the HEA analyses were completed.

DATA ANALYSIS: 2010-2106

Due to the physical and chemical properties of PCBs, it is unlikely that PCB concentrations will decline rapidly in the future without remedial actions (e.g., PCBs are expected to take decades to be eliminated from the food chain to any significant degree since sediment concentrations are not expected to decline rapidly; Stow et al. 2004, 1995; Exponent 2003). In addition, within the assessment area, remedial activities have been completed (e.g., GM remediation area), have yet to be selected (e.g., Grasse River), or are not planned (e.g., St. Regis River). For the RMC remediation area starting in 2010[29], post-remedial fish concentrations are assumed to be similar to post-construction GM remediation area fish.

SERVICE LOSSES

Service losses to fish resulting from contamination in the assessment area are estimated by assessing the weight of evidence provided by studies in the peer-reviewed literature regarding the severity and magnitude of effect associated with a range of PCB concentrations in fish tissue (Exhibit G-10).

[29] RMC supplemental remediation (e.g., nearshore excavation, PAH and PCB cap construction) completed September 2009.

EXHIBIT G-10 PERCENTAGE FISH SERVICE LOSSES ASSOCIATED WITH RANGES OF PCB CONCENTRATIONS IN FISH TISSUE

PCB CONCENTRATION (PPM WB WW)	PERCENTAGE SERVICE LOSS	EFFECTS
<0.28	0%	No relevant effects.
0.28-1.0	1%	Salmonid species sustain biochemical and immunological effects (increased sensitivity to other contaminants, increased fin erosion, alteration of liver lipids; Jorgensen et al. 1999, Bills et al. 1981, Bills and Marking 1977 as cited in Meador et al. 2002). Reduced fecundity and EROD induction in barbel (Hugla and Thome 1999)
>1.0-3.0	5%	Salmonid growth reduced (Fisher et al. 1994 as cited in Meador et al.2002). Increased lake trout fry mortality (Mac and Seeley 1981). Altered growth first generation of mummichog (Matta et al. 2001) No spawning first reproductive season, reduced fecundity and hatching , increased egg mortality in barbel (Hugla and Thome 1999) Renal lesions, increased hepatocytes, spleenic changes, and increased skin pigmentation in rainbow trout (Nestel and Budd 1975) Reduced hatchability of lake trout and minnows eggs collected from the field (Mac et al. 1993, Mac and Schwartz 1992). Increased fry mortality of lake trout (Berlin et al. 1981)

PCB CONCENTRATION (PPM WB WW)	PERCENTAGE SERVICE LOSS	EFFECTS
>3.0-7.0	10%	Increased incidence of tumors, pre-neoplastic lesions, immunological changes, EROD induction, and disease prevalence in walleye (Barron et al. 2000). Impacts on larval survival of sheepshead minnow (Hansen et al. 1974, Schimmel et al. 1974, as cited in Monosson 1999). Alterations in larval phototropism, impairment of predator-avoidance ability, and other behavioral effects in Atlantic salmon (Fisher et al. 1994).
>7.0-10.0	15%	Fry mortality in sheepshead minnow (Hansen et al. 1974) Moderate to severe erosion of the dorsal fin in rainbow trout (Thuvander and Carlstein 1991).
>10.0-25	25%	Increased mortality of juvenile spot fish and pinfish (Hansen et al. 1971). Inhibition of reproductive development (e.g., spawning, premature and reduced hatching, increased fry mortality in common minnow; Bengtsson 1980). Increased sheepshead minnow fry mortality (Hansen et al. 1974). Decreased fecundity and frequency of reproduction in adult fathead minnows (Dillon 1988).
>25-50	50%	Impairment of rainbow trout immune system of (Thuvander and Carlstein 1991). Increased mortality of juvenile spotfish (Hansen et al. 1971). Adverse effects on reproduction of brook trout (e.g., hatchability) (Freeman and Idler 1975 as cited in Monosson 1999) Increased trout fry mortality (Berlin et al. 1981). Degeneration of liver, spleen and thymus in rainbow trout (Thuvander et al. 1993).
>50-100	75%	Increased severity and frequency of pathological effects (Nebeker et al. 1974). Changes in biochemical (increased hepatic

PCB CONCENTRATION (PPM WB WW)	PERCENTAGE SERVICE LOSS	EFFECTS
		microsomal enzyme activity) and immunological function (decreased steroid hormone levels) of rainbow trout (Sivarajah et al. 1978 and as cited in Meador et al. 2002). Increased mortality of brook trout fry, impairment of fry backbone development (Mauck et al. 1978).
>100	100%	Adult mortality high (Niimi 1996).
Note: Trustee service losses were modified during negotiations		

Ecological service losses to fish resources within the assessment area are quantified using the following steps:

1. For each sub-section, compare the average annual whole body fish tissue PCB concentration to the PCB concentration described above and assign the corresponding service loss.
2. Assume 100 percent service loss pre-remedy for the RMC and GM remediation areas due to PCB, PAH and other COC contamination.
3. Multiply the service loss per year for each sub-section by the area (acres) of that sub-section to generate DSAYS.
4. Calculate the present value in 2010 of the lost acres for each sub-assessment area using a three percent discount rate.
5. Sum the present value acres lost over time to estimate DSAYs lost for the entire assessment area.

Annual service losses for each sub-section of the assessment area except the Grasse River from 1981 through 2106 are presented in Exhibit G-11. Service losses are constant every year except for those areas with completed or on-going remedial activities. Annual service losses for fish in the Grasse River are presented in Exhibit G-12. PCB-related service losses estimated for 2009 for each sub-section are assumed to attenuate to zero by 2106.

EXHIBIT G-11 ANNUAL PERCENTAGE FISH SERVICE LOSS FOR EACH SUB-SECTION OF THE ASSESSMENT AREA EXCEPT THE GRASSE RIVER (1981-2010)[1]

ASSESSMENT AREA SUB-SECTION	ANNUAL PERCENTAGE SERVICE LOSS (1981-2010)[2]
Moses Saunders/Polly's Gut	15%
Raquette River	15%
Power Canal	5%
Unnamed Tributary – Pre-Remedy (1981-1999)	10%
Unnamed Tributary – Post-Remedy (2000-2009) [3]	1%
Robinson Creek	5%
RMC Remediation Area – Pre-Remedy (1981-2009) [4]	100%
RMC Remediation Area – Post-Remedy (2010) [3]	5%
St. Lawrence River Around RMC	15%
RMC To Ship Channel	10%
GM Remediation Area – Pre-remedy (1981-1995) [4]	100%
GM Remediation Area – Post-remedy (1996-2009)	5%
St. Lawrence Around GM	15%
GM To Ship Channel	15%
Turtle Cove/Creek – Pre-remedy (1981-2005)	75%
Turtle Cove/Creek – Post-remedy (2006-2009) [3]	5%
St. Regis River	10%

Notes:

[1] Fish service losses for the Grasse River are presented separately in Exhibit 4-19 because service losses change over time.

[2] Annual percentage service losses are for each year from 1981 through 2010 except where noted in areas where remedial actions have been completed or are on-going. Average annual PCB concentrations adjusted for baseline conditions in the St. Lawrence River, where applicable.

[3] Average annual PCB concentrations for RMC remediation area and Turtle Cover/Creek post-remedy are estimated based on the post-remedy PCB concentration reported for sediments in the GM remediation area.

[4] Pre-remedy service loss for RMC and GM remediation areas assumed to be 100 percent due to PCBs, PAHs and other COCs.

EXHIBIT G-12 ANNUAL PERCENTAGE PCB FISH SERVICE LOSS FOR THE GRASSE RIVER (1981-2010)

YEAR	ANNUAL PERCENTAGE SERVICE LOSS
1981	50%
1982	50%
1983	50%
1984	50%
1985	50%
1986	50%
1987	50%
1988	50%
1989	25%
1990	25%
1991	25%
1992	25%
1993	50%
1994	50%
1995	25%
1996	25%
1997	25%
1998	25%
1999	25%
2000	25%
2001	25%
2002	25%
2003	15%
2004	15%
2005	25%
2006	15%
2007	5%
2008	10%
2009	5%
2010	5%

The percentage service loss per year for each sub-section is multiplied by the acreage of that sub-section, and the present value in 2010 of these lost acres is calculated using a discount rate of three percent. Results indicate a loss of fish services equal to approximately 31,047 DSAYs (Exhibit G-13).

EXHIBIT G-13 LOST FISH DSAYS (1981-2106)

ASSESSMENT AREA SUB-SECTION	LOST FISH DSAYS
Moses Saunders/Polly's Gut	3,711
Raquette River	3,039
Power Canal	321
Unnamed Tributary	20
Robinson Creek	87
RMC Remediation Area	1,547
St. Lawrence River Around RMC	3,318
RMC To Ship Channel	392
GM Remediation Area	281
St. Lawrence Around GM	9,440
GM To Ship Channel	93
Turtle Cove/Creek	373
St. Regis River	1,360
Grasse River	7,064
Total	**31,047**
Notes: Lost DSAYs in present value 2010. Total may not sum due to rounding.	

BIRDS

Avian resources utilize the aquatic habitat for foraging and breeding. Rivers provide food items such as vegetation, insects, and fish. Birds also fill essential roles in the aquatic foodweb, serving as both predators and prey and assisting with nutrient cycling and trophic energy transfer. PCB-induced avian losses were estimated based on a weight-of-evidence in the peer-reviewed literature of impacts to four bird species, each representing a different foraging guild: common terns are small piscivores, osprey are large piscivores, mallards are herbivores, and tree swallows are aerial insectivores.[30]

This includes the following steps:

1. Develop species-specific dietary dose models for the four representative species.

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[30] These species may not represent the range in sensitivity to PCBs of the overall avian community in the assessment area.

2. Apply site-specific sediment and fish concentrations in each sub-section of the assessment area for each year of the analysis (1981-2009) to the dietary dose models.

3. Develop a correspondence between PCB dose, adverse effects, and service losses based on information from the peer-reviewed literature.

4. Estimate service losses for each sub-section of the assessment area for each representative bird species for each year of the analysis (1981-2106).

5. Average the service losses across the four representative species to estimate an overall avian service loss for each sub-section and each year.

6. Calculate the present value of losses in 2010 for each subsection assessment area using a three percent discount rate.

7. Sum the present value acres lost over time to estimate the DSAYs lost for the entire assessment area.

DIETARY DOSE MODEL

To estimate the exposure of avian resources to PCBs in the assessment area, a dietary dose model was developed for each representative species, assuming that exposure to PCBs is via food only (i.e., not water or sediment). In order to calculate dietary doses, the species-specific information presented in Exhibit G-14 was used.

EXHIBIT G-14 AVIAN MODEL PARAMETERS

SPECIES	BODY WEIGHT (G)	INGESTION RATE (G/D)	INGESTION RATE (KG FOOD/KG BW/D)*
Tree swallow	20.2	35.2	1.74
Common tern	127	77.4	0.61
Osprey	1,500	315	0.21
Mallard	1,100	140	0.13

Note:
* Ingestion Rate (kg food/kg body weight/day) = Ingestion Rate (g/d) / Body Weight (g)
Source: EPA (1993).

Site-specific sediment and fish concentrations for each sub-section in each year of the analysis (1981-2009), along with species-specific dietary information were then used to estimate dietary dose of PCBs.

Tree swallow. Consume insects (EPA 1993). Because site-specific insect data are not available, a biota-sediment accumulation factor of 1.42 (Pickard et al. 2001, Gewurtz et al. 2000, Burzynski 2000, Baron et al. 1999, Froese et al. 1998) was used to convert sediment PCB concentrations (as described above) to insect PCB concentrations.

Mallard. Consume vegetation (EPA 1993). Because site-specific vegetation data are not available, a biota-sediment accumulation factor of 0.12 (Vanier et al. 1999, Richard 1997) was used to convert sediment PCB concentrations (as described above) to vegetation PCB concentrations.

Common tern. Consume fish less than 15 cm in length (For purposes of this assessment and supported by Nisbet 2002). Data from Exponent (2006) and NOAA (2006) was used to estimate PCB concentrations in fish in that size-class.

Osprey. Consume fish greater than 10 cm in length (For purposes of this assessment and supported by Poole et al. 2002 and VanDeele et al. 1982). Data from Exponent (2006) and NOAA (2006) was used to estimate PCB concentrations in fish in that size-class.

Input of these data and parameters into the model resulted in an estimate of the dietary dose of PCBs (mg PCBs/kg body weight/day) for each sub-section for each year of the analysis.

SERVICE LOSSES

Service losses to birds resulting from contamination in the assessment area are estimated by assessing the weight-of-evidence provided by studies in the peer-reviewed literature regarding the severity and magnitude of effects associated with a range of PCB dose concentrations (Exhibit G-15).

EXHIBIT G-15 PERCENTAGE AVIAN SERVICE LOSSES ASSOCIATED WITH RANGES OF PCB CONCENTRATIONS IN DIET

DOSE (MG PCB/KG BW/DAY)	PERCENTAGE SERVICE LOSS	EFFECTS
< 0.5	0%	No effects on sensitive species (Chapman et al. 2003).
0.5 - 1	5%	Effects on reproduction and growth of sensitive species (Chapman et al. 2003, CMOE 2001, EPA 1991).
>1 -2	14%	Effects on reproduction of moderately sensitive species (Kubiak et al. 1989, Tori and Peterle 1983, Peakall and Peakall 1973, Dahlgren et al. 1972).
> 2 - 4	27%	Increased incidence and severity of effects.
> 4 - 7	46%	Increased incidence and severity of effects.
> 7 - 11	83%	Effects on reproduction of less sensitive species (Fernie et al. 2001a, 2001b, Elliott et al. 1997).
> 11	100%	Mortality.

Ecological service losses to avian resources within the assessment area are quantified by using the following steps:

1. For each sub-section, compare the PCB dose for each representative species to the PCB ranges described above and assign the corresponding service loss.

2. Average the percentage service losses for the four representative species for each sub-section.
3. Multiply the average avian service loss per year for each sub-section by the area (acres) of that sub-section.
4. Calculate the present value in 2010 of the lost acres in each sub-section of the assessment area using a three percent discount rate.
5. Sum the present value acres lost over time to estimate DSAYs lost over the entire assessment area.

Annual service losses for each sub-section of the assessment area except the Grasse River from 1981 through 2010 are presented in Exhibit G-16. Service losses are constant every year except for those areas with completed or on-going remedial activities. Annual service losses for birds in the Grasse River are presented in Exhibit G-17. PCB-related service losses estimated in 2009 for each sub-section are assumed to attenuate to zero in about 100 years (2106).

EXHIBIT G-16 ANNUAL PERCENTAGE AVIAN SERVICE LOSS FOR EACH SUB-SECTION OF THE ASSESSMENT AREA EXCEPT THE GRASSE RIVER (1981-2010 UNLESS OTHERWISE NOTED)[1]

ASSESSMENT AREA SUB-SECTION [1]	ANNUAL PERCENTAGE SERVICE LOSS[2]				
	TREE SWALLOW[4]	MALLARD[4]	COMMON TERN	OSPREY	AVERAGE
Moses Saunders/Polly's Gut	NA	NA	0%	14%	4%-3%
Raquette River	46%	0%	0%	14%	15%
Power Canal	27%	0%	14%	0%	10%
Unnamed Tributary - Pre-Remedy (1981-1999)	100%	0%	14%	0%	29%
Unnamed Tributary - Post-Remedy (2000-2010) [3]	27%	0%	14%	0%	10%
Robinson Creek	46%	0%	0%	0%	12%-11%
RMC Remediation Area – Pre-Remedy (1981-2009)	100%	5%	14%	27%	37%
RMC Remediation Area – Post-Remedy (2010) [3]	46%	0%	14%	0%	15%
St. Lawrence River Around RMC	14%	0%	46%	27%	22%
RMC To Ship Channel	27%	0%	5%	5%	9%
GM Remediation Area – Pre-remedy (1981-1995)	100%	100%	46%	46%	73%
GM Remediation Area – Post-remedy (1996-2010)	46%	0%	14%	0%	15%
St. Lawrence Around GM	14%	0%	0%	14%	7%
GM To Ship Channel	14%	0%	0%	14%	7%
Turtle Cove/Creek - Pre-remedy (1981-2005)	100%	14%	100%	100%	79%
Turtle Cove/Creek - Post-remedy (2006-2010) [3]	46%	0%	14%	0%	15%
St. Regis River	NA	NA	0%	5%	1%
Notes:					

ASSESSMENT AREA SUB-SECTION [1]	ANNUAL PERCENTAGE SERVICE LOSS[2]				
	TREE SWALLOW[4]	MALLARD[4]	COMMON TERN	OSPREY	AVERAGE

[1] Avian service losses for the Grasse River are presented separately in Exhibit 4-24 because service losses change over time.

[2] Annual percentage service losses are for each year from 1981 through 2010 except where noted in areas where remedial actions have been completed or are on-going.

[3] Average annual PCB concentrations for Unnamed Tributary, RMC remediation area, and Turtle Cover/Creek post-remedy are estimated based on the post-remedy PCB concentration reported for sediments in the GM remediation area. Average annual PCB concentrations for RMC remediation area and Turtle Cover/Creek post-remedy are estimated based on the post-remedy PCB concentration reported for fish in the GM remediation area. Average annual PCB concentrations adjusted for baseline conditions in the St. Lawrence River, where applicable.

[4] Service losses to avian species with food webs tied to sediment (i.e., tree swallows and mallards) are not included in areas where it is unlikely Facility-related contaminants have come to be located in the sediment (i.e., Moses Saunders/Polly's Gut and St. Regis River).

[5] Average assumes NA = 0% because losses are estimated for the overall bird community; if loss to a species is not included in the damage claim (e.g., St. Regis River), then that species' loss is not incorporated into the overall loss to the avian community. Average may not calculate due to rounding.

EXHIBIT G-17 ANNUAL PERCENTAGE AVIAN SERVICE LOSS FOR THE GRASSE RIVER (1981-2010)

YEAR	ANNUAL PERCENTAGE SERVICE LOSS				
	TREE SWALLOW	MALLARD	COMMON TERN	OSPREY	AVERAGE
1981	100%	14%	100%	83%	74%
1982	100%	14%	100%	83%	74%
1983	100%	14%	100%	83%	74%
1984	100%	14%	100%	83%	74%
1985	100%	14%	100%	46%	65%
1986	100%	14%	100%	46%	65%
1987	100%	5%	100%	46%	63%
1988	100%	5%	100%	46%	63%
1989	100%	5%	83%	46%	63%
1990	100%	5%	83%	46%	63%
1991	100%	0%	83%	46%	57%
1992	100%	0%	83%	46%	57%
1993	100%	0%	46%	46%	48%
1994	100%	0%	46%	46%	48%
1995	100%	0%	83%	46%	57%
1996	100%	0%	46%	46%	48%
1997	100%	0%	46%	27%	43%

YEAR	ANNUAL PERCENTAGE SERVICE LOSS				
	TREE SWALLOW	MALLARD	COMMON TERN	OSPREY	AVERAGE
1998	100%	0%	27%	27%	39%
1999	100%	0%	27%	27%	39%
2000	100%	0%	14%	46%	40%
2001	100%	0%	14%	46%	40%
2002	100%	0%	14%	27%	35%
2003	100%	0%	14%	14%	32%
2004	100%	0%	5%	14%	30%
2005	100%	0%	83%	46%	57%
2006	100%	0%	46%	27%	43%
2007	100%	0%	14%	5%	30%
2008	100%	0%	5%	5%	28%
2009	100%	0%	5%	5%	28%
2010	99%	0%	5%	5%	27%

Note:
Average may not calculate due to rounding.

The percentage service loss per year for each sub-section is multiplied by the acreage of that sub-section, and the present value of these lost acres is calculated using a discount rate of three percent. Results indicate a loss of avian services equal to approximately 29,113 DSAYs (Exhibit G-18).

EXHIBIT G-18 LOST AVIAN DSAYS (1981-2106)

ASSESSMENT AREA SUB-SECTION	LOST AVIAN DSAYS
Moses Saunders/Polly's Gut	866
Raquette River	3,039
Power Canal	659
Unnamed Tributary	70
Robinson Creek	199
RMC Remediation Area	663
St. Lawrence River Around RMC	4,811
RMC To Ship Channel	363
GM Remediation Area	247
St. Lawrence Around GM	4,405
GM To Ship Channel	43
Turtle Cove/Creek	421
St. Regis River	170

Grasse River	13,321
Total	**29,278**

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APPENDIX H: ST. LAWRENCE ENVIRONMENT NATURAL RESOURCE DAMAGE ASSESSMENT PRELIMINARY ASSESSMENT OF EFFECTS OF FLUORIDE ON MAMMALS IN THE ST. LAWRENCE ENVIRONMENT

INTRODUCTION

The purpose of this document is to: 1) summarize information on fluoride in mammals and in fluoride-contaminated media to which mammals may have been exposed in the St. Lawrence Environment Assessment Area,[31] 2) compare these data with literature-based adverse effects information, and 3) develop a preliminary estimate of fluoride injury to mammals as part of the St. Lawrence Environment Natural Resource Damage Assessment.

In order to complete this analysis, the following approach was implemented:

Determine which mammals are found in the assessment area.

Collect, review, and summarize data regarding fluoride concentrations in assessment area mammals and contaminated media to which mammals are likely to be exposed.

Conduct a literature search for relevant toxicological information regarding the effect of fluoride on mammal species relevant to the assessment area.

Develop toxicity reference values for fluoride in mammals.

Compare site-specific fluoride levels in mammals and contaminated media to corresponding toxicity reference values (measured and modeled) and determine exceedences.

SUMMARY OF RESULTS

Data regarding fluoride concentrations in assessment area mammals and corresponding adverse effects thresholds are sparse. More data are available on fluoride concentrations in vegetation from the assessment area. Based on these vegetation data, concentrations of fluoride in forage are sufficiently high to have caused injury to mammals in the assessment area, specifically in the areas north of Alcoa and RMC and on Cornwall Island. For purposes of settlement negotiations, the Trustees have used available data to quantitatively evaluate potential mammal injury due to fluoride in the St. Lawrence Environment as part of the Natural Resource Damage Assessment, resulting in approximately 12,115 lost mammal-acre-years. To compensate for these losses, the Trustees will evaluate the concrete and significant benefits to St. Lawrence Environment mammals provided by restoration alternatives.

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[31] Preliminary assessment of the effects of other contaminants (e.g., PCBs) on assessment area mammals is discussed in Appendix F.

MAMMALS IN THE ASSESSMENT AREA

Over 40 species of mammals have been recorded in the St. Lawrence assessment area (Appendix F-A). These mammals have been described in the July 2005 memorandum, "St. Lawrence Environment Natural Resource Damage Assessment Preliminary Assessment of Effects of PCBs on Mammals in the St. Lawrence Environment."

TOXICOLOGICAL INFORMATION - FLUORIDE

Accumulating mainly in hard tissues, fluoride can cause both lethal and sub-lethal effects in mammals. For example, ingestion of large quantities of fluoride can lead to acute poisoning (Hodge and Smith 1965 in Cooke et al. 1996), indicated by convulsions, collapse, coma, and death. Symptoms of chronic fluoride exposure include dental erosion, bone damage, loss of appetite, stunted growth, reduced milk yield, vomiting, diarrhea, and respiratory, cardiac, and nervous depression (Allcroft et al. 1965 in Cooke et al. 1996). Numerous reviews have described a variety of effects of fluoride in wildlife and domestic animals, including gastroenteritis, muscular weakness, pulmonary congestion, respiratory and cardiac failure, dental lesions, bone fractures, lameness, appetite impairment, poor reproduction, and behavioral changes (Newman 1980, Newman 1979, NAS 1971). In smaller mammal species, accumulation of fluoride in teeth is typically more important than in the skeleton. Cattle and some deer species, however, can suffer fluorosis from accumulation in either teeth or bones.

To determine whether injury to mammals in the St. Lawrence Environment has occurred due to fluoride, published toxicological information, both site-specific and general, was reviewed. Literature is considered appropriate and relevant for this analysis if it meets the following criteria:

- Study focuses on a mammal species found in the assessment area, or a mammal species closely related to one found in the assessment area.
- Study focuses on the effect of fluoride.
- Study documents a body/tissue burden, dose/intake value, or concentration in vegetation and a corresponding adverse effect (measured or extrapolated from empirical studies on test species).
- Study focuses on adverse effects considered biologically relevant, including physiological changes, growth, reproduction, and mortality.

INJURY ASSESSMENT

SITE-SPECIFIC FLUORIDE DATA

In 1977, fluoride concentrations in dogwood (*Cornus spp*.) near the RMC facility were as high as 389 ppm (parts per million) and concentrations in bitternut hickory (*Carya cordiformis*) foliage were as high as 705 ppm (Miles 1981 as cited in Rice 1983). Elevated fluoride concentrations have been measured on unwashed foliage downwind of the Alcoa and RMC facilities in grasses (132 ppm), forbs (249 ppm), basswood (*Tilia*

Americana) (259 ppm), quaking aspen (*Populus tremuloides*) (157 ppm), elm (*Ulmus americana*) (158 ppm), and ash (*Fraxinus spp*.) (367 ppm) (Miles 1981 as cited in Rice 1983). Wild grape (*Vitis spp*.) had fluoride concentrations up to 196 ppm within one mile northeast of RMC and 119 ppm within two miles of Alcoa (Miles 1981 as cited in Rice 1983). In addition, the St. Regis Mohawk Tribe collected data on fluoride concentrations in assessment area plants. Average concentrations of fluoride in vegetation collected from 2000 to 2004 range from approximately 1 ppm to 111 ppm. (Exhibit H-2). Additional data on fluoride in vegetation collected by the St. Regis Mohawk Tribe is shown in Exhibit H-3. Also, the New York State Department of Environmental Conservation reported fluoride data in plants collected near Alcoa and Reynolds ranging from a mean of 17-92 ppm (NYSDEC 1997) (Exhibit H-4).

ADVERSE EFFECT THRESHOLDS

The State of New York established criteria for fluoride in forage for consumption by grazing ruminants (http://www.dec.ny/regs/4146.html). Average concentrations on a dry weight basis shall be less than the following in all levels:

For growing season (not to exceed 6 consecutive months) – 40 ppm.

For any 60 day period – 60 ppm.

For any 30 day period – 80 ppm.

Environment Canada has established identical standards for fluoride in livestock forage. Eight other states also have established fluoride standards for forage.

The published literature also suggests various thresholds for both body burden and dietary intake. These data are summarized in Exhibit H-1. Examples of body/tissue burden thresholds include 10 mg fluoride per liter blood plasma, which may be a reasonable threshold below which adverse effects would not be expected to occur (Cooke et al. 1996). Concentrations of 2,000 mg fluoride per kg dry weight in teeth and 2,500 mg fluoride per kilogram dry weight femur or whole skeleton are also indicative of sublethal effects and shortened life span (Cooke et al. 1996). The small mammal femur fluoride concentrations determined by Miles (1981) and Rice (1983) described above were generally in excess of bone concentrations associated with adverse effects in small mammals, as presented in Exhibit F-1.

There are visible manifestations of fluoride toxicity in plants, including yellowing of the leaf, necrosis and death of portions of the leaf, patterns of leaf discoloration and breaking away of injured tissues. The Ontario Ministry evaluated plant species on Cornwall Island known to be sensitive to fluoride over a number of years in the mid-1970s and early 1980s. Evidence of visible fluoride injury was noted on wild grape, gladiolus, and white pine (*Pinus strobus*), with less significant impacts to wild cherry and Manitoba maple (*Acer negundo*) (Emerson 1978-1982, as cited in Rice 1983).

In terms of dietary thresholds, the concentration of fluoride in grass of 20 mg fluoride per kg dry weight is the threshold above which effects can occur in herbivorous mammals

(Cooke et al. 1996). A concentration of 100 mg fluoride per kg dry weight grass (25 mg/kg/d) caused marked dental fluorosis and has been shown to lead to death after two to three months of dietary exposure in experimental field voles. Mink experienced visible changes in their bones at doses greater than 11 mg/kg bw/d (Shupe et al. 1987), and significant reduction in kit survival at 52.75 mg/kg/d (Aurelich et al. 1987 in Sample et al.1996).

SERVICE LOSS ESTIMATION

The Trustees identified the following service losses to address mammal injury to fluoride**:**

FLUORIDE CONCENTRATION IN VEGETATION (PPM)	PERCENTAGE ECOLOGICAL SERVICE LOSS
0-20	0%
20-40	5-10%
40-60	10-15%
60-100	15-25%
100-187	25-40%
187-300	40-60%
300-600	60-100%
>600	100%

Exhibit H-8 provides supporting data for these service losses. Impacts to mammals, such as weight loss, bone and dental changes (deer mouse), and even fatal intoxication (guinea pig) are noted in the literature within the dietary fluoride range of 20-40 ppm, justifying a five to ten percent service loss for that concentration range. A fluoride concentration of 40 ppm is the concentration in above which dental fluorosis in cattle may be observed. More significant impacts to herbivorous mammals are noted at dietary concentrations ranging from 60-100 ppm, including dental lesions in voles and mortality in rabbits and field voles, justifying a 15-25 percent service loss for mammals exposed to these concentrations of fluoride in their diet. The fluoride dietary range of 100-187 ppm encompasses studies with significant impacts to mice and voles (dental fluorosis, arched backs, mortality), as well as the maximum concentration allowed to sustain breeding in mink (135 ppm). Dietary concentrations between 300-600 ppm cause severe dental lesions and mortality in field voles. Substantial and rapid mortality in field voles was noted at dietary concentrations greater than 600 ppm.

GEOGRAPHIC SCOPE

There are two sub-sections within the assessment area that data indicate have been contaminated with fluoride from the Alcoa and RMC facilities, including an area near Alcoa and an area near RMC. The aerial extent of these areas is calculated based on the estimated size of contaminated air plumes and associated deposition. The Alcoa area is estimated to be 1,358 acres; RMC is estimated to be 1,071 acres. Alcoa and RMC polygons were estimated by evaluating fluoride vegetation data from 1977 through 2004. Data points with fluoride concentrations in excess of 20 ppm were assumed to be influenced by fluoride emissions and data points with fluoride concentrations generally less than 20 ppm were left outside of the polygon. The wind direction in the vicinity of the two plants is predominantly (but not entirely) from the west and southwest (Rice 1983), a factor that also influenced the shape of these polygons.

TEMPORAL SCOPE

This analysis focuses on past injury (1981-2007) to mammal resources from fluoride exposure. Data indicate that concentrations of fluoride in vegetation near RMC have declined over time. For example, current concentrations of fluoride in vegetation near RMC are below those that would cause injury to mammals. Average fluoride concentrations in vegetation near Alcoa, however, do not appear to have declined between 1981 and 2004. Because future concentrations of fluoride in assessment area vegetation are uncertain, this analysis does not quantify future injury. This analysis is therefore more likely to underestimate than overestimate ecological losses to mammals, particularly downwind of Alcoa where fluoride concentrations appear to have remained relatively stable over the last five years.

INJURY QUANTIFICATION

The following steps were used to quantify injury to mammals due to fluoride exposure:

Estimate average fluoride concentration in vegetation per year from 1981-2009 for Alcoa and RMC (Exhibit H-7). Data sources include SRMT (2007, 2005), Emerson (1987), Miles (1981) and NYSDEC (1997) (Exhibits 2-6). Where data for a given year are not available, the concentration is estimated as the average concentration of the closest previous and following years.

Compare average fluoride concentration per year to toxicological information and assign service losses. Service losses are estimated based on a linear extrapolation of the fluoride concentration to a percentage service loss based on the corresponding ranges (i.e., rather than assign one percentage service loss to an entire concentration range; see above discussion and Exhibit H-8).

Multiply percentage service loss per year with the acreage for each corresponding area.

Apply a three percent discount rate.

Estimate lost discount service acre-years (DSAYs) in present value 2010. Results indicate approximately 12,115 DSAYs lost from 1981-2009 for mammals. Details are presented in Exhibit H-8.

CONCLUSION

Data are sufficient to quantify past injury to mammals near Alcoa and RMC. Injury is determined based on concentrations of fluoride in vegetation compared to literature-based toxicological information. Approximately 12,115 DSAYs of mammal services are estimated to have been lost due to site-related fluoride contamination. Compensation for these losses will be addressed through restoration.

EXHIBIT H-1 SUMMARY OF LITERATURE-BASED FLUORIDE CONCENTRATIONS AND DOSES AND ASSOCIATED EFFECTS ON MAMMALS

SPECIES	FLUORIDE CONCENTRATION	UNIT	EFFECT	SOURCE
Small mammal	2000	mg Fl/kg dw incisor/ molar teeth	Dental fluorosis leading to reduced food intake and chronic nutritional problems	Cooke et al. 1996
	2500	mg Fl/kg femur or whole skeleton	Dental fluorosis leading to reduced food intake and chronic nutritional problems	
Vole	1866	mg Fl/kg femur	Slight dental lesions - faint horizontal banding of enamel, mottling, increased erosion	
	4619	mg Fl/kg femur	Moderate lesions	
	6175	mg Fl/kg femur	Marked lesions	
	5722	mg Fl/kg femur	Severe lesions	
Field voles	25	mg/kg/d	Dose contaminated grass, moderate-marked dental lesions	
	3022-3883	mg Fl/kg tooth	Dose contaminated grass, moderate-marked dental lesions	
	3201	mg Fl/kg femur	Dose contaminated grass, moderate-marked dental lesions	
Sheep	232	mg Fl/kg forage	Decreased blood levels of copper and calcium, lowered values of packed cell volume (PCV) (grazing 2 years)	Mehdi et al. 1978
Rat	150	mg Fl/L drinking water	NaFl, 75 days, decreased hemoglobin 95.5% of controls, decreased incorporation of iron into red blood cells and spleen, increased iron incorporation into liver and bone marrow	
Mouse	500	mg Fl/kg diet	Arched backs, death after 8th week	
	125	mg Fl/kg diet	Depression, emaciated, dehydrated, arched backs, mottled incisors	
Mouse	200	mg/L NaFl solution	Toxic effects on reproduction of female mice and development of fetal and newborn mice	Qing and Zicheng 2003
Mouse	17.3	mg Fl/kg bw	Decreased RBC	Pillai et al. 1989
	5.2	mg Fl/kg bw	Decreased hemoglobin	
Deer mouse	38	mg Fl/kg diet	Net loss of weight, proportional to amount of fluoride consumed, dental disfigurement, structural bone changes, mineralization of	Newman and Markey 1976

SPECIES	FLUORIDE CONCENTRATION	UNIT	EFFECT	SOURCE
			tendons	
	1065	mg Fl/kg diet	Mortality after 9 weeks	
	1355	mg Fl/kg diet	Dental disfigurement, structural bone changes, mineralization of tendons	
	1936	mg Fl/kg diet	Mortality after 2 weeks	
Deer mouse			Note: Prolonged absorption of fluoride causes enlargement of long and flat bones of animals (e.g., 5-8% enlargement	Newman and Markey 1976
			Note: Elongation/shortening of incisors (reverse), lead to impairment of feeding ability	
			Note: Fluoride causes changes in jaws and teeth of neonatal mice	
Mouse	46	mg Fl/kg bw	Mortality = 20%	Pillai et al. 1987
	49	mg Fl/kg bw	Mortality = 40%	
	51	mg Fl/kg bw	Mortality = 20%	
	57	mg Fl/kg bw	Mortality = 50%	
	60	mg Fl/kg bw	Mortality = 80%	
	51.6-54.4	mg Fl/kg bw	LD50	
Mink	2.48	mg Fl/kg bw/d	Diet = 7-8 months	Shupe et al. 1987
	4.75	mg Fl/kg bw/d	No visible effect	
	11.93	mg Fl/kg bw/d	Visible changes in bone	
	30.75	mg Fl/kg bw/d	Visible changes in bone	
	50	mg Fl/kg ww	Recommended maximum ingestion for breeding mink	
	135	mg Fl/kg dw	Recommended maximum ingestion for breeding mink	
Voles	80	mg Fl/kg dw vegetation	Mild dental lesions	Boulton et al. 1994a
	187	mg Fl/kg dw vegetation	Moderate to marked lesions, erosion of the cutting edge and grinding faces, cavities, etc.	
	549	mg Fl/kg dw vegetation	Marked to severe dental lesions, gross erosion, etc.	
	1169	mg Fl/kg dw femur	Mild dental lesions	
	5008	mg Fl/kg dw femur	Moderate to marked lesions, erosion of the cutting edge and grinding faces, cavities, etc.	
	5649	mg Fl/kg dw femur	Marked to severe dental lesions, gross erosion, etc.	
	988	mg Fl/kg dw incisor	Mild dental lesions	
	2530	mg Fl/kg dw incisor	Moderate to marked lesions,	

SPECIES	FLUORIDE CONCENTRATION	UNIT	EFFECT	SOURCE
			erosion of the cutting edge and grinding faces, cavities, etc.	
	3466	mg Fl/kg dw incisor	Marked to severe dental lesions, gross erosion, etc.	
	716	mg Fl/kg dw molar	Mild dental lesions	
Voles	3172	mg Fl/kg dw molar	Moderate to marked lesions, erosion of the cutting edge and grinding faces, cavities, etc.	Boulton et al. 1994a
	4060	mg Fl/kg dw molar	Marked to severe dental lesions, gross erosion, etc.	
White mouse	117	mg Fl/kg bw	12 weeks, no effect	Boulton et al. 1995b
Wood mouse	152	mg Fl/kg bw	12 weeks, no effect	
Field vole	580	mg Fl/kg bw	8 weeks, 100% mortality	
Bank vole	390	mg Fl/kg bw	Rapid loss of weight and physical condition, diarrhea and subsequent thirst	
Small mammals			Note: Increased severity of dental lesions with increased Fl concentration	

EXHIBIT H-2 AVERAGE FLUORIDE CONCENTRATION IN PLANTS IN THE ASSESSMENT AREA 2000-2004 (SRMT 2005)

LOCATION/YEAR	GROWING SEASON AVERAGE (PPM FL)	LOCATION	GROWING SEASON INFO PLOT (PPM FL)
(1) Wilson Hill Refuge - Background		(1) Wilson Hill Refuge	
2000	1	2000	1
2001	1	2001	1
2002	2	2002	2
2003	1	2003	1
2004	3*	2004	1
Site Average	2	Site Average	1
(2A) Love Farm - NYSDEC Regulatory		(2A) Love Farm	
2000	2	2000	3
2001	2	2001	5
2002	2	2002	2
2003	4	2003	2
2004	1*	2004	4
Site Average	2	Site Average	3
(3A) North of Alcoa - Informational		(3A) North of Alcoa	
2000	14	2000	37
2001	48	2001	249
2002	51	2002	116
2003	28	2003	46
2004	36	2004	108
Site Average	36	Site Average	**111**
(5A) Massena Airport - NYSDEC Regulatory		(5A) Massena Airport	
2000	2	2000	3
2001	4	2001	4
2002	4	2002	9
2003	5	2003	11
2004	5	2004	5
Site Average	4	Site Average	6
(4A) Donahue Road - NYSDEC Regulatory		(4A) Donahue Road	
2000	3	2000	2
2001	2	2001	4
2002	3	2002	3
2003	2	2003	5
2004	4*	2004	6
Site Average	3	Site Average	4
(6R) Barnhart - Informational		(6R) Barnhart	
2000	2	2000	3

LOCATION/YEAR	GROWING SEASON AVERAGE (PPM FL)	LOCATION	GROWING SEASON INFO PLOT (PPM FL)
2001	2	2001	7
2002	1	2002	3
2003	2	2003	4
2004	3*	2004	6
Site Average	2	Site Average	5
(7R) Reynolds Site - NYSDEC Regulatory		(7R) Reynolds Site	
2000	2	2000	4
2001	4	2001	11
2002	2	2002	5
2003	3	2003	2
2004	3*	2004	3
Site Average	3	Site Average	**5**
(8S) - Informational		(8S)	
2000	2	2000	2
2001	--	2001	--
2002	--	2002	--
2003	--	2003	--
2004	--	2004	--
Site Average	2	Site Average	2
(9S) - Tribal Regulatory	Raquette R.	(9S)	
2000	6	2000	6
2001	9	2001	5
2002	4	2002	8
2003	4	2003	7
2004	7	2004	21
Site Average	6	Site Average	9

*** Outlier values** not included in seasonal average as each of these values were outside of the 3-Sigma level.

-- indicates no data.

* Growing season average is the average concentration of fluoride in vegetation collected monthly throughout the growing season. These data were used in the injury analysis.

** Info Plot data are from the very end of the growing season.

EXHIBIT H-3 FLUORIDE CONCENTRATION IN PLANTS FROM TRIBAL LANDS (2000-2004) (SRMT 2007 UNPUBLISHED)

LOCATION	# SAMPLES	YEAR	MINIMUM (PPM)	MAXIMUM (PPM)	MEAN (PPM)
Iroquois Village	8	2000	1	22	5.86
	7	2001	3	21	8
	7	2002	3	8	4.82
	7	2003	2	7	4.17
	2	2004	4	4	4

EXHIBIT H-4 SEASONAL FLUORIDE CONCENTRATIONS IN VEGETATION FROM THE ASSESSMENT AREA (NYSDEC 1997)

LOCATION	YEAR	MAXIMUM CONCENTRATION (PPM)	SEASONAL MEAN CONCENTRATION (PPM)
Alcoa Sites (D2, D2A,D2B, D16, D16B, D17)	1989	119	38
	1990	280	68.5
	1991	262	92.3
	1992	479	70.7
	1993	166	51
	1994	137	52.2
	1995	155	64.2
	1996	290	86.4
	1997	204	69.2
RMC Sites (D9, D15)	1989	242	55.5
	1990	231	45.5
	1991	58	32
	1992	32	22
	1993	92	35.5
	1994	121	46
	1995	31	23.5
	1996	27	17
	1997	81	42.5

EXHIBIT H-5 MEAN FLUORIDE CONTENT OF SELECTED VEGETATION COLLECTED IN 1977 (MILES 1981, AS CITED IN RICE 1983)

SPECIES	ALCOA (SITE S15)	RMC (SITES S4 AND S23)
Timothy	79.3	25.3 (S4)

Kentucky Bluegrass	16	24.1 (S4)
Red-Top	32.7	17.2 (S4)
White Sweet Clover	--	18.4 (S4)
Dogwood	--	389.5 (S23), 36.4 (S4)
Cottonwood	--	24.8 (S4)
Aspen	--	28.5 (S4)
Elm	52	61.8 (S4)
Green ash	--	270.5 (S23)
Milkweed	--	--
Sumac	--	--
Wild Grape	--	--
Basswood	--	--
Mean	**45**	**89.6**
--Indicates no data.		

EXHIBIT H-6 AVERAGE CONCENTRATION OF FLUORIDE IN VEGETATION (PPM) FROM VARIOUS STUDIES CONDUCTED IN THE ASSESSMENT AREA

YEAR	ALCOA	RMC
1972	--	--
1973	--	--
1974	--	--
1975	--	--
1976	--	--
1977	45 [b]	90 [b]
1978	--	--
1979	--	--
1980	--	--
1981	--	--
1982	--	--
1983	--	--
1984	--	--
1985	--	--
1986	--	--
1987	--	--
1988	--	--
1989 [c]	38	56
1990 [c]	68	46
1991 [c]	92	32
1992 [c]	71	22
1993 [c]	51	36
1994 [c]	52	46
1995 [c]	64	24
1996 [c]	86	17
1997 [c]	69	42
1998	--	--
1999	--	--
2000 [d]	14	8
2001 [d]	48	11
2002 [d]	51	15
2003 [d]	28	5
2004 [d]	36	5

Sources:

a Emerson 1987

b Miles 1981 (Exhibit 6)

c NYSDEC 1997

d SRMT 2005 (Exhibits 2 and 3)

EXHIBIT H-7 SUMMARY OF EFFECTS USED TO DEVELOP SERVICE LOSS TO MAMMALS ASSOCIATED WITH FLUORIDE IN VEGETATION IN THE ASSESSMENT AREA

CONCENTRATION (PPM)	SPECIES	EFFECT	CITATION
20	Guinea pig (Davis 1961)	Fatal intoxication	Davis 1961
38	Deer mouse	Weight loss, bone and dental changes	Newman and Markey 1976
40	NYSDEC 6 month Effects Threshold	Forage Guidance Value	NYSDEC
60	NYSDEC 60 day Effects Threshold	Forage Guidance Value	NYSDEC
80	NYSDEC 30 day Effects Threshold	Forage Guidance Value	NYSDEC
80	Voles	Mild dental lesions	Boulton et al. 1994a
100	Rabbit	Mortality	Davis 1961
100	Field Vole	Mortality day 77	Boulton et al 1994a
125	Mouse	Depression, arched backs, mottled incisors	Mehdi et al. 1978
135	Mink	Maximum ingestion for breeding mink	Schupe et al. 1987
187	Voles	Moderate to marked lesions of teeth	Boulton et al. 1994a
232	Sheep	Decreased blood copper and calcium, lower packed cell volume	Mehdi et al. 1978
300	Field Vole	Mortality 28 days	Boulton et al. 1994a
549	Field Vole	Marked to Severe dental lesions	Boulton et al. 1994a
1,065	Deer mouse	Mortality – 9 weeks	Newman and Markey 1976
1,936	Deer mouse	Mortality - 2 weeks	Newman and Markey 1976

EXHIBIT H-8 DISCOUNTED SERVICE ACRE YEAR LOSSES TO MAMMALS ASSOCIATED WITH FLUORIDE IN VEGETATION

YEAR	FL (PPM) ALCOA	% LOSS	LOST ACRES 1358	DSAYS	FL (PPM) RMC	% LOSS	LOST ACRES 1071	DSAYS
1981	*42*	11	143	336	*71*	18	190	448
1982	*42*	11	143	326	*71*	18	190	435
1983	*42*	11	143	317	*71*	18	190	422
1984	*42*	11	143	308	*71*	18	190	410
1985	*42*	11	143	299	*71*	18	190	398
1986	*42*	11	143	290	*71*	18	190	386
1987	*42*	11	143	281	*71*	18	190	375
1988	*42*	11	143	273	*71*	18	190	364
1989	38	10	129	240	56	14	150	279
1990	68	17	231	417	46	12	123	222
1991	92	23	312	548	32	8	86	150
1992	71	18	241	410	22	6	59	100
1993	51	13	173	286	36	9	96	159
1994	52	13	177	283	46	12	123	198
1995	64	16	217	339	24	6	64	100
1996	86	22	292	442	17	0	0	0
1997	69	17	234	344	42	11	112	165
1998	*42*	11	143	203	*17*	0	0	0
1999	*42*	11	143	197	*17*	0	0	0
2000	14	0	0	0	8	0	0	0
2001	48	12	163	213	11	0	0	0
2002	51	13	173	219	15	0	0	0
2003	28	7	95	117	17	0	0	0
2004	36	9	122	146	*5*	0	0	0
2005	*36*	9	122	142	*5*	0	0	0
2006	*36*	9	122	138	*5*	0	0	0
2007	*36*	9	122	134	*5*	0	0	0
2008	*36*	9	122	130	*5*	0	0	0
2009	*36*	9	122	126	*5*	0	0	0
Sub-Total Past Loss (Present Value 2010)				7,502				4,613
Total Past Loss (Present Value 2010)								**12,115**

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APPENDIX I: RANDOM UTILITY MAXIMIZATION (RUM) MODEL FOR THE RECREATIONAL FISHING ASSESSMENT

INTRODUCTION

In developing this restoration compensation determination plan, the Trustees relied, in part, on the results of a model designed to evaluate the role of fish consumption advisories and other fishing site attributes on recreational angler behavior. While the RUM model was described in the main text, this appendix provides additional details regarding the data sources and estimation results.

Recreational fishing RUM models utilize data on angler site choices to determine how they trade off site quality attributes (e.g., catch rates, access conditions, presence of fish consumption advisories) with travel costs. The model can be used to calculate the change in utility (expressed in dollars or in trips "gained" or "lost") that an angler would experience given a change in the characteristics of a fishing site. In this case, the model is used to estimate the losses due to fish consumption advisories on rivers in the assessment area and the gains due to new or improved access to fishing sites.

DATA

FISHING TRIP CHARACTERISTICS

Fishing trip characteristics were obtained from a survey conducted by the Research Triangle Institute (RTI) between June 11, 1991, and May 20, 1992. The survey (hereafter, "RTI Survey") collected data on over 4,000 fishing trips taken between January 1991 and December 1991. The target population for the survey was adult (age 16 or over) outdoor recreators residing in the following five counties: St. Lawrence, Franklin, Clinton, Jefferson, and Lewis (Exhibit I-1). The target population was limited to residents of the five-county region because anglers in these counties are most likely to be affected by FCAs in the assessment area. Typically, anglers travel no more than 25 to 30 miles for a single-day recreation trip (U.S. Department of Interior, Fish and Wildlife Service 1992). Moreover, RUMs are usually limited to single-day trips because it is difficult to estimate the relative importance of site characteristics for multiple-day trips, which often have multiple purposes, include multiple locations, and have idiosyncratic features (Montgomery and Needelman 1997; Parsons and Needelman 1992).

The survey applied stratified random sampling to ensure adequate representation of residents living near the assessment area. The following six geographic strata were used: Village of Massena, remainder of St. Lawrence County, Franklin County, Clinton County, Jefferson County, and Lewis County. Exhibit I-2 shows how the sampling frame was allocated among these five strata.

EXHIBIT I-1 COUNTIES SAMPLED

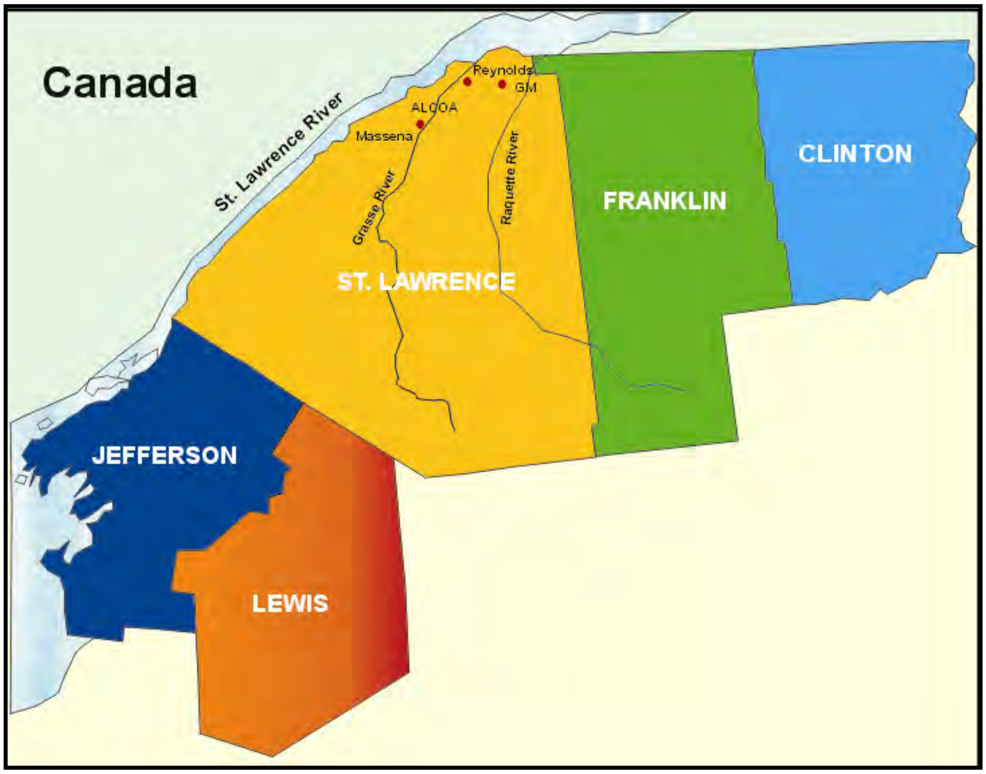


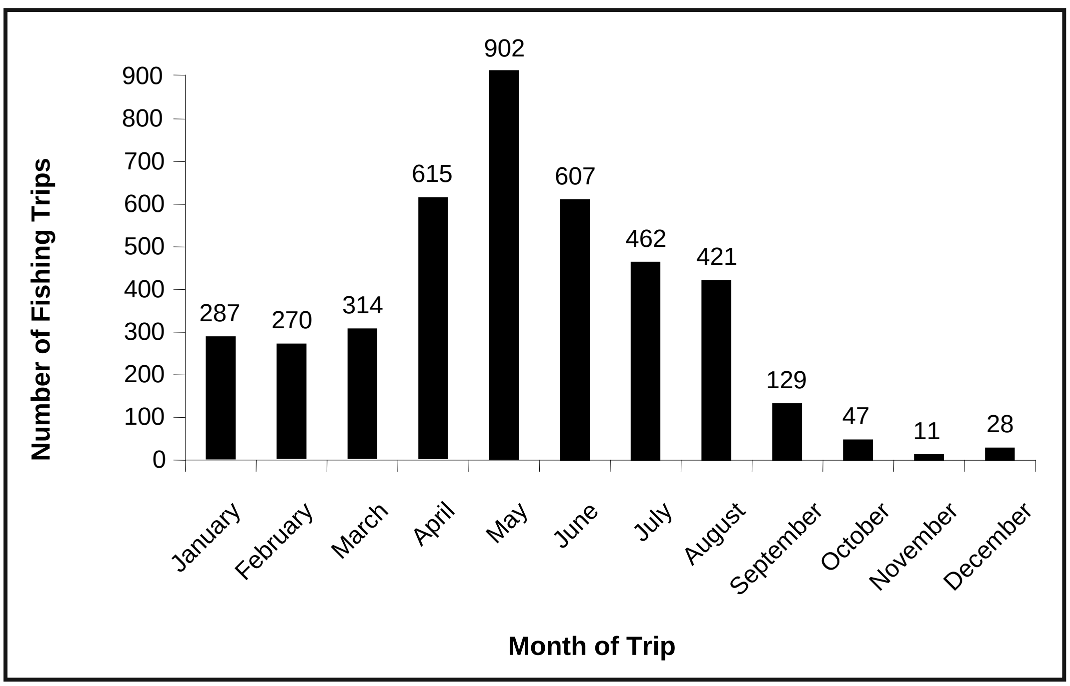
EXHIBIT I-2 SURVEY STRATIFICATION

STRATUM	PERCENT OF POPULATION OF THE FIVE-COUNTY REGION	PERCENT OF THE SAMPLING FRAME
Massena	3.1	37.5
St. Lawrence County besides Massena	26.2	37.5
Franklin County	12.3	10.0
Clinton County	22.3	5.0
Jefferson County	29.1	5.0
Lewis County	7.0	5.0

The survey used a two-phased approach (telephone survey followed by mail survey) to collect information about outdoor recreation. The first phase, a telephone survey, was implemented between June 11 and July 17, 1991. The telephone survey used a random-digit-dialing (RDD) design, which randomly selects telephone numbers within the target population, thus helping ensure that sampled respondents are representative of the target population. The telephone survey collected data on up to five outdoor recreation trips taken in 1991 and also recruited participants for the mail survey. Participants recruited from the telephone survey to participate in the mail survey received trip diaries designed to collect detailed information about outdoor recreation trips taken between June 1991 and December 1991. For fishing trips, this information included fish species targeted, number of fish caught, and number of fish eaten.

A total of 1,565 individuals responded to the telephone survey, including 914 outdoor recreators. The overall telephone survey response rate was 80 percent (calculated as the number of completed interviews divided by the sum of completed interviews, refusals, and non-contacts). Of the 914 outdoor recreators surveyed, 446 provided data on 3,989 single-day fishing trips.[32] These 446 anglers traveled an average of 13 miles one-way per fishing trip. The most popular fishing months were April, May, and June (Exhibit I-3).

EXHIBIT I-3 REPORTED FISHING TRIPS PER MONTH



[32] In an effort to keep the recreational fishing and cultural assessments separate, the recreational fishing assessment omits fishing trips taken by Native Americans in Franklin County.

The average angler is 38 years old and has lived in New York for 34 years. Nearly 40 percent of anglers are female, and over 45 percent are boat owners. The average angler took 9.5 fishing trips in 1991. Of the 3,989 single-day fishing trips reported by anglers, 54 percent were to the St. Lawrence River, 6 percent were to the Grasse River, 8 percent were to the Raquette River, and 32 percent were to other waterbodies.

FISHING SITE CHARACTERISTICS

Fishing sites were initially defined by RTI as part of their 1991-1992 survey effort through a combination of field reconnaissance work, a review of survey responses, and a review of other sources. Each pond, creek, beach, reservoir, and lake is considered a single site, while rivers are divided into multiple sites due to their length. Sites on rivers are defined by partitioning the rivers based on the nearest town or state park visited. In the vicinity of the assessment area, the boundaries between different river sites correspond to the boundaries for the state fish consumption advisories.

Determining the location of a fishing trip reported by a respondent is important for estimating the RUM and calculating potential gains and losses. The trip location affects the characteristics of sites and the estimated relative importance of the site characteristics, such as catch rates and facilities. For example, the exact location of a trip is important for evaluating whether the trip occurred within the assessment area. Survey participants were asked several questions to help identify the exact site of the trip. This approach ensured that multiple sources of information for determining the location of the trip were available to improve the accuracy of the data.

PC*Miler software (ALK Associates, Inc. 2000) was used to determine travel distances. The program generates point-to-point mileage estimates from each angler origin (zip code of residence) to each fishing site (based on latitude and longitude of the town or state park nearest the site). The United States Geological Survey website provided latitude and longitude data. The distances for the model are calculated using the shortest route method, which minimizes the total distance traveled while still following a reasonable route.

Site characteristics in the model included catch rates for various targeted species (walleye, trout, bass, panfish, pike, catfish, and other species), the number of fish stocked, the presence/absence of boat launches, the presence/absence of a fish consumption advisory, and indicators for specific waterbodies in the area. Continuous variables are incorporated in logarithmic form to reflect diminishing marginal utility. The complete set of site characteristics used to estimate the model are presented in Exhibit I-4.

EXHIBIT I-4 VARIABLE DESCRIPTIONS

VARIABLE NAME	DESCRIPTIONS
Catch – Targeted Species	
Walleye	Natural logarithm of average number of walleye pike caught at site plus one
Trout	Natural logarithm of average aggregate number of brook, brown, lake, rainbow, and other trout caught at site plus one
Bass	Natural logarithm of average aggregate number of largemouth, smallmouth, and other bass caught at site plus one
Panfish	Natural logarithm of average aggregate number of perch and panfish caught at site plus one
Pike	Natural logarithm of average aggregate number of northern pike, muskie, and other pike caught at site plus one
Catfish	Natural logarithm of average number of bullhead, catfish, or sucker caught at site plus one
Other	Natural logarithm of average number of no particular type caught at site plus one
Missing Catch	=1 if site has missing catch-rate information for all species and 0 otherwise
Site Characteristics	
Fish Advisory	=1 if there is any fish consumption advisory on any targeted/popular species and 0 otherwise
Access	Natural logarithm of the number of identified access points along any particular site plus one
Stocking	Natural logarithm of aggregate species stocked at site (in thousands) in 1990 plus one
Boat Launch	Natural logarithm of aggregate state-run boat launches at site plus one
Distance	Distance in miles traveled by each respondent from home to fishing site
Travel Costs	= (travel time times one-third wage rate) + (travel distance times 14 to 35 cents per mile)
Assessment Area (AA)	
AA St. Lawrence	=1 if site is along the South Channel of the St. Lawrence River from Snell Lock to the Canadian border and 0 otherwise
AA Power Canal	=1 if site is along the Power Canal and 0 otherwise
AA Grasse River	=1 if site is along the Grasse River from the Power Canal outlet to the river mouth and 0 otherwise
AA Raquette River	=1 if site is along the Raquette River from Raymondville to the river mouth and 0 otherwise
Alternative/Group-Specific Constants	
St. Lawrence River	=1 if site is anywhere along the St. Lawrence River and 0 otherwise
Raquette River	=1 if site is anywhere along the Raquette River and 0 otherwise
Grasse River	=1 if site is anywhere along the Grasse River and 0 otherwise
Private Site	=1 if site is a private site and 0 otherwise
Adirondack	=1 if site is located in the Adirondack State Park and 0 otherwise
Outside Area	=1 for single site that comprise sites outside the five-county area and unknown waterbodies. All these sites were grouped into this one site-indicator variable.
State Parks (SP)	Variables below relate to State Parks visited by respondents
Cedar Point SP	=1 for Cedar Point State Park and 0 otherwise

VARIABLE NAME	DESCRIPTIONS
Coles Creek SP	=1 for Coles Creek State Park and 0 otherwise
De Wolf Point SP	=1 for De Wolf Point State Park and 0 otherwise
Grasse Point SP	=1 for Grasse Point State Park and 0 otherwise
Jacques Cartier SP	=1 for Jacques Cartier State Park and 0 otherwise
Keewaydin SP	=1 for Keewaydin State Park and 0 otherwise
Kring Point SP	=1 for Kring Point State Park and 0 otherwise
Robert Moses SP	=1 for Robert Moses State Park and 0 otherwise
St. Lawrence SP	=1 for St. Lawrence State Park and 0 otherwise
Wellesley Island SP	=1 for Wellesley Island State Park and 0 otherwise
Cumberland Bay SP	=1 for Cumberland Bay State Park and 0 otherwise
Eel Weir SP	=1 for Eel Weir State Park and 0 otherwise
Higley Flow SP	=1 for Higley Flow State Park and 0 otherwise
Point Au Roche SP	=1 for Point Au Roche State Park and 0 otherwise
Westcott Beach SP	=1 for Westcott Beach State Park and 0 otherwise
Whetstone Gulf SP	=1 for Whetstone Gulf State Park and 0 otherwise

RESULTS

The estimation results are shown in Exhibit I-5. The results are generally consistent with expectations. The fish consumption advisory variable is negative and significant, indicating that anglers prefer sites without fish consumption advisories. The travel cost coefficient is also negative and significant, indicating that anglers prefer to fish at sites that are closer to their homes. The stocking variable and all of the catch rate variables (except trout) are positive and significant, indicating that anglers prefer sites that offer greater chances of catching targeted fish. The access and boat launch variables are positive and significant, indicating that anglers prefer sites that offer adequate public access. The Trustees did not have *a priori* expectations regarding the coefficients associated with the state park variables or the remaining site- and group-specific indicator variables. These variables are included in the model mainly to account for unique characteristics of sites/waterbodies and to correct for over- or under-prediction of trips to these locations.

EXHIBIT I-5 ESTIMATION RESULTS

	VARIABLE	PARAMETER ESTIMATE	T-STATISTIC
Catch – Targeted Species	Walleye	0.44	12.27
	Trout	-0.14	-6.23
	Bass	0.17	4.93
	Panfish	0.07	2.78
	Pike	0.14	3.36
	Catfish	0.12	5.27
	Other	0.13	4.34
	Missing Catch	-0.83	-3.76
Site Characteristics	Fish Advisory	-0.29	-3.15
	Access	0.86	20.90
	Stocking	0.23	7.53
	Boat Launch	0.70	11.43
	Travel Costs	-0.18	-75.24
Assessment Area	AA St. Lawrence	-1.12	-5.23
	AA Power Canal	-1.30	-4.15
	AA Grasse River	-0.33	-1.73
	AA Raquette River	0.37	2.35
Alternative/ Group-Specific Constants	St. Lawrence River	0.81	8.63
	Grasse River	-0.22	-2.33
	Raquette River	-0.36	-3.27
	Private Site	-1.21	-14.14
	Adirondack	0.65	7.53
	Outside	2.25	23.02
State Parks (SP)	Coles Creek SP	0.40	3.64
	De Wolf Pont SP	-1.37	-1.93
	Jacques Cartier SP	0.53	3.28
	Kring Point SP	1.18	5.73
	Cumberland Bay SP	-2.91	-4.05
	Eel Weir SP	-1.39	-6.28
	Point Au Roche SP	-0.85	-1.84

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ANTHROPOLOGICAL REPORT

THE EFFECTS OF ENVIRONMENTAL CONTAMINATION ON THE MOHAWKS OF AKWESASNE

Taiaiake Alfred, Ph.D., Theresa McCarthy, Ph.D., and Stella Spak, Ph.D.

September 22, 2006

CONTENTS

Executive Summary

This study provides an assessment of the cultural impacts of environmental contamination at the Akwesasne Mohawk Territory. It is the product of research undertaken under the CERCLA Natural Resource Damage Assessment (NRDA) process to assess the cultural impacts of environmental contamination related to multiple Superfund sites. The study is based on a review and analysis of materials related to the environmental contamination of Akwesasne and subsequent impacts on local cultural practices of the Mohawks of Akwesasne. The major question addressed in the study is this: To what degree have releases of hazardous substances by Alcoa, Reynolds, and General Motors affected the use of natural resources by the Mohawks of Akwesasne, and what impacts has this had on their cultural practices? The materials used were all previously collected and contained in the St. Regis Mohawk Tribe's database, except for a small set of interviews conducted specifically for the project.

Conclusions

Contaminants released into the natural environment definitely include the PCBs Aroclor (1248) and Therminol, polychlorinated dibenzofurans, dioxins, polyaromatic hydrocarbons, fluorides, cyanide, aluminum, arsenic, chromium, and styrene. There is also evidence indicating a probable release of heavy metals, including lead, arsenic, cadmium, chromium, and methylmercury.

The historical baseline set for resource-based cultural practices relative to ecological conditions "but for" the release of contaminants in 1955. Virtually the entire pre-pollution population of Akwesasne, considered in terms of family units, was reliant on traditional resources and resource-based cultural practices. Virtually all activities were cultural practices related to the land, ecosystem and aquasystem of Akwesasne for subsistence at the time identified for the baseline pre-pollution conditions.

Traditional cultural resource practices have survived, but are minimally practices today. Damage to natural resources caused by the release of hazardous substances has severely impaired the cultural uses of resources by the Mohawks of Akwesasne. The release of contaminants into the natural environment has forced Akwesasro:non to drastically reduce traditional resource harvesting activities. As a result, they have, on the whole as a community, been denied the ability to provide their families with healthy foods; denied the ability to fulfill their traditional obligations towards the land, waters, plants and animals; and, denied the ability to pass on practical, theoretical, philosophical and linguistic knowledge of what it means to be Akwesasro:non.

Restoration

The Mohawks of Akwesasne see restoration as the companies taking all necessary measures to restore the natural environment to its pre-industrial condition and to revive the health of the land, the river, the animals, the plants and thus the people, their culture, and their economy.

Overview of Research Method

The work on this study was begun by systematically reviewing and analyzing the materials provided in the SRMT database described below. The materials were organized into different areas of relevance, such as the history of Akwesasne, the history and impacts of the Seaway, the history and impacts of companies, scientific reports on contaminants, old interviews, etc. Once these materials had been extensively reviewed, numerous additional and supplemental academic sources were accessed. The additional sources were selected for their theoretical, ethnohistoric or methodological relevance in order to augment, enhance and further clarify the key interpretive and representational issues and objectives to be emphasized in the Report. Thus, for example, the theoretical anthropological literature on the interface or relationship between culture and environment was consulted (Basso 1996, Ellen 1993; Feit 1973, Freeman 1989; Ingold 1993, 1996; Moran 1990; Pixten et all 1983; Povinelli 1993; Richards 1993; Rivale; Scott 1989; Steward 1955, Tanner 1979) as well as sources on ethnohistory and community based research methods.

On the basis of all the materials accessed, the team decided that additional research was needed in order to address important primary research gaps (noted in previous summary progress reports). Thus a series of interviews were conducted in the late summer and fall of 2005, referred to as the Oral History Project. The interview questions devised for the Oral History Projects were contextualized by the previous overview of SRMT materials, and in July of 2005 the team participated in a two day training session specifically devoted to drafting, testing and reworking the interview questions.

Incorporating input on the Oral History Project from the various parties, including the companies, efforts were made to devise questions that were specifically focused on providing concise demographic information, specific locations of practices, precise timelines and personal histories relative to resource based cultural practices. Efforts were further made to quantify data on socio-cultural impacts that specifically engaged resource use and to separate impacts of contamination from the impacts of the Seaway. All questions were developed in a collaborative setting, with substantial input from community residents and SRMT staff. Interview questions further underwent several intensive sessions of field-testing with volunteers and were drafted approximately five times in order to incorporate the concerns, insights and sensibilities of participants. This process involved the training of community researchers, who in turn contributed invaluable Mohawk linguistic expertise enabling the reconciliation of issues of translation. Their contributions to the reworking of questions greatly increased the intelligibility of interviews conducted in the Mohawk Language. Collaboration with community researchers also brought awareness of the significance of particular linguistic cues, and code-switching instances in language use and their relevance as key socio-cultural impacts relevant to this assessment.

1. CONCEPTIONS OF CULTURE AND IMPACT

Over the last two decades, many anthropologists investigating issues of social change have rejected the idea of culture as a static, bounded entity in which non-Western peoples are contained. As a corrective to objectification and colonial imagining, this is a necessary critique of the concept of culture. Yet, in its conception of group identity as "historically contingent and contested and collective identities as friable, imagined and emergent" (Wilson 2000:21), this conceptual critique risks creating another flat image of the world's peoples by failing to distinguish between peoples that have a long and relatively stable history of cultural attachments, often through connections to specific lands, and others, especially migrant minorities, who do not (Samson 2005:2). It has only been in recent years that anthropologists have, in greater numbers, begun to take up the task of distinguishing between the land-based cultural attachments of Indigenous peoples and those of colonial settler societies and states who occupy and/or exploit their territories.

The refinement of anthropological dialogue on the broader questions of the relationship between humans and the environment, however, has been ongoing since the very inception of the discipline. In this context, anthropological theories of the role of culture in the human-environmental relationship have been historically promoted and discarded for a diverse array of reasons: for being either too specific or too general, too broad or too narrow, too historically based or too contemporary, too insular or too inclusive, too static or too transformative. Engaging in polemical debates about the extent to which culture was determined by environment (environmental determinism) or environments were determined by culture (cultural materialism), much of the theorizing slotted Indigenous peoples into various categories and typologies. Undoubtedly structured by a logic of primitivism, Indigenous peoples have long been labeled as "hunter-gatherers," "pastoralists" or "horticulturalists," and further characterized as "nomadic" or "sedentary" on the basis of simplified approaches to relationships with ecosystems and landscapes.

Currently, the most sophisticated understandings of Indigenous cultures, as expressed and reflected in relation to environments have been advanced by those anthropologists who willingly draw from multiple sources of insight. The disciplines of political science and cultural studies have produced complex analyses of power which can help explain why Indigenous peoples and settler societies see the same environment so differently (Alfred 1995; 1999; Tully 2000). Expanding literature on indigenous human rights has helped to situate localized experiences and realities more globally, and reinforces crucial linkages between the maintenance of cultural diversity and the protection and preservation of the world's remaining biodiversity (Maffi 1999; Shiva 2000). And perhaps most importantly, Indigenous scholarship has challenged anthropology to consider the Eurocentric nature of its interpretive frameworks and inquiries (Deloria 1995; Mihesuah 1998).

For the purposes of this Report, we too have drawn upon multiple sources of insight, alongside anthropology, in developing our approach to "culture," and "cultural impacts." In a broader sense, the most meaningful and appropriate way to approach an understanding of culture is to also reject the more static and reified approaches to it as a fixed assemblage of ideas, customs, beliefs, skills, arts, laws, and economies. In order to dispense with Eurocentric interpretive tendencies, our analysis is not geared exclusively towards enumerating the contents of culture and how it is transmitted. Instead we privilege an understanding of culture that hinges on the everyday practices and processes through which the people of Akwesasne actively express and produce distinct cultural understandings of their territorial environment. Following a directive promoted by Anishnaabe environmental scholar Deb McGregor, we approach culture as not just knowledge *about* Mohawk relationships with Creation, culture *is* the relationship; its locus is *the way* the people relate to Creation (McGregor 2004:394). This will be the basis of, and conceptual framework for, our working definition.

Interestingly, views of culture emphasizing agency, practice and process have become increasingly central to anthropological research that most specifically engages the effects of dispossession/industrial development on Indigenous peoples' relationship to their land-bases and ecosystems. The work of Harvey Feit on James Bay Cree struggles against transnational hydroelectric development projects (2004), the work of Al Gedicks on Anishnaabe struggles against strip mining in Wisconsin (2004), and Elisabeth Povenelli's work with Beyulan women and land rights struggles in Australia (1993), the Ngai Tahu of New Zealand, work on cultural redress within their land claim settlement (1996) (www.ngaitahu.iwi.nz) are important examples. Further explanation of the meaningfulness of "place" in Indigenous cultural life, particularly as an index of distinct identities emerging from distinctive relationships between peoples and their environments, has been contributed by several scholars. Fred Myers' research with Pintupi peoples (Western Australia) and "activities of place" (Myers 2002:106), and Keith Basso's insights on how the "sensing of place and the significance that all such related activities and beliefs hold for the Western Apache, constitutes a commonplace, everyday 'cultural activity'" (1996:143) have been highly informative.

With our approach to and treatment of culture established, it is now important to present what it is that we mean when we consider the cultural impacts of contamination and pollution on the Akwesasne Mohawk people. Cultural impacts will be assessed as discrepancies between historically commonplace or everyday cultural practices and shifts or alterations in these practices as they pertain to the *coerced* alteration of Mohawk relationships to the ecosystem and to natural resource usage because of contamination.

Following the guidance provided by Joseph Jorgensen (1995), professor of comparative culture and social science, our assessment framework gives consideration to cultural impacts as "absolute deprivations," the ways in which empirical damage to ecosystems and losses of natural resources affected the normal and conventional (i.e. culturally specific) means of harvesting and distributing those resources. We will also include consideration of the effects of contaminants on cultural expectations in terms of the discrepancies between what the people had prior to contamination and what they thought they were entitled to in light of cultural traditions. This second set of impacts on cultural expectations are further defined by Jorgensen as "relative deprivations," the negative discrepancy between legitimate expectation and actuality. This includes evaluating the legitimate expectations that Akwesasne Mohawk's have historically maintained about their space and the places within it, about naturally occurring resources, about the organization of subsistence, including harvesting, processing, distributing and consuming, and the ideas and ethics associated with these phenomena. As Jorgenson explains, damage to the environment from pollutants does affect the ordinary and normal expectations of persons. This includes the normal and ordinary ways in which people harvested, distributed and consumed resources, the ways they discussed the effects of change to the space in which they gain their livelihoods, the places of importance within that space, and the consequences to persons in their communities who were unable to provide their own necessities and who counted on relatives and friends to provide wild resources and by-products to them. If culturally defined expectations were negatively affected by pollution, personal responses of grief, dismay, anger, dysphoria and the like are not only evidence of deprivation, but effects of deprivation. Expectations are, to a considerable degree, culturally established. People suffer when their cultural expectations are not met (Jorgensen 1995:7-8).

Thus the report will focus on the commonplace everyday resource harvesting activities of the people of Akwesasne. It will document the extent to which these expressions of culture through practice have been damaged by the release of hazardous substances into the resources depended upon for these practices. In so doing, we will establish a baseline of what these activities were prior to the release of pollutants and show how they informed the peoples sense of self, their relationships to each other and relationship with the ecosystem they depended upon. We will then move forward in time and examine the extent to which these expressions of culture and identity through traditional resource harvesting practices have been impacted and/or changed through the release of hazardous substances, rather than as a result of natural adaptations and changes in culture, and answer these questions: Can culturally established expectations of resource harvesting and distribution still be met? How have these changes affected the cultural continuity of the people of Akwesasne?

2. HISTORICAL AND CULTURAL OVERVIEW

a) Pre-Industrial History of Akwesasne

This section of the report is intended to present a briefly synthesized history of the cultural development of the Mohawks of Akwesasne, from the foundation of the community to the period prior to industrialization of the region. This overview will highlight and contextualize historically the multi-dimensional roles that relationships to land, ecosystems and riverine environments have played in the dynamic development of environmentally based cultural practices that have been integral to the Akwesasne Mohawk's continuity, subsistence, survival and autonomy.

According to scholars Donald A. Grinde and Bruce E. Johansen, "for three millennia of human occupancy, the site the Mohawks call Akwesasne was a natural wonderland; well watered, thickly forested with white pine, oak, elm, hickory, and ash, home to deer, elk and other game animals. The rich soil of the bottomlands allowed farming to flourish" (Grinde & Johansen 1995). As a community-settlement, Akwesasne itself is older than the United States and Canada, although it is forced to deal with both states as well as with various subordinate jurisdictions within them (Frear 1981: 1). Despite the need to recognize these key bases of Akwesasne's ecological, cultural and political distinctiveness, a vast majority of historians, ethnohistorians and anthropologists tend to equate the origins of the community almost exclusively with missionary and European influence, interests and activities in the region. Akwesasne has been consistently represented in the written record as a settlement of "Catholic Mohawks," established near the site of a Jesuit mission founded by Father Antoine Gordon between 1747 and 1755. The earliest Mohawk occupants of the settlement are said to be emigrants from Kahnawake who elected to follow Father Pierre Billiard to the area. Reasons given for the emigration are variously associated with resistance to European intrusion and encroachment, refusal to becoming embroiled in colonial conflict and warfare, and a desire to escape the influence of unscrupulous furtraders. The relocation has also been attributed to factional disputes with their Kahnawake brethren over colonial alliances, and the need to flee from recurrent epidemics which continually threatened the population (Bonvillain 2001; Starna & Campisi 2000). In emphasizing the confluence of historical factors of this nature, such characterizations often overlook or elide explanations that foreground the agency and pragmatism of Akwesasro:non cultural ingenuity and practice as situated in the peoples full recognition of the utility, potential, and amenability of the landscape.

Emphasis on missionization and or European influences as the overriding determinant and impetus for settlement at Akwesasne is a reflection of rootedness of historical accounts in problematic Imperialist doctrines of discovery and terra nullius**.** These tendencies have long been criticized by Native people. Jann Day, the managing editor of Akwesasne Notes describes how the NYPA (New York Power Authority) has no Mohawk representation in any of its public relations materials and how offensive the Jacques Cartier-St. Lawrence Iroquois mural by Thomas Hart Benton is in its portrayal of the St. Lawrence River Valley as an empty territory waiting to be discovered and it further glorifies European dominion over the peoples of the St. Lawrence River Valley. (1997:conf.pres**).** Historian Darren Bonaparte contends that, in his exploration of the St. Lawrence in the 1500s, Jacques Cartier actually encountered a large village where the present-day city of Montreal is now located. Memories of the Montreal area constitute an important part of Mohawk oral tradition, as this "northern frontier" was then a prime location for hunting, fishing and trading (Bonaparte n.d:1). With respect to Akwesasne specifically, Bonaparte contends that the territory Akwesasne has long played a role in the lives of the Mohawk people going back thousands of years before Europeans explored the continent, and that oral tradition at Akwesasne transmits community memory that there were already people here long before the first Kahnawake migration occurred (Bonaparte n.d: &4). In an Akwesasne community history booklet printed circa 1944, Elder Ernest Benedict wrote that Akwesasne was settled in the early 1700's because it was known to be a place "where many of our forefathers were buried".

In 1673, Mohawk presence at Akwesasne was recorded in the journal of Count de Frontenac's voyage up the St. Lawrence River to Lake Ontario. He wrote: "…Made three leagues up to noon, and halted at a spot more delightful than any we had yet seen. It as close to the little channel which stretches along the sault on the north side, and opposite the mouth of a river by which people go to the Mohawk [Raquette River]. Sieur Le Moine was sent to examine that which goes to the Mohawks, and reported that it formed a large circular, deep and pleasant basin, behind the point where we had halted, and that the Iroquois whom he had found there, had informed him that there was five days' easy navigation in that river, and three when the waters were lower…", (Hough: 34)

Insofar as these interpretive tendencies preclude consideration of the historic actions, will, and agency of Mohawk peoples in choosing Akwesasne, the ecological characteristics of the region which informed those decisions, and the influences of the peoples' pre-1755 familiarity with the area, such premises reinforce historic analyses in accordance with European principles and ideals. Bonaparte notes that "Mohawk and other native people frequented the region to fish, hunt and trade as evidenced by the diverse archeological remains on the many islands and mainland north and south of the river. Upriver from Akwesasne, natives using the St. Lawrence were compelled to portage around the tumultuous Long Sault Rapids. In times of war this provided enemies with a chance to attack, but in times of peace it usually gave the weary traveler a chance to camp, rest, fish, hunt or trade before moving on" (Bonaparte n.d:1).

Further misconceptions and misinterpretations emerge from Eurocentric interpretive frameworks, particularly in regards to the perceptions of cultural continuity and change. While it tends to be assumed that historically all of the Mohawks residing in the mission villages were Christian, there is evidence that the "Praying Indians" recited a variation of the "Thanksgiving Address," observed the Strawberry, Seed, Harvest, and (according to verbal statements by Ernest Benedict) the Sun Ceremony. They also acknowledged the founder of the Confederacy, the Peacemaker, in one of their hymns (Bonaparte n.d:3). As members of the Haudenosaunee Confederacy, the Mohawks knew the workings of the League and drew on its principles and structure to establish themselves in a new political environment (Bonaparte n.d: 3).

Even indigenous interpretations of European influence on change must be appropriately qualified and tempered, Bonaparte notes. Although the Jesuit priests held considerable political power among these Mohawks, they still maintained their original clan system, wampum protocol, leadership, customs, and language, all of which was incorporated in the new alliance (Bonaparte n.d:2). In modern times the Jesuit missionaries of long ago have become scapegoats for the loss of our pre-contact culture. In some respects they must shoulder some of the blame, but in all fairness to the Jesuits, their efforts to preserve and maintain a Mohawk language (by translating and transcribing scripture, prayers and hymns into Mohawk) and the traditional clan system (by refusing to marry people of the same clan) may have been one of the reasons these aspects of our culture are as strong as they are today. Accounts from the late 1800s indicate that of all the Iroquois people still living in New York State, the native language was strongest at Akwesasne. The Jesuits accommodated the Mohawk language for strategic purposes, and were not as insistent as other missionaries that their converts learn a European language, and they did not promote assimilation with the outside culture. Mission registers in the late 18^{th} and 19^{th} centuries, for example, didn't list non-Mohawk family names when such names were known to exist (Bonaparte n.d:3).

The largely uninterrupted retention and maintenance of the Mohawk language well into the 20th century served to reinforce and affirm Akwesasro:non cultural identity and practices as invested in their relationships with and responsibilities to the land. Mohawk historian Deborah Doxtator, helps to elaborate the conceptual basis of Haudenosaunee culture and identity as being rooted in understandings of land-based and place-based actions and activities:

> The word *otara* in Mohawk means land, clay or earth as well as clan and in asking an individual what clan they belong to (*oh nisen'taroten'*), one is literally asking "What is the outline or contour of your clay?" In a world of clearing and forest both one's father's and mother's clan are important to economic survival since they refer to the land you can access and the territory to which you belong...Land relationships are the basis of understanding clans and political structures. The word otara more vividly embodies the meaning of "clans" as inextricably linked to land (Doxtator 1996: 6).

Similarly the term "nation" refers to a group of people who are connected to one another by sharing or having shared a common territory. In articulating this meaning, Doxtator (1996) refers to the Onondaga term, *tsyakauhwetsya'atta'shu*, or "earth, land be one" used in a nineteenth century version of the traditional story explaining the founding of the Confederacy (Doxtator 1996:6). Specified further, each of the five nations called themselves names which really described their territories. For instance the Seneca call themselves *Nundawaono* or "Great Hill people," the Cayuga *Gayahkono* or "People of the Mucky Land," the Mohawk are *Kanien'kehaka* or "People of the Flint" or "People of the Crystal" (a probable reference to the once surface extensive quartz deposits in the Mohawk Valley).

Doxtator further historicizes and elaborates on how the matrix of Rotinonshonni identity is rooted in place, activity and territory:

> In the nineteenth century the land reserves of a community became the centre which determined an individual's identity. One "belonged" to a particular reserve land area and community list of members. This in keeping with previous Rotinonshonni patterns of determining identity as being connected to a particular place. Villages or clearings, and one's clan lands had always played an important role in determining one's identity. For a Rotinonshonni individual in the seventeenth and eighteenth centuries, exile from the clearing, the usual form of punishment for behaviour destructive to the community, robbed that individual of a large part of their identity and security for survival. This local-community based focus of identity underlay the socialization of captives adopted into communities. In the seventeenth century entire village remnants of Huron were adopted into the Seneca and Mohawk nations and became respectively Senecas and Mohawks by virtue of living at the particular villages to which they were taken...Before the nineteenth century the Rotinonshonni people had great national diversity

among their clans. The biological lineage of individuals in the centuries prior to 1800s was not as important as the physical presence of the person sharing the common land of the community (Doxtator 1996:54).

In Rotinonshonni thought, an individual without a community and land base with which to belong was "socially dead." For a nation not to have people organized into communities with which to maintain control over territories was to be "no longer a people..." Without people in clans to connect with and use the land, the nation would cease to exist. In many ways the land, its nature and the kinds of relationships that the people had with it, influenced the social organization of Rotinonshonni people (Doxtator 1996:55).

The historical name of Akwesasne referred to the rapids of the St. Lawrence and the pounding of the grouse (partridge) on logs during mating season, hence the designation "Akwesasne: Land Where the Partridge Drums" (Martin 1999:3). The river, known by the Mohawks as *Kaniatarowanenneh*, translates from the language to mean "the majestic and magnificent river" (Sunday 1996:1). It provided the people of Akwesasne with abundant resources from its greatest depths to its shallowest marshes. Located at the confluence of the St. Lawrence, the Salmon River, the St. Regis River, the Grasse River and the Raquette River, the territory provided a rich ecosystem that propagated a myriad of land based, river based, river valley based and marshland based cultural practices upon which the people relied for their sustenance and self-sufficiency, and around which culturally distinct knowledge systems and ideologies developed and evolved. In the Mohawk language, the place names marking various locations and junctures on the land and riverine environment are themselves indices how Mohawks have inscribed the territory with meaning in ways that clearly encode the regions environmental and cultural character and geography. For example, the mouths of the Grasse River or *Nikentsiake*, "where the fish live," is so named since formerly it was possible to catch salmon and other large fish in the Grasse; the *Nihanawate*, "Rapid River" and the Raquette does indeed flow swiftly over a number of rapids although today it is checked by a number of power dams (Frear 1981:1). Writing in 1947, well known local historian and culture carrier, Aren Akweks, otherwise known as Tehanetorens or Ray Fadden, assembled a list of phonetic translations for Mohawk names of places that have long been relevant to their culture. Hogansburg or *Tekaswenkarorens* is "where they saw boards," Malone or *Tekanotaronwe* is "a village crossing the river," Montreal or *Tiotiake*, is "deep waters by the side of shallow," Cornwall Island is *Kawenokowanene* or "big island," Massena village or *Nikentsiake* is "full of large fishes," Black Lake or Lake *Otsikwake* is "where the ash trees grow in big knobs," Barnhart's Island is *Niionenhiasekowane* or "big stone," Isle au Rapid or *Tiehonwinetha* is "where the canoe is towed with a rope," Moira or

Sakorontaekehtas is "where small trees are carried on the shoulder," and Brasher Falls or *Tiohionhoken* is "where the river divides" (1947:20).

None of this is meant to imply that over the course of history, and specifically in the context of accelerating European interaction within the territory, that land-based cultural practices, knowledge and ideology remained static and unchanging. Rather, it is precisely because of the Mohawk cultures inherently dynamic nature and capacity for adaptation that resilience and continuity were better assured. Ethnohistorian Laurence Hauptman confirms that Mohawks have always been "a highly adaptable people" and praises their ability to adjust to "rapid economic change for four centuries." He goes on to specify how:

> In the seventeenth and eighteenth centuries, they adjusted to the coming of the fur trade. Their great prowess as canoemen led British and Canadian explorers of the Arctic and Africa to recruit their help in the nineteenth century. Many worked as timber rafters running oak and pine over the Lachine rapids, while others became farmers and dairy men in the same period. Some Saint Regis and Caughnawaga Mohawks were the first Indians involved in the traveling circuses and medicine shows of the late nineteenth century. Because of their early exposure to bridge construction from the 1870s onward, Mohawks to this day are internationally famous as ironworkers. This skill in high steel has led Mohawks to seek employment in cities, to make adjustment to the urban life, and to play key roles in the Indian communities of Syracuse, Rochester, and New York City (Hauptman, 1986: 135).

In summation, it is fair to say that the Mohawks who have resided in this area have had to be adaptable, as colonial contact history for the Mohawks is a history of conflict. Consider that the St. Regis Mission, originally established in 1755, was intended to draw the Mohawks into alliances with New France as military partners (Bonaparte, March 25, 2005). Of course, the French were not the only newcomers to realize the importance of military alliance with the Mohawks. The British also competed for Mohawk favor, and the war between the two European powers inevitably drew the Mohawks into combat. When the so-called French and Indian War broke out, Mohawks actually found themselves fighting other Mohawks (Klink & Talman). Demonstrating their adaptability, following the British defeat of the French in 1760, the Mohawks who had fought alongside the French (as well as France's other Indian allies) had no problem in forging a new relationship with Britain. Unfortunately, this cycle repeated itself with the American Revolution, which saw Mohawks fighting on both sides of the conflict, and again signing various peace agreements with the "victor". Of course, unlike the conclusion of the French and Indian Wars, the Revolutionary War and the later War of 1812-1813 saw both colonial powers remain in Mohawk territory, drawing and redrawing political boundaries, with the Mohawks caught in the middle. This is the origin of the present day divided territory of Akwesasne.

With the Mohawks under constant pressure from two separate colonial governments seeking to consolidate their own power bases, it is no surprise that conflicts continued. On both the Canadian and American sides of the border, attempts to unilaterally replace traditional governance structures with "band" or "tribal" councils resulted in violence, death, imprisonment and coercion of traditional peoples. It should be noted, though, that in both the American and Canadian contexts, the violence was primarily directed towards the Mohawks by policing authorities. With this clearly oppressive political relationship in place, the Mohawks were constantly confronted with new instances of colonial powers usurping land and authority and imposing alien bureaucracy, economic structures, and demands for land usage. The grand plan regarding the Akwesasne Mohawks demonstrated "a clear design to 'make over' the Indians" (Hauptman, 1999:219). As Hauptman notes:

> In 1846 the New York state Legislature enacted a law providing for school buildings and annual appropriations for the education of American Indians on four of the reservations: Allegany, Cattaraugus, Onondaga, and St. Regis. Later, state-administered schools were specifically established at Shinnecock in 1848, Tonawanda and Tuscarora in 1855, Oneida in 1857, and Poospatuck in 1875. One of the first enactments relating to American Indian education, passed in 1856, was entitles "An Act to facilitate education and civilization [emphasis mine] among the Indians residing within this state." The attitudes of school superintendents and educators of Indian children can clearly be seen by examining any report of the superintendent of Public Education. In 1888 William L. Paxon, the school superintendent at Tonawanda, reflecting total cultural myopia about his Seneca charges, advocated "doing away with the system of reservations, dividing up the lands among them, and making them citizens subject to our laws" in order to make his students better educated and to "improve their condition generally" (Hauptman, 1999:219).

The Mohawks, like all of the Indigenous peoples of New York State, were essentially singled out for cultural eradication. The Mohawks of St. Regis were particularly hard pressed, with their population physically and politically divided by the Canada-USA border, with the smaller population attempting to fend off the intrusive policies of various levels of American government.

Further, following the American Civil War, broad policy regarding Indians in New York State was created and administered by the Board of State Commissioners of Public Charities, the same organization designed to administer "poorhouses, institutions for the mentally and physically handicapped, 'lunatic and idiot asylums'", and so forth (Hauptman, 1999:219). This policy-making body was just one in a long line of intrusive government bodies which, without any legal grounding or historical justification, pushed American jurisdiction over almost every conceivable matter deep into the territory and daily lives of the Mohawk people. In essence, "American Indians, the state's first residents, ended up in a quasi-colonial status, dependent on the very people… who were responsible for dispossessing them" (Hauptman, 1999:220).

This dispossession took many forms, the most obvious of which is loss of land as large tracts were either "purchased" in shady swindles, or outright annexed, by both the state and federal governments – consider that the town of Hogansburg was purchased by the state of New York in the 1820s, and that this purchase was consistently challenged by the Mohawks, including a 1938 court action and as well a court case filed in 1982 by the Mohawk Council of Akwesasne and in 1989 by the St Regis Mohawk Tribe and the Mohawk Nation Council of Chiefs. Along with the dispossession of lands came challenges to traditional way of perpetuating culture and engaging in economic practices; it was often very difficult for Akwesasro:non to attend ceremonies and engage in trade across the Canada-USA border, and across other state boundaries. In pointing out the connection between present conflicts and historical events, Hauptman notes that, "It was no coincidence that the issue of free and unrestricted passage across the international boundary… became one of the first major battlefields of Iroquois Red Power. The International Bridge protest by Mohawks on Cornwall Island in December 1968 was a direct outgrowth of the earlier consciousness-raising protests… in the 1920s" (Hauptman, 1988: 206). This is in addition to obvious alterations to traditional lifestyles necessitated by the loss of access to resources along with land, as well as the expansionist jurisdictional policies of the New York State and federal governments, as already noted. The result of these changes in Mohawk circumstances was a necessary shift or transformation in cultural practice. However, it is important to note that the shift in cultural practice did not in and of itself denote a "loss" of culture.

While the incorporation of new concerns and activities subsumed certain aspects of previous patterns, these aspects were never completely replaced or obliterated, but were instead retained and further incorporated into subsequent adaptations. Within this conceptualization of change is the idea that previous patterns are incorporated and retained within the subsequent ones. Change is not replacement but incorporation and subsuming the structures of the past. Change also involves the idea of movement outward and inward around the centre" (Doxtator 1996:61). Furthermore Doxtator states:

In Rotinonshonni thought, change assumes continuity since it is essentially accumulative, continually moving and never "stops" or "freezes" on a certain date. This very movement about place and these cycles of accumulation form the basis of "history" in the Rotinonshonni world, not linkages between finite segments of time as in some European-based concepts of history (Doxtator 1996:64).

Doxtator articulates approaches to history and change inherent in Haudenosaunee traditionalism as cumulative and incorporating. Continuity is maintained as the principles, values and structures of previous teachings are affirmed and reinforced as they are brought forward and incorporated into more contemporary contexts.

As Doxtator states, "by presenting European influences as the central determining element of Rotinonshonni culture change, Rotinonshonni agency in our own history is diminished." She goes on to explain that Euro-North American influences, whether ideological or economic or legal are factors which must be discussed as influences (not solely as determinants) within the larger context of Rotinonshonni cultural traits, worldview and the way in which people related to their lands (1996:11).

Akwesasne community members articulate the dynamic and adaptive nature of land based cultural practices and the accumulation of requisite knowledge as follows:

The close relationship we have with the natural world allowed us to acquire a collective knowledge of it through our life experiences. This knowledge is constantly evolving and is transferred from one person to the next, from one generation to the next. It has its origins thousands of years ago. It is based on observations and practical experiments, in essence, a true science. Medicine people know where to look for certain plant species. Hunters and trappers learn where the animals they seek can best be found. Fisher people know where to find certain species of fish and at what time of year. They all understand that we must maintain a harmony with nature while practicing their lifestyles. Their knowledge is passed on to younger people who become the next generation of medicine people, hunters, trappers, and fishers. Experimentation was done as long as the experiment fit with the natural practices of a given area. If the experiment resulted in harm, then it was immediately dropped (Mohawk Nation Council of Chiefs 1997:5)

Today, the consolidated Akwesasne territory is still situated along the shores of the St. Lawrence River, at the confluence of the Raquette, St. Regis and Salmon Rivers with the St. Lawrence River on land where New York State, the Province of Ontario and the Province of Quebec meet. The reservation lies just east of Massena, NY and directly south of Cornwall, Ontario at a latitude of 44 degrees 56 minutes north. Approximately 22,400 acres in land area (some 14,640 of which are in the United States), Akwesasne also includes over 60 islands.

The region including the Great Lakes and St. Lawrence Valley referred to as the Great Lakes – St. Lawrence basin was sculpted by the Wisconsin Glaciations during the Pleistocene epoch as recently as 15000 years ago. Akwesasne is part of the St. Lawrence lowland physiographic province (also known as the St. Lawrence Marine Plain), which is approximately 200 feet above sea level and is characterized by low, elongated ridges of glacial till and broad, flat valleys abundant with marshland. The St. Lawrence River is an outlet from Lake Ontario (and thus the entire Great Lakes system) and flows northeasterly a distance of 530 miles and a descent of 245 feet to the Gulf of St Lawrence. The reservation lies just a few miles downstream from the Long Sault dam, the Moses-Saunders Power Dam and the Eisenhower Lock, all built during the construction of the St. Lawrence Seaway in the 1950s. With the exception of these projects, the topography of the region has changed little in the past 3000 years (SRMT TC pres n.d).

A summary report from an Elders Research project conducted by ATFE in 1995 helps to illuminate the descriptive context of what Akwesasne was like around the time period of the seaway. This account represents the people of Akwesasne as living independently and to some degree isolated from the massive and rapid changes occurring in North American society. In the 1940s and the early 1950s there were few telephones, few people with electricity, and very few roads. The majority of residents attained only a low level of formal mainstream education owing to the inferiority of the schooling systems made available to residents, and indigenous peoples in North America more generally – yet there were some who attained high school educations, college and university degrees. The primary language of the Territory continued to be Mohawk, with a small number of bilingual speakers of Mohawk and English and many who were multilingual in all of the Haudenosaunee and other indigenous languages. There were a number of people who had some comprehension of the French language, with a few fluent speakers. The uses of English and French seemed to be exclusively related to the conduct of business with neighboring communities. The economic system in place at this time was characterized as primarily a barter system, though a transition to a monetary system was well underway. Money was in short supply in the Territory, and thus it was primarily used for the purpose of conducting business in outside communities, both American and Canadian. Within the Territory, the barter system dominated until the early 1950s (ATFE 1995:10).

The ATFE report goes on to state that around 1950 there were approximately 22 families living on Cornwall Island. The majority of Akwesasne's working population remained involved in historically traditional occupations such as agriculture, farming, hunting, trapping and basketry. It is mainly for these reasons that people are said to have preferred living on the islands. Conversely the mainland continued to be seen as posing significant transportation problems. The river was the only source of year-round local transportation to carry on traditional activities such as fishing, trapping, and medicinal horticulture, although there were roads established at that time and automobiles and horse drawn buggies and sleds, not to mention walking, were popular and dependable seasonally. The cyclical activities of the Mohawks of Akwesasne continued to be intimately tied to the St. Lawrence River system. Trade and trapping would often take residents into the Williamsburg, Brockville and Smith Falls areas (AFTE 1995:10-11).

The Mohawks historic reasons for choosing to remain at Akwesasne can still be heard today in ways that are a direct reflection of the dynamic continuity of cultural knowledge and practice that has lasted over three millennia.

b) Traditional Cultural Practices at Akwesasne

This section of the Report provides an understanding of Akwesasne cultural life in the period before the release of pollutants. Cultural practices will be outlined and their historic roles in the community will be highlighted. The following is a brief overview of the basic ethnographic profiles for each of the interviewees whose commentary, narrative reflections and recorded responses to interview questions comprise the basis of this section. This synopsis is intended to help orient a time frame for cultural practices; the time frame can be confirmed by each interviewee's year of birth, and can be approximated further in the subsequent section on "Remembering," where interview excerpts and narratives focus on the period when each interviewee was a child or was growing up. Information relevant to time frames and practices can be further deduced from information about the activities of parents, relatives or neighbors, who were adults or elders during the time period of each interviewee's recollections. This synopsis provides a clear preliminary indication of how the interviewees, along with family members and neighbors, supported themselves and each other while making their livings prior to industrialization in the region.

Interviewee #62 was born in 1936, and grew up in *Tsi Snaihne* along the St. Lawrence Channel. His father was a hunter, a fisherman and carpenter. References are also made in the interview to his father trapping muskrats. Interviewee #62's mother was a basket maker, who also worked in the garden, and raised farm animals. Some of his neighbors were basket makers, most were "good farmers." Some worked in the forests as "shanty men" or did ironwork or road construction.

Interviewee #63 was born in 1938 and grew up in *Tsi Snaihne* until he was 8 years old. His father was a lumberjack, but the family moved to Syracuse when lumber extraction became mechanized. His mother was a basket maker, and the family returned to Akwesasne in the 1950s for farming. The interviewee's grandfather was also a farmer in the territory and all neighbors were described as farmers and basket makers.

Interviewee #32 was born on St. Regis Island in 1932. She stated that she knew everyone on the island where she was born and raised. All of the 15-20 families residing there made their living by subsistence farming. Certain families supplemented their income by fishing.

Interviewee #48 was born in 1944 and named locations she was born in Mohawk: "*Tsi Snaihne* and I lived in *Teiohnohkwanonhnhe* for a long time I grew up on the islands, it was called *Teiohnohkwanonhnhe* (connected islands) and here in *Tsi Snaihne*" (Interviewee #48). She stated that her father mainly used to hunt, and in the fall and spring he would fish also. Her mother made baskets and picked medicines. Her neighbor was a basket maker also.

Interviewee #99 grew up on one of the territory's islands. She states that she knew all the families on the whole island, "*I:non kwi tehonteron* (they lived far apart), *akiron inon teikakwateron tsiniiot tsi ionkwanononsoton*, (I could say the homes were very far apart) cause it was…and ah so *iah ni tekeiare toniiore* (I don't remember how far)" (Interviewee #99). She grew up mainly with her grandmother, who farmed, fished, was a midwife and picked medicines. She described most of the families on the island and her own as reliant on farming and fishing.

Interviewee #91 was born on May 16, 1927. He was raised on a farm on St. Regis Island, where the family remained year round. His mother was a housewife/farmer, and his father had once been an ironworker, but became a full time farmer when the interviewee was still small.

Interviewee #98 was born in 1921 and grew up on State Road. His neighbors were fisherman. His father was a construction worker. His grandmother was a medicine person and his grandfather was a lumberjack.

Like her parents and grandparents, Interviewee #79 was born and raised on the islands. Her father was a veteran and worked at Alcoa. The bulk of her interview deals with a discussion of island living and the associated activities of her extended family and neighbors in multiple areas of fishing, horticulture, farming, basketry, and guiding.

Interviewee #31 was born in 1941 and grew up in a location near the river, on the family farm. His father worked at Alcoa until he received an injury, and the family became dependant on their farm. His neighbor also worked at Alcoa. He describes fishing as a major supplement for his family and neighbors, as well as gathering fruits and nuts.

Interviewee #34 was born in 1934 in *Tsi Snaihne* and grew up there as did her parents. Her father was a construction worker and lacrosse stick maker and her mother was a basket maker. Her family did gardening in the spring and raised animals. Her neighbors were also involved in construction work, basketry and planting gardens.

Interview #72 was conducted with two individuals, born in 1948 and 1949. Both grew up in St. Regis village. One interviewees' mother grew up on St. Regis Island and his father in St. Regis village, the other's father grew up in St. Regis village and her mother in Syracuse. The father of one was a bricklayer and fisherman, and the father of the other was a laborer, the mother a homemaker, and the grandfather a fisherman. Both interviewees related that their neighbors were all fishermen.

Interviewee #33 was born in 1932 and grew up in *Tsi Snaihne*. The interviewee's mother grew up on Cornwall Island and father in *Tsi Snaihne*. His/her father used to work in lumber camps and on farms and he/his mother made baskets. Neighbors made a living through farming and basketry as well.

Interview #74 was conducted with two individuals although only one of the participants indicated his year of birth as 1928, and that he grew up on St. Regis Island. His mother was from Cornwall Island and his father grew up on another of the islands. Both interviewees indicate that their parents and neighbors were farmers and fished as well.

In summation of the ethnographic profiles of interviewees, all of those who indicated birthdates were born between the years of 1921 and 1948. The birth years of three of the interviewees, #99, #79 and #74b were unspecified. Interviewee #99 does indicate that she graduated from St. Andrews convent in the year 1950, so her childhood recollections obviously cover a time period prior to that date. The general contents of interviews with #79 and #74b do convey first hand memories of the time period prior to industrialization, and note post-industry changes to the ecosystem and to cultural practices. With the exception of Interviewees # 72a and #72b, who were born 1-2 years prior to 1950, all other interviewees can articulate first hand experiential knowledge of the land, the riverine environment and related cultural practices prior to the late 1950s.[33]. We will now turn to more expanded excerpts and narrative examples from the interviews to elaborate our historical understandings of Akwesasro:non cultural life prior to the arrival of the companies.

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[33] For a depiction of pre 1950s resource based activities and a characterization of the environment from #72a and #72b, we would have to rely on their recollections of their parents' activities.

Part 1: Remembering…

The following narratives, recorded interview excerpts and examples provide an overview of the environmental character of the territory and prevalent resource- based cultural practices prior to industrialization. This section will expand upon the information conveyed above in the condensed ethnographic profiles. So as not to disrupt the integrity of these narratives, materials are not subcategorized according to the various activities of hunting, trapping, fishing, farming and gathering specifically emphasized in this report. Descriptions of the quality and character of the ecosystem during the pre-industrial time period are also not separated or classified in such a way, with regards to the land, the water or the air. Separating and subcategorizing the information in this section would result in one missing how enmeshed and integrated cultural practices really were. Almost all examples elaborate the interviewees, as well as their families and neighbors multiple engagement with activities involving both the land and the riverine environment. In most cases commentary is contextualized by important characterizations of the ecosystem. In some of the interview question and answer examples (Q/A), ellipsis (…) were used to provide a more coherent presentation of historic land and river based cultural practices.

Like many of the interview excerpts presented below, the following is a response to a specific interview instrument question about how the lands/river was used by the people of Akwesasne in the past:

Q: How did we use the river in the past?

A: For our livelihood mainly, cause we've fished and whatever fish we didn't eat other people ate and so, maybe some people bought and we did a lot of our own gardens and ate whatever we produced…like we used to live off the land before, more…had no welfare back then…We had to live off the land…in my uncles time there, everybody fished, the whole village, a lot of people came and bought fish, after that everything changed….

Q:…you mentioned trapping too. Was that? What were you trapping for?

A: Mostly muskrats…beaver, oh anything…me and my brother used to hunt deer over there…We are so used to living in a certain way, even like I said, when I was growing up my grandfather used to do a lot of gardening and we were used to living from the food that we harvested when I was growing up (Interviewee #72)

Equally important to understanding relationships to land within the Akwesasro:non cultural milieu is a recognition of residents adamancy about their politicized connection to the territory. A connection of this nature ultimately incorporates the ecosystem and resources with which the territory is associated.[34].

It's always been, that is how I grew up, my mother told us that we are the principle owners here. The native people are the principle owners, it's their land base. Ever since I was growing up, that is what we have been told, it's our land, it does not belong to the government. She said, "there are papers, they made agreements, it is written, it is somewhere that it is ours, we were all told that Cornwall is also ours, I never thought I would ever find the papers where it is written that Cornwall was leased for 99 years. They were supposed to release Cornwall in 1811. They should have given it back to us, the native people, that is how long it was leased. That is how I grew up, that is what we were told, it is our land (Interviewee #80)

This rich and compelling experiential narrative of Interviewee #79's childhood emerged in a recorded discussion of her relationship to the land while growing up.

My play was helping out, cutting the grass, pulling weeds from the garden, pulling the garden out, canning, gathering fruits, drying fruits, canning everything that we had in the garden, we would fill up the cellar with all the food we had for the winter….

We never had to buy anything because they always had a way to survive….

Yes our whole livelihood was the river. It was the island, everywhere. I was on Plum Island with my grandmother, my Dad's mother XX and we did all that work to survive. There was lots of things that were to me like the Creators gifts to us; we didn't have to plant fruit trees, we had apple trees, we had all kinds of apple trees there, there was never any bugs…on the island way back, we never had that. We had plums, wild plums. I remember my grandmother and I making plum jam, plum pies, what ever you would plums. We had berries on the island, we went across to Hamilton, so we went across to Cameron's Island, we got more and more berries. I didn't have any fear of the river. I was always rowing the boat, my grandma had the paddles. She would spearhead, that's what they called it and for to buy staples like sugar and flour, we had to go way as far as Summerstown to buy 100 pounds of flour 100 pounds sugar and a gallon of molasses.

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[34] Notably, this is considered a reflection of what anthropologist Leslie Spicer (1971) has called a "persistent cultural system." Spicer contends that, central to Mohawk's well-defined collective identity system, are common beliefs and sentiments associated with specific symbols including treaties, jurisdiction and sovereignty (Spicer 1971: 796; quoted in Starna and Campisi 2000:44).

My grandmother taught me how to row and how to make the boat go sideways so we wouldn't drown, so our boat wouldn't capsize…When it rains we would try hard to get to an island and turn over the boat. The winds would be so strong that we would have to take cover under the boat. After the storm had passed we would then get back in the boat and keep going. Sometimes we would have to hide there for a long time before we got going. It would be a while before we got back to Plum Island. We took a lot of abuse to get what we needed, we had to get the required sweetener for our canning, and flour for our baking. We were always buying all these supplies sometimes it would get wet, my grandmother would get very sad if the sugar got wet, because it would melt. This is how we managed to get around on the river, and there were many times in the early hours of the morning I would stand out there and watch the fish as they swam around. Today you will never experience this sight when you go down to the river. There were no contaminants and you could see, everything was so visible, it was so clear. And I drank that water, I did everything. I still have my washboard up there. I used to wash my clothes, go to the river and wash my cloths, rinse them, hang them on the trees, branches, everything is dry and folded, then I go back up the hill, that's my memento, my washboard, and I have my mother's too up there. Anyway, I didn't know a washing machine until I was almost twenty years old when we got electricity in S. Regis, and the same thing I did at the river there, I washed my clothes down there. My tree is still standing there where I used to hang my clothes, willow tree, been chopped away at it but its still standing there.…(Interviewee #50)

In a manner similar to excerpt above, the following is another coherent experiential narrative account of childhood, Interview #99's in this case. Her narrative engages the salient theme of self-sufficiency, while illuminating particular contours of resource-based cultural practices, skills, and knowledge. Notably, use of Mohawk language was in some instances her only means to convey certain aspects of the ecosystem.

And in those days you know, if you went anywhere you had to go by boat and you had to row. None of this motor stuff you know and taon enskawe*, and in fact a lotta times its mentioned that's why we have diabetes on the reserve. I recall the very first case we had on this reserve…and I think it really had to do with our way of life which was we had, we ate certain foods because you gotta remember we didn't have electricity in those days so we were kind of limited as to what we could eat, because only the foods we could preserve without electricity, without refrigeration could we eat…our main food was pork and fish. It was fish days that's when all Catholics refrained from eating meat on Friday. So everyone ate fish and I remember the fish feed so plentiful and my grandmother would say "lets go down and get some perch" so I'd go with her and what do you call those weeds that grow close to the shore, they're round weeds* onota*, that's what we call them…anyway she'd take some of that* onota *and she'd tie it around the oarlock, we didn't use anchors…and I'd watch the perch down there in the bottom near the* onota*.* To tiken *like this and Grandma she'd be pulling them in.*

Some kind of seaweed but onota ki konwaiats*. They're round, we used to play with it all the time, it grows, its common but I don't know the English name for it…but my grandmother did, every Friday before noon she'd go down there because in those days you served three big meals a day, no coffee breaks either. She'd go down there and she'd bring that perch right in* kna enetsaseroni kna enetsakeritawe*, that's a big dinner and that's how it was…my uncle XXX, he was a fisherman. They were* *very self-sufficient and he did night lines and he put in gill nets and caught a lot of different kinds of fish, sturgeons, great big sturgeon…his fish box was at the same level as the river…and it seems like there were a few times someone used to come and they would take the roe, the fish eggs, the men I think they used to ship them…I remember that sturgeon was on the land and they split him open and I saw all those eggs in there.*

And in fact the water was so clean in those days when we'd row across to Glenwalter cause that's where we'd go to get supplies, a few groceries, like what you didn't grow on your land you had to get it at the store and sometimes we'd go down east a little ways down the St. Lawrence and we'd look at the bottom and there was a skeleton of a ship that sunk there…and you could see the remains of that ship through the clear water (Interviewee #99).

Interviewee #79 provides additional insight into her life on the land and river as a child. The excerpt speaks to freedom, independence and resource-based ingenuity of young people at the time:

Here's another thing, when I was little, well it wasn't just me, it was everybody. We'd go down to the river and we would swim and we wouldn't even go home from morning till night, and how we survived was, we would have cans and we would make a fire and we boil that water, and we'd get all that crayfish, you just pull a rock and you'd find all crayfish and some of them were this long, we'd eat that. We'd eat shell and all, it was so good. It was like eating soft crabs and lobster and all that, it was just like that. Can't do that today …

There are so many things…we always ate too when we were out on the river, when anyone brought to eat, we just ate what was there. I don't know what it is in English, ta-ra-kwi. *Did you ever hear of* ta-ra-kwi, *we used to love that. We'd eat it, it was like dates and I don't see any of it anymore. I periodically go down there and I [get] kinda reminiscent. I walk around and the things I survived on is no longer there* (Interviewee #79).

As in the majority of interviews, Interviewee #91 recalls he and his family's familiarity with a diverse array of resource based cultural practices when he was young:

I think just about everyone had gardens then…My first recollections were when you go down River Road past XXX place there and you go straight towards Snye and you make a sharp left…there used to be a house there, a farm. It was XXX's farm. And those are my first recollections. I guess I must've been five and a half, six years old. And I remember well because the windows were low to the floor and I could stand up to the windows and watch my father and my brother's work out in the fields, and I remember *that…And we moved there to the homestead where my mother grew up…and took over the farm. But in between that time my father always did farming wherever we lived, they had enough land to do farming. And so I always had plenty of exercise with the whole and milking the cows and that sort of thing. Never a dull moment…[And] I remember the fishing, I can remember going to St. Regis when I was a young fella and you could stop at almost maybe every other house and they'd have a fish box on the river and they'd be selling fish. If you wanted a fish from a certain person, you'd go there and they'd have it, if you wanted a particular kind of fish and they didn't have it, they'd tell where to get it, but you don't see that now. I don't think there's anybody that has a fish box in St. Regis where you can go and buy fish* (Interviewee #91).

Alongside referencing several resource-based cultural practices and describing the quality of the ecosystem, this interviewee suggests relevant knowledge and practices as significant to his work as a guide and a lumberjack:

Q: Where were you born?

A: On the reservation. Here. I lived on State road up until about 26 years ago [in 1992], then I bought this river front, right here. Then I built a camp here, a fishing camp. That's how I got acquainted with all the fishermen from St. Regis [lists names]. I got acquainted with all of them, they were all fisherman. Lot of fish here, everybody came here fishing, you know, lawyers, doctors, they all went away happy.

Q: What was it like around here then?

A: Oh it was beautiful, you know the water was clean, St. Lawrence River, you could make tea, coffee, they did, right through the late 50s when the plants opened up…

Q: One of the things you mentioned, the way people eat, they always ate off the land and everything, were people healthier?

A: Oh sure, everybody worked hard. Nowadays, you know everybody takes it easy right! Them days you had to get your own wood and your own, you know enough vegetables to plant to last you all winter, you know. You raised your pork, beef and enough potatoes, eighty, ninety bushels to last you all winter, big family, enough corn to feed your livestock…

Q: When you were young were you concerned about the environment?

A: No it was so good then, yeah nothing wrong with the land and the trees, the forests were all growing. From being in a lumber camp I got to know every tree that was growing in New York State, just bring me a leaf and I can tell you where it came from. The same with herbs I collected through the years, my grandmother used to send me out and get a certain herb. And sometimes I made a mistake, she sent me right back out to get the right one. If I got the right one she was happy and she would tell me what she was going to use it for (Interviewee #98).

This interviewee discusses general historic usage and quality of the river, and his father's knowledge of hunting and trapping practices:

Q: Okay. Around this time period [when you were growing up] how did people use the river and the land?

A: People used to use the river mainly for fishing, like my father used to night line for sturgeon and for perch he used a gill net. And the land was used for gardening. There was nothing wrong with it than. And we used to drink the river water. It didn't affect you to drink it, but now it's become bad. I don't even want to smell it because of the condition it's in…

Q: Do you remember how the river was before they arrived?

A: I know how the river was before the white skinned people opened up their plants. We all, everyone who lived around here use to drink the water from the river and we all ate fish and it didn't affect your health. Now, they're no more good...

Q: Because you know this information did you change your lifestyle as a result?

A: Yes, I did. I worked away from here. If I hadn't left here, there were no other jobs available…Like my father, I would've hunted and had the knowledge to become a fisherman, trapped for muskrats…My father taught me everything, how and where to hunt if I wanted to…

Q: Did you used to lay traps?

A: Yes. I used to trap until about 19..., 1968. I'll guess it was around that period…I'm not certain, but it was around that time when I quit.

Q: What kind of animals did you trap for?

A: Muskrat and mink (Interviewee #48).

Interviewee #48 further relates the knowledge of his grandfather's and his father's generation with regards to hunting, trapping and fishing and the significance of "place:"

They all knew what these areas were called, they respected each others hunting area. Where their night lines were, where they hunted muskrats. They all respected each other, they wouldn't go where your area was. XXX and XXXX they hunted in a certain area. My late father also hunted in a certain area and XXXX, XXXX, …they all knew. XXX, his name was XXXX. He knew and wouldn't go there and nightline in your area (Interviewee #48).

Again an interviewee acknowledges the peoples multiple engagements with a diverse array of resource based activities as integral to survival.

Q: …back then how did we use the river or the land in the past, how do you remember?

A: The land was...most of the land in Snye was used for farming and uh planting...that's, that's what kept us alive through the winter months and uh...nice corn fields, potatoes, tomatoes, you name it they planted it. Even my grandfather...Always had a garden….We lived on, ah, the river a lot too, fishing…I remember when ah, Friday ca..., Friday we never ate meat on Friday, always fish…We go fishing...we'd fish, and me and my mother'd take turns... drag, they call it drag lines.....and my father would row the boat and we'd uh catch good, pretty good sized northern pikes and that's what we'd have, great big fish dinners…

Um, that didn't ha...ah, ah, it wasn't even have to be Friday, just anytime you want.....got hungry for fish, we went out on the river fishing, got some (Interviewee #63).

The interdependency of Interviewee #34's family on cultural practices associated with farming, the river and medicine picking are conveyed in this excerpt:

Q: O.K., how did we use the river or the land in the past?

A: We did gardening in the spring, raised cows and pigs...we got wa..water from the river we swam in the river and we skated on the ice…[Farming] Cause a long time ago you could get your own, fix your own in the fall and have meat all winter, now I guess you can't do that...Unless you go out and buy it.

Q: And which kind of animals is this?

A: We had cows and we had pigs and we had chicken.

Q: Oh yeah, OK, ah...did you use to pick your own medicines?

A: Yeah, my late husband did…And we can't get sweetflag now and golden thread is hard to find. That wa..that used to be around here.

Q: OK, was there changes in ah.. in the medicines themselves? Did you notice any

changes in the sweetflag or how they looked or smelled?

A: They were like tinier an, they're not as...can't sm.., they don't smell as good as they used to.

Q: Uh huh, um, were you told to change the things that you used to do or did you just think it best to change?

A: We just never used it after ah...XXXX couldn't use them anymore.

Q: OK, did you start to feel good or bad by these changes?

A: Feel good or bad? Not...

Q: Uh huh, by these changes that happened.

A: Just that we couldn't get the medicine no more, we use to use a lot on the kids

when they growing up (Interviewee #34).

Prefacing some discussion about medicine gathering practices and medicinal knowledge, Interviewee #99 links the theme of self-sufficiency to health:

And you know on the Island, people there most of them were born at home, we had midwives. My grandmother was a midwife, my aunt was a midwife you know. In fact the other lady down the road was a midwife…so people didn't go to hospitals in those days. In fact the Mohawk word for hospital is what? Tseiakehetaientakwa *(that's where you put dead bodies), so there is that connection to it. And people just took care of their own health. To… medicines, willow tree bark for (fever, painkiller) small cherry branches to increase milk supply of nursing mothers... skunk oil for earaches…* (Interviewee #99)

In this excerpt the interviewee stresses how practices such as fishing and farming were key sources of sustenance, as well as sources of supplemental income. She raises several points about the expertise required with regards to fishing and navigating the river.

Well, everybody on the island had sustenance farming so we had our own food, we grew our own food and uh, our diet was supplemented with fish from the river. A lot of the men uh made that uh, fishing as uh, extra income…there was certain families, there was certain families who uh, supplemented their income by fishing. Not everybody did that…And like what I mean by supplementing their income they *did more fishing than other regular families who spent most of their time with farming. My uncle was one of them, my uncle did a lot of fishing. He used gill nets and night fishing and, and um, what do you call those lines? Night lines…He did that, and he always had a fish box. Whereas my father, they did that once in a while. Most of their income came from the farm. What they grew on the farm and they'd take in the milk and the cream and all that. That was their money.*

Q: Okay. Um, how did we use the river and the, and the land in the past?

A: How did we use it?

Q: Yeah, how do you remember?

A: Well, what I remember is that we didn't have motor boats. Everybody had to row in those days so we, uh everywhere we went uh, we had to row across the river because we were isolated on an island so in order to get off you had to row across the river and we did a lot of walking there was nothing motorized in those days. If you wanted to visit your neighbor at the far west end, you walked, and you walked back. And when we, if we had to go uh, Cornwall well we had to walk all the way to the shore and then we had to row across the St. Lawrence River, and then when we got to Glenwalter we walked the miles to Cornwall to pick up whatever we needed. We didn't go shopping that much because everything we had was supplied on the island…But, we still had to buy materials and maybe farm implements and we walked back and struggled with the St. Lawrence River and then walked back to the house so whatever nutrients we had in our system was worked out very, very fast and there weren't too many overweight people in those days. A lot of, a lot of physical activity.

Q: Oh, okay. Um, okay uh, do you remember while you're still in your younger days do you remember how well the fishing went or the farming, and later do you remember if there was any changes?

A: Well, people were content with what they were making in those days. There was nothing to compare it to. We hadn't yet experienced anything else. So we were complete and happy in our state.

Q: Mm, huh. Okay, um, I'm asking you how did we use to use the environment like the land, the water in the past, how do you see it being used now?

A: Oh my goodness! Well, I'll tell you, I'll tell you what it was like on St. Regis Island. We drank, our drinking water was directly from the St. Lawrence River. And um, we um, we ate fish once a week from the St. Lawrence River. That was part of our diet. And um, I remember on Fridays my grandmother would ask me to go with her and we would just anchor off the shore you know those green reeds that grow? She used to use that and tie it along the oar lock and that was our um, uh, what do you call it, anchor. She didn't use an anchor, she just used a…..and I would watch over the boat and I could see right down to the bottom and I could see the fishes in there and my grandmother would haul the fish in. I don't know if they were perch or bass cause I was young, I wasn't that interested. I just, and she would haul them in and than we could go up and she would clean them and that's what we had for dinner. Supper we always cooked extra in case somebody came hungry (Interviewee #32).

This interviewee discusses the centrality of fishing, along with planting, gathering and the overall quality and character of the river. A place name and the word for "sturgeon" are conveyed in Mohawk:

Q; And you say you planted?

A: Yes. We planted. We had animals, cows, horses, pigs.

Q: During that time, how did people use the river and the land?

A: We used to do a lot of fishing and fish frying. That's how we depended on it. It was our major food supplement.

Q: What about the land? You said earlier you used to plant?

A: We used it for planting, and to gather firewood to heat our home. There was also apple trees and nut trees and we would gather them in the fall.

Q: And this was on your land?

A: Yes. I think about it a lot. On Sunday mornings, my father and my mother would put us in the boat and my father would row and we would be visiting on Cornwall Island at Tekarihwakhenhne *(a location named after the man who lived there). We children would look over the side of the boat into the water and sometimes we would see* Teionakien:tare *(sturgeon) swimming. That's what we would watch. We would watch them and we could see clear down to the bottom of the river. It's no longer clear (Interviewee #31).*

Interviewee #48 relates the fishing expertise of his grandfather, and how these skills more generally provided further economic opportunities for people in the community:

Long Trees was my grandfather. I remember [he] used to ask my mother what kind of fish should we eat this evening, she would say which kind she wanted and he would go out and in a little while he would be back with that kind of fish. He knew where to go to catch a particular type of fish. That's the way it used to be before, there was some good fishing around here. The native people used to guide…For some big name people, they would paddle for them and they would pay very well…(Interviewee #48).

Interviewee #50 talks further about how she was fed by the river as a child, and some of the ways that these resources were prepared:

…we always had to gather wood for our grandmother, we had a woodstove no matter if its June, July or what how hot it got, that wood to cook your food, so we were along the edge of the river and gathering all the drift wood we could, and this great big eel come to the shore. The night before it had been stabbed you know, they go spearing and I guess it got away, it was barely alive. We were so happy we found that fish. We got a stick with a hook and we dragged it back to my grandmothers. My grandmother come out the door and she said, "Whaaa you children, the Creator must have sent this, we can eat again." My grandmother grabbed that fish and she got a big pot of water on the stove, she threw that fish in there right in that hot water, and that skin come off so easy cause I guess that was her method of cleaning. Cause I can clean easy but at that time, that's how she did it, so she cut all the meat off and then she boiled it and she put it in the oven. That was so good, of course we were hungry (she laughs), but it was so good…

Q: were there a lot of people who ate eel then?

Oh yes, we ate everything. That eel was so good, they smoked it, of course they had ways of cooking it and I know all the different ways and I live on that now. I buy fish, its expensive, but that's what I was growing up [with], that's all I want to eat all the time…(Interviewee #50)

Again the historical importance of fishing, and the abundance of this resource are referenced below, along with mention of the botanical ecology of the river. This interviewee did little trapping

and no medicine picking, but did garden:

Q: O.K., how did we use the river or the land in the past?

A: Enn*, everybody used to do a lot of fishing* enn*, and salt it for the winter... And, they grow a lot of their own food, kept their own livestock ...and, ah, there's quite a bit of changes along the river, when I was growing up there was a lot of, ah, bull rushes a... along, right to the edge to the deep part, now they're all gone....*

Q: OK, umm...you were into fishing and farming. Did you ever do medicine

picking?

A: No.

Q: No, uh trapping?

A: Very little.

Q: Very little! OK, when you did trapping, what did, what were you mainly trapping for?

A: Uh, muskrat.

Q: [and about fishing]

A: And, we used to get ah...a lot, a few hundred pounds a night and after that it's, started to go down after that, even the perch, er...were not as plentiful, as they used to be.

Q: OK, umm...what about, umm... did you used to make your own gardens?

A: Yes, I used to put a big garden in every year (Interviewee #33).

With the exception of engaging in medicine picking, this interviewee relates how his family's resource-based cultural practices consisted of hunting, fishing, farming, trapping and basketry.

I grew up on the river. We fished and we drank from it. Around the year 1940, maybe 1942 we fished and drank from it and the water was so good when our boat was afloat I could see approximately twenty feet into the water. I could see the fish eating…I was about six or eight years old when we [father] used to fish together…That was around the time they used to fish more and there was an abundance of fish. When my father was still young he said it was no big deal to catch sturgeon that weighed around one hundred pounds.

Q: Yes. When you were growing up what kind of work did your parents do?

A: My father was a hunter and a carpenter…He knew many different trades. My mother was a good basket maker. She worked in the garden and she also raised farm animals. She mainly raised chickens. We always had food to eat.

Q: Yes. You said your father was a hunter.

A: Yes. Everything he hunted...and they also hunted in the spring. I don't remember what Smiths Falls is called in Mohawk. That's where the hunting grounds were. They would bring home what they caught and salt them. In those days they used to salt them.(laughing) You know that muskrat is good...My father used to say that the muskrat ate the best and that's why the meat was so good.

Q: Yes, and at that time a lot of people still planted? Raised farm animals and planted?

A: Yes. They were good farmers (Interviewee #62).

As Arquette and Tarbell point out, it is often very difficult for non-Native people to understand why environmental pollution results in cultural destruction and community breakdown. They rightfully argue that the only place the people of Akwesasne can be Mohawk is on Mohawk land. This partially explains why the people of Akwesasne have always viewed the protection of their land, air, and water as central to their social, political, economic and religious structures. Subsistence activities are seen as critical not only for economic stability but for the long term survival of Mohawk language and culture (Arquette and Tarbell 2000:99). There are potentially thousands of cultural practices that can be associated with each of the resource-based activities involving fishing, hunting, trapping, medicine gathering, and farming highlighted in this report.[35] All of these practices are linked to the broader ecological contexts of the river and the river valley in which they are embedded. These practices are simultaneously further linked to the relational responsibilities peoples felt towards each other in their shared and mutual reliance on the land and ecosystem.

Thus to maintain resource based cultural practices is to support the continuity of generations of traditional ecological knowledge; the intergenerational transmission of ecological knowledges and practices; the retention of skills, and the development and evolution of resource based technologies along with the language associated with these cultural activities; and the requisite networks of collaborative labour and systems of social organization that constitute resource based cultural practices.

Part 2: Cooperative labor, Cohesion and Reciprocity

Cooperative labor, reciprocity and cohesion were historically strong and integral components of Akwesasne resource-based cultural practices. In the following excerpt, the distinctive nature of

[35] For a brief overview of examples of the multitude of practices that might possibly be associated with the harvesting of one resource, fishing requires experiential knowledge of an enormous array of different species, all information pertaining to fish habitat and its optimal conditions (seasons, time of day, spawning), knowledge and skills related to resource extraction and management, the various technologies associated with spearing, spotting, gill nets, night lines; the maintenance, management, and use of all necessary equipment; the skills associated with cleaning, preparing, storing; how to navigate the river; the topography of streams, shorelines and river beds; the ways in which one engineers, constructs and maintains a fish box, as well as culturally prescribed understandings about the appropriate resource distribution practices. An even more condensed list of practices and practice-based knowledge for working with medicines and medicine-picking could be similarly extended to incorporate a vast array of botanical species, their locations and their broader ecological contexts. This would include knowledge and practices that are not only associated with plants, but with animal products and water as well (and whatever combinations of these resources might be required) along with cultural knowledge and practices for gathering, cultivating, preparing, administering, etc..

cooperative labor and social cohesion was comparatively identified through the Interviewee #32's experience of moving from the island where she was born into the mainland village of St. Regis when she was older:

On St. Regis Island it was a practice over there that you help one another. You were also accepting of each other's uh, imperfection, their flaws. You didn't, you either walked away or, you never start arguments. Now, that was out of necessity because we're all marooned on an island together so we learned to be very patient with one another. That was my observation with my family. Maybe I didn't learn too well because I was very impatient but that's what I observed and because of that there was no exchange of money. That was a big revelation to me moving from the island where there was never any talk about money; money was not important at all but you had to have some you know to buy shoes and clothes (Interviewee #32).

This excerpt historically contextualizes the prevalence of cooperative labor practices with respect to the harvesting, preparation and storage of resources.

Then we used to have bees, where they would start at one end of the island and men would do the slaughtering in the fall, late fall and the women would make blood sausages. They would save whatever was edible from the animal. It was in the late fall tiken eknkwatiniatoahse*, that's what you call it…in the late fall they would do that, they would put the meat in barrels and is what I recall is wooden barrels, not metal, wooden barrels and they would put some kind of salt on it…but that's how they preserved the pork, the meat. They had meat all winter* (Interviewee #99).

Here Interviewee #98 describes how cooperative labor and reciprocity were once well established principles of cultural practice linked to the harvesting and distribution of vital resources:

It was good, good old days. Everybody help[ed] each other about planting corn. I mean white corn and yellow corn to feed people, you know, and chickens. Everybody had two, three cows, some had more…and got our own butter from the milk and cream…ahh the good old days. I keep telling the chiefs let's go back to the good old days, but I guess you can't…

That's why I asked you, lets go back to the old days you know, where you help your neighbors. He's planting and you got a team of horses with a plough, you go over there and plough for a couple of days, or he needs a load of wood and you got the horses, you go after that load of wood…and help that guy with 50, 60 chords pile up [the] wood shed…we'll help 'em load it, like a team of horses and a sled, and we'll help load each other and we'll all leave the convoy…

Interviewee's partner – And we used to have quilting bees, I went to them and all the men would get together and fix the houses (Interviewee #98).

Cooperative labor is described below as a normal and expected seasonal activity linked to harvesting resources; reciprocity with resources for help and energy expended comprised the basis of compensation for assistance.

And also in late summer this man used to come there from Cornwall Island…He used to bring his thrasher from Cornwall Island and he would start at one end of St. Regis Island…and he'd go from farm to farm, he do the island and…in those days there wasn't much money around, you got paid either by a share of the product that you, you know tokiniiot tsi hoteneatkariese*, like they get meat or some grain and I remember that's how they did that* (Interviewee #99).

The following two separate segments from an interview with Interviewee #50 speak to the importance of cooperative labor and resource distribution, while providing an indication of the central role of land and river based cultural practices in the local economy. With respect to her mother, Interviewee #50 states:

My mother, I remember how we used to help one another in the neighborhood with the canning, quilting, they were always helping each other. And on Sundays, when they were cooking, we shared our meals, she would send out food and someone else would send food our way, it was nice then. You never see anyone just going out to buy groceries because they always had food. We were always feasting (Interviewee # 50).

Despite her father's employment at Alcoa, Interviewee #50 further relates how river-based activities continued to anchor both her family's and the broader local economy.

…[my father] worked at the aluminum plant for many years…even though my father was working all the time, we always had a fish box by the river and a lot of people survived from that fish box cause he'd tell them, you know if you're hungry, let them have the fish...(Interviewee #50)

In the following excerpt, Interviewee #32 recalls her sense of others' initially positive reactions to more accessible opportunities for wage employment in the region. Nevertheless, she conveys economic hardships associated with her father's venture into wage-labor employment and how this necessitated her return to the island to live with her grandmother. Again we can see how resource-based cultural practices continued to anchor the Akwesasne economy even when other economic opportunities emerged:

Well, I remember how happy people were to have a job close to home…That's all I remember, I only remember positive things about it in the beginning and people were so happy that they finally have a good paying job close to home. We had power city bus lines that picked up the workers and brought them back and my father got a job in Massena, worked for the village so we started to feel a little more comfortable and then my mother went away too, went to work in Bombay Slipper Factory and then things got a little better at home but in that period of time you know we were so poor. Dad had given up the farm and uh, I remember time when all we had to eat was oatmeal, no sugar, no milk, just plain oatmeal and my parents, I don't know why they didn't think of ways to do it…But we did experience hardship but in that period of time [so] I went back to St. Regis Island to stay with my grandmother…And I saw how she was living, she was comfortable there, she had plenty to eat. Never, never, never had a time where you had nothing to eat. We always had a lot of food. There was, you know, you packed your stuff in the fall, all summer long you gathered your food, your berries, all the different berries, we had big gardens, you had your vegetables, your potatoes and you had your own meat. You had um, chickens, you had turkeys, hogs, beef, and we had milk, cream, cheese, butter, you made your own butter. We had plenty to eat and then you starve to death…. (laughs) (Interviewee #32).

Interviewee #91 relates how a greater sense of cohesion among families and neighbors was an inevitable outcome of people's mutual reliance on resources and on each other. This also helps to enhance our understanding of the scope of Akwesasro:non independence and autonomy in broader terms.

The only time we went away from the house other than to buy stuff was to visit our relatives. And that is something we did a lot more than we do today. We did it a lot. There was a…families were a lot closer when I was a young than they are today, much, much closer. It was when I know almost all of my cousins by name, their ages almost. And my uncles and aunts we used to visit them. We used to go to St. Regis Island, Yellow Island, Cornwall Island. I haven't been to Yellow Island in 40 years. It's a shame we don't get around there like we used to….

That's why I think there was so much neighborliness. There was a need for it. We were mostly stay at home folks that worked for a living from the land. And we didn't traipse around the country and we had more dealings with each other and the idea of helping your neighbor was strong then. Whenever there was help needed it seemed like there was always somebody ready to come and give you a hand. And we would do the same thing that they would do for us. It was a lot of fun. It was a lot of hard work, I got to tell you that, but it was, the atmosphere was nice (Interviewee #91).

To Interviewee #91 the levels of cooperative labor and reciprocity which reliance on resource based cultural practices necessitated, meant that people took better care of each other. This can be contrasted with interview excerpts presented below, where it is noted that movement away from the historic land-based economy and a greater reliance upon money, encouraged an acceleration of outlooks emphasizing individualism.

Q: Was there more respect for elders back then?

A: I think so. At that time the visitation amongst families was much more than it is today, and it seemed like whenever we would go see my grandfather it was a big event. And that would be something to look forward to, like when I would go over to my aunts and uncles…it was a holiday, and they seemed like ancient folks because we were small and they were big and they actually weren't old, but they appeared old. And uh I always had a nice feeling toward old folks and I never saw any of them abused. They weren't abused and their families took care of them and there was a lot of respect for them (Interviewee #91).

<u>Part 3: Resource-based cultural practices and interactions with external economies.</u>

Foregrounding the time period prior to and approaching regional industrialization, this section looks at various historic indications of transformation, change and continuity relative to the integration of resource-based cultural practices with external economic activities. To avoid reductionism in our interpretation it is important at the outset of this section to identify numerous mitigating factors that render economic integration as something other than change that can be assessed solely as "normal" or "organic." In broader discussions of cultural change fostered by European interactions with Indigenous peoples, references to processes of assimilation and acculturation are common. These processes are distinguishable on the basis of varying levels of adaptation or coercion that is implied by each. As a basic definition, acculturation constitutes a merging of cultures as a result of prolonged contact with each other; in essence cultures develop cultural modifications. Assimilation, on the other hand, is an act, process or instance of absorbing a population or a cultural group into another's distinctive cultural traditions.

In characterizing emergent cultural change as reflected by economic integration within this time period, both assimilation and acculturation as expressed in the above definitions are arguably insufficient. This is because the prospects for either, for the Akwesasne Mohawk people to abruptly assimilate or to more organically acculturate, have always been limited. The longstanding expectations that have been placed on the people with regards to assimilation or acculturation have often failed to identify the ironies and constraints which inhibit both of these very processes. Vast inequities in the distribution of power, and the maintenance of these inequities through discrimination, racism and exclusion have continually limited Mohawk participation in external economies on several fronts. These are the very factors that historically made Mohawk participation in more mainstream economic practices unreliable, particularly with respect to trade with external communities and wage labour economic participation. In light of the potential instability of non-community based market economic practices, although community land based activities may be externally perceived as having diminished value, and tend to be de-emphasized in assumptions about wage-labour economy and opportunities, in reality land-based economic practices continued to make crucial contributions to the overall economy and remained a source of stability as external economic opportunities fluctuated. Despite wage employment migration to cities, factories, etc., the land-based practices such as hunting, trapping, fishing, farming, and gathering consistently anchored the local economy and were considered by residents to be the more stable, sustainable, and reliable economic activities even when other choices became available.

Interview materials verifying these arguments attest to the resilience of local land-based technologies and expertise, co-operative labour and distribution of shared resources throughout the eras of emergent wage labour economic opportunities. The following example conveys how the imposition of external political structures (the international border) combined with discrimination, narrowly circumscribed and effectively limited the Mohawk's equitable participation in external trade:

Ista, my aunt, she made baskets…I remember they used to have problems at the border, the baskets, so they would make part of the basket on the island and then they would come across the border with their unfinished product to the American side with the relatives and they would finish their product there to sell, that's how it was. Hard times and it was hard because that was their only source of income. Cause you can't buy material to make a dress, you gotta buy shoes, so you had to have some money and it was hard times for people in those days, and the government did that to us, you know. And even in their trade, trading post was Hogansburg, you had to, he wouldn't give you money, he'd trade you goods [only] (Interviewee #99).

Another interviewee relates a similar situation. Here we can further see how the prescriptive limitations placed on Mohawk participation actually facilitated exploitation and humiliation rather than prosperity and well-being.

I remember my father's mother, I used to help her sell her baskets and it kinda disturbs me now when I think the hard times we had to get rid of her baskets. We would have to hide our baskets way up…the hill that was across the American side, so in the dark we'd wrap our baskets in a blanket, we'd hide. We wouldn't let nobody see it cause there was lots of squealers, so we'd hide our baskets and the next day we'd go pick it up and then we'd walk to Hogansburg…[and that man] would never allow me to get girls shoes, my grandmother would buy me shoes and [they] always had to be boys shoes, this high. I used to cry but he wouldn't let me have girls shoes, he wanted to get rid of them he said, surplus he had to get rid of… Anyway we would get butter, we'd get eggs, we'd get different things and then like all groceries, he wouldn't give her money, we always had to get groceries and for pennies, for those beautiful baskets, for pennies. Any you know one time a lady went in, took her baskets in, you know what McKinnon did, he kicked her baskets, he said " I don't want your baskets, get out of here" (Interviewee #50).

Of those interviewees who did seek employment at one of the companies built in either the pre-Seaway or post-Seaway era, a few recounted that they did not experience any racist and/or discriminatory attitudes or treatment in their personal experiences as employees.[36] The following excerpt, however, provides an example of an individual who did. Notably it is even the potential for such encounters and treatment that can affect the stability and reliability of external wage-labour opportunities.

Q: Yeah, and the people you worked with there [company] like other Onkwehon:we*, or white skinned people, or other people, were they viewed the same way by the company. No one was higher or lower?*

A: The company was known for treating Onkwehon:we *like lower class citizens, like something to wipe their feet on because the* Onkwehon:we *were not mean and they didn't defend themselves.*

Q: Yes.

A: That's how it used to be, however, these days they have much healthier minds.

Q: Yes.

A: They no longer allow themselves to be treated less than (Interviewee #31).

Discrimination with respect to accessing mainstream education is well known given the historic legacy of residential schooling, from which Akwesasne Mohawks were not exempt. Access to mainstream

[36] Interviewee #74 noted that at Alcoa in particular, "we were all treated the same…that's the reason why there was quite a large group of natives working there."

education ultimately correlates with access to the most advantageous opportunities in external wage-labour. In the following excerpt, the Interviewee speaks of the treatment she received when attempting to access mainstream education beyond the level she received at residential school. It is important to note the level of paternalism and mistreatment she is forced to endure in order to obtain the opportunity to advance:

So when we finally finished school in St. Regis, there was only five of us who passed the eighth grade. Two of us went to St. Andrews convent. Oh it was nice, we were well taken care, we were of all cultures, French, Irish, everyone that was there came from different places. I stayed there for a year, but I still wanted to go home because I would get so lonesome. It was lonesome. I told my father, I said I want to be home, I want to leave from home to go to school. So he said, well I'll talk to Mr. Bonna, who was the Indian Agent, he said we'll arrange so you can attend school in Cornwall. Well the Indian Agent wanted to see me, so I went to see him, he said, he talked to me, he said, if you don't go back where we placed you (meaning the convent) your father will have to quit drinking and he will have to pay for your schooling wherever it may be. I never felt so bad, you know its like that when someone says anything bad about your parents. Anyway my father said, Ok I'll pay my daughters way. So he paid and I went to Cornwall and he had to buy my books… my father was able to pay for me to go to school (Interviewee #50).

As evidenced in numerous interview excerpts above, as well as in the ethnographic profiles presented at the outset of this section, despite having parents employed by the companies or despite being employees of the companies themselves, interviewees remained adamant that they and their families were nevertheless primarily dependent on the natural resources, and on their fishing, hunting, gathering, trapping or farming activities. This remains consistent throughout the time period prior to and approaching industrialization in the region. To the extent that Mohawk residents of the territory did attempt to integrate resource harvesting practices with consumerism and wage-labour, the excerpts and summaries below identify relevant activities within the scope of the timeframe when these activities were still considered to be economically viable, before the release and effects of hazardous substances.

Previous interview excerpts have described at length Interviewee # 99 grandmother's proficiency in almost all of the general resource-based cultural practices emphasized in this report. In addition Interviewee # 99's grandmother worked as a domestic wage laborer.

But that's how grandma made extra money…she would hire herself out to do housework in Glenwalter in addition to running a farm and everything else on a farm, she had time to go do housework. Can you imagine? (Interviewee #99)

All of the interviews convey multiple examples of the integration of resource-based cultural practices with the external sale of resources. All of the interviews make reference to either a personal involvement, and/or the involvement of parents, neighbors and/or relatives in the sale of fish as supplemental to income. The abundance of this resource was frequently characterized, as were occasional references to the sale of specific species, particularly sturgeon (and sturgeon roe) and smoked ell either locally in adjacent towns/cities off reserve, or to areas farther away such as New York City. Like fishing, the exchange and distribution of resources associated with farming was a prevalent and consistent historic feature of the local economy. The external sale of dairy products was mentioned more prevalently than the sale of other resources associated with agricultural. The products of gathering activities, including fruits, nuts and edible plants were also common sources of supplemental income. With the exception of two (possibly three) interviews, black ash and sweetgrass gathering activities associated with basketry was also a key source of supplemental income, whether limited exclusively to trade (as in examples above) or sold for a monetary value. The majority of interviewees identified parents, relatives and or neighbors as making a living by basket making. In our data set there were few references to the sale of resources from trapping. Interviewee #33 notes that the rate of exchange on pelts had declined rapidly when he was still young. Save for door-to-door sales within the community of Muskrat, no other examples of the sale of resources from hunting were encountered. We can assume that the bulk of the resources accumulated from these activities were distributed and consumed locally. Four of the interviews #74, #98, #99 and #50 made specific reference to how the skills and expertise developed from fishing also provided a source of income, as residents were occasionally sought as guides by non-native visitors to the territory:

Anyway, the white people used to come over, they were doctors, lawyers, we still have friends today that are still alive. The oldies that used to come there and they would feast on that fish, they'd bring their tents, they'd set up tents there and they'd stay there and my uncles used to guide for fishing, and my grandmother and I, we did a lot of cooking for these special people that wanted a break from the cities and that's where they wanted to be when they wanted to go on vacation and enjoy themselves (Interviewee #50).

In the period approaching the larger scale industrialization of the region, Interviewee #99 noted that greater exposure to wage labour opportunities and a monetary economy, did induce some changes relative to the principles and cultural codes of conduct associated with resource-based cultural practices. As elaborated in this excerpt, her recognition of these changes became most pronounced when moving to St. Regis village where her father got a job:

So when we moved from the island to the mainland, there was a different breed of people in the village. These people in the village no longer had the same kind of empathy for their neighbors, they didn't help each other the way we did on the Island because on the Island we lived very comfortably without money. Money was not a requirement; it was not a goal in life. And it was years later before I figured out why and I think the reason for it was because they didn't have the lands to grow their own food, you know like we did on the Island. So they needed to have money to buy the food you see, so in doing so it changed, gradually changed the people's way of valuing another human being. They didn't pick up your pail and get a pail for you unless you asked them and if you did they had their hand out looking for a nickel, and that's just one example, everything else changed. And I found people in the village so much more aggressive. They were aggressive and they could swear words that I had never heard in my life… but it was like a foreign land, foreign language and foreign people, to me, from the way we were raised. I was nine years old. We came right across the ice… My first experience about people changing is when we moved from the Island. I met the people on the mainland, the village. There was that change, change in the value system. They had different values, where all money became very important from there on. I hate to say but there's been a gradual decline where money has become the most important thing in life, and what money can do for you and what money can buy for you. But it seems like in the last few years I see little glimpses of the old ways coming back, so I always have hope, you know like people are starting to want to move back to the Island, they got their gardens there and things like that, and the ladies they're into quilting, cause that's one of the things, quilting…people are learning how to tap maple trees and we used to do all that. I know how to do all that stuff. So becoming more conscious of what you eat and just general change and I think with that I notice too that more fathers are paying attention to their children than we had before. Fathers are taking a more active role as fathers in raising their children. For a period of time we didn't have that. The fathers, most of them were away working and every now and again they'd take the wives with them. The wives saw how the outside world was, and they started to wish they had this and that, so when they go home they say, "well I want to get a job too," but in the meantime they have children at home, so who takes care of the children you know, the babysitters…but anyway thinks like they maybe we'll get back and I think part of the answer about things getting back to their original value is when we start with our individual selves, when we start to respect ourselves again and demand respect from our children and everything else I believe will trickle down from that so that you will respect what the Creator put on Earth for our use…(Interviewee #99).

It is both indicated in the interviews, and well known more generally, that many of the men at Akwesasne had been participating in the wage labor economy for several decades as ironworkers prior to regional industrialization. This work was and still is largely seasonal and often requires extensive travel and being away from home for considerable periods. Although the per-hour wage for this work has always been comparatively high, this compensates for requisite expenses involving lodging, food and travel. In the period approaching and prior to industrialization, this wage- labor participation generated income that was primarily supplemental, while resource based cultural practices for those who remained in the territory when not working, remained central. This point is not only verified in a number of the interviews, it can also be deduced from proportional estimations which indicated that as much as half of the community was reliant upon fishing as recently as the late 1980s (Ransom 1987).

The upcoming section of this report will examine more concertedly issues associated with cultural change and adaptation by moving into the context of the early history of industrialization. To this point it is apparent that the theme of continuity in terms of cultural practices largely predominates over evidence of wide-spread cultural change or transformation. Despite the integration of wage labor and external economic interaction, traditional resource based cultural practices remain at the core of Akwesasro:non sustenance, livelihood and autonomy. We find that despite external pressures, expectations and other mitigating factors there is little evidence to support change in this time period as any indication of assimilation; in fact resource based cultural practices acted as both buffer and barrier against such processes. Attention to important mitigating factors associated with power, racism and exclusion help us to properly orient our approach to emergent change, as acculturation. This contributes complexity to our assessment of what constitutes change, and how we consider this to be organic or normal. Moreover, when we look at the examples of economic integration and merging, we can appreciate with greater clarity, the distinctiveness and resilience of Akwesasro:non cultural practices.

c) Adaptation and Alteration of Cultural Practices

This section correlates and historicizes evidence of community residents' awareness of contamination. It also presents materials involving the various measures undertaken to engage with the companies, as well as the actions taken in the community in direct response to the presence of contaminants. The issue of the contaminant advisory and the initial phases of community-based "awareness" of precarious changes to the environment are also specifically addressed herein. Numerous interviews indicate that the advisory itself and the awareness of contamination it generated, was not an exclusive determinant of people's recognition of changes to the environment and their impetus to alter resource-based cultural practices. In several cases it was found that because of resource-based cultural practices, the depth and intimacy of people's relationships to the lands, ecosystems and riverine environments were what ultimately informed their initial awareness of contamination, during intervals that predated the advisory. In other specific cases, awareness of contaminants stems from interviewees employment with the companies themselves. Although several interviewees did learn of contamination through various public advisories and media sources, the majority of the community was left to its own devices in seeking out precise information about what exactly contamination meant.

It is crucial to recognize that the people of Akwesasne's awareness of contamination and the development of their understanding of the full weight of its implications on resource-based cultural practices has been emergent, cumulative and a matter of process. Although it might be tempting to attribute "awareness" and requisite changes to practices and behaviors to particular historical moments and events when external information was publicized and disseminated, to do so is to miss and to misrepresent the participation and will of the Mohawk people in actively approaching and engaging with these circumstances. Representing a history of "awareness" that completely hinges on the causal connection between public advisories and their precipitation of immediate changes in cultural practices is to perpetuate several misconceptions and inaccuracies. Foremost among these is the establishment of the misconception that the industries were immediately forthright in revealing all information about their emissions and that they themselves knew and acknowledged the precarious potential of their impacts. This did not happen, and in fact as the oral and written records of the community clearly show, had it not been for the willful and persistent efforts of community members on many fronts, work to address and advance multiple strategies for dealing with and ameliorating these circumstances would not be as far along as they are today. Evidence and an analysis of this direct action as an important facet of the adaptation of cultural practices involving the land, ecosystems and riverine environments are presented below.

Akwesasne Mohawks earliest recognition of environmental contamination can be attributed to multiple sources, each of which played important roles in the development of yet another dimension of the people's collective knowledge base about the land and the environment. And like it had for so many millennia, the land and the rivers themselves were among the first to begin to tell this story, while those who had cultivated a longstanding relationship with this environment were among the first to listen. The following set of four excerpts are illustrative:

Excerpt 1:

Q: O.K., umm, do you remember anything or hearing anything about the river or environment from the time when the companies first built on the river?

A: Well, it's, as I remember, the river started to change to... in the 40's anyway...

Q: Enn hen...

A: ...and uh, about 47 or 49 we noticed that the water was getting dirtier....

Q: Umm, and you worked for a little while at General Motors, I think you said, huh?

A: Yeah, just for 2 weeks (Interview #33).

Excerpt 2:

Q: Yes. You talked about how it was before the plants were built, how people talked about how it was. Did you notice how the changes came about, or did people talk about how the changes came about?

A: Yes, I noticed it. When it was built everything we planted became ruined…And, it's not worth planting if you can't eat what you've planted...(Interview #48)

Excerpt 3:

Q: Who, did a doctor tell you that you couldn't drink now, from the river?

A: No a Doctor didn't tell me, I just knew, I was living on Cornwall Island before…

Q: Uh, yes.

A: Yes.

Q: You saw it yourself?

A: I saw it myself.

Q: What was it like, did the water change color or was there an odor?

A: It was really easy to see, where the waters met...

Q: Yes.

A: Easy to see, yes, easy to see (Interview #47).

Excerpt 4:

It was the hunters who noticed it. They went hunting and when they saw this they got scared…at the way they [deer] looked…They felt it was very unusual. I asked Henry Lickers right away and he said it was true. He said that the pollution from the plants, he referred to one called PCB's. That's what he said. But, it's a difficult situation. We can address the issue to the big money making company and the might pay environment but how? I would say it's the people who conduct air samples, it's doctors, the people who we refer to as scientists (Interviewee #63).

As in the above examples, alterations in another preeminent land-based cultural practice, medicine gathering, had begun to decline significantly in the years prior to the public advisory. Notably this decline cannot be attributed to improved access to alternate health care, or to the availability of other health care options because these had yet to occur relative to the community. Nonetheless, a demographic report on the community presented to the SRMT TC indicated that by the late 1970s, the use of natural medicines had declined to just 26.4 % although 56.3% of the community indicated they would like "Indian medicine" as part of their overall health program (SRMT TC Minutes 5-5-79). The juxtaposition of the noted decline in usage of Indian medicine alongside the desire for it given the time frame suggests that changes in the ecosystem were influential.

As the local land-based cultural economy became further integrated with wage-labor employment, the industries themselves became sources of information about changes to the environment. Obviously, the people themselves possessed the intellectual capacity to be able to deduce the linkage between industrialization and ecological change. Those who worked at the companies themselves, or knew of these experiences through relatives or neighbors continued to build upon and shape the understandings about why environmental changes continued to be occurring. Interviewee #34 related the following:

Alcoa had already been built by the time I was born…I remember when they built General Motors and Reynolds...I remember when they built those plants. That's why they built on that location so they could use the massive energy they needed. That's why they built the towns where they did. But when the plants began to emit the smoke our environment began to deteriorate. Our vegetation became infested.

Q: Did you work at General Motors, Reynolds or Alcoa?

A: When I used to work on iron, we sometimes got work at Alcoa to do repairs. I worked there once for about five or six weeks but I quit…………..

Q: Why?

A: Because XXX*X told me not to work there. He said that it is too dirty and it would ruin my respiratory system. He said to watch the workers. As soon as they retire they die shortly afterwards. He scared me enough to make me quit.*

Q: Oh (laughs) Do you remember what year this was?

A: Maybe, seventy, 1970 (Interviewee # 34).

Similarly, Interviewee #63 disclosed an account of his temporary employment at Reynolds during a scheduled plant shut down for clean up. Responsible for assisting with this clean-up, this Interviewee recalls what a filthy job this was. Though he admits that he didn't know what contamination was at the time, he does acknowledge having recognized the potential linkage between the thick air born emissions and the grime he encountered on the job with changes to the environment. While this particular example is elaborated in the Reports upcoming section on Effects of Contamination, the following passage highlights his awareness:

A: ...furnaces or whatever they're called them.

Q: And do you think there was harm being done to your health?

A: That...I think uh, not just my health I think a lot of harm did to the whole area cause...

Q: Oh?

A: Certain days you can smell that stuff coming out of those plants (Interviewee #63).

Interviewee #74a was a former employee of Alcoa and later worked at Reynolds in the early years when it was first built. He claims that he recognized pollutants in the environment from having worked at the plants. His partner verified an awareness of pollutants from washing his work clothes:

Q: When you started working at the plant, did you see what is called contaminants?

A: Yes.

Q: What kind…

A: I used to run what was called an aluminum press, it would compact the aluminum

Q: Yes.

A: Extrusion, is what they called it…the oil that is put in it contained a lot of PCB's…

Q: Yes

A: What would happen is…a crane driver would have to pick up the barrel and pour it in from the top, it was like transmission oil. But that's not what it was…synthetic, is what they called it. It contained a lot of PCB's…they used to tell us to always be careful…make sure you have your gloves on. We would change the oil in the press

Q: and where would they put the oil that comes from the oil change?

A: they would bury it right there somewhere, I don't know exactly where…a dump in the back. They would bury it…they didn't throw it in the water.

Q: Oh, it was in barrels

A: But they said it would get drawn out when it rains.

Q: Oh, they bury it, did you believe at the time that there was harm being done to the land, water and air?

A: You could really see it. Right there at the plant and nearby it would look like it was burnt, the land…the reason we notice this right there was because of the muskrats, as they would come out of the water looking for something to eat and they couldn't find anything because everything had dried up.

Q: Do you think that there was harm done to your health, how healthy you were because you worked there?

A: Maybe I was lucky in the way things happened, they called us back later, quite a few of us, Massena, they gave us x-rays. They found several of them with something in their chest. We still have a copy of my x-ray, there is nothing wrong with my chest.

Q: Yes, when you found out about this, did it change your way of doing things here and how did it change when you realized that it was dirty where you work?

A: Do you mean here?

Q: Yes, when you came home from work and you get home with your clothes and things.

A: It had a bad smell, my clothes. When she washed my clothes, she didn't like that job. There was aluminum, aluminum ore on there. That was all over it all along with PCB's

Q: And you brought that here?

A: Yes, I would bring that here and she would wash it.

A2: And it wouldn't all come off there when you wash them…(Interviewee #74a/b)

Public advisories therefore constituted an additive, rather than a definitive, phase of recognition and awareness. Though these advisories recommended that people take precautionary measures, they were not forthcoming in contributing to the development of residents understandings of the full weight of the meaning and implications of contamination. Rather, these understandings were advanced by resource-based cultural practices involving direct action, as is highlighted below. As many responses to the interview questionnaires indicated, inquiring from respondents about when they *noticed changes* in the environment and when they *knew why* these changes had begun to occur with respect to contamination, these are two really separate questions. Each can result in a distinct response with regards to *noticing* and *knowing* about pollution. The tendency in historical representations and analyses of this awareness however has been to conflate these responses into a single supposition that privileges the role of external agencies, and even the companies themselves, as the community's sole informants about these circumstances, despite the fact that this is untrue. The examples from Akwesasne's written and archival record of the time when concerns and advisories had begun to publicly emerge are illustrative:

In a letter to a charitable organization written in 1987, a community correspondent noted the following:

Many Mohawks families rely on fish taken from the St Lawrence River for a major part of their diet. However industrial pollution is rendering fish in the St Lawrence unfit for human consumption. In July 1987, a small carp collected from the St. Lawrence contained a concentration of 36 parts per million of toxic polychlorinated biphenyls or PCBs. This level is 18 times the Federal standard of 2 parts per million for PCB levels in fish.

In July 1986, a lake sturgeon netted in the St Lawrence River by Mohawk fisherman was found to contain 3.41 parts per million of PCBs in its meat, 10.2 parts per million in its liver, and 7.95 parts per million in its eggs. Sturgeon eggs are commonly sold as caviar. By the time the results were obtained, the fish had been eaten by the families of the fishermen… (JR 8/19/87).

According to an article in the *Post Standard* in June of 1977:

Dr. Lennart Krook (Veterinarian – Cornell University) – the fluoride emissions from a Reynolds metal Co plant near Massena NY caused the deaths of 187 cattle on a nearby island and threatened the lives of residents there…Krook said the plant, located east of Massena on the St Lawrence river has emitted 34 Kilograms of fluoride every hour of every day since 1973, with higher emissions from 1959 to 1973…Krook said that prior to the opening of the plant in 1959 there were 364 head of cattle in 29 barns on Cornwall Island in Ontario, downwind from the plants. Raising cattle was a major industry of a group of Mohawk Indians he said…ln late 1977, there were 177 cattle in nine barns, Krook said. No lawsuits were brought against Reynolds by the Indians because they lacked the money and although the Indians asked the Canadian government for funds to study the effects of fluoride, they were refused… "The Indians have a communal garden," he said. "In the summer of 1977, concentration of fluoride in the lettuce was 119 parts per million. The highest levels allowed in commercially marketed vegetables is 2 part per million." …Krook said the total human tolerance level for fluoride is 3.2 milligrams per day, a level "that is easily exceeded by sources available on the island."… Kenneth Murphy of the Reynolds Co in Richmond, Va., told The Post Standard, "We are not going to respond, we've been going around and around on this subject for three years. We've taken a hard nose stance and we will not deal through the press but we will see what we can do directly with the Indians involved to resolve the situation."

This excerpt from the official Minutes of the St. Regis Mohawk Tribal Council indicates an awareness of pollution and the well-established organization of community-based direct action by 1977:

In Sept 1977, Henry Lickers and his biological team presented a two hour lecture on the effects of fluoride to our people, crops and domestic animals on both sides of the St. Lawrence river. Documentation was presented through audio-visual to substantiate the findings. The St. Regis Band Council asked our delegation if the Biological team could make further surveys on the American side. It was agreed upon (SRMT TC Minutes 9-20-77)

According to a newspaper article published a full two years after the previous example from in the *Post Standard*, *The Courtland Standard* reported that "Reynolds has no comment on accusations (of fluoride poisoning)" in June 9, 1979. The article goes on to state:

A spokesman for Reynolds Metals co has declined comment on the charge that fluoride emissions from its St. Lawrence River plant near here are probably endangering humans as well as farm animals…Members of the Mohawk Indian tribe have complained of the damage to plant and animal life on the island for more than 10 years. Several thousand Indians live on Cornwall Island which has at times been claimed by both the US and Canadian governments (Courtland Standard, 6/9/79)

As recorded in St. Regis Mohawk Tribe Council Minutes in February of 1982:

Jim Ransom reported to Council on the results of an official pollution study. He indicated that 23 wells in Racquette Point area were tested so far and that two public well systems were tested on both sides of the border by the New York State Department of Health. Results showed one well with the most PCBs at .7parts per billion. The rest of the wells showed negative. Indicated plans for the future are to place test wells near the Central Foundry site and a private lab will be contacted to do additional testing.

Clearly, community members were aware of the pollution and were acting to moderate its effects. Although they were still unsure of the source of the pollution, General Motors was suspected to be the culprit.

Q: can they find out where the PCBs come from?

A: no, that's why we are putting in three more wells… some near the General Motors plant. (SRMT TC Minutes 2-6-82).

Showing recognition of the scope and seriousness of the pollution problem, Jim Ransom is quoted in the following discussion with the SRMT TC in 1983:

The thing that bothered me most was the gentleman from EEC who seemed to think that we didn't have such a tremendous problem. He said things don't move so fast. We have people like Jerry Gunther who thinks there is a tremendous problem, but he can't get these other people to come in and give any financial assistance…The only one who is worried about us is Jerry Gunther on the county level (SRMT TC Minutes 11-5-83) .

At this time Mohawks conducted testing on wells, but ran into problems with labs who appeared to be working in collaboration with the companies to prevent accurate scientific analyses of the problem:

The tests that we sent in, about half of them got lost. The ones that have pollution are the ones that we never got results on. We know there is something wrong, so there is some tremendous pressure on these labs.

Q: *how far has the pollution gone? All over the reservation?*

A: *nobody knows how far it's traveled* (SRMT TC Minutes 11-5-83).

Having situated the role of external agencies in generating public awareness and concerns involving contamination, the following set of five excerpts speak to when and how Akwesasne residents *furthered* their understandings of pollution.

Interviewee #72 specifies Akwesasne Elders and a research study:

A: And I mean our livelihood has changed, just the smell, you can smell the, the plants from here.

Q: Uh huh.

A: ...and um, I mean, they say not to grow, plan..ah, food, but ah, we're so used to it, that ...

Q: Uh huh.

A: that maybe we're slowly killing ourselves, I don't know, because we have to have whatever...

Q: OK

A: ...we're used to eating.

Q: When you say they, they said not to grow things. Who are they?

A: It would be our elders.

Q: Uh huh.

A: And the people who um, have stud, tud, I guess, did study's.

Q: Uh huh (Interviewee #72).

Interviewee #31 mentions the Cornell study regarding fluoride emissions:

Q: Yes. Since you planted, at some point, did someone tell you not to plant anymore, or not to fish anymore or was it a decision you made and why?

A: I think it was in 1972, I think it was concerning Reynolds, I think some people came from Cornell to do a study and they found that if the cows ate the grass…Their teeth would decay and they would fall out. They could no longer eat and they were dying from starvation. When the farmers heard about the outcome of the study they became scared. They said we live off the land and if this is happening to the livestock the same thing will happen to us and they stopped planting.

Q: Do you remember if their condition had a name?

A: They called it fluoride. It came from massive emissions they used to emit.

Q: Where did the emissions come from?

A: From Reynolds (Interviewee #31).[37]

Interviewee #34 refers to health care professionals and a guardian:

Q: O.K., how did we use the river or the land in the past?

A: We did gardening in the spring, raised cows and pigs...we got water from the river we swam in the river and we skated on the ice.

Q: How do we use the river or land, right now?

A: Umm...we don't plant that much anymore and we can't drink the water.

Q: Umm...Do you know why? Why you ...you don't plant anymore or you can't drink the water?

A: Because they told us it's polluted.

Q: OK, and who told you?

A: The nurses...

Q: En hen

A: The doctors...

Q: O.K., umm... why have things changed ?...or I can go on...ah...do you remember anything or hearing anything about the river or land from the time when the companies, meaning Alcoa, Reynolds and General Motors, first built on the river?

A: The lady I took care of told me that, the grass, trees and the medicines they used to have were all dying (Interviewee #34).

Interviewee #33 acknowledges being told to change, but does not specify the source:

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[37] Notably a Cornell study is not the same as official word from the companies. Although the study undoubtedly made a key contribution to enhancing residents understanding of fluoride emissions, research related ethical protocol at the time did not rigorously require the dissemination of research findings as they do today. Although this may not have been a problem in this case, numerous publications from Akwesasne scholars and ecologists note the frequency with which research exploitation has occurred.

Q: Yeah! OK. Now if you made changes in the way you lived. Were you told to change the way you did things or you just thought it best to change?

A: Oh we had to, because, things were not working out as, they used to be.

Q: Uh huh, so did you, did you figure this out on your own or did somebody else say you shouldn't swim or you shouldn't eat fish or you shouldn't do something?

A: Yeah...most, ah...we were told not to eat as much fish.

Q: Uh huh.

A: There wasn't that many fish ahh... by then (Interviewee #33).

Interviewees #72a and 72b indicate a time frame for changing, but do not specify a source of information:

Q: UH huh, um, would, would you remember like from what year to what year when this changed?

A1: For us it changed?

Q: UH huh.

A1: For us about 80.

A2: Up in the 80's, for us.

Q: That, that's when....

A1: Yeah, we ...

Q: You couldn't, you couldn't rely fully on the that...

A2: Yeah, couldn't rely on the land as much.

A1: Before that we didn't have to have welfare, I could trap in the winter and fishing.

Q: Uh huh, OK, and.... do you remember anything or hearing anything about the river or environment from the time the companies first built on the river, meaning Alcoa, Reynolds and General Motors?

A1:(whispers)...Yea, I'll get you after that one.

A2: Well, ah..the fishing died out right away, eh.

A1: My uncle's time there, everybody fished, the whole village, a lot of people came bought fish, after that everything changed, uh, fishing died out.

A2: There's only a handful now, that....that fish...

A1: But they don't make ah.. too good living on it uh!

Q: Is there something that happened to the fish themselves?

A1: Yeah, got less, uh.

Q: Uh huh.

A2: Got polluted (Interviewee #72a/b).

As the oral and written records of Akwesasne clearly demonstrate, it has been through the experiences and efforts of community members, not external agencies, that the awareness and understandings of environmental contamination caused by the companies has proliferated. These activities themselves exemplify the dynamic capacity of resource-based cultural practices in their ability to adapt even under the intensity and magnitude of the circumstances wrought by industrial contamination. Resource-based practices, altered and reoriented considerably by the imminent danger associated with interacting directly with the land, constitute outward transformations derived willfully and strategically in order to protect and ensure the centrality and continuity of land and river based activities and knowledge. The direct action and sustained engagement with concerns about and protection of the environment is a clear reflection of Doxtator's argument about the nature of Rotinoshonni approaches to history and change; while the incorporation of new concerns and activities subsumed certain aspects of previous patterns, these aspects were never completely replaced or obliterated, but were instead retained and further incorporated into subsequent adaptations. Change, Doxtator elaborates, is not replacement but incorporation and subsuming the structures of the past. Change also involves the idea of "movement outward and inward around the centre" (Doxtator 1996:61).

Bearing this in mind enables us to appreciate the ways in which Interviewee #98, who has long been a guide for people on the land, assumed a pivotal role in using his skills and expertise to help guide others to advance an understanding of the depth and breadth of pollution in the interests of the well-being of the ecosystem and the people.

…right through the late 50s when the plants were opened up, GM, Reynolds, Alcoa, all of them polluters, the worst ones is General Motors and Reynolds. In front of that place all the marine life is dead there, a 1000 feet of it in front of General Motors. And General Motors knew about that for the last 16 years cause they hired me as a guide to take them out and test the water, test the soil, the river bottom. We tested 15 places one year, back in the mid 70s and they came back the next year and we tested 26 places up to the current, where the swift current is. The whole bay…the marine life is dead there on account of pollution (Interviewee #98).

The same can be said for the fisherman who dispense similar assistance, making invaluable contributions on the basis of their knowledge, skills and expertise (JR 8/19/87). They may no longer fish for immediate subsistence, now they fish for long term answers. The following account elaborates:

Back in the, when it first started they took it back to Pennsylvania, doctor tested that, back in 78 and they found PCB's in the walleye….and they said it's bad up there. They used to call me before they started out you know, or I'd get a letter for appointment for a week fishing so I write it in a big book, I have a big log book. They begin to tell that the fish was polluted with PCB's, lead and Ward Stone showed up here. XX brought him here and we got acquainted right away and he was telling when I die, he said, "do you want to work for me and collect the fish and samples," and I said sure. We weren't doing no fishing anymore, five or six years ago now. So we worked on sampling the soil near General Motors and the water almost daily and we begin to collect fish. They bought us net, gill nets, traps, hoop, you know them hoop nets, so we fished near Alcoa on down to where MA lives down in Snye, all the way down we collected fish and we had a map showing the location that the fish was caught and the fish was tagged so it would go in the map you know, where the fish was caught. They were all tagged by numbers and it went on computer and it just handed you know, Kenny's office. Then we went to Gloversville, NY, a big lab there, so I had to clean the fish there and through the process, it come out with how much PCB's, mercury, and pesticides, whatever was in that fish would come out through that process. We were four weeks, I cleaned 900 and something fish, came back then we went to Cornwall, worked for Ontario Environmental there. And ah we cleaned fish for their lab and I been on TV from England and all over Canada and the United States about this pollution (Interviewee #98).

And of course, the same can be said for those who have fought to combat these impacts with pens, tape-recorders and on letterhead, in offices and boardrooms within the community and beyond. Although contexts and methods may have shifted and changed, the centrality of the environment and the maintenance of this relationship have been continuous and consistent. These too therefore are resource based cultural practices.[38]

An article published in *The Globe and Mail* on August 30th, 1977 quoted Henry Licker's, one of Akwesasne's first and most prominent public advocates for addressing the effects of pollution, as stating that "we don't want to have to rely on people to do things for us. We want to develop a means to monitor the environment itself, to look at the environment and see what is happening and what can be done." Mr. Lickers then said: "We want to initiate our own fish studies and draw on outside experts to

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[38] Anthropologist Harvey Feit draws a similar parallel in reference to James Bay Cree resistance to hydro-electric development. He suggests that the Crees' agency does not arise solely as a response to development projects or from agreements that offer cash, but in a different setting…their actions are rooted not in opposition or opportunism, but in the practice of everyday life in the communities and on the land (2004:93). He views direct political actions associated with such resistance as "life projects," which are not a sign of inconsistency in Cree commitments to their lands or a singular desire for monetary benefit. Instead the mobilization of political action as a "life project" seeks to reassert the power of Cree relationships to histories, lands, animals, places and peoples within the context of everyday living and survival in the midst of continuing destruction (2004:108).

test them. We have found that the government consultants are not always competent to carry out complete fish studies. Mr. Lickers said the island residents are fed up with trying to obtain test results from the Ontario Ministry of the Environment, "only to be told, "your under federal jurisdiction, call Environment Canada." And when we call the federal people, they tell us to call the Ontario Environment Ministry because they took the tests and have the results." The frustration just builds and builds and builds when the Government keeps telling us everything is okay. "If your food sources are contaminated, go buy from the IGA," they tell us. That is not the way of the Indian people. We depend on the land and the river for our food. Telling us to shop at the IGA is not the solution for stopping the pollution of our environment," Mr. Lickers said….In addition to studying the effects of contaminants such as PCBs, mercury and fluoride, Mr. Lickers said the new environment division will be setting up a contingency plan to deal with emergencies such as oil and chemical spills on the river. They will also be initiating a management program for fishing, hunting and trapping, as well as a diet survey for more than 4,000 residents (Malerek 1977).

Arquette and Tarbell (2000) provide a historical overview of Mohawk models for resisting pollution that continue to operate to this day. They note that because of the concerns brought by industrial pollution and the destruction of lands and waters, the people of Akwesasne mounted a strong response. Akwesasro:non commitments to providing a healthy, clean environment for future generations are central to these initiatives and efforts. In what can be viewed as a contemporary expression of cooperative labor and cohesion associated with resource-based cultural practices, Arquette and Tarbell note the complimentary efforts of the community's three governance structures. The Mohawk Council of Akwesasne, the St. Regis Mohawk Tribe, and their respective Environmental Divisions, along with the Traditional Mohawk Nation Council of Chiefs, have all made enormous contributions from raising local, national and international awareness of environmental degradation, to developing comprehensive plans for remediation and restoration. Since its formation in 1987, the grass-roots organization of the Akwesasne Task Force on the Environment (ATFE) has initiated, supported and developed hundreds of projects which support their mandate to conserve, preserve, protect, and restore the environment, the natural and cultural resources within the territory, and to promote sustainable, culturally significant activities (Arquette and Tarbell 2000:99-100; Marten 1999).

As the historical analysis of awareness and adaptation emphasized in this section clearly shows, just as it is inaccurate to assume that community residents were not central to the advancement of knowledge and awareness of contamination, so is it to consider these enormous investments of time, energy and resources, as being without purpose. A history that only tells of rupture, passivity, victimization and demise, is one in which the resilience, tenacity and continuity of the culture cannot be appreciated. Although the profound effects of contamination on resource based cultural practices is a crucial point of focus in an upcoming segment of this report, it is essential to recognize the various ways in which resource based cultural practices continue to exist despite contamination, and to acknowledge these as crucial to future restoration options.

The continuity of the interviewee's knowledge, skills and techniques relative to resource-

based cultural practices are very much part of the present, as is conveyed below:

Tsientos ken nise nowa? *(do you still do planting)* Sahetaien? *(Do you have a garden)?*

…I had my grandson do an elevated garden for me…and he's planting the old way…we're involved in using methods our ancestors planted. You know when you plant certain plants together in certain period of times so one plant protects the other, and there we also learn that some plants don't like each other so you do companion planting, so some plants they like to be next to other plants. And then in addition to that there's certain flowers too you can plant that will repellent particularly insects

…I've been working on this project…taking the wild edible plants that grow in our area and having them analyzed to find out what kinds of nutrients they have. Like for example burdocks, like burdock roots, in early spring…so what I'm doing, I take these plants…I got most of the stuff that grows in the area and what I need to do now is make recipes, you make recipes by using the food that there… I'm still looking for some kind of fungus that grows on trees and he said its called "poor man's steak." I don't know what it is, I don't know if anybody knows. That's what he used to call it…its some kind of fungus tanon, *it's different things like that…wild leeks, type of soil they come from, when they mature seeds pop* (Interviewee #98).

Interviewee #98 makes similar points about the continuity of medicinal knowledge and practices:

Q: How many different medicines do you know?

A: Everything, every ailment you know up to date…

Q: Do you still go collecting herbs?

A: Oh yeah, I got it loaded in here. Yeah I got medicines, a lot of medicines

Q: So you gather all your things locally, like how?

A: Yeah there's a few things I go to the mountains, like turtle socks and you know. I have to go to the mountains and find a swamp. And I like to go there to get away from here to pick the medicine at least 15 miles on account of the pollution. Cause the ground is polluted here at the point. Oh yeah, we're not supposed to even plant, but I plant like tomatoes and cucumbers and stuff and cabbage that grows on top, nothing underground. You can't plant carrots or potatoes.

Q: How do you think it affects the medicines that you pick, the pollution?

A: Its polluted just like drinking water you know, even though its what you call it, treated but we still got PCBs

People come here and I treat 'em and I burn tobacco to the Creator when the smoke rises I thank him for giving me the power to treat this person that come and asked for help and I ask their Indian names so I sent the message to the Creator and I have this person, this is what's wrong with him and I burn tobacco (Interviewee #98).

Interviewee #98 provides further insight into how he currently encourages his grandchildren's exposure to the knowledge, skills and the relationships that have always been intrinsic to cultural practices:

Q: Do you think that kids still respect their Elders?

A: Uh no I don't think so. You gotta have strict parents, you gotta be strict. He can't just eat a sandwich and run off. You gotta put em to work, mow the lawn, teach 'em something, do something…you gotta teach something at home…do something constructive. You teach 'em while they're young, you know. There's a lotta things to do you know. Either take 'em fishing once in awhile or take 'em to the mountains for trout fishing if you got boys, even girls, go for it. I do that with my grandchildren, my children, we used to go out and had a great day, you know.

I teach [my grandchildren] a lot of crafts, we carve and we make things, and I teach em how to fish and I teach em how to garden, even the five year old. You know, four, five years old, I take em to the garden. I got a garden here, two gardens that's for my grandchildren. I made em cause they wanted some help how to plant … I teach em …to talk to the plants every day. Teach 'em how to water when it don't rain for two, three days…teach em how to hoe potatoes and string beans…yeah teach em all that. We made our own compost, you know fertilizer. Yeah teach em all that. Weekends they rather come here than go anyplace…than go shopping. How bout that! I teach em about the trees, what kind of trees, what tree is good for wood, what tree is good for carving and you know like hickory, good for lacrosse sticks…

Even my grandson when they leave here, the parents, they say its in your hands, correct him the way you were brought up, but I haven't touched any of my grandsons. They haven't done nothing, haven't broken nothing. I teach em how to cook (Interviewee #98).

While this sections final two excerpts express continuity in a more generalized way, the attitudes of each speaker are poignant examples of why it is that Akwesasro:non understandings of their ecosystem, developed over three millennia, can still be heard today…

Excerpt:

A: And the people who um, have stud, tud, I guess, did study's.

Q: Uh huh.

A: Have advised... like fish and people are asking me, aren't you afraid to eat all this fish and I says, well, I says, my mother' s 75 and she's not glowing, yet.

Q: En, hen!

A:...and I said, so I'll quit when I start glowing too, I guess.

Q: OK!

A: Henh, henh! (Interviewee #72)

Excerpt:

Q: Yes, the way, you, the way you, did it change the way you live because of this, because they built here, General Motors, Reynolds and Alcoa, did it change you, the way you live?

A: No, not really.

Q: No? Really?

A: No, really, because it's hard to change me, isn't it?

Q: Yes.

A: That's a hard thing to do (Interviewee #47).

d) Conclusions

The concluding statements that follow are based on the information that has been assembled and analyzed in this segment of the Report, on the Pre-Industrial History of Akwesasne, Traditional Cultural Practices at Akwesasne and Adaptation and Alteration of Cultural Practices:

1. The historical baseline set for resource-based cultural practices relative to ecological conditions *but for* the release of hazardous substances is 1955.

2. Up to 1955, the entire population of Akwesasne relied in varying degrees on traditional resources and resource-based cultural practices. Notably, families rather than individuals constitute the key unit of measurement from which this conclusion has been determined. This is in keeping with the way in which culture at Akwesasne was historically practiced.

3. Virtually all activities up to 1955 were cultural practices for subsistence purposes related to the land, ecosystem and riverine environment of Akwesasne.

3. EFFECTS OF ENVIRONMENTAL CONTAMINATION

a) Types of Pollutants

There is documentation to prove that the companies referred to in this report have released the following substances into the natural environment at Akwesasne (Stone 1988; Gunther 2983; Schell and Tarbell 1998):

- PCBs, including Aroclor (1248) and Therminol
- Polychlorinated dibenzofurans
- Dioxins
- Polyaromatic hydrocarbons
- Fluorides
- Cyanide
- Aluminum
- Arsenic
- Chromium
- Styrene

The evidence also indicates a probable release by the companies of the following contaminants:

- Heavy metals including lead, arsenic, cadmium and chromium (found in water wells in a July 1983 Sampling exceeded drinking water standards).
- Fluorides
- Methylmercury

Furthermore, levels of PCBs, copper and cadmium in zebra mussel tissue for the area showed that the highest levels of bioaccumulation at Raquette Point, the site adjacent to the industrial facilities (McCallum, Johns and Pagano 1999).

b) Cultural Impacts of Contamination and Other Causes and Effects

Distinguishing the Effects of the Seaway from Industry

One of our challenges in assembling this report has been to try to separate and distinguish the effects of the construction of the dam and seaway from the effects of industrial contamination on Akwesasne Mohawk resource-based cultural practices. However, it is important to remember that the construction of the seaway and all subsequent industrial development go hand in hand. They are merely different steps in the same overall plan for the industrial development of the area. For example, it is well known that the construction of the St. Lawrence River FDR Power project and the St. Lawrence Seaway were preliminary components of an expansive, long term plan for the large scale industrialization of the region. This was understood by Robert Moses and Lionel Chevier, and later experienced by the Mohawk people affected by it, as a "package deal" (Cole & Arquette 2004:355). As longtime ethnohistorian of the Iroquois in the St. Lawrence and in New York, Laurence Hauptman explains:

> Moses' ideas for economic and energy development were the keys to his master plan which were to have the most impact on Mohawk life along the St. Lawrence river…By developing public hydroelectric power along the St. Lawrence River…he could stimulate heavy industry and at the same time, seaway transport. By constructing a series of parks and parkways for tourism and recreational purposes, he would counter any local opposition to the project. By providing special low rates for St. Lawrence residents, he would counter any local opposition to the project. By improving the states total economic picture, he would satisfy the utility companies' quest for increased profit margins. By sacrificing Indian land or those that were claimed by Indians, who were a small powerless racial minority largely outside the American electoral process, he would not alienate white voters and their political representatives, especially in the economically depressed North Country…Dams, reservoirs, and power development were part of the 1950s idea of progress and were seen as more important than Indians and the protection of treaty rights (Hauptman 1986:141; quoted in Cole & Arquette 2004:335).

Hauptman goes on to note in a more recent historical analysis that a "conspiracy of interests" became part of the "package deal" wherein Project proponents actively engaged in encouraging several industries to the region through the promise of cheap hydroelectric power (Hauptman 1999; Cole and Arquette 2004:355).

Thus, almost 50 years ago, the opening of the St. Lawrence Seaway and the lure of cheap hydroelectric power provided by the Moses Saunders Power Dam in Massena, New York made the region an attractive site for industries. Soon General Motors and Reynolds Metals seized the opportunity provided by this cheap power and built plants directly adjacent to Akwesasne – Alcoa had already been operating in the area since 1950. As a result the water, land, sediment, and air of the traditional territory of the Akwesasne Mohawks has become severely polluted.

The initial changes to the environment of Akwesasne undoubtedly resulted from the construction of the Seaway. This altered the quality and character of the geography; changed the flow of the water and submerged important islands which, with their trees, rice, and cranberries, not only disturbed aquaculture, but changed the quality of the water and winter ice. The construction itself and resulting structures (such as dam turbines) also lead to fish mortality, soil erosion (the seaway brought in large vessels) and other such problems (ATFE 2004; EAGLE 1996). It can thus be argued that the construction of the Seaway in-and-of-itself had detrimental effects on the resources the people of Akwesasne depended upon. Fish were becoming less plentiful and other aquatic species felt the effects of the changes in water flow, the introduction of large seagoing vessels, etceteras.

These changes were upsetting to the people depending on the resources provided by the river. It is however important to emphasize that, though such changes may have effected how, when and where people went in order to fish and gather marine resources, in the long run, adaptability could have been possible. After all, cultures are never static, but are continuously changing due to such naturally occurring factors as diffusion and slow variations in traditional resource availability. As long as there is room to do so, societies tend to find a way to incorporate and adapt to new technological and environmental conditions in ways directed by their culture (Park 2006).

Anthropologists and ethnohistorians studying 20th century Mohawk people therefore clearly discern the differential impacts of Seaway and Industrial contaminants. With respect to the comparison of Seaway-based developmental impacts on the Mohawk communities of Kahnawake and Akwesasne, anthropologist Dean Snow makes the following discerning statement:

Akwesasne lies 50 miles upstream from Kahnawake on the St. Lawrence River. The St. Lawrence Seaway project did less direct and immediate damage to Akwesasne than it did to Kahnawake. Damage in this case has come mainly from heavy industries that grew up along the seaway just upstream (and upwind) from Akwesasne. Aluminum and other pollutants have rendered fish inedible and gardens hazardous, damaging the quality of life of Mohawks who have lived there for nearly as long as they have been at Kahnawake (Snow 1994:201-202)

As long as the fish were still safe to eat Akwesasro:non depended upon them for sustenance. As long as the land and air was clean Akwesasro:non still depended on gardens and hunted and trapped (Interviewees #31, #32, #33,#34, #72,#74, #64). Thus as the evidence below will clearly show, as long as it was safe to consume the sustenance provided by the animals and plants, the Akwesasro:non were able to adapt their traditional cultural practices to new environmental conditions. After all, as the historic overview section of this report shows, they had already adapted to many changes since 1492, all without losing the most important aspects of their identity.

Nevertheless, the pollution of their lands, waters and air by heavy metals did unfortunately pose insurmountable challenges. How do you adapt to not being able to practice the essence of your existence and beliefs? How do you adapt when what you held to be sacred, becomes poisoned and deadly and you have to tell your children to stay away from the lifeblood of your culture, thus alienating them from their own identity?

In order to better understand why the release of heavy metals into the environment has had such detrimental effects on the cultural continuity of the people of Akwesasne, it is then necessary to take a brief look at the health concerns and impacts raised by the pollutants. While this section will not engage in health impacts *per se*, it has been determined that for natural resource based societies real, or even only perceived dangers to the peoples' health posed by environmental pollutants have had measurable effects on culture change. Thus we need to explore the linkages between perceived health risks and changes in culture.

Contrary to the conclusions of basic risk assessment models, community based researchers have often found that adverse health effects can and do occur even when there is no physical exposure to toxicants. This is because the people have had to give up traditional activities in order to protect their health from toxic exposure. The overall physical and mental health impacts of such changes in lifestyle not only result from the abandonment of traditional activities and the myriad of long term intergenerational effects this has on Indigenous communities such as Akwesasne, but also from the simple fact that the food that tends to be available to replace "country foods" is generally high in fats and sugars. Thus the inability to access traditional foods often leads to, and in the case of Akwesasne has lead to, new diseases such as diabetes, stroke, heart disease, high blood pressure, cancer, obesity, etceteras. Disease can further result from the inability of the people to access traditional medicinal plants needed for healing, as many are also no longer available to Akwesasro:non because of pollution (Schell and Tarbell 1998).

Initiatives to maintain cultural continuity in order to allow Akwesasro:non, and especially the younger generations, to experience and maintain important teachings and values (for example respect and patience), not to mention the transmission of language and important technical focal vocabulary embedded in traditional resource harvesting practices, are thus important aspects in the efforts to restoring the health and vitality of the people (Samson 2005). While Akwesasro:non work hard at teaching their children who they are, only so much can be transmitted in classrooms or other simulated settings. As many Indigenous peoples and academics have come to realize, the only way to really be able to teach Indigenous children about who they are is to take them "out on the land" and let them learn by observing, listening to and copying their elders knowledgeable in traditional resource activities. Many Indigenous communities in Canada and the US are successful in the maintenance and transmission of such traditional skills, knowledge, values, and language. This success, however, is always contingent upon having maintained a resource base that allows them to do this.

Furthermore, it is important to note that the relationship of Indigenous communities to the resources that sustain them is not based on the simple, supply and demand models found in the Western approach to resource management, where the goal of sustainable resource management is simply the maximum sustainable exploitation of resources (Feit 1988, Nadasty 2003, Notzke 1994, Spak 2005). Rather, Indigenous communities tend to see themselves as being responsible in a very real and tangible manner for the plants and animals and other life forms or "resources" that sustain them, as is evidenced in the Haudenosaunee thanksgiving address. Thus, being unable to fulfill responsibilities to the environment one is responsible for can have very real detrimental psychological and emotional effects on Indigenous peoples.

The EAGLE Project (1996) stresses this important point when it explains that fishing, hunting, trapping, agriculture and gardening, as well as the ceremonies that are a part of these activities, are an important part of honoring the seasons and the gifts provided by the environment. For Akwesasne, it goes on to explain, the severe pollution of the river and environment by the industrial plants led to alienation from the land. This then resulted in social upheaval due to the loss of cultural traditions and damage of the traditional social structures that supported their values, beliefs and norms. The impact of all this, concludes the EAGLE project, is spiritual, emotional, physical and psychological. For example, the lack of cultural meaning in diet has lead to the young disrespecting their food, themselves and mother earth (EAGLE 1996:15).

Thus, while the substances released by the companies have had some direct and measurable effects on Akwesasro:non (for example: the effects of PCBs on thyroid functioning in adolescents (i.e. thyroid hormone homeostasis); the relationship between PCB exposure and the cognitive functioning of children and youth (preliminary findings suggest that cognitive processing involving long term recall of new information (LTR, DR) was affected); the effects of PCBs and lead on the age girls attain menarche; the effects of PCBs and other pollutants that disrupt estrogen metabolism on human growth and development; asthma; and the potential effects of pollutants on fertility (PCBs and PHAs act like estrogens on the human body which can lead to sub-fertility, which in the long run has obvious huge effects on populations with high levels of exposure)(Denham 2005; Gallo 2005; Guillette 1994; Mackenzie 2005; Shell 2004; Schell 2005; Schell 1998), the health and well being of the people of Akwesasne has been severely effected simply by their inability to continue their traditional resource based activities and responsibilities.

A detailed examination of these activities and the reasons for their abandonment will clarify the immense impact of the contaminants on culture change in Akwesasne. The most pertinent information to understanding how cultural practices have been impacted by pollution comes from interviews with the elders of Akwesasne. The section below will thus rely heavily on the interview materials.

When one reads the interviews it becomes apparent that, before the people of Akwesasne were affected by the pollution from the industrial plants (or became aware of that pollution), life still centered around fishing, animal husbandry, horticulture and gathering. While some people did pursue outside employment, families still strove to be as self sufficient as possible through the procurement of food through farming, fishing, trapping, and hunting. Thus until people were cut off from their land base through pollution, income generated through outside employment did not have to be spent on the basic necessities of survival. While people would travel to the surrounding non-native communities from time to time in order to purchase such items as sugar, tea, clothing, and other luxury items, most of the basic food items like meat, fish, fruits, vegetables, milk, cream, etceteras, did not have to be purchased but were produced and/or supplied by family members or neighbors.

Thus until the whole area around Akwesasne became industrialized in the 1950s the people of Akwesasne still practiced their traditional land based economy. While some individuals did already seek out outside employment in the pre-industrial area, opportunities to fully participate in main- stream American culture were at that time limited. As can be seen in the interviews, most families in the pre-pollution area of the 1950s preferred to base their overall economy on traditional land based activities, with outside income generated by the occasional employment of individual members of the extended family simply seen as something that would supplement their traditional economy. While this was in part due to the preferences of the people of Akwesasne for traditional land based activities, the racism experienced by Akwesasro:non who did attempt to gain outside employment or even just tried to sell some of their products, also contributed to the continued heavy reliance on the traditional economy. Until the industrialization of the whole area in the 1950s the land and the traditional economy based on traditional resource harvesting activities was the only steady, continuous, safe and dependable source of livelihood for the people. All other sources of income were welcome supplements that could not always be counted on.

One often encounters the assumption in the general non-native population that traditional resource based activities would have been decreased anyway with the introduction of television and other influences of mainstream culture. However, anthropologists have generally been able to observe that land based Indigenous communities are very adept at incorporating modern items such as televisions and computers into their lifestyles without losing their culture provided they have continued, uninterrupted access to their traditional resource base. As long as the intergenerational educational process taking place during traditional resource harvesting activities is not interrupted, the transmission of the most central aspects of cultural knowledge and values of natural resource based societies continues (Cruikshank 1998; Nadasty 2004). For example, in Denendeh (NWT, Northern Saskatchewan, Northern Manitoba), most Dene communities still rely heavily on the caribou and fish their lands and waters provide them with as the main staples of their diet, in spite of the fact that many community members are "on-line" and hold "modern" jobs. This not only keeps them grounded in their identity as Dene, but also provides for a healthy dietary continuity, not to mention lowering the cost of living since basic food items such as meats and fish don't have to be purchased.

With this in mind let us now turn to the interview material in order to determine how the release of hazardous substances into the environment that sustained the Akwesasro:non has affected their culture as practiced through resource based activities.

<u>Water, Fishing and the Use of the River</u>

Life in Akwesasne centered around the river. As the interview excerpts below clearly demonstrate, the river was one of the most important resources the people of Akwesasne depended upon until the industrialization of the area in the 1950s. The river provided the people with their main source of protein and fish, and fishing as a cultural activity was central to the identity of the people. The river also provided the people with a source of clean drinking water, a means of transportation, a way to supplement their income from the sale of fish and from work as fishing guides, a favorite re-creative pastime (swimming), and further provided nourishment through other aquatic animals and plants. Thus as the interviews below will show, being cut off from the physical/psychological and re-creative sustenance provided to Akwesasro:non by the river has impacted the people negatively in countless ways.

"Used to be lots of fish just go down to get them before meals. People kept them in fish boxes."

"Water used to be so clean. Used to do everything with that water drink it. Wash clothes etc, etc…. ate a lot of fish back then, canned sturgeon….set night lines for sturgeon, put bait on hooks and put sand on it…get sturgeon in the morning…her grandfather would get the sturgeon early in the morning, what they did not sell sometimes her and her grandmother would can that for the winter just like salmon and her grandfather would smoke it too. Had his own smoke house." …

"Also had doctors, lawyers come and stay in their own tents there would feast on that fish, would buy that fish and her uncles would be guides, take them fishing"

"Used to swim all day and cook crayfish in cans by river for lunch. Today you can't do any of that…Used to lift up rocks and that's were you would find them. Are like soft crabs or lobster, taste so good. Today you can't do that now you don't even want to touch anything by the shore, its all slimy down there… Now she has to buy fish because that is what she prefers to eat and that is expensive."

"Used to be able to sell fish."

"Used to do a lot of fishing and fish frying that's how we used the river, that's how we depended on it. It was our major food supplement"…

"On Sunday mornings, my father and my mother would put us in the boat and my father would row and we would be visiting on Cornwall Island at Tekarihwakhenhne *(location named after man who lived there). We children would look over the side of the boat into the water and sometimes we would see* Teikonakien:tare *(sturgeon) swimming. That's what we would watch. We would watch them and we could see clear down to the bottom of the river. It's no longer clear."*

"Certain families supplemented their income by fishing. Not everybody did that. His uncle was one of them, used gill nets and night lines… "

"Drinking water came from St. Lawrence."

"Everybody used to do a lot of fishing and salt it for winter" (Interviewee #32).

"Look at the condition of the water. I grew up on the river. We fished and we drank from it. Around the year 1940, maybe 1942 we fished and drank from it and the water was so good when our boat was afloat I could see approximately twenty feet into the water. I could see the fish eating. You're lucky today if you can see three feet into the water.

I was about six or eight years old when we used to fish together. That was around the time they used to fish more and there was an abundance of fish. When my father was still young he said it was no big deal to catch sturgeon that weighed around one hundred pounds" (Interviewee #62).

"We lived on, ah, of the river a lot too, fishing…I remember when ah, Friday ca..., Friday we never ate meat on Friday, always fish… We go fishing...we'd fish, and me and my mother'd take turns... drag, they call it drag lines....and my father would row the boat and we'd uh catch good, pretty good sized northern pikes and that's what we'd have, great big fish dinners…Um, that didn't ha...ah, ah, it wasn't even have to be Friday, just anytime you want...got hungry for fish, we went out on the river fishing, got some" (Interviewee #63).

"What I would like to see is for us to see the water becoming clean again, the water used to be so good in the St. Lawrence that you could see right to the bottom…right now its so dirty you can't even see it…before we used to use lights to go fishing around the island, lanterns were hung at the front of the boat and we would use a spear, harpoon…you can't do that anymore because the water is too dirty…Long trees, was my grandfather I remember used to ask my mother what kind of fish should we eat this evening, she would say which kind she wanted and he would go out and in a little while he would be back with that kind of fish….he knew where he had to go to catch a particular type of fish…that's the way it used to be before, there was some good fishing around here. The native people used to guide…for some big name people the would paddle for them and they would pay very well…now today no one really knows where there is a lot of fish……what I would come up with would be for them [the companies] to try hard to fix everything that has become dirty, to make it better again" (Interviewee #74a).

"How did we use the river or the land in the past? For our livelihood mainly, cause we've fished and uh, whatever fish we didn't eat other people ate and so, maybe some people bought and we did a lot of our own gardens and ate whatever we produced" (Interviewee #72).

As can be seen through the interview excerpts above, fishing was a very important traditional activity and the consumption of fish made up a large part of the pre-pollution diet. People also sold fish for extra income and made money as fishing guides. The river further played an important role in cultural and recreational activities as well as being a source of clean drinking water. As is stated in the interview excerpts, people have a strong preference for fish as a food source and fishing as a traditional family activity. Thus they very much miss having access to clean fish, they not only miss their ability to go fishing but also their overall river based lifestyle. This becomes evident in the following excerpts:

#63: "But I, I missed the swimming.....But ah, we were told, you had to slow down swimming... I, I lived in the water.. (laughs)"

TP: "Why were you told, no more swimming, did they say?"

#63: "Cause they suspected uh, then, that the water wasn't right...." (Interviewee #63).

#63: "…we used to go out and get, get our, do our fishing and it never bothered us or anything...before the plants and…After the plants came up and everything, I think I'll refer back to the changing of the color of the water... everybody just automatically slowed down or stopped fishing altogether...They still had fishing derby's but I think they just throw 'em back in."

TP: "Oh yeah, OK, um, did you start to feel good or bad by these changes?"

#63:   "Pretty bad".

TP: "Pretty bad?"

#63:   "I turned bitter."

TP: "OK, uh, like what made you feel bad, about it?"

#63: "The way I grew up, my way of life and.... I enjoy, what I enjoyed the best in my young life, I, guess, just growing up and..." (Interviewee #63).

TP: "And how do we use the river and land now?"

 # 72: "Maybe, not as....Use it mostly just for recreation...Mostly boating and a little bit of fishing…Like before we used to live off the land before, more. We used to, even her and I in our time, when we were young, we used to make a living off of it....we never got rich, you know, but it...got us through…Before that we didn't have to have welfare, I could trap in the winter and fishing".

TP: "Uh huh, OK, and.... do you remember anything or hearing anything about the river or environment from the time the companies first built on the river, meaning Alcoa, Reynolds and General Motors?"

 # 72: "Well, ah…the fishing died out right away, eh. ..My uncle's time there, everybody fished, the whole village, a lot of people came [and] bought fish, after that everything changed, uh, fishing died out. There's only a handful now, that...That fish...But they don't make ah…too good living on it uh!"

TP: "Is there something that happened to the fish themselves?"

 # 72: "Yeah, got less, uh. Got polluted" (Interviewee #72).

TP: "When you said you used to get water from the river can you still do that today?"

74a: "No, the water is really dirty and it smells too. When I would cross the river here, I had a white boat and right when the water level is on the boat there would be an oily film on my boat….when I would cross the river and my glasses got splashed I had to clean the oil off them also."

TP: "Did you used to fish and pick medicines or maybe hunt for muskrats, concerning these things were there changes here too?"

74a: "Yes we really felt bad because of how fast things changed….now the type of fish that I really liked to eat were the sturgeon…at that time, the last man that went out to catch fish was XXXX…that was his name, he used to live on Yellow Island…he always had fish, then one time I went to buy fish there, we ate it but did didn't taste good anymore, it had a gassy smell to it..."

TP: "Did this happen to all around here?"

74a: "Like a gasoline smell"

TP: "Yes and do these fish feed right at the bottom".

74a: "Yes."

TP:" Yes, what about how many fish you used to catch, was there a difference there?"

74a: "Yes and they were smaller."

TP: "Did you make up your mind to change your way of doing things which would have been a direct result of these changes or did someone tell you?"

74a: "I would say that I learned to make these changes by the way these changes were occurring…we didn't expect that when we went fishing that we would catch as many fish as we used to before…sometimes a guy would catch two fish, well he's happy with that…at least he caught something"

TP: "What about the way you were thinking, did this change, did it cause you to not feel good about things or what happened when you notice these changes?"

74a: "Yeah well, I would feel sorry for…, well I was crossing the river and this eel came up next to me...he had his mouth open because he was trying to breathe, oxygen was what he was lacking...so I reached down and I caught him and put him in the boat, when I got to the island I took him near the house and I let him go. There was still dew on the grass" (Interviewee #74a).

"*Last summer Freddie he still gets sturgeon, he still smokes sturgeon, but the last sturgeon he gave me last summer (1998) I could not eat it. It was fresh when I got it. I cooked it, what a difference. I better not eat it, it did not taste the same. I felt bad because for me I hunger for all this stuff I was brought up with and its not possible anymore"* (Interviewee #79).

"Yes even the water changed color in the coves. It seemed to turn yellow. It used to be like a nice shade of black but now its turned yellow, probably because of everything they dumped in the water" (Interviewee #31).

"On the river because it is not safe to eat the fish…also a lot of changes along rivers used to be a lot of bull rushes a…along right to the edge to the deep part. Now they are all gone….. and the water is dirty. Can't even see the bottom. Used to be able to see for 15 20 feet down"…

"Were told not to eat as much fish. There was no that many fish by then And ah there was a lot of sores on the fish, they were…like bullheads or ahh… there's a lot of...its sores on them and…we used to get a lot a few hundred

pounds a night an after that its started to go down after that, even the perch were not as plentiful as they used to be. Perch also seemed to be getting smaller" (Interviewee #33).

"Can't swim in the river any more. Used to go fishing right from our house and that's changed. There's a lot of swamp growing there and the water is dirty and there's a lot of green stuff that come out and you can't eat the fish you can catch today. Why? Contaminated, PCB's lead and everything."

"Noticed that the water started to smell bad, like sawdust, First tasted it when he made whole in ice by Snake Island. Stopped drinking river water. Changed his lifestyle , the way he planted and fished, entirely, quit it because people would no longer buy it from him" (Interviewee #34).

"They, they....they just talked about how bad the water's getting and.... they even saw the changing of the color of the water.

It used to be clear blue water and all of a sudden..... it got green and then it... muggy and..."

TP: "Uh huh, what about uh, fish themselves, did they talk about the fish"?

#63: "Not too much, they ah, they still went fishing, but not as much as they used cause they I guess they sort of worried about what happened to the water" (Interviewee #63).

Obviously, people very much miss the ability to fish and use the water of the St. Lawrence. What is important to emphasize here is that many people noticed changes in the water quality, including the taste and smell of both fish and the water, and adapted their resource harvesting activities accordingly. This was done long before the official fish advisory.

Horticulture and Farming & Basket Making

In addition to fisheries, the people of Akwesasne also relied on traditional horticultural and farming activities to support their subsistence, with further moneys generated through the sale of hand made baskets and locally produced and/or collected food items. As the interview excerpts below show, horticulture and farming was an important aspect of the peoples lives right up to the time when pollution made such activities difficult. These interview excerpts also give the reader a good idea of the extent to which the pre-pollution diet was made up of locally produced food:

"Used to grow gardens and fruit orchards. Dry apples on top of copper roof to keep for winter Used to grow wheat (oatmeal) and of course corn. Used to have pigs and slaughter them in fall and salt them in for winter. Pretty self sufficient lifestyle back then, just bought a few things from the store…"(Interviewee #99)

"On the island they had wild plums, apple trees, never had any problem with bugs on apples. Where she is now she takes care of her apple trees well but has many worms etc, can't use apples. Had berries on the island…made everything they ate at home back then, only bought flour sugar and molasses. When he killed pigs he used to smoke pork too…"

"...also had pigs, chickens ducks, turkey...fishing. Make soap from pig fat…"

"Used to make her own cottage cheese. Grandmother used to say eat up that yogurt its good medicine…ancestors seemed to have known about acidophilus bacteria even back then…"

"…used collect the nuts, the hazel nuts, used to have bags of them ,, that was another way of getting food…Sold nuts, fish, produce from gardens, her grandmother made and sold baskets…"

"St. Regis Island, I remember going there a lot of times for hickory nuts. We made a lot of money selling hickory nuts. We go to Sawatis' and they let us pick what was on the ground and then we'd fill our baskets, we always sold them. Can't do that today, there is no more, and butter nuts. When we had butter nuts my aunts used to make beautiful fudge with that, that was so good. It is so lonesome at the way things have happened."

"Used to chop away at the ice in winter time for the iceboxes in the summer. Also had hand dug wells where you could hang your pile and your butter and anything you wanted to keep cold down there. We got by with no electricity, no running water…" (Interviewee #79).

"And everything was organic. No pesticides…"(Interviewee #79).

"Grew up near the river on a farm planted had cows, horses pigs…parents Leo Swamp and Charlotte, first lived where Peter Backs house is now. Father used to work at ALCOA. Does not know how long he worked there but then he was injured and they had to depend on the farm"

"Used the land for planting and to gather firewood to heat our home. There were also apple trees and nut trees and we would gather them in the fall. And this was on your land? Yes. Is it still like this today? No it isn't like this anymore. All the trees have since died" (Interviewee #31).

"Parents made a living from sustenance farming supplemented by fish from river, fishing as extra income…Neighbors made living in the same way. his father, most of income came from farm they would take in the milk and the cream and all that…"

"A lot of physical activity. Were not many overweight people in those days."

"Grandmother still living on the island had everything to eat she needed. Lots of work though. Berries picking, vegetables from the garden, chickens, turkeys, hogs, beef, milk, cream." …"Used to eat and preserve fern (fiddle heads)" (Interviewee #32).

"Farming and baskets. Grew a lot of their own food kept their own livestock…" (Interviewee #33)

TP: "Yes, and at that time a lot of people still planted? Raised farm animals and planted?

#62: "Yes. They were good farmers"

TP: "What about your neighbors, do you remember what kind of work they used to do?"

#62: "Some of them were basket makers and some worked in the forest"

"My mother was a good basket maker. She worked in the garden and she also raised farm animals. She mainly raised chickens. We always had food to eat" (Interviewee #62).

TP: "OK, when you were growing up, how did your parents make a living?

#63: "Baskets and ah...my mother [made] baskets and my father worked in lumber camps."

TP: "And do you remember how your neighbors made a living?

#63: "Same as us, uh, my neighbors we called her grandma, they had a small farm. They did uh, farming and same thing, baskets, yea a lot of people made a living in baskets."

TP: "Uh huh, OK, and uh back then how did we use the river or the land in the past, how do you remember?"

#63: "The land was...most of the land in Snye was used for farming and uh planting....that's, that's what kept us alive through the winter months and uh......nice corn fields, potatoes, tomatoes, you name it they planted it…Even my grandfather...Always had a garden" (Interviewee #63).

"Neighbors were farmers. Would trade with each other. Got a good crop of something and the neighbors of something else we would trade with each other…We all used it [the land] there was no running water in those days, we had to go and get the water from the river that we used for drinking, cooking and to wash up with, it wasn't like it is today …" (Interviewee #74a).

As can be seen in these narratives, people were largely self-sufficient. The ability to produce most food items through horticulture and farming (along with that acquired through fishing, hunting and trapping), provided people with the power to be in control of the changes to their traditional practices. The people themselves therefore were in charge of deciding on the adoption of some new technologies and the rejection of others, while keeping the overall horticultural and farming practices grounded in the traditional values of how one was to interact with mother earth. The physical rigor of these traditional activities further served to keep people healthy. As can also be seen from the above narratives, some family members would engage in outside employment, but if they lost their jobs, traditional activities could always be relied on in order to feed their families.

Thus while the non-native presence in the territories of Akwesasne Mohawks did of course have some effects on their culture, their unchanged ability (until the late 1950s) to produce the necessities of life gave them important independence and protection from the unwanted aspects of settler society. Although diffusion and cultural borrowing has been shaping the world's cultures since the dawn of mankind and has of course also shaped culture change in Akwesasne, as long as the natural and slow change of cultures is controlled and directed by the culture in question it does not tend to result in the loss of culture per se (Park 2006). Until the time of heavy industrialization of the traditional territory of the Akwesasro:non in the late 1950s the people of Akwesasne were able to assert a measure of control over the impacts of the outside world on their culture because they were in control of how they made their livelihood.

All families in Akwesasne relied on traditional resource harvesting activities until the industrialization of the area in the late 1950s. While this does not mean that each and every individual was still engaged in traditional resource harvesting activities until that time, each family had members who were engaged in these activities and thus provided their families with the basic necessities of life.

As the interview excerpts below will testify, the people of Akwesasne had to abandon their traditional horticultural, farming and food gathering practices because of pollution. While some stopped such practices after being warned about the dangers of the pollution, it is again interesting to note that many simply observed changes in the flora and then decided they had to abandon their traditional horticultural, farming and food gathering practices out of fears that such changes in the size, color or taste of plants would be a health hazard. Some of these fears were, as can be seen below, also corroborated by observations that the animals who also depended on these plants died after their consumption:

TP: "OK, and today how do we use the river or land now, how do you see it, how is it used today?"

#63: "Great big power boats up and down the river, can't use it for anything else."

TP: "And how about planting and stuff like that?"

#63: "That has...the....I ...I think the planting too is just a thing in the past for the people of Snye cause of all the pollutions......the plants aren't coming up too good…"

TP: "Uh huh, OK, so as you see it things changed and why have they changed, do you think?"

#63: "A lot of things changed the way of living since I think they put up these plants around..."

#63: "…People couldn't really work their gardens anymore because of the plants that came in."

TP: "OK, um, so what you're referring to is ah, it wasn't good to plant or they didn't have time to plant, cause they were at, at the plant working?"

#63: "I think it wasn't good to plant it just ah...too much ah, dirt got spoiled and all that. It, it, you didn't see anymore great big high plant potatoes and all that...they still had some but not as good as they used to, though" (Interviewee #63).

#74a: "We had quite a few milk cows and we would send our cream to Cornwall, that was how we got money and whatever we harvested, what we planted is what we lived on. The land was good in those days".

TP: "Oh it changed?"

#74a: "Yeah"

TP: "The land changed?"

#74a: "Yes."

TP: "What caused the land to change?"

#74a: "They said when it started, it was the acid rain, it really showed, the best trees started dying off slowly, the only ones left are those…there was one just out here…willow. They are still there along the river, but the good trees like maple and elm all died. It's like they dried up"

TP: "Today is someone still planting over there?"

*74a: "Not very many people live there now, XXXX still plants small gardens, no more big gardens…No TXXXX, he plants corn for washing, Indian corn. When I used to leave from the Island, I knew where to find (*onennoron*) sweetflag and I would bring a bag full so we would always have some, then I noticed that the root changed. It used to be white in color and now it turned yellow. I thought it might be better if we didn't use it anymore, when it dried now it became really hard like a stick. You can't cut it with a knife, that's how it changed and I also saw muskrats that had died they were lying all over the place and that's what they eat sweetflag roots."*

74a: "Even with the cows, dairy farming, I tried to farm, dairy cattle…that did not go well, my animals died, several of them died and when you ask them what killed this animal, they won't tell you…there are a lot of things that have *gone bad for us... the gardens are not as good as they used to be…if they could fix these things, they are the ones that have the money".*

TP: "Yes, would you say that nothing got away, the land, the water and the air, it all, all of it changed"

74a: "Yes" (Interviewee #74a).

Like with fishing and the general use of the St-Lawrence, Akwesasro:non were clearly made to drastically reduce their traditional resource harvesting activities due to pollution.

<u>Medicine Plants and Healing (Health)</u>

The substances released by the companies have also had detrimental effects on the medicinal plants that knowledgeable Akwesasro:non gathered in order to deal with many issues from increasing the milk supply of nursing mothers to treating fevers, pain, boils, toothache, hair loss and so on. In some cases, the pollution led to the disappearance of medicine plants and in other cases, it changed the appearance or taste of the plants, alarming healers. Medicines also came from animal parts that can now no longer be obtained for similar reasons.

While some still travel to distant locations in order to attempt to pick up traditional medicines, much of this knowledge is at risk of being lost given that traditional healing can no longer be practiced without the local availability of medicines. Furthermore, as is explained below, the loss of medicinal plants like ginseng also had financial consequences since ginseng could then be sold for $35 a pound, which was quite a lot of money for that time.

The following interview excerpts will give some idea of the medicines and medical knowledge that have been destroyed through the release of hazardous substances.

"…medicines, willow tree bark for (fever, painkiller) small cherry branches to increase milk supply of nursing mothers.. skunk oil for earaches…

"Even certain organs from certain animals were medicines also blue flower cools down a fever. Would pick medicines… knew where they grew, the sweet ones and also the bitter ones…Never had to go to a doctor when people

got sick. The woman picked all the medicine we picked it right there to help the people. Ahton:neha *her grandmother would put that on boils and it would draw it right out...it would take about two days to clear up. There was never a doctor consulted to give you medicine to put on. Even if you had trouble with your eyes the woman knew what medicine to prescribe, toothache, everything they knew what to do. It was really nice."*

"…her father before he worked for Alcoa, he used to pick ginseng and sell it. Made a living on that, used to get thirty-five dollars a pound for it. (That was when she was a baby). Can't go where it grows anymore now. …Its only on virgin land where they don't mow. That is were they grow and if people begin to gather there they disappear. My mother, I remember her working, I remember how we used to help one another in the neighborhood with the canning, quilting, they were always helping each other."

"I remember my father often saying to me when someone was hurt to cross the river to the island, He said to pick Ohosera *and bring it to me. He would prepare the medicine and use it to remedy his shoulder that had been broken. He would prepare it until it became like a paste" (Interviewee #31).*

TP: "Did you used to pick your own medicine?

34: My late husband did…and we can't get sweetflag now and golden thread is hard to find."… "Sweetflag were tinier and don't smell as good as they used to. We just never used it after… ah XXX couldn't get them anymore." "Could not get the medicines any more. Used to use a lot on the kids when they were growing up"(Interviewee #34).

TP: "What about medicines, a while ago you mentioned sweetflag?"

74a: "Yes that is what happened to the sweetflag too, I brought some here, it did not taste good anymore…When it had not changed yet, you could keep that in your mouth all day…you could chew it like gum…and it was bitter"

"….about the sweetflag that was about that time [1970s]…yeah over here too at Paul Sebastian's we used to call it that…that is another place where we used to go to pick medicines, now there are none growing there.."

TP: "They died".

74b: "Around where, I would say used to go swimming, there was a sand beach…a little further over, there was a wetland area that's where yellow root used to grow…and another type was like a crawling grape vine they would be around where there were, not really trees, but where there were what do you call them, fences, where the fences are, they *would climb on there, they had these small oranges hanging off of them, this is the medicine for when your hair starts falling out….they're all gone…….".*

Hunting and Trapping

Along with fishing, horticulture and farming, people also depended on hunting and trapping in order to supplement their diet and income. Hunters and trappers tend to be experts in animal behavior and health. This is not only because of their continuous observation and recording of the health of animals while they skin and process them (including such areas as organ health, normal fat layers, etceteras), but also because of their detailed knowledge of the interdependencies of all plants and animals of the ecosystem they rely on (Feit 1973; Freeman 1992; Berkes 1999; Nadasty 2004; Spak 2001). Hunters and trappers then tend to be "at the front line" of observing environmental change, which often includes an awareness as to why certain animals are becoming sick, given that they know what these animals eat and need in order to survive.

It is therefore not surprising that the hunters and trappers of Akwesasne noted changes in the animals and decided against the consumption of their meat before any official advisories had been given. The interviews below clearly demonstrate the knowledge and awareness that something was wrong with both the animals and the environment.

"These days, and it might have started about twenty years ago, I hear them say that the muskrat, beaver and other animals became infested with disease."

"They did not feel like eating the meat anymore…They were afraid to get sick as a result" (Interviewee #31).

"… And muskrats Heard that muskrat and also fish started to have sores on them and that is when people stopped eating them.. When? Not sure, maybe late fifties early sixties…" (Interviewee #32).

"Before when you skinned the muskrat when you would pull its hide and you would the fat in its legs it had turned yellow. It used to be white, like that paper right there. That's how you could tell it was healthy. And in the snow, we found piles of muskrats that were all dead. Something they were eating was not right. They ate mainly marsh and there was something wrong with it. That is what killed them? Yes" (Interviewee #48).

TP: "You said your father was a hunter".

#62: "Yes".

TP: "During that period did he ever talk about things like the strange deer they see now?"

#62: "No. There were none. Everything he hunted...and they also hunted in the spring…. They would bring home what they caught and salt them. In those days they used to salt them.(laughing) You know that muskrat is good...My father used to say that the muskrat ate the best and that's why the meat was so good."

TP: "Roots?"

#62: "Yes."

TP: "You don't [remember] him ever saying that there was anything wrong with the wild animals?"

#62: "No. It was still good" (Interviewee #62).

TP: "Uh, what were you trapping for?"

 # 72: "Mostly muskrats... Beaver, oh anything…Fisher, everything".

TP: "Did you notice ah, a change in the animals, those animals?"

 # 72: "Ah, we, my brother and I used to hunt deer over there uh…And they're full of sores...So, we won't eat them anymore, in the Reynolds area…where the heavy pollutants hit the ground, must be heavier over that way…we skinned a few there and there was ah, sores all over them, awh…It was awful…You can't see them, you have to skin them…Then you'll see it under the skin".

TP: "Did this happen with the muskrats too?"

 # 72: "Uh, we don't eat muskrat no more, cause it's, they're too polluted, huh…we could see like funny looking...ah, almost like pus sores" (Interviewee #72).

As is clearly demonstrated, the above noted observations regarding the changes in animal health due to pollution led to the abandonment of traditional hunting and trapping practices. What is even more worrisome than these changes however are the observations noted below concerning actual mutations in the animals.

Mutations

"It wasn't that long ago they told us they were hunting for deer and they were strange. Some of the female had horns and some of the male had both male and female sex organs. …It was the hunters who noticed it. They went hunting and when they saw this they got scared…at the way they looked. They felt it was very unusual. I asked Henry Lickers right away and he said it was true. He said that the pollution from the plants, he referred to one called PCB's. That's what he said. But, it's a difficult situation" (Interviewee #62).

#63: "And I would like to see that intake, what's coming out of there at night...I, I've heard from some other fishermen that ah, they caught fish around there that weird looking fish..."

TP: "Weird looking?"

#63: "Where the intakes, regular ah...... pikes...Walleye, they're regular but...sort of funny looking they're deformed, around them intakes..."

TP: "Oh so this is where the, the stuff is going into the river".

#63: "Yeah, when they discharge stuff out of the plant and it goes into the river, I don't know if it's still there but when I used to boat we'd go by there and we used to see the great big pipe coming off there...But you don't see nothing floating out of that during the day..." (Interviewee #63).

TP: "OK, um, were there things happening to the fish themselves? Did you see anything?"

#72: "Yeah I got like, some of them look like frogs and stuff. A lot of mutation, hen. *Sure, funny looking tails on it."* (Interviewee #72).

As can be seen through these interviews, many people cut back their consumption of traditional foods before any advisories had been given based on their own observations of unusual changes in the animals and plants they were harvesting. While the timing of this abandonment of traditional activities due to pollution differs and depends on the activities, the interviews above, especially interviews # 62 and #32 give clear indications that these changes were being observed and began to effect the resource harvesting activities of the people as far back as 1950.

In concluding these sections on the direct effects the release of hazardous substances had on the traditional fishing, horticulture/farming, hunting, trapping and medicine gathering practices of the people of Akwesasne, some simple quantitative observations can and should be made. As the interview materials indicate, until the industrialization of their traditional resource base in the 1950s, all families of Akwesasne relied on traditional resource harvesting activities to some degree. As already discussed, this does not mean that each and every family member was still active in these areas, but that each family relied on the products of the land as main staples that could be depended upon. And furthermore, many people had strong preferences for items like fish over expensive store bought fare. Following the release of hazardous substances into the environment however almost all families severely reduced their traditional resource harvesting activities, as is especially evidenced in interviewees #31, #33,#34#,48#, #63, #72,#74a. A few individuals still practice some of these activities such as horticulture, even though the plants no longer grow well and they are worried about "beginning to glow" from their consumption.

Psychological Effects

Knowledge of real, unexplained and worrisome changes in the plants and animals that have sustained Akwesasro:non for millennia, or even only perceived health threats due to pollution, have drastically affected cultural practices based on natural resource use. Whether people changed their way of life because of their own observations of changes in the environment or because of health advisories, the psychological effects of being cut off from the most important aspect of one's culture and way of life are innumerable. As one community member puts it: "*The way I think of it, it's like they put handcuffs on your wrists. You're no longer free to live the way you want to live, it's like something's holding you back, holding you down." "It often feels like that*"(Interviewee #31). As this statement demonstrates, regardless of the actual measurable effects of pollution, the psychological effects of having been cut off from ones way of life are devastating.

The following interview excerpts clearly show that community members were quite aware of the pollution and its effects on their environment. What they have indicated here is that what is wished for most is for a proper cleanup of the lands and waters so that future generations will not have to live with even more toxic waste, but may one day be able to breathe easier and perhaps even begin to harvest the land as their forefathers had done.

"I remember when they built GM and Reynolds…built on that location so they could use the massive energy they needed, That's why they built the towns where they did. But when the plants began to emit smoke our environment began to deteriorate, our vegetation became infested."

"Stopped eating what they planted because in 1972 people from Cornell to do a study and found out that if cows ate the grass they would get sick and their teeth would decay and fall out. They could no longer eat and they were dying from starvation. When farmers heard about the outcome of this study they became scared and said we live off the land and if this is happening to the livestock the same thing will happen to us and they stopped planting. Condition was called fluoride (fluorosis). Came from emissions from Reynolds"

"When I used to work on iron we sometimes got work at Alcoa to do repairs. I worked there once for about six weeks but I quit… Why? Because XXX told me not to work there. He said that it is too dirty and it would ruin my respiratory system, He said to watch the workers. As soon as they retire they die shortly afterwards. He scared me enough to make me quit. What year maybe 1970."

"The way I think of it, it's like they put handcuffs on your wrists. You're no longer free to live the way you want to live, it's like something's holding you back, holding you down."

"It often feels like that" (Interviewee #31).

"Sneezing stuffed up cold symptoms for a whole month, so I think it must be something in the air…A lot of people have allergies, trouble breathing etc, etc. need to walk around with puffers we never used to have that. Its because of what's in the air from companies. Also never used to have diabetes in the past… money is too important now. Used to get water, wood etc for other people for free" (Interviewee #32).

"Used to put in a big garden every year, but there were a lot of changes in the garden they were not so healthy cause I would say it was mostly from acid rain noticed a kind of grey rusty color on a lot of the plants I don't know if that is from pollution or…….this started in the 1970s".

"Lot of brown spots on cabbages pumpkin leaves etc does not know if that is what was burning it, did not find any insects on it"…

"Trees, some of them are dying. Sugar maples are not doing too good.

TP: "Is there a pattern are all the trees affected do they die from the top down? Or the root?"

#33: "Um mostly from the top…I see a lot of dried branches now, um…"

"Also a lot of the farmers quit because their animals were not as healthy after that. Fluoride or something was affecting them.

TP: "Which area?"

#33 "Well worst was in Cornwall Island."

"A lot of them just gave up on farming because the garden wasn't as healthy. Plants were not growing as good any more and even fertilizing them but it still didn't give us plants that good (Interviewee #33).

"Did gardening raised cows and pigs got water from river, swam in the river, skated on the ice. Now, don't plant much anymore and cant drink the water."

"Why, because they told us its polluted."

"Lady I took care of told me that the grass, trees and the medicines they used to have were all dying…"

"…there is not that much stuff like sweetgrass and they're all drying out."

"Used to get choke cherries, we can't get that. Wild grapes. They have all disappeared" (Interviewee #34).

"The buildings (plants) have been there for a long time, and a lot of people worked there. And you know XXX, a lot of people have died afterwards several years later. Look at my neighbor XXX over there. Its called takwaahshon *(Cancer), That's what killed him and he had there for 35 years and your uncle too. That's what causes it"*

"Yes, they saw it. Don't mention his name when you write this, he kept it to himself what he saw there. That Reynolds or that Chevy plant one of those, I think it was GM they used to drill holes in the ground and I think there's mercury in them."

"They have buried it and they told the workers to keep it a secret."

"We can't keep it a secret because that is what is harming us today."

"Look at our underground springs, we can't drink it anymore they have dirtied it."

TP: "That's how you know it to be, many things are buried?"

#48: That's what I have been told."

TP: "Even though you have never worked there, in your opinion do you think they have harmed our environment or your health?

#48: Yes, definitely yes. Depending on which direction the wind comes from we can smell the emissions from the smoke stacks this far. And its not like that only around here Teddy. It goes beyond here, all the way to the Adirondacks, you can see the fall out trails." (Interviewee #48).

"…canal and they got electricity and the power to run it, and they got it, and what they call the foundry and the Chevy plant. That's how they started, and it started to pollute the water, the air...and also...just everything….the earth also. And the emissions from the plant descended to the earth and polluted the soil, it isn't good soil anymore. That's where it all started……The air got bad and that's how a lot of people started to get sick…" (Interviewee #62).

TP: "UH huh, OK, what would you like done to make things better, what would you like to see the companies do, meaning Reynolds Alcoa and General Motors?"

#63: "I think they should ah, um, ge, get, more serious about a cleanup then just digging a few trenches here and there and saying yeah, that's clean…It isn't, it... (Ahem)...right away they talk money, you know and hah, they don't have enough money to clear up what they did."

TP: "Uh huh, I see, so ah, the plant that you were working at, that's Alcoa or...?"

#63: "At Reynolds ...and all that stuff they, they throw on the ground like they say it's harmless and it isn't" (Interviewee #63).

TP: "What would you like to see done to make things better? What would you like to see the companies do? Meaning Alcoa, Reynolds and General Motors."

 # 72: "Oh, they gotta clean up the, the ah, dump they got there...they just covered it, uh, and...them barrels are still under there, they got toxic waste in there, when that rots, it's gonna leak out...And then...They didn't do a good job, they just covered it , uh! And where's it going to go? Once it, rots out. Gonna seep into the river, you know, a hundred years from now. It's still going to...When that barrel rots it's going to go into the water. Like a time bomb…Uh huh...I guess it's just that um, they should be accoun... held accountable, for all the damage that they have done with the reservation...and probably some of even the outlying area's, off the reservation, cause I don't think we were the only one's affected and they should be held completely accountable for the damage, that they have done and there has to be some kind of compensation, there has to be something, that they do, within, even their compounds, to make sure that, all this pollution is either cleared out or at least minimized to, be at, where it will not be so poisonous…to the people and to the environment" (Interviewee #72).

TP: "Uh, do you remember hearing about what happened to the river since they built Reynolds, Alcoa and General Motors?"

74a: "That's when it started that things went bad really fast for fishing and hunting.

Muskrats used to be so plentiful in Snye that some of the trappers would catch a hundred muskrats a night. They used to lay down traps, there were a lot of muskrats but now that are all dead. Its like it dried up where they live, I think what did that is too many chemicals getting in there. Mercury came in there". (Interviewee #74a).

74a:"[Worked] Over there at ALCOA. By the time I retired [I had worked there for] 35 years…There in plant number 5, up on the hill, that's what we used to call it. Remelt area combined with St. Lawrence plant metals pot rooms is where it comes from to be graded some are 20-24 depending on how hard it is…There was nothing wrong yet [with the river] at the time [they were building the plant]…There was not any damage yet…it was when Reynolds was built it really showed that something was happening…I don't know if it was something mixing together or what happened but it really showed the damage…not long after Reynolds was built you could see…"

TP: "Yes that there was pollution, do you remember what year that would have been?"

74b: "59 was when I worked there"

74b: "Do you mean when they were building Reynolds?"

JD "yes"

74b: "I would say that was the middle 1960s those years…"

TP: "When you started working at the plant did you see what is called contaminants?"

74a: "Yes, I used to run what is called a press, it would compact the aluminum

extrusion, is what they called it…the oil that is put in it contained a lot of PCB's…

What would happen is… a crane driver would have to pick up the barrel and pour it in from the top, it was almost like transmission oil…But that's not what is was…synthetic, synthetic is what they called it…it contained a lot of PCB's…they used to tell us to always be careful…make sure you have your gloves on when you're doing that work…we would change the oil in the …press"

TP: "And where would they put the oil that comes from the oil change?"

74a: "They would bury it right there…somewhere, I don't know exactly where…somewhere, a dump in the back…they would bury it...they didn't throw it in the water."

TP: "Oh it was in barrels."

74a: "But they said, it would get drawn out when it rains."

TP: "Oh, they bury it, did you believe at that time that there was harm being done to the land, water and air?"

74a: "You could really see it…right there at the plant and nearby it would look like it was burnt, the land…the reason we would notice this right there was because of the muskrats, they would come out of the water looking for something to eat and they couldn't find anything because everything had dried up."

TP : "Do you think there was harm done to your health, how healthy you were, because you worked there?"

74a: "Maybe I was lucky in the way things happened, they called us back later, quite a few of us, Massena, they gave us x-rays…they found several of them with something in their chest…"…

74b: "[he, my husband] had aluminum ore on his clothes when came home from work…as well as PCBs…smells like dried up battery acid…would not really come out in the wash also on his skin…" (Interviewee #74).

74b: "PCBs they say over here that the PCBs will not go anywhere, it will stay near where it comes out that is where it settles and look at how far away Montreal is and they are finding it underwater there. It seems that from the way they are talking it is like jelly and it sticks to the bottom. It is hard to beat them…and it is hard to make them understand because there are no other people that live the way we used to live right now the kids can no longer go swimming, you can no longer drink the water, you can't see you go out on a boat and you can't see anything. They go fishing and if they catch anything they throw them back in….the way we eat, it has all changed, look, technology, every time they speak it's technology, technology, well let's let them get it together, well then that's what they should use…at least on the river, they should fix that. Just like …it goes together with, just like the Seaway came through and then on this side it was the money you know…tats when they started making these buildings, they went together with that…now all of our shoreline is falling in, Racquette Point I know that, the islands I know that it started leaning and all of a sudden it falls in, what is happening?"

74a: "That is erosion… used to be so much oil on glasses when you got splashed with water that " glass cleaner would just make it dirty, I would have to use hot water and put it in dish soap in order to clean them…that's how much oil was on them" (Interviewees #74a;74b)

74a: "You tell him what problems the woman are having, our daughter for example…she is a young woman but she is like an old woman…she is constantly sick.."

74b "How many years has it been?"

74a: "Five"

74b "Yes its been about that, all of a sudden these young people got this disease it was like they caught a cold and they are all about the same age, this happened to them the arthritis….we were looking at her, our daughter, one of them, we were looking at her ankle went like this, it swelled like this, this summer, that's when it started I said its around the time when it's going to rain. They have a hard time walking and they are all young….yes, last I heard they said there are now 53 of them, most of them were woman…"

"… Its like there is a lot of in our community thyroid!....and what's the other one?"

74a: "Diabetes".

74b: "Diet …well, diabetes there was another one before that onslaught and that some of them were kids…now they say fish, you got to have fish you got to have fish you got to have fish, well make a treaty, well we can't go fishing anymore… well now you have to buy it and you, you buy it and its loaded with preservatives and they say…" (Interviewees #74a;74b).

Many studies on depression and other psychological issues have shown that for Indigenous peoples overall health and especially psychological health tends to be tied to cultural continuity and identity. Individuals with a strong sense of identity grounded in their culture and cultural way of relating to the others and their environment tend to have less problems with depression and other psychological issues. Thus there is a strong link between overall psychological health and cultural continuity or revival.

Effects of Contamination on Populations

As can be seen through the materials provided above, the overall effects of the pollutants released by the companies on the people of Akwesasne and their way of life (i.e. culture) as practiced through traditional resource harvesting activities was immense. The overall reliance of families on foods and other products provided through traditional resource harvesting activities went from total the baseline period to minimal today. The following summary clearly demonstrates how the release of hazardous substances into the environment has affected the different segments of the population of Akwesasne.

i. Animals

The animals traditionally depended upon by the people of Akwesasne are the ones who have carried the greatest burden. Animals have suffered immensely because of pollution. Unlike people, they can not protect themselves against ingesting pollutants, but are at the mercy of all humans who mistreat the ecosystem they depend upon. As the interviews with hunters, trappers and fishers show, many animals have acquired sores, strange growths, or have even died because of the consumption of poisoned plants. Even more worrisome is the observation that some of the animals living in the areas with concentrated pollutants have developed strange forms, exhibit both male and female attributes, or have other mutations that are likely the result from the release of hazardous substances into their environment. Such intergenerational effects are grave and worrisome. To Akwesasro:non, who saw themselves as living in respectful, reciprocal relationships with the plant and animal brothers and sisters that surrounded and provided for them, it must have been very difficult to watch their kin suffer so greatly without being able to help or fulfill their traditional obligations towards them. The psychological effects of having to witness such suffering should not be overlooked.

ii. Children and Adolescents

As becomes evident through the interview materials on hunting, trapping, fishing, horticulture, and farming presented above (especially interviews #31, #33,#34#,48#, #63, #72,#74a), the release of hazardous substances into the environment of Akwesasne lead to the abandonment of all traditional resource harvesting activities. More specifically, the water became murky and took on a bad strange smell, fish developed sores and strange worrisome mutations, many of the animals people trapped or hunted were covered in sores, had changes in the color or consistency of their fat layer, or displayed strange combinations of intersex traits (female deer with horns, male deer with both female and male sex organs, etceteras.) Plants stopped growing as well as before, developed strange brown spots and also underwent changes in the color, consistency and taste of their roots. Fear of the effects all these changes would have on their own health and on that of their children lead the people of Akwesasne to abandon their traditional resource harvesting activities. This in turn lead to unhealthy changes in the diets of children since healthy meats, fish, fruits vegetables, nuts and dairy products traditionally relied upon became unavailable, or would have to be purchased at inhibitive costs. As a result of these changes in diet along with the pollution of the land, water and air around them, the children and youth of Akwesasne now suffer from numerous pollution related ailments such as asthma, eczema, allergies, diabetes, changes in the timing of girl's first menarche, etceteras (Denham 2005).

These pollution related changes have been detrimental to the health of the children and youth at Akwesasne. However, the simple fact that they have been denied their birthright of growing up within the traditional culture of resource harvesting activities and practices of their people has itself had huge impacts on Akwesasne's children and youth. Today's children have not only learned to fear the environment their people traditionally saw as the mother that provided for all their needs, they have also not had the ability to learn many of the resource harvesting activities that make up their cultural way of life. While past generations grew up with the river as their main focal point, swimming in it from an early age and learning about the proper way to interact with the waters, fish, plants, and animals, today's children can not go fishing with their parents, grandparents or other relatives and are thus denied the ability to learn an important aspect of their culture by doing. Thus as a result of the release of hazardous substances, the children and youth of Akwesasne not only cannot learn traditional fishing and fish processing methods, but are also unable to learn the traditional terminology and ways of relating to fish that go hand in hand with such activities.

In the past children would also have grown up in the gardens and farms, learning of the importance of honoring the seasons, taking care of plants and animals, and how to make a living off the product they provide. Again, people no longer grow gardens or work at farming due to fears for their health stemming from the release of PCBs and other hazardous substances into the environment. For the children and youth this loss of traditional horticultural and farming activities is not only one of simple practical skills but also one of language (i.e. focal vocabulary tied to such activities) and overall worldview since it is difficult to teach such things without the needed natural settings. The same can be said for the traditional hunting and trapping activities that have been drastically reduced due to pollution. Akwesasne's children and youth are not only denied these practical skills, they are also missing out on the overall cultural teachings of the proper relationships between humans and animals that go hand in hand with such activities.

iii. Elders

As the traditional teachers responsible for transmitting cultural and practical knowledge, the release of hazardous substances and the resultant abandonment of all traditional resource harvesting activities has meant that Elders can no longer fulfill their obligation to pass their knowledge of what it means to be an Akwesasro:non on to the younger generation. While they try to do so to some degree, this learning-teaching process is nearly impossible to practice without the traditional land based activities within which the culture was framed. The loss of all resource harvesting activities has thus meant that Elders have to stand by and watch their children and grandchildren become more and more influenced by English and mainstream culture, without being able to take them "out on the land" to teach them about their true identity.

Getting "away from it all" by going out on the land with their Elders has proven to be very important for the cultural and psychological health of many of today's Indigenous youth and Elders. Those with a healthy resource base to do so tend to have a good chance at maintaining their language and cultural identity. Thus the loss of all traditional resource harvesting activities at Akwesasne has not only denied Elders the ability to teach the children and youth the practical resource harvesting skills of their people, they are also denied the necessary setting needed to transmit the overall cultural teachings of the proper relationships between humans and animals that go hand in hand with such activities.

Furthermore, the changes in diet and the abandonment of traditional activities have led to an onslaught of disease like diabetes, heart disease, stroke, high blood pressure, and cancer, many of which were unknown to previous generations of Elders.

iv. Women of childbearing age

The woman of Akwesasne can be seen as having been at the frontline of the effects, fears, worries and changes in traditional activities caused by pollution. To mothers who want to protect their children, nothing can be worse than finding out that the breast milk you provide your infants with is laced by poisons. As the studies on PCB levels in human breast milk indicate, until women stopped eating local fish, (a food traditionally considered important for the nutritional health of mothers and infants and thus encouraged during gestation and lactation) the PCB levels in their breast-milk was high (Fitzgerald: 1998).

Further, while a few women had pursued outside employment prior to the abandonment of traditional resource harvesting activities due to the release of hazardous substances, most stayed at home and provided for their families through gardens and farming (see interviews #31,#32, #62, #63, #74a). Thus even if their spouses took up the occasional outside employment, women tended to be the ones who kept the farms and gardens going (or went fishing) in order to provide the necessities their families needed. The continuation of such traditional activities allowed them to look after their children while working to provide for their families. Not only did they not need daycare for their children but involving their children in these traditional activities from an early age gave them the ability to teach their children important survival skills while also transmitting the wider epistemological framework of their culture. Thus being cut off from the land through the release of hazardous substances into the environment has been extremely detrimental to women in their role as caregivers, teachers and providers. Not only can they no longer teach their children about their identity through the daily interactions with the land, but, being unable to grow food for their families they now need to pursue outside employment that takes them away from their children for most of the day. As the center of families and the teachers of children, the loss of the ability of women to teach their children (and grandchildren) how to relate to and take care of the plants, animals and the land while providing for them through land based activities is perhaps the most important aspect effecting long-term culture change at Akwesasne.

v. Men

While some men were already pursuing outside employment prior to the release of hazardous substances into the environment, such employment tended not to be permanent and most families still depended on hunting, fishing, trapping and gardening for a large part of their sustenance. Thus being unable to provide for their families as fishers, hunters, trappers, horticulturalist and farmers forced men to either leave their families for outside employment or become dependent on welfare. Being unable to take their children hunting, fishing, trapping, or to teach them about plants and the land in general made it difficult for men to fulfill their traditional obligations as providers and teachers. They no longer had the medium needed to teach their children who they were or how they should interact with and relate to the plants, animals and the land.

vi. Overall

This report shows that damage to natural resources caused by the release of hazardous substances has severely impaired the cultural uses of resources by the Mohawks of Akwesasne. The release of hazardous substances into the environment of Akwesasne has forced Akwesasro:non to drastically reduce their traditional resource harvesting activities. As a result of the decline of these activities, they have been denied the ability to provide their families with healthy foods; denied the ability to fulfill their traditional obligations toward the land, waters, plants and animals; denied the ability to pass their practical, theoretical, philosophical and linguistic knowledge of what it means to be Akwesasro:non on to younger generations. In short, environmental contamination has denied them the ability to continue to live as Akwesasro:non. For the people of Akwesasne then, the release of hazardous substances into their environment has meant rapid forced acculturation.

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APPENDIX: OVERVIEW OF METHOD & MATERIALS USED

The work on this study was begun by systematically reviewing and analyzing the materials provided in the SRMT database described below. The materials were organized into different areas of relevance, such as the history of Akwesasne, the history and impacts of the Seaway, the history and impacts of companies, scientific reports on contaminants, old interviews, etc. Once these materials had been extensively reviewed, numerous additional and supplemental academic sources were accessed. These additional sources were selected for their theoretical, ethnohistoric or methodological relevance in order to augment, enhance and further clarify the key interpretive and representational issues and objectives to be emphasized in the Report. Thus, for example, the theoretical anthropological literature on the interface or relationship between culture and environment was consulted (Basso 1996, Ellen 1993; Feit 1973, Freeman 1989; Ingold 1993,1996; Moran 1990; Pixten et al 1983; Povinelli 1993; Richards 1993; Rivale; Scott 1989; Steward 1955, Tanner 1979) as well as sources on ethnohistory and community based research methods.

On the basis of all the materials accessed, the team decided that additional research was needed in order to address important primary research gaps (noted in previous summary progress reports). Thus a series of interviews were conducted in the late summer and fall of 2005, referred to as the Oral History Project. The interview questions devised for the Oral History Project were contextualized by the previous overview of SRMT materials, and in July of 2005 the team participated in a two-day training session specifically devoted to drafting, testing and reworking the interview questions.

Incorporating input on the Oral History Project from the various parties, including the companies, efforts were made to devise questions that were specifically focused on providing concise demographic information, specific locations of practices, precise timelines and personal histories relative to resource based cultural practices. Efforts were further made to quantify data on socio-cultural impacts that specifically engaged resource use and to separate impacts of contamination from the impacts of the Seaway. All questions were developed in a collaborative setting, with substantial input from community residents and SRMT staff. Interview questions further underwent several intensive sessions of field-testing with volunteers and were drafted approximately five times in order to incorporate the concerns, insights, and sensibilities of participants. This process involved the training of community researchers, who in turn contributed invaluable Mohawk linguistic expertise enabling the reconciliation of issues of translation. Their contributions to the reworking of questions greatly increased the intelligibility of interviews conducted in the Mohawk language. Collaboration with community researchers also brought awareness of the significance of particular linguistic cues, and code-switching instances in language use and their relevance as key socio-cultural indicators of resource use and cultural change. These indicators further form an important means for determining socio-cultural impacts relevant to this assessment.

The following is a summary of the relevant content in the source materials from the SRMT files pertaining to the Cultural Impact Assessment.

1. SRMT Tribe Monthly Meeting Minutes

2. SRMT Tribe Correspondence Record

3. NRD Coded Interviews (various)

4. NYPA/St. Lawrence FDR Relicensing Public Scoping Meeting Records

Book One

Various interviewees speaking on issues that include: concerns about the fish, plant, food, medicine, animal, tree and bird nations; environmental impacts of the NYPA dam; environmental assessment frameworks; "Naturalized Knowledge Systems"; need to understand the workings of the environment and ways in which the people worked in the community; oral history of the area; effects on fishing as the livelihood of the community; Akwesasne as a river community; social change bringing suicide and forced lifestyle changes; dependence on the river and how industry has harnessed, contaminated and polluted the waterway; the nature and scope of Mohawk culture and values; responsibility to execute restoration and rehabilitation plan for the river and culture; and, how Akwesasro:non obtained food from the land before the seaway and subsequent contamination.

Book Two

Various interviewees speaking on issues that include: how EAGLE project blended the knowledge of indigenous peoples with western scientific information; Eating Patterns Survey (EPS) and how the loss of fishing and other resource-based activities has significantly impacted Akwesasne; Socio-Cultural Impact Study indicating reliance on fishing, hunting and farming; list of social impacts due to alienation from the land; historical documents and the complete transcription of the Adams Case (SCC 1996); the importance of traditional medicines and the loss of plant species and medicinal plants; the founding of the Haudenosaunee Environmental Task Force and their relationship with the Environmental Protection Agency; how family life has changed; the loss of the means of transferring the knowledge; calls for compensation to help strengthen the language and culture through educational systems; the need for greater educational resources within the community due to the loss of healthy, sustaining relationships with the natural world; need for resources for Indigenous Knowledge Awareness Training.

5. SRMT Library Materials

The complete listing of materials used from the SRMT library are detailed in the *SRMT Library Materials Index*, consolidated in both CD-ROM and hard-copy format and included with this Report. The database includes a large number of newspaper reports and copies of journal articles available in the public domain and in other databases or libraries. It also includes community-based research reports and copies of materials from other environmental and ecological research oriented processes conducted in Akwesasne. For the purposes of this Cultural Impact Assessment, materials were reviewed and selected by the Project Coordinator and consolidated into a limited-parameter database for the purpose of preparing this Report. Beyond the materials which provide general background information on the community and its history and the NRDA process, key documents used in the development of this Report include:

<u>Elders Research Project</u>

Relates mainly to the Seaway, but provides indications of what life was like before the industrialization of the river.

<u>Ethnographic Exploratory Research</u>

Describes social conditions and the living arrangements of community members in Akwesasne within the context of Mohawk traditions; 1990 statistics for housing and residence patterns on the reservation.

<u>The St. Lawrence River – Past and Present</u>

Army Corps of Engineers study on problems stemming from the seaway. Provides a list of endangered species, including fish and birds, and assigns minimal role to the Seaway in their endangerment; does not deal with issue of contaminants.

St. Regis Indian Reservation Sanitary Survey (October 11, 1968)

New York State Office of Economic Opportunity commissioned study conducted by the Health Department.

St. Regis Environmental Healthy Study (1983)

Extent of fluorosis in children which is caused by excessive fluoride, a nutrient and industrial byproduct. Concluded that residents are exposed to fluoride emissions but that aluminum plants are within safe limits according to New York State air pollution regulations.

Breast Milk Study: Executive Summary (1992)

Describes how Mohawk women rarely eat fish anymore because of advisories issued by Mohawk, state and federal agencies.

The Community of Akwesasne (1996)

Historical overview of the community. Describes how in 1930, there were 129 farms but in 1970 there were only 55 (only 9 in 1996). Commensurate decline in number of fishermen (1930=104 fishermen. 1970=46. But an increase in fishermen from 1990 to 1996 from 11 to 400).

E.A.G.L.E. Project Report

Socio-Cultural Component Report on impacts of Seaway and contamination.

The St. Lawrence Seaway and the Economic Transformation of Mohawk Life

A history of the seaway and its effects on the Mohawk. Also points out the effects of the pollution on the sweetgrass, which has made it less readily available in the entire North Country area, and how ecological changes have virtually ended the Mohawk dairy industry. Also talks about how the tribal fishing industry has come to an end because of the pollution.

6. Cornell University History Course Pack ("Akwesasne: A Community Study")

The pre-industrial history section of the Report utilized a package of course materials prepared by Cornell University's Department of History Prof. Jon Parmenter, in conjunction with community members, for use in the delivery of an on-site course on the history of the community. The materials contained in the course package are detailed and comprehensive, and include scholarly as well as community-based resources. The course's temporal scope included the whole history of Akwesasne, from inception to the present day.

APPENDIX K CULTURAL IMPACT STUDY. ASSESSMENT AND OVERVIEW OF THE EFFECTS OF ENVIRONMENTAL CONTAMINATION ON THE MOHAWKS OF AKWESASNE

CULTURAL IMPACT STUDY

ASSESSMENT AND OVERVIEW OF THE EFFECTS OF ENVIRONMENTAL CONTAMINATION ON THE MOHAWKS OF AKWESASNE

Taiaiake Alfred, Ph.D.

September 27, 2006

Message from Alcoa & GM:

The companies have actively participated in the cooperative natural resource damage assessment process for several years. This process has brought together federal, state, and tribal trustees and the companies to undertake the studies necessary to develop and implement a successful restoration of natural resources in the St. Lawrence environment. The companies understand that some studies, such as the cultural impact assessment study, are important to the needs of specific trustees in the assessment process. While recognizing this importance, the companies do not agree with the conclusions of this report. Nevertheless, the companies hope that the completions of the report will enable the tribal trustees to continue forward in the Cooperative Assessment process to determine the appropriate scale of restoration of cultural resources.

EXECUTIVE SUMMARY

Background

This study provides an assessment of the cultural impacts of environmental contamination at the Akwesasne Mohawk Territory. It is the product of research undertaken under the CERCLA Natural Resource Damage Assessment (NRDA) process to assess the cultural impacts of environmental contamination related to multiple Superfund sites. The study is based on a review and analysis of materials related to the environmental contamination of Akwesasne and subsequent impacts on local cultural practices of the Mohawks of Akwesasne as detailed in the accompanying *Anthropological Report*. The materials used in the research were all previously collected and contained in the St. Regis Mohawk Tribe's database, except for a small set of interviews conducted specifically for the project.

Objective

The major question addressed in the study is: To what degree have releases of hazardous substances by Alcoa, Reynolds, and General Motors affected the use of natural resources by the Mohawks of Akwesasne, and what impacts has this had on their cultural practices?

Conclusions

Contaminants released into the natural environment definitely include the PCBs Aroclor (1248) and Therminol, polychlorinated dibenzofurans, dioxins, polyaromatic hydrocarbons, fluorides, cyanide, aluminum, arsenic, chromium, and styrene. There is also evidence indicating a probable release of heavy metals, including lead, arsenic, cadmium, chromium, and methylmercury.

The historical baseline set for resource-based cultural practices relative to ecological conditions "but for" the release of contaminants is 1955. Virtually the entire pre-pollution population of Akwesasne, considered in terms of family units, was reliant on traditional resources and resource-based cultural practices. Virtually all activities were cultural practices related to the land, ecosystem and aquasystem of Akwesasne for subsistence at the time identified for the baseline pre-pollution conditions.

Traditional cultural resource practices have survived, but are minimally practiced today. Damage to natural resources caused by the release of hazardous substances has severely impaired the cultural uses of resources by the Mohawks of Akwesasne. The release of contaminants into the natural environment has forced Akwesasro:non to drastically reduce traditional resource harvesting activities. As a result, they have, on the whole as a community, been denied the ability to provide their families with healthy foods; denied the ability to fulfill their traditional obligations toward the land, waters, plants and animals; and, denied the ability to pass on practical, theoretical, philosophical and linguistic knowledge of what it means to be Akwesasro:non.

Restoration

The Mohawks of Akwesasne see restoration as the companies taking all necessary measures to restore the natural environment to its pre-industrial condition and to revive the health of the land, the river, the animals, the plants and thus the people, their culture, and their economy.

1. OVERVIEW OF METHODS AND MATERIALS USED

The *Anthropological Report* is based in anthropology but draws upon multiple sources of insight in developing its approach to "culture," and "cultural impacts." In a broader sense, the most meaningful and appropriate way to approach an understanding of culture is to also reject the more static and reified approaches to it as a fixed assemblage of ideas, customs, beliefs, skills, arts, laws, and economies. In order to dispense with Eurocentric interpretive tendencies, the analysis is not geared exclusively towards enumerating the contents of culture and how it is transmitted. Instead it privileges an understanding of culture that hinges on the everyday practices and processes through which the people of Akwesasne actively express and produce distinct cultural understandings of their territorial environment. Following a directive promoted by Anishnaabe environmental scholar Deb McGregor, it approaches culture as not just knowledge about Mohawk relationships with Creation, culture is the relationship; its locus is the way the people relate to creation (McGregor 2004:394). This is the basis of, and conceptual framework for, the working definition of culture used in the Report.

The Report focuses on the commonplace everyday resource harvesting activities of the people of Akwesasne and the extent to which these commonplace everyday expressions of culture through practice have been affected and changed through the release of hazardous substances into the resources depended upon for these practices. In so doing, it establishes a baseline of what these activities were prior to the release of pollutants and shows how they informed the people's sense of self, their relationships to each other and relationship with the ecosystem they depended upon. It then moves forward in time and examines the extent to which these expressions of culture and identity through traditional resource harvesting practices have been impacted and or changed through the release of hazardous substances, rather than as a result of natural adaptations and changes in culture. The guiding questions are: Can culturally established expectations of resource harvesting and distribution still be met? and, How have these changes affected the cultural continuity of the people of Akwesasne?

The research and reporting element of the Cultural Impact Assessment was begun by systematically reviewing and analyzing the materials provided in the SRMT database described herein. The materials were organized into different areas of relevance, such as the history of Akwesasne, the history and impacts of the Seaway, the history and impacts of companies, scientific reports on contaminants, and interviews. Once these materials had been reviewed, additional and supplemental academic sources were accessed. These additional sources were selected for their theoretical, ethnohistoric or methodological relevance in order to augment, enhance and further clarify the key interpretive and representational issues and objectives to be emphasized in the Anthropological Report.

It was determined that additional research was needed in order to address important research gaps, and in 2005 an Oral History Project was conducted. The Oral History Project was designed with input from all parties, including the companies, and questions specifically focused on providing concise demographic information, specific locations of practices, precise timelines and personal histories relative to resource based cultural practices. Questions were developed collaboratively with substantial input from the community and SRMT staff. The Oral History Project involved training community researchers who in turn contributed invaluable linguistic expertise in Kanienkeha, addressing vexing issues of interpretation and translation. The contributions of the community researchers to the reworking of questions greatly increased the intelligibility of interviews conducted in Kanienkeha. Collaboration with community researchers also brought awareness of other indicators and generated further means for determining socio-cultural impacts.

Efforts were made by the researchers to quantify data on socio-cultural impacts that specifically engaged resource use and to separate impacts of contamination from the impacts of the Seaway, but the data did not provide an adequate basis to support a rigorous quantitative analysis. For this reason and in response to the fundamental objection of the community to any quantification of cultural damage – the community perspective is that the data and questions do not lend themselves to quantitative analysis – quantitative aspects of the research were discontinued and are not reflected in the Report. It was concluded that the only possible and appropriate use for the information in the SRMT database and in the Oral History Project interviews at this time is a qualitative analysis.[39]

2. CULTURAL IMPACTS OF ENVIRONMENTAL CONTAMINATION

The cultural impacts of environmental contamination at Akwesasne must be assessed in the larger historical and political context of the attempted genocide of indigenous peoples by the United States government and the continuing presence of cultural and social forces in American society that prejudice and threaten the very existence of the Mohawk people as autonomous and free people in their homelands. Particularly in regard to the Mohawks of Akwesasne, the industrialization of the area of their habitation and resource use was promoted by American governments and industrial corporations with complete disregard for the sovereignty, inherent and constitutional-treaty rights of the Mohawk people, and with blatant disregard for the health, well-being and safety of the Mohawk people.

The specific impacts of industrialization, including those related to the release of hazardous substances in the natural environment, are part of a larger complex of the effects of dispossession, economic marginalization, and political subjugation over time. In characterizing emergent cultural change as reflected by economic integration within this time period, both assimilation and acculturation as expressed in the above definitions are arguably insufficient. This is because the prospects for the Akwesasne Mohawk people to either abruptly assimilate or to more organically acculturate have always been limited. Ironically, the expectations placed upon the Mohawk people by the dominant society to assimilate or acculturate have failed to identify the constraints which block both of these very processes. Vast inequities in the distribution of power, and the maintenance of these inequities through discrimination, racism and exclusion have continually limited Mohawk participation in external economies on several fronts. These are the very factors that historically made Mohawk participation in more mainstream economic practices unreliable, particularly with respect to trade with external communities and wage labour economic participation. In light of the potential instability of non-community based market economic practices, although community land based activities may be externally perceived as having diminished value, and tend to be de-emphasized in assumptions about wage-labour economy and opportunities, in reality land-based economic practices continued to make

[39] In a strictly scientific perspective, the survey data and the overall protocols, framework and indicators presented in the Report may indeed support a quantitative analysis. The researchers found that it may be possible to generate statistical correlations based on variables such as resource sharing, economic conflicts, significant environmental symbols, contamination's effect on income, causation of conflict, varieties of species harvesting, income levels, changes in diet, etc. may be possible to generate using data in the SRMT database. But the time and expense, equipment, and expertise in statistics, as well as specific training in specialized quantitative research methods required were beyond the capacity of the project as currently formed and staffed.

crucial contributions to the overall economy and remained a source of stability as external economic opportunities fluctuated.

It is an ironic fact that systemic discrimination and racism in the larger society in fact served as barriers to Mohawk participation in modern society, and contributed to the maintenance of a land-based economy and culture in Akwesasne, until recently. Despite wage employment migration to cities, factories, etc., the land-based practices such as hunting, trapping, fishing, farming, and gathering consistently anchored the local economy and were considered by residents to be the more stable, sustainable, and reliable economic activities even when other choices became available. Local land-based technologies and expertise, co-operative labour and distribution of shared resources throughout the eras of emergent wage labour economic opportunities are resilient features of Akwesasne life. For example, despite having parents employed by the companies or despite being employees of the companies themselves, numerous interviewees tell of how they and their families nevertheless remained primarily dependent on the natural resources, and on their fishing, hunting, gathering, trapping or farming activities. This is a consistent theme running throughout the time period prior to and approaching the industrialization in the region. To the extent that Mohawk residents of the territory did attempt to integrate resource harvesting practices with consumerism and wage-labour, the traditional activities were still considered to be economically viable, before the release and effects of contaminants.

The data clearly conveys numerous examples of the integration of resource-based cultural practices with the external sale of resources. All of the interviews done for the Oral History Project, for example, make reference to either a personal involvement, and or the involvement of parents, neighbors and or relatives in the sale of fish as supplemental to income. The abundance of this resource was frequently characterized, as were occasional references to the sale of specific species, particularly sturgeon (and sturgeon roe), either locally in adjacent towns and cities off-reserve, or to areas even farther away.

Like fishing, the exchange and distribution of resources associated with farming was a prevalent and consistent historic feature of the local economy. The external sale of dairy products was mentioned more than the sale of other resources associated with agricultural. The products of gathering activities, including fruits, nuts and edible plants were also common sources of supplemental income. With rare exception in the community, black ash and sweetgrass gathering activities associated with basketry was also a key source of supplemental income, whether limited exclusively to trade or sold for a monetary value. The majority of interviewees identified parents, relatives and or neighbors who made a living by basket making.

The data set showed few references to the sale of resources from trapping or hunting. We can assume (although there are a few specific references based on personal recollection) that the bulk of the resources accumulated from these activities were distributed and consumed locally. There is limited but specific reference in the data to how the skills and expertise developed from fishing also provided a secondary and separate source of income, as residents were occasionally sought as guides by non-indigenous visitors to the territory:

Alterations in another land-based cultural practice, medicine gathering, had begun to decline significantly in the years prior to the public advisory. Notably, this decline cannot be attributed to improved access to alternate health care, or to the availability of other health care options because these had yet to occur relative to the community. A demographic report on the community presented to the St. Regis Mohawk Tribal Council indicated that by the late 1970s, the use of natural medicines had declined to just 26.4 % although 56.3% of the community indicated they would like “Indian medicine” as part of their overall health program (SRMT TC Minutes 5-5-79). The juxtaposition of the noted decline in usage of "Indian medicine" alongside the desire for it given the time frame suggests that changes in the ecosystem were influential.

It is both indicated in the data, and well-known generally, that many of the men at Akwesasne had been participating in the wage labor economy for several decades as high-steel ironworkers prior to regional industrialization and as far back as the 1890s. This work was, and still is, sporadic and largely seasonal and often requires extensive travel and being away from home for considerable periods. Although the per-hour wage for this work has always been comparatively high, this only compensates for requisite expenses involving lodging and food expenses in major cities and travel costs. In the period approaching and prior to industrialization, this wage- labor participation generated income that was primarily supplemental, while resource based cultural practices for those who remained in the territory when not working, remained central. This point is not only verified in a number of the interviews, it can also be deduced from proportional estimations which indicated that as much as 50% of the community was reliant upon fishing as recently as the late 1980s (Ransom 1987).

The data showed that because of resource-based cultural practices, the depth and intimacy of peoples relationships to the lands, ecosystems and riverine environment themselves were the things that ultimately informed their initial awareness of contamination, during intervals that predated the advisory. In other specific cases, awareness of contaminants stemmed from people's employment with the companies themselves. Although several persons interviewed did learn of contamination through various public advisories and media sources, the majority of the community was left to its own devices in seeking out precise information about what exactly contamination meant.

It is crucial to recognize that the people of Akwesasne's awareness of contamination and the development of their understanding of the full weight of its implications on resource-based cultural practices has been emergent, cumulative and a matter of process. Although it might be tempting to attribute "awareness" and requisite changes to practices and behaviors to particular historical moments and events when external information was publicized and disseminated, to do so is to miss and to misrepresent the active participation and the will of the Mohawk people in approaching and engaging with these circumstances. Representing a history of awareness that completely hinges on the causal connection between public advisories and their precipitation of immediate changes in cultural practices is to perpetuate several misconceptions and inaccuracies. Foremost among these is the establishment of the misconception that the companies were forthright in revealing information about their emissions and that they themselves knew and acknowledged the precarious potential of their impacts. This did not happen. In fact, the oral and written records of the community clearly show that addressing the effects of industrial contamination in this area would not be happening today had it not been for the willful and persistence efforts of community members on many fronts, working to address and advance multiple strategies for dealing with and ameliorating these circumstances. There is clear evidence of how this direct action to counter contamination is itself an important facet of the adaptation of cultural practices involving the land, ecosystems and aquasystems at Akwesasne. Public advisories therefore constituted an additive, rather than a definitive, phase of recognition and awareness. Though these advisories recommended that people take precautionary measures, they were not forthcoming in contributing to the development of resident's understandings of the full weight of the meaning and implications of contamination. Rather, these understandings were advanced by resource-based cultural practices involving direct action.

There is a difference when residents *noticed changes* in the environment and when they *knew why* these changes had begun to occur with respect to contamination. These are really separate questions. Each can result in a distinct response with regards to *noticing* and *knowing* about pollution. The tendency in historical representations and analyses of this awareness, however, has been to conflate these responses into a single supposition that privileges the role of external agencies, and even the companies themselves, as the community's sole informants about these circumstances, despite the fact that this is untrue.

Akwesasne Mohawks' earliest recognition of environmental contamination can be attributed to multiple sources located in a context formed by the web of the social and knowledge networks of the community, each of which played important roles in the development of yet another dimension of the peoples' collective knowledge base about the land and the environment. And like it had for so many millennia, the land and the rivers themselves were among the first to begin to tell this story, while those who had cultivated a longstanding relationship with this environment were among the first to listen.

Impacts of the Seaway and Health Issues

The Report sought to separate and distinguish the effects of the construction of the St. Lawrence River FDR Power project and St. Lawrence Seaway from the effects of industrial contamination on Akwesasne Mohawk resource-based cultural practices. However, it is important to recall in any discussion of cultural impacts that the construction of the Seaway and all subsequent industrial development go hand in hand. They are merely different steps in the same overall plan for the industrial development of the area. The construction of the dam and the Seaway were preliminary components of an expansive, long term plan for the large scale industrialization of the region. This fact was understood by both its American and Canadian champions, Robert Moses and Lionel Chevier, as well as by the Mohawk people affected by the "package deal" (Cole & Arquette 2004:355).

The initial changes to the environment undoubtedly resulted from the construction of the Seaway. Its construction altered the quality and character of the geography; changed the flow and quality of the water and submerged important islands and islets which, with their trees, rice, and cranberries, not only disturbed aquaculture, but changed the quality of the water and winter ice. The construction itself and resulting structures (such as dam turbines) also lead to fish mortality, soil erosion (the Seaway brought in large vessel shipping traffic and its inherent effects) and other such problems (ATFE 2004; EAGLE 1996). Thus the construction of the Seaway in-and-of-itself had detrimental effects on the resources the people of Akwesasne depended upon. Fish became less plentiful and other aquatic species felt the effects of the changes in water flow, the introduction of large seagoing vessels, etc. These changes were upsetting to the people who depended on the resources provided by the river. But it is important to emphasize however, that, though such changes may have effected how, when and where people went in order to fish and gather marine resources, the Mohawks could have adapted to the changes brought on by the Seaway. Mohawk culture, like all others, is not static, but continuously changes due to such naturally occurring factors as diffusion and slow variations in traditional resource availability. There is every indication from the pattern of adaptation demonstrated by Mohawks through the 1950s that as long as there was room to do so, they would have found a way to incorporate and adapt to the new technological and environmental conditions in ways directed by their culture.

Anthropologists and ethnohistorians studying the Mohawk Nation in the 20th century clearly discern the differential impacts of Seaway and industrial contaminants. With respect to the comparison of Seaway-based developmental impacts on the Mohawk communities of Kahnawake and Akwesasne, anthropologist Dean Snow makes the following discerning statement:

Akwesasne lies 50 miles upstream from Kahnawake on the St. Lawrence River. The St. Lawrence Seaway project did less direct and immediate damage to Akwesasne than it did to Kahnawake. Damage in this case has come mainly from heavy industries that grew up along the seaway just upstream (and upwind) from Akwesasne. Aluminum and other pollutants have rendered fish inedible and gardens hazardous, damaging the quality of life of Mohawks who have lived there for nearly as long as they have been at Kahnawake (Snow 1994:201-202).

The Report does not analyze or engage health impacts *per se*, but it does respect and integrate into its analysis the conclusion in the scientific literature that for natural resource based societies real or perceived dangers to the people's health posed by industrial contamination have measurable effects on culture change. It explores the linkages between perceived health risks and changes in culture.

Contrary to the conclusions of basic risk assessment models, community based researchers have found that adverse health effects can and do occur even when there is no physical exposure to toxicants. This is because the people have had to give up traditional activities in order to protect their health from toxic exposure. The overall physical and mental health impacts of such changes in lifestyle not only result from the drastic reduction of traditional activities and the myriad of long term intergenerational effects this has on indigenous communities such as Akwesasne, but also from the simple fact that the food that tends to be available to replace "country foods" is generally high in fats and sugars. Thus, the inability to access traditional foods in the case of Akwesasne has lead to new diseases such as diabetes, stroke, heart disease, high blood pressure, cancer, obesity, etc.

Direct Effects of Contamination on Cultural Practices

The specific ways and the extent to which Mohawk cultural practices were affected by environmental contamination are as follows:

Water, Fishing and the Use of the River

Life in Akwesasne centered around the rivers, which provided the people with their main sources of protein - fishing as an economic and cultural activity was central to the identity of the people. The rivers also provided the people with a source of clean drinking water, a means of transportation, and a favorite recreation, in swimming. Being cut off from the physical and psychological and re-creative sustenance provided to Akwesasro:non by the river has impacted the people negatively in countless ways. People miss the ability to fish and use the water of the St. Lawrence and other rivers. People noticed changes in the water quality, including the taste and smell of both fish and the water, and adapted their resource harvesting activities accordingly. This was done long before the official fish advisory.

Horticulture and Farming & Basket Making

The people of Akwesasne relied on traditional horticultural and farming activities to support their subsistence, with further moneys generated through the sale of hand made baskets and locally produced and or collected food items. These activities were important aspects of the people's lives right up to the time when pollution made such activities difficult if not impossible. Until such time, people in Akwesasne were largely self-sufficient. The ability to produce most food items through horticulture and farming (along with that acquired through fishing, hunting and trapping), provided people with autonomy and independence and the power to be in control of the changes to their traditional practices. The people themselves were in charge of deciding on the adoption or rejection of new technologies, while keeping the overall horticultural and farming practices grounded in the traditional values of how one was to interact with the earth. The physical rigor of these traditional activities further served to keep people healthy.

The non-indigenous presence in the territory of the Akwesasne Mohawks did, of course, have some effects on their culture. Yet the Mohawks' unchanged ability (until the late 1950s) to produce the necessities of life gave them crucial protection from the unwanted aspects of modern society. Diffusion and cultural borrowing has been shaping the world's cultures since the dawn of mankind and has of course also shaped culture change in Akwesasne. But, as long as the change is controlled and directed by the people in question, *cultural change* does not equate with *loss of culture* (Park 2006). Until the time of the heavy industrialization the people of Akwesasne were able to assert an effective measure of control over the impacts of the outside world; this autonomous existence and balanced organic pattern of change was effectively destroyed by the industrialization of the area and the ensuing effects of its toxic by-products on the environment.

Medicine Plants and Healing

The contaminants released by the companies have also had detrimental effects on the medicinal plants that knowledgeable Akwesasro:non gathered in order to deal with many issues from increasing the milk supply of nursing mothers to treating fevers, pain, boils, toothache hair loss, etc. In some cases, the pollution led to the disappearance of medicine plants and in other cases, it changed the appearance or taste of the plants, alarming healers. Medicines also came from animal parts that can now no longer be obtained for similar reasons. While some healers still travel to distant locations in order to attempt to pick up traditional medicines, much of this knowledge is lost and what remains is at risk of being lost because traditional healing can no longer be practiced without the local availability of medicines.

Hunting and Trapping

People in Akwesasne also depended on hunting and trapping in order to supplement their diet and income. Because of the intimacy and detail of contact with the animals and natural environment inherent in these practices, hunters and trappers noted changes in the animals and decided against the consumption of their meat or use of their products and restricted or stopped their practices altogether well before any official advisories had been given.

Effects of Contamination on Populations

The knowledge of real, unexplained and worrisome changes in the plants and animals that have sustained Akwesasro:non for millennia, or even only perceived health threats due to pollution, has drastically affected cultural practices based on natural resource use. Whether people changed their way of life because of their own observations of changes in the environment or because of health advisories, the psychological effects of being cut off from the most important aspect of one's culture and way of life are profound and innumerable. One community member is quoted in the Report as saying: "*The way I think of it, its like they put handcuffs on your wrists. You're no longer free to live the way you want to live, it's like something's holding you back, holding you down. It often feels like that*". As this statement demonstrates, regardless of the actual measurable physical effects of pollution, the psychological effects of having been cut off from ones way of life are devastating.

Initiatives to maintain cultural continuity in order to allow younger generations to experience and maintain important teachings and values, not to mention the transmission of language and important technical focal vocabulary embedded in traditional resource harvesting practices, are important aspects in the efforts to restoring the health and vitality of the people. The only effective way to teach children about who they are is to take them "out on the land" and let them learn by observing, listening to and copying their elders who are knowledgeable in traditional resource activities. Many indigenous communities in the United States and Canada are successful in the maintenance and transmission of such traditional skills, knowledges, values, and language. This success, however, is always contingent upon having maintained a resource base that allows them to do this.

Furthermore, it is important to note that the relationship of indigenous communities to the resources that sustain them is not based on the simple supply and demand models found in the Euroamerican approach to resource management, where the goal of sustainable resource management is simply the maximum sustainable exploitation of resources (Feit 1988, Nadasty 2003, Notzke 1994, Spak 2005). Rather, indigenous peoples see themselves as being responsible for the plants and animals and other life forms that sustain them, as is evidenced in the Haudenosaunee Thanksgiving Address. Thus, being unable to fulfill responsibilities to the environment one is responsible for has very real detrimental psychological and emotional effects – these have been observed and are clearly represented in the data for Akwesasne.

The Report demonstrates that the overall effects of the pollutants released by the companies on the people of Akwesasne and their way of life (i.e. culture) as practiced through traditional resource harvesting activities was immense. The overall reliance of families on foods and other products provided through traditional resource harvesting activities went from near total reliance in the early 1950s to minimal reliance today. The changes in culture were not the result of an organic or natural process of cultural evolution or adaptation to modernity. The Mohawks continued their traditional cultural practices up to the point they could no longer use the land and the river without observed or feared adverse effects due to the release of hazardous substances by the companies.

The following summary demonstrates how the release of hazardous substances into the environment has affected the various segments of the population of Akwesasne:

Animals

The animals depended upon by the people of Akwesasne are the ones who have carried the greatest burden. Animals have suffered immensely because of pollution. Unlike people, they cannot protect themselves against ingesting pollutants, but are at the mercy of all humans who mistreat the ecosystem they depend upon. Many animals have acquired sores, strange growths, or have even died because of the consumption of poisoned plants. Some of the animals living in the areas with concentrated pollutants have developed strange forms, exhibit both male and female attributes, or have other mutations that are likely the result from the release of hazardous substances into their environment. Such intergenerational effects are grave and worrisome.

Children and Adolescents

Fear of the effects of hazardous substances in the natural environment and of the effect observed changes would have on their own health and on that of their children led the people of Akwesasne to reduce their traditional resource harvesting activities. This in turn lead to unhealthy changes in the diets of children since healthy meats, fish, fruits vegetables, nuts and dairy products traditionally relied upon became unavailable, or had to be purchased at prohibitive costs. As a result of these changes in diet, along with the pollution of the land, water and air around them, the children and youth of Akwesasne's health has been affected detrimentally and they now suffer from numerous pollution related ailments such as asthma, eczema, allergies, diabetes, changes in the timing of girl's first period, etc. (Denham 2005). The simple fact that they have been denied their birthright of growing up within the traditional culture of resource harvesting activities and practices of their people has itself had huge impacts on Akwesasne's children and youth. Today's children have not only learned to fear the environment their people traditionally saw as the mother that provided for all their needs, they have also not had the ability to learn many of the resource harvesting activities that make up the Mohawk way of life. Thus as a result of the release of hazardous substances, the children and youth of Akwesasne not only cannot learn traditional activities, but are also unable to learn the terminology and ways of relating to the environment that goes hand in hand with such activities.

Elders

The loss of all traditional resource harvesting activities at Akwesasne has not only denied elders the ability to teach the children and youth the practical resource harvesting skills of their people, they are also denied the necessary setting needed to transmit the overall cultural teachings of the proper relationships between humans and animals that go hand in hand with such activities. Furthermore, the changes in diet and the decrease of traditional activities have led to a debilitating and culturally limiting onslaught of disease like diabetes, heart disease, stroke, high blood pressure, and cancer, many of which were unknown to previous generations of elders.

Women of Childbearing Age

The women of Akwesasne have been at the frontline of the effects, fears, worries and changes in traditional cultural practices caused by environmental contamination. They have been psychologically affected by finding out that the breast milk they provided to their infants was laced with poison. And, while a few women had pursued outside employment prior to the reduction of traditional resource harvesting activities due to the release of hazardous substances, most women stayed at home and gardened and farmed the land, which allowed them to look after their children while working to provide for their families and transmitting culture to the next generations. Thus being cut off from the land through the release of hazardous substances into the environment has been extremely detrimental to women in their role as caregivers, teachers and providers. Not only can they no longer teach their children about their identity through the daily interactions with the land, but, being unable to grow food for their families they now need to pursue outside employment that takes them away from their children for most of the day. As the center of families and the teachers of children, the women's loss of the ability to teach their children and grandchildren how to relate to and take care of the plants, animals and the land while providing for them through land-based activities is perhaps the most important aspect effecting long-term culture change at Akwesasne.

Men

While some men were already pursuing outside employment prior to the release of hazardous substances into the environment, such employment tended not to be permanent and most families still depended on hunting, fishing, trapping and gardening for a large part of their sustenance. Thus being unable to provide for their families as fishers, hunters, trappers, horticulturalist and farmers forced men to either leave their families for outside employment or become dependent on welfare. Being unable to take their children hunting, fishing, trapping, or to teach them about plants and the land in general made it difficult for men to fulfill their traditional obligations as providers and teachers. The psychological and social-cultural effects of this forced change on the individual men and families in Akwesasne has been detrimental, widespread and profound.

Conclusions

1. The historical baseline set for resource-based cultural practices relative to ecological conditions *but for* the release of contaminants is 1955. The Report concludes that previous to this date the Mohawks of Akwesasne were not detrimentally affected by industrialization and maintained the capacity to adapt to cultural diffusions and changes in the natural environment in ways that were consistent with their values and the responsibilities inherent in Haudenosaunee culture.

2. When the area became industrialized in the late 1950s, the people of Akwesasne still practiced their traditional land-based economy. While some individuals did already seek out outside employment in the pre-industrial area, most families in the pre-pollution era based their overall economy on traditional land-based activities, with outside income generated by the occasional employment of individual members of the extended family to supplement their traditional economy. Until the industrialization of the whole area in the late 1950s the land and the traditional economy based on traditional resource harvesting activities was the only steady, continuous, safe and dependable source of livelihood for the people.

3. The whole of the population of Akwesasne relied on traditional resources and resource-based cultural practices up to the late 1950s. Notably, families rather than individuals constitute the key unit of measurement from which this percentage has been derived. This is in keeping with the way in which culture at Akwesasne was historically practiced.

4. At the time identified for the baseline pre-pollution conditions, virtually all of the community's activities were based on subsistence cultural practices related to the land, ecosystem and riverine environment of Akwesasne.

5. The changes that happened were due to environmental contamination, and more specifically, the release of hazardous substances by the companies into the natural environment. The contaminants proven to have been released into the environment include the PCBs Aroclor (1248) and Therminol, Polychlorinated dibenzofurans, Dioxins, Polyaromatic hydrocarbons, Fluorides, Cyanide, Aluminum, Arsenic, Chromium, and Styrene. The scientific evidence also indicates a probable release by the companies of the following contaminants: heavy metals including lead, arsenic, cadmium, chromium, and, methylmercury.

6. People in Akwesasne observed the effects of environmental contamination and changed their cultural practices. They did not change their practices in response to official or company advisories. The data clearly shows that damage to natural resources caused by the release of hazardous substances has impaired the cultural uses of resources.

7. A small number of people in Akwesasne still practice traditional activities in spite of their fears of becoming toxic through the use and interactions with natural resources, but the overall reliance on such activities today by the families of Akwesasne is minimal.

8. Cultural responses to the release of hazardous substances are related to a general awareness in the community of the observed effects of the substances in the environment and as well of the reported conclusions of scientific studies. Expert knowledge of the details or the existence of specific scientific studies by community members has not been a factor in influencing changes in cultural practices as a result of the release of hazardous substances, as the conclusions of scientific studies have been widely circulated and have reverberated through social and knowledge networks in Akwesasne.

9. The release of hazardous substances into the environment of Akwesasne has forced the Mohawk people at Akwesasne to give up nearly all traditional resource harvesting activities. As a result of the drastic reduction of these activities, they have to a large extent been denied the ability to provide their families with healthy foods; had their ability to fulfill their traditional obligations toward the land, waters, plants and animals severely hindered; denied the ability to pass their practical, theoretical, philosophical and linguistic knowledge of what it means to be Akwesasro:non on to younger generations. They have been largely denied the ability to continue to live as Akwesasro:non and forced to endure rapid forced acculturation.

3. RESTORATION OPTIONS

The following options for restoration have been generated through focus-group meetings and interviews and conversations with community members over the entire course of the Cultural Impact Assessment project. They have been discussed and vetted by the project's Community Advisory Group. It must be noted that there is great consistency between the options put forward in the community consultations specific to this Cultural Impact Assessment and those developed in similar research for previous environmental processes. The full background and developed rationales for all of the various measures suggested by the community in the area of cultural and environmental restoration are well documented in previous reports and numerous documents listed in the SRMT library. Thus, the recommendations below are put forward in straightforward fashion and in the form of a comprehensive listing of major themes and areas for action.

The list below is a focused selection from the numerous suggestions garnered out of the community consultations and previously generated lists based on their direct relation to the cultural impacts and harms identified by the researchers in the Report. All of them are important and instrumental to addressing the harm caused by industrial contamination as described in the Report, and all have been developed by community members in response to real and present effects, and all are seen by community members to be necessary and equally important.

It should be noted that in suggesting restoration options, the community seeks cooperation with the companies and governments in advancing Akwesasne's self-determining effort to reconstruct a viable existence on the land and the river in the context of Haudenosaunee cultural values and principles. Thus, all of the restoration options listed below are meant to convey ways in which the companies and governments can support the autonomous self-determination of the Mohawk people, not as projects to be implemented by the companies and or governments for the benefit of the Mohawk people.

There is a great sense of urgency among community members with respect to the restoration of the environment and traditional cultural practices on the land and in the riverine environment. Unfortunately, the community's hold on their traditional culture is tenuous as a result of the damage that has been done to the natural environment by the companies' release of hazardous substances. Most of the people who still hold on to the knowledge so crucial to the cultural survival of the Mohawk people at Akwesasne are old. The aging and infirmity of the knowledge holders are seriously affecting the ability of the community to ensure the transmission of cultural knowledge – especially forms of transmission that require interactions on the land and the river. The restoration options below have been developed in recognition of both the urgency of the situation and of the opportunities that still exist and need to be seized upon.

It must be acknowledged that the most prevalent view on restoration in the community is that the companies should shut down operations, and begin to take measures to restore the natural environment to its original condition before their arrival. This means stopping producing pollution, and expending whatever moneys and taking whatever measures necessary to revive the health of the land, the river, the animals, the plants and thus, the people. Given that this is an unlikely outcome of the present process – the inability thus far of the companies and government agencies to ensure protection or restoration of the natural environment are taken as an indication of the limited possibilities for justice on these issues – the discussion that follows is set in a pragmatic context. Short of doing what is ultimately right and absolutely necessary, the companies and government agencies can achieve some alleviation of the cultural damage caused by their contamination of the natural environment by supporting the community in its ongoing struggle to adapt and to survive.

One of the underlying assumptions of the community's approach to restoration is that cultural damage must be considered for its overall effect on the life of the community and must recognize that culture is practice and as such, cultural damages have affected the practices that ensured cultural continuity, self-sufficiency, and political independence. The Mohawks suffered cultural harm, and in suffering cultural harm, their freedom as individuals and independence as a community was severely impacted as well. In this sense, cultural damage has not only cultural effects, but *political* and *economic* effects. This must be considered in designing and developing a response that hopes to be taken as appropriate and adequate. Cultural harm is economic harm. Cultural harm is also political harm. Given that addressing the political effects of cultural harm is outside the purview of the NRDA process, the approach to restoration outlined herein focuses solely on the two aspects which can be addressed within the legal framework of the process: cultural and economic restoration.

Restoration Options

To begin to address the cultural harm caused by their release of hazardous substances into the natural environment at Akwesasne, the companies should consider the following restoration options:

1. The top soil and other areas of contaminated ground and sub-surface areas in Akwesasne must be replaced with clean earth.

2. The community must have access to a safe, clean source of water. A new or expanded-capacity water and sewer system must be built.

3. The areas still used for traditional cultural practices by community members, and the practices themselves, must be inventoried, preserved and protected.

4. Community and governmental programs in the area of environmental protection and conservation of natural resources must be fully funded on a permanent basis.

5. Snye Channel must be rehabilitated.

6. All homes, public buildings and facilities in Akwesasne must be provided with electricity free of charge.

7. An endowment must be established to fund scholarships to support Akwesasne Mohawks in higher education in fields of study related to traditional culture, the natural environment and land-based practices, including agriculture, aquaculture, forestry, environmental sciences, and resource management.

8. A commercial fishing fleet and a large-scale aquaculture enterprise must be established and supported with the necessary expertise, material aid and funding to ensure the reintegration of Akwesasne into the fisheries market at a competitive position as well as a system for storage and distribution of food fish for consumption within the community.

9. Agricultural must be restored as a viable economic activity in Akwesasne. The community must be provided with the necessary training, capital and clean land areas so that an agricultural sector can be reestablished and the community can re-achieve self-sufficiency (in conjunction with the revitalization of its fisheries) in its food supply.

10. Affected wetlands and other specialized and micro-environments must be rehabilitated, and domesticated sweetgrass used in basket-making and the areas of cultivation of medicine plants used in traditional healing must be reestablished.

11. The community must restore knowledge and the reintegration of traditional culture in the area of child-rearing and in the addressing special needs (knowledge and training and support) of children and families whose health and social relations and behaviors have been affected as a result of contamination.

12. A comprehensive community-based traditional knowledge education program to restore cultural knowledge and promote the resurgence of land-based cultural practices among the Mohawks of Akwesasne must be established.

13. Addictions treatment and prevention facilities and programs that promote the regeneration of traditional healing practices to address the effects of the decline of healthy, extended family relationships due to the effects of contamination must be established.

14. The Thompson Island youth camp must be guaranteed stable and long-term funding.

15. A Senior's Center, including a full array of associated programs and services, must be built.

16. The Akwesasne Freedom School must be re-located to clean ground and fully funded in all its operations on an ongoing basis.

17. A large-scale community-based language restoration initiative to supplement existing programs must be established, supported with the necessary material assistance, finances, staff training and technological capacity.

18. Fitness, recreation and sports facilities and public health initiatives must be established, with a special focus on water safety, recreational swimming and water sports.

19. The companies must establish integrated and experiential education programs for their employees on the history and culture of the Mohawk people and the effects of industrial contamination on the environment and on the Mohawk community.

20. The Akwesasne Task Force on the Environment's (ATFE) Kaniatarowaneneh Research Institute and other community-based research initiatives designed to conduct research and develop programs to protect and restore the environmental and cultural resources within Akwesasne must be fully funded on a long-term basis. Specific funding needs include:

a) Construction and administration costs (including salaries, research funds, new facilities with office space, laboratory, a boathouse and dock);

b) Community Environmental Education Project Fund (includes continued support for ongoing projects such as the development of educational units and curricula; funding for materials such as the ATFE calendar which describes elements of creation such as traditional medicines; developing educational materials about the Superfund sites, remediation and restoration; developing materials to support the life skills on the land program; and funding and supporting environmental youth camps;

c) Sustainable Forestry Program (includes continued support for ongoing projects such as the Black Ash tree program, a sustainable economic development project that has examined ways in which black ash trees can be grown and replenished within Akwesasne). Other ongoing programs include distributing fruit and nut trees and berry bushes and sponsoring community education workshops about growing, pruning, grafting and caring for trees;

d) Medicine Plant Restoration Program (includes continued support for ongoing projects such as restoration of sweetgrass plots and wild rice areas in Akwesasne, and the development of a medicine garden);

e) Community Environmental Health Education & Outreach (includes support for ongoing efforts to educate the community of Akwesasne and the general public about the ongoing health and environmental studies related to toxic substances);

f) ATFE Environmental Laboratory (this program includes support for staff, equipment, supplies and materials to expand an existing small laboratory so that it is capable of conducting contaminant immunoassays and capillary chromatography for congener specific PCB analysis of sediment, soil and biota);

g) Biological Monitoring Program (includes studies to examine ecosystem health in Akwesasne following the construction and operation of the St. Lawrence-FDR power project);

h) Community Sustainable Projects Fund (this program will to work with businesses and home owners in Akwesasne to explore and implement measures to support sustainable, pollution free, waste limiting and energy saving technologies);

i) Sustainable Agriculture Program (includes continued support for organic gardening projects begun by ATFE, such as an annual seed, plant and tree give away); and,

j) An interpretive center for a habitat education program.

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Proposal ID #: _______________
Scorer Name: _______________________ Date: ______________________

Screening Criteria	Fails to meet Expectations 0	Adequate Expectations 3	Exceeds Expectations 5
	*Please circle the response that best fits your assessment of this criteria.		
How well does the project fit the NRDA mandate to restore a territory; species and/or cultural practice that has been impaired by contamination? (i.e. Water, fishing and use of the river; Horticulture, farming and basketmaking; Medicine plants and healing; Hunting and trapping)?	0	3	5

Total Score for Category=

Evaluation Criteria	Fails to meet Expectations 0	Adequate Expectations 3	Exceeds Expectations 5
	*Please circle the response that best fits your assessment of these criteria.		
The project's potential to restore traditional community practices in water, fishing and/or use of the river?	0	3	5
The project's potential to restore traditional community practices in Horticulture, farming and/or basketmaking?	0	3	5
The project's potential to restore traditional community practices in Medicine and healing?	0	3	5
The project's potential to restore traditional community practices in hunting and/or trapping?	0	3	5
The project's potential to increase food security and sustainability in the community?	0	3	5
The project's potential to promote the transmission of community knowledge to future generations through the revitalization of Elder/youth and other community relationships?	0	3	5

The project's potential to assist in language revitalization?	0	3	5
The project's potential to promote ***short-term*** improvements in terms or restoring land-based cultures and/or traditional community based economies?	0	3	5
The project's potential to promote ***long-term*** improvements in terms of restoring land-based cultures and/or traditional community economies?	0	3	5
Does the organization/individual have a previous record of stability and success in terms of achieving objectives outlined by NRDA restoration criteria?	0	3	5
Is there potential to integrate the project with Master Apprenticeship Program?	0	3	5

Total Score for category=

Organizational Criteria	*Please circle the response that best fits your assessment of these criteria.
Are the project goals well-defined and feasible?	Major Revision Needed Acceptable with Minor Revisions Acceptable
Is the project budget comprehensive and reasonable given the stated time period?	Major Revision Needed Acceptable with Minor Revisions Acceptable
Planning schedule for proposed programs complete and feasible?	Major Revision Needed Acceptable with Minor Revisions Acceptable
Methods in place for evaluating the effectiveness of the project's implementation?	Major Revision Needed Acceptable with Minor Revisions Acceptable

Number of Major revisions needed: _____

Overall/Ranking Score:

I recommend:

☐ Full Acceptance of this proposal with minor/no changes.

☐ Conditional approval of this proposal pending satisfactory revisions in the following areas:

☐ Rejection of this proposal with option to re-submit at a future date.

☐ Rejection of this proposal with no option to re-submit

Please use the space below (or attach additional pages) to add constructive comments and/or recommendations for strengthening this proposal.