Famous Hazardous Waste Sites and Fractured Rock Hydrology of the Niagara Falls Area, Niagara County, New York State

Guidebook for the Field Trip Held
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A. Introduction

More than 200 waste disposal sites have been identified within 5 kilometers of the Niagara River, which connects the largest freshwater system in the world (Yager, 1996). Chemical contaminants are likely to have leaked from one-third of these waste sites. Many of these hazardous waste facilities have discharged waste into the Lockport Group that underlies the region. The Silurian-aged Lockport Group (or Lockport Dolomite according to USGS designation) is fractured along highly continuous bedding planes that bear and conduct water. The hydrogeology of the Niagara Falls Area, and therefore the ground-water contamination, are dominated by fractured rock hydrology.

The objective of this field trip is to provide a first hand exposure to some of the most well-known ground-water contamination sites in the context of the regional hydrogeology of the Niagara Frontier. We will visit four Superfund sites, Love Canal, Bell Textron, 102 Street, and Hyde Park, and then view the stratigraphy of the Lockport group at the Niagara Gorge. Along the way, general principles of fractured rock hydrology will be discussed. Because this trip is held on a Saturday, we will not have direct access to any of the sites themselves, but we should be able to see enough from the road to provide the hydrogeologic setting.

Figure 1. Overview of the Niagara Falls study with trip stops.

Ground-Water Contamination of Niagara Falls, New York

The history of ground-water contamination of the Niagara Falls region is as old as the history of its industrial development. Although the root of the contamination is often blamed upon ignorance of environmental systems, this was not always the case. For example, in a memo to the US Army Corps of Engineers, the superintendent of the Linde Ceramics plant, A. R. Holmes, described alterative options for disposal of radioactive waste generated at the plant (Kelly and Ricciuti, 2006). They might (Plan1) discharge the waste to a storm sewer or (Plan 2) pump the waste into onsite wells. "Plan 1 is objectionable," Holmes wrote, "because of probably future complications in the event of claims of contamination against us. Plan 2 is favored because our law department advises that it is considered impossible to determine the course of subterranean streams and, therefore, the responsibility for contamination could not be fixed." Ultimately, nearly 50 million gallons of liquid wastes were pumped into these shallow wells where they likely discharged to the Niagara River.

The fact that the bedrock ground water and Niagara River are closely linked is certainly recognized now. In 1987, a Declaration of Intent was signed by authorities in both the United States and Canada which included a commitment to reduce the toxic substance loadings to the Niagara River fifty percent (50%) by 1996. In 1989, the U.S. Environmental Protection Agency (EPA) and New York Department of Environmental Conservation (DEC) issued a report identifying 33 site clusters with potential for polluting the Niagara River and proposed a remediation schedule to reduce toxic chemical loadings from these site by 99% by 1996 (**Appendix A1**). This list was later reduced to 26 sites, and it was estimated that a 90% reduction of toxic loadings to the Niagara River had been achieved by the year 2000 (U.S. Environmental Protection Agency and New York State Department of Environmental Conservation, 2000). Clearly, there has been a significant reduction in toxic loadings to the Niagara River.

This remarkable reduction in toxic loadings to the Niagara River has come at a cost of over $370 million (New York State Department of Environmental Conservation, 1985).

Current schedules call for the remainder of the 26 priority sites to be remediated by 2003, with additional costs of remediation exceeding $261 million. Such enormous expenditures have been justified because the threat to human health was considered critical and immediate. As remediation nears completion at many of these sites, new questions are emerging. If over half-a-billion dollars is a justifiable expenditure to reduce the loadings by 99%, what is a justifiable cost to eliminate the remaining 1%? At most of the 26 hazardous waste sites, the term "remediation" really means containment in perpetuity, with ground-water extraction wells producing millions-of-gallons of water that must be treated. Over what period of time will treatment be cost-effective or even necessary? Once the 26 identified hazardous waste sites have been controlled or remediated, should other sites be revisited and included in the toxic loading calculations? How can the costs of remediated specific hazardous waste sites be compared to the controlling other sources of contamination, say from industrial runoff and other less-obvious non-point sources?

The Hydrogeology of the Niagara Falls, New York

Excellent summaries of the hydrogeology of the Niagara Falls Region have been published and will not be repeated here (Novakowski and Lapcevic, 1988; Novakowski, 1998; Tepper et al., 1991; Yager, 1996, 1998; Yager and Kappel, 1998) . Bedrock geology is dominated by the dolomite of the Niagaran Series (Middle Silurian), which strikes east-west and dips gently to the south at about 4.7 m/km . The Lockport Group crops out along the Niagara Escarpment, where it forms the cap rock of Niagara Falls. The Lockport Group is a petroliferous dolomite that contains gypsum and metal sulfides (Zenger, 1965). Naturally derived hydrocarbons are disseminated throughout the rock matrix in some stratigraphic horizons. Thin layers of bitumin are also present and are commonly associated with layers of gypsum. The stratigraphic nomenclature of the Lockport Group was recently revised by Brett and others, and is shown in **Appendix A2.**

Ground water is thought to flow regionally through the Niagara Falls Area along bedding plane fractures of the Lockport (Novakowski and Lapcevic, 1988). These sub-horizontal bedding plane fractures extend over kilometers. Water bearing fractures identified in Niagara Falls sequences have been identified to be conductive also in Smithville, Ontario, over 40 kilometers to the west (Novakowski et al., 1999). These horizontal bedding plane fractures are thought to be connected by steeply dipping or vertical fractures but such features have never been directly identified in boreholes.

Ground water flows away from a topographic high near the Niagara Escarpment (Figure 2). Northward water discharges to the Escarpment. Southward ground water moves generally toward the southwest where it discharges to the Niagara River. Ground water potential is highly influenced by a number of major man-made structures. The New York Power Authority (NYPA) reservoir recharges the Lockport as does leakage from municipal water supply and storm drains. Excavations act as high-permeability conduits for ground water. The most significant of these is the Falls Street Tunnel, an unlined storm sewer.

Based on information available in 1987, the U.S. identified the Falls Street Tunnel, a major unlined industrial sewer cut into the bedrock under the City of Niagara Falls, as the largest source of toxic pollutants from any of its point sources (U.S. Environmental Protection Agency and New York State Department of Environmental Conservation, 2005). By the mid-1980s, the Tunnel was only receiving overflows of wastewater from the sewers of a Niagara Falls industrial area, in addition to contaminated groundwater infiltrating from major waste sites via cracks in the Tunnel's bedrock walls. In contrast to flows from other point sources, effluent from the Falls Street Tunnel entered the Niagara River untreated. In 1993, EPA and DEC required the City of Niagara Falls to treat the Falls Street Tunnel discharges during dry weather at the Niagara Falls WWTP. Data gathered by the U.S. indicate that WWTP treatment of the Tunnel's dry weather discharge has reduced mercury loadings by 70% relative to 1980 loads, tetrachloroethylene loadings by 85%, and the loadings of four other priority toxic chemicals by almost 100%

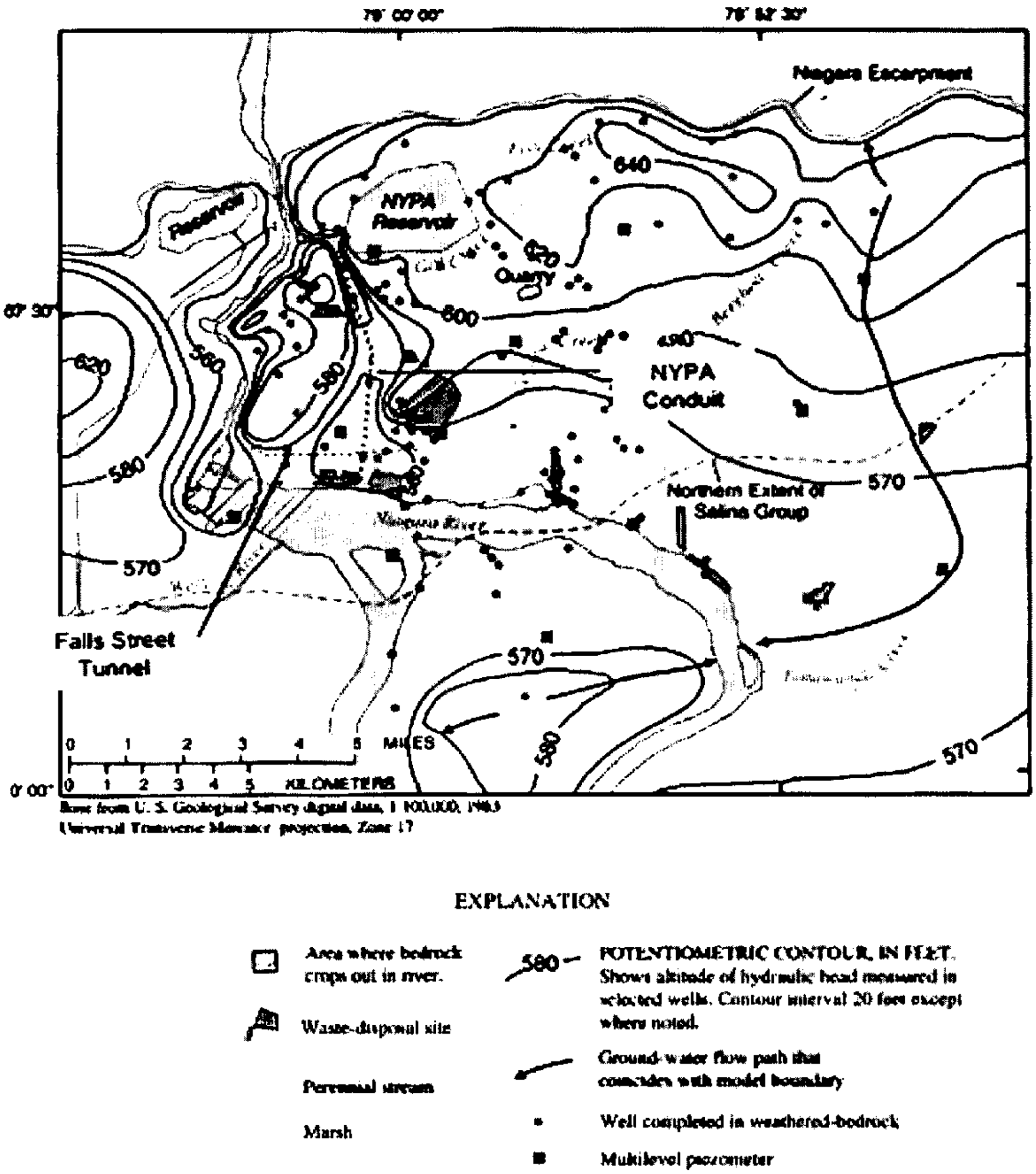


Figure 2. From Figure 3A in Yager (1996). Ground-water potential in the weathered bedrock measured in selected wells. The Falls Street Tunnel and NYPA Conduits are indicated.

The NYPA conduits that transport Niagara River water to the NYPA forebay canal also constitute a major sink and pathway for ground water. A drain system extends the length of the conduits and intersects the entire Lockport Group. A grout curtain surrounding the intakes prevents direct hydraulic communication between the river and the drain system (Yager, 1996).

B. Description of the Stops

Bell Aerospace Textron Site

The Bell Aerospace Textron Site is located in Wheatfield, New York, adjacent to the east site of the City of Niagara Falls. In the 1950's and 1960's TCE (triochloromethane) was used in the production process. Waste TCE was discharged to a shallow "neutralization" pond which infiltrated to the Lockport Group. By 1990, a 280-acre aqueous plume in the Guelph Dolomite (**Figure 3**) that contained TCE and its metabolites (DCE, dichloroethane and VC, vinyl choride) extended about 4,300 ft south of the pond. A 20-acre dense, nonaqueous phase (DNAPL) plume of TCE extended 620 ft south of the pond. A pump-and-treat remediation system consisting of six wells near the pond and five wells 2,900 ft downgradient from the pond began operation in 1993 to decrease the size of the aqueous plume and prevent its further migration.

The study by Yager (2000) illustrates some of the interesting characteristics of contaminant transport in bedrock systems. Flow and transport is through individual fractures with hydraulically estimated apertures of 1 to 1.5 mm. The transmissivity estimated through model calibration is 140 m^2/day. As is often the case in bedrock studies, it is difficult to estimate the effective porosity. Yager (Yager, 2000) modeled effective porosity between 0.3 and 3 percent. The smaller number was consistent with the hydraulic aperture estimates and the larger was more consistent with transport modeling. Ground water velocities are thought the be on the order of meters per day, but are difficult to confirm given the uncertainty in effective porosity. The plume (**Figure 3**) is nearly as wide as it is long, reflecting the similarity in transverse and longitudinal dispersion that is thought to be characteristic of transport in fractured bedrock. Another important consideration in transport is the exchange in contaminant mass between fractures and rock matrix through a process known as "matrix diffusion". Molecular diffusion becomes an important consideration in fate and transport through dual porosity media. Models of plume transport and biodegradation were extremely sensitive to the rate of matrix diffusion assumed. Matrix diffusion is difficult to measure independently for application to field studies.

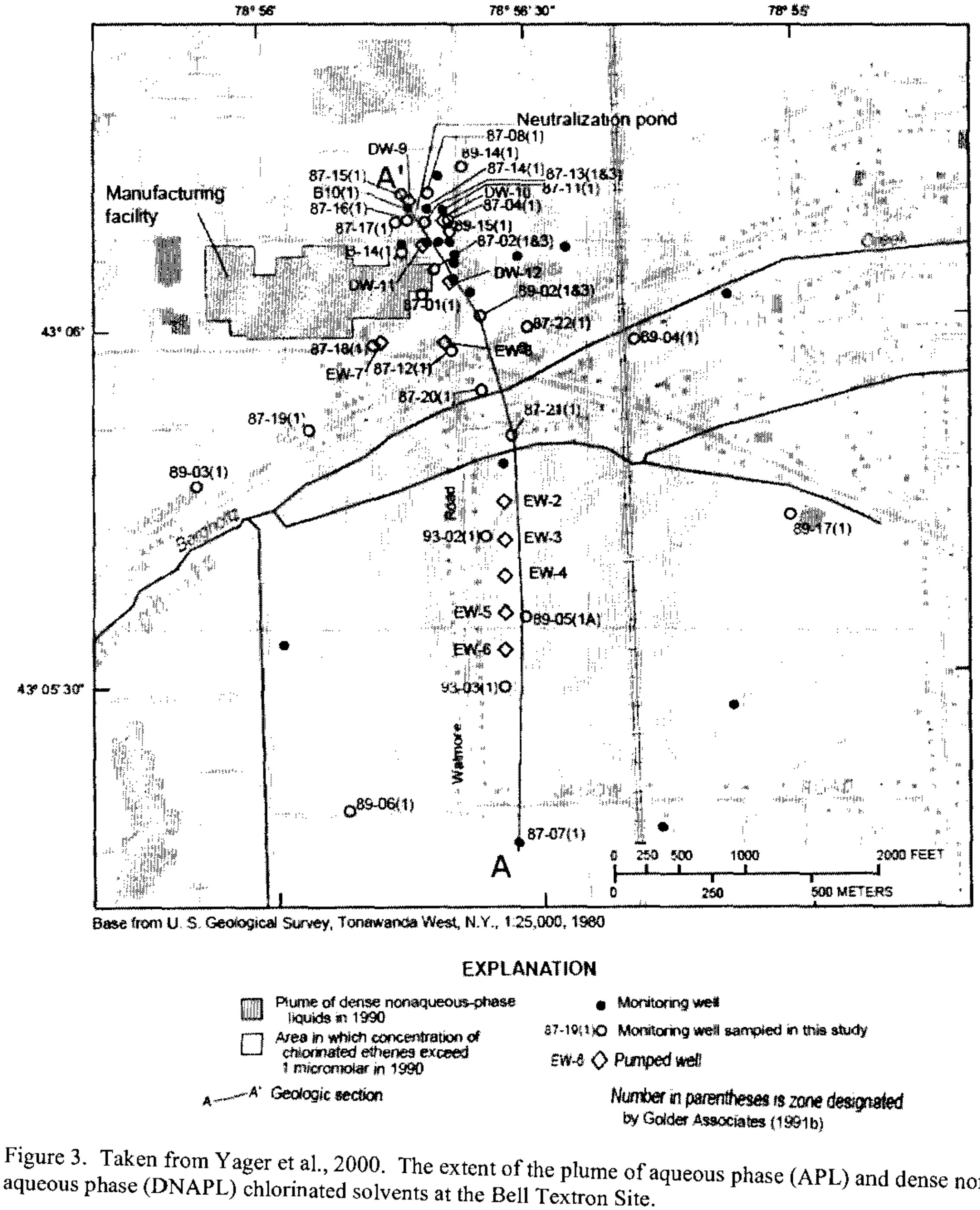


Figure 3. Taken from Yager et al., 2000. The extent of the plume of aqueous phase (APL) and dense non-aqueous phase (DNAPL) chlorinated solvents at the Bell Textron Site.

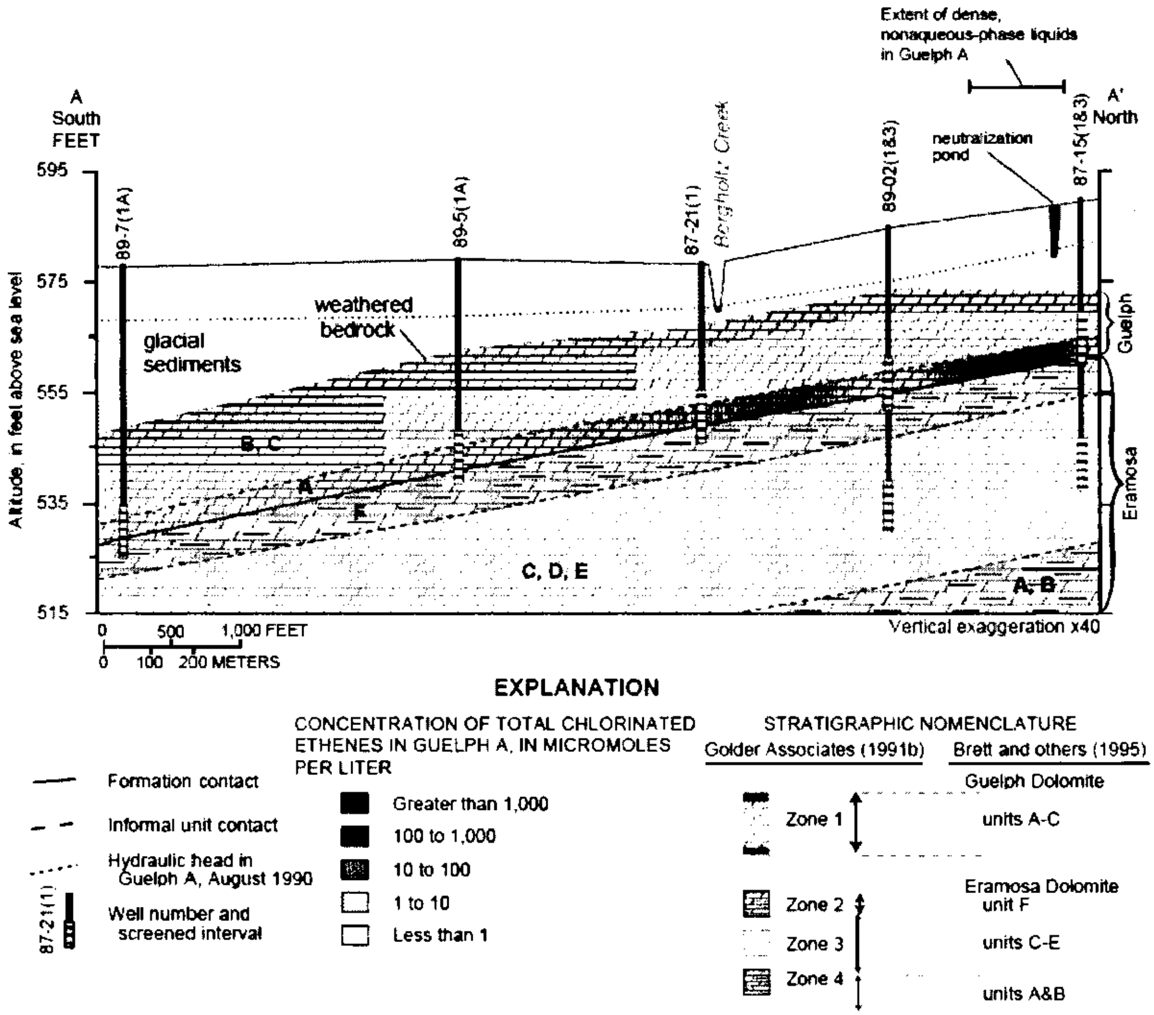


Figure 4. Taken from Yager et al., 2000. Vertical section A-A' through the Bell Textron Site (see Figure 3 for section location).

The plume at the site appears to have reached a dynamic equilibrium between the rate of TCE dissolution and the rate of removal through pumping and biodegradation. The presence of dissolved mass in the rock matrix and non-aqueous phase pools in fractures provides a constant source of TCE. Degradation rates for TCE are 21 to 25 days, DCE are 170 to 230 days, and VC are 18 to 23 days. Consequently, if the source could be remove the plume would disperse rapidly. Removal of all the contamination source in the rock and fractured bedrock is consider impractical given current remediation technology. A summary of the site is provided in **Appendix B1** (U.S. Environmental Protection Agency and New York State Department of Environmental Conservation, 2005).

Love Canal

It is unlikely that any reader has not at least heard of Love Canal. It is, perhaps, the most famous ground-water contamination site in the country and launched the creation of the Superfund program in the United States. A brief History is presented in **Appendix B1**. The site was removed from the EPA's National Priority Listing (Superfund List) in 2004 and its final remediation actions have been implemented. The hydrogeology underlying Love Canal consists of a shallow system of silts and fine sands, underlain by confining layers of lacustrine clays and glacial till, which are underlain by the Lockport Dolomite. Wastes were emplaced in the canal excavated as part of William T. Love's plan to create a canal that connected the Niagara River to Lake Ontario. The site resembled a geologic bathtub filled with waste and capped with soil. After wet periods, leachate would rise to the surface in swales where humans could come in direct contact with the material. Leachate also seeped into nearby basements.

The 1988 Superfund record of decision for cleanup of the site was "The selected remedial action for this site includes: excavation and solidification/stabilization of 7,500 yd^3 of soil; placement of solidified soil back in excavated location; installation of a RCRA cap; ground water monitoring; and implementation of treatability studies for solidification process." This essentially is the solution that was ultimately implemented at the site. Occidental Chemical owns the site and operates the treatment facility housed on the property. Hazardous materials are stripped from the ground water and sent to an incineration facility in Texas for ultimate disposal.

The hydrogeology underlying Love Canal consists of a shallow system of silts and fine sands, underlain by confining layers of lacustrine clays and glacial till, which are underlain by the Lockport Dolomite. The sediments are believed to form a liner that prevented extensive contamination of the bedrock. Constant pumping within the excavated canal appears to have reversed the ground-water flow at the canal and removed dissolved contamination from both the bedrock and the overburden sediments.

OCC S-Area

The S-Area site is an eight-acre landfill on Occidental Chemical Corporation's (OCC) Buffalo Avenue Plant. The site is located approximately 200 yards north of the Niagara. The site was used primarily from 1947 to 1961 for the disposal of approximately 63,000 tons of organic and inorganic chemicals. Chemicals deposited at the site included chlorobenzenes, organic phosphates, acid chlorides, phenol tars, thionyl chloride, chlorendic acid, trichlorophenol, benzoyl chloride, liquid and chlorotoluene-based disulfides, metal chlorides, thiodan, and miscellaneous chlorinated hydrocarbons. The EPA Fact Sheet for this site is provided in **Appendix B3.**

The S-Area Landfill is historically significant because it was at this site that the term "non-aqueous-phase-liquid" (NAPL) was first used (Pankow and Cherry, 1996). The landfill is located immediately adjacent to the form City of Niagara Falls Water Treatment plant. The plant drew water from the Niagara River via a bedrock tunnel. Contaminants from the S-Area landfill leaked into this tunnel, contaminating water supplies. The entire treatment plant was abandoned and a new plant constructed in 1997. The site of the former water treatment is clearly visible between the S-Area and new treatment plant.

The contaminated ground water flowed toward the treatment plant intakes and the Niagara River prior to remediation. Ground-water flow was through three zones: (1) overburden sediments, (2) shallow weather bedrock, and (3) deeper bedrock (**Figure 5**). Due to the sites close proximity to the Niagara River, contaminated ground water discharged to the Niagara River or to bedrock beneath the river. The remediation strategy is containment. A combination of pumping, drains, and slurry walls are used to create an inward hydraulic gradient at the site. Effluent is treated onsite and then discharged to the Niagara River.

Unlike the Bell Aerospace Textron site, little is known about the natural attenuation of chlorinated solvents. This is essentially because the plume extends immediately to the Niagara River making water quality observation difficult.

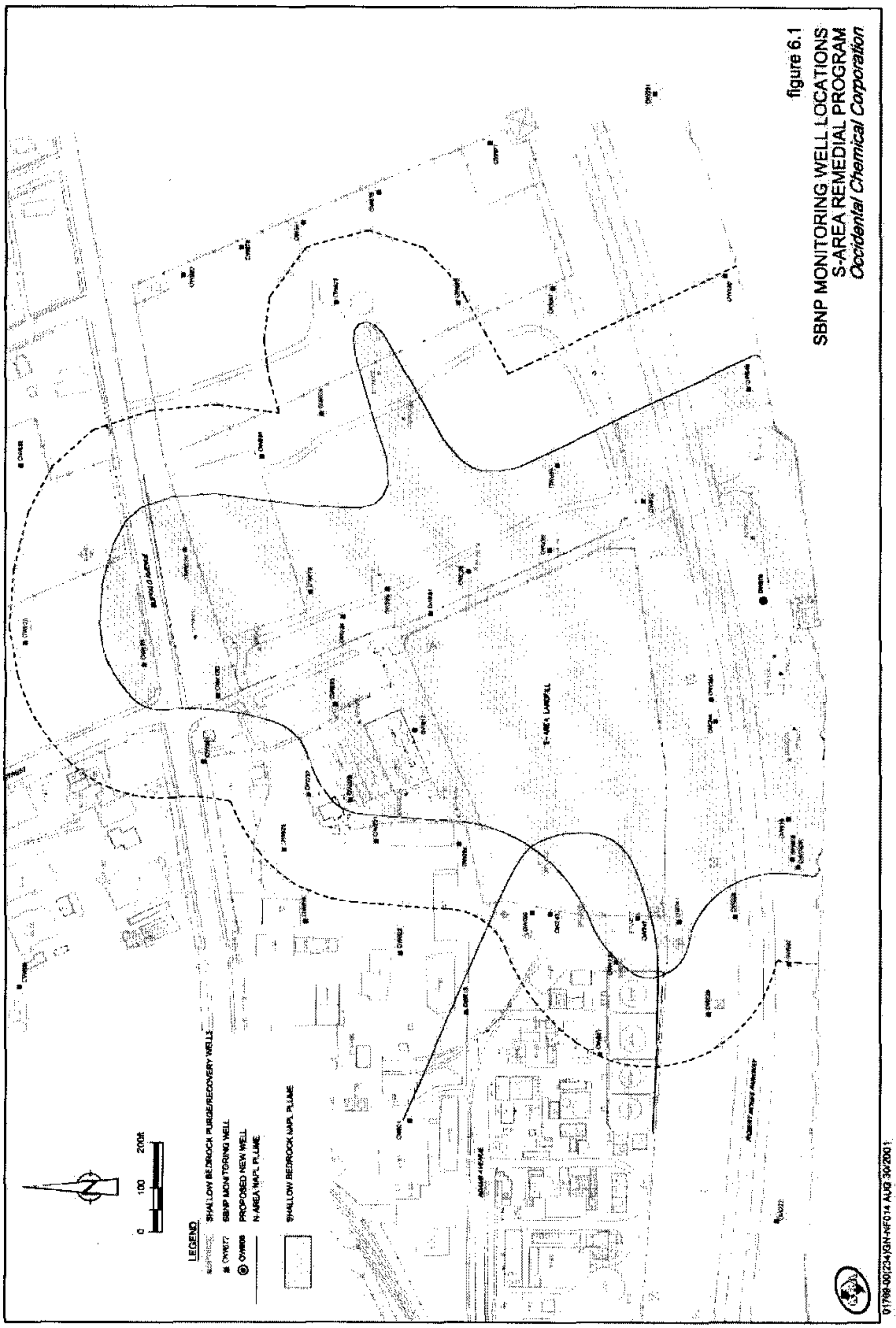


Figure 5a. Extent of the S-Area contamination in the shallow bedrock (compliments of Martin Derby).

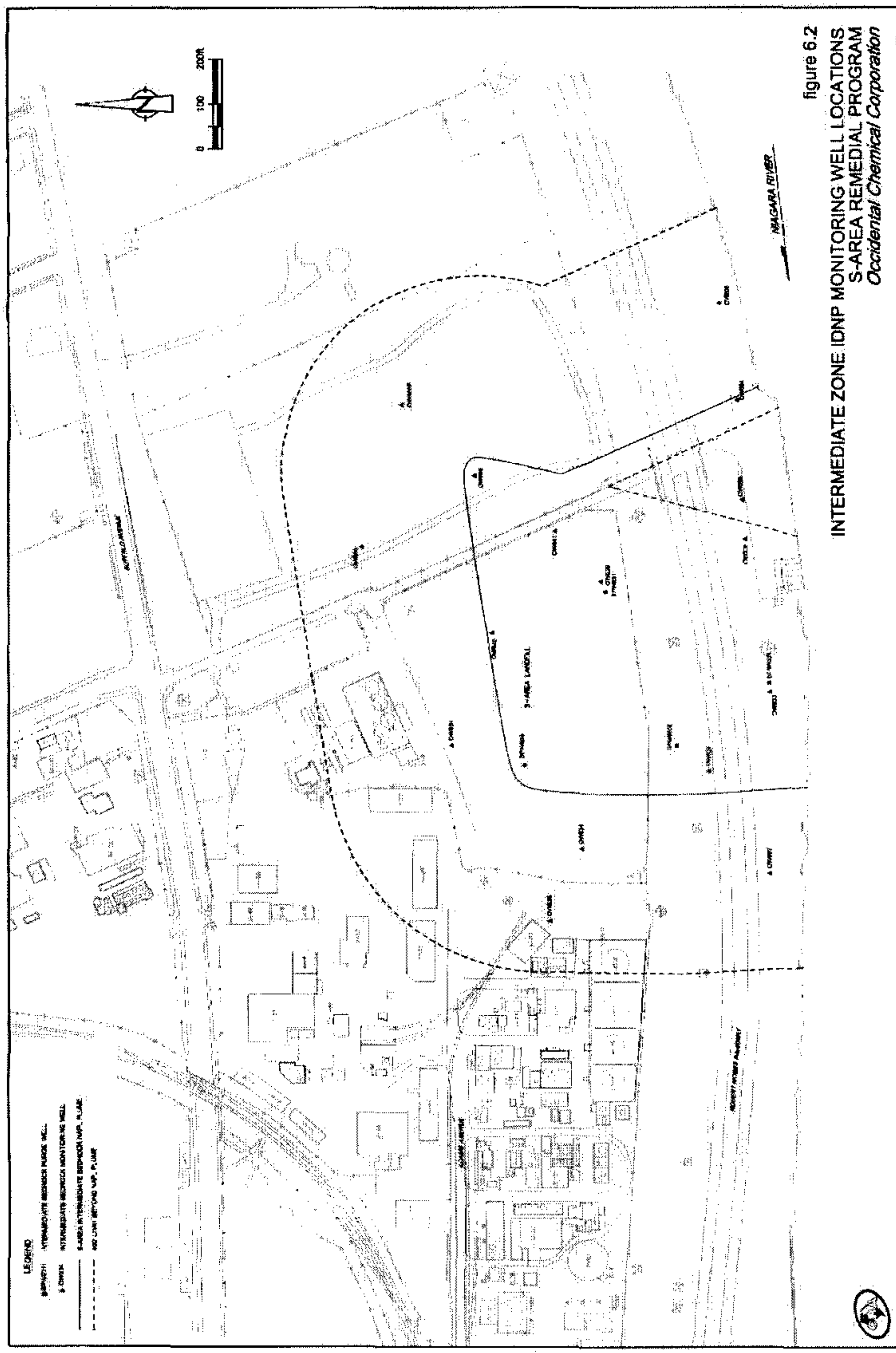


Figure 5b. Extent of the S-Area contamination in the intermediate bedrock zones (compliments of Martin Derby).

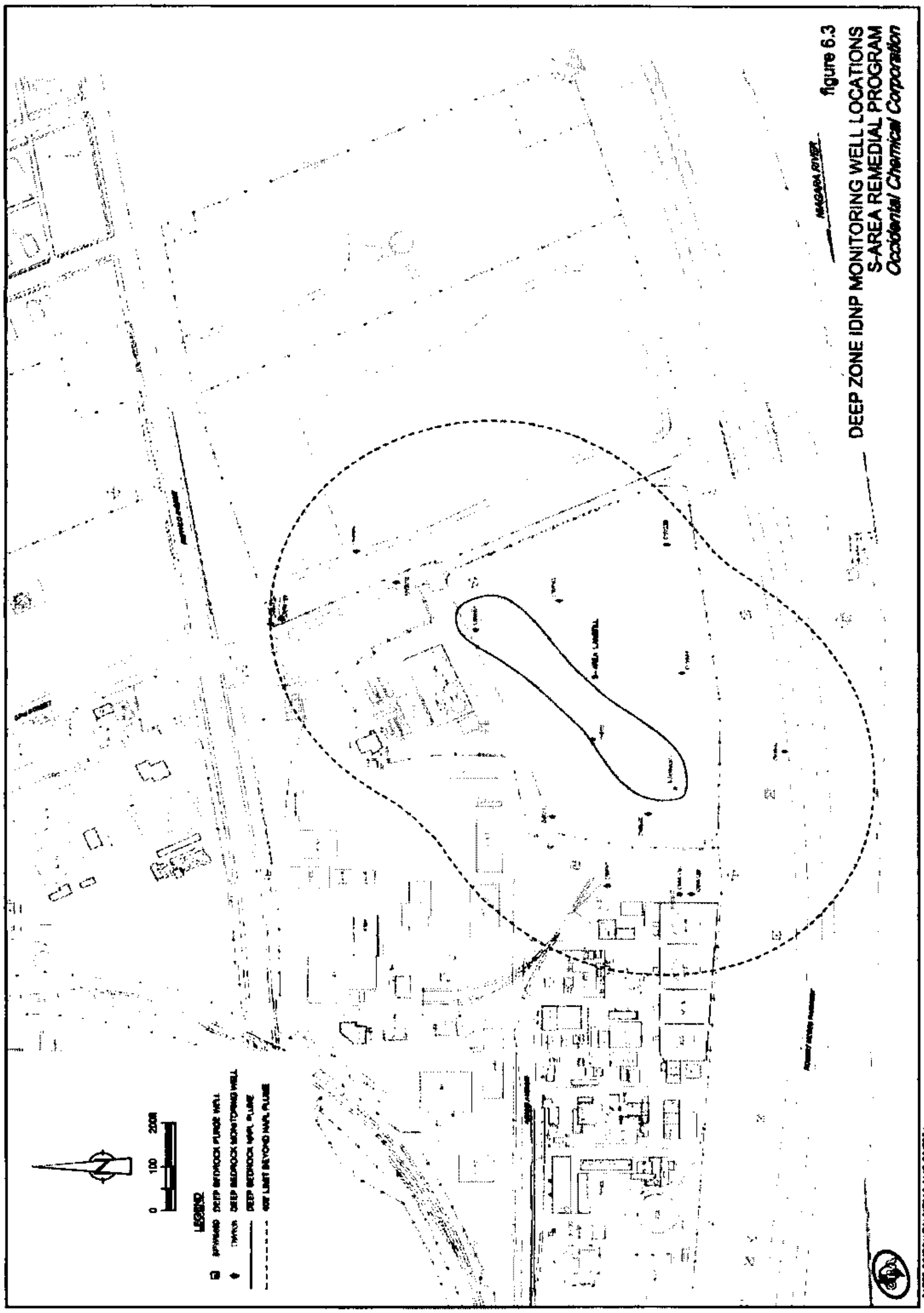


Figure 5c. Extent of the S-Area contamination in the deep bedrock zones (compliments of Martin Derby).

Hooker (OCC) Hyde Park

Occidental Chemical Corporation's (OCC) Hyde Park site is a 15-acre landfill in northwest Niagara Falls, less than one-half mile from the Niagara River. From 1953 to 1975, the company (then Hooker Chemicals and Plastics) deposited approximately 80,000 tons of chemical wastes at the site. This is arguably the largest mass of DNAPL contamination site in the United States. The hazardous materials disposed on site included 3,300 tons of 2,4,5-trichlorophenol (TCP) wastes, which are known to contain significant amounts of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD); approximately 0.7 - 1.6 tons of dioxin are believed to be associated with the TCP. Chlorinated organic wastes, including hexachloropentadiene derivatives, chlorendic acid, chlorinated toluenes, benzenes and phenols, predominate at the site. The former drainage stream of the landfill, Bloody Run, which flows into the Niagara River, was historically contaminated with organic chemicals, including dioxin. A clay cap and a shallow leachate collection system were installed at the site in 1979. A summary of remediation activities can be found in **Appendix B4**.

The site is underlain by Pleistocene overburden deposits that overlie the Lockport bedrock. Overburden sediments are glacial till, lake deposits, and some localized sand and gravel deposits. The principal water bearing zones are in the Lockport Group are the weathered bedrock surface and horizontal-fracture zones that coincide with stratigraphic contacts (Yager, 1996). The underlying Rochester Shale is thought to have much lower hydraulic conductivity than the Lockport and therefore constitutes the lower limit of possible contamination below the Hyde Park Site (S.S. Papadopulos & Associates, 2001). Historically, contaminated ground water seeped at the Niagara Gorge face east of the power dam (**Figure 6**).

The Hyde Park Site is another excellent illustration of the difficulties faced when characterizing and remediating ground water in fractured bedrock. As in the case of Bell Textron and S-Area, DNAPL has seeped into the bedrock and cannot be removed entirely. The remediation strategy is, therefore, perpetual containment. At Hyde Park, containment is achieved by the placement of pumping wells that are designed to assure a constant inward hydraulic gradient at the site boundary. In bedrock, pumping is carried out at three depths that coincide with water bearing fractures identified by local testing and regional modeling (**Figure 7**). In spite of the use of 15 purge wells over three zones, it has been difficult to capture the dissolved phase plume. A recent modeling evaluation of purge well effectiveness showed that only the southern portion of the plume was being captured in the upper bedrock zone. Most of the plume was being captured, however, in the middle and lower zones.

Actually monitoring the ground water velocity vectors has proved challenging at Hyde Park. Monitoring wells were installed radially away from the center of the contaminated area with the intention of ensuring inward hydraulic gradients. Local heterogeneities in transmissivity make such monitoring difficult. The local changes in head due to local changes in transmissivity serve to confuse the hydraulic data. The actual ground-water divide induced by on-site pumping cannot be determined with any certainty. Although the MODFLOW model calibrated to monitoring data indicates that the most of the contaminant plume is currently captured(S.S. Papadopulos & Associates, 2001), this cannot be confirmed with head monitoring data.

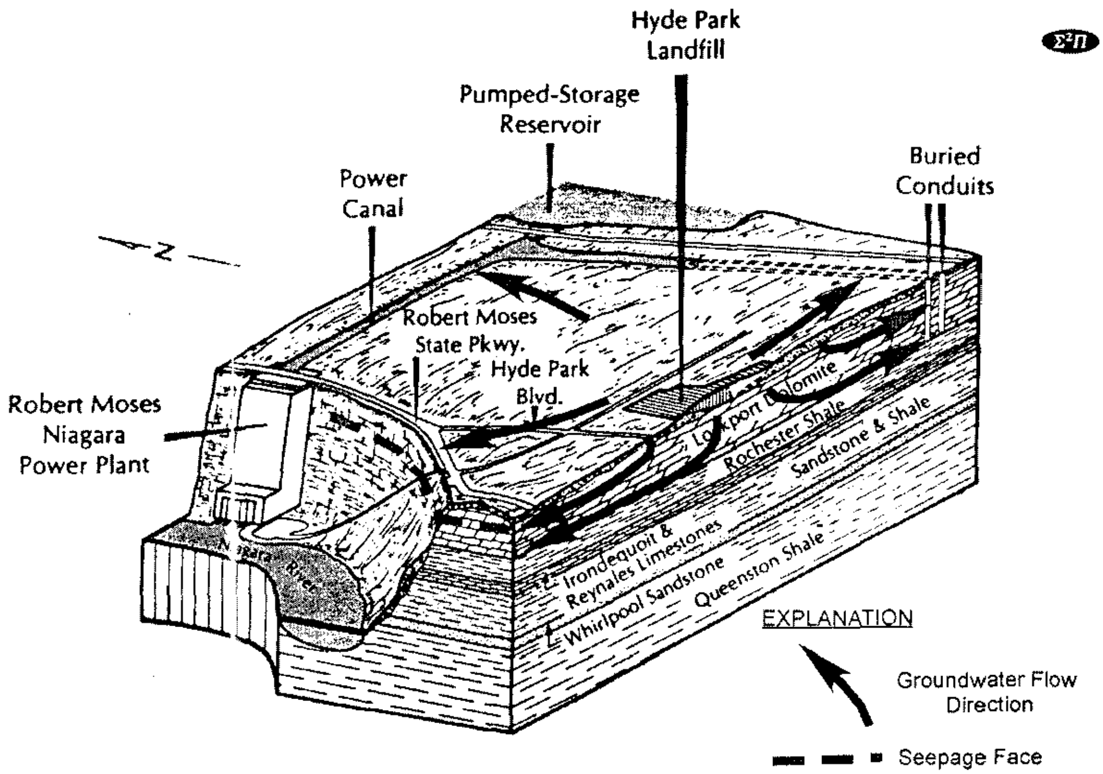
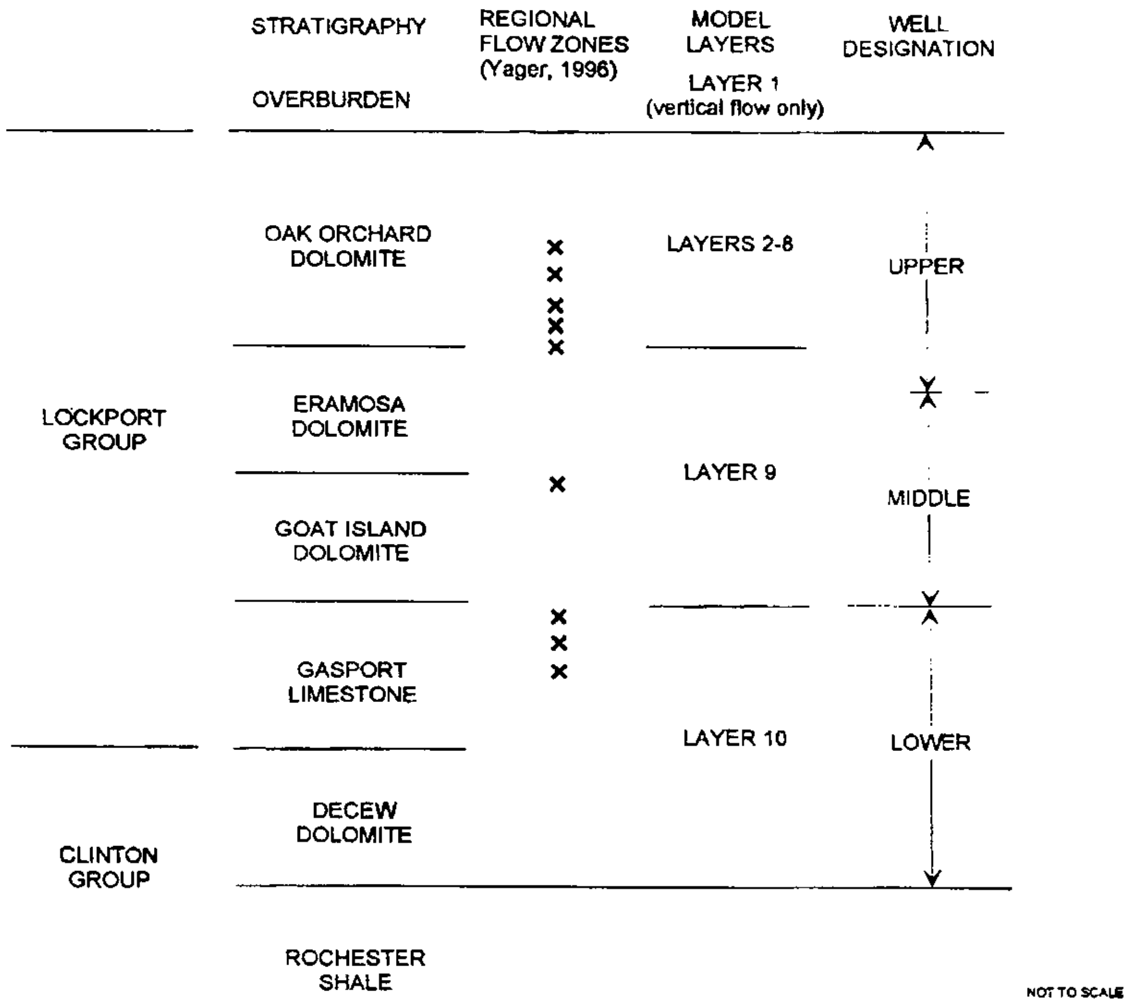


Figure 6. Conceptual sketch of ground-water flow patterns from the Hyde Park Landfill (S.S. Papadopulos & Associates, 2001)



NOTE: Layer 2 is a top-of-rock layer. Therefore, in Site area, layer 2 may correspond to the Oak Orchard Dolomite, or the Eramosa Dolomite (where Oak Orchard Dolomite is not present), or the Goat Island Dolomite (where the Oak Orchard Dolomite and the Eramosa Dolomite are not present).

Layer 3 correpsonds to Vernon Shale and is not present at the Site.
Layers 4 and 5 are the upper portion of the Oak Orchard formation, and are not present at the Site.

Figure 7. Hydrostratigraphic zones used at Hyde Park Landfill. Note that the stratigraphic terminology is that of Zenger (1965) rather than the revised nomenclature of Brett and others (1995).

NYPA Access Road (Hall Road)

This road leads to the base of the NYPA dam where a fishing platform is located. An excellent section of the Lockport and Clinton Group is exposed. Recent installation of fencing has obscured the view somewhat. About half way down the road an ephemeral seep is fenced to keep visitors away from contaminated ground water derived from Hyde Park. In spite of the hydraulic controls at Hyde Park, these seep is occasionally active. The revised stratigraphy of the Lockport and Upper Clinton are provided here (**Figures 8 and 9**).

Table 1. Bedrock stratigraphy of the Niagara Falls area

[Modified from Miller and Kappel, 1987, with additional data from Fisher and Brett, 1981; Brett and Calkin, 1987, Brett and others, 1995.]

System	Series	Group	Formation	Average thickness (feet)	Description
Silurian	Cayugan	Salina	Vernon Shale	57 (in study area)	Green and red shale.
	Niagaran	Lockport	Guelph Dolomite	33	Brownish-gray to dark gray, fine to medium, thick-bedded dolomite, with some argillaceous dolomicrite, particularly near contact with the Vernon Shale.
			Eramosa Dolomite	52	Brownish-gray, biostromal, bituminous, medium- to massive-bedded dolomite, with some argillaceous dolomicrite.
			Goat Island Dolomite	41	Light olive-gray to brownish gray, fine to medium crystalline, thick- to massive-bedded saccharoidal, cherty dolomite, with argillaceous dolomicrite near top of formation.
			Gasport Limestone	33	Basal unit is dolomitic, crinoidal grainstone, overlain by argillaceous limestone.
		Clinton	DeCew Dolomite	10	Very finely crystalline dolomite, medium to dark gray, thin to medium bedded.
			Rochester Shale	60	Dark-gray calcareous shale weathering to light gray to olive
			Irondequoit Limestone	12	Light-gray to pinkish-white coarse-grained limestone.
			Reynales Limestone	10	White to yellowish-gray shaly limestone and dolomite
			Neahga Shale	5	Greenish-gray soft fissile shale.
		Medina[1]	Thorold Sandstone	8	Greenish-gray shaly sandstone
			Grimsby Sandstone	45	Reddish-brown to greenish-gray cross-bedded sandstone interbedded with red to greenish-gray shale.
			Power Glen Shale	40	Gray to greenish-gray shale interbedded with light-gray sandstone.
			Whirlpool Sandstone	20	White, quartzitic sandstone.
Ordovician	Upper	Richmond	Queenston Shale	1,200	Brick-red sandy to argillaceous shale.

[1] Designated Albion Group by the U.S. Geological Survey

Figure 8. From Yager (1996). Detalied bedrock stratigraphy of the Niagara Falls area.

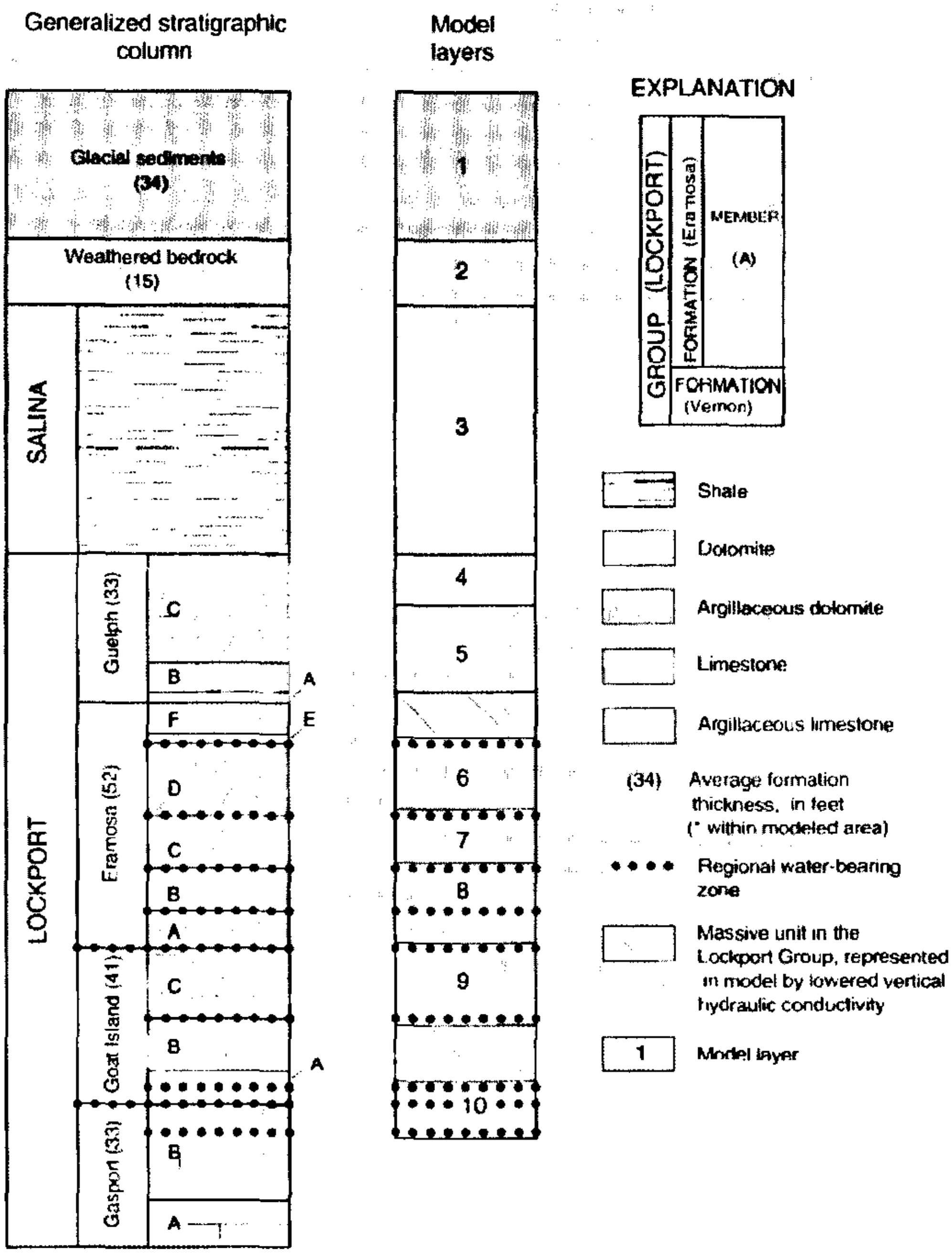


Figure 9. From Yager (1996). Bedrock stratigraphy of the Niagara Falls area showing major water bearing units. Also shown is the construction of a MODFLOW model used to represent regional ground water flow.

NYPA Power Vista Center

We will stop at the Power Vista Visitor's Center (http://www.nypa.gov/vc/niagara.htm) to get a view of the forebay canal. When the Niagara project produced its first power in 1961, it was the largest hydropower facility in the Western world at the time. The Niagara project, located about 4 1/2 miles downstream from the Falls, consists of two main facilities: the Robert Moses Niagara Power Plant, with 13 turbines, and the Lewiston Pump-Generating Plant, with 12 pump-turbines. In between the two plants is a forebay capable of holding about 740 million gallons of water; behind the Lewiston plant, a 1,900-acre reservoir holds additional water.

The excavation of the forebay into the Lockport provides a unique view of how water moves through fractured bedrock. Vegetation and water staining, along with ice formation in the winter, designate seeps along the canal walls. Notice that these seeps occur along specific bedding plane contacts, but only in specific locations. This "flow channeling" is characteristics of water flow through fractured bedrock. It implies that (1) effective porosity may be much smaller than would be estimated from fracture occurrence and (2) monitoring of contamination in bedrock may be partly a matter of luck. When effective porosity is overestimated, ground-water velocity is underestimated, based upon hydraulic arguments. This is due to the expectation in Darcy's Law that effective porosity (n_{eff}) relates specific discharge (q) and average linear velocity of a contaminant (v); $v = q/n_{eff}$.

Devils Hole State Park

If time allows we will hike down the trail that leaves from Devils Hole State Park. This trail affords an opportunity to seem more Lockport exposure up close as well as a natural cave. There are few examples of karst morphology in the Lockport Dolomite. It is unlikely that karst effects ground-water flow in the region. This cave was probably formed during the carving of the gorge by the Niagara River. It does provide an up close and personal look at the Lockport Dolomite.

C. Directions

Start at Bell Textron Site	**On Walmore Road North of Niagara Falls Blvd. in Wheatfield, NY 43.102137, -78.927063**	
	Head **south** from **Walmore Rd** - go **0.2 mi**	0.2 mi
	Turn **right** at **Cayuga Dr** - go **0.8 mi**	**0.8 mi** 1 min
	Turn **left** at **Williams Rd** - go **0.6 mi**	**0.6 mi** 1 min
	Turn **right** at **Colvin Blvd** - go **0.7 mi**	**0.7 mi** 2 mins
	Turn **left** at **95th St** - go **0.4 mi**	**0.4 mi** 1 min
Arrive at Love Canal		
	Head **south** from **95th St** - go **0.2 mi**	**0.2 mi**
	Turn **right** at **Frontier Ave** - go **0.3 mi**	**0.3 mi** 1 min
	Bear **right** at **S Military Rd** - go **0.2 mi**	**0.2 mi**
	Turn **left** at **Cayuga Dr** - go **0.1 mi**	**0.1 mi**
	Turn **right** into the **LaSalle Expwy West** entry ramp - go **0.3 mi**	**0.3 mi**
	Merge into **LaSalle Expy W** - go **1.1 mi**	**1.1 mi** 1 min
	Take the **I-190 S** ramp - go **0.6 mi**	**0.6 mi** 1 min
	Take the **RT-384** exit **21** - go **0.2 mi**	**0.2 mi**
	Turn **right** at **Buffalo Ave** - go **0.6 mi**	**0.6 mi** 2 mins
Arrive at S-Area	**43.078085, -79.003627**	
	Head **west** from **Buffalo Ave** - go **0.8 mi**	**0.8 mi** 2 mins
	Turn **right** at **Hyde Park Blvd** - go **3.6 mi**	**3.6 mi** 6 mins
	Turn **right** at **Power Auth Service Dr** - go **0.1 mi**	**0.1 mi**

Arrive at OCC Hyde Park	**43.132229, -79.038333**	
	Continue along NYPA Service Drive	**0.5 mi**
Arrive at NPYA Access Road	**43.135535, -79.043717**	
	Return up Access road and turn left at Hyde Park Blvd (Rt 61).	0.4 mi
	Take Rt 61 to Rt 104,	0.2 mi
	Turn Right at Rt 104 go 0.4 mi	0.4 mi
Arrive at Power Vista	**43.141132, -79.040698**	
	Exit Parking lot, turn left at blinking light onto rt 104 West – go 2.0 mi	2.0 mi
	Turn Rt onto Findlay Drive – go 0.2 mi	0.2 mi
	Turn Rt onto Robert Moses Parkway – go 1.5 mi	1.5 mi
Arrive at Devil's Hole State Park	Arrive at Devil's Holes State Park	

D. Appendices

Appendix A1: Niagara Falls Hazardous Waste Sites

From (U.S. Environmental Protection Agency and New York State Department of Environmental Conservation, 2005)

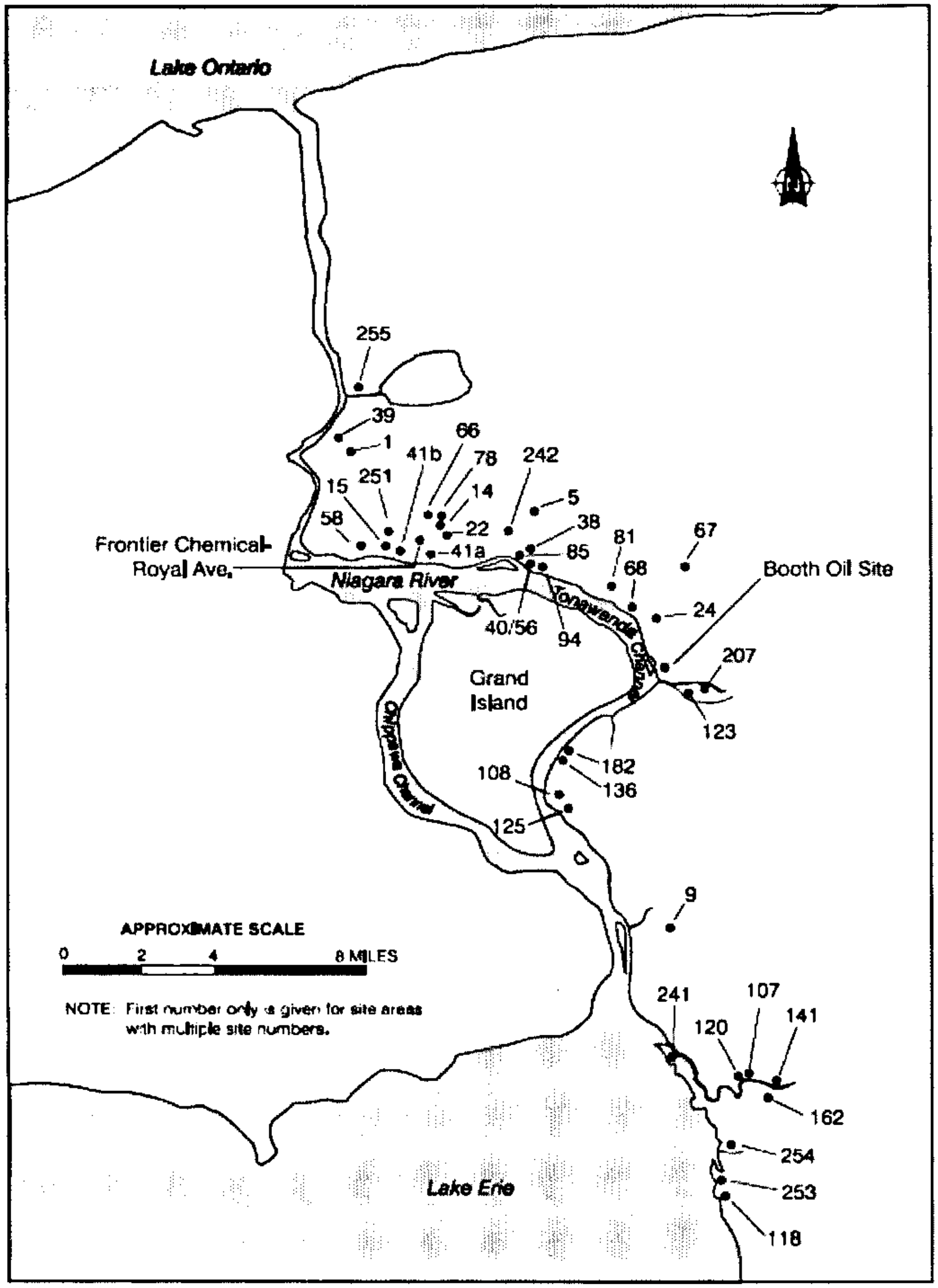


Figure 1: LOCATION OF SIGNIFICANT NIAGARA RIVER HAZARDOUS WASTE SITES

From (U.S. Environmental Protection Agency and New York State Department of Environmental Conservation, 2005)

Figure 1: LEGEND

USGS SITE NUMBERS	SITE NAME
41b-49	Occidental Chemical Corp. (OCC), Buffalo Ave. Avenue
81	Niagara County Refuse Disposal
14	DuPont Necco Park
78a,b	CECOS International/Niagara Recycling
39	OCC, Hyde Park
40,56,85,94*	102nd Street
5	Bell Aerospace Textron
66	Durez Corporation, Packard Road Facility (formally OCC, Durez Division)
41a	OCC, S-Area
255	Stauffer Plant (PASNY)
251	Solvent Chemical
1	Vanadium Corp. (formerly SKW Alloys)
58,59,248	Olin, Buffalo Avenue
15-19,250	DuPont, Buffalo Avenue Plant
254	Buffalo Harbor Containment
120-122	Buffalo Color Corporation, including Area D
118	Bethlehem Steel Corporation
136	River Road (INS Equipment)
67	Frontier Chemical, Pendleton
24-37	OCC, Durez, North Tonawanda
253	Small Boat Harbor Containment
68	Gratwick Riverside Park
141	Mobil Oil
162	Alltift Realty
242	Charles Gibson
22	Great Lakes Carbon
182	Niagara Mohawk Cherry Farm
241	Times Beach Containment
108	Tonawanda Coke
107	Allied Chemical
207	Tonawanda Landfill
125-127	Dunlop Tire and Rubber
123	Columbus-McKinnon
38	Love Canal
9-15-141	Iroquois Gas/Westwood Pharmaceutical

* Occidental 102nd Street site (#40), Olin 102nd Street site (#56), Griffon Park (#85), and Niagara River Belden site (#94)

Appendix A2: Lockport Group Stratigraphy

Revised Stratigraphy of the Lockport Group according to Brett and others (Brett et al., 1995).

REVISED STRATIGRAPHY AND CORRELATIONS

<table>
<tr><th colspan="10">AUTHOR OR SOURCE</th></tr>
<tr><th colspan="3">BOLTON (1957)</th><th colspan="2">ZENGER (1965)</th><th colspan="2">RICKARD (1975)</th><th colspan="3">THIS REPORT</th></tr>
<tr><td rowspan="7">ALBEMARLE GROUP</td><td colspan="2" rowspan="2">GUELPH FORMATION</td><td rowspan="7">LOCKPORT FORMATION</td><td rowspan="2">OAK ORCHARD MEMBER</td><td rowspan="7">LOCKPORT GROUP</td><td rowspan="2">GUELPH DOLOMITE</td><td rowspan="7">LOCKPORT GROUP</td><td colspan="2">GUELPH DOLOMITE</td></tr>
<tr><td colspan="2">ERAMOSA DOLOMITE</td></tr>
<tr><td rowspan="5">LOCKPORT FORMATION</td><td>ERAMOSA MEMBER</td><td>ERAMOSA MEMBER</td><td>ERAMOSA FORMATION</td><td rowspan="3">GOAT ISLAND DOLOMITE</td><td>VINEMOUNT MEMBER</td></tr>
<tr><td rowspan="2">GOAT ISLAND MEMBER</td><td rowspan="2">GOAT ISLAND MEMBER</td><td rowspan="2">GOAT ISLAND FORMATION</td><td>ANCASTER MEMBER</td></tr>
<tr><td>NIAGARA FALLS MEMBER</td></tr>
<tr><td rowspan="2">GASPORT MEMBER</td><td rowspan="2">GASPORT MEMBER</td><td rowspan="2">GASPORT FORMATION</td><td rowspan="2">GASPORT DOLOMITE</td><td>PEKIN MEMBER</td></tr>
<tr><td>GOTHIC HILL MEMBER</td></tr>
</table>

Figure 21. Historical summary of Lockport Group nomenclature in the Niagara region.

Appendix B1: Summary of Bell Aerospace Textron Site

(U.S. Environmental Protection Agency and New York State Department of Environmental Conservation, 2000)

Site Program: RCRA (State and Federal)
Summary Prepared by: EPA and DEC

Site Description

The Bell Aerospace Textron plant is located approximately 2.5 miles north of the Niagara River, adjacent to the Niagara Falls International Airport.

Between 1950 and 1980, the company used an unlined 60' X 100' surface impoundment to collect wash water from rocket engine test firings, storm run-off, and solvent drippings from cleaning, degreasing, and anodizing operations. Hazardous waste and constituents of concern include trichloroethylene and dichloroethylene. The wastes were discharged to a sanitary sewer after pH adjustment.

Beneath the site lies one overburden and two bedrock aquifers. Groundwater flow through the overburden aquifer is primarily to the south-southeast. There is a potential vertical flow between the overburden and the upper bedrock aquifer, and at least some of the groundwater from the overburden discharges to Bergholtz Creek. The upper bedrock aquifer flows primarily in a southeasterly direction and in the lower bedrock aquifer groundwater flow is generally to the south. The down-gradient extent of groundwater contamination in each of the three aquifers has been well defined, and, as of this update, no contaminated groundwater appears to be discharging directly to the Niagara River.

Remedial Actions

Bell Aerospace Textron is an RCRA site with a closed surface impoundment. The company excavated 1225 tons of contaminated soil and capped the area in 1987.

All of the remedial actions that were required here have been accomplished on schedule.

Since the initial 1989 hazardous waste site report, an RCRA Facility Investigation (RFI) has determined the extent of contaminant migration and a Corrective Measures Study (CMS) has addressed on- and off-site groundwater contamination. A State Part 373 post-closure permit was issued to Bell Aerospace in September 1992, which will expire in September 2003. The permit required final Corrective Measures Implementation (CMI), consisting of groundwater pump-and-treat programs for on- and off-site contamination. In addition, in October 2001 the facility has installed (on a voluntary basis) monitoring wells through the cap of the Neutralization Pond as part of an ongoing investigation of the natural degradation of groundwater contamination at the facility.

The overall remedial program is designed to intercept the bedrock groundwater that is migrating off-site toward the Niagara River. It consists of the installation of 11 groundwater extraction wells.

The off-site remedial system was started up in April 1993. It is achieving its designed objective. The capture zone associated with the system covers the area of groundwater contamination, and the areal extent of the contamination is diminishing. Five extraction wells have been installed to contain the off-site groundwater. However, as the off-site plume has become smaller, four extraction wells were determined to be optimal for pumping. The extracted groundwater contamination is discharged into the publicly owned treatment works (POTW) of the Town of Wheatfield. The off-site system is designed to recover two pounds of volatile compounds daily. The performance of the off-site remedial system is considered acceptable.

The on-site remedial system began the start-up operating period in April 1995. Several technical problems prevented the on-site system from attaining all of its design objectives. The remedial system was redesigned to address these problems, and the following two modifications were made:

- the installation of a 900 foot-long pipeline to divert the cooling water discharge from a rocket testing facility operating at the site to the storm drainage system; and,
- the installation of a slurry wall barrier along the main sewer line on Walmore Road to prevent the water migration from the sewer line to the on-site system.

However, even after these modifications, the on-site system was still not attaining satisfactory hydraulic containment. To address this, an additional extraction well was installed along the southern boundary of the site. This well was installed in July 1998, and is currently in operation. The operation of this well has increased the groundwater capture zone along the southern edge of the facility, but the capture zone was not consistently continuous from two of the five extraction wells. A higher capacity pump has been in operation on the new well since August 20, 1999, thus increasing the groundwater pumping rate.

With the above modifications, the on-site system is achieving its design goals. The on-site system has been effective in creating a groundwater capture zone over the DNAPL plume, therefore, all contaminated groundwater is being intercepted and treated on-site, so that no loading is migrating from the site. Six extraction wells are currently operating in the on-site system. The operation of the higher capacity pump has maintained a continuous capture zone. Monitoring data of 2002-2003 indicates a complete capture zone has been obtained along the southern boundary. The on-site system is designed to recover four pounds of volatile compounds daily.

Appendix B2a: Love Canal History

ecumenical task force
of the niagara frontier

Love Canal Collection

See: http://ublib.buffalo.edu/libraries/projects/lovecanal/

Background on the Love Canal

Introduction

During the summer of 1978, the Love Canal first came to international attention. On August 7, 1978, United States President Jimmy Carter declared a federal emergency at the Love Canal, a former chemical landfill which became a 15-acre neighborhood of the City of Niagara Falls, New York.

The Love Canal became the first man-made disaster to receive such a designation based on a variety of environmental and health related studies. As a result of grass roots interest and media attention, the Love Canal provided an impetus for dramatic interest in and changes to environmental concerns worldwide.

History of the Love Canal: 1892 -1978

The Love Canal, a neighborhood in the southeast LaSalle district of the City of Niagara Falls, New York, takes its name from the failed plan of nineteenth century entrepreneur, William T. Love. Approximately four miles upstream of Niagara Falls, Love saw an ideal location to harness water to generate power to the burgeoning industries developing along the seven mile stretch of the River to the mouth of Lake Ontario. In 1892, the canal was his solution to provide ships a route to bypass the Falls.

A few years later Love's dream of the navigable waterway evaporated. A nationwide economic depression, loss of financial backing, and the invention of alternating electrical current forced Love to abandoned his project. Only one mile of the canal had been dug.

U.S. Geological Aerial Photographs taken in 1927 clearly show an open body of water sixty feet wide and three thousand feet long at the otherwise undeveloped edge of the City. The Love Canal remained as a recreational area for swimming and boating well into the early 20th century.

By 1920, Love's land was sold at public auction and quickly became a municipal and chemical disposal site. From 1942 through 1953, the Love Canal Landfill was used principally by Hooker Chemical, one of the many chemical plants located along the

Niagara River. Nearly 21,000 tons (42 million pounds) of what would later be identified by independent scientists as "toxic chemicals" were dumped at the site.

In 1953, with the landfill at maximum capacity, Hooker filled the site with layers of dirt. As the post-war housing and baby boom spread to the southeast section of the City; the Niagara Falls Board of Education purchased the Love Canal land from Hooker Chemical for one dollar. Included in the deed transfer was a "warning" of the chemical wastes buried on the property and a disclaimer absolving Hooker of any further liability.

Single-family housing surrounded the Love Canal site. As the population grew, the 99th Street School was built directly on the former landfill. At the time, homeowners were not warned or provided information of potential hazards associated with locating close to the former landfill site.

According to residents who lived in the area, from the late 1950s through the early 1970s repeated complaints of odors and "substances" surfacing in their yards brought City officials to visit the neighborhood. The City assisted by covering the "substances" with dirt or clay, including those found on the playground at the 99th Street School. Faced with continuing complaints, the City, along with Niagara County hired Calspan Corporation as a consultant to investigate. A report was filed indicating presence of toxic chemical residue in the air and in the sump pumps of residents in living at the southern end of the canal. Also discovered were 50 gallons drums just below the surface of the canal cap and high levels of PCB's (polycholorinated biphenyls) in the storm sewer system. Remedial recommendations included covering the canal with a clay cap, sealing home sump pumps and a tile drainage system to control migration of wastes. No action was taken.

By 1978, the Love Canal neighborhood included approximately 800 private, single-family homes, 240 low-income apartments, and the 99th Street Elementary School - located near the center of the landfill. Two other schools, 93rd Street School and 95th Street School - were also considered to be part of this neighborhood comprised of working class families.

In April 1978, Michael Brown, a reporter for the Niagara Gazette newspaper, wrote a series of articles on hazardous waste problems in the Niagara Falls area, including the Love Canal dumpsite. In response to the articles, Love Canal residents once more began calling on City and County officials to investigate their complaints. By this time, many residents were beginning to question health risks and noting already existing inexplicable health problems.

At the same time, the New York State Department of Health (NYSDOH) began collecting air and soil tests in basements and conducting health studies of the 239 families immediately surrounding the canal. On April 25, 1978, the New York State Commissioner of Health, Dr. Robert Whalen issued a determination of public health hazard existing in the Love Canal Community. He ordered the Niagara County

Health Department to remove exposed chemicals from the site and install a protective fence around the area.

Once the report was public, Lois M. Gibbs, a resident and mother of two small children, canvassed the neighborhood to petition the closure of the 99th Street School where her son attended kindergarten.

Throughout the spring and summer of 1978, New York State Health Department, City of Niagara Falls and County of Niagara Falls officials, and Love Canal residents met to discuss the growing health hazard.

On August 2, 1978, the New York State Commissioner of Health, Robert M. Whalen, M.D. declared a medical State of Emergency at Love Canal and ordered the immediate closure of the 99th Street School. Immediate cleanup plans were initiated and recommendations to move were made for pregnant women and children under two who lived in the immediate surrounding area of the Love Canal.

The President of the United States Jimmy Carter declared the Love Canal area a federal emergency on August 7, 1978. This declaration would provide funds to permanently relocate the 239 families living in the first two rows of homes encircling the landfill. The remaining 10 block area of the Love Canal, including the home of Lois Gibbs, were not included in the declaration.

Appendix B2b: EPA Love Canal Fact Sheet

Love Canal

New York

EPA ID#: NYD000606947

EPA REGION 2

Congressional District(s): 29

Niagara

Niagara Falls

NPL LISTING HISTORY
Proposed Date: 10/1/1981
Final Date: 9/1/1983
Deletion Date: 9/30/2004

Site Description

The fenced 70-acre Love Canal site (Site) encompasses the original 16-acre hazardous waste landfill with a 40-acre clay/synthetic liner cap. Also, a barrier drainage system and leachate collection and treatment system is in place and operating. The Site includes the "original" canal that was excavated by Mr. William T. Love in the 1890's for a proposed hydroelectric power project but was never implemented. Beginning in 1942, the landfill was used by Hooker Chemicals and Plastics (now Occidental Chemical Corporation (OCC)) for the disposal of over 21,000 tons of various chemical wastes, including halogenated organics, pesticides, chlororbenzenes and dioxin. Dumping ceased in 1952, and, in 1953, the landfill was covered and deeded to the Niagara Falls Board of Education (NFBE). Subsequently, the area near the covered landfill was extensively developed, including the construction of an elementary school and numerous homes. Problems with odors and residues, first reported in the 1960's, increased during the 1970's, as the water table rose, bringing contaminated groundwater to the surface. Studies indicated that numerous toxic chemicals had migrated into the surrounding area directly adjacent to the original landfill disposal site. Runoff drained into the Niagara River, approximately three miles upstream of the intake tunnels for the Niagara Falls water treatment plant. Dioxin and other contaminants migrated from the landfill to the existing sewers, which had outfalls into nearby creeks. In 1978 and 1980, President Carter issued two environmental emergencies for the Love Canal area. As a result, approximately 950 families were evacuated from a 10-square-block area surrounding the landfill. The Federal Emergency Management Agency (FEMA) was directly involved in property purchase and residential relocation activities. In 1980, the neighborhoods adjacent to the Site were identified as the Emergency Declaration Area (EDA), which is approximately 350 acres and is divided into seven separate areas of concern. Approximately 10,000 people are located within one mile of the Site; 70,000 people live within three miles. The Love Canal area is served by a public water supply system; the City of Niagara Falls water treatment plant serves 77,000 people. The Site is 1/4 mile north of the Niagara River. The contamination problem discovered at the Site ultimately led to the passage of Federal legislation, governing abandoned hazardous waste sites

On December 21, 1995, a consent decree, as a cost recovery settlement between the United States and OCC, was lodged with the United States District Court. As part of the settlement, OCC and the United States Army have agreed to reimburse the Federal government's past response costs, related directly to response actions taken at the Site. The primary portion of OCC's reimbursement is $129 million; OCC has also agreed to reimburse certain other Federal costs, including oversight costs, and to make payments in satisfaction of natural resource damages claims. In a second part of this decree, the United States Army agreed to reimburse $8 million of the Federal government's past response costs; these funds have now been directed specifically into EPA Superfund and FEMA accounts.

Also, $3 million of the settlement funds will be directed to the Agency for Toxic Substances and Disease Registry (ATSDR) for the development of a comprehensive health study using the Love Canal Health Registry. ATSDR has awarded a grant to the New York State Department of Health (NYSDOH) to conduct this study which is the final stages of completion.

Site Responsibility: This Site is being addressed through Federal, State and potentially responsible party actions.

Threat and Contaminants

As a result of the landfill containment, the leachate collection and treatment system, the groundwater monitoring program and the removal of contaminated creek and sediments and other clean up efforts, the Site does not present a threat to human health and the environment.

Cleanup Approach

This Site has been addressed in seven stages: initial actions and six major long-term remedial action phases, focusing on 1) landfill containment with leachate collection, treatment and disposal; 2) excavation and interim storage of the sewer and creek sediments; 3) final treatment and disposal of the sewer and creek sediments and other Love Canal wastes; 4) remediation of the 93rd Street School soils; 5) EDA home maintenance and technical assistance by the Love Canal Area Revitalization Agency (LCARA), the agency implementing the Love Canal Land Use Master Plan; and, 6) buyout of homes and other properties in the EDA by LCARA.

Three other short-term remedial actions: a) the Frontier Avenue Sewer remediation, b) the EDA 4 soil removal, and c) the repair of a portion of the Love Canal cap, were completed in 1993 and are discussed below.

Response Action Status

Initial Actions: In 1978, New York State Department of Environmental Conservation (NYSDEC) installed a system to collect leachate from the Site. The landfill area was covered and fenced and a leachate treatment plant was constructed. In 1981, EPA erected a fence around Black Creek and conducted environmental studies.

Landfill Containment: In 1982, EPA selected a remedy to contain the landfill by constructing a barrier drain and a leachate collection system; covering the temporary clay cap with a synthetic material to prevent rain from coming into contact with the buried wastes; demolishing the contaminated houses adjacent to the landfill and nearby school; conducting studies to determine the best way to proceed with further site cleanup; and, monitoring to ensure the cleanup activities are effective. In 1985, NYSDEC installed the 40-acre cap and improved the leachate collection and treatment system, including the construction of a new leachate treatment facility.

Sewers, Creeks, and Berms: In May1985, as identified in a Record of Decision (ROD), EPA implemented a remedy to remediate the sewers and the creeks which included 1) hydraulically cleaning the sewers; 2) removal and disposal of the contaminated sediments; 3) inspecting the sewers for defects that could allow contaminants to migrate; 4) limiting access, dredging and hydraulically cleaning the Black Creek culverts; and, 5) removing and storing Black and Bergholtz creeks' contaminated sediments. [The remediation of the 102nd Street outfall area, as originally proposed in the 1985 ROD, has been addressed under the completed remedial action for the 102nd Street Landfill Superfund site.] The State cleaned 62,000 linear feet of storm and sanitary sewers in 1986. An additional 6,000 feet were cleaned in 1987. In 1989, Black and Bergholtz creeks were dredged of approximately 14,000 cubic yards of sediments. Clean riprap was placed in the creek beds, and the banks were replanted with grass. Prior to final disposal, the sewer and creek sediments and other wastes [33,500 cubic yards] were stored at OCC's Niagara Falls RCRA-permitted facilities.

Thermal Treatment of Sewers and Creeks Sediments: In October 1987, as identified in a second ROD, EPA selected a remedy to address the destruction and disposal of the dioxin-contaminated sediments from the sewers and creeks: 1) construction of an on-site facility to dewater and contain the sediments; 2) construction of a separate facility to treat the dewatered contaminants through high temperature thermal destruction; 3) thermal treatment of the residuals stored at the Site from the leachate treatment facility and other associated Love Canal waste materials; and, 4) on-site disposal of any non-hazardous residuals from the thermal treatment or incineration process. In 1989, OCC, the United States and the State of New York, entered into a partial consent decree (PCD) to address some of the required remedial actions, i.e ., the processing, bagging and storage of the creek sediments, as well as other Love Canal wastes, including the sewer sediments. Also, in 1989, EPA published an Explanation of Significant Differences (ESD), which provided for these sediments and other remedial wastes to be thermally treated at OCC's facilities rather than at the Site. In November 1996, a second ESD was issued to address a further modification of the 1987 ROD to include off-site EPA-approved thermal treatment and/or land disposal of the stored Love Canal waste materials. In December 1998, a third ESD was issued to announce a 10 ppb treatability variance for dioxin for the stored Love Canal waste materials. The sewer and creek sediments and other waste materials were subsequently shipped off-site for final disposal; this remedial action was deemed complete in March 2000.

93rd Street School: The 1988 ROD selected remedy for the 93rd Street School property included the excavation of approximately 7500 cubic yards of contaminated soil adjacent to the school followed by on-site solidification and stabilization. This remedy was re-evaluated as a result of concerns raised by the NFBE, regarding the future reuse of the property. An amendment to the original 1988 ROD was issued in May 1991; the subsequent selected remedy was excavation and off-site disposal of the contaminated soils. This remedial action was completed in September 1992. Subsequently, LCARA purchased the 93 rd Street School property from the NFBE and demolished the building in order to return the resulting vacant land to its best use.

Home Maintenance: As a result of the contamination at the Site, the Federal government and the State of New York purchased the affected properties in the EDA. LCARA is the coordinating New York State agency in charge of maintaining, rehabilitating and selling the affected properties. Pursuant to Section 312 of CERCLA, as amended, EPA provided funds to LCARA for the maintenance of those properties in the EDA and for the technical assistance during the rehabilitation of the EDA. EPA awarded these funds to LCARA directly through an EPA cooperative agreement for home maintenance and technical assistance. The rehabilitation and sale of these homes is complete. Since the rehabilitation program began, approximately 260 homes were sold. Also, a new senior citizen housing development has been constructed on vacant property in the habitable portion of the EDA. In 2000, EPA closed out this cooperative agreement with LCARA.

Property Acquisition: Section 312 of CERCLA, as amended, also provided $2.5M in EPA funds for the purchase of properties (businesses, rental properties, vacant lots, etc.) which were not eligible to be purchased under the earlier FEMA loan/grant. EPA awarded these funds to LCARA through a second EPA cooperative agreement. In 2000, EPA closed out this cooperative agreement with LCARA. LCARA was dissolved by NYS statute in August 2003.

Short-Term Remedial Actions: 1) The Frontier Avenue Sewer Project required excavation and disposal of contaminated pipe bedding and replacement with new pipe and bedding--excavated materials have been transported for off-site thermal treatment and/or land disposal. 2)The EDA 4 Project required the excavation and disposal of a hot spot of pesticide contaminated soils in the EDA and backfill with clean soils; excavated materials were disposed of off-site. 3) The Love Canal Cap Repair required the liner replacement and regrading of a portion of the cap. These short-term remedial actions were completed in September 1993.

Cleanup Progress

In 1988, EPA issued the Love Canal EDA Habitability Study (LCHS), a comprehensive sampling study of the EDA to evaluate the risk posed by the Site. Subsequent to the issuance of the final LCHS, NYSDOH issued a Decision on Habitability, based on the LCHS's findings. This Habitability Decision concluded that: 1) Areas 1-3 of the EDA are not suitable for habitation without remediation but may be used for commercial and/or industrial purposes and 2) Areas 4-7 of the EDA may be used for residential purposes, i.e., rehabitation.

In 1998, the wastewater discharge permit issued to OCC was modified to include the treatment of the leachate water from the 102nd Street Landfill site. In March 1999, the Love Canal leachate collection and treatment facility (LCTF) began receiving the 102 nd Street leachate water for treatment. The latest estimates represent the make up of the various Love Canal waste materials:

Sewer and Creek Sediment Wastes - 38,900 cubic yards @ 1.6 tons/cubic yard = 62,240 tons Collected LCTF DNAPL - 6000 pounds Collected 102nd Street DNAPL - 14,400 pounds Spent Carbon Filter Wastes - 40,380 pounds Treated LCTF Leachate - 4.35 MG Treated 102nd Street Landfill Treated Leachate - 0.58 MG

OCC is responsible for the continued operation and maintenance of the LCTF and groundwater monitoring. The Site is monitored on a continual basis through the numerous monitoring wells which are installed throughout the area. The yearly monitoring results show that the Site containment and the LCTF are operating as designed.

As shown above, numerous cleanup activities, including landfill containment, leachate collection and treatment and the removal and ultimate disposition of the contaminated sewer and creek sediments and other wastes, have been completed at the Site. These completed actions have eliminated the significant contamination exposure pathways at the Site, making the Site safe for nearby residents and the environment.

As a result of the revitalization efforts of LCARA, new homeowners have repopulated the habitable areas of the Love Canal EDA. More than 260 formerly-abandoned homes in the EDA were rehabilitated and sold to new residents, thus creating a viable new neighborhood. The vacant property in the EDA is currently being developed, according to the zoning and deed restrictions that are in place.

The Site was deemed construction complete on September 29, 1999. In September 2003, EPA issued a Five-Year Review Report that showed that the remedies implemented at the Site adequately control exposures of Site contaminants to human and environmental receptors to the extent necessary for the protection of human health and the environment. The next Five-Year review is scheduled for September 2008.

The Site was deleted from the National Priorities List on September 30, 2004.

Site Repositories

EPA Western New York Public Information Office @ (716) 551-4410, 186 Exchange Street, Buffalo, New York 14204.

Appendix B3: OCC S-Area EPA Fact Sheet

HOOKER CHEMICAL S-AREA
NEW YORK
EPA ID# NYD980651087
EPA REGION 2
CONGRESSIONAL DIST. 29
NIAGARA COUNTY
ALONG THE NIAGARA RIVER

Site Description

The Hooker Chemical SArea site is an 8acre industrial landfill owned by the Occidental Chemical Corporation. It is located at the southeast corner of OCC's Buffalo Avenue chemical plant in Niagara Falls, New York, along the Niagara River. Adjacent to the landfill is the City of Niagara Falls (City) drinking water treatment plant (DWTP). The Province of Ontario, Canada, is located across the Niagara River, a distance of approximately two miles. The landfill lies atop approximately 30 feet of soil, clay, till, and manmade fill on an area reclaimed from the Niagara River. Beneath these materials is fractured bedrock. OCC disposed of approximately 63,000 tons of chemical processing wastes into the landfill from 1947 to 1961. The landfill also was used by OCC for disposal of other wastes and debris, a practice that ended in 1975. Two lagoons for nonhazardous waste from plant operations were located on top of the landfill and were operated under New York State permits until 1989, when OCC discontinued operating these lagoons. During an inspection of the DWTP in 1969, chemicals were found in the bedrock water intake structures. In 1978, sampling of the structures and bedrock water intake tunnel revealed chemical contamination. The site is located in a heavily industrialized area of Niagara Falls. There is a residential community of approximately 700 people within 1/4 mile northeast of the site. The DWTP serves an estimated 70,000 people.

Site Responsibility:

This site is being addressed through Federal and potentially responsible parties' actions.

NPL LISTING HISTORY

Proposed Date: 12/01/82
Final Date: 09/01/83

Threats and Contaminants

On and offsite ground water and soil are contaminated with toxic chemicals occurring as both aqueous (water soluble) phase liquids (APLs) and nonaqueous (immiscible) phase liquids (NAPLs). These chemicals include primarily chlorinated benzenes. Dioxin is also present in ground water at trace levels. The main health threat to people is the risk from eating fish from the lower Niagara River/Lake Ontario Basin. Consumption of drinking water from the City's DWTP is not presenting health risks at present. However, the site, because of its proximity to the DWTP, presents a potential public health threat to the consumers of drinking water from the plant.

Cleanup Approach

The site is being addressed in three phases: immediate actions and two longterm remedial phases focusing on cleanup of the entire site and construction of a municipal drinking water treatment plant.

Response Action Status

Immediate Actions: The City closed the contaminated main intake tunnel at the DWTP and put an emergency tunnel into service to alleviate the threat of contaminating drinking water.
Entire Site: EPA selected a containment remedy to prevent further chemical migration from the landfill toward the DWTP and into and under the Niagara River. The remedy includes: (1) a slurry cut-off wall (barrier wall) to encompass the landfill and offsite areas contaminated with chemicals in overburden soils, (2) an overburden collection system located within the barrier wall and comprised of horizontal drains and groundwater extraction wells to contain and collect both APL and NAPL chemicals, (3) a bedrock remedial system consisting of groundwater extraction wells and NAPL recovery wells; (4) an onsite leachate storage facility for separating and storing APL and NAPL chemicals prior to treatment; (5) a carbon adsorption facility for treating APL chemicals; (6) incineration of NAPL chemicals; (7) a final cap; and (8) monitoring programs to determine the effectiveness of the remedy. All components of the remedy selected for the landfill, with the exception of the final cap and monitoring programs, have been constructed. Operational startup of the remedial systems began in 1996. An evaluation of the remedial systems performances is ongoing.
The evaluation of the overburden drain collection system revealed that it was not operating or functioning as designed. Upon further inspection, the horizontal drain pipe was found to be crushed at several locations. The damaged drain collection system was replaced in 1999. The final cap, once scheduled for completion in 1999, will be installed in the year 2000.
City of Niagara Falls Drinking Water Treatment Plant: The remedy selected to address contamination at the DWTP includes the construction of a new plant at a new location and demolition and cleanup of the old plant property. The new plant was built and on-line by the end of March 1997. Demolition of the old plant was completed in late 1997. The remedy selected for the old plant property includes (1) a slurry cut-off wall (an extension of the S-Area barrier wall) to contain NAPL and APL chemicals, (2) a drain collection system to prevent APL chemicals in overburden soils from migrating to the Niagara River, (3) grouting of the old bedrock raw-water intake tunnel, and (4) capping. Engineering designs were completed in 1997. The slurry cut-off wall, drain collection system and cap were constructed in 1998. The tunnel grouting project is scheduled for 2000.
Site Facts: In 1979, the U.S. Department of Justice, acting on behalf of the EPA, filed a complaint against the parties potentially responsible for the site contamination. The State of New York joined in the suit and a Settlement Agreement was signed by the parties in

January 1984. It was approved and entered by the District Court of Western New York in April 1985. The Agreement called for a potentially responsible party to conduct an investigation at the site, to recommend cleanup standards for the site, and to conduct site cleanup activities. A second agreement was signed by the parties in September 1990 and approved by the Court in April 1991. This Agreement, which amended the original 1985 Settlement Agreement, included an expanded cleanup program to address offsite areas and the construction of a new DWTP.

Cleanup Progress
The construction of a new $70 million DWTP at a new location addresses the threat to the drinking water supply from S-Area. The new plant replaces the old facility, which supplied drinking water to city residents for the past 83 years. The S-Area barrier wall and remedial systems provide physical and hydraulic containment of the 63,000 tons of chemical waste buried in the landfill. Their operations have also reduced the loadings of toxic chemicals to the Niagara River. Approximately 320,000 gallons of contaminated ground water are treated per day, with the treated effluent discharged to the Niagara River via a permitted outfall. Since the startup of the S-Area remedial systems in 1996, approximately 350 million gallons of contaminated ground water have been treated. Approximately 65,000 gallons of NAPL have been collected for incineration.

Site Repository
USEPA Public Information Office, Carborundum Center, Suite 530, 345 Third Street, Niagara Falls, New York, 14303

Appendix B4: Hooker Hyde Park EPA Fact Sheet

Hooker - Hyde Park

New York

EPA ID#: NYD000831644

EPA REGION 2

Congressional District(s): 29

Niagara

Northwest of the City of Niagara Falls

NPL LISTING HISTORY

Proposed Date: 12/1/1982

Final Date: 9/1/1983

Site Description

Hooker-Hyde Park is a 15-acre site that was used to dispose of approximately 80,000 tons of waste, some of it hazardous material, from 1953 to 1975. The landfill is immediately surrounded by several industrial facilities and property owned by the New York Power Authority. The Niagara River, which flows into Lake Ontario, is located 2,000 feet northwest of the site. Bloody Run Creek, the drainage basin for the landfill area, flows from the northwestern corner of the landfill. The creek eventually flows into storm sewers and down the Niagara Gorge Face into the Niagara River. The site is located a few blocks east of a 500-home residential community. Approximately 3,000 people are employed by the industries near the site. All of the industries and most of the residences are connected to a municipal water supply system.

Site Responsibility This site has been addressed through Federal and potentially responsible parties' actions.

Threat and Contaminants

The ground water is contaminated with volatile organic compounds (VOCs) and dioxin from former disposal activities. Bloody Run Creek sediments were contaminated with VOCs until their removal in 1993 and surface water of the Niagara Gorge Face was contaminated with VOCs. Potential health threats include the consumption of contaminated fish from Lake Ontario. Although groundwater is contaminated, there are no known uses of groundwater within the area, so it is unlikely that people would be exposed to groundwater contaminants. Access to the landfill is restricted by a fence and a 24-hour guard.

Cleanup Approach

The site is being addressed in a single long-term remedial phase focusing on cleanup of the entire site.

Response Action Status

Entire Site: Remedial Construction has been completed at this site.

In 1985, EPA selected cleanup remedies which include the following: (1) a source control extraction well system to remove non-aqueous phase liquids (NAPL) from the overburden in the landfill; (2) an overburden drain system surrounding the landfill; (3) a bedrock remedial system to prevent the migration of leachates comprised of (a) a NAPL plume containment system and (b) an aqueous phase liquid (APL or contaminated leachate) plume containment system; (4) a shallow and deep groundwater study; (5) a Niagara Gorge seep program; and, (6) the treatment of leachates. The potentially responsible party, Occidental Chemical Corporation (OCC), has implemented these remedies since 1985. To date, OCC has completed the following remedies. Two source control wells were pump tested in 1993 and are operating. Four additional source control wells were installed in 1994 and are also operating. The Overburden Barrier Collection System, a drain surrounding the landfill to collect and contain leachate, was completed in 1990. This drain system prevents leachate from migrating outwardly through the overburden from the landfill. The bedrock NAPL containment system is a system of extraction wells that will recover NAPL and APL from the bedrock. These wells are placed in three discrete bedrock zones. Pumping these wells will create an inward hydraulic gradient (ground-water flow) towards the landfill which will prevent the outward migration of leachate in the bedrock, while collecting the leachate for treatment. The bedrock NAPL containment system is being installed in phases since not enough is known of the hydrogeology in fractured bedrock to design a final system. Phase I wells were completed in 1993 and are operating. Phase II wells were completed in late 1993 and are operating. Three additional extraction wells (Phase III) were installed in 1997. Two wells were installed in 1998 and connected via a force main to the on-site treatment facility. OCC installed two new extraction wells and the associated monitoring wells during 1999. Currently, the bedrock NAPL containment system consists of a total of twelve extraction wells operating around the site. The APL plume containment system consists of two extraction wells placed near the Niagara Gorge that recover APL and prevent it from reaching the Niagara River. These wells were completed in 1994. The construction of the on-site leachate storage, handling, and treatment facility was completed in 1989. APL is treated on-site with activated carbon. NAPL is collected at this facility and transferred to OCC's Main Plant in Niagara Falls for incineration. The Niagara Gorge Face seeps have been remediated. Contaminated sediment was removed and some water diverted into a culvert so that people no longer have access to these seeps. In addition to these remedial measures, an Industrial Protection Program to protect nearby workers from contaminants has been completed. The draft Lake Ontario Dioxin Bioaccumulation Study was completed in 1989, distributed for scientific review and was available to the public in September 1992. Fish and sediment samples from Lake Ontario were collected and analyzed, and laboratory studies were conducted. The community monitoring program, consisting of monitoring wells placed within the community and sampled quarterly to provide early warning of contamination from Hyde Park indicator chemicals, is ongoing. An assessment was completed in March 1992 to determine the risk of excavating Bloody Run sediments. The risks from excavation, EPA's preferred alternative, were found acceptable and the decision made to excavate the Bloody Run. Excavation was completed in February 1993. The perimeter of the landfill was capped in 1992. The landfill itself was capped in late 1994.

OCC installed 5 additional extraction wells in 2001 because the monitoring system indicated that there was not 100% capture of the contaminated groundwater. OCC upgraded its onsite treatment facility to process 400 gallons per minute in 2002. Even though OCC was effectively dewatering the aquifer, they could not demonstrate complete capture. OCC proposed a new site conceptual model in which there are 11 flow zones at the site and not just 3 aquifers. OCC conducted an extensive geophysical sampling program at the site in 2001 in order to better characterize the ground-water flow zones.

OCC, using an extensive monitoring system which was installed at the site during 2001 and 2002, concluded in the Remedial Characterization Report: Hydrologic Characterization (June 2003) that the contaminated groundwater surrounding the site was being captured by the extraction well system and that the requirements of the RRT were being achieved. OCC conducted a study to determine the relative age of the water near the site and determined that the relative age of the groundwater between the extraction wells and the Niagara Gorge is younger than the groundwater underlying the site. This indicates that the extraction wells are effectively preventing migration of groundwater from the landfill to the Niagara River. The seeps along the gorge were determined not to be groundwater discharge, but surface runoff, indicating that the APL wells have been effective at controlling the groundwater near the gorge.

Site Facts: In 1981, the EPA, the Department of Justice, the State, and a potentially responsible party, Occidental Chemical Corporation, signed a Consent Decree specifying OCC's responsibilities for cleanup of contamination at the site and maintenance of these remedies. In 1985, the EPA selected the final method to clean up the site. There is intense public scrutiny of activities related to this site. Two citizens' groups have intervened in the lawsuit against the potentially responsible party. The Canadian government also reviewed all of the program activities.

Cleanup Progress

The cleanup actions at the Hooker-Hyde Park site were completed in September 2003. The removal of contaminated soils and sediments and the leachate control and treatment operations have substantially reduced potential health risks and further environmental degradation.

Remedial construction included the installation of a system of extractions wells, both in the bedrock and overburden, to contain and collect NAPL & APL. A Leachate Treatment Facility was built on-site. Contaminated sediments were removed from Bloody Run.

Approximately 5 million gallons of ground water have been treated on-site; approximately 350,000 gallons of NAPL have been extracted from the site and incinerated; 46,720 tons of contaminated sediments were removed from Bloody Run.

Future Activities:

• Operation and maintenance of the ground-water extraction and treatment systems. Approximately 250 million gallons of groundwater will need to be treated over the next 30 years;

• NAPL is currently incinerated offsite at a facility in Texas.

Site Repositories

US EPA Western NY Public Information Office 186 Exchange Street Buffalo, New York 14204 716.551.4410

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