Alaska Department of Environmental Conservation

Reuse & Redevelopment Initiative

Brownfield Assessment

Summary of Environmental Research:

Noyes Slough Reclamation Evaluation

Fairbanks, Alaska

Submitted to:
Department of Environmental Conservation
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By:
OASIS Environmental, Inc.
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SUMMARY OF ENVIRONMENTAL RESEARCH: NOYES SLOUGH RECLAMATION EVALUATION

FINAL
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ACRONYMS AND ABBREVIATIONS

AR .... Alaska Railroad
BMESB.......... Bentley Mall East Satellite Building
BTEX............. benzene, toluene, ethylbenzene, and total xylenes
COF............... City of Fairbanks
BTP .... Bentley Trust Property
DCA............... dichloroethane
DCE............... dichloroethylene
DDD .... metabolite of DDT
DDE............... metabolite of DDT
DDT............... dichlorodiphenyltrichloroethane
DEC............... Alaska Department of Environmental Conservation
DO................. dissolved oxygen
DOT............... Alaska Department of Transportation and Public Facilities
DRO .... diesel-range organics
E.................... Estimated value
EPA............... Environmental Protection Agency
FAIR.............. Fairbanks Area-wide Industrial Reclamation
FNSB............. Fairbanks North Star Borough
GCL............... Groundwater Cleanup Level
GRO .... gasoline-range organics
GVEA .... Golden Valley Electric Association
ID................... Identification
kg .... kilograms
L .... liter
LUST............. leaking underground storage tank
µg .... micrograms
mg .... milligrams
MW................ monitoring well
ND................. Compound not detected
NOAA............ National Oceanic and Atmospheric Administration
NSAC .... Noyes Slough Action Committee
OASIS .... OASIS Environmental, Inc.
PAH............... polynuclear aromatic hydrocarbon
PCB............... polychlorinated biphenyl
PCE............... tetrachloroethylene
SCL .... Soil Cleanup Level
SL.................. Screening Level
SPAR .... Spill Prevention and Response Program
SVE............... soil vapor extraction
SVOC............ semivolatile organic compound

TCE .... trichloroethylene
TCLP .... Toxicity Characteristic Leaching Procedure
TSS .... total suspended solids
TVWA .... Tanana Valley Watershed Association
USGS .... United States Geological Survey
VOC .... volatile organic compound

1. INTRODUCTION

Under the Alaska Department of Environmental Conservation (DEC) SPAR Term Contract 18-9028-05, OASIS Environmental, Inc. (OASIS) was tasked with researching and compiling information on the environmental impacts to Noyes Slough, Fairbanks, Alaska, presenting all pertinent information in a DEC-compatible geographic information systems (GIS) map, and summarizing the findings in a brief report. This report was funded by DEC in support of a Targeted Brownfield Assessment awarded to the Tanana Valley Watershed Association (TVWA), which has the restoration of Noyes Slough to a natural recreational asset to the community of Fairbanks as one of its goals. To achieve this goal, the TVWA wishes to work toward increasing flow in the slough; this would possibly require dredging the entire length of the slough to deepen its channel, designing and constructing engineering controls to divert additional water into the slough from the Chena River, or a combination of the two. This report can be used as background in considering the potential effects these restorative measures might have on the environmental condition of the slough and adjacent lands and properties.

1.1. Project Background

Noyes Slough is a 5.5-mile slough of the Chena River in Fairbanks, Alaska. Noyes Slough branches off of the Chena River about 1,000 feet downstream from the Wendell Street Bridge. It meanders north until it reaches College Road and then turns south, reconnecting with the Chena River near Goldizen Avenue. The slough has been on the EPA Section 303(D) List of Impaired Waterbodies since 1994. Restoration efforts have occurred intermittently over the past 30 years, including studies on the quality of the slough's water, sediments, and fish habitat (see Section 2), cleanup activities, and dredging of the slough channel. These past studies and activities support the general understanding of the environmental health of the slough. The present effort aims to further the understanding of Noyes Slough in order to facilitate decision making on the slough's future.

1.2. Hydrogeologic Setting

Noyes Slough flows through the silty sands and gravels of the alluvial plain of the Tanana and Chena Rivers. In the past, the slough was fed primarily by river water, with flushing events during the fall rainy season when the stage of the Chena River is typically higher. Before 1945, both the Tanana and Chena Rivers contributed flow to the Chena Slough, which is now the lower Chena River that flows through Fairbanks. The Chena Slough contributed water to Noyes Slough during times of high flow (Burrows and others, 2000). Flood control measures have changed the hydraulics of the slough, beginning with construction of the Moose Creek Dike in 1945, which blocked flow from the Tanana River from reaching the Chena Slough (and subsequently the Chena River) and Noyes Slough. This has greatly reduced the sediment load of the Chena River, resulting in downcutting of the river channel. Because the river channel is lower, higher flow is required in the river in order for it to contribute water to Noyes Slough. More recently, the Moose Creek Dam, which was completed in 1980 and is located 20 miles upstream from Fairbanks on the Chena River, was designed to reduce maximum flows in the river to 12,000 cubic feet per second in downtown Fairbanks (Burrows and others, 2000).

Thus, the combination of the downcutting of the Chena River channel and the reduction of the river's peak flow has resulted in a drastic reduction of the volume of water contributed by the Chena River to Noyes Slough. As a result, the primary source of water in the slough is now groundwater and runoff from storm drains, with almost no flushing occurring at high river stages. It is assumed that the water seen in stagnant ponds along the slough channel represents the level of the groundwater table in the local aquifer (Burrows and others, 2000).

In addition to the relationship between the Chena River and Noyes Slough, the strong hydraulic connection between surface water and the groundwater in the underlying shallow aquifer also affects flow in the slough. In general, during periods of high river stage, the surface water system in the Tanana Valley recharges the groundwater system (Nakanishi and Lilly, 1998). It is possible that when the Chena River is at high stage or when runoff into the slough increases, the slough will locally recharge groundwater. Conversely, at times of low stage, groundwater may discharge into the slough. The groundwater table is at its lowest in the winter and early spring. The slough depth is also low at these times. In winter, the slough has been reported to freeze to the bottom in places, suggesting that winter groundwater flow into the slough may be very limited. Dredging of the slough may increase groundwater flow into the slough by deepening its channel. However, seasonal flushing of the slough with river water and recharging of groundwater will also increase if dredging is accompanied with construction of a weir at the inlet to divert more water into the slough.

During past dredging and sampling activities, approximately 1 to 4 feet of silt and sand were observed overlying the natural gravels of the slough bed. This layer is believed to be permeable and is not a barrier to the hydraulic connection between the slough and the aquifer (Ben Kennedy, personal communication, 2007).

1.3. Physical Conditions of the Slough

This section highlights the physical conditions of Noyes Slough. Physical conditions can impede flow or contribute inputs. Features of the slough are documented in photographs provided in Appendix A. A major source of inputs to the slough is stormwater outfalls. Outfalls can deliver significant amounts of sediment and pollutants from urban runoff. In addition to generally polluting the slough, these inputs contribute to eutrophication, which can lead to a decrease in the quality of fish habitat and impede the flow of water through the slough. Approximately 35 outfalls empty into Noyes Slough (ADOT&PF, 2007).

Similarly, bridges can act as an input source, as gravel and other material are routinely cleared from the road and allowed to fall into the slough. The Danby Road Bridge is a notable example: In 2003 the Noyes Slough Action Committee (NSAC) proposed dredging an area approximately 120 feet long by 60 feet wide and 2 feet deep (approximately 500 cubic yards) underneath the bridge because gravel build-up restricted the flow of the slough (NSAC, 2003). In addition to input from road clearing, components of the actual bridges can impede flow. Bridge pilings sometimes decrease water flow and allow debris to dam up, adding to the situation.

Another major flow impediment within the slough is beaver dams, with approximately two dams per mile. In 1999 and 2000, NSAC attempted to improve flow by installing flow-through devices in beaver dams located within the slough (Carlson, 2006); additionally, three dams were removed from the slough in 2000. John Carlson, former NSAC president and leader of the effort, reported that two of the three dams were quickly rebuilt by beavers (Carlson, 2007). Neither attempt to increase flow through the dammed areas provided long-term success.

Shallow utility corridors can also act as flow impediments. Seven water and four sewer lines cross Noyes Slough (Burdick, 2007). One water and sewer crossing, located west of Illinois Street near the railroad crossing, has been noted as particularly shallow because the concrete encasement is at least 1.5 feet above the seasonal low stage of the Chena River near the Noyes Slough inlet (ADF&G, 1992). The Fairbanks electric utility company, Golden Valley Electric Association (GVEA), verified that no buried electrical lines exist under the slough. OASIS was unable to contact a knowledgeable source for locating any natural gas or communications lines that may cross the slough.

Given that dredging may be done in the future to improve flow in Noyes Slough, data on the depth of the slough along its course could prove useful. The data can also aid in selecting future sampling locations in areas where further characterization is desired. The following sources provide data on the depth of the slough along its course:

- The 2004 United States Geological Survey (USGS) report on an assessment of fish habitat, water quality, and selected contaminants in sediments of the slough: The Noyes Slough channel was divided into 13 reaches for bottom profiles and other characteristics (Kennedy and others, 2004).
- The 1982 USKH Feasibility Study: As part of a study on the feasibility of creating a canoe trail, the slough's bed profile was mapped along its entire course. This detailed profile is provided as Figure 10 in the USKH report (USKH, 1982).
- USGS National Water Information System Database (http://waterdata.usgs.gov/nwis/sw): The database provides information such as maximum depth, cross-sectional profile, discharge, and velocity at USGS gauging stations. Such gauging stations exist at several bridges along Noyes Slough and its depths are gauged periodically. The most recent gauging of the slough occurred at three locations in August and September of 2003 (Best, 2007). Data inquiries can be made at the following address at the USGS database:

  http://nwis.waterdata.usgs.gov/nwis/feedback/?to=NWISWeb%20Data%20Inquiries.

- Record of shallow utility crossings: As mentioned earlier, an especially shallow crossing west of Illinois Street (near the railroad crossing) was noted during a previous dredging effort (ADF&G, 1992).

1.4. Purpose and Scope

This report summarizes the known and potential environmental impacts to the slough, including existing environmental conditions and historical activities, with particular focus on the existing and historical contaminated sites located along the slough. This report also discusses potential problem areas along Noyes Slough, where soil, groundwater, or surface-water contamination is either partially delineated or suspected but unconfirmed. Areas requiring further characterization are also identified. A conceptual site model of Noyes Slough and screening levels protective of the receptors identified in the model are provided in Section 6.

In order to support the information presented in this report, the GIS map (Index Map) and six large-scale tiles of the map (Tiles 1 through 6) are included in the "Maps" section; recent photographs of Noyes Slough illustrating specific examples, close-up views of insets from historical aerial photographs showing specific areas of concern, and a conceptual exposure pathway diagram are provided in the "Figures" section. Various additional photographs of Noyes Slough are provided without commentary in Appendix A; historical aerial photographs are presented in Appendix B; a summary of channel profiles and sediment data from the U.S. Geological Survey's fish habitat study (Kennedy and others, 2004) are presented in Appendix C; and a full account of an interview by OASIS with a City of Fairbanks (COF) engineer concerning past dredging efforts is provided in Appendix D. The historical aerial photographs in Appendix B were provided by Aero-Metrics Inc. of Anchorage, Alaska. The other photographs in this report were provided by DEC.

1.5. GIS Map Explanation

As stated previously, this report contains seven GIS maps. The first, known as the "Index Map," presents the entire study area, which includes Noyes Slough and everything within ½ mile of it. This area is outlined in red. The remaining six maps are insets of the Index Map and are referred to as "tiles." They are ordered from east to west, with Tile 1 beginning at the inlet and Tile 6 ending at the mouth of the slough. The purpose of the tiles is to zoom into certain areas and features that are discussed in the text, rather than to present a close-up of the entire length of the slough. Consequently, some overlap or slight gaps exist between them.

A legend is found along the right side of each of the maps. The legend defines all of the features and symbols on the map. Physical features include water bodies, stormwater piping and outfalls, beaver dams, and municipal roads and building outlines.

Samples discussed in the report are also located on the maps. For each sampling symbol, the legend defines the type of media sampled (e.g., surface water, stormwater, groundwater, sediment). Each sample is labeled either by the site or study for which the sampling was conducted or by the organization that performed the sampling.

Lastly, the map shows contamination features. These include DEC Contaminated Sites, which are represented by yellow and red triangles; potential sources of contamination, such as businesses that use significant amounts of petroleum products or hazardous substances; estimated delineations of contaminant “plumes” in groundwater, mapped on the basis of sampling results (color-coded by type of contaminant); and other areas of concern, where contamination has either been detected or historical uses indicate the potential for environmental problems.

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2. PREVIOUS SAMPLING OF NOYES SLOUGH WATER AND SEDIMENT

Aside from contaminated-site investigations, sampling has been performed by various organizations in an effort to determine the water and sediment quality of Noyes Slough. This section provides a brief summary of each event and pertinent results.

In each of the data tables presented in this section, the most stringent proposed screening levels for surface water and sediment, which are currently under consideration by the State of Alaska, are provided for reference and comparison. These screening levels are discussed in detail in Section 6 of this report and were chosen on the basis of exposure pathways of concern in the slough. Most of the proposed screening levels are set lower than the current cleanup levels in DEC regulations and take into account ecological effects as well as human-health risk factors. In some cases, the sediment screening level is the same as DEC's most stringent proposed cleanup level for soil. These soil-cleanup levels are being applied in this report as the "disposal criteria" for determining whether dredged sediment would have to be handled as contaminated material. Other state and federal regulations may also apply.

2.1. 1993–1994 Water Sampling by AGRA Earth & Environmental

In November 1993 and February 1994, AGRA Earth & Environmental sampled surface water under the ice in the slough for halogenated volatile organic compounds (VOCs). In 1993, four locations within the first two miles of the slough were sampled (SL-1 through SL-4, Tiles 1 and 2). Because the slough was completely frozen at two of the four locations, only two locations (SL-2 and SL-4) were sampled again in 1994. Tetrachloroethylene (PCE) and trichloroethylene (TCE) were detected at concentrations above their applicable screening levels in all samples from both events (Superior Precision Analytical, 1993 and 1994). It is also of note that these compounds exceeded the maximum contaminant levels for drinking water, which are far less stringent. In addition, cis-1,2-dichloroethylene (DCE), 1,2-dichloroethane (DCA), trichlorofluoromethane, or chloroethane were detected in one or more of the samples from these two events. Visible sheen was noted at both locations in 1994 (Carnahan, 1994). These results are presented in Table 1.

Table 1. Volatile Organic Compounds in Surface Water, Noyes Slough

Sample ID	PCE	TCE	cis-1,2 DCE	1,2-DCA	Trichloro-Fluoromethane	Chloroethane
11/18/1993						
SL-1	**78**	**15**	1.1	**0.6**	ND	ND
SL-2	**61**	**11**	1.0	0.5	ND	ND
SL-3	**37**	**12**	0.9	0.5	0.5	ND
SL-4	**37**	**13**	0.8	**0.6**	ND	ND
2/3/1994						
SL-1	--	--	--	--	--	--
SL-2	**56**	**11**	2.2	**1.2**	ND	2.5
SL-3	--	--	--	--	--	--
SL-4	**23**	**13**	1.4	ND	**1.3**	2.0
Proposed SL	*0.5*	*0.5*	*7*	*0.5*	*1.1*	*29*

Notes: 1. Measurements are in micrograms per liter (µg/L).
2. Sample points are labeled on maps with same ID as in table.
3. Bold type indicates value above the most stringent proposed screening level (SL).
4. ND denotes compound was not detected.
5. -- denotes no analysis performed.

2.2. 1999–2002 Water and Sediment Sampling by the Noyes Slough Action Committee

The NSAC organized three sampling events in 1999 and 2000. Two of the events involved surface water sampling and one sediment sampling. The objective was to determine whether any contaminants of concern exceeded state or federal water and sediment quality criteria (Carlson, 2000). The first water sampling event occurred in October 1999. Samples were collected at the Lion's Park canoe launch (NSAC-4, Tile 3) and near Goldizen Avenue (NSAC-5, Tile 6) and were analyzed for heavy metals. Heavy metal concentrations were within acceptable limits in both samples (John Carlson, 2000). The original data sheets from the 1999 sampling are not available.

The second water sampling event occurred in June 2000. Samples were collected in three locations: behind College Cleaners (NSAC-3, Tile 2), immediately downstream of the Minnie Street Bridge (NSAC-2, Tile 1), and again at the Lion's Park canoe launch (NSAC-4). Samples were analyzed for organochlorinated herbicides, VOCs, gasoline-range organic compounds (GRO), diesel-range organic compounds (DRO), and benzene, toluene, ethylbenzene, and total xylenes (BTEX). Solvents (namely PCE, TCE, and cis-1,2 DCE) were detected at the College Cleaners site. These results were confirmed by a duplicate sample, as shown in Table 2. All other analytes were either not detected (ND) or detected at a concentration reported as an estimated value, noted as "E" (AGRA, 2000).

Table 2. Volatile Organic Compounds in Surface Water, Noyes Slough

Sample ID	PCE	TCE	cis-1,2 DCE	Benzene	Toluene
	6/18/2000				
NSAC-2	ND	ND	ND	0.46E	0.92E
NSAC-3	**4.27**	**1.62**	1.32	ND	ND
NSAC-3 Dup	**4.22**	**1.60**	1.12	ND	ND
NSAC-4	**0.80E**	**0.63E**	ND	ND	ND
	10/21/2002				
NSAC-7	**3.78**	**5.17**	0.92E	ND	ND
Proposed SL	*0.5*	*0.5*	*7*	*0.5*	*2*

Notes: 1. Measurements are in micrograms per liter (µg/L).
2. Sample points are labeled on maps with same ID as in table.
3. Bold type indicates value above the most stringent proposed screening level (SL).
4. ND denotes compound was not detected.
5. E denotes estimated value, below method reporting limits.

In August and October of 2002, one water sample was collected from the slough behind the former Fred Meyer and near the Aurora Drive Bridge, respectively (DEC file no. 100.38.147). The Fred Meyer sample from August 2002 is identified as NSAC-6 (Tile 1) and the Aurora bridge sample from October 2002 is identified as NSAC-7 on the map (Tile 3). NSAC-6 was analyzed by EPA Method 624 for VOCs and by EPA Method 625 for semi-volatile organic compounds (SVOCs) (Northern Testing Laboratories, 2002a), while NSAC-7 was analyzed for VOCs and SVOCs by EPA methods 8260B and 8270C respectively (Northern Testing Laboratories, 2002b). Both samples were also analyzed for metals and hardness. No VOCs were detected in NSAC-6, and no SVOCs were detected in either sample. Lead, cadmium, and mercury were not detected in either sample. The VOCs detected in NSAC-7 are shown in Table 2, and metals and hardness reported for both samples are shown in Table 3.

Table 3. Metals in Surface Water, Noyes Slough

Sample ID	Chromium	Zinc	Arsenic	Copper	Hardness
	8/7/2002				
NSAC-6	**0.0031**	**0.364**	ND	**0.0185**	10.8
	10/21/2002				
NSAC-7	**0.002E**	**0.51**	**0.004E**	ND	250.3
Proposed SL	*0.000266*	*0.021*	*0.001*	*0.000205*	*NA*

Notes: 1. Measurements are in milligrams per liter (mg/L).
2. Sample points are labeled on maps with same ID as in table.
3. Bold type indicates value above the most stringent proposed screening level (SL).
4. ND denotes compound was not detected.
5. NA denotes that no applicable screening level exists for this compound.
6. E denotes estimated value, below method reporting limits.
7. Hardness reported as mg/L calcium carbonate.

Sediment samples were collected in June 2000 at three locations: at the slough inlet (NSAC-1s, Tile 1), behind College Cleaners (NSAC-3s, Tile 2), and behind a private residence within the Aurora subdivision (this sample point is not marked on any of the figures because there is no record of the location). Samples were analyzed for metals;

polynuclear aromatic hydrocarbons (PAHs); persistent organic pollutants, including polychlorinated biphenyls (PCBs) and organochlorinated pesticides; alkanes; and sterols (Venkatesan, 2000). Results for metals are shown in Table 4, PAHs in Table 5, and PCBs and pesticides in Table 6.

Table 4. Metals in Sediments, Noyes Slough, June 2000

Sample ID	Arsenic	Cad-mium	Copper	Lead	Mercury (total)	Methyl Mercury	Nickel	Van-adium	Zinc
NSAC-1s	**35.8**	**1.21**	**65.7**	31.6	0.0558	**0.00014**	**76.0**	**249**	**221**
NSAC-3s	**43.6**	**1.96**	**83.4**	**50.0**	0.0612	**0.00071**	**91.0**	**284**	**377**
Aurora Backyard	**33.6**	**1.22**	**44.7**	**36.1**	0.0568	**0.0002**	**51.8**	**189**	**324**
Proposed SL	*0.45*	*0.003*	*10*	*35*	*0.17*	*0.012*	*18*	*71*	*3*

Notes: 1. Measurements are in milligrams per kilogram (mg/kg).
2. Sample points are labeled on maps with same ID as in table.
3. Bold type indicates value above the most stringent proposed screening level (SL).

All of the metals were present at concentrations above the proposed screening levels (Table 4). Because no state sediment quality criteria existed, NSAC referred to guidelines published by the National Oceanic and Atmospheric Association (NOAA) and the Canadian Interim Sediment Quality Guidelines for protection of aquatic life. Sample results indicated that certain metals, namely arsenic, nickel, and zinc, were at levels above the NOAA and Canadian "upper effects" thresholds. In the NOAA and Canadian guidelines, the "upper effects" threshold is set at a level that is likely toxic to microorganisms and invertebrates (Carlson, 2000). However, NSAC noted that local species might be more tolerant of compounds naturally high in the local environment, such as arsenic.

Table 5. PAHs in Sediments, Noyes Slough, June 2000

Sample ID	Acenaph-thene	Acenaph-thylene	Anthracene	Benzo(a)-Anthracene	Benzo(a)-Pyrene	Benzo(b)-Fluor-anthene	2,3-Benzo-fluorene
NSAC-1s	ND	ND	0.56	0.51	ND	1.69	ND
NSAC-3s	0.27	1.44	3.02	2.45	10.1	7.64	2.19
Aurora Backyard	0.21	2.01	4.74	3.47	15.8	9.27	3.06
Proposed SL	*6.7*	*5.87*	*10*	*15.7*	*31.9*	*27.2*	*NA*

Sample ID	Benzo(g,h,i)-perylene	Benzo(k)-Fluor-anthene	Biphenyl	Coronene	Dibenzo (a,h)-Anthracene	Dibenzo-thiophene	Fluoran-thene
NSAC-1s	7.85	2.84	ND	5.67	ND	3.00	2.01
NSAC-3s	15.8	9.56	0.63	10.7	ND	12.7	6.55
Aurora Backyard	34.8	9.98	0.56	15.8	ND	13.1	5.05
Proposed SL	*170*	*27.2*	*NA*	*NA*	*10*	*NA*	*31.5*

Sample ID	Fluorene	Indeno(1,2,3-c,d)-pyrene	1-Methyl-naphthalene	2-Methyl-naphthalene	Naphth-alene	Phenan-threne	Pyrene
NSAC-1s	1.16	4.56	ND	ND	ND	2.74	2.45
NSAC-3s	3.82	14.6	1.00	2.12	2.52	10.8	7.81
Aurora Backyard	5.72	**25.8**	1.27	2.55	2.53	9.97	5.72
Proposed SL	*10*	*17.3*	*6,200*	*20.2*	*34.6*	*18.7*	*44.3*

Notes: 1. Measurements are in micrograms per kilogram (µg/kg).
2. Sample points are labeled on maps with same ID as in table.
3. Bold type indicates value above the most stringent proposed screening level (SL).
4. ND denotes compound was not detected.
5. NA denotes that no applicable screening level exists for this compound.
6. Alkylated homologs are not included in this table unless a screening level is available.

In general, PAH concentrations increased with distance from the inlet (Table 5). PAH concentrations in the slough were not compared to sediment-quality guidelines, but the concentrations were below the proposed screening levels with the exception of one compound, indeno(1,2,3-cd)pyrene. Like PAH concentrations, PCB concentrations appear to increase with distance from the inlet but were present at two locations above the proposed screening levels (Table 6).

Table 6. PCBs and Pesticides in Sediments, Noyes Slough, June 2000

Sample ID	Aldrin	Alpha-Chlordane	DDT	DDD	DDE	Heptachlor
NSAC-1s	0.035	0.026	**6.66**	**0.882**	0.175	0.012
NSAC-3s	0.070	0.028	**2.49**	**1.11**	0.274	ND
Aurora Backyard	ND	0.027	**1.49**	**1.58**	0.221	ND
Proposed SL	*2*	*NA*	*1.19*	*0.300*	*0.300*	*10*

Sample ID	Heptachlor-Epoxide	Hexachloro-Benzene	Lindane	Mirex	Total PCBs	Trans-Nonachlor
NSAC-1s	0.032	0.037	0.018	0.006	1.43	ND
NSAC-3s	ND	0.136	ND	0.020	**2.74**	0.017
Aurora Backyard	ND	0.047	ND	0.018	**3.73**	ND
Proposed SL	*0.6*	*47*	*9.5*	*7*	*2.00*	*NA*

Notes: 1. Measurements are in micrograms per kilogram (µg/kg).
2. Sample points are labeled on maps with same ID as in table.
3. Bold type indicates value above the most stringent proposed screening level (SL).
4. ND denotes compound not detected.
5. NA denotes that no applicable screening level exists for this compound.

The organochlorinated pesticide DDT and its degradation products, DDD and DDE, were detected in all three samples at levels above the proposed screening levels provided in Table 6 and the NOAA "lower effects" threshold referenced by NSAC. Compounds above the "lower effects" level have potential to affect organisms, but with a much lower likelihood than if they were above the "upper effects" level (Carlson, 2000). The analytical laboratory expressed concern over the levels of DDT and its degradation products, given that DDT use was banned in the United States in 1972. NSAC recommended toxicity testing of aquatic life in and around the slough as well as sampling for DDT in the Chena River near the Noyes Slough inlet to determine if the river was a source of the DDT. However, neither of the proposed actions was conducted by NSAC or an affiliated organization.

2.3. 2001–2002 Sediment Sampling by the U.S. Geological Survey

In the summers of 2001 and 2002, USGS scientists conducted an assessment of the Noyes Slough water quality, fish habitat, and contaminants in sediment (Kennedy and others, 2004). In this study, water quality parameters (e.g., dissolved oxygen [DO], temperature, and conductivity) were measured at 26 locations. Sediment samples were collected from 23 locations throughout the length of the slough. In addition, the slough was divided into 13 reaches in which such features as beaver dams, log jams, bed profiles, stream cross-sections, and observable fish species were recorded. Appendix C includes the figures showing these reaches.

Water quality results revealed low DO as well as high temperature and specific conductivity in several areas of low flow. Temperature and DO levels did not meet EPA and DEC recommended levels in several instances. The high specific conductivity indicates potentially high levels of urban pollution. In contrast, areas of relatively high flow had acceptable levels of temperature, DO, and specific conductivity; there were also fewer obstructions to fish passage. Therefore, one of the study's conclusions was that stream flow is one of the biggest determinants of water quality and fish habitat in the slough.

Sediment samples were analyzed for trace metals, SVOCs, PCBs, and organochlorinated pesticides. The complete sets of sediment sample results are provided in Appendix C. The sediment sample locations are marked in Tiles 1-6. Selected results are shown in Tables 7, 8, 9, and 10. While many compounds were detected in the slough sediments, the tables include only those that are discussed herein and those that were detected in the NSAC 2000 sediment sampling event.

Like the NSAC sediment samples, all of the metals were detected at concentrations above the proposed screening levels (Table 7). The USGS did not identify most of these metals as contaminants of concern because the observed levels are common in the Fairbanks area. However, the study concluded that the high levels of zinc, in combination with high levels of lead in a few samples, were indicators of urban pollutants. In general, the most notable sampling locations were those for SED13 (Tile 3), SED14 (Tile 4), and SED 20 (Tile 5).

Table 7. Metals in Sediment, Noyes Slough, 2001

Sample ID	Arsenic	Cadmium	Copper	Lead	Mercury (total)	Nickel	Vanadium	Zinc
SED13	**11.3**	ND	**34.2**	**59.4**	0.055E	**25.6**	34.2	**562**
SED14	**7.4**	ND	**21.3**	**56.5**	0.041E	**19.6**	30.2	**57.4**
SED20	**9.7**	ND	**30.4**	**1,490**	0.065	**22.7**	36.8	**90.1**
Proposed SL	*0.45*	*0.003*	*10*	*35*	*0.17*	*18*	*71*	*3*

Notes: 1. Measurements are in milligrams per kilogram (mg/kg).
2. Sample points are labeled on maps with same ID as in table
3. Bold type indicates value above the most stringent proposed screening level (SL).
4. E denotes concentration is below laboratory reporting limit and considered estimated.
5. ND denotes metal not detected.

Sediment samples SED13, SED21 (Tile 6), and SED23 (Tile 6) contained the highest SVOC concentrations in the sediment samples analyzed by the USGS (Tables 8 and 9). The USGS samples had low levels of PAHs, although these concentrations were generally higher than those found by NSAC. Other notable organic compounds detected include thiophene and 4H-cyclopenta(def)phenanthrene, potential indicators of coal tar contamination; p-cresol, a wood treatment product; bis(2-ethylhexyl)-phthalate, a plasticizer detected in SED13 at concentrations close to the aquatic life guideline referenced by the USGS; and dichlorobenzenes, detected in one sample, SED09 (Tile 2).

Table 8. PAHs in Sediments, Noyes Slough, October 2002

Sample ID	Acena-phthene	Acena-phthylene	Anthra-cene	Benzo(a)-Anthracene	Benzo(a)-Pyrene	Benzo(b)-Fluor-anthene	Benzo(k)-Fluor-anthene	Benzo(g,h,i) Perylene
SED09	**<70**	**<70**	**15E**	13E	19E	**<70**	**<70**	<70
SED13	**<150**	**31E**	**54E**	**94E**	**120E**	**200**	**89E**	110E
SED21	**<100**	**<100**	**24E**	**21E**	27E	19E	5E	<100
SED23	**85**	**<50**	**41E**	**48E**	**35E**	**44E**	**29E**	<50
Proposed SL	*6.7*	*5.87*	*10*	*15.7*	*31.9*	*27.2*	*27.2*	*170*

Sample ID	Chrysene	Dibenzo (a,h)-Anthracene	Fluor-anthene	Fluorene	Naphth-alene	Phen-anthrene	Pyrene
SED09	13E	**<70**	19E	**<70**	10E	13E	21E
SED13	**230**	**100E**	**330**	**40E**	30E	**160**	**300**
SED21	**27E**	**<100**	**52E**	**<100**	20E	**34E**	**47E**
SED23	**66E**	**<50**	**240**	**69E**	**60E**	**200**	**220**
Proposed SL	*26.8*	*10*	*31.5*	*10*	*34.6*	*18.7*	*44.3*

Notes: 1. Measurements are in micrograms per kilogram (μg/kg).
2. Sample points are labeled on maps with same ID as in table.
3. < denotes less than the laboratory limit provided on table (i.e., not detected).
4. E denotes estimated value.
5. Bold type indicates value above the most stringent proposed screening level (SL).
6. Some laboratory reporting limits are greater than the proposed screening levels.

Table 9. Other SVOCs in Sediments, Noyes Slough, October 2002

Sample ID	Bis(2-ethylhexyl)-phthalate	Butylbenzyl-phthalate	p-Cresol	4H-cyclo-penta(def) phena-nthrene	1,2-Dichloro-benzene	1,4-Dichloro-benzene	1,3-Dichloro-benzene	Thiophene
SED09	200	79	66E	<70	13E	19E	23E	12E
SED13	**2,600**	170	200	36E	**<150**	**<150**	<150	41E
SED21	130	81E	86E	10E	**<100**	**<100**	<100	17E
SED23	130	57E	99E	29E	**<50**	**<50**	<50	15E
Proposed SL	*330*	*290,000*	*1,500*	*NA*	*23*	*31*	*28,000*	*NA*

Notes: 1. Measurements are in micrograms per kilogram (µg/kg).
2. Sample points are labeled on maps with same ID as in table.
3. Bold type indicates value above the most stringent proposed screening level (SL).
4. NA denotes that no applicable screening level exists for this compound.
5. < denotes less than the laboratory limit provided on table (i.e., not detected).
6. E denotes estimated value.
7. Some laboratory reporting limits are greater than the proposed screening levels.

The DDT and PCB findings in the USGS study were also similar to the NSAC sediment study (Table 10). The organochlorinated pesticide DDT or one of its degradation products was detected in all 13 sediment samples analyzed for pesticides. Total PCBs were reported in 11 samples. The concentrations of DDD, DDE, and PCBs were above the proposed screening levels but were below the guidelines the study used to determine impact to aquatic life.

Table 10. Pesticides and PCBs in Sediments, Noyes Slough, October 2002

Sample ID	Aldrin	DDT	DDD	DDE	Heptachlor	Heptachlor Epoxide
SED01	<1.0	**1.1E**	**1.31E**	**0.33E**	<1.0	**<1.0**
SED13	<2.0	**<8.0**	**1.8E**	**0.64E**	<2.0	**<2.0**
SED23	<1.0	**1.8E**	**14.6E**	**0.91E**	<1.0	**<1.0**
Proposed SL	*2*	*0.300*	*0.300*	*0.300*	*10*	*0.6*

Sample ID	Hexachloro-Benzene	Lindane	Trans-Nonachlor	Mirex	Total PCBs
ED01	<1.0	<1.0	<1.0	<1.0	**<50**
SED13	46	<2.0	<2.0	<2.0	**27E**
SED23	<1.0	<1.0	<1.0	<1.0	**9.2E**
Proposed SL	*47*	*9.5*	*NA*	*7.00*	*2.00*

Notes: 1. Measurements are in micrograms per kilogram (µg/kg).
2. Sample points are labeled on maps with same ID as in table.
3. Bold type indicates value above the most stringent proposed screening level (SL).
4. NA denotes no applicable screening level exists for this compound.
5. < denotes less than the laboratory limit provided on table (i.e., not detected).
6. E denotes estimated value.
7. Some laboratory reporting limits are greater than the proposed screening levels.

2.4. 2006–2007 Stormwater Outfall Sampling

The Fairbanks North Star Borough (FNSB) and the Department of Tranportation and Public Facilities (DOT) have recently begun sampling stormwater outfalls in waterways in order to comply with the National Pollutant Discharge Elimination System permit requirements. It is a voluntary effort that the DOT and FNSB hope to perform semi-annually. The first two events occurred in August 2006 and April 2007. Samples were collected from three locations along Noyes Slough: under the western crossing of the

Johansen Expressway (Johansen SW, Tile 6), under the Minnie Street bridge (Minnie St. SW, Tile 1), and under the Illinois Street bridge (Illinois St. SW, Tile 2). Water quality parameters (e.g., pH and conductivity) were measured at each sample location; samples were collected for oil and grease, total suspended solids (TSS), PAHs, and BTEX. The Noyes Slough samples had detections of oil and grease as well as TSS. These results are presented in Table 11. All other analytical results were below laboratory reporting limits.

Table 11. TSS and Oil & Grease at Storm Outfalls in Noyes Slough

Sample ID	Oil & Grease	TSS	Oil & Grease	TSS
	Aug-06		Apr-07	
Johansen SW	ND	0.053	ND	0.0068
Minnie St. SW	ND	0.072	ND	0.0774
Illinois St. SW	0.0059	0.099	--	--

Notes: 1. Measurements are in micrograms per liter (μg/L).
2. Sample points are labeled on maps with same ID as in table.
3. TSS – total suspended solids.
4. -- denotes not tested for this parameter.

2.5. 2007 Surface-Water Sampling by DEC

On May 22, 2007, DEC representatives collected 13 surface-water samples from Noyes Slough for analysis of VOCs. The sampling locations are identified as “BFNS-XX” on the GIS map. The samples were analyzed by EPA Method 8260B by Analytica International, Inc. No VOCs were detected in the samples, with the exception of toluene reported as an estimated concentration of 0.58 micrograms per liter (μg/L) in sample BFNS-8 collected from the Illinois Street Bridge location.

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3. HISTORICAL RECORDS REVIEW

Historical records reviewed for this study included historical aerial photographs of the area obtained from AeroMetrics, Inc., DEC complaint logs through the DEC Complaints Automated Tracking System, and review of DEC solid waste, hazardous waste, contaminated sites, and leaking underground storage tank files. Information on these reviews is provided in this section. The compiled results are provided in Sections 4 and 5.

3.1. Review of Historical Aerial Photographs

The four historical aerial photographs reviewed for this study are provided in Appendix B and briefly described as follows:

- The historical aerial photograph from 1949 (Figure B1) shows early development in the eastern area of the slough closest to Fort Wainwright, development in the area of the railroad south of the slough, and early construction activities of the Phillips Field Air Strip (see also Tiles 1 and 5). This figure also shows activity in the area from the GVEA south of the Railroad Industrial Area.
- The 1959 historical aerial photograph (Figure B2) shows where several current-day gravel pits begin to appear. Development is evident along most of the slough.
- The 1979 historical aerial photograph (Figure B3) does not show the entire slough but shows continued development along the slough and gravel pits. This figure also shows several areas where the slough is blocked by debris or beaver dams. It also appears to be narrowing in some developed areas, such as the sections west of Kiwanis Park, O'Connor Road and Kathryn Avenue, and O'Connor Road and Antoinette.
- The 1987 historical aerial photograph (Figure B4) provides a view of the continued development of areas around the slough. This aerial photograph shows the most development to date. It also shows the locations of many areas of potential concern or sources of contamination to the slough inferred from documented activities. One area that shows substantial change is in the Aurora Drive area, which is discussed in greater detail in Section 5.4 of this report.

3.2. Review of DEC Complaint Logs

Dumping of waste is likely the most common practice that has affected the slough. Illegal dumping into the slough has been documented for more than 30 years (Figure 1). Examples of the dumping violations from DEC complaint logs and files related to Noyes Slough are presented in Table 12.

Table 12. Sample of Dumping Violations into Noyes Slough from DEC Complaint Logs and Files

Incident	Approximate Date	Location
Dumping of debris from Bentley-Miller salvage yard	June 1, 1974	In and near slough across from Noyes Street and Ina Street (see Figure 1)
Dumping of debris by Aeries Building	June 1, 1991	In slough at Alaska Way
Fred Meyer snow dump pushed into slough	March 24, 1992	In slough behind former Fred Meyer on College Road
Taco Bell snow dump pushed into slough	March 25, 1992	In slough behind Taco Bell on College Road
Denuding banks, dumping debris and concrete waste into slough and onto banks. Beaver, muskrats, and waterfowl which used to frequent area are gone.	June 3, 1992	In and near slough near H&H gravel pit
Concrete, cable, and pipe in slough from H&H gravel pit	July 10, 1992	In slough near H&H gravel pit
Arctic Pumping & Thawing pumped 15,000 gallons of liquid containing sewage into slough	January 26, 1994	In slough at Morgan Way
2 drums labeled 'Part B' found floating in slough; empty	June 3, 1994	In slough behind Gold Rush Estates
4 drums found floating in slough with holes; empty	May 19, 1995	In slough behind Gold Rush Estates #162
H&H Contractors pumped greasy black substance into hole dug alongside slough	June 26, 1996	50 yards east of slough on Goldizen Avenue

Dewatering of gravel pits near the slough has also been documented in connection with citizen complaints as well as in general DEC regulatory information. Dewatering has been shown to lower water-table levels around the slough, drying up wells and potentially affecting water levels in the slough itself. Moreover, dewatering activities can spread contaminated groundwater from industrial areas through the subsurface (DEC File no. 102.38.123) and may have introduced contaminants through direct discharges into Noyes Slough. The effects on the slough of gravel-pit-dewatering activities in June 1991 are shown in Figures 2 and 3. Note the reddish color of the slough after water with a high iron content and turbidity was pumped into it during dewatering of the Bentley-Miller gravel pits. DEC records indicate that dewatering at rates up to 30,000 gallons per minute occurred at the Bentley-Miller and Sealand gravel pits (Index Map and Tile 5, respectively) periodically in the late 1980s and early 1990s. The water was ultimately discharged into Noyes Slough. Dewatering into Noyes Slough also occurred at Walden Pond (Tile 2) and possibly other gravel pits near the slough.

3.3. Review of DEC Files

During a source-water protection study in 2001 by DEC's drinking-water program, an inventory was compiled of past and existing businesses that have the potential to affect public drinking-water sources. The information was provided by Chris Miller of the drinking water program and has not been independently verified. During a more recent review of DEC files for this project, several businesses were added to the inventory identified by the drinking water program. These businesses are identified as potential contamination sources on Tiles 1 through 6.

The present study reduced the DEC inventory to a listing of the businesses located close to the slough or with a high potential to release contaminants that could reach the slough (Table 13). Several of these sites are discussed later in Section 5. Some businesses were considered important because they were identified as having an injection well on site. Although the types of injection wells are unknown, they could potentially have been used to inject hazardous and non-hazardous fluid waste into shallow aquifers. Examples include septic tank systems and dry wells in automotive shops that are used to drain fluids from maintenance bays (EPA, 2006).

Table 13. Inventory of Potential Contamination Sources Near Noyes Slough

Site	Address	Comments
Phillips Field Airstrip	North side of Phillips Field Road, near west end	Historical aircraft-fuel releases probable
Urethane Contractors and Consulting	100 Deere Street	Drums given away in 1992; similar drums found floating in slough in 1994, 1995; drums supposedly empty at time of giveaway, but uncertain (DEC File No. 100.23.079)
USHUD Private Residence	3025 Chinook Street	Record of hazardous waste ('waste petroleum distillate') disposal prior to property sale in 1991 (DEC File No. 102.23.046)
Phillips Field Equipment & Repair	3415 Phillips Field Road	230 feet from Noyes Slough; on EPA Injection Well list
Body Glass & Works	2755 Phillips Field Road	On EPA Injection Well list
European Car Care	2626 Phillips Field Road	On EPA Injection Well list
Screamers & Moaners	2207 Hanson Road	On EPA Injection Well list
Alaska Pacific Transport	1011 Deere Street	On EPA Injection Well list
Doogan's Tiffany Auto Rebuild	1725 Willow Street	On EPA Injection Well list (near USGS sample SED 13; see discussion in text, below)
Port Machine Shop	810 Andrew Street	On EPA Injection Well list
George's Laundromat and Dry Cleaning	701 College Road	Property operated as dry cleaner from 1965-1977 (DEC File No. 102.38.131)
Bentley-Miller Salvage Yard	North of College Road	Former salvage yard; drum cache in 1965 air photo and debris scattered from Old Steese Highway to Illinois Street (DEC File No. 102.15.004)
H&H Contractors	3050 Phillips Field Road	LUST site (1997 release and excavation, DEC File No. 100.26.169); former gravel pit operation and cold asphalt processing plant; several complaints in DEC log related to waste dumping (Table 12)
Triangle Service Station	Illinois Street and College Road intersection	Former service station; some cleanup completed in the 90's but groundwater was not investigated for contamination (DEC File No. 102.38.021)

In addition to these potential sources, files for contaminated sites within ½ mile of the slough were reviewed during this project (Index Map and Tiles 1 through 6). Contaminated sites are properties where the presence of soil or groundwater contamination has been confirmed. These properties are regulated by DEC through the

Contaminated Sites Program. Files for a related regional study and two road-improvement projects, which do not appear on the maps, were also reviewed. Based on the file review, sites where contaminants were likely to reach the slough were identified and are shown as red triangles on the map. The identified contaminated sites are discussed in the next two sections and listed in Table 14.

Table 14. Contaminated Site Program Files Reviewed

Site Name	DEC File Number	Comments
U.S. Travel Systems	102.26.046	Petroleum-contaminated groundwater near slough; associated with a release from a gasoline station
Bentley Mall East Satellite Building	102.38.122	Solvent-contaminated groundwater near slough; associated with a release from a dry-cleaning operation
Bentley Trust Property, Tax Lot 221	100.38.166	Solvent-contaminated groundwater near slough; may be associated with Bentley Mall East Satellite Building
Bentley Trust Property, Tax Lot 201	102.38.123	Solvent-contaminated groundwater near slough; associated with a pipe-coating facility
Letter Shop	102.23.015	Solvent-contaminated groundwater near slough; associated with a printing shop
229 3rd Street	102.38.130	Solvents found in soil near a former dry cleaner approximately 700 feet from the slough; groundwater contamination has not been confirmed but is likely
ADOT/PF Third Street Widening Project	102.38.133	Solvent contamination in soil; led to investigation at 229 3rd Street
FAIR Study	102.38.155	Solvent-contaminated groundwater at various locations near the slough
Office Place	102.26.033	Petroleum contamination near slough; associated with heating oil tank
GVEA Gas Turbine Building	103.23.001	Solvent-contaminated groundwater near slough; source of contamination is unknown
Alaska Gold House	102.38.013	Mercury and arsenic contamination in soil; associated with a gold processing operation
College Road Cleaners	102.23.053	Stoddard solvent-contaminated groundwater near slough; associated with a release from a dry-cleaning operation
ADOT/PF Illinois-Barnette Street Improvement Project	102.38.120	Mercury contamination in soil next to bridge over Noyes Slough; may be associated with Alaska Gold House

Review of past slough-sampling results, aerial photographs, DEC complaint logs, and other DEC files highlighted several areas where evidence suggests the slough may be contaminated. These areas are discussed in the next two sections.

4. AREAS OF GROUNDWATER CONTAMINATION WITH HIGH POTENTIAL TO AFFECT THE SLOUGH

This section highlights locations where on-site activities currently or historically have resulted in groundwater contamination extending to Noyes Slough. These locations are associated with DEC contaminated sites and are depicted on the map (Tiles 1 through 6) as contaminated sites with potential to affect Noyes Slough. An estimated area of groundwater contamination is also shown on the map near each of these sites that demonstrates what is currently known about the extent of the groundwater contamination. The most stringent groundwater cleanup levels (GCLs) and soil cleanup levels (SCLs) currently used in DEC's Contaminated Sites Program are included for reference in each of the data tables below.

4.1. U.S. Travel Systems, DEC Site No. 102.26.046

The Former U.S. Travel Systems site, currently used by Allstate Insurance, was once a Texaco service station. The site is located at the corner of Old Steese and 3rd Street, which is near the slough. It has been a leaking underground storage tank (LUST) site since 1992 and has been a significant source of petroleum-hydrocarbon contamination. An air-sparge and soil vapor extraction (SVE) system operated on-site between 1995 and 2003. Investigations to further characterize the contamination are ongoing, and a new remediation system is scheduled for installation in late 2007.

Groundwater monitoring has been conducted since 1993 (Shannon & Wilson, 2003). Four off-site wells were installed down-gradient of the site and run along the slough (US-MW-7 through 10 on Tile 1). Benzene and GRO have been the main petroleum-related contaminants of concern in these off-site wells: detections have been above the state GCLs for both compounds. Concentrations of petroleum, oil, and lubricants have decreased over time. Recently, GRO has not been detected above the GCL in the off-site wells. Monitoring well US-MW-9 is the only off-site well with benzene concentrations significantly above the GCL. Benzene and GRO concentrations in groundwater in the off-site wells as well as in on-site wells with the highest historical concentrations are presented in Table 15.

Table 15. Benzene and GRO in Groundwater, U.S. Travel Site

	Benzene				GRO			
	Recent		Historical Maximum		Recent		Historical Maximum	
Well ID	Date	Result	Date	Result	Date	Result	Date	Result
US-MW-4	9/6/2006	**1,700**	6/28/1993	**49,000**	9/6/2006	**13,000**	4/6/2006	**19,000**
US-MW-6	9/6/2006	**520**	7/8/1994	**37,000**	9/6/2006	**19,000**	4/6/2006	**32,000**
US-MW-7	9/6/2006	**5.4**	5/9/1995	66	9/6/2006	20	12/1/2000	68.7
US-MW-8	9/6/2006	**3.9**	12/18/1995	**4,000**	9/6/2006	16	12/1/2000	**1,580**
US-MW-9	9/6/2006	**76**	5/28/2002	385	9/6/2006	490	5/28/2002	**1,520**
US-MW-10	9/6/2006	1.0	5/28/2002	4.97	9/6/2006	ND (10)	--	--

Notes: 1. Measurements are in micrograms per liter (µg/L).
2. Sample points are labeled on maps with same ID as in table.
3. Bold type indicates values above GCL of 5.0 µg/L for benzene or 1,300 µg/L for GRO.

To determine if contaminants were present in Noyes Slough near the contaminated-groundwater plume, surface-water samples were collected in July 2001 and August 2002 south of the Minnie Street Bridge. No VOCs were detected in these samples. Attempts to collect samples in the winter at this location found the slough completely frozen. It is of note here that the sample collected by NSAC in June 2000 immediately downstream of the Minnie Street Bridge, NSAC-2, contained low level concentrations of benzene and toluene.

4.2. Bentley Mall East Satellite Building, DEC Site No. 102.38.122

The Bentley Mall East Satellite Building (BMESB) is located at the northern corner of College Road and Old Steese Highway, approximately 700 feet east of the slough. A dry-cleaning business operated there in either the late 1970s or early 1980s and is believed to be the source of contamination. The contaminants of concern are PCE and its degradation products (TCE, cis-1,2 DCE, and trans-1,2 DCE), which are collectively referred to as “solvents” in this report. Because of the location of a private septic line running west from the building, it is believed that solvent was released from this sewer line while the former dry-cleaning business operated.

The BMESB is one of the most significant sources of solvent contamination believed to be affecting the slough. The extent and magnitude of contamination from this site are likely the most well-defined relative to the other sites of concern. Several environmental investigations were conducted between 2002 and 2005 in which solvent contamination was found in soil and groundwater above state cleanup levels. In addition, results of a 2005 surface-water study, in which passive-diffusion bags were placed about 1 foot deep in the bed of the slough to measure solvent concentrations in sediment pore water, showed PCE concentrations were slightly above and below the state cleanup level at locations northwest of the site (see samples identified as “BM-NS-XX” in Tile 1 and data in Table 16, below). The state cleanup levels for groundwater were applied to the pore-water results.

Table 16. Solvent Concentrations, Sediment Pore Water, Noyes Slough, BMESB Site

Sample ID	PCE	TCE
BM-NS-8	1.3	1.0
BM-NS-9	0.95	0.50
BM-NS-11	1.4	0.92
BM-NS-12	0.78	ND
BM-NS-15	1.4	0.77
BM-NS-17	**6.9**	**6.8**
BM-NS-18	**5.5**	4.5
BM-NS-19	0.76	ND
BM-NS-20	4.8	4.0

Notes: 1. Measurements are in micrograms per liter (µg/L).
2. Sample points are labeled on maps with same ID as in table.
3. Bold type indicates values above the GCL of 5.0 µg/L for PCE or TCE.
4. Samples were collected on June 20, 2005.

The groundwater solvent contamination begins along the southwestern edge of the property (along College Road) and extends west (i.e., down-gradient) toward and potentially beneath or across Noyes Slough. The estimated area of groundwater contamination, based on groundwater sample data from 2004, is shown in Tile 1 (DEC, 2005). Note that the BMESB is not necessarily the sole source of this contamination; the source is unknown in certain areas, especially near the down-gradient (northwest) limit. Groundwater data associated with this site and the adjacent site, Bentley Trust Property Tax Lot 221, are presented in Table 17. In addition, a 2002 area-wide groundwater assessment (Shannon & Wilson, 2002) found PCE slightly above the GCL in a well close to the slough (FAIR-MW-4, Tile 1). This sample was collected under the Fairbanks Area-wide Industrial Reclamation (FAIR) study (DEC File No. 102.38.115). The source of the contamination is also unknown, but BMESB is a likely candidate, judging from comparable PCE levels found in groundwater close to FAIR-MW-4 (e.g., BM-MW-7, Tile 1) during BMESB site investigations (ARES, 2005).

Table 17. Solvent Concentrations in Groundwater, BMESB Site

Sample ID	Date	PCE	TCE	Associated Site
BM-MW-2	Sept-Oct 2005	**2,900**	**15**	BMESB
BM-MW-5	Sept-Oct 2005	**210**	**31**	BMESB
BM-MW-6	Sept-Oct 2005	**64**	**5.6**	BMESB
BM-MW-7	Sept-Oct 2005	**7.3**	3.6	BMESB
BM-MW-8	Sept-Oct 2005	1.9	ND	BMESB
BM-MW-9	Sept-Oct 2005	**8.3**	4.3	BMESB
BM-MW-10	Sept-Oct 2005	**80**	**43**	BMESB
BM-MW-11	Sept-Oct 2005	1.8	0.24	BMESB
BM-MW-12	Sept-Oct 2005	**430**	**30**	BMESB
221-SB-2	6/27/2002	**53.2**	ND (1)	BTP Lot 221
221-SB-8	8/21/2002	ND (1)	ND (1)	BTP Lot 221
221-SB-9	8/21/2002	**642**	**19.5**	BTP Lot 221
221-SB-10	8/21/2002	**26.2**	ND (1)	BTP Lot 221
221-SB-11	8/22/2002	**356**	ND (1)	BTP Lot 221
FAIR-MW-4	6/10/2002	**6.0**	**6.2**	FAIR Study

Notes:
1. Measurements are in micrograms per liter (µg/L).
2. Sample points are labeled on maps with same ID as in table.
3. Bold type indicates values above the GCL of 5.0 µg/L for PCE or TCE.
4. 'Associated Site' indicates the site for which the data were collected.
5. BMESB – Bentley Mall East Satellite Building
6. BTP Lot 221 – Bentley Trust Property, Tax Lot 221.
7. ND (x) – Non-detect; value in parentheses indicates laboratory reporting limit.

A remediation system was installed on this property to treat the solvent contamination through air sparging and SVE in 2006. A site remedy was chosen in 2007 when DEC considered the extent of contamination sufficiently characterized. The remedy, which is described fully in DEC's 2007 Record of Decision, includes continued operation of the remediation system until it is no longer effective, monitored natural attenuation, and restrictions on groundwater use.

In addition to the BMESB site, the Bentley Trust Property, Tax Lot 221 (DEC Site No. 100.38.166), has provided data about this area of contaminated groundwater. This site lies between the BMESB and Noyes Slough. Given that the groundwater gradient is to the north-northwest, this site is down-gradient of the BMESB and up-gradient of the slough. A 2002 environmental investigation at Tax Lot 221 found concentrations of PCE in groundwater well above the GCL (AMEC, 2002). The highest solvent concentrations were found along the property boundary closest to the BMESB (221-SB-9 and 221-SB-11), while the lowest concentrations were found at the opposite edge of the property (221-SB-8), thus suggesting the BMESB as a likely source. These analytical results are also included in Table 17.

4.3. Bentley Trust Property, Tax Lot 201, DEC Site No. 102.38.123

The Bentley Trust Property contaminated site is located east of the slough and north of the BMESB (Index Map). The symbol representing the site is located off Tile 2 to the east, but the plume of contaminated groundwater resulting from this site is shown. The lot encompasses a large expanse (154 acres) of land south of the Johansen Expressway, east of College Road and north of Old Steese Highway (see also Figure 4). The site has a long history of industrial land use dating back to the 1940s. Former land users include the U.S. Army (barracks), Great Western Chemical, and Snoopy (auto) Repair Shop (Figure 5). The heaviest activity occurred during the Trans-Alaska Pipeline construction of the 1970s, when the land was used for Alyeska pipe storage and a pipe double-jointing and coating facility (Figure 5). Businesses and storage yards related to pipeline construction were abandoned in the early 1980s, and the site was essentially vacant until 2004 (DEC, 2006). The site has been used commercially by various businesses since then. A 2006 aerial photograph (Figure 6) of the area identifies the current businesses in Tax Lot 201 and also shows the lot to the north containing the Bentley-Miller gravel pits, Tax Lot 203.

The contaminant of concern at this site is TCE. PCE, cis- and trans-1,2-DCE have been detected but generally at concentrations at least one order of magnitude lower than those of TCE. Groundwater contamination extends at least 30 to 40 feet below the water table (DEC, 2006). The double-jointing and coating building was identified as a major source area in 2003, and “undefined releases” are also believed to have occurred in other areas from various leaks, spills, and outdated practices of hazardous-substance disposal and storage (SLR, 2006; DEC, 2006).

Groundwater monitoring wells were installed at the site and have been sampled for solvents since 2001. The highest concentration of TCE was 2,380 µg/L in 2003 in monitoring well 201-MW-24 (Index Map). Off-site monitoring wells were also installed as part of site investigations. Because of the western gradient in this area, the off-site wells were placed around and west of the Johansen Expressway, extending as far west as Antoinette and Margaret Avenues (Index Map and Tile 2). A plume of contaminated groundwater that extends to Antoinette Avenue was delineated in 2005. In addition to down-gradient migration, this plume has migrated north of the site, likely owing to intensive dewatering of the Bentley-Miller gravel pits (Index Map and Figure 6; DEC, 2006).

This area of contaminated groundwater is believed to have intercepted a small reach of Noyes Slough (DEC, 2006). Solvents were detected above state GCLs in several monitoring wells near the slough between 2001 and 2005. Groundwater data from these wells are listed in Table 18. The well locations are shown in Tile 2 and on the Index Map. Monitoring well 201-MW-77 is the most notable in that it is on the bank of the slough and has a sample record of high TCE concentrations. Although Tax Lot 201 may not be the only source of chlorinated-solvent contamination in this area (see item 2 of Section 5.3), it is believed to be the primary source.

Table 18. TCE Concentrations in Groundwater, Tax Lot 201 Site

	Recent		Historical Maximum	
Well ID	**Date**	**Result**	**Date**	**Result**
201-MW-24	10/1/2005	**650**	9/16/2003	**2380**
201-MW-29	Jun-05	**59.3**	10/6/2004	**133**
201-MW-56	9/29/2005	**44**	9/19/2003	**64.6**
201-MW-57	Jun-05	**173**	Jun-05	**173**
201-MW-61	Jun-05	**55.9**	Jun-05	**55.9**
201-MW-63	9/29/2005	**140**	9/19/2003	**231**
201-MW-64	9/29/2005	**6.0**	9/19/2003	**9.6**
201-MW-65	9/27/2005	1.4	Jun-05	1.44
201-MW-77	10/3/2005	**120**	10/6/2004	**152**
201-MW-84	Jun-05	**74.8**	8/20/2002	**180**
201-MW-87	10/3/2005	**45**	Jun-05	**57.2**

Notes: 1. Measurements are in micrograms per liter (µg/L).
2. Sample points are labeled on maps with same ID as in table.
3. Bold type indicates values above the GCL of 5.0 µg/L.
4. Tax Lot 201 – Bentley Trust Property, Tax Lot 201.

A remediation system was installed on this property to treat the solvent contamination through air sparging and SVE and ran from late fall 2002 until September 2005. The system and associated monitoring wells were removed when Wal-Mart acquired the property and began construction. In 2006, Alyeska completed a human health and ecological risk assessment, which compared the maximum chemical concentrations in the contaminated groundwater plume to freshwater ambient water-quality criteria, under the conservative assumption that contaminated groundwater discharges directly into Noyes Slough without any dilution by slough water. No compounds exceeded the ambient water-quality criteria (SLR, 2006). Using this information, DEC agreed in its January 2007 Record of Decision that no further active remediation efforts were required; however, land-use restrictions and groundwater monitoring would continue until concentrations reach drinking-water standards. The current monitoring schedule is semi-annual but may change as concentration trends become evident (DEC, 2006).

5. OTHER AREAS OF CONCERN

The previous section demonstrates that a considerable amount of data identifies areas that could potentially affect Noyes Slough. However, other areas should be further characterized to fully understand how contaminants may affect the slough and what potential risks to human and ecological health and the environment may exist. The areas that have been identified as requiring further characterization include the following: the Minnie Street area, the Illinois Street area, the Lemeta Subdivision area, the Aurora Drive area, the Deere Street area, and the Phillips Field Road area. Each area of concern is shown within blue dashed lines on the Index Map and Tiles 1-6. The most stringent GCLs and SCLs used in DEC's Contaminated Sites Program are included for reference in each of the data tables in the following subsections.

5.1. Minnie Street Area

Solvents and petroleum have been reported in groundwater at various locations in the Minnie Street area (Tile 1). The source of these solvents is not known, nor has the solvent contamination in this area been characterized. The analytical results are described in detail below and presented in Table 19.

1. Letter Shop (DEC Site No. 102.23.015): The Letter Shop, also known as Graphic North, is a printing business that has been in operation since 1981 or earlier (ADOT&PF, 1992). PCE is the main contaminant of concern at this site and is believed to have been derived from on-site waste-disposal activities. Environmental investigations were conducted at this site between 1991 and 2002. In two of the three existing on-site wells (labeled on the map as LS-W-1, LS-GN-1, and LS-GN-2), PCE was detected above the GCL.
2. 229 3rd Street (DEC File No. 102.38.130) and DOT Third Street Widening Project (DEC File No. 102.38.133): During the DOT Third Street Widening Project, PCE was detected in a soil sample collected at 8 to 10 feet below ground surface at this location (Golder, 2005). This property is reported to be the location of a former dry cleaner and potential source of the PCE. The PCE concentration in the soil sample was 1.7 milligrams per kilogram (mg/kg), which exceeds the DEC cleanup level of 0.03 mg/kg (Golder, 2005). A single groundwater sample was collected on Third Street and no solvents were detected; however, this result does not represent contamination levels present at this site, because the well point was located near the up-gradient edge of the property. A later soil-gas survey (TPECI, 2005) confirmed PCE is present and extends into Forty Mile Avenue, but additional groundwater sampling has not yet been conducted.
3. U.S. Travel Systems (DEC File No. 102.26.046): Sampling for chlorinated solvents began in one of the off-site wells (US MW-7) in 1994. PCE concentration was detected at or slightly below the GCL until 2000. The other three wells were not sampled for chlorinated solvents until after 2000; since then, PCE has been detected below the GCL in all four off-site wells. PCE concentrations in groundwater in the off-

site wells are presented in Table 19. Note that PCE has never been detected in the on-site wells that indicated petroleum contamination. Unlike the petroleum contamination, the source of the solvent contamination is unknown. Two potential sources are the Letter Shop and 229 3rd Street, mentioned previously, which are both located generally up-gradient of the wells.

4. FAIR Study (DEC File No. 102.38.155): During the area-wide groundwater investigation conducted under the FAIR study, PCE contamination was also found in a well located about 500 feet down-gradient of the Letter Shop site and close to the slough (FAIR-MW-8 in Tile 1; Shannon & Wilson, 2002). The Letter Shop and 229 3rd Street are considered potential sources of the PCE contamination. Groundwater data associated with this site are presented in Table 19.

Table 19. PCE Concentrations Observed in Groundwater in the Minnie Street Area

		Recent		Historical Maximum	
Well ID	**Site/Study**	**Date**	**Result**	**Date**	**Result**
LS-W-1	Letter Shop	--	--	6/95	**5.4**
LS-GN-1	Letter Shop	--	--	6/95	ND (2.0)
LS-GN-2	Letter Shop	--	--	6/95	**46**
FAIR-MW-8	FAIR	--	--	6/10/2002	**20**
US MW-4	US Travel	4/6/2006	ND (0.5)	--	--
US MW-6	US Travel	4/6/2006	ND (0.5)	--	--
US MW-7	US Travel	4/6/2006	ND (0.5)	12/1/2000	1.68
US MW-8	US Travel	4/6/2006	ND (0.5)	8/31/1995	**5.5**
US MW-9	US Travel	4/6/2006	3	4/6/2006	3
US MW-10	US Travel	4/6/2006	ND (0.5)	5/28/2002	1.37

Notes: 1. Measurements are in micrograms per liter (μg/L).
2. Sample points are labeled on maps with same ID as in table.
3. Bold type indicates values above the GCL of 5.0 μg/L.
4. ND (x) – Non-detect; value in parentheses indicates laboratory reporting limit.

5. Petroleum contamination may also be affecting the slough from the site known as the Office Place (DEC File No. 102.26.033). This is the location of a closed LUST site at the northwest corner of the slough and Minnie Street intersection. The tank and associated contamination was excavated; analytical laboratory sample results confirmed that all contaminated soil had been removed. A single monitoring well was sampled and low levels of petroleum hydrocarbons were detected. The well appears to be located up-gradient of the former LUST; the LUST location is between the slough and the well. The groundwater may interact with the slough, considering its proximity (about 80 feet). Therefore, samples from this up-gradient well may not be a good indicator of impact to the slough.

5.2. Illinois Street Area

Solvent contamination in the groundwater associated with the Bentley Trust, Tax Lot 201 and Bentley Mall East Satelite Building sites is known to extend into the Illinois Street Area (Tiles 1 and 2). However, solvents have also been observed in the groundwater in this area whose source is not yet understood. These observations are described below and analytical results are presented in Table 20. Metals from gold-mining activities are also possible contaminants of concern in this area.

1. GVEA Gas Turbine Building (DEC Site No. 103.23.001): Groundwater monitoring at this site has occurred on a quarterly-to-annual basis since 1993. PCE and TCE were first detected in August 1993 in the on-site wells. PCE is the main contaminant of concern and has been repeatedly detected in several of the wells. Although the prevailing groundwater gradient in the area is west-northwest, the groundwater near the eastern border of this site (e.g., near wells AR-58 and AR-59) has potential to interact with the slough during seasonal changes in gradient (Lilly and others, 1996). No source of solvent contamination has been confirmed at this site. The BMESB and Tax Lot 201 contaminated sites are considered potential sources of this groundwater contamination, but other sources may exist. Solvent data for groundwater samples collected from monitoring wells on the GVEA property are presented in Table 20 (TPECI, 2006).
2. FAIR Study (DEC File No. 102.38.155): Several monitoring wells (FAIR-1, FAIR-2, and AR-110) were sampled in this area during the 2002 FAIR investigation (Table 20, AMEC, 2002). Solvents were detected at low levels in these wells suggesting that there have been solvent spills in the vicinity. The size and significance of these spills is not known. The higher concentrations of PCE degradation products (TCE and cis-1,2-DCE) in FAIR-1 may indicate that this area is the down-gradient end of a larger solvent plume, possibly the BMESB plume discussed previously. FAIR-2 is located on the property previously occupied by the Bentley-Miller Salvage Yard, that is a possible source for contamination in this area.
3. Bentley-Miller Salvage Yard (102.15.004): The salvage yard is a potential source of contamination because of documented complaints to the DEC as noted in Table 12 and illustrated in Figure 1. The salvage yard existed in 1959, as shown in Figure 4. An apparent drum stockpile is evident in an aerial photograph taken in 1965 (Figure 7). No available information links this site to contamination identified in past investigations of the slough.
4. Triangle Service Station (DEC File No. 102.38.021): This site, located at the Illinois-College Road intersection (Figure 8), is not in DEC's contaminated sites database; however, soil contamination was revealed during a DOT road construction project in 1991. Low levels of PCE, 1,2-DCA, 1,1,1-trichloroethane, and petroleum hydrocarbons were detected in soil samples taken from the excavation walls, indicating that contaminated soil may remain in the area. No groundwater samples were collected.
5. Alaska Gold House site (DEC File No. 102.38.013): Metals are also a possible contaminant of concern in the Illinois Street area because of former activities. This site is located slightly southwest of the GVEA Gas Turbine Building. The Alaska Gold House was a mining operation that operated between the 1920s and 1960s. Mine tailings containing high mercury and arsenic concentrations were stockpiled on-site. Dust from these piles may have blown into the slough. Sediments from this area of

the slough have been sampled on two separate occasions; mercury and arsenic levels were not above typical background levels (NSAC, 2000; Kennedy and others, 2004). However, during a 2004 DOT study (DEC File No. 102.38.120), mercury was detected at 74.1 mg/kg (above the SCL of 1.4 mg/kg) in near-surface soil at the northwest corner of the Illinois Street Bridge (Golder, 2004).

Table 20. Selected Solvent Concentrations in Groundwater in the Illinois Street Area

		Historical Maximums				
Well ID	**Site**	**PCE**	**TCE**	**cis-1,2-DCE**	**Chloroethane**	**1,2-DCA**
AR-56	GVEA	**16** (11/18/1993)	1 (8/15/1995)	ND	1.4 (11/18/1993)	ND
AR-57	GVEA	**7.1** (2/3/1994)	1.31 (8/14/2006)	ND	2.0 (2/3/1994)	ND
AR-58	GVEA	4.1 (5/16/1995)	**11** (5/16/1995)	1.7 (11/18/1993)	ND	**5.4** (11/21/1995)
AR-59	GVEA	**28** (10/23/1997)	ND	3.26 (10/29/1999)	4.0 (2/3/1994)	1.1 (5/16/1995)
FAIR-1	FAIR	1.2 (6/5/2002)	4.9 (6/5/2002)	13 (6/5/2002)	ND	ND
FAIR-2	FAIR	ND	ND	ND	ND	1.1 (6/5/2002)
AR-110	FAIR	ND	ND	ND	ND	1.1 (6/5/2002)

Notes:
1. Measurements are in micrograms per liter (µg/L).
2. Sample points are labeled on maps with same ID as in table.
3. Bold type indicates values above GCLs of 5.0 µg/L for PCE, TCE, and 1,2-DCA, and 70 µg/L for cis-1,2-DCE. Chloroethane is not currently regulated.
4. ND denotes compound not detected.
5. Trichlorofluoromethane was also detected frequently. Other VOCs were detected that are not listed here.

5.3. Lemeta Subdivision Area

Solvent contamination documented in the slough and the groundwater in the Lemeta Subdivision area (Tile 2) may be associated with the Bentley Trust, Tax Lot 201 site discussed earlier. However, other locations may contribute to the contamination.

1. College Road Cleaners, (DEC Site No. 102.23.053): A dry-cleaning business known as College Cleaners operated at this site between 1955 and 1997. U-Haul acquired the property in 2000, at which point the College Cleaners building was demolished and a U-Haul storage facility was built on the site. Leading up to the property redevelopment by U-Haul (1999-2000), a series of environmental investigations revealed that soil and groundwater hydrocarbon contamination existed within a 60-foot radius of the College Cleaners building. The source was believed to be a perforated 55-gallon drum located under the basement. The drum was used as a sump during the operation of College Cleaners. The drum and approximately 600 cubic yards of soil were excavated in 2000; a relatively small amount of contaminated soil could not be removed. The contaminants of concern were DRO, GRO, and Stoddard solvent. In 2004 four monitoring wells were installed toward the property boundaries (i.e., outside of the estimated 60-foot zone of contamination in the center of the property). None of the hydrocarbon contaminants of concern were detected in these wells during sampling events in 2004 and 2006, indicating no sign of a plume migration away from the former building.

Although samples have been analyzed for Stoddard solvent, they have not been tested for chlorinated solvents. This is because it was believed that only Stoddard solvent was used during the dry-cleaning operation, and Stoddard solvent is a mineral spirit-based compound. However, PCE and TCE were detected in Noyes Slough surface water samples that were collected directly behind the College Cleaner's building in three separate sampling events: in November 1993, February 1994, and June 2000 (Superior Precision Analytical, 1993 and 1994; AGRA, 2000). These PCE and TCE concentrations were above the state allowable limits for groundwater in November 1993 and 1994 and were slightly below the GCLs in 2000.

2. George's Laundromat and Dry Cleaning, (DEC File No. 102.38.131): This site, currently operated by Geraldo's Restaurant, was a dry cleaning operation between 1965 and 1977 (possibly longer). During off-site investigations being conducted for Tax Lot 201, the site was identified as a potential groundwater PCE source, because an elevated level of PCE was detected down-gradient of the site (Bauer, 2005). An alternative explanation for the high down-gradient concentration is that a preferential flow path was created by a sewer line running on the south side of College Road (Bauer, 2005), but this theory is uncertain. Further groundwater sampling would be required to determine a source.

5.4. Aurora Drive Area

The results of past sampling events and historical uses in the area of the slough near the Aurora Drive Bridge (Tiles 3 and 4) indicate additional investigation is warranted. An automobile repair shop, Doogan's Tiffany Auto Rebuild, was included on the EPA's list of businesses with injection wells found during the source-water protection study of 2001. This property is shown in Figure 9 as it existed in 1987. This is a potential source of contamination found in slough sediment samples collected downstream from the shop (See SED13 and SED14 sample results, Appendix C). In addition to the automobile repair business, a long-term resident provided anecdotal information to the USGS involving a small engine and firearms shop that was historically active on a property near Aurora Drive that routinely dumped waste into the slough through a sump drain located inside the shop building (Ben Kennedy, personal communication, 2007).

Sample SED13, collected downstream from the former location of Doogan's Tiffany Auto Rebuild (Tile 3) and just upstream from the Aurora Drive Bridge, had elevated levels of heavy metals (particularly lead and zinc) and also contained the following SVOCs: dimethylphthalate and other phthalates (plasticizers); alkyl homologs of naphthalene (biological toxins); 4H-cyclopenta(d,e,f)phenanthrene (coal tar product); n-nitrosodiphenylamine (man-made chemical, not produced in the United States after 1980, used in rubber as a retarder to prevent premature vulcanization of rubber compounds during mixing and other processing operations); 9,10-anthraquinone (a bird repellent used at some airports to keep geese out); carbozole (coal tar and crude oil product); thiophene (tar component); p-cresol (wood treatment); hexachlorobenzene (a pesticide until 1965, used in fireworks and ammunition, and used to manufacture synthetic rubber [Kennedy and others, 2004]); and various other SVOCs.

Sample SED14, collected downstream from the Aurora Drive bridge, also showed elevated levels of lead. A water sample, NSAC-7, collected by the NSAC at the Aurora Drive bridge in 2002, had PCE and TCE concentrations of 3.78 and 5.17 µg/L, respectively.

5.5. Deere Street Area

Deere Street runs north-south in an industrial area located southwest of the Aurora Subdivision (Tile 5, Figure 10). Several different potential sources for contamination were identified in this area. Although only limited data exist, mostly resulting from the USGS sediment sampling effort (Kennedy and others, 2004), DEC complaint logs and review of files involving injection wells and other industrial business practices have led to concerns about this area. Urethane Contractors and Consulting is one such business located on Deere Street. It is considered a potential source of empty drums that were found in the slough because of the drum labeling and the fact that the business held a drum giveaway prior to drums being found in the slough (Table 13). Alaska Pacific Transport and Screamers & Moaners are two other businesses of concern along Deere Street because injection wells reportedly were or are located on their properties. Dewatering of the Sealand gravel pit, located west of Deere Street, reportedly may have spread contamination (DEC File no. 100.48.001). In addition, a complaint filed with the DEC in 1994 reported that Arctic Pumping and Thawing discharged 15,000 gallons of liquid containing sewage into the slough near Morgan Way (Figure 10).

Sediment sampling results from the 2001-2002 USGS study (Appendix C) provide the only evidence of contamination in the slough near Deere Street (samples SED18, SED19, and SED20). All three samples contained concentrations of metals that were above one or more of the screening levels presented in Section 6. Sediment sample SED18 contained zinc at a concentration above the ecological toxic-effects level. Sediment sample SED19 contained thallium at a concentration above both the human-health and ecological bioaccumulation-effects screening levels. Lead was detected in sediment sample SED20 at a concentration of 1,490 mg/kg. This was the highest concentration of lead found in the USGS study and was above all applicable cleanup and screening levels.

5.6. Phillips Field Road Area

Phillips Field Road, which runs east-west between downtown and the University of Alaska Fairbanks, is another area heavy with industrial activity. The western end of the road is about 200 feet from the slough and slightly southwest of the Deere Street area (Tile 6, Figure 11). Just north of this western side of the road is the former location of the Phillips Field Airstrip. The runway and associated aircraft hangars have not been investigated but are considered potential sources of inputs to the slough. In addition, current and former business operations along Phillips Field Road are potential contamination sources, such as Phillips Field Equipment and Repair, which had an injection well on-site. H&H Contractors is another example: several complaints filed with DEC in the 1990s were related to the dumping of debris and concrete waste into the slough (Table 12). One complaint was that H&H Contractors pumped a greasy black substance into a hole dug alongside the slough and then backfilled the hole; this reportedly occurred at the east end of Goldizen Avenue. The business also dewatered a gravel pit close to the slough in the 1990s.

Surface-water samples have been collected in four locations in this area and downstream, but no contaminants of concern were detected. As with the Deere Street industrial area, the USGS sediment sampling data (Appendix C) provides the only evidence of contamination in the slough. Samples SED21 through SED23 were collected in this area; SED23 was collected near the location where H&H Contractors reportedly pumped waste into a hole. Sample results from SED21 included a zinc concentration reported above the ecological bioaccumulation and toxic-effects screening levels, a few PAH concentrations that were slightly above the ecological toxic-effects screening levels, and DDD and DDE concentrations slightly above the ecological bioaccumulation-effects levels. Sediment sample SED23 contained DDT, DDD, and DDE at concentrations above the ecological toxic-effects screening levels; the DDD and DDT concentrations were also above the ecological bioaccumulation-effects levels. Several PAHs were detected in SED23 at concentrations above the ecological toxic-effects screening levels.

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6. CONCEPTUAL EXPOSURE PATHWAYS

A conceptual exposure model describes how contaminants are expected to affect people and biota at a specific site. Typically, a conceptual exposure model consists of four primary components:

1. Sources of contamination.
2. Transport pathways for contaminants to the slough and within the slough.
3. Receptors exposed to contamination.
4. Routes by which receptors take up contaminants.

The following sections, complemented by Figure 12, describe a conceptual exposure model for contaminants that are known or expected to be present in Noyes Slough. This model should be updated when new information is available.

6.1. Sources and Transport Routes

On the basis of the information presented in this report, the following are considered the primary sources contributing contamination to the slough:

6.1.1. Contaminated Groundwater

Dissolved contaminants in groundwater are present in the slough at several locations along the east end. It is possible that other areas of groundwater contamination are present that have not yet been identified (e.g., near injection wells). Chlorinated solvents, such as PCE and TCE, are the primary concern because these contaminants can persist and travel for long distances in groundwater. However, petroleum may also enter the slough from contaminated groundwater associated with gasoline stations and fuel-storage facilities.

Once discharged into running water, solvents and petroleum are likely to be diluted, degraded, or may volatilize and disappear from the water column. Observation of these compounds in the water column would indicate that an ongoing source is continuously discharging contaminants into the slough. Because less volatilization and dilution will occur in the sediments beneath the slough, sampling sediment pore water is a better strategy than collecting surface-water samples for detecting dissolved contaminants that may be entering the slough through groundwater.

6.1.2. Storm-Drain Discharge and Localized Runoff

Runoff into the slough may be localized or channelized through the city stormwater system. Runoff is likely to transport particulates into the slough, such as contaminated soil or dust particles. Persistent contaminants, including heavy metals, pesticides, and herbicides, can be carried into the slough through runoff and may be sequestered in the slough sediments. The distribution of contaminated sediments in the slough will depend on where the contaminants were deposited, what kind of sediment deposition has occurred since the contaminated material was deposited, and whether any material has been removed by flushing events or dredging.

Contaminated runoff around Noyes Slough may contain petroleum and metals from spills and air pollution deposition as well as pesticides and herbicides from home and yard maintenance. DDT was also widely used in aerial spraying for mosquito control in the COF until the 1970s.

6.1.3. Direct Dumping

Direct dumping of wastes containing hazardous materials into the slough may have contributed to contamination of the surface water or sediments. Anecdotal evidence indicates that the slough has long been used as a dumping ground for solid waste and wastewater. Examples of hazardous materials that are known to have been dumped in the slough include transformers, batteries, and septic wastewater.

6.2. Human Health Exposure Pathways

The people most likely to be exposed to slough water or sediments are those using the slough for recreation. Boating, occasional fishing, and wading are possible along the slough today; these activities would probably increase if the slough were dredged to accommodate a canoe trail. Volunteers, including school children, participate in slough cleanup days and slough-related natural science projects. People using the slough may be exposed to contaminants by accidentally ingesting slough water, skin contact with slough water, and skin contact with slough sediments. If people consume fish from the slough, or if dredging returned more edible fish to the slough, consuming contaminated fish could be another human exposure route.

6.3. Ecological Exposure Pathways

Plants and animals may be exposed to contamination through contact with or ingestion of the slough water, sediments, or through food sources living in the slough (such as invertebrates). Concern increases for aquatic organisms and for organisms that are trophically elevated and may accumulate certain contaminants in their tissues. Fish and bird species observed in the slough have been recorded by the USGS (Kennedy and others, 2004) and the Alaska Bird Observatory (Benson, 2000), respectively. Fish species observed in Noyes Slough are listed below:

- Arctic grayling*
- Arctic lamprey
- Humpback whitefish*
- Longnose sucker
- Northern pike*
- Slimy sculpin
- Unknown whitefish*
- Burbot*

- Alaska blackfish
- Lake chub

*Possible human consumption

Bird species identified as using Noyes Slough are presented in Table 21.

Table 21: Bird Species Identified as Using Noyes Slough, May 2000

Common Name	Genus/Species	Status	Habitat
Green-winged Teal	Anas crecca	PB	slough
Mallard	Anas platyrhynchos	B	slough
Northern Pintail	Anas acuta	PB	slough
Northern Shoveler	Anas clypeata	U	slough
American Wigeon	Anas americana	PB	slough
Sandhill Crane	Grus canadensis	U	unknown
Semipalmated Plover	Charadrius semipalmatus	M	slough
Lesser Yellowlegs	Tringa flavipes	PB	slough
Solitary Sandpiper	Tringa solitaria	M	slough
Semipalmated Sandpiper	Calidris pusilla	M	slough
Least Sandpiper	Calidris minutilla	M	slough
Pectorial Sandpiper	Calidris melanotos	M	slough
Long-billed Dowitcher	Limnodromus scolopaceus	M	slough
Common Snipe	Gallinago gallinago	PB	slough
Mew Gull	Larus canus	U	unknown
Belted Kingfisher	Ceryle alcyon	B	slough
Northern Flicker	Colaptes auratus	U	forest
Alder Flycatcher	Empidonax alnorum	PB	shrub
Hammond's Flycatcher	Empidonax hammondii	PB	forest
American Tree Swallow	Tachycineta bicolor	PB	unknown
Violet-green Swallow	Tachycineta thalassina	U	unknown
Gray Jay	Perisoreus canadensis	U	unknown
Common Raven	Corvus corax	U	unknown
Black-capped Chickadee	Poecile atricapillus	PB	shrub
Boreal Chickadee	Poecile hudsonicus	PB	forest
Ruby-crowned Kinglet	Regulus calendula	B	forest
Gray-cheeked Thrush	Catharus minimus	U	shrub
Swainson's Thrush	Catharus ustulatus	PB	forest
American Robin	Turdus migratorius	U	cultivated
Bohemian Waxwing	Bombycilla garrulus	PB	forest
Orange-crowned Warbler	Vermivora celata	U	shrub
Yellow Warbler	Dendroica petechia	U	shrub
Yellow-rumped Warbler	Dendroica coronata	PB	forest
Townsend's Warbler	Dendroica towsendi	U	forest
Northern Waterthrush	Seiurus noveboracensis	U	shrub
Wilson's Warbler	Wilsonia pusilla	U	shrub
Savannah Sparrow	Passerculus sandwichensis	U	shrub
Fox Sparrow	Passer iliaca	PB	shrub
Lincoln's Sparrow	Melospiza lincolnii	PB	shrub
White-crowned Sparrow	Zonotrichia leucophrys	PB	shrub
Dark-eyed Junco	Junco hyemalis	PB	forest
White-winged Crossbill	Carduelis flammea	U	forest
Redpoll sp.	Carduelis sp.	U	unknown

Notes: B = Breeder
PB = Probably breeder
M = Migrant
U = Unknown

Terrestrial mammals such as moose and hares may be exposed to contaminated water or vegetation, but because they are not limited either to aquatic habitats in general or Noyes Slough in particular, the level of concern for their exposure is relatively low. Aquatic mammals such as beaver (see photograph of dam, May 2007, in Figure 13) and muskrat live in the slough year-round and may be exposed to contamination through contact with water and sediments, drinking the water, or through their food, which includes aquatic vegetation and occasional invertebrates or fish.

Aquatic birds may nest or feed in the slough. Birds can be exposed through contact with water and sediments, by drinking the water, and through their food, including invertebrates and small fish. Exposure to some contaminants, such as DDT, may have the greatest effects on avian embryos, so birds that nest in the slough (such as goldeneyes) are of greater concern than those that do not. Intense usage, such as shorebird staging before migration, can also expose birds to harmful levels of contaminants. During staging birds eat a large amount of food from the same area in a short amount of time then rapidly utilize the food during migratory journeys to the next staging area (Angela Matz, personal communication, 2007).

Fish can be a sensitive indicator of ecological mobilization of contaminants from the slough. Exposure through contact with water and sediments and through the food chain (invertebrates and smaller fish) are expected for resident fish, such as Alaska blackfish, and for any anadromous (e.g., king salmon were previously documented in Noyes Slough) or otherwise migratory fish (e.g., pike, which make seasonal migrations among freshwater areas) that may use the slough (Nancy Ihlenfeldt, personal communication, 2007). As with birds, concern is elevated for fish spawning in the slough, since many contaminants have the greatest impacts on young.

The Noyes Slough invertebrate community is an important indicator of the current health of the slough and forms the base of a food web that supports waterfowl, shorebirds, and fish. Ingestion or contact with contaminated water and sediments can include direct toxicity to individuals or changes in species abundance and diversity, which can then indirectly impact fish and wildlife higher on the food chain.

Aquatic and riparian plants can contact contaminated water and sediments, with potential effects including dieback and subsequent alteration of plant communities. Physical processes, such as erosion and ice action, can also affect plants and are probably of greater importance in the Noyes Slough ecosystem (although this has not been tested).

Should the slough be dredged, mobilization of sediments could increase ecological exposures (Figure 12), including downstream from Noyes Slough in the Chena River, unless mobilization of contaminants of concern was prevented. Such a dredge-induced increase in contaminant mobilization could be a temporary effect. However, the associated redistribution of persistent compounds could have a deleterious effect downstream.

6.4. Screening Levels for Comparison to Noyes Slough Data

During past studies, a variety of risk-based criteria have been compared to Noyes Slough samples. These criteria can vary greatly and are often revised as understanding of the risk associated with different chemical exposures improves. This section provides a single set of updated screening levels to use when evaluating surface-water and sediment samples in future efforts. Screening levels differ from cleanup levels in that screening levels are set at lower concentrations to identify contaminants of concern during the initial phase of an investigation. These are the chemicals that should be retained in the sampling program until the site is adequately characterized. Once investigative efforts have characterized the magnitude and the extent of the contamination, a cleanup level is established based on current or potential exposure at the site and the applicable regulations to determine if the chemicals pose a risk and remedial action is necessary. Please note that in an effort to be as updated as possible with the current standards for evaluating human health and ecological risk, many of these levels are drafts or in review. Coordination with DEC to determine if the appropriate screening levels are being used should be continued during future efforts to manage Noyes Slough.

Surface-water screening levels proposed for Noyes Slough are described below and shown in Table 22.

- Human Health Criteria – These criteria are based on one tenth of the DEC proposed groundwater cleanup levels, in accordance with Alaska drinking water regulations (18 AAC 80). Because this level is protective of drinking water and people are unlikely to use Noyes Slough water as a daily source of drinking water, these levels are very conservative. One tenth of the cleanup level is required by DEC guidance for determining chemicals of concern during site investigation.
- Ecological Criteria – These criteria are based on surface-water screening levels provided in DEC's Ecoscoping Guidance (2007). These levels were compiled for DEC in 2001, updated in 2007, and are based on the minimum effect-based levels provided through resources such as: Oregon Department of Environmental Quality, Oak Ridge National Laboratory, U.S. Environmental Protection Agency, Canadian Council of Ministers of the Environment, and NOAA.

Table 22: Surface-Water Screening Levels for Contaminants Detected in Noyes Slough

Chemical	Human Health Screening Level	Ecological Screening Level	Maximum Detected in Slough	Location and Date of Maximum
Petroleum and PAHs				
Benzene	0.0005	0.021	0.00046	NSAC-2, 2000
Toluene	0.1	0.002	0.00092	NSAC-2, 2000
Other VOCs and SVOCs				
1,2-Dichloroethane	0.0005	0.1	**0.0012**	SL-2, 1994
Tetrachloroethylene	0.0005	0.084	**0.078**	SL-1, 1993
Trichloroethylene	0.0005	0.047	**0.015**	SL-1, 1993
cis-1,2-Dichloroethylene	0.007	0.59	0.0022	SL-2, 1994
Chloroethane (Ethyl Chloride)	0.029	--	0.0025	SL-2, 1994
Trichlorofluoromethane	1.1	--	0.0013	SL-4, 1994
Metals				
Arsenic	0.001	0.0081[1]	**0.004**	NSAC-7, 2002
Chromium	0.01	0.000266[2]	**0.0031**	NSAC-6, 2002
Copper	0.1	0.000205	**0.0185**	NSAC-6, 2002
Zinc	0.5	0.021	**0.51**	NSAC-7, 2002

Notes: Measurements are in milligrams per liter (mg/L).
Bold type indicates a chemical was detected above a screening level. The screening level exceeded is also listed in bold type.
-- denotes screening level was not available in the resources consulted.
[1] Level set for Arsenic I.
[2] Level set for Chromium VI. The level for Chromium III is 0.00844 mg/L.

Sediment screening levels proposed for Noyes Slough are described below and shown in Table 23.

- Human Health Criteria – These criteria are one tenth of the DEC proposed direct contact cleanup levels, in accordance with the DEC Risk Assessment Procedures Manual (2005). This level is protective for people that incidentally ingest soil and absorb contaminants through skin contact with contaminated soil and sediment. One tenth of the cleanup level is required by DEC guidance for determining chemicals of concern during site investigation.
- Ecological Criteria for Toxic Effects – These criteria are based on sediment screening levels provided in DEC's Ecoscoping Guidance (2007). These levels were compiled for DEC in 2001, updated in 2007, and are based on the minimum effect-based levels provided through resources such as: Oregon Department of Environmental Quality; Canadian Council of Ministers of the Environment; NOAA; and Wisconsin Department of Natural Resources.
- Ecological Criteria for Bioaccumulation – These criteria are intended to screen for effects in fish and birds from the uptake and concentration of bioaccumulative contaminants through the food chain (ODEQ, 2001).

In addition to the risk-based screening levels, the levels at which DEC will classify dredged sediment as polluted are also included in Table 23 under the "Alaska Disposal Criterion" column. Soil containing contaminants above the disposal criteria may be subject to regulations in 18 AAC 75 (Alaska Contaminated Site Regulations) and 18 AAC 60 (Alaska Solid Waste Regulations). Please note that in an effort to be as updated as possible with the current standards for evaluating human health and ecological risk, many of these levels are drafts or in review. Coordination with DEC to determine if the appropriate screening levels are being used should be continued during future efforts to manage Noyes Slough.

Table 23: Sediment screening levels for contaminants detected in Noyes Slough

Chemical	Alaska Disposal Criterion	Human Health Screening Level	Ecological Screening Level		Maximum Detected in Slough	Location and Date of Maximum
			Toxic effects	Bio-accumulation		
Petroleum and PAHs						
Acenaphthene	180	280	**0.0067**	--	**0.085**	SED23, 2002
Acenaphthylene	180	280	**0.00587**	--	**0.031**	SED13, 2002
Anthracene	3,000	2,060	**0.01**	--	**0.054**	SED13, 2002
Benzo(a)anthracene	3.6	0.49	**0.0157**	B	**0.094**	SED13, 2002
Benzo(a)pyrene	0.4	**0.049**	**0.0319**	**0.1**	**0.12**	SED13, 2002
Benzo(b)fluoranthene	4	0.49	**0.0272**	B	**0.2**	SED13, 2002
Benzo(k)fluoranthene	40	4.9	**0.0272**	B	**0.089**	SED13, 2002
2,3-Benzofluorene	--	--	--	--	0.00306	Aurora, 2000
Benzo(g,h,i)perylene	1,100	140	0.17	--	0.11	SED13, 2002
Chrysene	360	49	**0.0268**	B	**0.23**	SED13, 2002
Coronene	--	--	--	--	0.0158	Aurora, 2000
Dibenzo(a,h)anthracene	0.40	**0.049**	**0.01**	B	**0.1**	SED13, 2002
Fluoranthene	1,400	190	**0.0315**	B	**0.33**	SED13, 2002
Fluorene	220	230	**0.01**	--	**0.069**	SED23, 2002
Indeno(1,2,3-c,d)pyrene	4	0.49	**0.0173**	B	**0.0258**	Aurora, 2000
Naphthalene	20	140	**0.0346**	--	**0.06**	SED23, 2002
1-Methyl Naphthalene	6.2	280	--	--	**0.00127**	Aurora, 2000
2-Methyl Naphthalene	6.1	280	**0.0202**	--	**0.00255**	Aurora, 2000
Phenanthrene	3,000	2,060	**0.0187**	--	**0.2**	SED23, 2002
Pyrene	1,000	140	**0.0443**	B	**0.3**	SED13, 2002
Other VOCs and SVOCs[1]						
9,10-Anthraquinone	--	--	--	--	0.11	SED13, 2002
Biphenyl	--	--	--	--	0.00063	NSAC-3s, 2000
Bis(2-ethylhexyl)phthalate	13	22	**0.75**	**0.33**	**2.6**	SED13, 2002
Butylbenzylphthalate	920	290	--	--	0.17	SED13, 2002
Carbazole	6.5	29	0.14	--	0.039	SED13, 2002
p-Cresol (4-Methylphenol)	1.5	35	--	--	0.2	SED13, 2002
4H-Cyclopenta(*def*) phenanthrene	--	--	--	--	0.036	SED13, 2002
Dibenzothiophene	--	--	--	--	0.0131	Aurora, 2000
Dibutylphthalate	80	790	0.11	**0.06**	**0.079**	SED13, 2002
Dimethylphthalate	--	--	0.53	--	0.01	SED13, 2002
1,2-Dichlorobenzene (o-Dichlorobenzene)	5.1	910	0.023	--	0.013	SED09, 2002
1,4-Dichlorobenzene (p-Dichlorobenzene)	0.64	35	0.031	--	0.019	SED09, 2002
1,3-Dichlorobenzene (m-Dichlorobenzene)	28	910	--	--	0.023	SED09, 2002
Diethylphthalate	--	--	0.61	8,300	0.029	SED13, 2002
Dioctylphthalate	3,800	310	0.58	--	0.530	SED13, 2002
n-Nitrosodiphenylamine	15	750	--	--	0.045	SED13, 2002
Phenol	68	2,320	**0.048**	--	**0.11**	SED13, 2002
Thiophene	--	--	--	--	0.041	SED13, 2002
Pesticides and PCBs						
Aldrin	0.07	0.03	0.002	0.04	0.00007	NSAC-3s, 2000
Alpha-Chlordane(Cis)	--	--	--	--	0.000028	NSAC-3s, 2000
DDT	7.3	2.1	**0.00119**	**0.000300**	**0.00666**	NSAC-1s, 2000
DDD	7.2	3.0	**0.00354**	**0.000300**	**0.0146**	SED23, 2002
DDE	5.1	2.1	0.00142	**0.000300**	**0.00091**	SED23, 2002
Heptachlor	0.28	0.13	0.01	0.024	0.000012	NSAC-1s, 2000
Heptachlor Epoxide	0.014	0.063	0.0006	B	0.000032	NSAC-1s, 2000
Hexachlorobenzene	0.047	0.32	0.100	B	0.046	SED13, 2002
Lindane	0.0095	0.56	0.100[2]	1.16	0.000018	NSAC-1s, 2000
Mirex	2.7	0.27[3]	0.00700	--	0.00002	NSAC-3s, 2000
PCBs	0.3	0.1	**0.026**	**0.00200**[4]	**0.027**	SED13, 2002
Trans-Nonachlor	--	--	--	--	0.000017	NSAC-3s, 2000

Table 23 (Continued): Sediment screening levels for contaminants detected in Noyes Slough

Metals						
Antimony	3.6	4.1	2.0	10	1.4	SED03, 2002
Arsenic (background[5])	**3.7**	**0.45**	**5.9**	**4.00**[6]	**43.6**	NSAC-3s, 2000
Barium	1,100	2,030	--	--	299	SED13, 2002
Beryllium	42	20	--	122	0.41	SED21, 2002
Cadmium	5	7.9	**0.583**	**0.003**	**1.96**	NSAC-3s, 2000
Chromium	**25**	**30**	**36.3**	4,200	**36.7**	SED12, 2002
Cobalt	--	--	--	--	16.2	SED12, 2002
Copper	460	410	**28**	**10**	**83.4**	NSAC-3s, 2000
Lead	**400**	**40**	**35**	**128**	**1,490**	SED20, 2002
Manganese	--	--	460	--	459	SED12, 2002
Mercury (total)	1.4	3	0.17	B	0.08	SED19, 2002
Methyl Mercury	0.012	0.77	--	B	0.00071	NSAC-3s, 2000
Molybdenum	--	--	--	--	1.1	SED17, 2002
Nickel	**86**	200	**18**	316	**91**	NSAC-3s, 2000
Selenium	**3.4**	51	--	**0.1**	**4.9**	SED10, 2002
Silver	11.2	51	1.6	B	0.69	SED20, 2002
Thallium	1.9	**0.81**	--	**0.7**	**1.2**	SED10/19, 2002
Vanadium	580	**71**	--	--	**284**	NSAC-3s, 2000
Zinc	4,100	3,040	**98**	**3**	**562**	SED13, 2002

Notes: Measurements are in milligrams per kilogram (mg/kg).
Bold indicates a chemical was detected above screening levels or the disposal criteria. The screening level or disposal criteria is also listed in bold type when it was exceeded.
-- denotes screening level was not available in the resources consulted.
B indicates that the compound is identified by the DEC as a bioaccumulative compound but a bioaccumulative screening level is not available. Other sampling approaches may be needed for these compounds, such as tissue sampling or food web modeling.
[1]Alkylated homologs of SVOCs are not included in this table unless an applicable screening level is available.
[2] Level set for total hexachlorocyclohexanes; Lindane is gamma-hexachlorocylohexane.
[3] From EPA Region 6 preliminary remediation goals.
[4] Level set for Aroclor 1242 – this is the most conservative screening level for the PCB compounds.
[5] Maximum detected concentration is below the background concentration estimated by USGS (2004).
[6] Level set for Arsenic III.

Other regulatory levels may also apply to contaminants in Noyes Slough. For instance, the Resource Conservation and Recovery Act requires that the generator of a waste, such as dredged sediments, determine if any of the waste is hazardous before disposal of the material. This is completed through a hazardous waste determination under 40 CFR 262.11. For contaminants such as those in Noyes Slough, a hazardous waste determination may be limited to comparing sampling data that is representative of the materials to be removed from the slough to the Toxicity Characteristic Leaching Procedure (TCLP) regulatory levels (40 CFR 261.24). With the exception of lead in sediment that exceeds 100 mg/kg, it does not appear that the sample results for Noyes Slough described in this section would exceed TCLP limits.

The Alaska State Water Quality Standards (18 AAC 70) may also apply. Because water-quality standards exist for many of the contaminants that have been detected in the sediments (e.g., lead, DDT, heptachlor, heptachlor-epoxide, mirex, PCBs, and various metals), it is possible that dredging will mobilize contaminants from sediments into the surface water, violating water quality standards. Water-quality standards are often calculated using site-specific water quality parameters (e.g., hardness and pH) and are compared to sample averages (e.g., one-hour average, four-day average). Consequently, appropriate sampling must be planned if results will be compared to these standards.

7. SUMMARY AND RECOMMENDATIONS

This report summarizes the available data on the sediment and water quality in Noyes Slough, on groundwater contamination near the slough, and on areas of concern where data are insufficient to determine if the slough is being affected by contamination. The analytical data presented in this report were produced by several different organizations, using different sampling techniques and locations, different laboratories, analytical methods, and quality control procedures, and were reported using different data reduction methods. Therefore, this information can be used as a general starting point for development of a comprehensive, systematic sampling approach to meet specific reclamation and management objectives for Noyes Slough.

7.1. Summary

The following summary lists compounds that have been found in the slough above one or more human health or ecological screening criteria. The summary is broken down by media and criteria:

- Surface Water Samples Compared to Human-Health Screening Levels: PCE, TCE, cis-1,2-DCE, arsenic, and zinc have exceeded the human health screening levels chosen for surface water. These screening levels are based on the use of surface water as a drinking-water source. Although incidental ingestion and dermal contact with surface water are possible in the slough, use of the slough as a drinking-water source is not likely. PCE, TCE, and cis-1,2-DCE have not been detected in any surface water samples collected from the slough since 2000.
- Surface Water Samples Compared to Ecological Screening Levels: Chromium, copper, and zinc exceeded ecological screening levels in surface water. These metals may be naturally occurring in the slough but this has not been confirmed.
- Sediment Samples Compared to Human-Health Screening Levels: Benzo(a)pyrene, dibenzo(a,h)anthracene, arsenic, chromium, lead, and vanadium exceeded human-health screening levels chosen for sediment. The USGS (2004) concluded that the arsenic levels found in Noyes Slough sediments were naturally occurring concentrations, but that the highest levels of lead in the slough sediments were above naturally occurring concentrations,.
- Sediment Samples Compared to Ecological Screening Levels: Bis(2-ethylhexyl)phthalate, DDT, DDD, DDE, PCBs, arsenic, cadmium, chromium, copper, lead, nickel, zinc, and all of the PAHs except benzo(g,h,i)perylene exceeded the ecological screening levels for sediment. Except for lead and zinc, which were identified as anthropogenic inputs by USGS (2004), the other metals may be associated with naturally occurring levels.

Four metals (arsenic, chromium, lead, and nickel) also exceeded DEC disposal criteria for soils. These criteria indicate that this soil is considered contaminated under the DEC Contaminated Sites Program unless these concentrations occur naturally. With the exception of lead, which was found to be enriched at several locations in Noyes Slough (USGS, 2004), these metals may be naturally occurring in the slough. For purposes of hazard characterization and disposal, other state and federal regulations will also apply.

The outstanding unknowns concerning contamination in the slough are the following:

- Chlorinated Solvents in Slough Sediments: The presence of solvent-contaminated groundwater has been well documented in certain areas along the first 1.5 miles of the slough. However, because sediment sampling in the slough has yet to include chlorinated solvents, it is not known if the contaminated groundwater is actually affecting sediments. Although surface-water sampling and pore-water sampling results have shown the presence of solvents, sediment data are more useful because the opportunity for contaminant volatilization, dilution, and transportation from the source is lower.
- Contamination in Other Areas of Concern: Both sediment and groundwater data are lacking in the areas outlined in Section 5. The primary contaminants of concern are selected solvents (PCE, TCE, and DCE), metals (lead, zinc, and mercury), and petroleum hydrocarbons (benzene and PAHs). Mercury is included because it is associated with the former Alaska Gold site, although it was not present above ecological screening levels in any of the USGS sediment samples.
- Bioaccumulative compounds: Bioaccumulative compounds, such as benzo(a)pyrene, PCBs, DDT and its degradation products, bis(2-ethylhexyl)phthalate, dibutylphthalate, and mercury have been identified in the slough and may accumulate in plant and animal tissues associated with the slough or downstream areas if the sediment were disturbed. Tissue testing and food-web modeling are often necessary to understand the effects of bioaccumulation in a freshwater system.

7.2. Recommendations

To better determine the type, extent, and impact of contamination in the slough, further investigation is recommended. In 2000, the NSAC made the following recommendations:

- Expand the previous sampling scheme to cover the entire length of Noyes Slough. Data could be used to determine hot spots, with the eventual goal of determining inputs or sources.
- Expand the study to include additional sediment sampling in the Chena River upstream and downstream from Noyes Slough. These data may help determine sources and inputs.
- Measure contaminant concentrations in invertebrates and possibly higher trophic levels, focusing on compounds that biomagnify. This will help to identify threats to higher trophic levels, particularly birds that nest in the slough. (Other techniques, such as the use of lipid bags and food-web models may be sufficient to evaluate bioaccumulative compounds.)

- Perform toxicity testing of sediment and/or water samples. This will help determine if contaminant levels found in the water and sediments are specifically detrimental to micro-organisms and invertebrates.

After reviewing DEC records, historical aerial photographs, and data collected since the NSAC made these recommendations, OASIS and DEC would like to add the following recommendations:

- The first recommendation made by NSAC (expanding sampling effort to cover all of slough) was in part carried out by the USGS 2001-2002 study. However, because the sediments were not sampled for chlorinated solvents, sediment sampling is recommended for these compounds in the areas where groundwater solvent contamination is known and in the other areas of concern discussed in this report. Further assessment of the other compounds that exceeded screening levels in localized areas of the slough is also recommended.
- Sample slough water, slough sediments, or groundwater in the “Other Areas of Concern” (Section 5) to determine whether contamination is affecting the slough in those areas. Work with DEC’s Contaminated Sites Program to identify contamination sources and evaluate them according to regulatory guidelines.
- Evaluate the potential for bioaccumulative effects in biota before any dredging that may resuspend bioaccumlative contaminants in the slough and the Chena River.
- Follow consistent, matrix-specific quality assurance and sampling plans for future sampling, analysis, and data-reduction efforts. Use the information presented in this report to develop sampling plans for specific reaches of the slough to support reclamation and management objectives. Consider sampling depth and the history of dredging and sediment accumulation in the slough when collecting sediment samples. Also consider the effect of ice cover in winter on volatile contaminants in surface water.

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FIGURES

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Figure 1. Dumping into Noyes Slough behind Bentley-Miller Salvage Yard.
This view is across the slough from the intersection of Noyes and Ina Streets, June 1974.

Figure 2. Results of dewatering activity at the Bentley-Miller gravel pits.
Noyes Slough at Aurora Drive, June 1991.

Figure 3. Dewatering activity at the Bentley-Miller gravel pits discolors the slough.
Near Walden Pond and military housing on Hampstead Avenue, June 1991.

Figure 4. 1959 aerial photograph of the Former Bentley-Miller Salvage yard.
The salvage yard is bounded by College Road to the west and the Alaska Railroad tracks to the north. Refer to Figure B2 for the location of this figure.

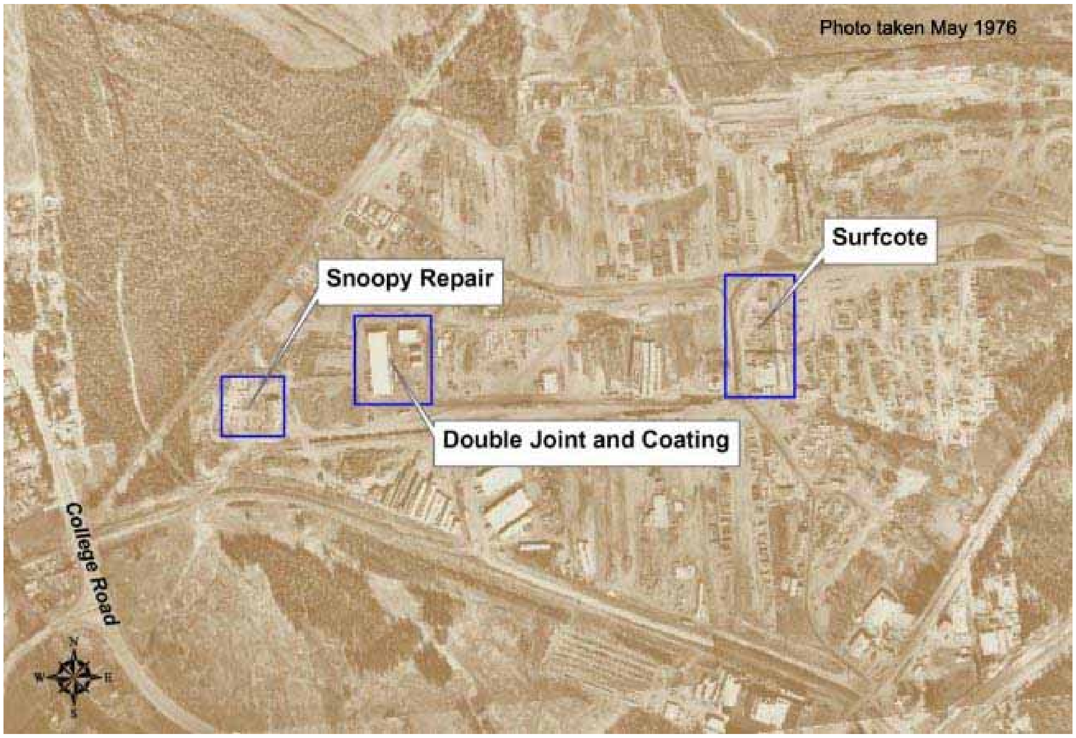


Figure 5. 1976 aerial photograph of Bentley Trust Property Tax Lot 201.
Businesses considered potential sources of solvent contamination are identified (DEC, 2006).

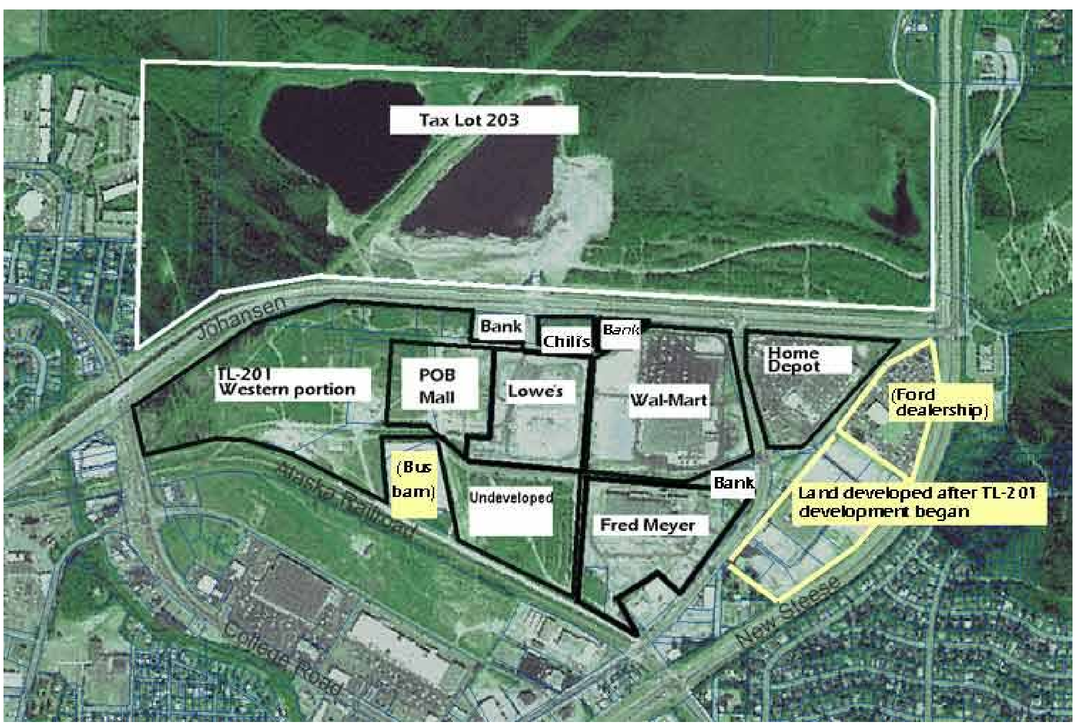


Figure 6. 2006 aerial photograph of Bentley Trust Property Tax Lots 201 and 203.
Current commercial business operations on Tax Lot 201 are identified (DEC, 2006).

Figure 7. 1965 aerial photograph of the former Bentley-Miller Salvage Yard.
A cache of drums appears inside the red circle. College Road at the entrance of Illinois Street is shown to the left.

Figure 8. 1959 aerial photograph showing the former location of the Triangle Service Station. Location is at the junction of College Road and Illinois Street. Refer to Figure B2 for the location of this figure.

Figure 9. 1987 aerial photograph of Doogan's Tiffany Auto Rebuild.
Noyes Slough flows from right to left. Note restricted flow of slough near the Aurora Drive bridge, upper left part of photograph (bridge also shown in Figures 2 and 13). USGS sample SED13 was collected just upstream from the bridge and yielded high levels of metals and semi-volatile compounds associated with activities using urethane, coal tar, tire tar, and petroleum products.

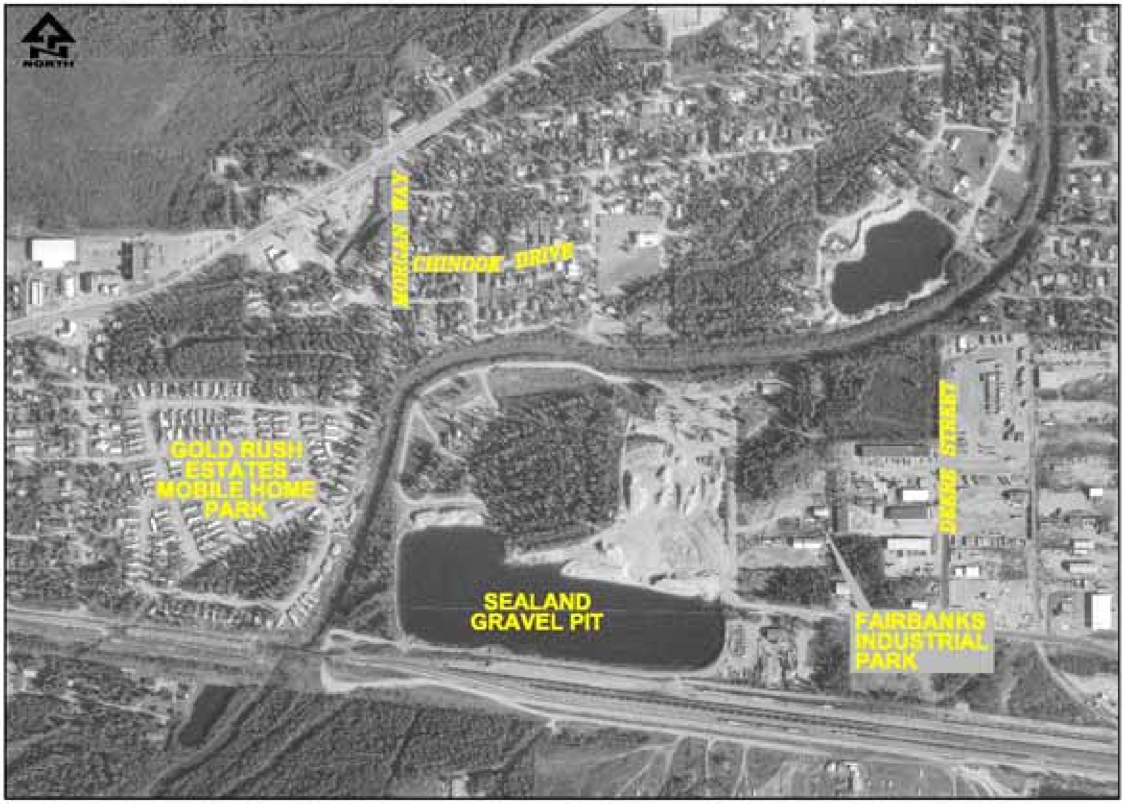
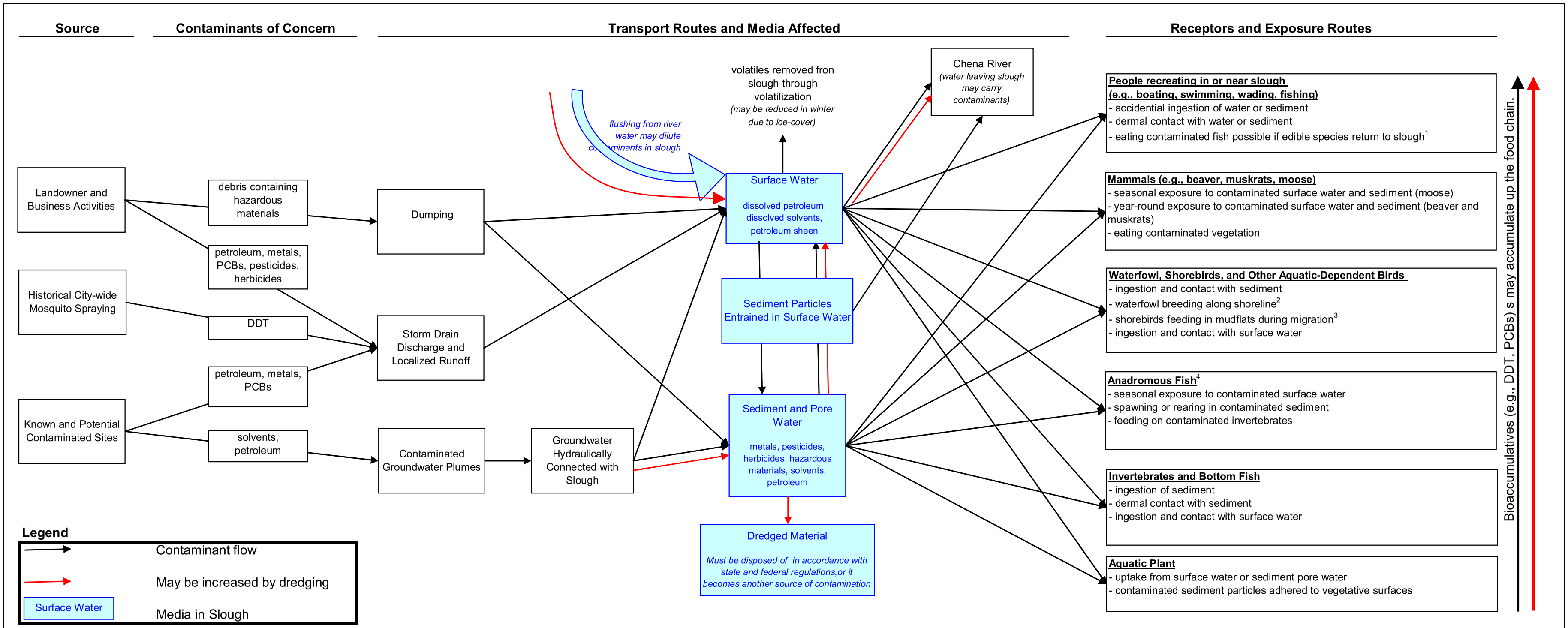


Figure 10. 1987 aerial photograph (Appendix B) showing industrial areas on and around Deere Street.
Several businesses and reported incidents in this area are considered potential sources of contamination to the slough (see Tables 12 and 13). The streets and areas associated with these businesses and incidents are highlighted with yellow text. Refer to Figure B4 for the location of this figure.

Figure 11. 1987 aerial photograph (Appendix B) showing the Phillips Field industrial area. Several businesses and reported incidents in this area are considered potential sources of contamination to the slough (see Tables 12 and 13). The streets and areas associated with these businesses and incidents are highlighted with yellow text. Refer to Figure B4 for the location of this figure.



[1] There are anecdotal reports of people fishing in the slough although eating fish from the slough probably occurs only rarely. Edible species are listed in the Conceptual Exposure Pathways section.

[2] The Alaska Bird Observatory notes several nesting waterfowl along slough, including many Belted Kingfishers (Benson, 2000). A species list is provided in Table 21 of the report. US Fish & Wildlife reported thin eggshells for a Goldeneye using a nest box near the slough.

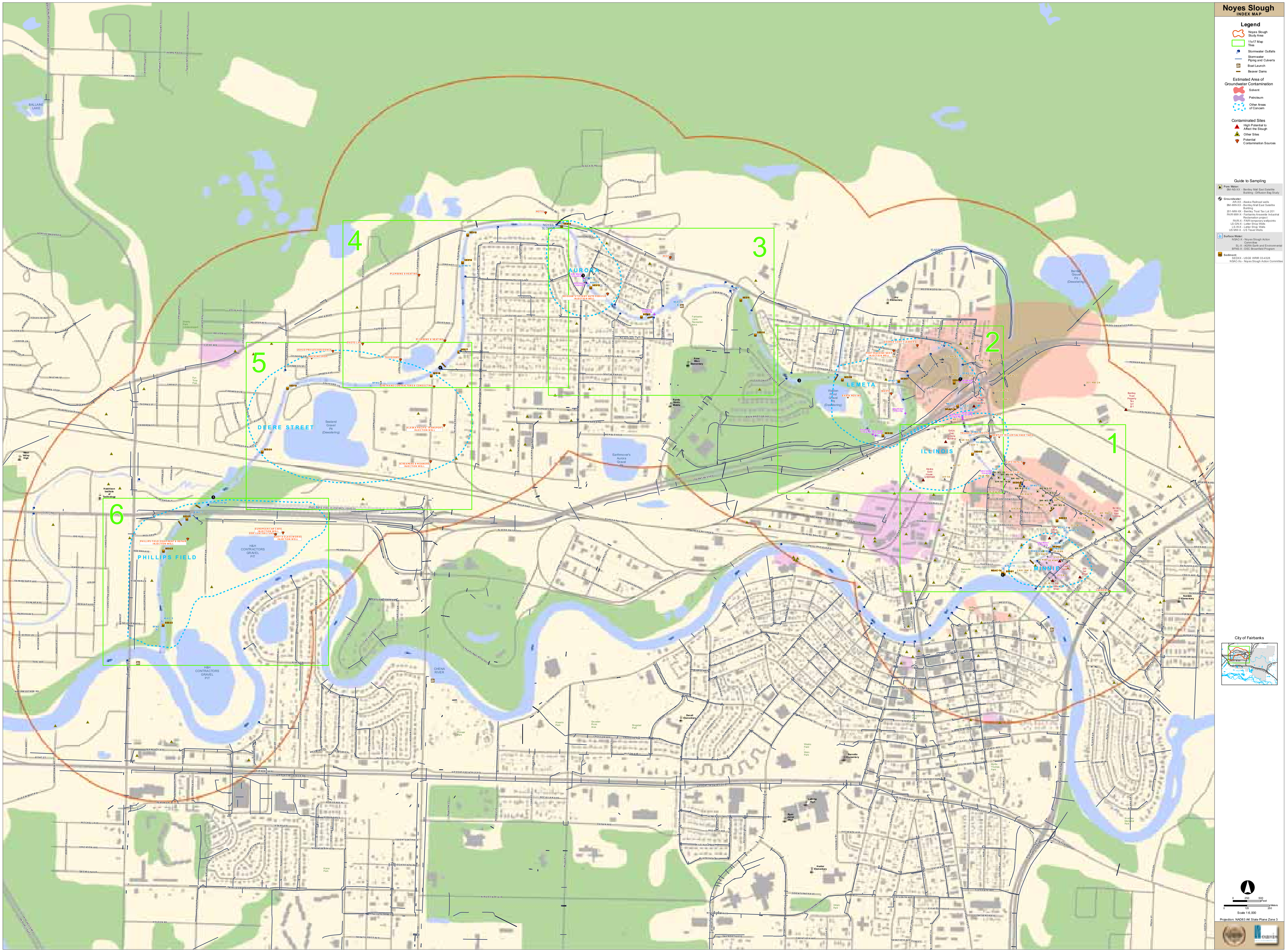
[3] The Alaska Bird Observatory noted shorebirds feeding in mudflats during the last leg of their migration spring migration in May, after slough depth dropped (Benson, 2000).

[4] A fish species list was published by USGS (2004) and is summarized in Section 6 of the report. King Salmon reportedly used the slough as rearing habitat before flow became severely restricted. Anadromous fish may use the mouth of the slough now (Nancy Ehlenfeldt, personal communication).

Figure 12. Conceptual exposure pathway model for Noyes Slough, showing possible effects of dredging.

Figure 13. Noyes Slough and beaver dam with debris below Aurora Drive bridge. May 22, 2007. This bridge also appears in Figures 2 and 9.

TILE MAPS



Noyes Slough
INDEX MAP
Legend
Noyes Slough Study Area
11x17 Map Tiles
Stormwater Outfalls
Stormwater Piping and Culverts
Boat Launch
Beaver Dams
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Petroleum
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BM-NS-XX - Bentley Mall East Satellite Building - Diffusion Bag Study
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BM-MW-XX - Bentley Mall East Satellite Building
201-MW-XX - Bentley Trust Tax Lot 201
FAIR-MW-X - Fairbanks Areawide Industrial Reclamation project
FAIR-X - FAIR temporary wellpoints
LS-GN-X - Letter Shop Wells
LS-W-X - Letter Shop Wells
US MW-X - US Travel Wells
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SL-X - AGRA Earth and Environmental
BFNS-X - DEC Brownfield Program
Sediment:
SEDXX - USGS WRIR 03-4328
NSAC-Xs - Noyes Slough Action Committee
City of Fairbanks
0 250 500 Feet
0 125 250 Meters
Scale 1:6,000
Projection: NAD83 AK State Plane Zone 3
1
2
3
4
5
6
AURORA
LEMETA
ILLINOIS
MINNIE
DEERE STREET
PHILLIPS FIELD
CHENA RIVER
BALLAINE LAKE


Tile 1
Noyes Slough
Legend
Noyes Slough Study Area
Stormwater Outfalls
Stormwater Piping and Culverts
Boat Launch
Beaver Dams
Estimated Area of Groundwater Contamination
Solvent
Petroleum
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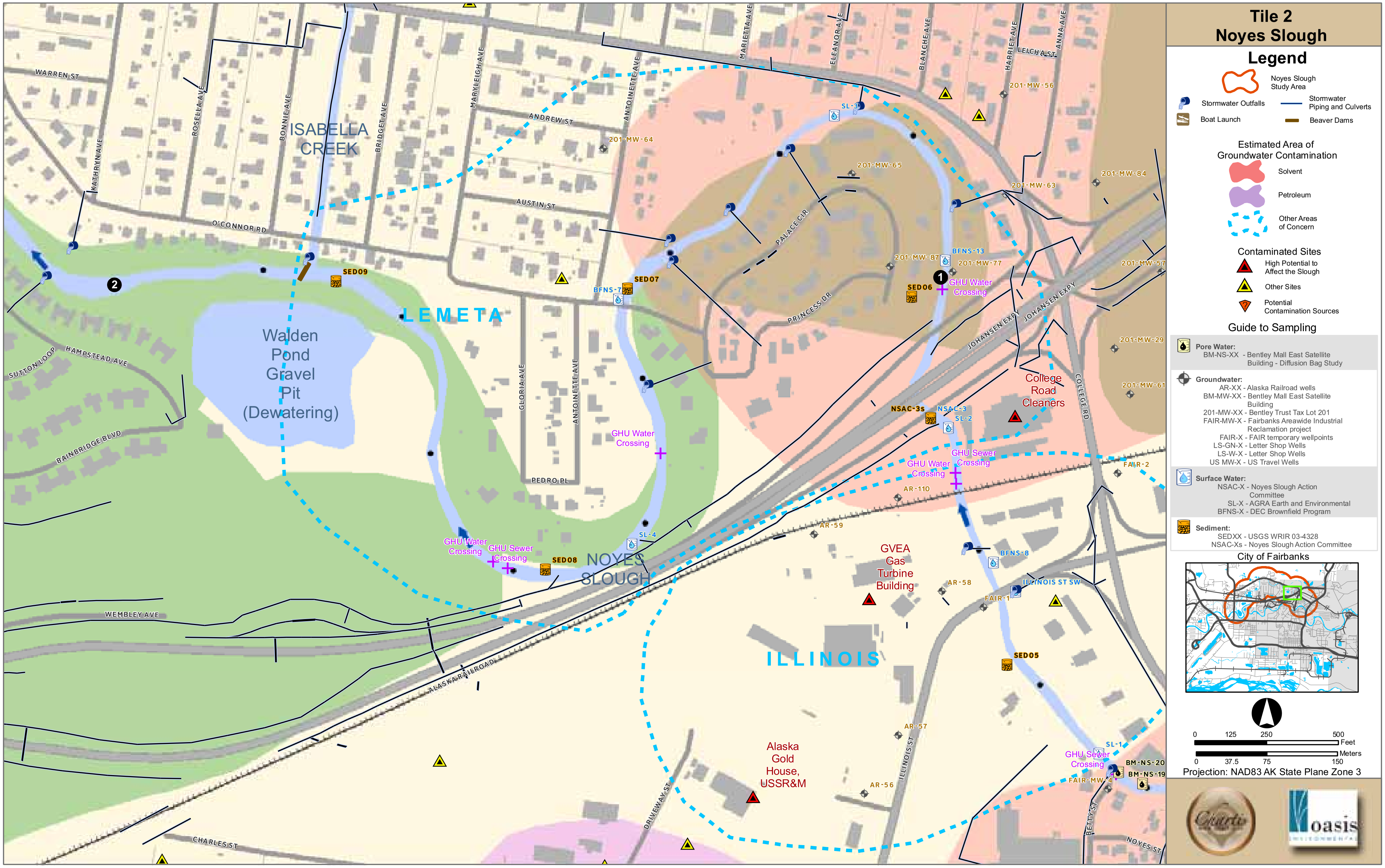
City of Fairbanks
0 125 250 500 Feet
0 37.5 75 150 Meters
Projection: NAD83 AK State Plane Zone 3
ILLINOIS
MINNIE
NOYES SLOUGH
CHENA RIVER
Slaterville Park
GVEA Gas Turbine Building
Alaska Gold House, USSR&M
Bentley Mall East Satellite
The Office Place, Inc.
US Travel Systems
The Letter Shop
229 3rd Street
GHU Sewer Crossing
GHU Water Crossing
ILLINOIS ST SW
MINNIE ST SW
SED01
SED02
SED03
SED04
SED05
NSAC-1s
NSAC-2
NSAC-6
SL-1
BFNS-8
BFNS-9
BFNS-10
BFNS-11
BFNS-12
BM-NS-8
BM-NS-9
BM-NS-11
BM-NS-12
BM-NS-15
BM-NS-17
BM-NS-18
BM-NS-19
BM-NS-20
BM-MW-2
BM-MW-5
BM-MW-6
BM-MW-7
BM-MW-8
BM-MW-9
BM-MW-10
BM-MW-11
BM-MW-12
221-SB-2
221-SB-8
221-SB-9
221-SB-10
221-SB-11
AR-56
AR-57
AR-58
AR-59
FAIR-1
FAIR-MW-3
FAIR-MW-4
FAIR-MW-8
US MW4
US MW6
US MW7
US MW8
US MW9
US MW10
LS-GN-1
LS-GN-2
LS-W-1
JOHANSEN EXPY
DRIVEWAY ST
ALASKA RAILROAD
CHARLES ST
OIL AVE
ILLINOIS ST
ERCEG ST
PHILLIPS FIELD RD
CHURCH ST
SLOUGH ST
CUSHMAN ST N
MONROE ST
INA ST
BETTY ST
ELLINGSON ST
FULTON ST
CLARA ST
NOYES ST
WELL ST
SLATER ST
MINNIE ST
COLLEGE RD
BENTLEY ACCESS RD
OLD STEESE HWY
FOURTH ST
THIRD ST
SECOND ST
FRONT ST
FORTY MILE AVE
NEW STEESE HWY


Tile 2
Noyes Slough
Legend
Noyes Slough Study Area
Stormwater Outfalls
Stormwater Piping and Culverts
Boat Launch
Beaver Dams
Estimated Area of Groundwater Contamination
Solvent
Petroleum
Other Areas of Concern
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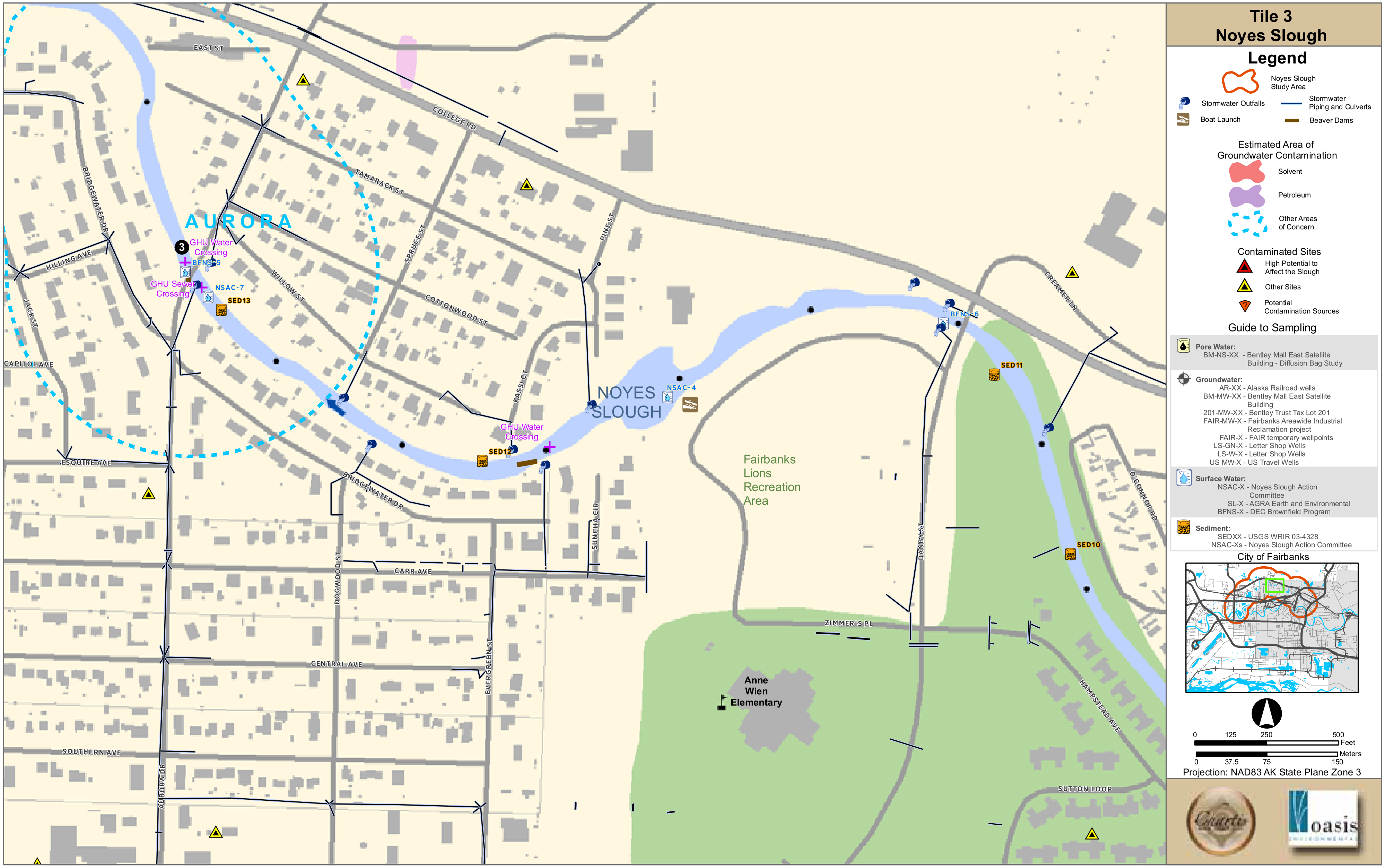
City of Fairbanks
0 125 250 500 Feet
0 37.5 75 150 Meters
Projection: NAD83 AK State Plane Zone 3
oasis
ISABELLA CREEK
LEMETA
Walden Pond Gravel Pit (Dewatering)
NOYES SLOUGH
ILLINOIS
College Road Cleaners
GVEA Gas Turbine Building
Alaska Gold House, USSR&M
GHU Water Crossing
GHU Sewer Crossing
WARREN ST
KATHRYN AVE
ROSELLA AVE
BONNIE AVE
BRIDGET AVE
MARYLEIGH AVE
ANDREW ST
ANTOINETTE AVE
AUSTIN ST
O'CONNOR RD
MARIETTA AVE
ELEANOR AVE
BLANCHE AVE
HARRIET AVE
ANNA AVE
LEICHA ST
PALACE CIR
PRINCESS DR
JOHANSEN EXPY
COLLEGE RD
SUTTON LOOP
HAMPSTEAD AVE
BAINBRIDGE BLVD
GLORIA AVE
PEDRO PL
WEMBLEY AVE
ALASKA RAILROAD
CHARLES ST
DRIVEWAY ST
ILLINOIS ST
ILLINOIS ST SW
BETTY ST
NOYES ST
SED05
SED06
SED07
SED08
SED09
NSAC-3s
NSAC-3
SL-1
SL-2
SL-3
SL-4
BFNS-7
BFNS-8
BFNS-13
BM-NS-19
BM-NS-20
FAIR-MW-4
FAIR-1
FAIR-2
AR-56
AR-57
AR-58
AR-59
AR-110
201-MW-29
201-MW-56
201-MW-57
201-MW-61
201-MW-63
201-MW-64
201-MW-65
201-MW-77
201-MW-84
201-MW-87
1
2

Tile 3
Noyes Slough



Tile 4
Noyes Slough
Legend
Noyes Slough Study Area
Stormwater Outfalls
Stormwater Piping and Culverts
Boat Launch
Beaver Dams
Estimated Area of Groundwater Contamination
Solvent
Petroleum
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City of Fairbanks
0 125 250 500 Feet
0 37.5 75 150 Meters
Projection: NAD83 AK State Plane Zone 3
oasis
AURORA
NOYES SLOUGH
DEERE STREET
SED14
SED15
SED16
SED17
SED18
BFNS-4
BFNS-3
4
COLLEGE RD
R.J. LOOP
WESTWOOD WAY
CARIBOU WAY
OLD PIONEER WAY
SMITH ST
LATOYA CIR
MACK BLVD
QUIET AVE
TOTEM DR
REILLY RD
LUKE ST
ALASKA WAY
BRIDGEWATER DR
FERN ST
JACK ST
HILLING AVE
CAPITOL AVE
ESQUIRE AVE
CARR AVE
CENTRAL AVE
SOUTHERN AVE
BUSH ST
CEDAR ST
ASPEN ST
DEERE ST

Tile 5
Noyes Slough

Legend

- Noyes Slough Study Area
- Stormwater Outfalls
- Stormwater Piping and Culverts
- Boat Launch
- Beaver Dams

Estimated Area of Groundwater Contamination

- Solvent
- Petroleum
- Other Areas of Concern

Contaminated Sites

- High Potential to Affect the Slough
- Other Sites
- Potential Contamination Sources

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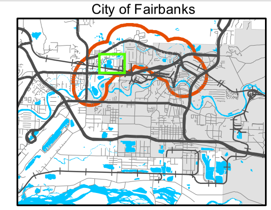
City of Fairbanks



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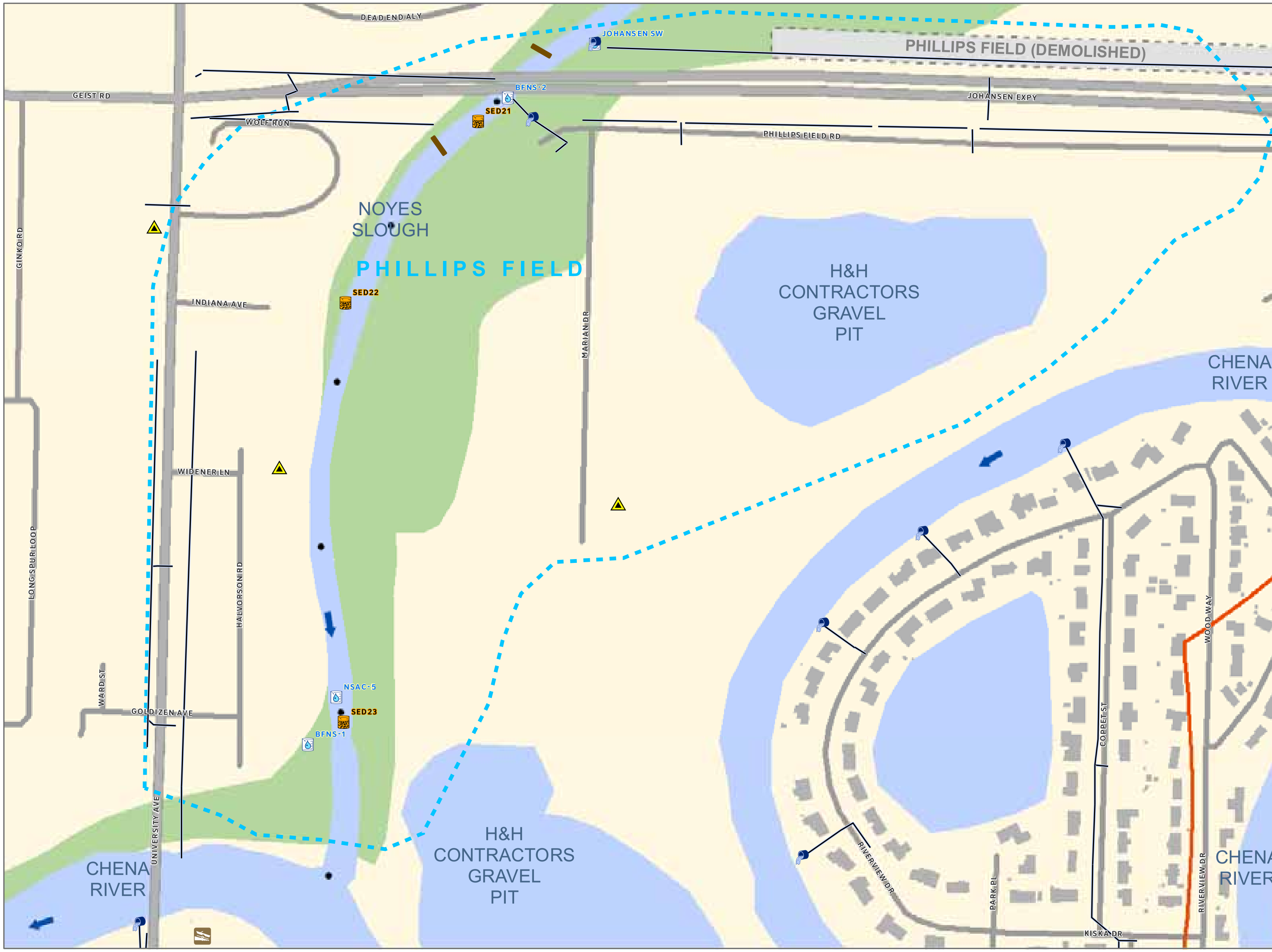
Projection: NAD83 AK State Plane Zone 3



Tile 6
Noyes Slough

Legend

Noyes Slough Study Area
Stormwater Outfalls
Stormwater Piping and Culverts
Boat Launch
Beaver Dams

Estimated Area of Groundwater Contamination
Solvent
Petroleum
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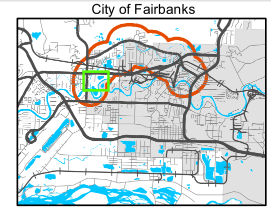
City of Fairbanks



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Projection: NAD83 AK State Plane Zone 3