Appendix DD
Ecological Risk Assessment

Ecological Risk Assessment

Pownal Tannery Superfund Site
Pownal, Vermont

Prepared for:

U.S. Environmental Protection Agency
Region 1
Boston, Massachusetts

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TABLE OF CONTENTS

TABLES

FIGURES

ATTACHMENTS

1.0 INTRODUCTION

This ecological risk assessment describes existing habitats and ecological receptor species that have been noted or are expected to be present at the Pownal Tannery Superfund site and evaluates the potential risks associated with the exposure of these biota to surface water, sediment and surface soil contaminants detected during the site characterization. The ecological risk assessment is largely a screening-level analysis of potential environmental risk (i.e., a Tier I analysis). Site reconnaissance was conducted by TRC ecologists and supplements data provided in the Ecological Inventory Report (Metcalf & Eddy, 1996). The objective of this risk assessment is to evaluate whether contaminants present within the Pownal Tannery Study Area and attributable to the former tannery operations may pose adverse impacts to biota inhabiting the site or habitats adjacent to the site. The Pownal Tannery Study Area includes the former lagoon area, aquatic habitats located adjacent and/or downgradient of the landfill, and the section of the Hoosic River located downriver from the landfill, former tannery building, or lagoon area.

This ecological risk assessment was conducted in accordance with the following U.S. Environment Protection Agency (U.S. EPA) guidance:

- Risk Assessment Guidance for Superfund (RAGS). Vol. II – Environmental Evaluation Manual. EPA 540/1-89/001, December 1989. (U.S. EPA 1989a).

- Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference. EPA 600/3-89/013, March 1989 (U.S. EPA, 1989b).

- Ecological Assessment of Superfund Sites: An Overview. ECO Update, Intermittent Bulletin, Vol. 1, No. 2. EPA Publ. 9345.0.0-51. (U.S. EPA, 1989c).

- Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments. EPA/540/R-97-006. June 1997 (U.S. EPA, 1997a).

- Guidelines for Ecological Risk Assessment. EPA/630/R-95/002Fa. May 1998 (U.S. EPA, 1998).

Following the guidelines prepared by the EPA, the basic components of the ecological risk assessment for the site is composed of the following parts:

- Problem Formulation

  - Description of the Ecological Resource (Resource Characterization);
  - Hazard Identification;
  - Site Conceptual Model;
  - Assessment Endpoints and Measurement Receptors;

- Analysis
  - Exposure Assessment;
  - Ecological Effects Assessment; and
- Risk Characterization.

2.0 PROBLEM FORMULATION

Problem Formulation is comprised of two primary components: Resource Characterization and Hazard Identification. Resource Characterization describes habitats present within the Pownal Tannery Study Area and identifies potential receptor species. Hazard Identification discusses exposure pathways and identifies contaminants of ecological concern. The results of these components are used to develop a site conceptual model and select both assessment and measurement endpoints.

2.1 Resource Characterization

The Pownal Tannery Study Area is situated between the Taconic Mountains to the west and the Green Mountains to the east and includes areas within and in close proximity to the Hoosic River. Metcalf & Eddy (1996) previously described the ecological attributes of the Hoosic River, lagoon area, and landfill area. This information was supplemented with observations and data collected by TRC ecologists in Spring 2000 during site reconnaissance, wetlands delineation, and sampling activities. A general description of habitat cover types present within the areas of concern within the Pownal Tannery Study Area (i.e., Hoosic River, lagoon area, and landfill area) is presented below and is followed by a discussion of potential ecological receptors (i.e., wildlife) that may utilize these habitats. In addition, a reference area for several of the identified wetland communities was also selected and is discussed below.

2.1.1 Habitat Characterization

Hoosic River

The Hoosic River represents a Class B Water as defined by the Vermont Water Resources Board (1997). Class B waters have an objective of providing water quality that consistently exhibits good aesthetic value and provide high quality habitat for aquatic biota, fish and wildlife. Uses of Class B waters include public water supply (with filtration and disinfection); irrigation and other agricultural uses; swimming and recreation. The Hoosic River is also classified as a Cold Water Fish Habitat (i.e., suitable for coldwater fishes such as trout). In Spring 2000, the Vermont Fish and Wildlife Department stocked 1,500 yearling brown trout (*Salmo trutta*) within the lower Hoosic River which includes the Pownal Tannery Study Area.

The width of the Hoosic River upriver of the North Pownal dam ranges from approximately 100 to 150 feet. Downriver of the dam, the river is narrower with an average width of approximately 75 to 100 feet. The topography surrounding the Hoosic River within the Pownal Tannery Study Area is characteristic of an alluvial floodplain. Broad flat areas adjacent to the river are located within the 100-year floodplain of the Hoosic River. However, occasional areas of exposed bedrock are also evident within reaches of the river. Terraces and severe scouring (e.g., bank undercutting) were evident along the reach of the Hoosic River downriver from the dam. The noted presence by TRC ecologists of wrack lines and sediment deposits within areas adjacent to the river provide additional evidence of periodic flooding. Distinct cut banks are present along the concave (outer) side of river bends while sediment accretion deposits were noted along the convex (inner) side of the Hoosic River.

Based on river sediment samples collected by TRC and analyzed for grain size, sediments downriver of the dam consist of medium and fine sand (with some finer silt/clay present as well as coarse sand) while sediments upriver of the dam generally contain more silt/clay and fine sand. Total organic carbon content within the river sediments range from less than 0.5 percent to nearly 4 percent (average of 1.25 percent). The average pH of surface water within the Hoosic River is approximately 8.0.

The National Wetland Inventory (NWI) map of the Pownal Tannery Study Area (USFWS, 1991) classifies the Hoosic River as lower perennial, unconsolidated bottom riverine wetlands. Several upper perennial riverine wetlands including Reservoir Hollow, Potter Hollow and Halifax Hollow are present within or in close proximity to the Pownal Tannery Study Area and represent tributaries to the Hoosic River.

Riparian habitat is present along the banks of the Hoosic River and within several small islands located downriver of the dam and slightly upriver from the lagoons. The vegetation along the riverbanks in the vicinity of the lagoons is generally diverse and consists predominately of cottonwood (*Populus deltoides*) and box-elder (*Acer negundo*) in the tree layer with some individuals of silver maple (*Acer saccharinum*) and sycamore (*Platanus occidentalis*) also present. The dominant shrub is silky dogwood (*Cornus amomum*) with tatarian honeysuckle (*Lonicera tatarica*) also present. Herbaceous understory vegetation is comprised predominately of garlic mustard (*Alliaria officinallis*), goldenrod (*Solidago* spp.) and reed canary-grass (*Phalaris arundinacea*). The small islands consist of scrub-shrub vegetation that is comprised predominately of silky dogwood. Vegetation on the opposite bank of the Hoosic River from the lagoons is markedly different. A conifer forest comprised of eastern white pine (*Pinus strobus*) and eastern hemlock (*Tsuga canadensis*) is present on the steep eroding bank. The wetlands adjacent to the Hoosic River are not classified by the Vermont Department of Environmental Conservation (VTDEC) as "high-quality" wetlands (Class II) as they are not depicted on the NWI map.

Two state-significant natural communities are present along the Hoosic River further downriver of the Pownal Tannery study area. A River Cobble Shore and a Sugar Maple-Ostrich Fern Riverine Floodplain Forest are present approximately two miles downriver from the dam (VTANR, 2000).

<u>*Lagoon Area*</u>

Habitats identified within the lagoon area include three wetland communities: palustrine unconsolidated bottom (shallow marsh), palustrine emergent persistent (wet meadow), and palustrine scrub-shrub. An upland community comprised of scrub-shrub vegetation interspersed with stands of deciduous saplings and herbaceous vegetation is also present within this area. The locations of these habitat cover types are depicted in Figure 1. The entire lagoon area is located within the 100-year floodplain of the Hoosic River (FEMA, 1980). Brief descriptions of each cover type present within the lagoon area are provided below.

The shallow marsh community is located primarily within Lagoon 5 (1.25 acres) although several small areas of standing water are also present within Lagoons 2 (0.35 acres) and 4 (0.5 acres). This cover type generally consists of an acre area of open water (approximately one to two feet in depth) surrounded by a band of emergent wetland vegetation comprised primarily of reed canary-grass (Lagoons 4 and 5) or co-dominated by purple loosestrife (*Lythrum salicaria*) and reed canary-grass (Lagoon 2). Other vegetation noted within these areas includes broad-leaved cat-tail (*Typha latifolia*), bebb willow (*Salix bebbiana*) and common reed (*Phragmites australis*).

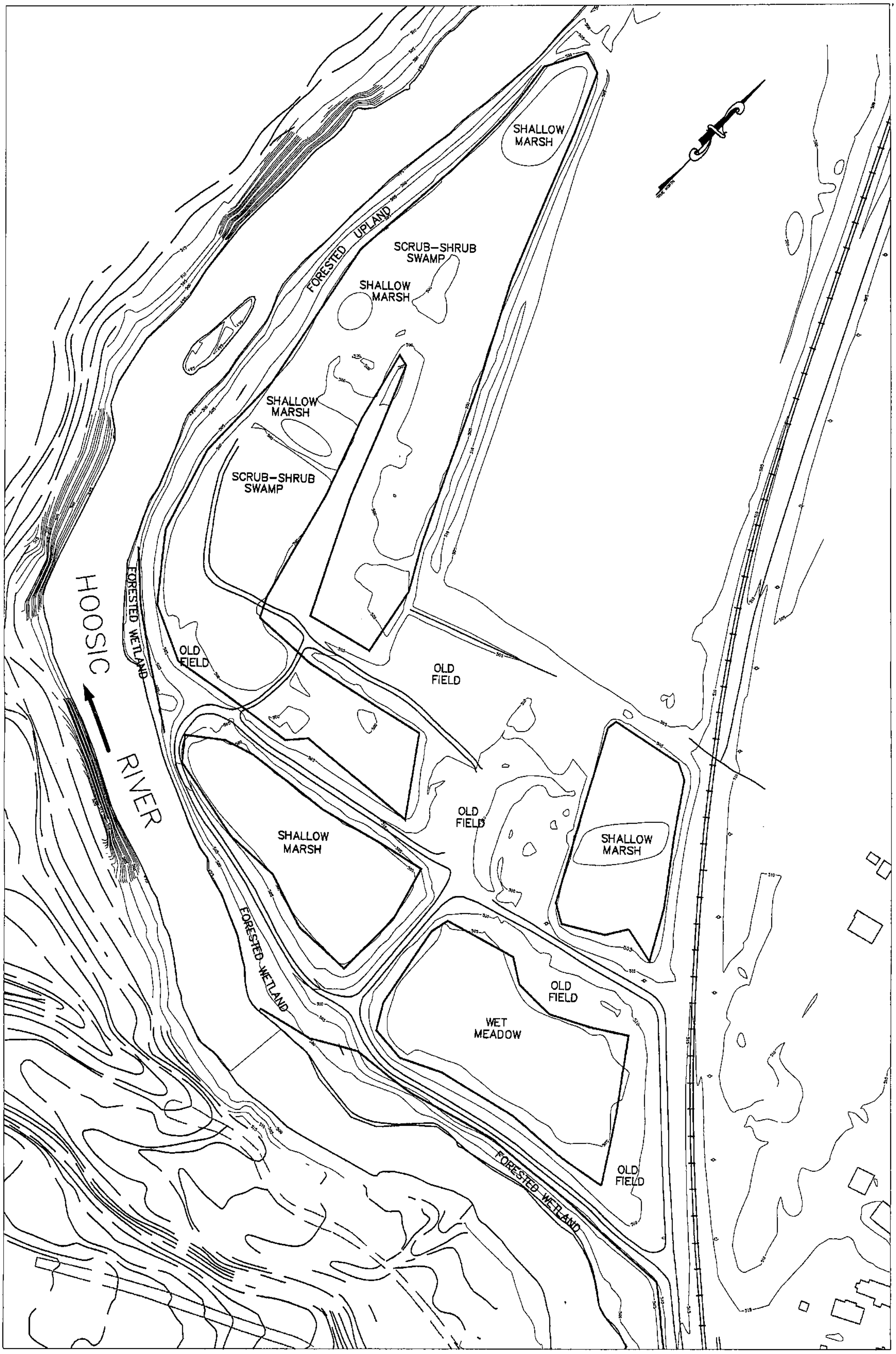
The emergent wet meadow community is present within Lagoon 1 and is comprised primarily of common reed with broad-leaved cat-tail and reed canary-grass also present. Standing water is present for a shorter duration within this cover type than within the shallow marsh communities present within the lagoons.

A scrub-shrub wetland area occupies much of Lagoon 4. Small box-elder, bebb willow, and cottonwood trees are present with a dense shrub stratum comprised primarily of multiflora rose (*Rosa multiflora*), tatarian honeysuckle, and staghorn sumac (*Rhus typhina*). Herbaceous vegetation is dominated by common reed, reed canary-grass and Canada goldenrod (*Solidago canadensis*). Other less common herbaceous species noted within this wetland include blue vervain (*Verbena hastata*), garlic mustard and wild madder (*Gallium mollugo*). Although plant species typical of upland areas are common within this cover type, the majority of the vegetation was comprised of hydrophytic species. Hydric soils associated with wetlands due to prolonged saturation were noted within this habitat; however, standing water is typically not present.

Uplands within the lagoon area and on the roadways located between the lagoons are generally representative of an early successional plant community ("old field" habitat). This cover type is found within portions of Lagoons 1, 2, 3 and 4. Vegetation consists of cottonwood, box-elder and aspen (*Populus tremuloides*) saplings, multiflora rose, tatarian honeysuckle and staghorn sumac in the shrub stratum and a herbaceous layer comprised of Canada goldenrod, garlic mustard, wild madder, common tansy (*Taracetum vulgare*), ragweed (*Ambrosia artemisiifolia*), Queen Anne's lace (*Dauca carota*), and gill-over-the-ground (*Glechoma hederacea*).

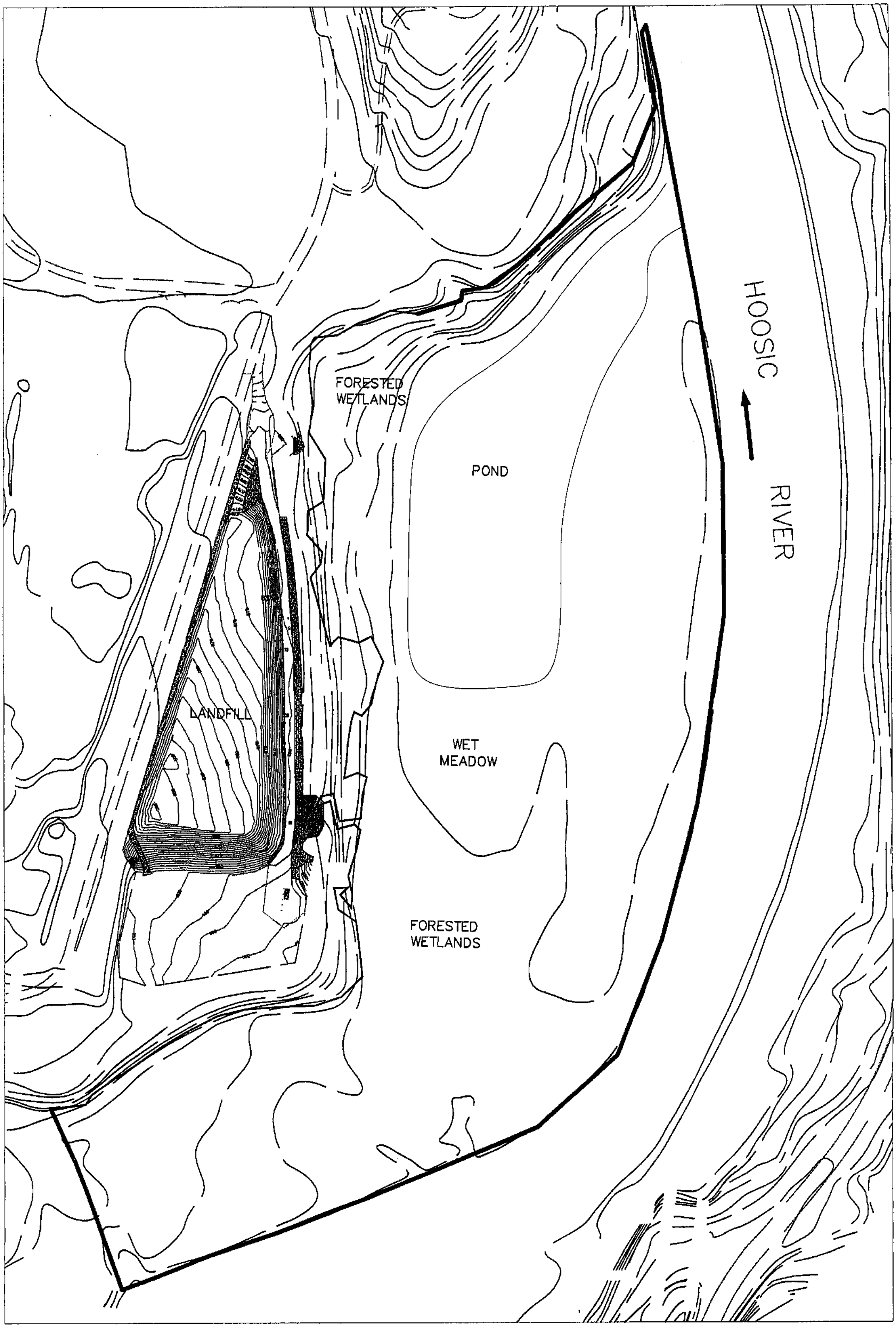
Landfill Area

Habitats of concern present in the vicinity of the landfill include stream (Halifax Hollow), palustrine unconsolidated bottom (pond), palustrine emergent wetland (wet meadow), and palustrine forested wetland (seepage areas). Figure 2 depicts the approximate locations of these cover types. The pond and wet meadow communities are present within the 100-year floodplain of the Hoosic River. Brief descriptions of these communities are described below.



TRC Boott Mills South Foot of John Street Lowell, MA 01852 978-970-5600	FIGURE 1 HABITAT COVER TYPES LAGOON AREA
TRC PROJ. NO.: 02136-0220-01N93	POWNAL TANNERY POWNAL, VERMONT
EPA CONTRACT NO.: 68-W6-0042	
RAC SUBCONTRACTOR NO.: 107061	M&E Metcalf & Eddy

PROJECTS\POWNAL\FIGURES\HABITAT COVER



TRC
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Foot of John Street
Lowell, MA 01852
978-970-5600

TRC PROJ. NO.: 02136-0220-01N93

EPA CONTRACT NO.: 68-W6-0042

RAC SUBCONTRACTOR NO.: 107061

FIGURE 2
HABITAT COVER TYPES
LANDFILL AREA

POWNAL TANNERY
POWNAL, VERMONT

M&E Metcalf & Eddy

O:\PROJECTS\POWNAL\FIGURES\HABITAT COVER

Halifax Hollow is a small perennial stream located south and adjacent to the landfill. This stream is a tributary to the Hoosic River slightly upriver from where the landfill is situated along the Hoosic River. The watershed to Halifax Hollow consists of forested slopes associated with the Taconic Mountains to the west of the landfill. The stream channel is approximately six to eight feet wide and very well defined adjacent to and upgradient of the landfill with one to two foot vertical banks present. Downgradient of the landfill, the stream contains many braids though a broad forested wetland with little topographical relief. Only some of the braids contain flowing water. It appears that the formation of the braids is in response to severe precipitation events where surface water flows overtop the stream banks creating new channels through the forested wetland. The substrate within both the braided and the well-defined channel portions of the stream consists predominately of cobbles, gravel and sand. Surface water depths noted by TRC during Spring 2000 ranged from approximately two to six inches. No seepage areas originating from the landfill and discharging to Halifax Hollow were noted by TRC.

The palustrine unconsolidated bottom (pond) wetland community is present to the northeast and near the base of the landfill slope. This pond may represent an oxbow pond in that a former meander bend of the Hoosic River became separated from the main channel and partially filled in with sediment forming a pond. The 4.0 acre pond is connected to the Hoosic River via a narrow outlet at the northeast end of the pond. Vegetation within the pond is sparse and consists of wool-grass (*Scirpus cyperinus*), broad-leaved cat-tail, and sedges (*Carex* spp.) growing primarily along the periphery of the pond. Significant areas of exposed and unvegetated mudflat are also present within portions of the pond. Sources of water to the pond include several seeps located along the steep slope downgradient of the landfill as well as from direct precipitation and flooding events from the nearby Hoosic River. Surface water depths within the pond are shallow (generally less than three feet in depth) with a soft substrate comprised primarily of fine material (silt, clay and organic matter). The average total organic carbon content of the sediment is nearly five percent. In Spring 2000, iron-stained leachate was noted by TRC to be present within the southern portion of the pond.

The wet meadow community is located immediately adjacent to and south of the pond. This floodplain wetland is dominated by reed canary-grass with sedges, sensitive fern (*Onoclea sensibilis*), and wool-grass also present. The substrate of the wet meadow generally consists of fine silt, clay and organic matter. Hummocks of vegetation are interspersed with narrow rivulets where surface water flows are occasionally present. Surface water flows discharge into the adjacent pond. In Spring 2000, TRC observed iron flocs and sheens within several of these rivulets. In addition, a small dead sunfish was also noted by TRC within one of the rivulets.

The forested wetland is present along the northeast slope located below the landfill and is associated with several seepage areas that originate along the slope. The seeps are weakly defined with small channels. Surface water depths were approximately three inches with a slight perceptible flow. The seepage areas discharge both to the downgradient pond and wet meadow. Vegetation within the adjacent forested wetlands consists predominately of red maple (*Acer rubrum*) with some yellow birch (*Betula alleghanensis*) and cottonwood also present in the tree layer. Numerous tree throws were noted within this habitat indicating shallow rooting by the overstory trees. Speckled alder (*Alnus rugosa*) is the predominate species present in the shrub stratum with scattered tatarian honeysuckle, multiflora rose, and silky dogwood also present.

The ground layer of vegetation contains primarily sedges, sensitive fern, and sphagnum moss (*Sphagnum* sp.) with water hemlock (*Cicuta maculata*), garlic mustard and goldenrod also present. The substrate within the seepage areas consisted primarily of fine silt, clay and organic matter.

Reference Area

A reference area was selected for the pond and wet meadow communities present near the landfill. The locations of the reference communities and their position relative to the former tannery, lagoon area and landfill are presented in Figure 3. The reference pond represents a small isolated pond located within the 100-year floodplain of the Hoosic River. The wet meadow is present around the periphery of the reference pond and contains similar vegetation as the landfill wet meadow (i.e., it is dominated by reed canary-grass). Surface water depths within the pond range from several inches to over three feet. The source of water within the reference pond appears to be attributable to flooding events from the nearby Hoosic River as well as direct precipitation and surface water runoff from the adjacent wet meadow. No stream tributaries to the pond are present.

Reference riverine and stream communities were selected within areas of the Hoosic River and Halifax Hollow that are located upgradient of the landfill. These areas have not been affected by past operations at the Pownal Tannery (including the upgradient landfill). Surface water and sediment sampling locations from these upgradient reference communities are also depicted in Figure 3.

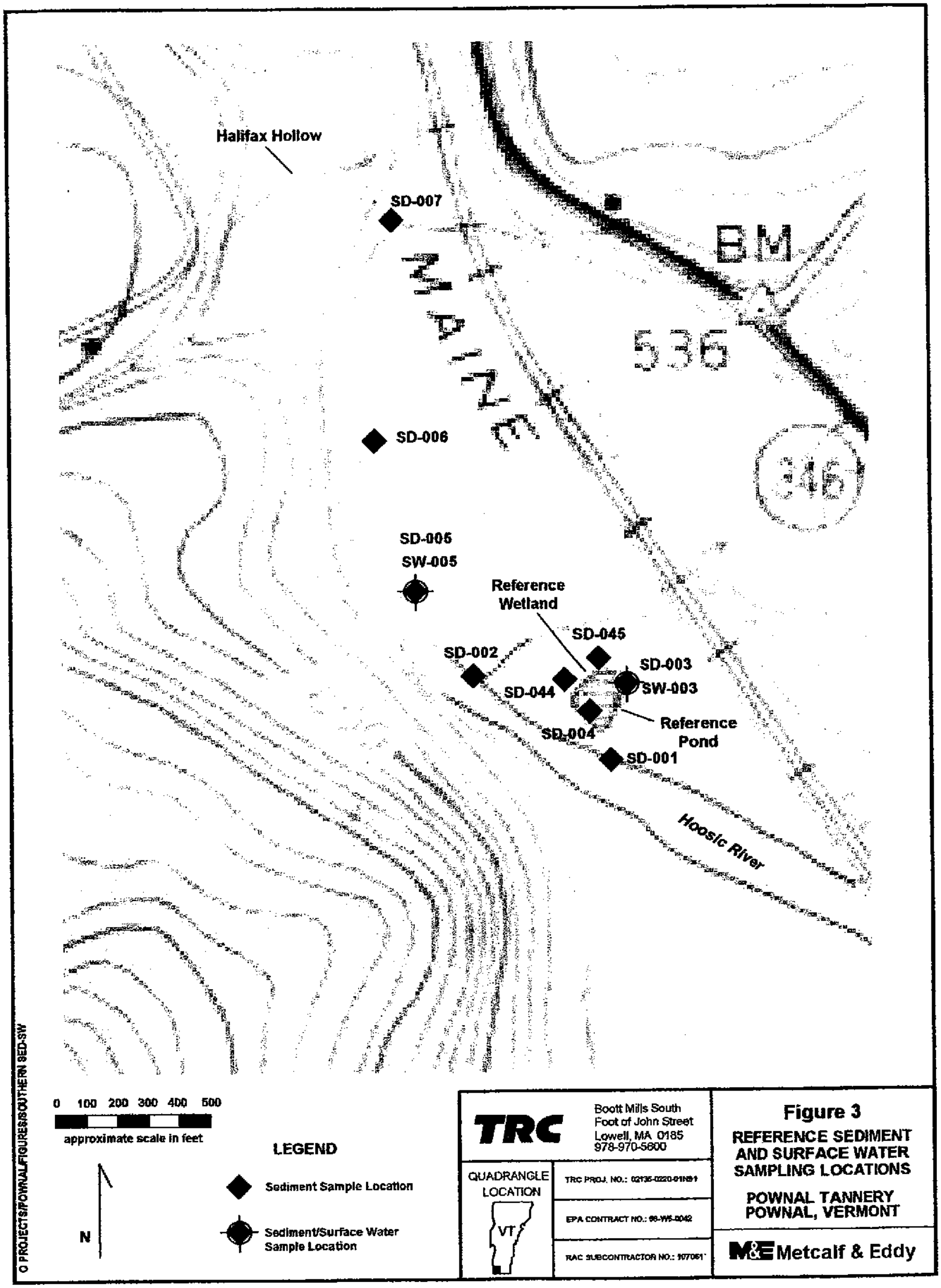
2.1.2 Wildlife Receptor Species Characterization

A variety of wildlife has been observed within the Pownal Tannery Study Area or are expected to inhabit the various cover types identified within the Pownal Tannery Study Area. A list of potential wildlife receptors noted or expected to utilize the identified cover types is presented in Table 1. Brief discussions of wildlife receptors expected to be present within each habitat cover type are provided below.

Hoosic River

Riverine wetlands such as the Hoosic River and the immediately adjacent palustrine wetlands may support a variety of aquatic, semi-aquatic, and terrestrial species. These species would include invertebrates, fish, amphibians, reptiles, birds and mammals. A listing of wildlife species that may occur within the Hoosic River or adjacent riparian forest are provided in Table 1.

A variety of amphibian and reptilian species may potentially use the aquatic habitats associated with the Hoosic River. Several of the identified amphibian species inhabit aquatic habitats throughout the year. Examples of these species include the northern spring salamander, red-spotted newt and bullfrog. Additional amphibians may potentially use the aquatic and riparian habitats of the Hoosic River seasonally as a breeding or foraging habitat. At other times of the year, these species may forage within uplands or wetlands located adjacent to the river.



Halifax Hollow
SD-007
MAINE
BM
536
346
SD-006
SD-005
SW-005
Reference
Wetland
SD-045
SD-002
SD-003
SW-003
SD-044
SD-004
Reference
Pond
SD-001
Hoosic River
0 100 200 300 400 500
approximate scale in feet
N
LEGEND
Sediment Sample Location
Sediment/Surface Water
Sample Location
TRC
Boott Mills South
Foot of John Street
Lowell, MA 0185
978-970-5600
QUADRANGLE
LOCATION
VT
Figure 3
REFERENCE SEDIMENT
AND SURFACE WATER
SAMPLING LOCATIONS
POWNAL TANNERY
POWNAL, VERMONT
M&E Metcalf & Eddy

TABLE 1. POTENTIAL ECOLOGICAL RECEPTORS FOR POWNAL TANNERY STUDY AREA.

Family	Common Name	Scientific Name	Guild2	Forage Method	Breeding Substrate	Hoosic River	River Riparian Forest	Lagoon Shallow Marsh	Lagoon Scrub-Shrub	Landfill Pond	Landfill Seep Forest	Landfill Meadow
Amphibians												
Ambystomatidae	Blue-spotted Salamander	*Ambystoma laterale*	I	Ground Gleaner	Water		X	X			X	X
	Jefferson Salamander	*Ambystoma jeffersonianum*	I	Ground Gleaner	Water		X	X				
	Spotted Salamander*	*Ambystoma maculatum*	I	Ground Gleaner	Water		X	X			X	
Bufonidae	Eastern American Toad*	*Bufo a. americanus*	I	Ground Ambusher	Water		X	X	X	X	X	X
Hylidae	Gray Treefrog*	*Hyla versicolor*	I	Bark Ambusher	Water		X	X		X	X	X
	Northern Spring Peeper*	*Pseudacris c. crucifer*	I	Riparian Ambusher	Water		X	X		X	X	X
Plethodontidae	N. Dusky Salamander	*Desmognathus f. fuscus*	I	Water Gleaner	Riparian Subsurface	X					X	
	N. Spring Salamander	*Gyrinophilus p. porphyriticus*	I	Water Gleaner	Water	X						
	N. Two-lined Salamander	*Eurycea b. bislineata*	I	Water Gleaner	Water	X					X	
	Redback Salamander	*Plethodon c. cinereus*	I	Ground Gleaner	Terrestrial Subsurface		X				X	
Ranidae	Bullfrog*	*Rana catesbeiana*	C	Water Ambusher	Water	X		X		X		
	Green Frog*	*Rana clamitans melanota*	I	Riparian Ambusher	Water	X	X	X		X	X	X
	Pickerel Frog*	*Rana palustris*	I	Riparian Ambusher	Water	X		X		X	X	X
	Wood Frog*	*Rana sylvatica*	I	Ground Ambusher	Water		X	X			X	
Salamandridae	Red-spotted Newt*	*Notophthalmus viridescens*	I	Water Gleaner	Water	X	X	X		X	X	X
Birds												
Accipitridae	Cooper's Hawk	*Accipiter cooperii*	C	Air Hawker	Tree-Branch				X		X	
	Northern Harrier	*Circus cyaneus*	C	Ground Pouncer	Riparian Ground							X
	Red-tailed Hawk*	*Buteo jamaicensis*	C	Ground Pouncer	Tree-Branch				X			
	Sharp-shinned Hawk	*Accipiter striatus*	C	Air Hawker	Tree-Branch				X		X	
Alcedinidae	Belted Kingfisher*	*Ceryle alcyon*	P	Water Plunger	Riparian Subsurface	X				X		
Anatidae	American Black Duck	*Anas rubripes*	O	Water Forager	Riparian Ground	X		X		X		X
	Canada Goose*	*Branta canadensis*	H	Ground Grazer	Riparian Ground	X		X		X		X
	Common Merganser*	*Mergus merganser*	P	Water Diver	Riparian Tree Cavity	X						
	Hooded Merganser	*Lophodytes cucullatus*	P	Water Diver	Riparian Tree Cavity	X				X		
	Mallard*	*Anas platyrhynchos*	G	Water Forager	Riparian Ground	X		X		X		X
	Wood Duck	*Aix sponsa*	G	Water Forager	Riparian Tree Cavity	X	X	X		X		
Apodidae	Chimney Swift*	*Chaetura pelagica*	I	Air Screener	Buildings	X		X	X	X		X
Ardeidae	Black-crowned Night Heron	*Nycticorax nycticorax*	C	Water Ambusher	Riparian Twig-Branch	X		X		X		
	Great Blue Heron*	*Ardea herodias*	C	Water Ambusher	Riparian Twig-Branch	X		X		X		X
	Green-backed Heron*	*Butorides striatus*	C	Water Ambusher	Riparian Shrub	X	X	X		X		X
Bombycillidae	Cedar Waxwing	*Bombycilla cedrorum*	F	Upper Canopy Gleaner	Tree-Twig		X		X			
Caprimulgidae	Common Nighthawk	*Chordeiles minor*	I	Air Screener	Buildings			X				X
Certhiidae	Brown Creeper	*Certhia americana*	I	Bark Gleaner	Tree Cavity-Crevice		X				X	
Charadriidae	Killdeer	*Charadrius vociferus*	I	Ground Gleaner	Ground-Herb							X
Columbidae	Mourning Dove	*Zenaida macroura*	G	Ground Gleaner	Tree-Branch				X			
Corvidae	American Crow*	*Corvus brachyrhynchos*	O	Ground Gleaner	Tree-Branch		X		X			
	Blue Jay*	*Cyanocitta cristata*	O	Ground Gleaner	Tree-Branch		X		X		X	
Cuculidae	Black-billed Cuckoo	*Coccyzus erythropthalmus*	I	Lower Canopy Gleaner	Tree-Branch				X			
	Yellow-billed Cuckoo	*Coccyzus americanus*	I	Lower Canopy Gleaner	Tree-Branch				X			
Falconidae	American Kestrel	*Falco sparverius*	C	Ground Pouncer	Tree Cavity-Crevice				X			X
Fringillidae	American Goldfinch*	*Carduelis tristis*	O	Ground Gleaner	Shrub		X		X		X	X
	American Tree Sparrow	*Spizella arborea*	O	Ground Gleaner	Not applicable		X		X			X
	Dark-eyed Junco	*Junco hyemalis*	G	Ground Gleaner	Ground-Herb				X		X	
	Field Sparrow*	*Spizella pusilla*	O	Ground Gleaner	Ground-Herb				X			
	Indigo Bunting	*Passerina cyanea*	I	Lower Canopy Gleaner	Ground-Herb		X		X		X	
	Northern Cardinal	*Cardinalis cardinalis*	O	Ground Gleaner	Shrub		X		X		X	X
	Rose-breasted Grosbeak	*Pheucticus ludovicianus*	O	Lower Canopy Gleaner	Tree-Twig		X		X			
	Savannah Sparrow	*Passerculus sandwichensis*	O	Ground Gleaner	Ground-Herb			X				X
	Song Sparrow*	*Melospiza melodia*	O	Ground Gleaner	Ground-Herb		X		X		X	X

TABLE 1. POTENTIAL ECOLOGICAL RECEPTORS FOR POWNAL TANNERY STUDY AREA.

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Fringillidae	Swamp Sparrow	*Melospiza georgiana*	I	Ground Gleaner	Riparian Ground		X	X		X		X
	Vesper Sparrow	*Pooecetes gramineus*	O	Ground Gleaner	Ground-Herb				X			
Hirundinidae	Bank Swallow*	*Riparia riparia*	I	Air Screener	Terrestrial Subsurface	X		X	X	X		X
	Barn Swallow	*Hirundo rustica*	I	Air Screener	Buildings	X		X	X	X		X
	Cliff Swallow	*Hirundo pyrrhonota*	I	Air Screener	Buildings	X		X	X	X		X
	N. Rough-winged Swallow	*Stelgidopteryx serripennis*	I	Air Screener	Terrestrial Subsurface	X		X	X	X		X
	Tree Swallow*	*Tachycineata bicolor*	I	Air Screener	Tree Cavity-Crevice	X	X	X	X	X		X
Icteridae	Baltimore Oriole*	*Icterus galbula*	O	Upper Canopy Gleaner	Tree-Twig		X		X		X	
	Brown-headed Cowbird	*Molothrus ater*	O	Ground Gleaner	Nest Parasite		X		X		X	X
	Common Grackle*	*Quiscalus quiscula*	O	Ground Gleaner	Tree-Branch	X	X	X		X		X
	Red-winged Blackbird*	*Agelaius phoeniceus*	O	Ground Gleaner	Shrub	X		X		X		X
Laridae	Herring Gull	*Larus argentatus*	C	Riparian Scavenger	Beach-Rock-Dune	X						
Mimidae	Brown Thrasher	*Toxostoma rufum*	O	Ground Gleaner	Shrub		X		X		X	
	Gray Catbird*	*Dumetella carolinensis*	O	Ground Gleaner	Shrub		X		X		X	X
Paridae	Black-capped Chickadee*	*Parus atricapillus*	I	Lower Canopy Gleaner	Tree Cavity-Crevice		X		X		X	
	Tufted Titmouse	*Parus bicolor*	I	Lower Canopy Gleaner	Tree Cavity-Crevice		X				X	
Parulidae	American Redstart	*Setophaga ruticilla*	I	Lower Canopy Gleaner	Tree-Twig		X				X	
	Black-and-White Warbler	*Mniotilta varia*	I	Bark Gleaner	Ground-Herb		X				X	
	Canada Warbler	*Wilsonia canadensis*	I	Lower Canopy Gleaner	Riparian Ground		X				X	
	Chestnut-sided Warbler	*Dendroica pensylvanica*	I	Lower Canopy Gleaner	Shrub				X		X	
	Common Yellowthroat*	*Geothlypis trichas*	I	Lower Canopy Gleaner	Ground-Herb		X	X	X	X	X	X
	Golden-winged Warbler	*Vermivora chrysoptera*	I	Lower Canopy Gleaner	Ground-Herb				X			
	Nashville Warbler	*Vermivora ruficapilla*	I	Lower Canopy Gleaner	Ground-Herb				X			
	Northern Waterthrush	*Seiurus noveboracensis*	I	Riparian Gleaner	Riparian Subsurface	X						
	Yellow Warbler*	*Dendroica petechia*	I	Lower Canopy Gleaner	Shrub				X		X	
Phalacrocoracidae	Double-crested Cormorant*	*Phalacrocorax auritus*	P	Water Diver	Riparian Ground	X						
Picidae	Downy Woodpecker	*Picoides pubescens*	I	Bark Gleaner	Tree Cavity-Crevice		X				X	
	Hairy Woodpecker*	*Picoides villosus*	I	Bark Gleaner	Tree Cavity-Crevice		X					
	Northern Flicker	*Colaptes auratus*	I	Ground Gleaner	Tree Cavity-Crevice		X		X			
	Pileated Woodpecker	*Dryocopus pileatus*	I	Bark Excavator	Tree Cavity-Crevice		X					
Ploceidae	House Sparrow	*Passer domesticus*	G	Ground Gleaner	Buildings				X			
Scolopacidae	American Woodcock	*Scolopax minor*	I	Ground Prober	Ground-Herb				X		X	X
	Common Snipe	*Gallinago gallinago*	I	Water Gleaner	Riparian Ground							X
	Spotted Sandpiper*	*Actitis macularia*	O	Riparian Gleaner	Ground-Herb	X				X		
Sittidae	White-breasted Nuthatch	*Sitta carolinensis*	I	Bark Gleaner	Tree Cavity-Crevice		X				X	
Strigidae	Eastern Screech-Owl	*Otus asio*	C	Ground Pouncer	Tree Cavity-Crevice		X		X		X	X
	Great Horned Owl	*Bubo virginianus*	C	Ground Pouncer	Tree-Branch		X		X		X	X
Sturnidae	European Starling*	*Sturnus vulgaris*	O	Ground Gleaner	Buildings		X		X			X
Sylviidae	Blue-gray Gnatcatcher	*Polioptila caerulea*	I	Upper Canopy Gleaner	Tree-Branch				X		X	
Tetraonidae	Ruffed Grouse	*Bonasa umbellus*	O	Ground Gleaner	Ground-Herb				X		X	
Trochilidae	Ruby-throated Hummingbird*	*Archilochus colubris*	O	Floral Hover-Gleaner	Tree-Branch				X		X	
Troglodytidae	House Wren	*Troglodytes aedon*	I	Lower Canopy Gleaner	Tree Cavity-Crevice		X		X		X	
	Marsh Wren	*Cistothorus palustris*	I	Ground Gleaner	Riparian Ground			X				
Turdidae	American Robin*	*Turdus migratorius*	O	Ground Gleaner	Tree-Branch		X		X		X	X
	Eastern Bluebird	*Sialia sialis*	O	Ground Gleaner	Tree Cavity-Crevice				X			
	Hermit Thrush	*Catharus guttatus*	I	Ground Gleaner	Ground-Herb		X				X	
	Wood Thrush	*Hylocichla mustelina*	O	Ground Gleaner	Tree-Branch		X				X	
Tyrannidae	Alder Flycatcher	*Empidonax alnorum*	I	Air Sallier	Shrub		X		X			X
	Eastern Kingbird*	*Tyrannus tyrannus*	I	Air Sallier	Tree-Twig		X		X	X		
	Eastern Phoebe*	*Sayornis phoebe*	I	Air Sallier	Buildings	X	X		X			X
	Least Flycatcher	*Empidonax minimus*	I	Air Sallier	Tree Branch		X				X	
	Olive-sided Flycatcher	*Contopus borealis*	I	Air Sallier	Tree Branch					X		

TABLE 1. POTENTIAL ECOLOGICAL RECEPTORS FOR POWNAL TANNERY STUDY AREA.

Family	Common Name	Scientific Name	Guild2	Forage Method	Breeding Substrate	Hoosic River	River Riparian Forest	Lagoon Shallow Marsh	Lagoon Scrub-Shrub	Landfill Pond	Landfill Seep Forest	Landfill Meadow
Tyrannidae	Willow Flycatcher	*Empidonax traillii*	I	Air Sallier	Shrub				X			
Vireonidae	Red-eyed Vireo	*Virea olivaceus*	I	Upper Canopy Gleaner	Tree-Twig		X					
	Warbling Vireo	*Vireo gilvus*	I	Upper Canopy Gleaner	Tree-Twig		X					
Mammals												
Canidae	Coyote	*Canis latrans*	O	Ground Forager	Terrestrial Subsurface		X	X	X		X	X
	Gray Fox	*Urocyon cinereoargenteus*	O	Ground Forager	Ground-Herb		X	X	X		X	X
	Red Fox	*Vulpes vulpes*	O	Ground Forager	Terrestrial Subsurface		X	X	X		X	X
Castoridae	Beaver*	*Castor canadensis*	H	Water Grazer	Riparian Subsurface	X	X	X		X		
Cervidae	White-tailed Deer*	*Odocoileus virginianus*	H	Ground Grazer	Ground-Herb		X	X	X		X	X
Cricetidae	Deer Mouse	*Peromyscus maniculatus*	O	Ground Forager	Terrestrial Subsurface		X		X		X	
	Meadow Vole*	*Microtus pennsylvanicus*	H	Ground Grazer	Terrestrial Subsurface				X			X
	Muskrat*	*Ondatra zibethicus*	H	Water Grazer	Riparian Subsurface	X		X		X		X
	S. Red-backed Vole	*Clethrionomys gapperi*	H	Ground Grazer	Terrestrial Subsurface		X		X		X	
	Southern Bog Lemming	*Synaptomys cooperi*	H	Ground Grazer	Ground-Herb			X				X
	White-footed Mouse	*Peromyscus leucopus*	O	Ground Forager	Terrestrial Subsurface		X		X		X	X
	Woodland Vole	*Microtus pinetorum*	H	Ground Grazer	Terrestrial Subsurface		X		X		X	
Didelphidae	Virginia Opossum	*Didelphis virginiana*	O	Ground Forager	Tree Cavity-Crevice		X	X	X		X	X
Leporidae	Eastern Cottontail*	*Sylvilagus floridanus*	H	Ground Grazer	Ground-Herb		X		X		X	X
	New England Cottontail	*Sylvilagus transitionalis*	H	Ground Grazer	Ground-Herb		X		X		X	X
	Snowshoe Hare	*Lepus americanus*	H	Ground Grazer	Ground-Herb				X			
Muridae	House Mouse	*Mus musculus*	O	Ground Forager	Buildings				X			
	Norway Rat	*Rattus norvegicus*	O	Ground Forager	Terrestrial Subsurface				X			
Mustelidae	Ermine	*Mustela erminea*	C	Ground Pursuer	Ground-Herb		X		X		X	
	Long-tailed Weasel	*Mustela frenata*	C	Ground Pursuer	Terrestrial Subsurface		X	X	X		X	X
	Mink	*Mustela vison*	P	Water Diver	Riparian Subsurface	X	X	X		X	X	X
	River Otter	*Lutra canadensis*	P	Water Diver	Riparian Subsurface	X	X			X		
	Striped Skunk*	*Mephitis mephitis*	O	Ground Forager	Terrestrial Subsurface		X	X	X		X	X
Procyonidae	Raccoon*	*Procyon lotor*	O	Ground Forager	Tree Cavity-Crevice	X	X	X	X		X	X
Sciuridae	Eastern Chipmunk	*Tamias striatus*	G	Ground Forager	Terrestrial Subsurface				X			
	Red Squirrel	*Tamiasciurus hudsonicus*	G	Upper Canopy Forager	Tree Cavity-Crevice		X				X	
	Woodchuck*	*Marmota monax*	H	Ground Grazer	Terrestrial Subsurface				X			
Soricidae	Masked Shrew	*Sorex cinereus*	I	Ground Gleaner	Terrestrial Subsurface		X	X	X		X	X
	N. Short-tailed Shrew	*Blarina brevicauda*	I	Ground Gleaner	Terrestrial Subsurface		X		X		X	X
	Pygmy Shrew	*Sorex hoyi*	I	Ground Gleaner	Riparian Subsurface		X					
	Smoky Shrew	*Sorex fumeus*	I	Ground Gleaner	Terrestrial Subsurface		X				X	
	Water Shrew	*Sorex palustris*	I	Water Gleaner	Riparian Subsurface	X		X		X		X
Talpidae	Hairy-tailed Mole*	*Parascalops breweri*	I	Ground Gleaner	Terrestrial Subsurface		X		X		X	
	Star-nosed Mole	*Condylura cristata*	I	Water Gleaner	Riparian Subsurface	X		X		X		X
Vespertilionidae	Big Brown Bat	*Eptesicus fuscus*	I	Air Hawker	Buildings	X		X	X	X		X
	Eastern Pipistrelle	*Pipistrellus subflavus*	I	Air Hawker	Cave-Crevice	X		X	X	X		X
	Hoary Bat	*Lasiurus cinereus*	I	Air Hawker	Tree-Twig	X		X	X	X		X
	Little Brown Bat	*Myotis lucifugus*	I	Air Hawker	Buildings	X		X	X	X		X
	N. Long-eared Bat	*Myotis septentrionalis*	I	Air Hawker	Tree Cavity-Crevice	X		X	X	X		X
	Red Bat	*Lasiurus borealis*	I	Air Hawker	Tree-Twig	X		X	X	X		X
	Silver-haired Bat	*Lasionycteris noctivagans*	I	Air Hawker	Tree-Twig	X		X	X	X		X
Zapodidae	Meadow Jumping Mouse	*Zapus hudsonius*	O	Ground Forager	Ground-Herb			X	X			X
	Woodland Jumping Mouse	*Napaeozapus insignis*	O	Ground Forager	Ground-Herb		X		X		X	
Reptiles												
Chelydridae	Snapping Turtle*	*Chelydra serpentina*	O	Bottom Forager	Riparian Subsurface	X		X	X	X		
Colubridae	E. Smooth Green Snake	*Opheodrys v. vernalis*	I	Ground Ambusher	Terrestrial Subsurface		X		X		X	X

TABLE 1. POTENTIAL ECOLOGICAL RECEPTORS FOR POWNAL TANNERY STUDY AREA.

Family	Common Name	Scientific Name	Guild2	Forage Method	Breeding Substrate	Hoosic River	River Riparian Forest	Lagoon Shallow Marsh	Lagoon Scrub-Shrub	Landfill Pond	Landfill Seep Forest	Landfill Meadow
Colubridae	Eastern Garter Snake*	*Thamnophia s. sirtalis*	C	Ground Ambusher	Terrestrial Subsurface	X	X	X	X		X	X
	Eastern Milk Snake	*Lampropeltis t. triangulum*	C	Ground Ambusher	Terrestrial Subsurface						X	
	Eastern Ribbon Snake	*Thamnophis s. sauritus*	C	Water Ambusher	Riparian Subsurface	X		X		X		X
	Northern Black Racer	*Coluber c. constrictor*	C	Ground Ambusher	Terrestrial Subsurface		X		X			X
	Northern Brown Snake	*Storeria d. dekayi*	I	Ground Ambusher	Terrestrial Subsurface				X		X	X
	Northern Redbelly Snake	*Storeria o. occipitomaculata*	I	Ground Ambusher	Terrestrial Subsurface						X	X
	Northern Water Snake	*Nerodia s. sipedon*	C	Water Ambusher	Riparian Subsurface	X	X			X	X	X
Emydidae	Midland Painted Turtle*	*Chrysemys p. marginata*	O	Bottom Forager	Terrestrial Subsurface	X		X		X		
	Wood Turtle	*Clemmys insculpta*	O	Ground Forager	Terrestrial Subsurface	X	X	X	X	X	X	X
Kinosternidae	Musk Turtle	*Sternotherus odoratus*	C	Bottom Forager	Riparian Subsurface	X		X	X	X		

* Species (or sign) observed on the site during site reconnaissance or sampling by TRC.

1 Includes resident, breeding, and wintering amphibian, avian, mammalian, and reptilian species within the vicinity of the Hoosic River, lagoons, and landfill pond and wetlands. Migratory species are also likely to use these habitats, however, these species would have less potential for prolonged exposure to site contaminants than species inhabiting the site for extended periods.

2 Guilds include:
C: Carnivore G: Granivore I: Insectivore P: Piscivore
F: Frugivore H: Herbivore O: Omnivore

Amphibians are generally insectivores consuming insects and other invertebrates although larger species such as the bullfrog may also feed on small vertebrates.

Several species of snakes and turtles are also expected to inhabit the Hoosic River and adjacent riparian area. Snake species that may be present are generally carnivorous and include two species in particular that are often associated with aquatic/wetland habitats: the northern water snake and eastern ribbon snake. Turtle species potentially present are generally omnivorous species that forage on the water bottom. Egg deposition for several of these species, including the common snapping turtle and painted turtle is usually in fairly close proximity to an aquatic habitat such as a river bank.

A diverse assemblage of avian species representing a variety of feeding guilds may use the habitats provided by the Hoosic River and adjacent riparian forest. Aquatic bird species that may forage within the Hoosic River include a variety of waterfowl such as the Canada goose, mallard, and common merganser. Additional aquatic bird species such as various wading birds (e.g., herons) and kingfishers may also forage on small fish, amphibians and macroinvertebrates within the Hoosic River.

Several species of swallows are likely to hawk insects above the Hoosic River as emerging insects are particularly abundant above an aquatic environment. A wide diversity of songbirds are also expected to inhabit the riparian vegetation present along the banks of the river. These species would include shrub nesters such as the common yellowthroat and tree nesters such as the eastern kingbird, insectivores that may consume terrestrial insects and recently emerged aquatic insects.

Several mammal species representing different foraging guilds are expected to use the aquatic and riparian habitat provided by the Hoosic River (see Table 1). Herbivorous rodents including aquatic species such as the muskrat and beaver may inhabit the river while a variety of bat species are likely to forage for insects above the Hoosic River. Aquatic habitats are generally very productive sites for invertebrates including a variety of aquatic insects. Emerging insects would provide an important food resource for bats in the vicinity of the site. Species such as the little brown bat and big brown bat are often associated with structures/buildings located near aquatic habitats. Additional bat species such as the red bat and silver-haired bat may forage above the Hoosic River adjacent to forested areas that provide roosting sites.

Mammalian predators such as the raccoon and various mustelids are expected to forage within or along the banks of the Hoosic River. The raccoon is an omnivorous feeder that consumes a wide variety of items including macroinvertebrates and amphibians that would be present along a river shoreline. The river otter and mink are two carnivorous members of the weasel family that consume a high proportion of fish in their diets.

Lagoon Area

The former lagoons and adjacent roadways provide a variety of wetland and upland habitats. These habitats are expected to provide suitable habitat for a diversity of herptile, avian and mammalian species (see Table 1). Several of the former lagoons (e.g., Lagoons 4 and 5) contain areas of standing water for several months that do not contain adult fish populations. These areas are important for some amphibians as breeding sites. Amphibians such as the spotted salamander and wood frog breed almost exclusively in these areas while other species including the American toad and gray treefrog also find suitable breeding sites within these fish-free bodies of water. Egg masses or evidence of breeding by all four of these amphibians was noted by TRC in the vicinity of the former lagoons. These species would also use the adjacent uplands as foraging areas during the remaining portions of the year when they are active.

Several turtle and snake species are also likely to forage or breed within the lagoon areas. These species would include aquatic species such as the painted turtle and northern water snake as well as terrestrial species such as the northern black racer.

A wide variety of birds are expected to use the habitats provided by the lagoons. Species typically associated with aquatic habitats such as the mallard and great blue heron would use the areas of open water provided by the lagoons while other species including the red-winged blackbird would nest and forage along the edge of the ponding areas in the dense emergent vegetation. Various swallows are also likely to forage above the ponding areas on emerging aquatic insects. The upland habitats are expected to provide suitable nesting and foraging habitat for avian species that prefer shrubs or scattered trees. These species include a variety of songbirds including warblers, thrushes and sparrows. Several raptors may also forage for small birds and mammals in these areas.

Aquatic mammalian species such as the muskrat are expected to use the aquatic habitats provided by the former lagoons while the emergent wetlands may present suitable habitat for more terrestrial species such as the meadow vole and star-nosed mole. Larger predators such as the red fox and various mustelids are also likely to forage on small mammals and aquatic species present within the wetlands and/or along the periphery of the open water areas. A variety of small mammal species and larger species such as the eastern cottontail and white-tailed deer are likely to use the upland habitats present as both food and cover are provided within the herbaceous and scrub-shrub cover types. Predators such as the coyote are also likely to forage within these areas.

Landfill Area

The pond, wet meadow and forested seepage areas are each expected to provide suitable habitat for a variety of aquatic, semi-aquatic and terrestrial wildlife (see Table 1). The pond is expected to provide suitable habitat for aquatic species including various amphibians and reptiles such as the green frog, bullfrog, painted turtle and common snapping turtle. Most of these species forage, breed and hibernate within the pond itself, however, turtles generally deposit eggs in nearby upland areas. These species would be expected to forage primarily on the various macroinvertebrates present within the pond. Some of these species may also utilize the adjacent wet meadow habitat. Snakes such as the northern water snake and eastern ribbon snake are likely to forage both within the pond and wet meadow habitats. The forested seeps are likely to provide suitable habitat for species that prefer small and shallow areas of flowing water such as the northern two-lined and northern dusky salamanders and pickerel frogs. Several snakes including the northern redbelly snake and eastern garter snake may also forage along the margins of the seeps.

Birds noted or likely to use the pond itself as a foraging area include primarily aquatic species such as waterfowl, wading birds and shorebirds. These species may be attracted by the presence of vegetation and macroinvertebrates inhabiting the soft substrate of the pond. Shorebirds such as the spotted sandpiper prefer exposed mudflats or areas of shallow water that often contain abundant macroinvertebrates. The small fish likely to inhabit the pond may also provide food for wading birds such as green-backed herons and piscivorous species such as the belted kingfisher. Aerial screeners such as various swallows and bats are likely to forage on emerging insects above the pond. Other mammals such as the herbivorous muskrat and piscivorous mink and river otter may also occasionally forage within the pond on fish, amphibians and larger macroinvertebrates such as crayfish that inhabit the pond.

The wet meadow is expected to provide suitable habitat for a variety of avian species (see Table 1) that may forage on invertebrates and/or seeds such as various sparrows, finches, brown-headed cowbird, and American woodcock. Similar to the pond, a variety of swallows and bats are likely to forage on insects above the wet meadow. Small mammals including herbivores (e.g., meadow vole), omnivores (e.g., white-footed mice and meadow jumping mice), and insectivores (e.g., short-tailed and masked shrews) are likely to inhabit the wet meadow throughout the year except during flooding events. Larger herbivorous mammals such as white-tailed deer and muskrat and omnivorous species such as the Virginia opossum and raccoon are also likely to forage on the vegetation or the invertebrates and amphibians present within the wet meadow. Predators such as red fox and several raptor species such as the northern harrier are also likely to prey on small mammals inhabiting the meadow.

The forested seepage area contains greater vertical structural habitat diversity than the wet meadow cover type. This increase in habitat structure is likely to provide additional foraging and/or nesting habitat for birds and mammals (see Table 1). For example, shrub nesters such as northern cardinal, chestnut-sided warbler, and gray catbird are likely to nest and forage within this cover type. The early-growth tree layer is also expected to provide additional foraging/nesting habitat for species such as downy woodpecker, black-capped chickadee, thrushes and flycatchers. Ground nesters and/or feeders such as the American woodcock are also expected to be present within this habitat. A variety of small mammal species including herbivores, omnivores, and insectivores are anticipated to inhabit the forested seep area as are larger predators such as mustelids, coyote, and gray fox.

2.2 Hazard Identification

For the characterization of ecological risk, the primary media of concern within the Pownal Tannery Study Area are surface water, sediment, and surface soil. Possible exposure pathways for ecological receptors present within the Pownal Tannery Study Area include the direct ingestion of contaminated surface water, sediments and surface soils and the indirect ingestion of contaminated biota in the food chain. Exposure of biota to subsurface soils and airborne contaminants (through volatilization or fugitive dust emissions) via inhalation or dermal contact are not expected to represent as significant pathway as direct ingestion of contaminated media or ingestion of contaminated biota in the food chain. In addition, methods to evaluate exposure of ecological receptors via the inhalation and dermal exposure pathway generally contain considerable uncertainties. Ecological receptors are also not anticipated to be directly exposed to groundwater contaminants although the evaluation of surface water and sediment (including seepage areas) indirectly evaluate contaminants transported through ground water discharge.

The selection of contaminants of concern (COCs) for this ecological risk assessment is based on frequency of detection (constituents detected in 5 percent or less of samples were not retained as COCs) and toxicity to biota (essential nutrients were not retained as COCs). Analytical data used in the risk assessment include recent surface water, sediment and surface soil sampling results from the Spring 2000 sampling (Metcalf & Eddy, 2000). The following section describes which samples were grouped together for risk analysis. Summary statistics detailing contaminant concentrations (mean and maximum) and frequency of detection for each media grouping are presented in Attachment I.

Surface Water

Surface water samples collected within the Pownal Tannery Study Area were grouped into four sampling groups in addition to the upgradient reference samples collected from the Hoosic River (one sample), reference pond (one sample) and Halifax Hollow (one sample). The four sampling groups represent the Hoosic River (5 samples within the Pownal Tannery Study Area), lagoons (6 samples), landfill pond and seeps (1 pond and 4 seep samples) and Halifax Hollow (1 sample). A listing of each surface water sample for each group is presented in Table 2. A summary of the surface water COCs selected for each grouping is provided in Table 3. Locations of surface water samples are presented in Figure 4 (Hoosic River/Halifax Hollow), Figure 5 (Lagoon), and Figure 6 (Landfill Pond/Seeps).

Hoosic River: Several dioxin congeners were detected at one or two sampling locations and were retained as COCs. No additional organic compounds were detected in the surface water samples. Nine inorganics (aluminum, barium, chromium, copper, iron, lead, manganese, mercury, and zinc) were detected in either filtered (dissolved) or unfiltered (total recoverable concentration) and retained as COCs.

Lagoons: Several dioxin congeners were also detected at one or two lagoon surface water sample locations and retained as COCs. Three VOCs (acetone, 2-butanone and toluene) and one SVOC (bis(2-ethylhexyl)phthalate) were also detected in the lagoon samples and retained as COCs. A total of 15 inorganics (aluminum, arsenic, barium, cadmium, chromium, cobalt, copper, iron, manganese, mercury, nickel, silver, thallium and zinc) were detected and retained as COCs.

Landfill Pond/Seeps: Several dioxin congeners were detected and retained as COCs. No other organic compounds were detected in the pond or seep samples. A total of 16 inorganics were detected in the pond/seep samples and retained as COCs.

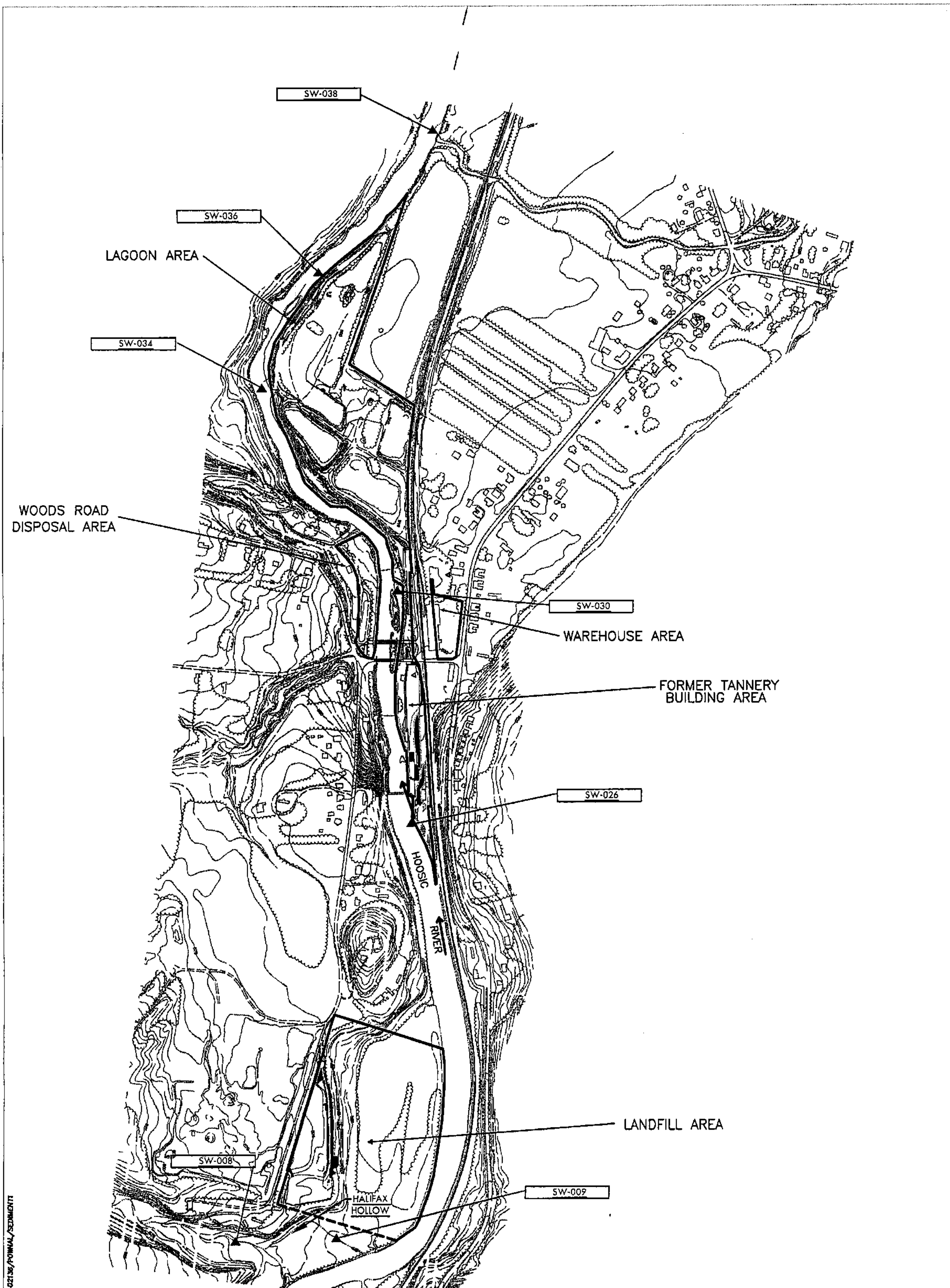
Landfill Stream (Halifax Hollow): One dioxin congener and five inorganics (aluminum, barium, copper, iron, and manganese) were detected in the one surface water sample from the landfill stream and were retained as COCs.

Table 2. Surface Water Samples for Each Area of Concern
Pownal Tannery Study Area

Hoosic River	Lagoons	Landfill Pond/Seeps	Halifax Hollow
SW-026	SW-0L1	SW-011	SW-009
SW-030	SW-0L2	SW-012	
SW-034	SW-0L4A	SW-013	
SW-036	SW-0L4B	SW-020	
SW-038	SW-0L4C	SW-021	
	SW-0L5		

Table 3. Surface Water Contaminants of Concern
Pownal Tannery Study Area

Hoosic River	Lagoons	Landfill Pond/Seeps	Halifax Hollow
1,2,3,4,6,7,8-HpCDF	Acetone	1,2,3,4,6,7,8-HpCDF	OCDD
1,2,3,4,7,8-HxCDF	2-Butanone	OCDF	Aluminum
1,2,3,6,7,8-HxCDF	Toluene	Aluminum	Barium
1,2,3,7,8-PeCDD	Bis(2-ethylhexyl)phthalate	Antimony	Copper
2,3,7,8-TCDF	1,2,3,4,6,7,8-HpCDD	Barium	Iron
Aluminum	1,2,3,4,6,7,8-HpCDF	Beryllium	Manganese
Barium	2,3,7,8-TCDF	Cadmium	
Chromium	OCDF	Chromium	
Copper	Aluminum	Cobalt	
Iron	Arsenic	Copper	
Lead	Barium	Iron	
Manganese	Cadmium	Lead	
Mercury	Chromium	Manganese	
Zinc	Cobalt	Mercury	
	Copper	Nickel	
	Iron	Selenium	
	Lead	Vanadium	
	Manganese	Zinc	
	Mercury		
	Nickel		
	Silver		
	Thallium		
	Zinc		



0 200 400 600 800 1000
SCALE IN FEET

LEGEND

TANNERY PROPERTY BOUNDARY

▲ SURFACE WATER SAMPLE LOCATION

TRC Boott Mills South, Foot of John Street, Lowell, MA 01852, 978-970-5600

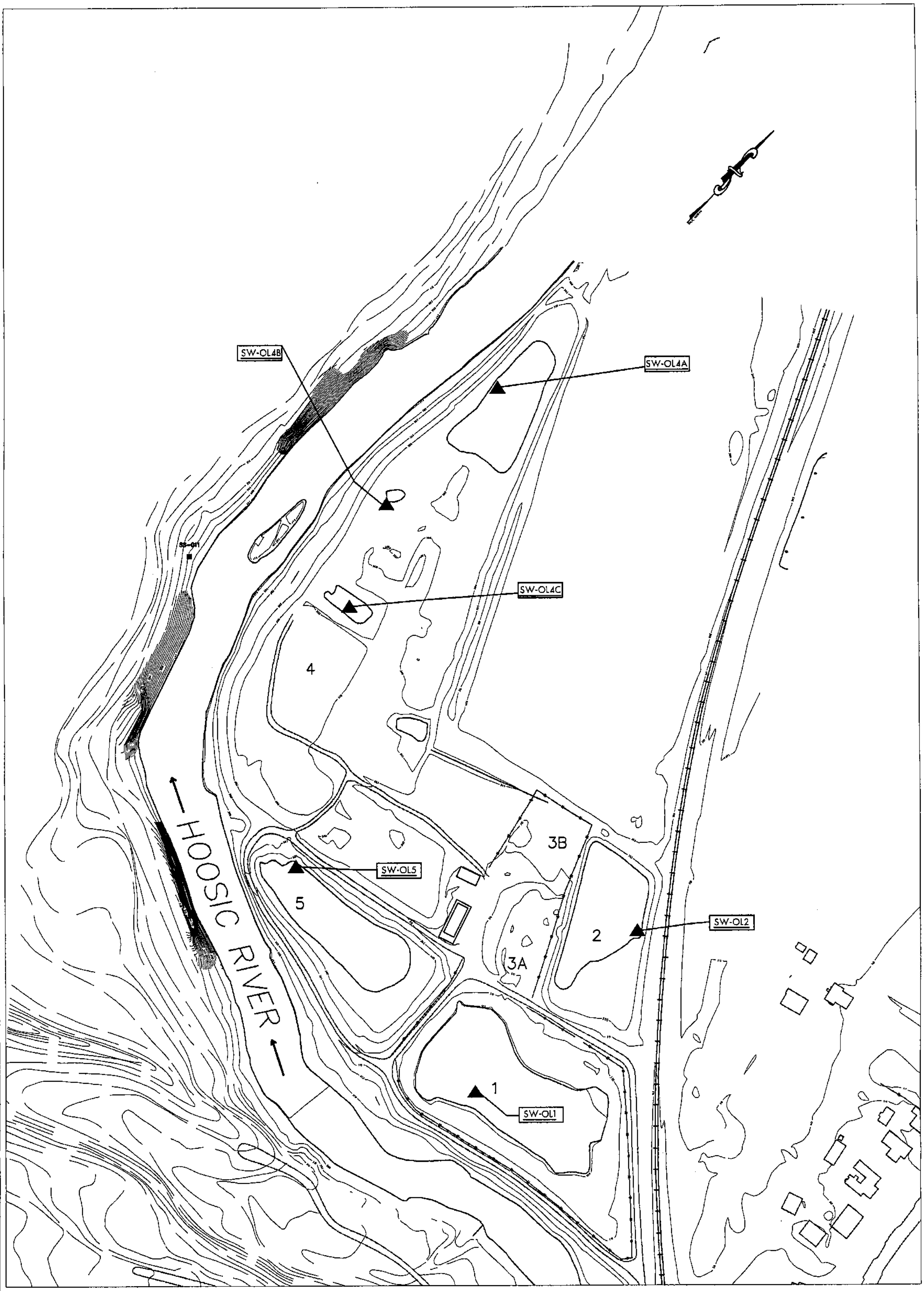
TRC PROJ. NO.: 02136-0220-01N93

EPA CONTRACT NO.: 68-W6-0042

RAC SUBCONTRACTOR NO.: 107061

FIGURE 4
HOOSIC RIVER/HALIFAX HOLLOW SURFACE WATER SAMPLING LOCATIONS
POWNAL TANNERY
POWNAL, VERMONT

M&E Metcalf & Eddy



0 40 80 120 140
SCALE IN FEET

LEGEND

▲ SURFACE WATER SAMPLE LOCATION

—x—x— FENCE

TRC
Boott Mills South
Foot of John Street
Lowell, MA 01852
978-970-5600

TRC PROJ. NO.: 02136-0220-01N93

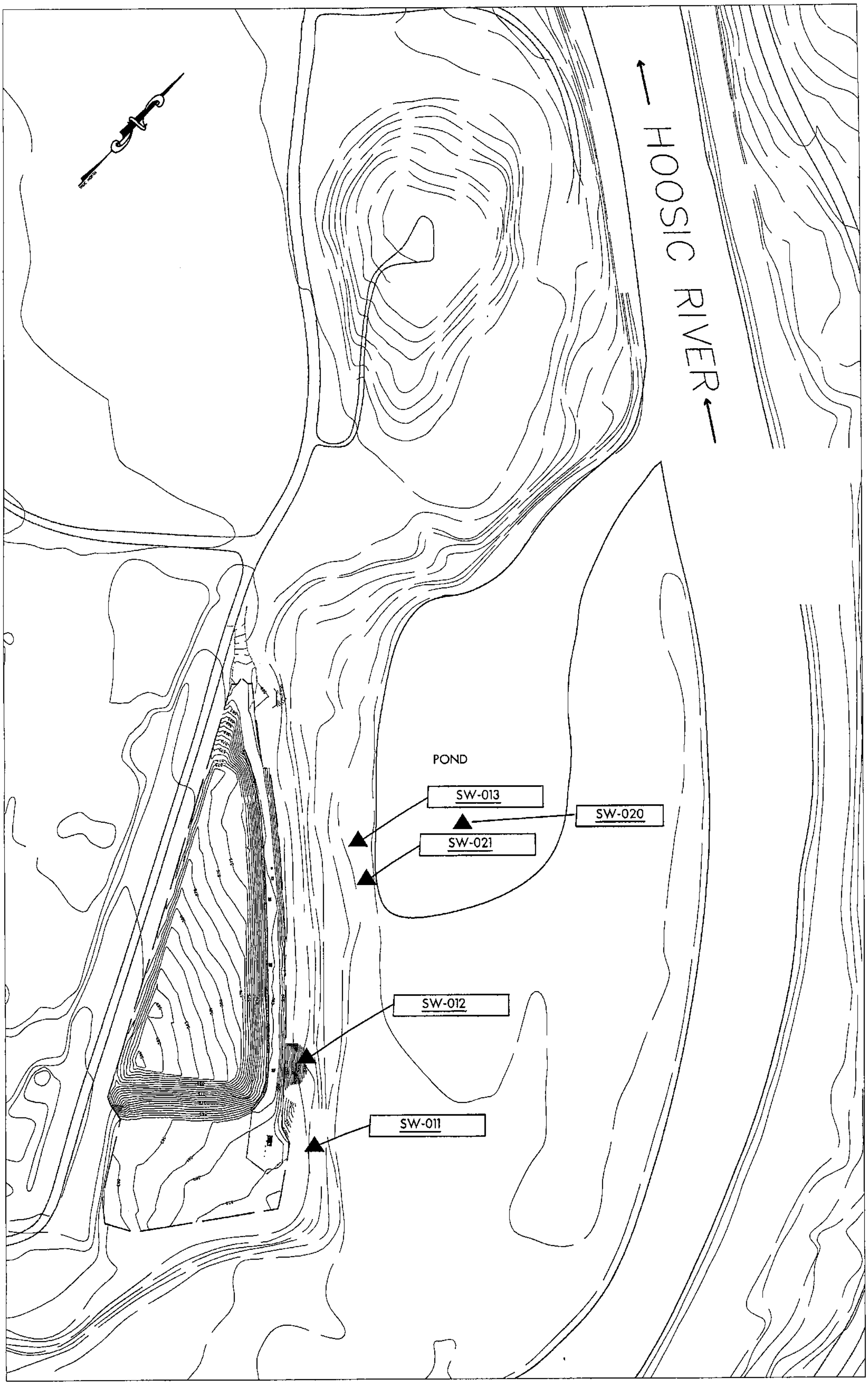
EPA CONTRACT NO.: 68-W6-0042

RAC SUBCONTRACTOR NO.: 107061

FIGURE 5
LAGOON SURFACE WATER SAMPLING LOCATIONS

POWNAL TANNERY
POWNAL, VERMONT

Metcalf & Eddy



0 40 80 120 140
SCALE IN FEET

LEGEND

▲ SURFACE WATER SAMPLE LOCATION

TRC — Boott Mills South, Foot of John Street, Lowell, MA 01852, 978-970-5600	FIGURE 6 LANDFILL POND/SEEP SURFACE WATER SAMPLING LOCATIONS POWNAL TANNERY POWNAL, VERMONT
TRC PROJ. NO.: 02136-0220-01N93	
EPA CONTRACT NO.: 68-W6-0042	
RAC SUBCONTRACTOR NO.: 107061	Metcalf & Eddy

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Sediment

In addition to the four reference sediment groupings (Halifax Hollow upgradient, reference Hoosic River, pond and wetland locations) sediment samples collected within the Pownal Tannery Study Area were grouped into five sampling groups. The five sampling groups represent the Hoosic River (19 samples within the Pownal Tannery Study Area), lagoons (9 samples), landfill pond (5 samples), landfill seeps and wet meadow (4 seep and 5 wet meadow samples) and Halifax Hollow (1 sample). Lagoon samples were classified as sediments if standing water was present at the sample location at the time of sampling. Samples used for each sediment group are presented in Table 4. A summary of the COCs selected for the sediment pathway is provided in Table 5. Sediment sampling locations are presented in Figures 7 (Hoosic River/Halifax Hollow), Figure 8 (Lagoons), and Figure 9 (Landfill Pond/Seeps).

Hoosic River: A total of three VOCs were detected (acetone, methylene chloride, and toluene) and retained as COCs. A total of 25 SVOCs (including 16 polycyclic aromatic hydrocarbons) were detected in the Hoosic River sediment samples and were retained as COCs. A total of 19 pesticides were retained as COCs. Seventeen dioxin congeners and 19 inorganics were also retained as COCs.

Lagoons: A total of 12 VOCs and 30 SVOCs were detected and retained as COCs. The SVOCs included 11 polycyclic aromatic hydrocarbons (PAHs), 5 phenols, and 4 phthalates. Fifteen pesticides and three polychlorinated biphenyls (PCBs) were also detected in lagoon sediment samples and retained as COCs. A total of 17 dioxin congeners were detected and retained as COCs while 20 inorganics were also retained as COCs.

Landfill Pond: Three VOCs were detected in the landfill pond sediments and retained as COCs. A total of 15 SVOCs (including 12 PAHs), 12 pesticides, 2 PCB aroclors, 17 dioxin congeners, and 18 inorganics were detected and retained as COCs.

Landfill Seeps/Wet Meadow: No VOCs were detected in the seep and wet meadow sediment samples. A total of 13 SVOCs (including 10 PAHs), 6 pesticides, 16 dioxin congeners, and 20 inorganics were detected and retained as COCs.

Halifax Hollow: Three SVOCs and 10 inorganics were detected in the lone sediment sample collected from this stream. All detected constituents (except essential nutrients) were retained as COCs.

Surface Soil

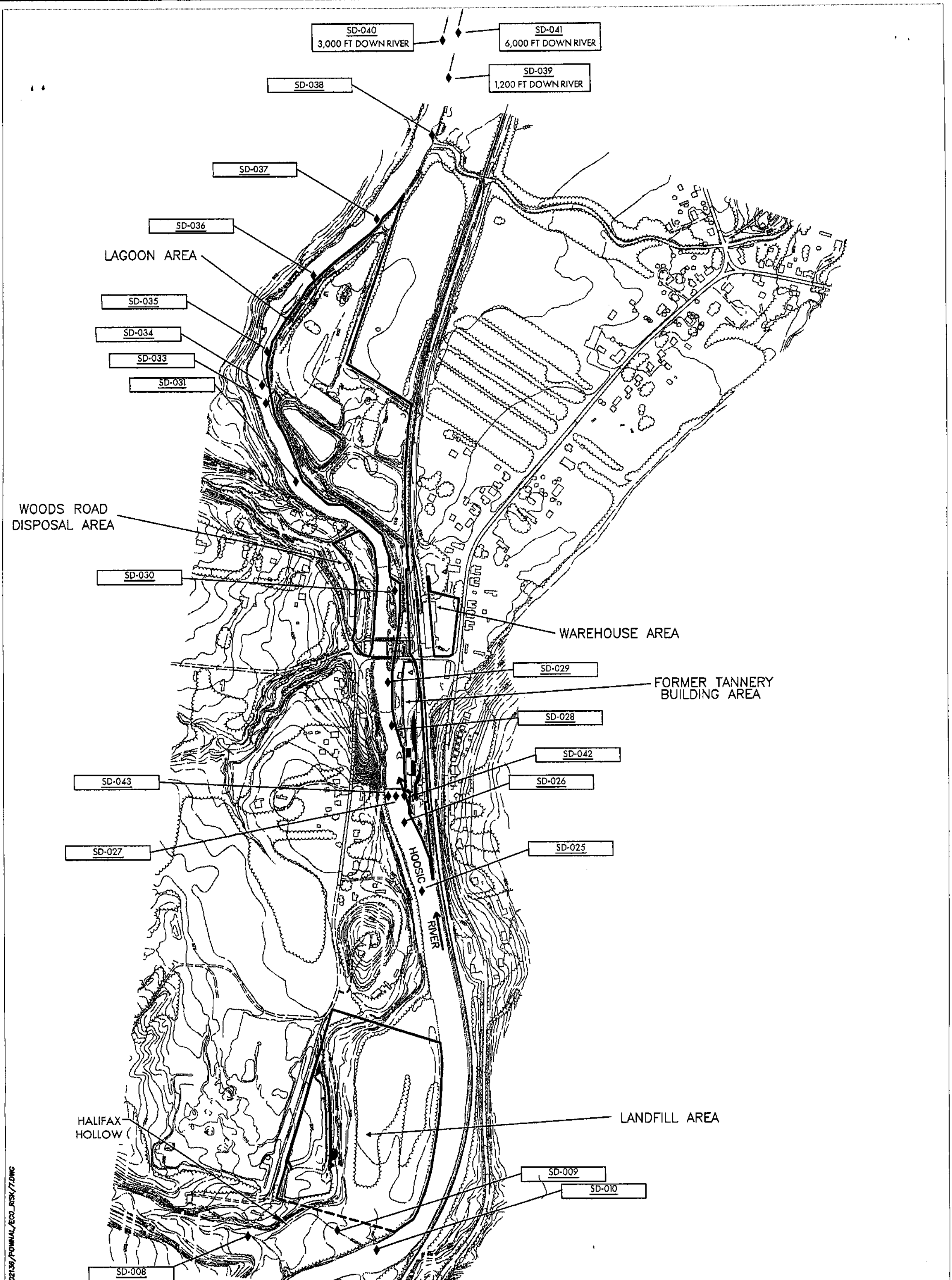
Surface soil samples collected from the vicinity of the lagoons were grouped together and are presented in Table 6. The COCs selected for the lagoon surface soil grouping are presented in Table 7. Surface soil sampling locations in the vicinity of the lagoons are depicted in Figure 10.

Table 4. Sediment Samples for Each Sediment Grouping Area Pownal Tannery Study Area				
Reference Hoosic River	**Reference Pond**	**Reference Wetland**	**Reference Halifax Hollow**	
SD-001	SD-003	SD-044	SD-008	
SD-002	SD-004	SD-045		
SD-005				
SD-006				
SD-007				
Hoosic River	**Lagoons**	**Landfill Pond**	**Landfill Seeps/ Wet Meadow**	**Halifax Hollow**
SD-010	SBL2-02	SD-019	SD-011	SD-009
SD-025	SBL2-04	SD-020	SD-012	
SD-026	SD-0L4B	SD-022	SD-013	
SD-027	SD-0L4C	SD-023	SD-014	
SD-028	SBL4-02	SD-024	SD-015	
SD-029	SBL5-01		SD-016	
SD-030	SBL5-02		SD-017	
SD-031	SBL5-04		SD-018	
SD-033	SBL5-05		SD-021	
SD-034	SBL5-06			
SD-035				
SD-036				
SD-037				
SD-038				
SD-039				
SD-040				
SD-041				
SD-042				
SD-043				

Table 5. Sediment Contaminants of Concern
Pownal Tannery Study Area

Hoosic River			
Acetone	Fluorene	gamma-Chlordane	Aluminum
Methylene Chloride	Indeno(1,2,3-cd)pyrene	Heptachlor	Arsenic
Toluene	Naphthalene	Hepachlor epoxide	Barium
2-Methylnaphthalene	Pentachlorophenol	Methoxychlor	Beryllium
4-Methylphenol	Phenanthrene	1,2,3,4,6,7,8-HpCDD	Cadmium
Acenaphthene	Pyrene	1,2,3,4,6,7,8-HpCDF	Chromium
Acenaphthylene	4,4-DDD	1,2,3,4,7,8,9-HpCDF	Chromium(Hexavalent)
Anthracene	4,4-DDE	1,2,3,4,7,8-HxCDD	Cobalt
Benzaldehyde	4,4-DDT	1,2,3,4,7,8-HxCDF	Copper
Benzo(a)anthracene	Aldrin	1,2,3,6,7,8-HxCDD	Cyanide
Benzo(a)pyrene	alpha-BHC	1,2,3,6,7,8-HxCDF	Iron
Benzo(b)fluoranthene	alpha-Chlordane	1,2,3,7,8,9-HxCDD	Lead
Benzo(g,h,i)perylene	Aroclor 1242	1,2,3,7,8,9-HxCDF	Manganese
Benzo(k)fluroanthene	Aroclor 1254	1,2,3,7,8-PeCDD	Mercury
Bis(2-ethylhexyl)phthalate	Aroclor 1260	1,2,3,7,8-PeCDF	Nickel
Carbazole	delta-BHC	2,3,4,6,7,8-HxCDF	Silver
Chrysene	Dieldrin	2,3,4,7,8-PeCDF	Thallium
Dibenzo(a,h)anthracene	Endosulfan Sulfate	2,3,7,8-TCDD	Vanadium
Dibenzofuran	Endrin	2,3,7,8-TCDF	Zinc
Diethylphthalate	Endrin Ketone	OCDD	
Di-n-butylphthalate	gamma-BHC (Lindane)	OCDF	
Fluoranthene			
Lagoons			
1,2,4-Trichlorobenzene	Benzo(k)fluroanthene	Aroclor 1248	2,3,7,8-TCDD
1,2-Dichlorobenzene	Bis(2-chloroethoxy)methane	Aroclor 1254	2,3,7,8-TCDF
1,4-Dichlorobenzene	Bis(2-chloroethyl)ether	beta-BHC	OCDD
Acetone	Bis(2-ethylhexyl)phthalate	delta-BHC	OCDF
2-Butanone	Caprolactam	Endosulfan II	Aluminum
Carbon Disulfide	Chrysene	Endosulfan Sulfate	Antimony
Methyl Acetate	Di-n-butylphthalate	Endrin	Arsenic
Methylene Chloride	Di-n-octylphthalate	Endrin Ketone	Barium
Tetrachloroethylene	Diethylphthalate	gamma-BHC (Lindane)	Beryllium
Tetrahydrofuran	Fluoranthene	gamma-Chlordane	Cadmium
Toluene	Indeno(1,2,3-cd)pyrene	Heptachlor Epoxide	Chromium
Xylene (Total)	Isophorone	1,2,3,4,6,7,8-HpCDD	Cobalt
2,2-oxybis(1-Chloropropane)	N-Nitroso-di-n-propylamine	1,2,3,4,6,7,8-HpCDF	Copper
2,4-Dichlorophenol	Naphthalene	1,2,3,4,7,8,9-HpCDF	Cyanide
2,4-Dimethylphenol	Nitrobenzene	1,2,3,4,7,8-HxCDD	Iron
2-Nitroaniline	Phenanthrene	1,2,3,4,7,8-HxCDF	Lead
2-Nitrophenol	Pyrene	1,2,3,6,7,8-HxCDD	Manganese
4-Chloro-3-methylphenol	4,4-DDD	1,2,3,6,7,8-HxCDF	Mercury
4-Chloroaniline	4,4-DDE	1,2,3,7,8,9-HxCDD	Nickel
4-Nitrophenol	4,4-DDT	1,2,3,7,8,9-HxCDF	Selenium
Anthracene	Aldrin	1,2,3,7,8-PeCDD	Silver

Table 5. Sediment Contaminants of Concern Pownal Tannery Study Area			
Benzaldehyde	alpha-BHC	1,2,3,7,8-PeCDF	Thallim
Benzo(a)anthracene	alpha-Chlordane	2,3,4,6,7,8-HxCDF	Vanadium
Benzo(a)pyrene	Aroclor 1242	2,3,4,7,8-PeCDF	Zinc
Benzo(b)fluoranthene			
Landfill Pond			
Acetone	Pyrene	1,2,3,4,7,8,9-HpCDF	Barium
2-Butanone	4,4-DDD	1,2,3,4,7,8-HxCDD	Beryllium
Toluene	4,4-DDE	1,2,3,4,7,8-HxCDF	Cadmium
4-Methylphenol	Aldrin	1,2,3,6,7,8-HxCDD	Chromium
Acenaphthylene	alpha-BHC	1,2,3,6,7,8-HxCDF	Cobalt
Anthracene	alpha-Chlordane	1,2,3,7,8,9-HxCDD	Copper
Benzaldehyde	Aroclor 1242	1,2,3,7,8,9-HxCDF	Cyanide
Benzo(a)anthracene	Aroclor 1254	1,2,3,7,8-PeCDD	Iron
Benzo(a)pyrene	beta-BHC	1,2,3,7,8-PeCDF	Lead
Benzo(b)fluoranthene	delta-BHC	2,3,4,6,7,8-HxCDF	Manganese
Benzo(k)fluroanthene	Dieldrin	2,3,4,7,8-PeCDF	Mercury
Bis(2-ethylhexyl)phthalate	Endosulfan Sulfate	2,3,7,8-TCDD	Nickel
Chrysene	Endrin Aldehyde	2,3,7,8-TCDF	Silver
Dibenzo(a,h)anthracene	gamma-Chlordane	OCDD	Thallium
Fluoranthene	Heptachlor	OCDF	Vanadium
Indeno(1,2,3-cd)pyrene	1,2,3,4,6,7,8-HpCDD	Aluminum	Zinc
Phenanthrene	1,2,3,4,6,7,8-HpCDF	Arsenic	
Landfill Seeps/Meadow			
4-Methylphenol	alpha-Chlordane	1,2,3,7,8-PeCDD	Cobalt
Benzaldehyde	Dieldrin	1,2,3,7,8-PeCDF	Copper
Benzo(a)anthracene	Endrin	2,3,4,6,7,8-HxCDF	Cyanide
Benzo(a)pyrene	gamma-BHC (Lindane)	2,3,4,7,8-PeCDF	Iron
Benzo(b)fluoranthene	gamma-Chlordane	2,3,7,8-TCDF	Lead
Benzo(g,h,i)perylene	1,2,3,4,6,7,8-HpCDD	OCDD	Manganese
Benzo(k)fluroanthene	1,2,3,4,6,7,8-HpCDF	OCDF	Mercury
Bis(2-ethylhexyl)phthalate	1,2,3,4,7,8,9-HpCDF	Aluminum	Nickel
Chrysene	1,2,3,4,7,8-HxCDD	Antimony	Selenium
Fluoranthene	1,2,3,4,7,8-HxCDF	Arsenic	Silver
Indeno(1,2,3-cd)pyrene	1,2,3,6,7,8-HxCDD	Barium	Thallium
Phenanthrene	1,2,3,6,7,8-HxCDF	Beryllium	Vanadium
Pyrene	1,2,3,7,8,9-HxCDD	Cadmium	Zinc
4,4-DDE	1,2,3,7,8,9-HxCDF	Chromium	
Halifax Hollow			
4-Chloroaniline	Barium	Copper	Manganese
Benzo(g,h,i)perylene	Chromium	Iron	Nickel
Bis(2-ethylhexyl)phthalate	Cobalt	Lead	Zinc
Aluminum			



0 200 400 600 800 1000

SCALE IN FEET

LEGEND

TANNERY PROPERTY BOUNDARY

♦ SEDIMENT SAMPLE LOCATION

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EPA CONTRACT NO.: 68-W6-0042

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FIGURE 7
HOOSIC RIVER/HALIFAX HOLLOW SEDIMENT SAMPLING LOCATIONS
POWNAL TANNERY
POWNAL, VERMONT

Metcalf & Eddy

0 40 80 120 140

SCALE IN FEET

LEGEND

◆ SEDIMENT SAMPLE LOCATION

—×—×— FENCE

TRC

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Foot of John Street
Lowell, MA 01852
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EPA CONTRACT NO.: 68-W6-0042

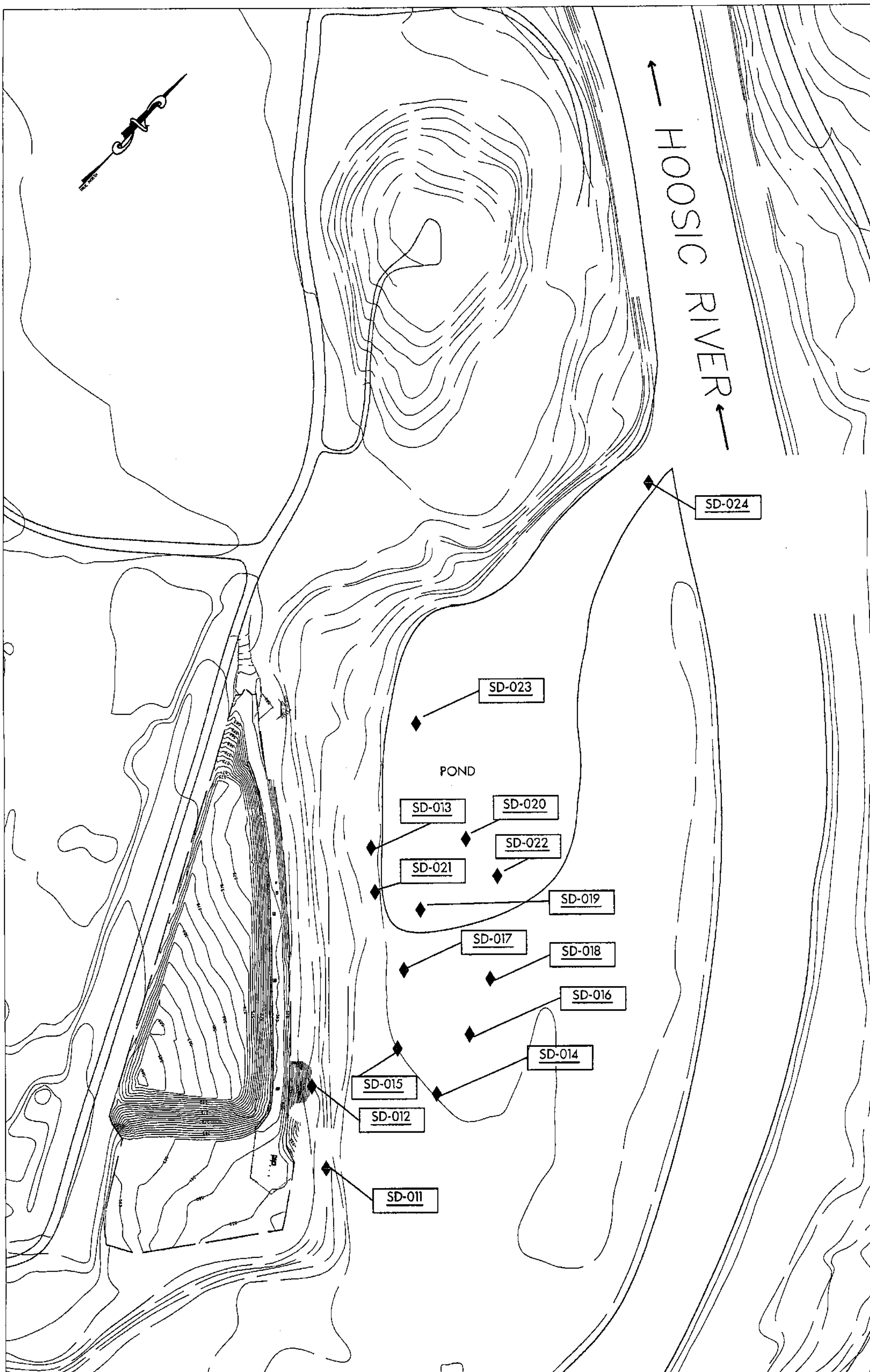
RAC SUBCONTRACTOR NO.: 107061

FIGURE 8

LAGOON SEDIMENT SAMPLING LOCATIONS

POWNAL TANNERY
POWNAL, VERMONT

M&E Metcalf & Eddy



0 40 80 120 140
SCALE IN FEET

LEGEND

◆ SEDIMENT SAMPLING LOCATION

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FIGURE 9
LANDFILL POND/SEEP
SEDIMENT SAMPLING
LOCATIONS

POWNAL TANNERY
POWNAL, VERMONT

M&E Metcalf & Eddy

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Table 6. Surface Soil Samples for Lagoons Pownal Tannery Study Area			
SBL1-01	SBL3AB-01	SBL4-10	SBL4-20
SBL1-02	SBL3B-01	SBL4-11	SBL4-21
SBL1-03	SBL3B-02	SBL4-12	SBL4-22
SBL1-09	SBL3B-03	SBL4-13	SBL4-23
SBL1-11	SBL4-01	SBL4-14	SBL4-24
SBL2-01	SBL4-04	SBL4-15	SBL4-25
SBL2-03	SBL4-05	SBL4-16	SBL4-26
SBL2-05	SBL4-07	SBL4-17	SBL4-27
SBL2-06	SBL4-08	SBL4-18	SBL5-07
SBL2-07	SBL4-09	SBL4-19	SD-32
SBL3A-01			

Table 7. Surface Soil Contaminants of Concern at Lagoons Pownal Tannery Study Area			
1,4-Dichlorobenzene	Fluoranthene	Methoxychlor	Antimony
2-Butanone	Indeno(1,2,3-cd)pyrene	1,2,3,4,6,7,8-HpCDD	Arsenic
Acetone	Naphthalene	1,2,3,4,6,7,8-HpCDF	Barium
Benzene	Phenanthrene	1,2,3,4,7,8,9-HpCDF	Beryllium
Carbon Disulfide	Pyrene	1,2,3,4,7,8-HxCDD	Cadmium
Methylene Chloride	4,4-DDE	1,2,3,4,7,8-HxCDF	Chromium
Toluene	4,4-DDT	1,2,3,6,7,8-HxCDD	Cobalt
Xylene (Total)	alpha-Chlordane	1,2,3,6,7,8-HxCDF	Copper
Anthracene	beta-BHC	1,2,3,7,8,9-HxCDD	Cyanide
Benzo(a)anthracene	delta-BHC	1,2,3,7,8,9-HxCDF	Iron
Benzo(a)pyrene	Endosulfan I	1,2,3,7,8-PeCDD	Lead
Benzo(b)fluoranthene	Endosulfan Sulfate	1,2,3,7,8-PeCDF	Manganese
Benzo(g,h,i)perylene	Endrin	2,3,4,6,7,8-HxCDF	Mercury
Benzo(k)fluoranthene	Endrin Aldehyde	2,3,4,7,8-PeCDF	Nickel
Bis(2-ethylhexyl)phthalate	Endrin Ketone	2,3,7,8-TCDD	Selenium
Carbazole	gamma-BHC (Lindane)	2,3,7,8-TCDF	Silver
Chrysene	gamma-Chlordane	OCDD	Thalliium
Di-n-butylphthalate	Heptachlor	OCDF	Vanadium
Dibenzo(a,h)anthracene	Heptachlor Epoxide	Aluminum	Zinc

0 40 80 120 160

SCALE IN FEET

LEGEND

● SOIL BORING LOCATION

■ SURFACE SOIL SAMPLE LOCATION

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FIGURE 10

SURFACE SOIL SAMPLE LOCATIONS

POWNAL TANNERY
POWNAL, VERMONT

M&E Metcalf & Eddy

01236/ECO RISK/SAMPLE LOCATIONS

A total of 15 VOCs were detected in the surface soils collected from the lagoon area. Eight VOCs were retained as COCs while the remaining seven (1,2-dichlorobenzene, cyclohexane, ethylbenzene, isopropylbenzene, methyl acetate, methylcyclohexane, and trichloroethene) were eliminated due to low frequency of detection (5 percent or less). Although 25 SVOCs were detected in surface soil samples, 9 SVOCs (2-methylnaphthalene, acenaphthene, acenaphthylene, benzaldehyde, butylbenzylphthalate, dibenzofuran, diethylphthalate, fluorene, and pentachlorophenol) were eliminated due to low detection frequencies. The remaining 16 SVOCs (including 13 PAHs) were retained as COCs.

A total of 23 pesticides/PCBs were detected and 15 were retained as COCs. The remaining eight (4,4-DDD, aldrin, alpha-BHC, aroclors 1242, 1254 and 1260, dieldrin, and endosulfan II) were not retained due to their low frequency of detection. All 17 dioxin congeners were retained as COCs as were 20 inorganics (all except essential nutrients).

2.3 Site Conceptual Model

As discussed above in Section 2.1, a variety of ecological receptors may be present within the aquatic, wetland and terrestrial habitats present within the Pownal Tannery Study Area. Insects and other invertebrates, amphibians, reptiles, birds and mammals representing a diverse assemblage of feeding guilds are important components of the ecological community present within the Pownal Tannery Study Area. These species may potentially be exposed to surface water, sediment and surface soil contaminants present at the site and forms the basis to the development of a site conceptual model.

The historic tannery-related operations at the site may have resulted in contamination of the adjacent Hoosic River sediments (and surface water as contaminants are released to the overlying water from the sediments) from direct discharge to the river from the former tannery or lagoons. The deposition of tannery-related constituents to the Hoosic River via contaminated groundwater and/or flooding events may also have occurred. These contaminants may directly affect aquatic organisms including fish and/or may be transferred to aquatic vegetation or macroinvertebrates. The plants and invertebrates may subsequently be consumed by ecological receptors inhabiting the Hoosic River potentially resulting in adverse impacts to these populations or to higher trophic levels through biomagnification.

In addition to the river, the abandoned lagoons received tannery waste discharges. The lagoons themselves currently provide habitat for a variety of receptors. Although fish populations are not present within the lagoons, a variety of plants, macroinvertebrates and wildlife (including breeding amphibians) inhabit the lagoons. These receptors as well as wildlife that forage on these items may be exposed to contaminants formerly discharged to the lagoons.

The landfill formerly received wastes from the tannery operation. Contaminants at the landfill may be transported via groundwater and surface water runoff to downgradient habitats including Halifax Hollow and the seeps, pond and wet meadow located northeast of the landfill. Plants, invertebrates, and a variety of receptors that forage within these potentially affected habitats may be exposed to tannery-related contaminants.

Figure 11 presents a site conceptual model for the Hoosic River, lagoon area and landfill area that details potential exposure pathways for ecological receptors inhabiting the Pownal Tannery Study Area.

2.4 Assessment Endpoints and Measures of Effect

Assessment endpoints represent an expression of an ecological attribute that is to be protected (USEPA, 1996). The selection of the assessment endpoints considered the following:

- Existing habitats and species potentially present at the site;
- Contaminants present and their concentrations;
- Modes of toxicity to various receptors by contaminants;
- Ecologically relevant receptors that are potentially sensitive or likely to be highly exposed to life history attributes; and
- Potentially complete exposure pathways.

Table 8 presents the assessment endpoints that were selected for important components of the aquatic, wetland, and terrestrial communities identified within the Pownal Tannery Study Area. The selected assessment endpoints represent both community level endpoints (e.g., benthic macroinvertebrate diversity and productivity) and population level endpoints (e.g., survival, growth and reproduction of particular guilds such as fish-eating birds).

Measures of effect are measures used to evaluate responses of each assessment endpoint exposed to a stressor such as mercury (USEPA, 1997a). The measures of effect proposed for the ERA are also presented in Table 8. The selected parameters represent both community and population level measures. A brief discussion of the proposed measures of effect for each assessment endpoint is presented below.

Community-based measures of effect were selected for community level assessment endpoints and evaluated via community toxicity values (e.g., ambient water quality criteria, sediment quality benchmarks). For population level endpoints that assess receptor guilds present within the Pownal Tannery Study Area (as detailed in the site conceptual model), specific indicator species were selected as measures of effect.

The selection of indicator species is based on several factors including:

- Potential for contact with COCs;
- Sensitivity to COCs present at the site;
- Natural history information readily available to assess exposure and toxicity;
- Ecological relevance; and
- Social or economic importance.

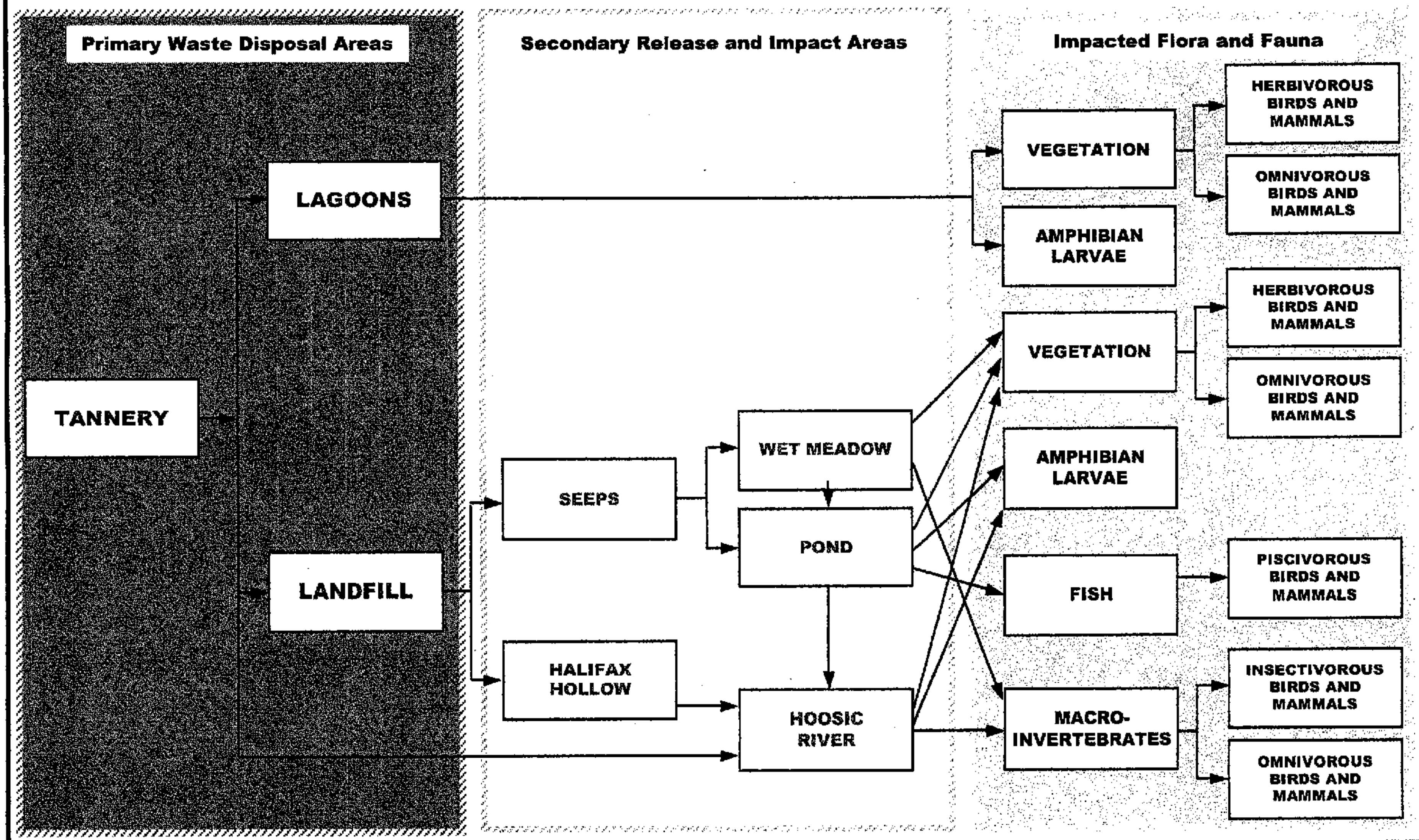

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Figure 11

CONCEPTUAL SITE MODEL FOR POWNAL TANNERY STUDY AREA

POWNAL TANNERY
POWNAL, VERMONT

M&E Metcalf & Eddy

02136/POWNAL/SITE MODEL

Table 8
Assessment Endpoints and Measures of Effect for Pownal Tannery Study Area

Assessment Endpoints	Measures of Effect	Area(s)
Aquatic System		
Macrobenthic Community Diversity and Productivity	Comparison of bulk sediment concentrations with sediment guidelines associated with adverse effects to benthic biota; and evaluation of sediment SEM/AVS testing results on metal bioavailability.	1,2,3,4,5
Fish and Water Column Invertebrate Community Survival/Reproduction	Comparison of water contaminant concentrations with acute and chronic ambient water quality criteria and lowest acute and chronic adverse effect levels reported in scientific literature.	1,2,3,4,5
Amphibian Larvae Survival/Growth	Comparison of water contaminant concentrations with lowest survival or growth effect levels reported in scientific literature.	2,3,4
Avian Herbivore Survival/Reproduction/Growth	Comparison of estimated contaminant exposure doses received by Canada Goose to survival, reproductive, or growth effects reported in scientific literature.	1,2,3
Mammalian Herbivore Survival/Reproduction/Growth	Comparison of estimated contaminant exposure doses received by muskrat to survival, reproductive, or growth effects reported in scientific literature.	1,2,3
Avian Insectivore Survival/Reproduction/Growth	Comparison of estimated contaminant exposure dose received by spotted sandpiper to survival, reproductive, or growth effect concentrations reported in scientific literature.	1,2,3
Mammalian Insectivore Survival/Reproduction/Growth	Comparison of estimated contaminant exposure dose received by little brown bat to survival, reproductive, or growth effect concentrations reported in literature.	1,2,3
Avian Piscivore Survival/Reproduction/Growth	Comparison of estimated contaminant exposure doses received by belted kingfisher to survival, reproductive, or growth effect levels reported in literature.	1,3
Mammalian Piscivore Survival/Reproduction/Growth	Comparison of estimated contaminant exposure doses received by mink to survival, reproductive, or growth effect levels reported in literature.	1,3
Avian Carnivore Survival/Reproduction/Growth	Comparison of estimated contaminant exposure dose received by mallard to survival, reproductive, or growth effect concentrations reported in literature.	1,2,3
Mammalian Omnivore Survival/Reproduction/Growth	Comparison of estimated contaminant exposure dose received by raccoon to survival, reproductive, or growth effect concentrations reported in literature.	1,2,3

Table 8
Assessment Endpoints and Measures of Effect for Pownal Tannery Study Area

Assessment Endpoints	Measures of Effect	Area(s)
Terrestrial System		
Avian Omnivore Survival/Reproduction/Growth	Comparison of estimated contaminant exposure dose received by American robin to survival, reproductive, or growth effect concentrations reported in literature.	6
Mammalian Omnivore/Insectivore Survival/Reproduction/Growth	Comparison of estimated contaminant exposure dose received by deer mouse to survival, reproductive, or growth effect concentrations reported in literature.	6
Mammalian Herbivore Survival/Reproduction/Growth	Comparison of estimated contaminant exposure does received by meadow vole to survival, reproduction, or growth effect concentrations reported in literature.	4,6,7
Avian Insectivore Survival/Reproduction/Growth	Comparison of estimated contaminant exposure dose received by American woodcock to survival, reproductive, or growth effect concentrations reported in literature.	4,6,7
Mammalian Insectivore Survival/Reproduction/Growth	Comparison of estimated contaminant exposure dose received by short-tailed shrew to survival, reproductive, or growth effect concentrations reported in literature.	4,6,7

Notes (from Areas):
1: Hoosic River
2: Lagoon Area (Aquatic Habitats)
3: Landfill Pond
4: Landfill Seeps
5: Landfill Stream (Halifax Hollow)
6: Lagoon Area (Terrestrial Habitats)
7: Landfill Wet Meadow

Based on these considerations, a variety of indicator species were selected as measures of effect for the diverse habitats present within the Pownal Tannery Study Area. Specific indicator species selected include: belted kingfisher (*Ceryle alcyon*), mink (*Mustela vision*), Canada goose (*Branta canadensis*), muskrat (*Ondatra zibethicus*), spotted sandpiper (*Actitis macularia*), little brown bat (*Myotis lucifugus*), mallard (*Anas platyrhynchos*), raccoon (*Procyon lotor*), meadow vole (*Microtus pennsylvanica*), deer mouse (*Peromyscus maniculatus*), short-tailed shrew (*Blarina brevicauda*), American robin (*Turdus migratorius*), and American woodcock (*Scolopax minor*). A brief discussion of the proposed measures of effect for each assessment endpoint is presented below.

2.4.1 Benthic Macroinvertebrate Community Diversity and Productivity

The evaluation of this assessment endpoint will compare contaminant concentrations within the sediment to sediment quality criteria and guidelines associated with effects on benthic biota. Applicable criteria/guidelines for this evaluation include: threshold effects level (TEL) and probable effects level (PEL) as presented in the National Oceanic and Atmospheric Administration's Screening Quick Reference Tables (NOAA SquiRTs) (Buchman, 1999), lowest effect levels (LEL) and severe effect levels (SEL) provided by the Ontario Ministry of the Environment (Persaud et al., 1993), consensus-based threshold effects concentration (TEC) and probable effects concentration (PEC) developed for freshwater sediments (Swartz, 1999), and effect levels developed through the equilibrium partitioning approach (Jones et al., 1997).

Sediment contaminant concentrations below the lower thresholds (i.e., TELs, LELs, and TEC) are unlikely to result in adverse impacts to the benthic community while concentrations above the upper thresholds (i.e., PELs, SELs, and PECs) are likely to limit the diversity and abundance of benthic biota.

2.4.2 Fish and Water Column Macroinvertebrate Community Survival and Reproduction

Contaminants detected in surface water samples collected from aquatic habitats within the Pownal Tannery Study Area will be compared to chronic and acute ambient water quality criteria (USEPA, 1999b). If criteria are unavailable, adverse chronic and acute effect levels reported in the literature (Suter and Tsao, 1996) will be used to evaluate the detected constituents. Contaminant concentrations above acute criteria or effect levels are likely to result in a decrease in fish and/or macroinvertebrate abundance while elevated levels above chronic criteria or effect levels may be associated with reduced growth or reproductive rates.

2.4.3 Amphibian Larvae Survival and Growth

Contaminants detected in surface water samples from suitable aquatic habitat within the Pownal Tannery Study Area will be compared to amphibian larvae toxicity data reported in the literature (Pauli et al., 2000). Exceedences of the survival or growth toxicity data may indicate reduced amphibian larvae populations.

2.4.4 Aquatic Avian Piscivorous Survival, Reproduction, and Growth

The belted kingfisher was selected as an indicator species for piscivorous birds that may forage within the aquatic habitats containing fish (i.e., Hoosic River and landfill pond). The kingfisher may be exposed to contaminants that accumulate within small fish and invertebrates (e.g., crayfish) that it preys upon. Estimated contaminant exposure doses will be compared to chronic survival, reproductive, or growth effect levels (NOAELs and LOAELs) reported in the literature. Exccedences of the chronic NOAEL effect levels indicate effects are possible to individuals while exceedences of the chronic LOAEL effect level indicates adverse effects are likely to this species.

2.4.5 Mammalian Piscivorous Survival, Reproduction, and Growth

The mink was selected as an indicator species for piscivorous mammals. Mink are upper trophic level predators that may be exposed to contaminants that bioaccumulate within fish, amphibians and large invertebrates. Mink are known to be sensitive to contaminants (e.g., PCBs). Estimated contaminant exposure doses will be compared to chronic survival, reproductive, or growth effect levels (NOAELs and LOAELs) reported in the literature. Exccedences of the chronic NOAEL effect levels indicate effects are possible to individuals while exceedences of the chronic LOAEL effect level indicates adverse effects are likely to this species.

2.4.6 Avian Aquatic Herbivore Survival, Reproduction, and Growth

The Canada goose was selected as an indicator species to represent exposure to avian herbivores (including granivores and frugivores) inhabiting aquatic cover types. The Canada goose is primarily a grazer feeding on succulent green vegetation although seeds (e.g., corn, grains) are also important seasonal components of the diet. The Canada goose is important economically as it is a commonly hunted waterfowl species. Estimated contaminant exposure doses will be compared to chronic survival, reproductive, or growth effect levels (NOAELs and LOAELs) reported in the literature. Exccedences of the chronic NOAEL effect levels indicate effects are possible to individuals while exceedences of the chronic LOAEL effect level indicates adverse effects are likely to this species.

2.4.7 Mammalian Aquatic Herbivore Survival, Reproduction, and Growth

Mammalian herbivores using the aquatic habitats were assessed by estimating exposure to the muskrat. The muskrat is a common aquatic species that is important to aquatic systems by influencing aquatic vegetation density and diversity. The muskrat has a relatively high ingestion rate. This species is also important economically as it plays a role in the fur industry. Estimated contaminant exposure doses will be compared to chronic survival, reproductive, or growth effect levels (NOAELs and LOAELs) reported in the literature. Exccedences of the chronic NOAEL effect levels indicate effects are possible to individuals while exceedences of the chronic LOAEL effect level indicates adverse effects are likely to this species.

2.4.8 Mammalian Terrestrial Herbivore Survival, Reproduction, and Growth

The meadow vole is generally found within grassland habitats or other similar cover types providing dense herbaceous vegetation. The vole is primarily herbivorous and feeds on green succulent vegetation as well as seeds, roots, and bark. Although home range size is dependent upon habitat quality and vole density, home ranges are generally. The meadow vole represents a sensitive indicator species for the mammalian herbivore guild (selected assessment endpoint) due to its small home range and relatively high food intake rate. Estimated contaminant exposure doses will be compared to chronic survival, reproductive, or growth effect levels (NOAELs and LOAELs) reported in the literature. Exccedences of the chronic NOAEL effect levels indicate effects are possible to individuals while exceedences of the chronic LOAEL effect level indicates adverse effects are likely to this species.

2.4.9 Avian Aquatic Insectivore Survival, Reproduction, and Growth

The spotted sandpiper was selected to represent insectivorous birds within aquatic habitats as this species is expected to be a sensitive measurement receptor due to its high ingestion rate of invertebrates as well as incidental ingestion of sediment. Estimated contaminant exposure doses will be compared to chronic survival, reproductive, or growth effect levels (NOAELs and LOAELs) reported in the literature. Exccedences of the chronic NOAEL effect levels indicate effects are possible to individuals while exceedences of the chronic LOAEL effect level indicates adverse effects are likely to this species.

2.4.10 Mammalian Aquatic Insectivore Survival, Reproduction, and Growth

The little brown bat was selected as an indicator species for insectivorous mammals that forage on insects emerging from aquatic habitats within the Pownal Tannery Study Area. The little brown bat is important to humans due to its high consumption of insects, many of which are either annoying or harmful to agricultural crops. The little brown bat is expected to represent a sensitive receptor due to its high food ingestion rate. Estimated contaminant exposure doses will be compared to chronic survival, reproductive, or growth effect levels (NOAELs and LOAELs) reported in the literature. Exccedences of the chronic NOAEL effect levels indicate effects are possible to individuals while exceedences of the chronic LOAEL effect level indicates adverse effects are likely to this species.

2.4.11 Avian Terrestrial Insectivore Survival, Reproduction, and Growth

The American woodcock represents an insectivorous bird that inhabits wetlands and uplands present within the Pownal Tannery Study Area. American woodcock are exposed to contaminants that accumulate within the tissue of earthworms and other invertebrates as well as through the ingestion of soil as it probes for prey. American woodcock also represent an important game bird. Estimated contaminant exposure doses will be compared to chronic survival, reproductive, or growth effect levels (NOAELs and LOAELs) reported in the literature. Exccedences of the chronic NOAEL effect levels indicate effects are possible to individuals while exceedences of the chronic LOAEL effect level indicates adverse effects are likely to this species.

2.4.12 Mammalian Terrestrial Insectivore Survival, Reproduction, and Growth

The short-tailed shrew is common within a variety of terrestrial habitats. The shrew is generally a fossorial species with a small home range. The diet of the short-tailed shrew is comprised primarily of insects and other invertebrates with small vertebrates and plant matter also consumed. The short-tailed shrew represents a sensitive indicator species for insectivore species as it would be exposed to contaminants that accumulate in invertebrates, has a small home range, and has a high food intake rate relative to its body weight. Estimated contaminant exposure doses will be compared to chronic survival, reproductive, or growth effect levels (NOAELs and LOAELs) reported in the literature. Exccedences of the chronic NOAEL effect levels indicate effects are possible to individuals while exceedences of the chronic LOAEL effect level indicates adverse effects are likely to this species.

2.4.13 Avian Aquatic Omnivore Survival, Reproduction, and Growth

Mallards were selected as an indicator species for omnivorous waterfowl that may inhabit the aquatic cover types identified within the Study Area. The mallard is important ecologically as it disperses seeds of aquatic vegetation and is an important component in the diet of many predators. Mallards are exposed to contaminants as they forage on both plants and invertebrates within shallow areas of water and sediment. The mallard is also an important game species. Estimated contaminant exposure doses will be compared to chronic survival, reproductive, or growth effect levels (NOAELs and LOAELs) reported in the literature. Exccedences of the chronic NOAEL effect levels indicate effects are possible to individuals while exceedences of the chronic LOAEL effect level indicates adverse effects are likely to this species.

2.4.14 Mammalian Aquatic Omnivore Survival, Reproduction, and Growth

The raccoon was selected to represent omnivorous mammals that may potentially be exposed to contaminants present within vegetation and invertebrates (e.g., crayfish) as it forages within the Pownal Tannery Study Area aquatic habitats. The raccoon is important economically as it is trapped and is a game species. Estimated contaminant exposure doses will be compared to chronic survival, reproductive, or growth effect levels (NOAELs and LOAELs) reported in the literature. Exccedences of the chronic NOAEL effect levels indicate effects are possible to individuals while exceedences of the chronic LOAEL effect level indicates adverse effects are likely to this species.

2.4.15 Mammalian Terrestrial Omnivore Survival, Reproduction, and Growth

The deer mouse was selected as an indicator species for omnivorous species within the wetland and upland habitats present within the Study Area. Deer mice are common small mammals within the environment and form an important component of the diet of many avian and mammalian predators. Deer mice have small home ranges and feed on both plant and animal material. Estimated contaminant exposure doses will be compared to chronic survival, reproductive, or growth effect levels (NOAELs and LOAELs) reported in the literature. Exccedences of the chronic NOAEL effect levels indicate effects are possible to individuals while exceedences of the chronic LOAEL effect level indicates adverse effects are likely to this species.

2.4.16 Avian Terrestrial Omnivore Survival, Reproduction, and Growth

The American robin inhabits forested areas but prefers to forage in open areas containing herbaceous vegetation. The diet of the robin varies seasonally but includes a high proportion of vegetation (primarily seeds and fruits which is disperses) as well as animal matter (invertebrates such as insects and worms). Home ranges are also fairly small for the robin. The American robin represents a ground-feeding avian omnivorous species that might be exposed to site contaminants that accumulate in both plants and invertebrates. Estimated contaminant exposure doses will be compared to chronic survival, reproductive, or growth effect levels (NOAELs and LOAELs) reported in the literature. Exccedences of the chronic NOAEL effect levels indicate effects are possible to individuals while exceedences of the chronic LOAEL effect level indicates adverse effects are likely to this species.

3.0 ANALYSIS

The analysis component of the risk assessment consists of assessing the exposure of the selected measurement receptors to the COCs (Exposure Assessment) and determining the toxicity of the COCs to the receptors (Toxicity Assessment).

3.1 Exposure Assessment

Exposure represents the contact (including ingestion) of a measurement receptor with a COC through the various exposure pathways identified in Section 2.4. Exposure to community measurement receptors (i.e., aquatic water invertebrates, fish, benthic invertebrates and amphibian larvae) is simply represented by the concentrations of COCs within the media of concern that the particular community inhabits. Surface water (dissolved and total) and sediment contaminant concentrations (mean and maximum) are provided in Attachment I. These concentrations are assumed to represent exposure point concentrations for these community receptors.

Exposure to contaminants via the food chain is evaluated by modeling exposure to the selected indicator species or measurement receptors (kingfisher, mink, Canada goose, muskrat, meadow vole, spotted sandpiper, little brown bat, green frog, woodcock, short-tailed shrew, mallard, raccoon, deer mouse and robin). The exposure scenarios developed in the Problem Formulation place measurement receptors within exposure pathways that are most likely to contribute to contaminant intake.

The belted kingfisher and mink may be exposed to contaminants that have bioaccumulated within fish and large macroinvertebrates. The Canada goose, muskrat and meadow vole may be exposed to soil contaminants through direct ingestion and through consumption of vegetation that have accumulated contaminants through plant uptake. The spotted sandpiper, little brown bat, short-tailed shrew and American woodcock may consume contaminants directly through soil ingestion or indirectly via the consumption of invertebrates that are in direct contact with

5.0 SUMMARY

The ecological risk assessment for the Pownal Tannery Study Area was designed to identify COCs for the area's ecological communities and to estimate potential risk to organisms using the area. Study Area habitats include palustrine and riverine wetlands as well as uplands associated with the Hoosic River and adjacent floodplain. Exposure doses were determined for receptors noted or expected to utilize the aquatic, wetland, and terrestrial habitats present within the Study Area.

Risks to fish, amphibian larvae, and aquatic invertebrates (both benthic and water column communities) were evaluated by company measured surface water and/or sediment concentrations in the aquatic habitats with applicable toxicity reference values. Comparisons were made from samples collected from the Hoosic River, lagoons, landfill ponds, seeps, and Halifax Hollow (landfill stream).

Risks to wildlife receptors including belted kingfisher, mink, Canada goose, muskrat, spotted sandpiper, little brown bat, mallard, raccoon, meadow vole, American woodcock, short-tailed shrew, American robin, and deer mouse were estimated by bioaccumulation modeling and comparing the estimated exposure doses with chronic NOAEL and LOAEL toxicity reference values. Wildlife receptors were evaluated with five communities: Hoosic River, lagoons (both aquatic and upland habitats), landfill pond, and landfill wet meadow/seepage areas.

A summary of potential risks associated with COCs detected within the Pownal Tannery Study Area are provided in Table 48. Potential risks for aquatic invertebrates, fish and amphibian larvae are based on surface water or sediment concentrations exceeding their respective chronic or acute TRVs. Potential risks to wildlife receptors are based on estimated exposure doses that exceed their respective LOAEL TRV.

Fish and aquatic invertebrates may potentially be impacted by detected concentrations of aluminum and iron within the landfill pond and seeps (invertebrates only). Risks to fish and aquatic invertebrates within the Hoosic River, lagoons, and Halifax Hollow are not expected to be elevated above background levels. Amphibian larvae may be at an acute risk from mercury concentrations present within important amphibian breeding areas (landfill pond and lagoons). Benthic invertebrates may potentially be at risk from detected concentrations of COCs within sediments of the Hoosic River, lagoons, and landfill pond. Primary COCs with sediment include PAHs, pesticides, and several metals including chromium, lead, cadmium, and mercury.

Wildlife receptors potentially at risk (above background risk levels) within the Hoosic River community include the little brown bat from elevated concentrations of high molecular weight PAHs within the sediments. Sediments and surface soils associated with the lagoons provide elevated risk above background risk levels to a variety of wildlife receptors including aquatic mammalian herbivores (muskrat), insectivorous birds (spotted sandpiper and American woodcock), and mammals (little brown bat and short-tailed shrew), as well as omnivorous birds (American robin) and mammals (raccoon and deer mouse). Primary risk drivers within the lagoon sediment and surface soils are dioxin/furans, chromium, cadmium, and lead.

Table 48. Summary of Receptor Risks, Hazards, and Limitations

Ecological Risk Evaluation
Pownal Tannery Study Area, N. Pownal, Vermont

Area	Sampling Limitations: Low Sample Number (1)	Sampling Limitations: Analyses Not Performed (2)	Receptor	Mean or Maximum	Total Chronic or NOAEL Risk	Total Acute or LOAEL Risk	Media	Major Contributors to Risk (HI > 1)
Hoosic River	-	SW- Pest./PCBs	Fish/Water Invertebrates	Mean	5.00E+00	3.00E-01	SW	(C/N) - Al (3), Ba (3)
				Maximum	6.00E+00	5.00E-01		(A/L) - NA
			Benthic Invertebrates	Mean	2.50E+01	5.00E+00	SD	(C/N) - PAHs, Pest., Tol, Ba (3), CN, Cd (3), Cr (3), Cu, Fe, Pb, Hg, Mn,
				Maximum	1.40E+02	3.00E+01		Ni (3), Zn
								(A/L) - PAHs, Pest., Hg, Pb
			Avian Aquatic Herbivores	Mean	1.00E-01	5.00E-03	NA	(C/N) - NA
				Maximum	2.00E-01	2.00E-02		(A/L) - NA
			Mammalian Aquatic	Mean	2.90E+01	3.00E+00	SD	(C/N) - Al (3), Dx (3,5)
			Herbivores	Maximum	4.80E+01	5.00E+00		(A/L) - Al (3)
			Avian Piscivores	Mean	8.00E+00	8.00E-01	SD	(C/N) - Dx (3, 5), Cr (5), Pb (5), Zn (3), DDT (3), PCBs (3), BEHP (5)
				Maximum	4.20E+01	5.00E+00		(A/L) - PCBs (3, 5)
			Mammalian Piscivores	Mean	1.20E+01	1.00E+00	SD	(C/N) - Dx (3), Al (3), PCBs (3,5), PAHs (5)
				Maximum	4.20E+01	5.00E+00		(A/L) - Dx (5), Al (3, 5)
			Avian Aquatic	Mean	1.00E+00	1.00E-01	SD	(C/N) - PCBs (3,5)
			Omnivores	Maximum	7.00E+00	1.00E+00		(A/L) - NA
			Mammalian Aquatic	Mean	6.20E+01	6.00E+00	SD	(C/N) - Dx (3), Al (3), Cu (5), Ag (3,5), PCBs (3,5), PAHs
			Omnivores	Maximum	1.50E+02	1.60E+01		(A/L) - Dx (3), Al (3), Cu (5), PCBs (3,5), PAHs (5)
			Avian Aquatic	Mean	3.20E+01	3.00E+00	SD	(C/N) - Dx (3), Al (3), Cd (5), Cr (3), Cu (5), CN (5), Pb (3), Hg (5)
			Insectivores	Maximum	1.40E+02	1.60E+01		Zn (3), DDT (3), PCBs (3), DNBP (5)
								(A/L) - Dx (3,5), Cr (3,5), Cu (5), Pb (3,5), Hg (5), Zn (3,5), PCBs (5)
			Mammalian Aquatic	Mean	2.00E+02	2.10E+01	SD	(C/N) - Dx (3), Al (3), Cd (5), Cu, Pb (3,5), Ag (3), Th, Zn (3,5),
			Insectivores	Maximum	1.10E+03	1.20E+02		PCBs (3), Hept., PAHs
								(A/L) - Dx (3), Al (3), Cu, Ag (5), PCBs (3), PAHs
Lagoon Area	-	SW- Pest./PCBs	Fish/Water Invertebrates	Mean	1.10E+01	7.00E-01	SW	(C/N) - Al (3), Ba (3), Mn (3)
				Maximum	2.00E+01	2.00E+00		(A/L) – NA
			Benthic Invertebrates	Mean	3.60E+02	6.90E+01	SD	(C/N) - VOCs, SVOCs, Pest., Ba (3), Cd, Cr, Cu(3), CN, Pb, Mn(3),
				Maximum	2.00E+03	2.20E+02		Hg, Ni(3), Se, Zn(3)
								(A/L) - Pest., Cd, Cr, Pb, Hg, Cds
			Amphibian Larvae	Mean	NE	2.00E+00	SW	(A/L) - Al (3), Hg
				Maximum	NE	7.00E+00		
			Avian Aquatic	Mean	2.00E-01	5.00E-02	NA	(C/N) - NA
			Herbivores	Maximum	6.00E-01	1.00E-01		(A/L) - NA
			Mammalian Aquatic	Mean	4.50E+01	4.00E+00	SD	(C/N) - Dx, Al (3), BCE (5)
			Herbivores	Maximum	7.40E+01	7.00E+00		(A/L) - Dx (5), Al (3)
			Avian Aquatic	Mean	2.00E+00	4.00E-01	SD	(C/N) - Cr
			Omnivores	Maximum	5.00E+00	1.00E+00		(A/L) - NA

Table 48. Summary of Receptor Risks, Hazards, and Limitations

Ecological Risk Evaluation
Pownal Tannery Study Area, N. Pownal, Vermont

	Sampling Limitations							
Area	Low Sample Number (1)	Analyses Not Performed (2)	Receptor	Mean or Maximum	Total Chronic or NOAEL Risk	Total Acute or LOAEL Risk	Media	Major Contributors to Risk (HI > 1)
Lagoon Area			Mammalian Aquatic	Mean	2.90E+01	3.00E+00	SD	(C/N) - Dx, Al (3), PCBs
			Omnivores	Maximum	7.60E+01	8.00E+00		(A/L) - Dx, Al (3), PCBs (5)
			Avian Aquatic	Mean	8.80E+02	1.70E+02	SD	(C/N) - Dx, Al (3), Cd, Cr, CN (5), Pb, Hg, Vd (5), Zn (3), PCBs
			Insectivores	Maximum	2.10E+03	4.00E+02		(A/L) - Dx, Cd (5), Cr, Pb, Hg (5), Zn (5)
			Mammalian Aquatic	Mean	2.30E+02	2.30E+01	SD	(C/N) - Dx, Al (3), Sb (5), Cd, Pb (5), Ag, PCBs
			Insectivores	Maximum	8.00E+02	8.00E+01		(A/L) - Dx, Al (3), PCBs
			Mammalian Terrestrial	Mean	4.70E+01	5.00E+00	SS	(C/N) - Dx, Al, Sb (5), Cd (5), Th (5)
			Herbivores	Maximum	1.30E+02	1.30E+01		(A/L) - Dx (5), Al
			Avian Terrestrial	Mean	1.00E+03	1.90E+02	SS	(C/N) - Dx, Al, Cd, Cr, CN (5), Pb, Hg (5), Se (5), Th (5),
			Omnivores	Maximum	1.20E+04	2.30E+03		Vd (5), Zn, DDT (5), BEHP (5)
								(A/L) - Dx, Cd, Cr, Pb, Hg (5), Zn (5)
			Mammalian Terrestrial	Mean	1.70E+02	1.60E+01	SS	(C/N) - Dx, Al, Sb (5), Cd, Cr (5), Pb (5), Se (5), Ag (5), Th,
			Omnivores	Maximum	9.70E+02	9.60E+01		PAHs
								(A/L) - Dx, Al, Cd (5)
			Avian Terrestrial	Mean	8.40E+02	1.60E+02	SS	(C/N) - Dx, Al, Cd, Cr, Cn (5), Pb, Hg (5), Se (5), Th (5), Vd (5), Zn,
			Insectivores	Maximum	9.70E+03	1.90E+03		DDT (5)
								(A/L) - Dx (5), Cd, Cr, Pb, Hg (5), Vd (5), Zn (5)
			Mammalian Terrestrial	Mean	6.00E+02	5.90E+01	SS	(C/N) - Dx, Al, Sb (5), Ba (5), Cd, Cr (5), Pb, Mn (5), Se, Ag,
			Insectivores	Maximum	2.50E+03	2.50E+02		Th, Vd, Zn (5), PAHS
								(A/L) - Dx, Al, Cd, Pb (5), Se (5), PAHs (5)
Landfill Pond/		SW- Pest./PCBs	Fish/Water Invertebrates	Mean	1.40E+01	1.00E+00	SW	(C/N) - Al, Ba (3), Fe, Mn (3)
Seeps				Maximum	2.90E+01	3.00E+00		(A/L) - Al
			Benthic Invertebrates	Mean	3.80E+01	8.00E+00	SD	(C/N) - Ac, Pest., Ba (3), Cd (4), Cr, Cu (4), CN, Fe, Pb (4),
				Maximum	5.40E+01	1.00E+01		Mn, Hg (4), Ni (4), Zn (4)
								(A/L) - DDD, DDE, Cr, Hg (4)
			Amphibian Larvae	Mean	NE	1.10E+01	SW	(A/L) - Al (3), Hg
				Maximum	NE	2.80E+01		
			Avian Aquatic	Mean	5.00E-02	4.00E-03	NA	(C/N) - NA
			Herbivores	Maximum	4.00E-02	4.00E-03		(A/L) - NA
			Mammalian Aquatic	Mean	5.70E+01	6.00E+00	SD	(C/N) - Al (3)
			Herbivores	Maximum	7.90E+01	8.00E+00		(A/L) - Al (3)
			Avian Piscivores	Mean	7.00E+00	1.00E+00	SD	(C/N) - Cr (4), Zn (4), PCBs
				Maximum	1.00E+01	1.00E+00		(A/L) - NA
			Mammalian Piscivores	Mean	4.00E+00	4.00E-01		(C/N) - Al (3)
				Maximum	7.00E+00	7.00E-01		(A/L) - NA
			Avian Aquatic	Mean	5.00E-01	6.00E-02	NA	(C/N) - NA

Table 48. Summary of Receptor Risks, Hazards, and Limitations

Ecological Risk Evaluation
Pownal Tannery Study Area, N. Pownal, Vermont

Area	Sampling Limitations: Low Sample Number (1)	Sampling Limitations: Analyses Not Performed (2)	Receptor	Mean or Maximum	Total Chronic or NOAEL Risk	Total Acute or LOAEL Risk	Media	Major Contributors to Risk (HI > 1)
Landfill Pond			Omnivores	Maximum	6.00E-01	7.00E-02		(A/L) - NA
			Mammalian Aquatic	Mean	3.50E+01	5.00E+00	SD	(C/N) - Dx (5), Al, Ag (5)
			Omnivores	Maximum	4.80E+01	9.00E+00		(A/L) - Al
			Avian Aquatic	Mean	7.10E+01	9.00E+00	SD	(C/N) - Dx, Al, Cd (4), Cr (4), CN (5), Pb (4), Vd (3), Zn (4), PCBs
			Insectivores	Maximum	8.90E+01	1.10E+01		(A/L) - Cr (4), Pb (4), Vd (3,5), Zn (4)
			Mammalian Aquatic	Mean	1.30E+02	1.30E+01	SD	(C/N) - Dx, Al, Cd (4), Cu (4), Ag, Th, PCBs, PAHs (5)
			Insectivores	Maximum	1.90E+02	1.90E+01		(A/L) - Dx, Al, Cu (4), Ag, PCBs
Landfill Seeps/	-		Mammalian Terrestrial	Mean	4.70E+01	5.00E+00	SD	(C/N) - Al (3)
Wet Meadow			Herbivores	Maximum	6.10E+01	6.00E+00		(A/L) - Al (3)
			Avian Terrestrial	Mean	8.00E+00	1.00E+00	SD	(C/N) - Al (3), Cr (5), Pb (3), Zn (3)
			Insectivores	Maximum	1.40E+01	2.00E+00		(A/L) - NA
			Mammalian Terrestrial	Mean	3.60E+02	3.70E+01	SD	(C/N) - Al (3), Sb (5), Ba (5), Cu (3), Mn (5), Se (5), Ag, Th, Vd (3)
			Insectivores	Maximum	4.80E+02	5.20E+01		(A/L) - Al (3), Cu (3), Se (5)
Halifax Hollow	SW - VOC, SVOCs	SW- Pest./PCBs	Fish/Water Invertebrates	Mean	3.00E+00	3.00E-01	SW	(C/N) - Al (3), Ba (3)
	DX, MT			Maximum	3.00E+00	3.00E-01		(A/L) - NA
	SD - VOC, Pest./		Benthic Invertebrates	Mean	4.00E+00	1.00E+00	SD	(C/N) - Ba (3)
	PCBs, SVOC, DX, MT			Maximum	4.00E+00	1.00E+00		(A/L) - NA

Notes:
(1) Low quantity of samples (1 or 2 only)
(2) Samples not collected for following analyses, by media
(3) Contaminant detected at higher or similar concentrations in upgradient or reference samples.
(4) SEM/AVS ratio indicates low bioavailability in this area.
(5) Only maximum detected concentration exceeds TRV.
(C/N) - Chronic or NOAEL Toxicity Reference Values
(A/L) - Acute or LOAEL Toxicity Reference Values
NA - Not Applicable

Cds - Carbon Disulfide
BEHP - Bis(2-ethylhexyl)phthalate
DNBP - Di-n-butylphthalate
Hept. - Heptachlor
Tol – Toluene

NE - Not Evaluated due to lack of data
SW - Surface Water
SD - Sediment
SS - Surface Soil
Dx - Dioxins
MT - Metals
VOC - Volatile Organic Compounds
SVOS - Semivolatile Organic Compounds
Ac - Acetone
BCE – Bis(2-chloroethyl) ether

Insectivorous birds (spotted sandpiper) and mammals (little brown bat) may potentially be at risk from concentrations of dioxins, chromium, and silver detected within the sediments of the landfill pond. No wildlife receptors were identified at risk above background levels from COCs detected in sediment associated with the wet meadow/seep community present downgradient of the landfill.

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ATTACHMENT I
SUMMARY STATISTICS

LIST OF TABLES

Table

ATTACHMENT II
WILDLIFE EXPOSURE DOSES

LIST OF TABLES

Table