LANDFILL TECHNICAL MEMORANDUM
URS

2.1 INTRODUCTION

The City of Bellevue is considering using the Eastgate Area Properties for a park or other recreational facilities. URS Corporation, a member of The Portico Group project team, evaluated the former Boeing-Eastgate Landfill which underlies a portion of the Eastgate property. The evaluation was based in part on site visits and a review of documents written by other companies, including the following:

- Landfill Issues Report, SCS Engineers. July, 2 2002.
- Geotechnical and Environmental Studies. AMEC Earth and Environmental Inc. May, 28 2002.
- RS Means, Heavy Construction Cost Data. (31 23 23.18).2008
- Boeing-Eastgate Landfill Drawings, CH2MHILL. 1987.
- Geotechnical Engineering Services Duct Bank Relocation Boeing Eastgate Landfill, June 28, 2004 for Puget Sound Energy, Geo Engineers
- Cedar Hills Regional Landfill, Bid Comparison. Scarsella. 2008.
- Rabanco Waste Management. Waste Management Personal Communications for Disposal Costs. June 6, 2008.

While active the landfill accepted both Construction/Demolition waste (C&D) and Municipal solid waste (MSW) from 1951 through 1964. Waste was placed in a former drainage channel that collected water from the Eastgate area, and directed water north to Phantom Lake, a half mile north of the landfill site. Waste material was placed and spread with a small bulldozer. It is reported waste was placed in layers six to eight feet thick and periodically covered with soil. The landfill area encompassed approximately 9.6 acres. When the landfill stopped receiving waste in 1964 a soil cap was placed. Over the years a significant amount of soil fill has been placed above the old landfill. In 1974 additional soil mixed with construction debris (including concrete) was placed over the southern portion of the site. Subsequently, the site has been graded to encourage run-off to a storm drainage system that empties into a two pond water quality treatment system north of the landfill. In 1986 a landfill gas collection system was installed in the waste mass by the Boeing Company. The system includes extraction wells, collection and conveyance piping, condensate traps, vacuum blowers and a flare to burn the methane. In addition, some surface grading was performed, and monitoring wells were installed. The maximum thickness of waste has been reported to be 42 feet. In conjunction with decomposition of organic wastes, the area has settled with reports of closed depressions on the order of three to four feet, cracks and swales in the north end of the old runway pavement, Boeing parking lot settlements of one to two feet, etc.

Over the years a number of utilities have been installed in, through, and across the landfill. These include storm & sanitary sewers, PSE power ducts (now abandoned), the landfill gas collection & conveyance system and the road & utilities associated with the Advanta development on the southern portion of the landfill. Currently the landfill is used as a low impact recreation area used for walking jogging, dog park with wide trails and an open gently sloping field covered with shrubs, grasses & blackberry bushes.

2.2 ASSESSMENT AND CONCLUSIONS

The landfill portion of the area has been covered with a soil cap for approximately 44 years. While grading and storm drains provide a means for surface water to drain to the storm system, it is clear a

significant amount of precipitation is, and has been, able to percolate through the soil cover to the waste. As such the organic portions of the waste deposited have mostly decomposed. This is evidenced by the very low quantities of landfill gas currently being collected and the need to significantly augment the flare with propane when the system is energized. However, the site will continue to generate landfill gas in small quantities. Landfill gas is composed of methane, carbon dioxide, other trace elements and water, therefore; any excavation, vault, or structure placed in or near the landfill should be considered a confined space.

The landfill cover soils are described as silty sand with gravel and cobbles. These soils are susceptible to disturbance, erosion and are difficult to work or compact when wet. The waste in the landfilled area is a very poor material for use in construction. It was placed in layers and likely has multiple zones of perched water. It is composed up of heterogeneous materials including large chunks of concrete, logs, stumps, tires, and other non-decomposable garbage. It is compressible and subject to differential, uneven, settlement from loading.

Therefore and development of the site should include consideration of engineered measures to address the life safety, environmental and construction risks associated with building on or near an old landfill. This includes the following:

- For structures; Either remove portions of the waste around the structure(s), use piles or other means to support the structure(s) or perform ground improvement to address compressible soils, water and gas barriers to prevent landfill gas intrusion.
- For sport field(s); perform installation of water and gas barriers to collect precipitation/irrigation prior to it reaching the waste and generating more leachate or landfill gas, and protect the surface features from landfill gas.
- For any development provide monitoring to verify performance of the protection systems installed.

2.3 CALCULATION OF SOLID WASTE VOLUME

2.3.1 Introduction

The vast majority of organic waste has decomposed during the intervening 44 years. The volume of the waste material was estimated for two purposes: 1) to estimate the cost of its removal, if this option is chosen; and 2) to estimate the amount of methane gas that is still being generated by the remaining waste. A cover layer of soil (called the "cap") was placed over the waste as part of the closure of the landfill in 1964. This soil cap covers the entire landfill. There are several landfill gas extraction wells located near the edge of the landfill that extend through the soil cap to the bottom of the waste installed to capture the methane gas produced by the waste.

2.3.2 Surface Area of Waste

Based on the Boeing-Eastgate Landfill Drawings (drawings) the volume of refuse in the Eastgate Landfill was calculated by scaling out the area. There is an outline of the landfill on the outer edge of the extraction wells, from this the area can be measured. The remaining area of the entire landfill was calculated to be approximately 380,000 square feet (8.6 Acres). The area within the extraction wells was also calculated based on scaled drawings (Figure 1). The area within the extraction wells was calculated to be 260,000 sf (6 Acres). The original size was estimated to encompass 9.6 acres, but portions have been removed or are now capped by the Advanta property (Figure 2).

2.3.3 Volume of Waste

After the area is established the average depth of the soil cap and the average depth of the refuse material were determined. The average soil cap depth was found to be 10 feet stated in the Geotechnical and Environmental Studies Report. The depth of the refuse material was estimated based on the depth of the extraction wells. A table on the drawings contains the drilled depths of the 21 extraction wells. The average was taken of those depths to be used as the average depth of the refuse material, 38 feet. The volume of the landfill within the extraction wells was calculated by multiplying the area within the extraction wells by the difference between the average depth of refuse and the average depth of the soil cap. The volume was 270,000 cubic yards(yd^3). The edge of the landfill sloped downward to the bottom of the extraction wells. This volume was assumed to be geometrically a triangle. To calculate the volume outside the extraction wells the difference between the total landfill area and the area within the extraction wells is multiplied by the difference between the average depth of refuse and the average depth of the soil cap then multiplied by ½. The volume for sides outside the extraction wells was 40,000 yd^3. The two volumes were then added together to get the total volume of waste in the Eastgate landfill, 310,000 yd^3.

In the Landfill Issues Report, calculations of the volume of refuse in the Eastgate Landfill have reported similar quantities.

2.4 LANDFILL GAS

2.4.1 Gas Generation Status

The base of Eastgate Landfill appears to be located above the water table (based on data from groundwater monitoring wells). The waste mass is likely to be wet or moist because of soil cover. Since it has been forty years since the landfill closure, gas generation of the refuse has decreased drastically. A graphical representation is seen in Appendix A. Eastgate landfill closed in 1964, and the landfill gas production probably peaked in 1965. By 2005 the landfill gas system was only turned on and burned three times a week by the City. Three years later the landfill gas system is turned on three times a week, but requires augmentation with propane to maintain combustion in the flare.

2.4.2 Gas Generation Volume

A graphical representation was made of the gas generation from the landfill. Under the curve represents the amount of gas that is generated. There were extraction wells installed in 1986. They worked sufficiently but now they no longer can burn the gas produced by the landfill. Propane needs to be added in order to burn the gas that is generated by the Eastgate landfill.

The amount of gas that is produced by the landfill was calculated using the volume of waste under the soil cap and the weight of the waste. From the total volume of waste it is assumed that only 80% is refuse. That would make 248,000 yd^3 of refuse. Of that only 75% generates gas, assuming that 25% of the refuse is inert. It was assumed that waste in place is somewhat dense at 1800 pounds per cubic yard. The weight of waste and the volume of the waste were multiplied together to come up with the pounds of waste that resides in the Eastgate landfill, 335,000,000 lbs.

The potential methane generation capacity of refuse is 120 cubic meters per tonne of refuse. The pounds of refuse was converted to tonne and then multiplied by the capacity. The theoretical amount of methane generation is 18,000,000 m^3 for the Eastgate Landfill.

2.5 SOIL REMOVAL

2.5.1 Reason for Soil Removal

To determine the cost of excavating and removing refuse material from the landfill site, the volume of the refuse and the surrounding contaminated soil was estimated using standard engineering techniques. The estimate was performed assuming 2.5 feet of soil above and below would need to be removed in addition to the refuse in place. URS also assumed the area excavated would need to be covered with a 2.5 foot layer of clean soil and vegetated. This would leave the old landfill site clean and ready for new development.

2.5.2 Volume of Soil Removal

Refuse material to be removed is the volume of the total landfill, 310,000 yd^3, and surrounding material that may contain or be in contact with refuse. An additional two and a half feet from the top and bottom of the landfill would also need to be removed. Only 2.5 feet of the soil cap can be saved and reused to help fill in the excavated portions of the old landfill, which is approximately 35,000 yd^3. The remainder of the soil cap will need to be removed and disposed to remove any waste that may be touching the soil cap. The soil cap that needs to be removed has a volume of 103,000 yd^3. Adding the volumes of the soil cap, the volume of refuse, and the volume of the additional soil the total amount of material that will need to be excavated will be 565,000 yd^3.

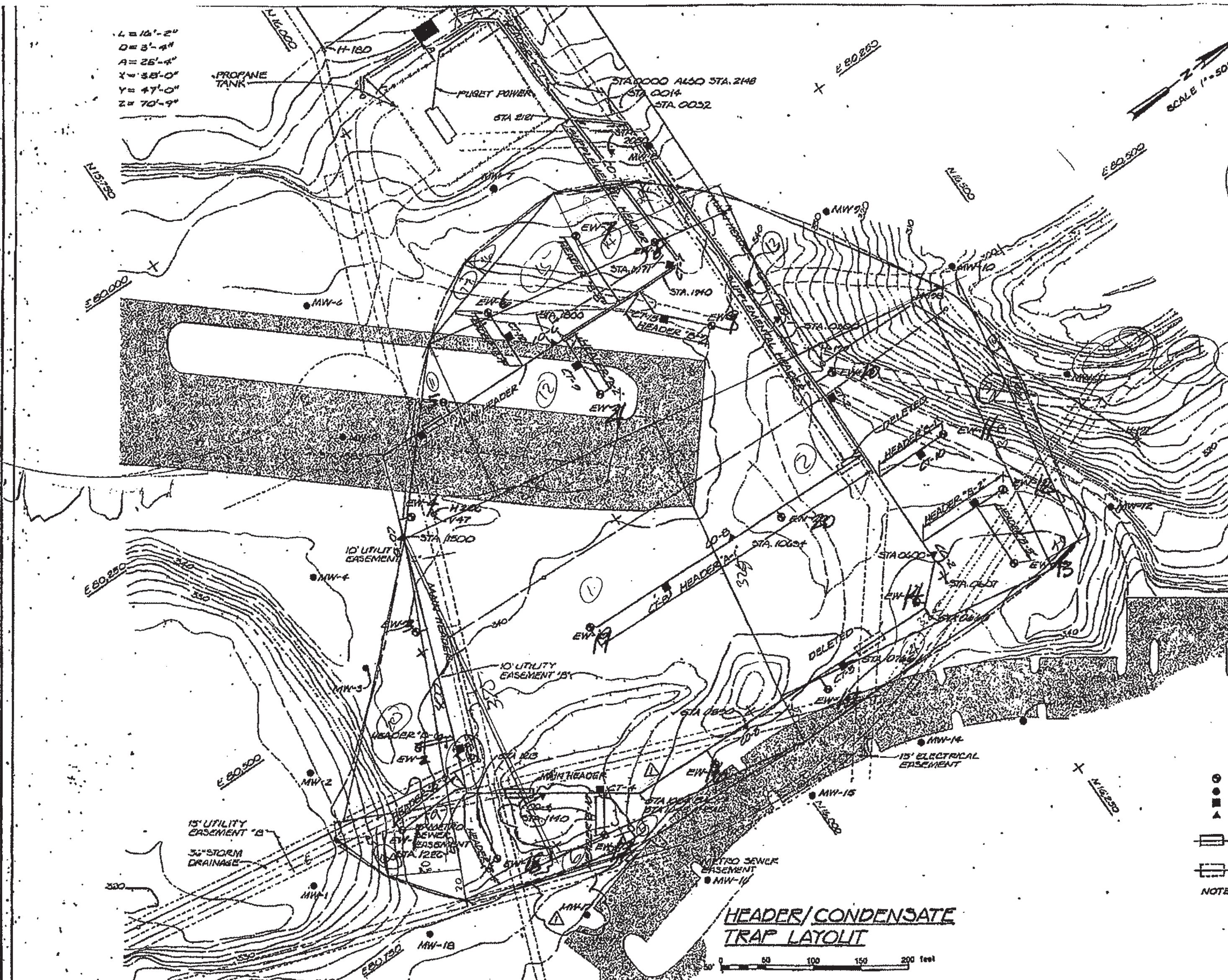
2.5.3 Cost of Soil Removal

The top 2.5 feet of the soil cap can be moved to the side with a scraper, this cost is estimated to be $104,000. Based on the volume of the total amount of material that will need to be excavated, 565,000 yd^3, the estimated cost to excavate it would be $8,800,000. This cost estimate is from RS Means, Heavy Construction Cost Data 2008. There will be an additional cost to dispose of the refuse. This cost is includes hauling it off and dumping it at the Rabanco Recycling Center and Transfer Station. This total cost is estimated to be $32,000,000. The total cost to excavate and remove the refuse from the Eastgate Landfill is estimated to be $41,000,000, see Appendix B.

2.6 RECOMMENDATIONS

Development of the site should include consideration of engineered measures to address the life safety, environmental and construction risks associated with building on or near an old landfill. For structures, this will require either remove portions of the waste around the structure(s), using piles or other means to support the structure(s) or perform ground improvement to address compressible soils, water and gas barriers to prevent landfill gas intrusion. For sport field(s); this will require installation of water and gas barriers to collect precipitation/irrigation prior to it reaching the waste and generating more leachate or landfill gas, and protect the surface features from landfill gas. Any development would require installation of monitoring systems to verify performance of the protection systems installed.

Figure 1


EXISTING
ENTIRE LANDFILL AREA
PONDS
4/13
L = 16'-2"
D = 3'-4"
A = 26'-4"
X = 38'-0"
Y = 47'-0"
Z = 70'-9"
PROPANE TANK
PUGET POWER
STA.0000 ALSO STA.2148
STA.0014
STA.0032
STA.2161
SCALE 1"=50'
HEADER/CONDENSATE TRAP LAYOUT
10' UTILITY EASEMENT
10' UTILITY EASEMENT "B"
15' UTILITY EASEMENT "B"
15' ELECTRICAL EASEMENT
36" STORM DRAINAGE
METRO SEWER EASEMENT
MAIN HEADER
DELETED
STA.1500
STA.1063
STA.1140
STA.1400
STA.0600
STA.0820
MW-1
MW-2
MW-3
MW-4
MW-6
MW-7
MW-10
MW-11
MW-12
MW-14
MW-15
MW-18
MW-20

NOTE: BENDS CAN BE ACHIEVED BY USING MOLDED FITTINGS AND/OR BY BENDING HDPE PIPE ACCORDING TO MANUFACTURER'S RECOMMENDATION

HORIZONTAL POSITIONS △

POINT	N	E
H 180	16,026.885	79,912.925
H 197	16,504.734	80,748.135
H 196	16,391.766	80,495.163
H 198	16,278.165	80,492.1795
H 208	15,842.859	80,385.371

BENCHMARK △

V-47 342.18

LEGEND

- ⊙ EW - EXTRACTION WELL, DETAIL 1/8, 21 TOTAL
- ● MW - MONITOR WELL, DETAIL 1/8, 18 TOTAL
- ■ CT - CONDENSATE TRAP, DETAIL 2/8, 13 TOTAL
- ▲ CO - CLEANOUT, DETAIL 5/8, 8 TOTAL
- STA - STATION
- 12" STEEL JACK CASING UNDER UTILITIES AND 12" STEEL CASING UNDER FUTURE ACCESS ROAD
- 12" STEEL JACK CASING UNDER UTILITIES ONLY — DELETED

NOTE: 30-DAY NOTICE REQUIRED PRIOR TO EXCAVATION NEAR ELECTRICAL DUCT BANK. NOTIFY BOEING COMPUTER SERVICES, BOEING REPRESENTATIVE.

SYM	REVISION	BY	APPROVED	DATE
△	RELOCATIONS PER BOEING	JNT		6-25-86
△	AS-BUILTS PER BOEING			5-1-87

BOEING FACILITIES DEPARTMENT
■ BELLEVUE, WA. 98004

☐ AUBURN, WA. 98002
☐ EVERETT, WA. 98201
☐ KENT, WA. 98031
☐ PORTLAND, OR. 97220
☐ RENTON, WA. 98055
☐ SEATTLE, WA. 98124

CH2M HILL

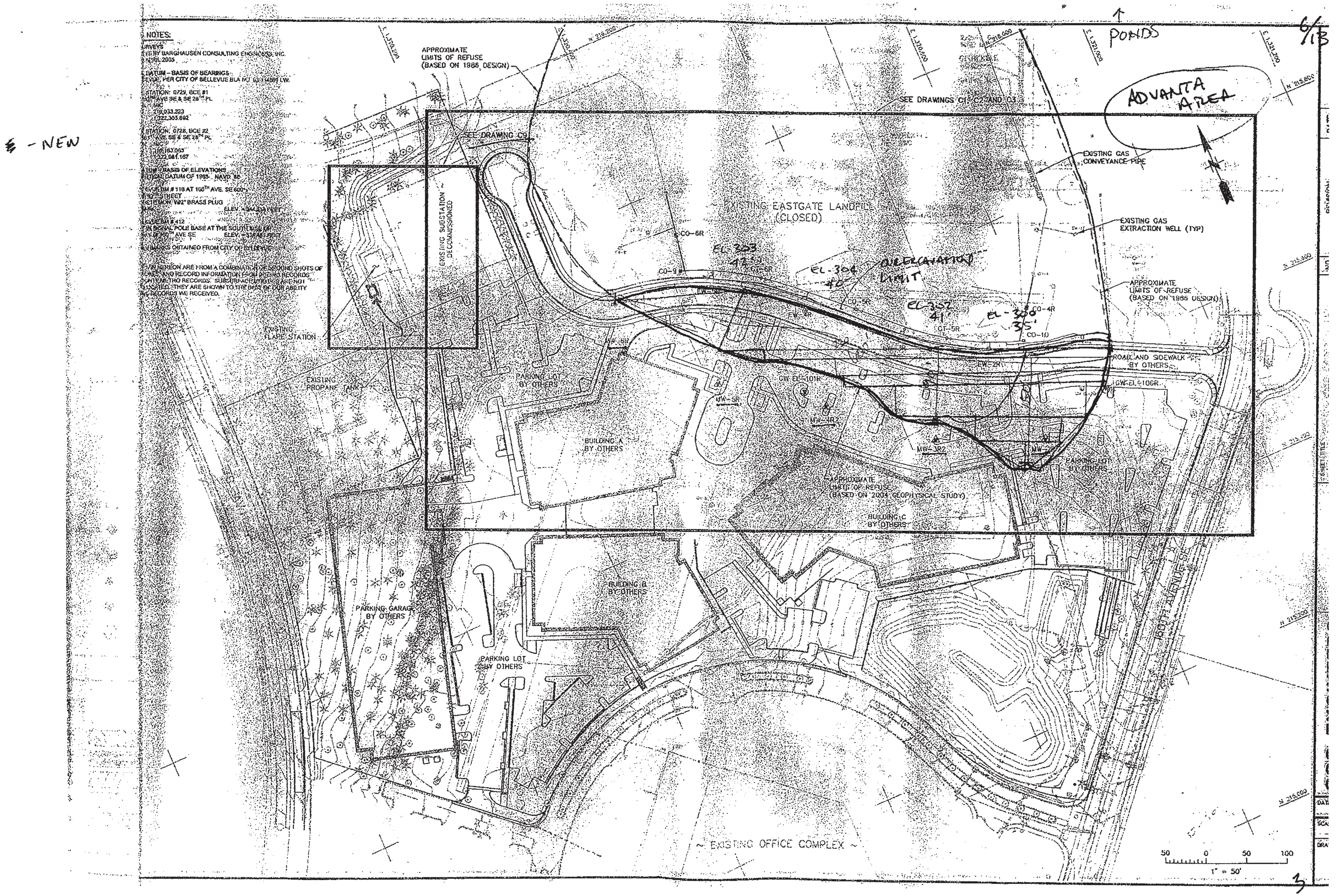
HEADER/CONDENSATE TRAP LAYOUT

BOEING-EASTGATE LANDFILL
LFG MIGRATION CONTROL SYSTEM

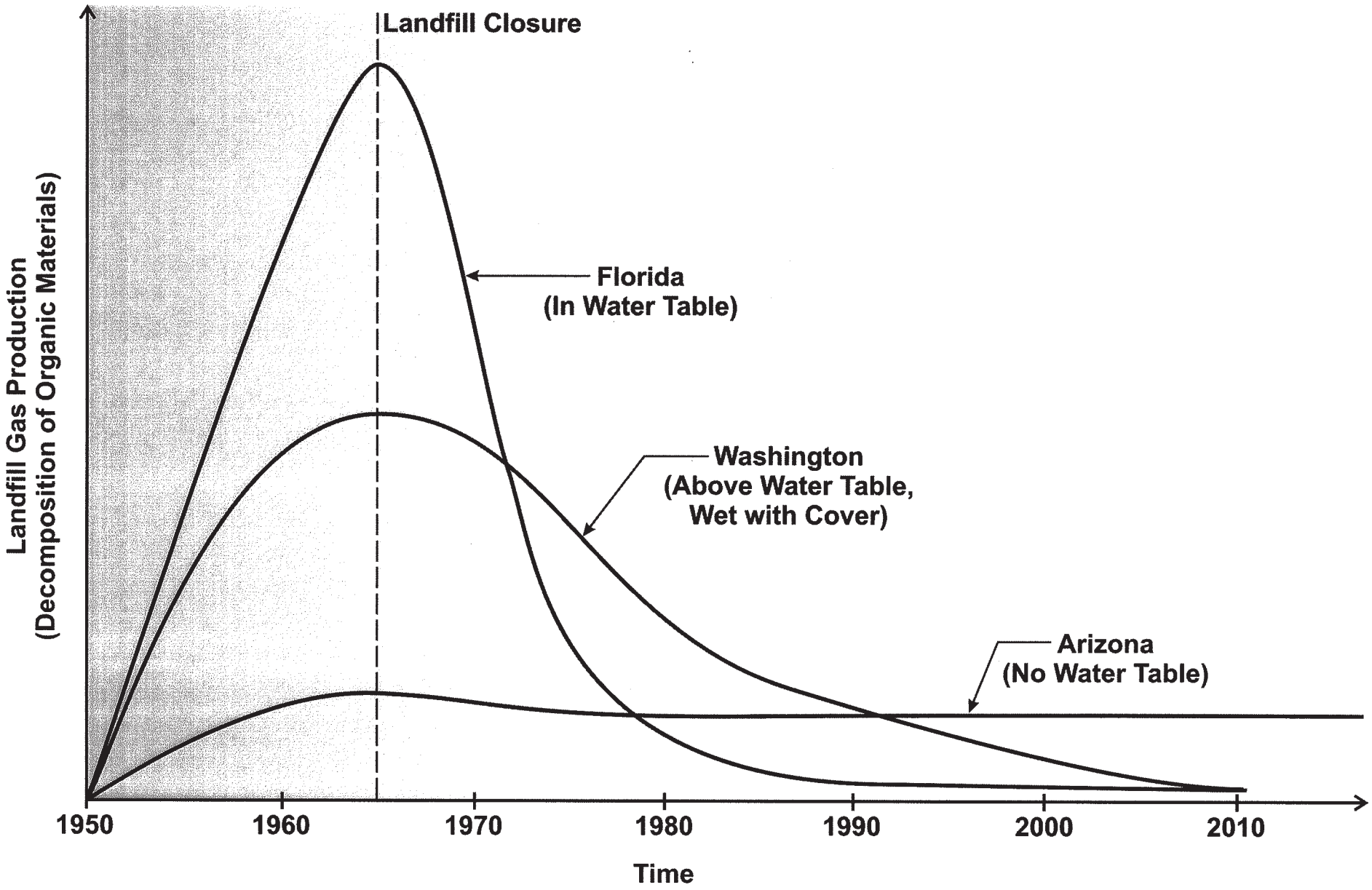
C-5

33-00-YD-1012-C5

Figure 2


NOTES:
APPROXIMATE LIMITS OF REFUSE (BASED ON 1986 DESIGN)
SEE DRAWINGS C1, C2 AND C3
SEE DRAWING C9
EXISTING SUBSTATION ~ DECOMMISSIONED
~ EXISTING EASTGATE LANDFILL ~ (CLOSED)
EXISTING GAS CONVEYANCE PIPE
EXISTING GAS EXTRACTION WELL (TYP)
EXISTING FLARE STATION
EXISTING PROPANE TANK
PARKING LOT BY OTHERS
BUILDING A BY OTHERS
BUILDING B BY OTHERS
BUILDING C BY OTHERS
APPROXIMATE LIMIT OF REFUSE (BASED ON 2004 GEOPHYSICAL STUDY)
ROAD AND SIDEWALK BY OTHERS
PARKING GARAGE BY OTHERS
~ EXISTING OFFICE COMPLEX ~
1" = 50'
PONDS
ADVANTA AREA
E - NEW
EL-303 42'
EL-304 40'
EL-357 41
EL-300 35'
6/13

Appendix A


Landfill Closure
Florida
(In Water Table)
Washington
(Above Water Table,
Wet with Cover)
Arizona
(No Water Table)
Landfill Gas Production
(Decomposition of Organic Materials)
1950
1960
1970
1980
1990
2000
2010
Time

Appendix B

Fee	Units	Quantity	Unit Price	Amount
Tipping	TON	565280	$43.00	$24,307,040.00
Hauling	CY	565280	$13.00	$7,348,640.00
Excavation	CY	565280	$15.60	$8,818,368.00
Moving top of Soil Cap	YD	34718	$3.00	$104,154.00
Total				$40,578,202.00