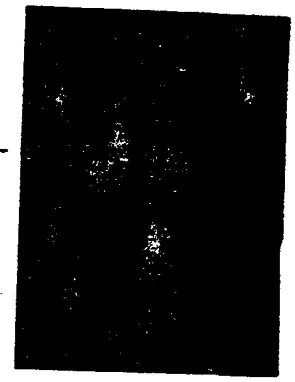
Anchorage
Boston
Chicago



Jersey City
Juneau
Long Beach
Portland
Seattle

MEMORANDUM

DATE: October 20, 2000

TO: Jim Thomson, HNTB

FROM: Michael A.P. Kenrick, P.E., and Michael J. Bailey, P.E., Hart Crowser

RE: **Sea-Tac Third Runway – Borrow Area 3**
Preservation of Wetlands
J-4978-06

As requested by the Port of Seattle, this memo and the attached figures provide conceptual design and supporting information for the proposed drainage swale to protect wetlands in Borrow Area 3. We also provide a brief explanation of the hydrology that supports the wetlands, including why excavation of Borrow Area 3 will not drain these wetlands. Figure 1 shows the location of Borrow Area 3 to the south of Sea-Tac Airport.

REVIEW OF BORROW AREA 3 WETLAND HYDROLOGY

The first section of this memo provides a review and explanation of the hydrology that currently supports and sustains wetlands in Borrow Area 3. Understanding these hydrologic factors is important in ensuring the long-term preservation of the wetlands during and after excavation of the fill materials contained in Borrow Area 3.

Factors Promoting Preservation of the Wetlands

Existing wetlands and current topography in Borrow Area 3 are shown on Figure 2; the proposed area of mining and resulting contours for final excavation are shown on Figure 3.

The series of wetlands mapped in Borrow Area 3 follow a line of shallow depressions in the southcentral part of the site, extending to the southeast from Wetland 29 through Wetlands B9, 30, B7, B6, and B5. These wetlands exist in an area of relatively permeable subsoils where the main groundwater table is at a depth of 10 to 15 feet below the wetlands. Depth of the water table indicates the wetlands are supported by other sources of water. The sources of water appear to include surficial runoff and shallow interflow, as well as

'0 Fairview Avenue East
'ttle, Washington 98102-3699
206.328.5581
206.324.9530

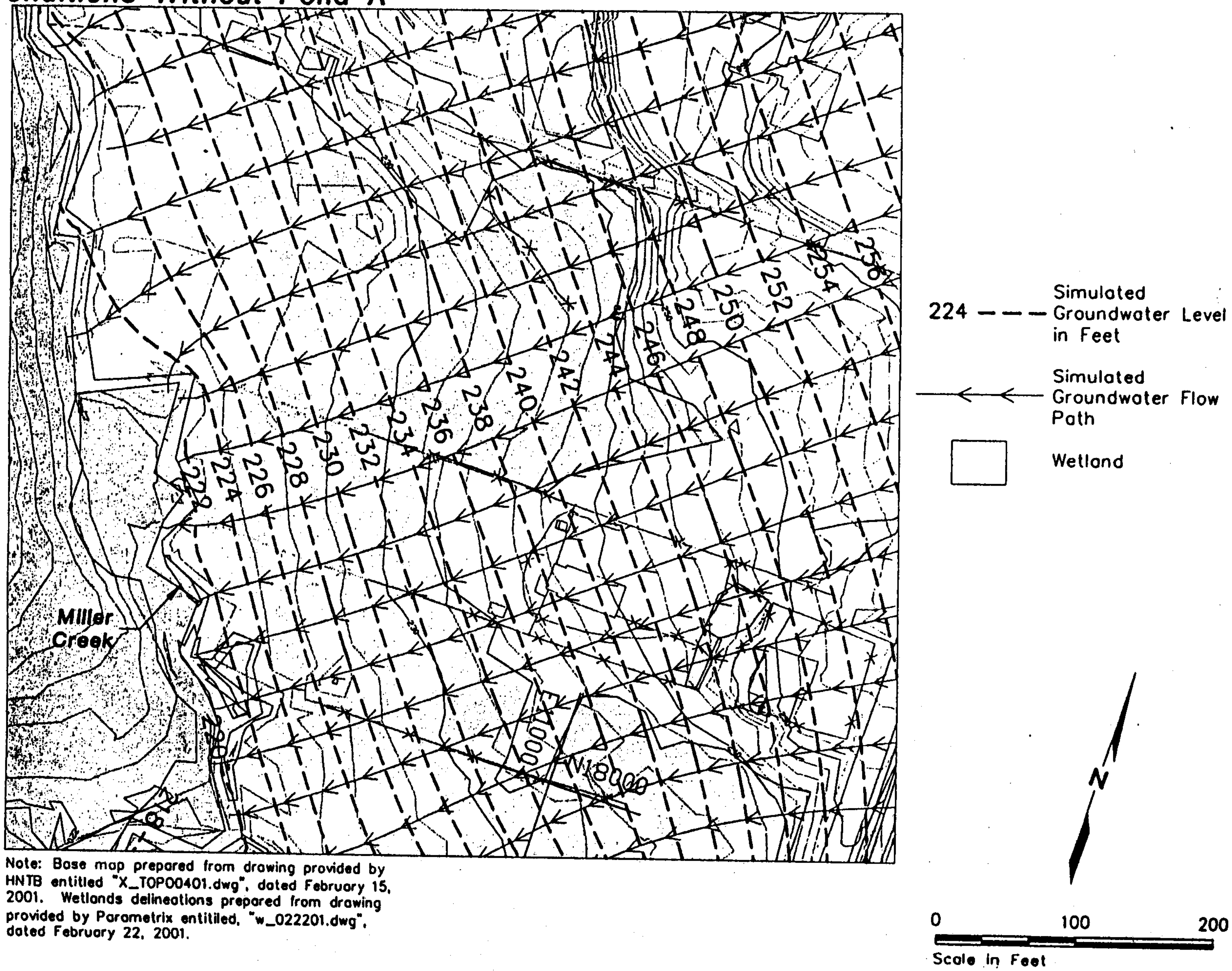
ECY00022165

Exhibit-2206

RC 6/18/01 . (sref)oee drawing file/charlie-8.pc2 49780682

Simulated Average Water Table

Existing Conditions Without Pond A



Note: Base map prepared from drawing provided by HNTB entitled "X_TOP00401.dwg", dated February 15, 2001. Wetlands delineations prepared from drawing provided by Parametrix entitiled, "w_022201.dwg", dated February 22, 2001.

HARTCROWSER

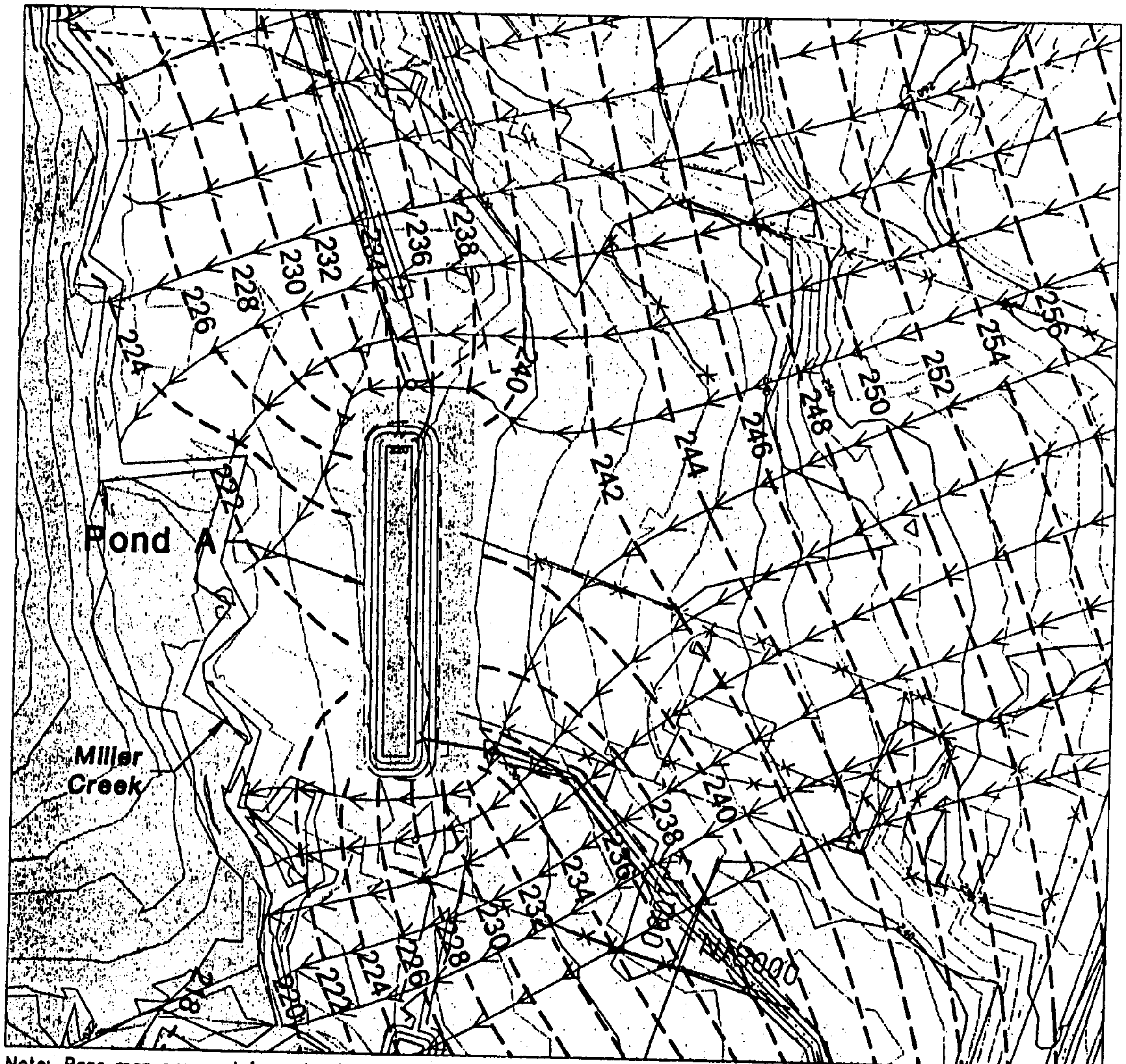
J-4978-06 6/01

Figure B-2

ECY00022166

AR 034784

Sim..ated Average Water Table
Pond A with Sheet Piles



224 — — — Simulated Groundwater Level in Feet

Simulated Groundwater Flow Path

Wetland

0 100 200
Scale in Feet

Note: Base map prepared from drawing provided by HNTB entitled "X_TOPO0401.dwg", dated February 15, 2001. Wetlands delineations prepared from drawing provided by Parametrix entitiled, "w_022201.dwg", dated February 22, 2001.

HARTCROWSER
J-4978-06 6/01
Figure B-3

Simulated Average Water Table

Pond A With Sheet Piles and Diversion Drain

224 — — — Simulated Groundwater Level in Feet

Simulated Groundwater Flow Path

Wetland

N

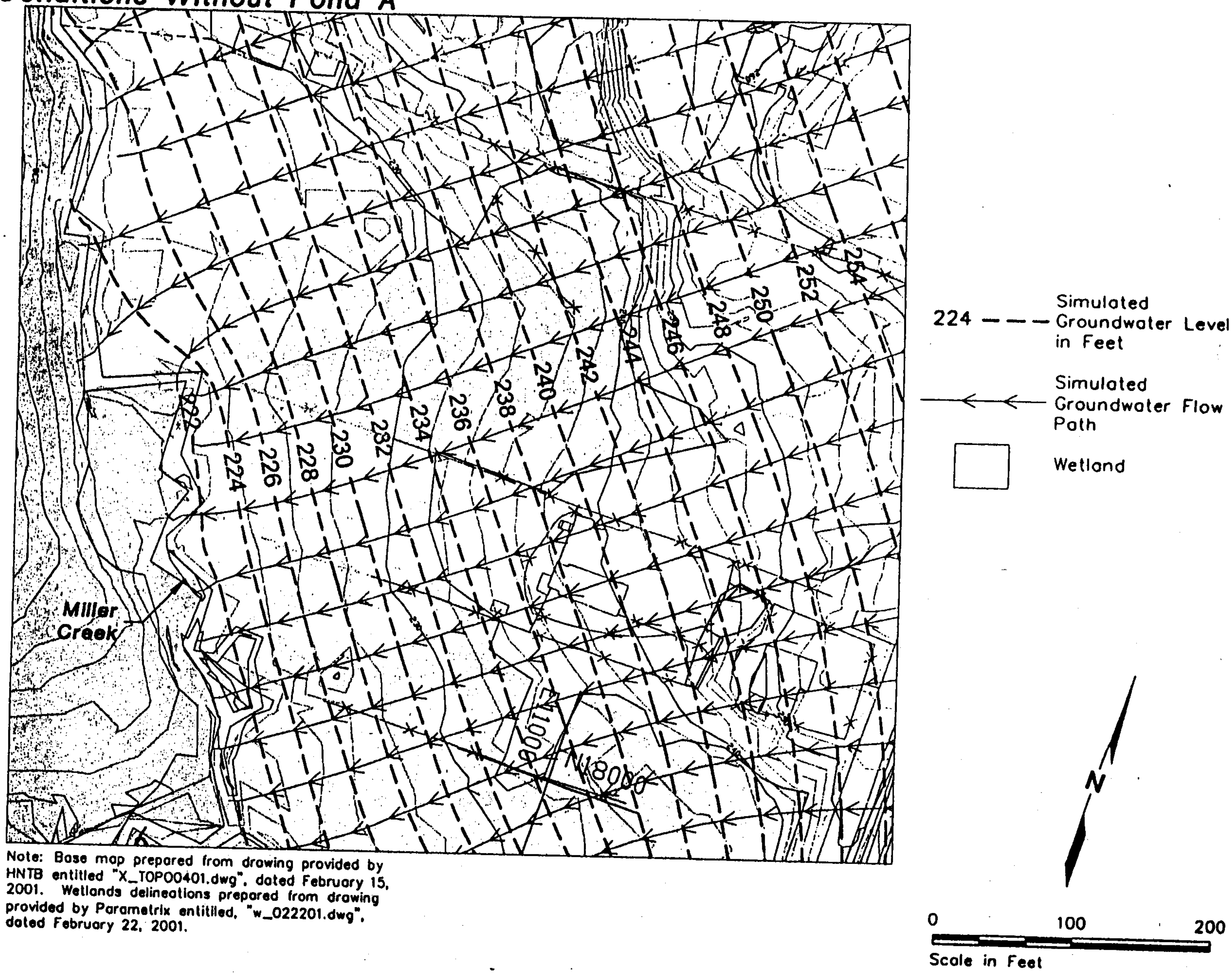
0 100 200
Scale in Feet

Note: Base map prepared from drawing provided by HNTB entitled "X_TOP00401.dwg", dated February 15, 2001. Wetlands delineations prepared from drawing provided by Parametrix entitiled, "w_022201.dwg", dated February 22, 2001.

HARTCROWSER
J-4978-06 6/01
Figure B-4

Sim 'ated Late Summer Water Ta⌣le

Existing Conditions Without Pond A



Note: Base map prepared from drawing provided by HNTB entitled "X_TOPO0401.dwg", dated February 15, 2001. Wetlands delineations prepared from drawing provided by Parametrix entitled, "w_022201.dwg", dated February 22, 2001.

HARTCROWSER

J-4978-06 6/01

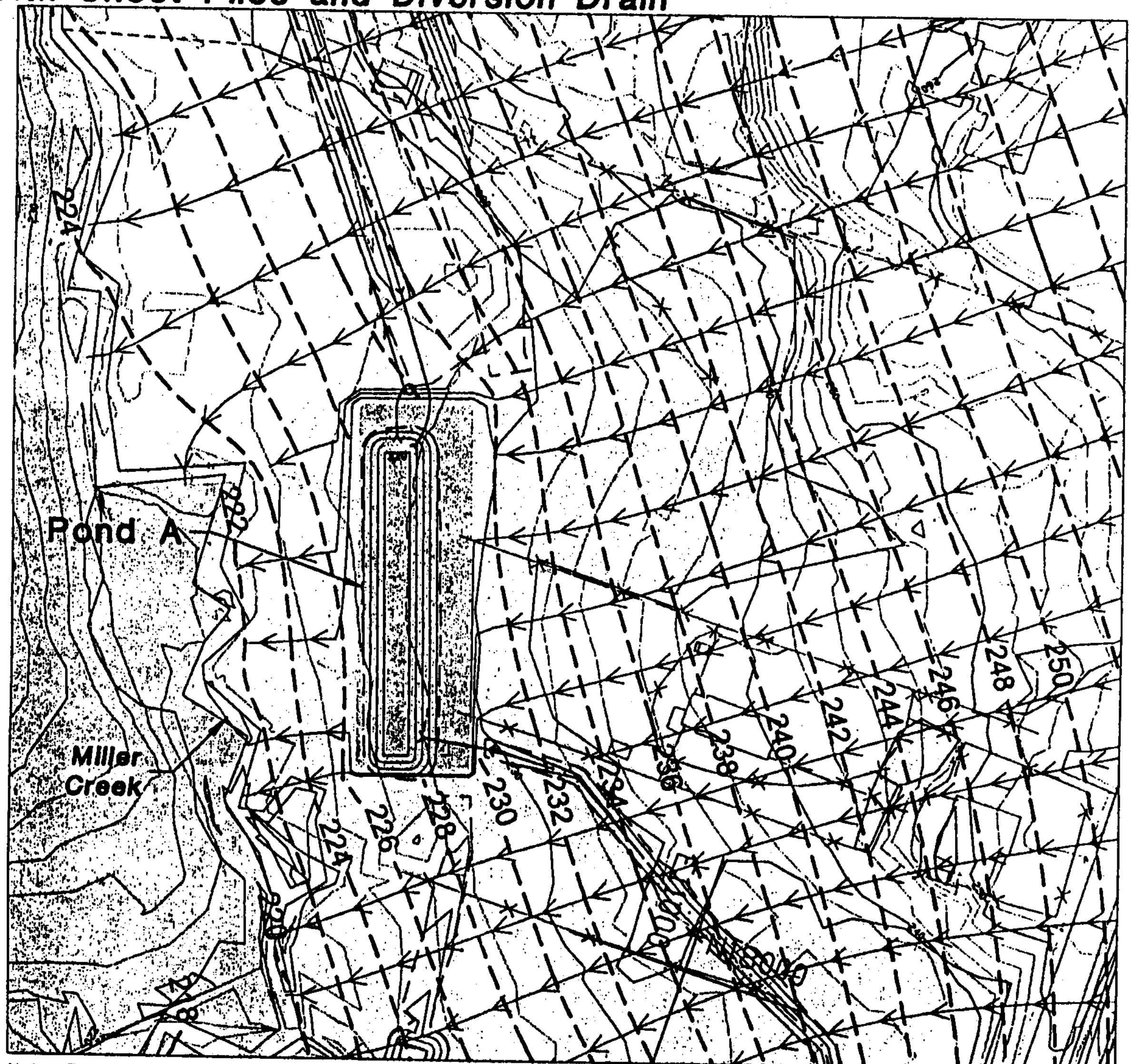
Figure B-5

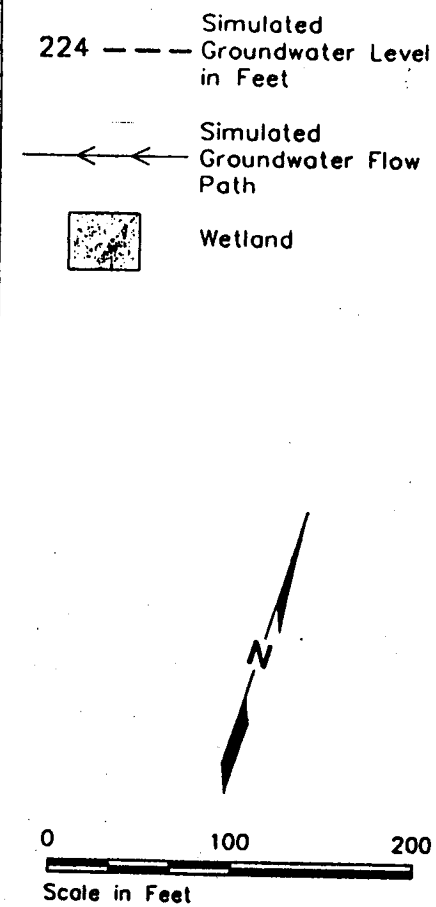
ECY00022169

AR 034787

Simulated Late Summer Water Table

Pond A With Sheet Piles and Diversion Drain





Note: Base map prepared from drawing provided by HNTB entitled "X_TOPO0401.dwg", dated February 15, 2001. Wetlands delineations prepared from drawing provided by Parametrix entitiled, "w_022201.dwg", dated February 22, 2001.

HARTCROWSER

J-4978-06 6/01

Figure B-6

ECY00022170

AR 034788

APPENDIX C
SHEET PILE DESIGN AND CONSTRUCTION

APPENDIX C
SHEET PILE DESIGN AND CONSTRUCTION

The proposed sheet piles around Pond A were designed to fulfill three functions:

a. Cut-off shallow groundwater so that seepage into the pond does not remove shallow groundwater from the adjacent wetland;

b. Protect adjacent wetlands from potential excavation-induced impacts such as slope failure and sloughing of loose/soft soil during excavation of the pond); and

c. Provide long-term static stability for pond constructed within a soil profile of loose and soft soils above glacial till.

Design

Sheet pile design to address the functional requirements noted above was based on soil and groundwater conditions encountered in local borings (see Appendix A). For design, we assumed water level in the pond varied from completely full to completely empty, or about 226 to 220 feet in elevation. We assumed groundwater coincides with ground surface on the upslope side of the sheet pile walls due to the anticipated effects of the perimeter drainage trench.

Table C-1 provides the soil parameters used in our slope stability and force/moment calculation. These analyses are discussed further below.

Earth Pressure Diagrams

Soil strength parameters were used to develop earth pressure diagrams for the embedded portion of the sheet pile. The diagrams enable a structural engineer to calculate the required sheet pile section modulus.

We assumed the sheet pile "cell" around the pond should be designed as a cantilever wall without anchorage. Active earth pressures acting on the piles located east of Pond A typically should include a surcharge pressure equal to the weight of an additional 2 feet of soil, to account for increased loads where the access road is located adjacent to the sheet pile wall. Passive earth pressures were factored to account for the loss of support due to the pond excavation.

Our analysis of sliding and overturning discussed below indicates the passive resistance sufficient to achieve target factors of safety depends on embedment, therefore design may need to be reviewed and/or modified in the event minimum embedment is not obtained due to variations in elevation of the glacial till. However, since the till is relatively impermeable and much stronger than the surficial soils, reduced penetration of piles due to shallow glacial till is not anticipated to result in any reduction in slope factors of safety.

Our analysis of the stability of the sheet pile wall and pond slopes consisted of two separate analyses: limit equilibrium analysis using the program Slope/W to analyze global slope stability (i.e., potential for failure below sheet piles) and b) force/moment equilibrium calculations to check factors of safety against sliding and rotation.

Slope Stability Analysis

We used Slope/W with Spencer's method for limit equilibrium analysis to calculate factors of safety for circular and wedge-type failure surfaces passing below the sheet pile wall. We analyzed the following conditions:

- Steady state (pond full) including the effect of soil buoyancy;
- Steady state (pond empty) without the effect of buoyancy; and
- Rapid drawdown (pond empty) including the effect of pore pressures.

Minimum target factors of safety were 1.5 for steady state conditions and 1.1 for rapid drawdown, consistent with normal geotechnical engineering practice for this area.

Factors of safety met target criteria provided sheet pile can be embedded at least 8 feet (to the top of the very dense glacial till) on the north side of the pond, with the case of rapid drawdown of the pond level being most critical. Embedment was critical for stability.

Force and Moment Equilibrium

Analyses were completed to verify that adequate factors of safety were achieved for both force and moment equilibrium, for resistance to sliding (or translation) and rotation. Target factors of safety were achieved for both steady state (pond full, buoyant conditions) and rapid drawdown conditions. By inspection we concluded that the steady state (pond empty) condition was less critical than the other two cases.

Erosion and Sloughing

Hart Crowser used the weighted creep method of analysis to assess potential for piping below the bottom of the sheet piles through fine to medium sand and silt soils. Results indicate mitigation is needed. Also, considering the soft and loose to medium dense soils that will be exposed in the 2H:1V pond side slopes, we expect that the slopes of the pond may undergo sloughing related to water level fluctuations during normal pond operations.

Recommended mitigation consists of driving the sheet piles to refusal in the underlying glacial till and lining the pond with a geotextile separation fabric and minimum 1 foot thickness of quarry spalls.

Construction

Hart Crowser makes the following recommendations for construction:

- Install the perimeter French drain entirely around the proposed pond prior to any sheet pile installation. This will assure adequate access for construction on the west side of the pond without any wetland encroachment and avoid any interruption of groundwater seepage as the sheet piles are installed.

- Install sheet piles on the west, north, and south sides of the pond (i.e., the sides closest to Miller Creek) prior to excavation. This will enable the piles to protect the creek in the event there is any excavation sloughing during pond construction.

- Drive piles to refusal in the top of the glacial till soils. The Port's contract documents should state that "jetting" shall not be used to aid driving.

- Prior to construction, the Contractor should provide the Port with a submittal that describes pile driving equipment and sequence of construction. During construction, the Port should verify that minimum embedment criteria are met.

F:\docs\jobs\497806\PondAReportRev2.doc

AR 034792

Table C-1 - Soil Parameters Used in Design

Soil Type	Moist Unit Weight in pcf	Drained Strength		Undrained Strength	
		c' in psf	ϕ' in deg.	c in psf	ϕ in deg.
Loose to Medium Dense Sand	125	0	32	-	-
Medium Dense to Dense Sand	130	0	35	-	-
Dense to Very Dense Silty Sand (Glacial Till)	135	250	40	-	-
Soft Peat or Organic Silt	90	0	15	300	0
Soft to Stiff Silt/Clay	115	0	30	1000	0

F:\docs\jobs\497806\PondAReportRev2.doc

AR 034793