



*Pilot Study Report  
Deschutes County Construction  
Demolition Landfill  
Bend, Oregon*

Prepared for:  
Deschutes County

September 16, 2016  
2112-03



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A handwritten signature in blue ink, appearing to read 'John P. Foxwell', written over a horizontal line.

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Senior Associate*



**EXPIRES: DEC. 31, 2017**

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## **1.0 Introduction**

This document is the Pilot Study Report for the former Deschutes County Construction and Demolition Landfill, in Bend, Oregon (the Site; Figure 1). The Site is a 72.4-acre multi-parcel property located southwest of the intersection of SW Simpson Avenue and SW Century Drive. This Report was prepared for Deschutes County in accordance with an *Agreement for Funding of Removal and Remedial Actions from the Solid Waste Orphan Account* between Deschutes County and the Oregon Department of Environmental Quality (DEQ). The Pilot Study approach and work scope is described in the *Pilot Study Work Plan, Deschutes County Construction and Demolition Landfill*, dated April 12, 2016.

### **1.1 Pilot Study Objectives**

The objective of the pilot test is to evaluate the feasibility, costs, and time required for a waste excavation and processing project at the Site. The pilot test data was collected to evaluate:

1. Whether landfill materials [e.g., clean overburden, landfilled construction debris, and other solid waste] can be segregated in a cost-effective manner;
2. What amount of waste reduction is possible as a result of segregation and recycling;
3. The process and time required to segregate materials; and
4. Programs and processes necessary to prevent nuisance conditions [e.g., dust, odors, noise, etc.] and protect public safety and health.

## **2.0 Background**

Background on the Deschutes County Construction and Demolition Landfill is described in this section. The Site includes former construction-demolition landfill cells (referred to as Areas 1 through 3). Each were created at different times and are comprised largely of former mill wastes, construction and demolition waste (CDW), and other miscellaneous waste materials. Municipal solid waste (MSW) is not documented at the landfill. Figure 2 shows each area and a summary of the general landfilling history for each area.

The Pilot Test was performed at Areas 1 and 2. Area 1 is the oldest cell and has the greatest thickness of debris. Area 2 is less extensive than Area 1 and has large areas where CDW was placed in a lesser thickness, relative to other locations at the Site. Area 3 is not included in the pilot test because the redevelopment scenarios generally considered for the Site include Area 3 as a future disposal site due to its significant remaining capacity.

The eastern portions of Area 1 are subject to subsidence from thermal breakdown of deeper mill wastes that are present across an approximate 75-foot-wide strip of Area 1 that runs parallel to the east property boundary (Figure 3). This portion of the landfill corresponds to the deepest sections of the landfill

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(approximately 60 to 80 feet deep). The combination of anaerobic degradation and overburden pressure on the finer grained materials at depth initiates a pyrolysis reaction that results in low temperature combustion of the materials and subsequent subsidence. Mitigation requirements in this area will go beyond the material sorting and processing activities that are the focus of this work plan. Due to safety considerations associated with working in unstable areas and the unique mitigation requirements, the Pilot test was not to be completed in these areas.

## 2.1 Site Location and Description

The former Deschutes County Construction and Demolition Landfill site (the Site) is shown on Figures 1 and 2. It contains four parcels (60000100, 600000110, 60000111, and 60000719), for a total of 72.4 acres. There are three distinct former landfilling areas (Areas 1, 2, and 3), as shown on Figure 2. The landfill was first permitted in 1972 by DEQ. In 2008, a closure permit was issued for the landfill. The closure permit will require renewal in 2016. Area 3 is the only portion of the landfill with a DEQ-approved soil cover.

The Site is bordered to the southeast by OSU Cascades and the former Robinson Quarry. OSU Cascades has an option to purchase the former Robinson Quarry. The properties to the west and north of the Site are developed for single-family residential uses. Properties to the east of the Site are used for retail and office uses. Parcel 60000109, located at the approximate center of the Site, consists of offices and operations for the City of Bend Parks and Recreation. Some landfill wastes are present on this parcel; however, this parcel is not considered part of the landfill.

## 2.2 Landfilling History

This section describes the general history of landfilling activities at the Site. The lateral extent of former landfill debris at Areas 1, 2, and 3, based on work completed by GBB (2008), are shown on Figure 2. Cross-sections that show the vertical profile of debris in each area, including the thickness of cover soil, depth of landfilled materials, and depth to bedrock, are provided in Appendix A.

Landfill Area 1 encompasses tax lots 60000110 and 6A000719, and is approximately 23.2 acres in total size. Area 1 operated from the 1960s, prior to the 1972 permit, until 1980. Debris in the eastern portion (tax lot 110) of this area reportedly consists of sander dust and fine wood waste, general wood waste, and pond sludge mixed with wood waste. This debris is present to depths of as much as approximately 90 feet below the ground surface (bgs). Approximately 10 feet of sand covers the debris. Some parts of tax lot 110 have experienced significant subsidence and low temperature underground combustion activity. Most of the subsidence and combustion has been observed at the eastern portion of this area, the location with the greatest vertical accumulation of landfill debris. The southeastern portion of Area 1 (tax lot 719) reportedly includes a large deposit of buried tires, mixed with wood-waste. Combustion and subsidence have not been documented at tax lot 719 to the extent observed at tax lot 110.

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Landfill Area 2 is approximately 9.8 acres and encompasses most of tax lot 60000111. A small area at the northeast portion of tax lot 111 reportedly does not include landfill debris. Area 2 operated from 1988 to 1997. Approximately 30 to 90 feet of landfill debris, consisting primarily of wood debris, is present at Area 2. Signs of subsurface combustion have not been observed at Area 2.

Landfill Area 3 is approximately 39.4 acres and encompasses approximately half of tax lot 60000100. The southern portion of tax lot 100 reportedly does not include landfill debris. Area 3 operated from 1992 to 1996 and is the only portion of the former landfill that has a DEQ-approved soil cover. The thickness of landfill debris ranges from approximately 25 feet at the west side of Area 3 to approximately 110 feet at the east side. Buried debris reportedly includes primarily construction and demolition wastes, with proportionally less wood waste than in Areas 1 and 2. Some timber and slash have reportedly been buried near the surface in northwest part of Area 3.

### **2.3 Waste Occurrence, Composition, and Volumes**

Deschutes County retained GBB in 2008 to characterize the occurrence, nature, and volume of waste materials at the Site and to develop an information package that would be useful to future developers when considering redevelopment strategies for the property. GBB utilized a combination of historical resources, geophysical investigation data, and subsurface investigation data to describe the conditions in Areas 1, 2, and 3, estimate waste volumes and cover soil present in each area, and develop information regarding the composition and distribution of waste materials in each area.

Historical information and data gathered by GBB (2008) indicate that landfill debris at Areas 1 and 2 are composed largely of wood products derived from area mills. The Brooks-Scanlon mill, later Crown Pacific Ltd., operated until 1994 and is a primary source of debris for the Site. Initially, Ponderosa Pine wood was milled at the Brooks-Scanlon facility. Subsequently, the facility manufactured plywood, molding, and particle board. Mill wastes identified at the Site include ash from wood-fired boiler systems, coarse sawdust, fine texture sander dust, mill ends and various wood trimmings.

Mill waste, presumably from the Crown Pacific Mill, was encountered in Area 3 during the 2008 explorations. The later years of operations at Area 3 (through 1996), coincide with a period when the City of Bend was growing rapidly. GBB (2008) concluded that significant deposits of demolition debris were likely disposed in Area 3, including remnants of razed structures, concrete and waste rock. Large quantities of woody debris, such as stumps, logs, and slash, are also present in Area 3.

The table below summarizes the characteristics of each landfill area, based on information compiled by GBB (2008). The GBB volume estimates were based on geophysical survey and account for the fact that the depth of the landfill cells is extremely variable (See cross-sections in Appendix A). The waste fraction percentages estimated by GBB were based on sorting percentages from a study performed by GBB on a New York project site, and then extrapolated to the site.

**Waste Occurrence, Composition, and Volumes**

	<u>Area 1</u>	<u>Area 2</u>	<u>Area 3</u>
Operation Period	1972-1987	1988-1992	1992-1996
Size (acres)	23.2	9.8	39.4
Waste Footprint (acres)	25.3 <sup>1</sup>	6.8	19.5
Est. Max. Waste Depth (ft)	60 – 70	70 – 80	70 - 80
Est. Waste Volume	1,133,500	456,000	838,000
Est. Cover Material Volume	258,000	24,000	245,900
<b>Estimated Materials</b>			
	<b>% of total</b>	<b>Volume (cy)</b>	<b>% of total</b>
			<b>Volume (cy)</b>
Ash	3.1	35,650	2.1
Gravel	0.9	10,223	0.0
Demolition Wastes	9.5	107,457	18.1
Reclamation Fill	1.0	11,638	0.5
Sawdust	7.0	78,987	8.1
Metal	0.6	7,119	0.0
Tires	0.3	3,638	0.0
Unidentified	43.1	488,883	0.0
Wood Waste	34.4	389,895	71.2
<b>Total</b>	<b>100.0</b>	<b>1,133,500</b>	<b>100.0</b>

**Notes:**

After GBB, 2008

1. Area 1 waste footprint includes waste from Area 1 that extend to the Parks and Recreation property.

### **3.0 Pilot Study Activities**

Pilot study activities were completed from April 18 to April 28, 2016. Apex Companies completed field oversight, documentation, and monitoring throughout the course of the field project. The pilot study consisted of the following work activities that are summarized in this section:

- Preparatory Activities;
- Protection of Environment;
- Pilot Study Excavations;
- Waste Processing;
- Site Restoration; and
- Field Screening and air monitoring.

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Test pit logs and photographs summarizing the pilot test activities are included in Appendix A and B, respectively.

### **3.1 Preparatory Activities**

**Site Health and Safety Plan.** A Site-specific HASP was prepared for the excavation and processing activities. The HASP was prepared in accordance with OAR 340-248 and OAR 437-003 and was maintained on-Site during the field activities.

**Permits.** No permits were required for the Pilot Test work.

**Underground Utility Location.** The Oregon Utility Notification Center was contacted to mark underground utilities and Deschutes County reported that all the active landfill areas were free of County owned underground utilities.

**Neighborhood Outreach.** Apex worked with Deschutes County to develop and distribute a project work notification. OSU Cascades provided an email distribution list for OSU Cascades project stakeholders and adjacent property owners.

### **3.2 Protection of Environment**

#### **3.2.1 Erosion Control**

Excavations were sloped inward to direct stormwater runoff to infiltrate within the exposed CDW. Rain did not occur during the project. Silt fences or other erosion and sediment control measures were not required.

#### **3.2.2 Dust Control**

Dust created during the excavation activities could be a nuisance and a potential risk to human health. The Contractor maintained a condition of no visible dust outside the immediate work area. A water truck was available on site for dust control if needed. Dust control was not required during the pilot test.

#### **3.2.3 Noise Control**

The Contractor minimized noise impacts by operating equipment in compliance with the requirements of Deschutes County. Noise generated by the project did not generate any nuisance conditions. Equipment was entirely staged within the landfill area.



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### **3.2.4 Odor Control**

Throughout the project duration Apex monitored for the present of nuisance odors. This was completed at the excavation and work areas, and perimeter air monitoring stations for the asbestos monitoring program described in Section 4.6.1. Nuisance conditions were occasionally observed closer to the excavations (see additional discussion Section 4.6.2). In no circumstances did these conditions extend past the immediate excavation area or persist for an extended period of time. Mitigation procedures were not required.

### **3.2.5 Fire Management During Excavation**

The test pits completed in Area 1 were completed away from the thermal areas. Some minimal smoke venting that did not require mitigation measures was observed in test pit 1-5 in the southeast portion of the site. A water truck was available throughout the pilot test in the event fire suppression was required.

### **3.2.6 Site Security**

The access gate to the landfill was kept closed during the pilot study to prevent public access. The gate was locked each night.

### **3.2.7 Decontamination of Equipment**

During the course of the work, the Contractor minimized the amount of equipment entering/leaving the pilot study area. Work was completed in a specific area, then all equipment moved to the next location. No tracking occurred between areas or on roads. In total, only two truckloads of waste left the site.

## **3.3 Pilot Study Excavations**

Test pits and trenches were excavated to assess waste composition and identify materials to remove for processing. Eleven (11) test pit excavations were completed in Area #1 and six (6) test pit excavations were completed in Area #2. Figure 3 shows the test pit exploration locations. The excavation and onsite material handling for the project was completed by Taylor Northwest, of Bend, Oregon. Test pit excavations were completed between April 18, 2016 and April 26, 2016. Test pit logs were maintained for each excavation and are included in Appendix A.

Each of the test pit excavations generally had similar lateral dimensions, approximately 20 feet by 6 feet. The Contractor removed cover soil and minimal vegetation at each test pit location in order to access the CDW. The thickness of cover soils encountered during excavation ranged from 1.5 to 5 feet in Area 1 and from 1.5 to 2 feet in Area 2. Excavated cover soils were stockpiled adjacent to the excavation area for eventual backfill for CDW cover.

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Cover thicknesses and excavation depths were measured at each test pit. Excavation depth was measured using gradations on the excavator arm. Locations of test pits were recorded with a sub-meter grade global positioning system.

The excavation sequence involved excavating to a depth of approximately 23 feet (corresponding to the limit of the excavator), then benching the excavation approximately 7 feet deep, which allowed the test-pit excavation to be completed an additional 10 feet to approximately 30 feet deep. At location 1-11, located in one of the deepest sections of Area 1, a second excavation bench was cut in order to attain a total excavation depth of 40 feet bgs. The test pit areas were approximately 20 feet long by 6 feet wide.

Materials encountered in the Area 1 test pits was primarily wood waste, mostly consisting of sawdust mixed with wood waste, with occasional pockets of dimensional lumber and logs. Minor amounts of non-wood waste were observed. Non-wood waste items that were occasionally observed included metal banding, wire, tires, and miscellaneous debris. During the course of the work, two drums were encountered. At TP 1-2, a crushed plastic drum was excavated and soils in the vicinity of the drum had an organic odor and a corresponding PID reading of 58 parts per million. The drum was encountered at a depth of approximately 10 feet. The drum and associated soils were replaced at the interval they were encountered and the test pit was stopped at that depth. A second drum that contained solids was observed at 7 feet bgs in TP-5. Field screening of the soil and exterior of the drum did not indicate volatile organic compounds (VOCs). This test pit was continued to depth and the drum as placed near the top of the test pit after backfill.

Materials encountered in Area 2 included a significant amount of sawdust, but also materials that would be expected in a construction-demolition debris landfill. Drums were not observed. An accumulation of potential ACM materials (roofing debris) were observed at approximately 23 feet in TP 2-2. An occasional ammonia-like odor was noted in TP 2-3.

### **3.3.1 Excavated Materials for Processing**

Materials were excavated from the pilot study areas and staged for processing. Materials were encountered in the Area 1 test pit excavations were nearly exclusively wood waste. All of the recovered wood waste from each of the test pits excavated from Area 1, approximately 1,000 cubic yards of wood waste, was reserved for processing (total volume was 986 cubic yards). For Area 1, the volume of wood waste removed from each test pit ranged from 65 to 205 cubic yards, based on excavation dimensions. Piles were also field measured with a GPS enabled range finder and the removal volumes were similar, ranging from 56 to 187 cubic yards.

Materials from Area 2 were excavated and staged for processing. Nearly all of the materials excavated from Area 2 consisted of mixed CDW (wood waste, concrete/brick rubble, metal, soil). Materials could not be readily sorted with an excavator or screening equipment. No onsite processing of this material was

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completed. Therefore, a subset of materials from each excavation were retained and transported to the Materials Recovery Facility (MRF) for processing.

### 3.4 Processing

The on-Site wood waste processing was completed to remove wood for eventual chipping. This was completed exclusively from the Area 1 wood waste. Approximately 986 cubic yards of wood waste was segregated for onsite processing. Onsite processing was completed from April 21 to April 24, 2016.

Onsite processing included passing the material through a screening plant with a ½-inch screen. The materials required two rounds of screening through the plant. Following screening, the pile of processed material was found to contain a sufficient amount of metal and rocks/rubble that rendered the material incompatible with chipping. Therefore, no chipping was completed onsite. All of the wood that was removed from the screened materials, approximately 35 cubic yards from Area 1, was taken for off-Site processing at the Materials Recovery Facility (MRF).

The load of processed wood waste from Area 1 and the load of mixed waste from Area 2 were taken to Greenway Recycling, an MRF in Portland, Oregon for sorting. The MRF separated each load into the waste streams described below.

**Landfill Cover (Soil, Rock, Inert Materials).** Rock, concrete, and other inert materials were separated into fractions less than 1-inch (generally qualifying for use as alternate daily cover) and larger diameter materials (> 2 inches) that could be crushed and used in the future for soil cover.

**Metal.** The MRF manually separated metal from the waste stream.

**Wood Waste.** Wood waste from the Area 1 and Area 2 loads were separated for chipping. These fractions were weighed and accounted for separately in the composition estimates in later sections. After the wood waste was weighed, the two loads of wood waste were combined and sent to the Bar Seven A facility in Redmond, Oregon for chipping on May 9, 2016. Approximately 15 cubic yards of wood waste was chipped. Separation at the MRF sufficiently removed the metal so the chipping process was unimpeded by foreign materials.

**Landfill Waste.** Landfill waste represents the residual materials that cannot be reused or recycled.

### 3.5 Site Restoration

Once the pilot test activities were complete, residual CDW left after processing was returned to the excavation and the excavations were backfilled. CDW was backfilled and compacted with the excavator

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bucket to a dense, non-yielding condition. Because the excavation cover varied across the pilot test area, the CDW was backfilled generally to the point that matched the CDW in each excavation.

Cover was replaced over the excavation areas to match the current grade. Some additional backfill cover was taken from an onsite borrow area at the edge of Area 1 where excess soils were previously placed for a possible recreational field. The County will manage any further backfill and revegetation that may be required under the solid waste permit.

### **3.6 Asbestos Monitoring Program**

Accumulations of asbestos containing material (ACM) were not been positively identified during previous work at the site. GBB (2008) notes that possible ACM was occasionally observed, but their report did not provide, details or locations of the possible ACM. Because definitive information regarding asbestos presence is unavailable, an asbestos monitoring program was implemented to continually screen for the presence of asbestos.

The asbestos monitoring program consisted of visual observations for ACM debris, air monitoring at the test pit and processing areas, air monitoring at the perimeter of the work area, and worker monitoring. An AHERA Asbestos Inspector (acting as the OSHA “Competent Person”) was responsible for implementing the asbestos monitoring program.

Worker, work area, and perimeter air samples were collected using an air pump, set to a pumping rate of approximately to 5 liters per minute. The perimeter air pumps were deployed for approximately 8 hours, during normal working hours. The samples were analyzed using PCM methods by a NIOSH 582-certified analyst using NIOSH Method 7400 counting rules.

Asbestos concentrations were considered acceptable:

- For public health if the detected concentrations in perimeter air samples were less than the EPA AHERA clearance level of 0.01 f/cc. The action level of 0.01 f/cc corresponds to the clearance level mandated by OAR 340-248-0270(13) and is more conservative than the action level that would be calculated using EPA (2008) recommended methods.
- For worker protection if the detected concentrations for personal samplers were less than the OSHA PEL [0.1 f/cc, based on an 8-hour Time-Weighted Average (TWA)] during normal operating conditions).

**Visual.** Roofing materials were the only potential ACMs that were observed in during the Pilot Study. These materials were observed in Area 2 in test pit TP-2.

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**Work Area Monitoring.** Daily work area samples were run and none of the samples exceeded the action levels. Air samples were collected from locations corresponding to the daily excavation areas and the processing area. The work area air sample locations moved with the excavation equipment and were consistently placed downwind of the work area.

**Perimeter Monitoring.** Daily perimeter samples were run and none of the samples exceeded the action levels. Air samples were collected from locations between the processing area and property boundary to confirm impacts to offsite residential and commercial areas adjacent to the site did not occur. The perimeter air sample locations were located downwind of specific work areas each day. A minimum of one 8-hour air sample was collected at each perimeter location on a daily basis.

**Worker Monitoring.** Daily worker monitoring samples were run and none of the samples exceeded the action levels. The excavator operated in constant contact with the landfilled materials. Worker breathing space air samples were collected during the pilot study activities from within the excavator cabin. The excavator cabin was a sealed, positive pressure cabin.

### **3.7 Field Screening**

Field screening information collected during the pilot study included: (1) the potential presence of VOCs measured using a photoionization detector (PID); (2) the potential presence of petroleum hydrocarbons by sheen testing; and (3) the potential presence of combustible gas using a Lower Explosive Limit (LEL) meter calibrated to methane. Field screening was conducted once the excavation was open to a depth of between 10 and 15 feet. After that depth, field screening was conducted from the stockpiles of material placed at the side of the excavation in order to avoid approach of the excavation. All excavations within the pilot study areas were subject to specific excavation safety requirements and air quality monitoring for asbestos as described in the Work Plan (Apex, 2016).

## **4.0 Processing Results**

The results of the processing activities are summarized in this section. Two waste streams were sent to the MRF in Portland. These included one 35 cubic yard trailer all the Area 1 materials (primarily wood waste) retained after screening and one 35 cubic yard trailer of the representative materials from Area 2, which were not screened.

The Area 1 processing results are summarized in the table below. The table summarizes the fractions of each waste sorted at the MRF (as both the weight and fraction percentage) and Total Volumes that represent the composition of the material handled during the pilot test. Weights for each fraction, except fines, were provided by the MRF. The weight of the fines was determined by subtracting the weight of each weighed fraction (wood, metal, concrete/brick, and miscellaneous materials) from the total load weight. Volume estimates within the sorted fraction were estimated by based on the sorted fraction percentage

applied to a 35 cubic yard trailer. Total Volumes, reflecting the composition of the waste that was handled during the pilot test, were estimated by incorporating the approximately 960 cubic yards of fines that were screened on site. Waste fractions representative of the material handled during the pilot test were also calculated (Total %).

#### Area 1 Processing Results

Material	Weight (pounds)	Sorted % at MRF	Sorted Volume (cubic yards)	Total Volume (cubic yards)	Total %
Wood	13,080	38.6 %	13.5	13.5	1.4 %
Fines	18,930	55.8 %	19.54	980.99	98.4 %
Metals	30	0.1 %	0.03	0.03	0.00 %
Concrete/Brick	780	2.3 %	0.81	0.81	0.1 %
Misc.	1,080	3.2%	1.12	1.12	0.1 %
Total	33,900	100%	35	996.44	100%

The Area 2 processing results are summarized in the table below. The table summarizes the fractions of each waste sorted at the MRF (as both the weight and fraction percentage) that were determined in the same manner as used for the Area 1 sorting. Since onsite processing was not completed for Area 2, the Sorted fractions reported below also represent the composition of the material handled during the pilot test.

#### Area 2 Processing Results

Material	Weight (pounds)	Sorted %	Sorted Volume (cubic yards)
Wood	1,140	3.0 %	1.0
Fines	31,110	81.4 %	28.5
Metals	370	1.0 %	0.3
Concrete/Brick	3,580	9.4 %	3.3
Misc.	2,000	5.2%	1.8
Total	38,200	100%	35

The results indicate that the materials in Area 1 are predominantly comprised of fine-grained materials (sawdust, soil, etc.). The amount of fines measured at the site may be slightly higher than the in-place volume due to wood breakdown in the screening plant. Note that neither the Area 1 or Area 2 breakdown reflects waste omitted from the pilot study (e.g., the large accumulation of tires in the southeast corner of Area 1 and the limited area of potential ACM roofing materials encountered in Area 2).

## **5.0 Wood Waste Testing**

The processing activities yielded two wood-waste streams – wood chips and sawdust/fines. Samples of each waste stream were sent to Umpqua Research in Myrtle Creek, Oregon for laboratory for physical and elemental parameters useful to evaluate possible cogeneration uses. These analyses include:

- Heating value (BTU/pound) using ASTM D240;
- Ash Content using ASTM E1102-84;
- Sulfur content using ASTM E775-87;
- Moisture content using ASTM E 871-82;
- Volatile Matter using ASTM E872; and
- Cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), zinc (Zn), arsenic (As), mercury (Hg) and lead (Pb).

The results for the two samples are summarized in the table below.

	Units	Wood Chips	Area 1 Fines	Criteria
Heating value (BTU/pound) using ASTM D240	BTU/pound	10,200	1,130	Minimum = 5,500 <sup>1</sup> Minimum = 4,125 to 6,600 <sup>2</sup>
Ash Content using ASTM E1102-84	mg/kg	71,000 (7%)	603,000 (60%)	Maximum = 3% <sup>1</sup> Maximum = 3%, Typical = 1% <sup>2</sup>
Moisture content using ASTM E 871-82	%	38.9	28.7	25% - 42% <sup>1</sup> 25% - 50% <sup>2</sup>
Volatile Matter	%	88.4	15.4	80% to 90% <sup>3</sup>
Sulfur content using ASTM E775-87	mg/kg	41.2	0	See Appendix C <sup>4</sup>
Arsenic	mg/kg	1.51	0.467	See Appendix C <sup>4</sup>
Cadmium	mg/kg	0.376	0.277	See Appendix C <sup>4</sup>
Chromium	mg/kg	5.52	3.98	See Appendix C <sup>4</sup>
Copper	mg/kg	7.86	13.0	See Appendix C <sup>4</sup>
Lead	mg/kg	49.1	13.3	See Appendix C <sup>4</sup>

	Units	Wood Chips	Area 1 Fines	Criteria
Mercury	mg/kg	0.0726	0.0509	See Appendix C <sup>4</sup>
Nickel	mg/kg	3.29	7.49	See Appendix C <sup>4</sup>
Zinc	mg/kg	176	36.9	See Appendix C <sup>4</sup>

**Notes:**

1. Woodchip Fuel Specifications and Procurement Strategies for the Black Hills, Biomass Energy Resource Center, 2007
2. Woodchip Heating Fuel Specifications in the Northeastern United States, Biomass Energy Research Center, 2011
3. Widely reported literature values.
4. Elemental Analysis of Wood Fuels, New York State Energy Research and Development Authority, 2013

The laboratory analysis was completed to provide a preliminary assessment of the likelihood that chipped wood waste generated at the site could be utilized for power generation in a cogeneration facility or wood fired boiler. The measured properties were compared to a variety of criteria that were obtained from internet and literature resources. Each of the criteria are summarized in the table above. For the metals analysis, the plots in Appendix B summarize the range of typical metals concentrations.

Many of the measured properties suggest the wood waste sample could be used as fuel. All measured properties were within the general ranges obtained from literature, with limited exception. The ash content (71,000 mg/kg or approximately 7%) is above the published range of acceptable values. While the detected metals concentrations also fell within the range of typical concentrations, the detected mercury concentrations were above the reported range.

The Area 1 fines sample was outside of nearly every one of the physical parameters. It was lower than the typical ranges for heating value, and volatile matter, and well in excess of the typical range for ash content (600,000 mg/kg or 60% vs. 3%). The detected metals concentrations also fell within the range of typical concentrations, except for mercury which well above the reported range.

## **6.0 Conclusions**

Each of the waste fractions (concrete/brick, fines, metal, miscellaneous, and wood) generated in Area 1 or Area 2 were applied to the waste volume calculated by GBB (2008). This provides a general comparison of the pilot study results with the initial fraction estimates. The fraction of wood waste in both areas is significantly lower than previously estimates, and the fraction of fines is significantly greater.



**Area 1 – Estimated and Observed Waste Distribution**

Operation Period	1972-1987		Est. Max. Waste Depth (ft)	60 – 70	
Size (acres)	23.2		Est. Waste Volume (cy)	1,133,500	
Waste Footprint (acres)	25.3		Est. Cover Material Volume	258,000	
Prior Estimate			Pilot Test Results		
Estimated Materials	% of total	Volume (cy)	Material	% of total	Volume (cy)
Ash	3.1	35,650	--	--	--
Gravel	0.9	10,223	Concrete/Brick	0.81	916.1
Demolition Wastes	9.5	107,457	--	--	--
Reclamation Fill	1.0	11,638	--	--	--
Sawdust	7.0	78,987	Fines	98.4	1,115,918
Metal	0.6	7,119	Metal	0.003	35.2
Tires	0.3	3,638	--	*	--
Unidentified	43.1	488,883	Misc.	0.1	1268.4
Wood Waste	34.4	389,895	Wood	1.4	15,361
<b>Total</b>	<b>100.0</b>	<b>1,133,500</b>		<b>100</b>	<b>1,133,500</b>

\*Tires are present at the southeast corner of Area 1 and were not a part of this pilot test.

**Area 2 – Estimated and Observed Waste Distribution**

Operation Period	1988-1992		Est. Max. Waste Depth (ft)	70 – 80	
Size (acres)	9.8		Est. Waste Volume (cy)	456,000	
Waste Footprint (acres)	6.8		Est. Cover Material Volume	24,000	
Prior Estimate			Pilot Test Results		
Estimated Materials	% of total	Volume (cy)	Material	% of total	Volume (cy)
Ash	2.1	9,555	--	--	--
Gravel	0.0	0	Concrete/Brick	9.4	42,735
Demolition Wastes	18.1	82,482	--	--	--
Reclamation Fill	0.5	2,422	--	--	--
Sawdust	8.1	36,877	Fines	81.4	371,365.4
Metal	0.0	0	Metal	1.0	4,416.8
Tires	0.0	0	--	--	--
Unidentified	0.0	0	Misc.	5.2	23,874.4
Wood Waste	71.2	324,664	Wood	3.0	13,608.4
<b>Total</b>	<b>100.0</b>	<b>456,000</b>			<b>456,000</b>

---

The significant reduction in the amount of recoverable wood waste marks a significant departure from the current site model that wood could be recovered from the landfill and re-used in a beneficial manner. While the physical testing suggests there is potential that wood chips generated from the landfill could be used as cogeneration or boiler fuel, the relatively small fraction of recoverable wood suggests there will be little economic benefit.

In Area 1, the fine materials that are present are predominantly sawdust and sander dust, intermixed with soil. Sawdust/sander dust is the predominant waste product in Area 1. The excavated materials were fairly mixed. Distinct zones of soil cover within the waste material profile were not observed. This is likely a function of all or a combination of the following factors: settling and degradation within the landfill, mixing of the soil during placement, or mixing during excavation. Conditions observed during the pilot study were not amenable to recovering large amounts of wood waste that could be chipped and potentially re-used, or other recoverable material.

In Area 1, sawdust is the primary waste stream, and the pilot study information suggests these materials contain soil and other deleterious materials that appear incompatible with a fuel use. If a waste consolidation scheme is contemplated for future redevelopment, developing a beneficial reuse approach for the fine materials will be a key component. Because of the diverse waste stream in Area 2, it is unlikely that the wastes can be sorted onsite unless an onsite MRF is constructed. In order to estimate the time required to process wastes from the landfill, an expert in this area should be engaged. Estimating processing time for materials in an MRF was beyond the scope of this pilot test.

The air monitoring program implemented for the pilot test was comprehensive and focused on monitoring of workers and potential risks to nearby residents and businesses. Apex did not observe methane levels that indicate potential risks. The asbestos monitoring program did not indicate worker risk, or the potential for risks to adjacent residents and property users. The results of the asbestos monitoring program should not be considered definitive and future excavation work should evaluate this potential risk to determine if asbestos air monitoring is appropriate for the specific project.

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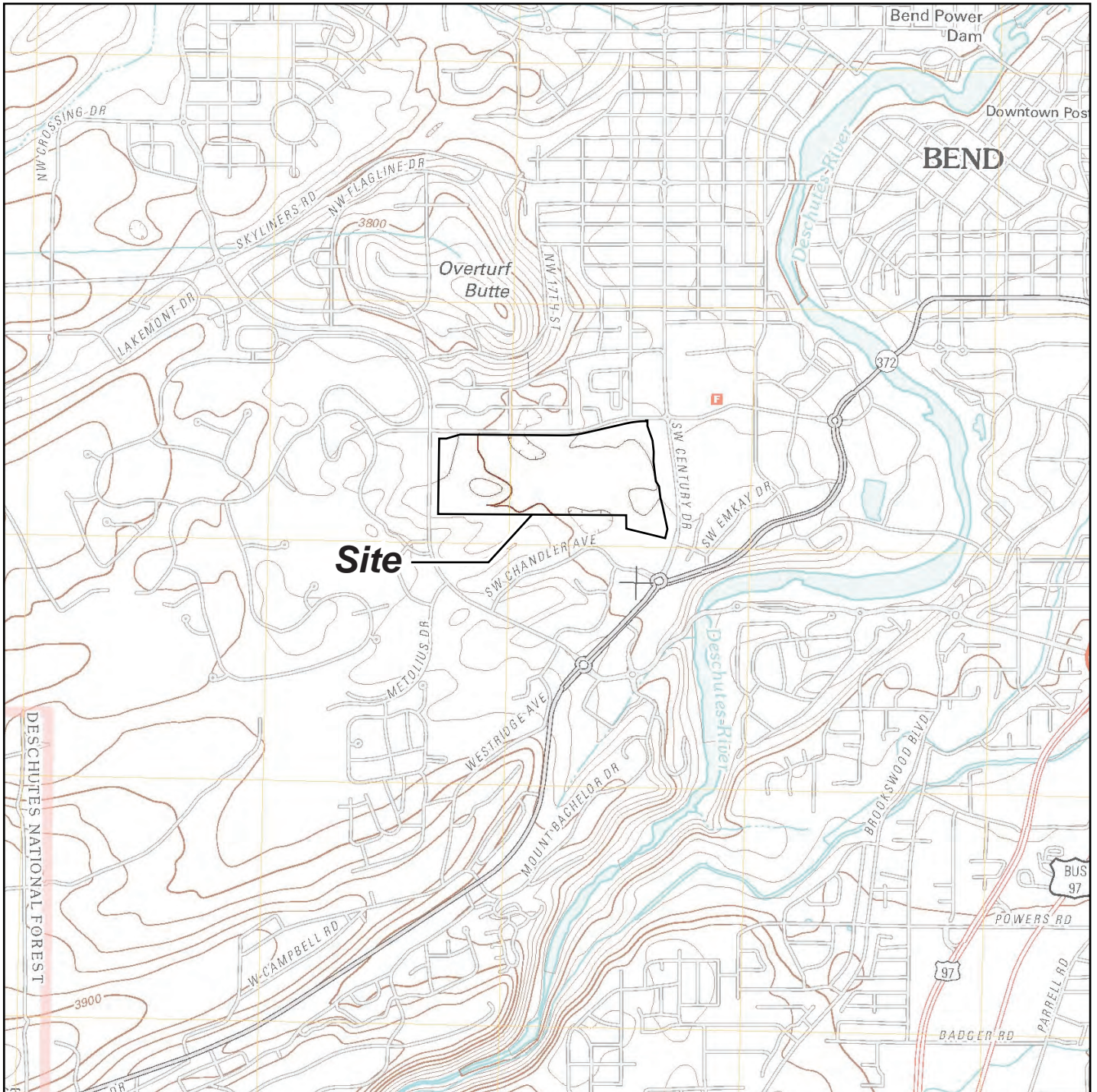
## **7.0 References**

DEA et al, 1997. *Demolition Landfill Subsurface Fire Assessment*, Prepared by David Evans and Associates, Bend, Oregon. June, 1997.

GBB, 2008. *Demolition Landfill Subsurface Investigations Study*, prepared by Gershman, Brickner, and Bratton, Fairfax, Virginia. October 31, 2008.

PBS, 2013. *Phase II Characterization Report – Groundwater Assessment Monitoring, Demolition Landfill, 19755 Simpson Avenue*, prepared by PBS Environmental of Bend, Oregon. June, 2013.

Apex, 2016. Pilot Study Work Plan, Deschutes County Construction Demolition Landfill. April, 2016.




**Note:** Base map prepared from USGS 7.5-minute quadrangle of Bend, OR, dated 2011 as provided by USGS.gov.



## Site Location Map

Deschutes County Demolition Landfill  
Bend, Oregon

 Apex Companies, LLC  
3015 SW First Avenue  
Portland, Oregon 97201

Project Number	2112-03
May 2016	

Figure  
**1**





## ***Appendix A***

---

### **Logs and Cross-Sections**

## Sample Descriptions

Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, and grain size, and should not be construed to imply field nor laboratory testing unless presented herein. Visual-manual classification methods of ASTM D 2488 were used as an identification guide.

Soil descriptions consist of the following:

MAJOR CONSTITUENT with additional remarks; color, moisture, minor constituents, density/consistency.

### Density/Consistency

Soil density/consistency in borings is related primarily to the Standard Penetration Resistance. Soil density/consistency in test pits and push probe explorations is estimated based on visual observation and is presented parenthetically on test pit and push probe exploration logs.

SAND and GRAVEL	Standard Penetration Resistance in Blows/Foot	SILT or CLAY	Standard Penetration Resistance in Blows/Foot	Approximate Shear Strength in TSF
<u>Density</u>		<u>Density</u>		
Very loose	0 - 4	Very soft	0 - 2	<0.125
Loose	4 - 10	Soft	2 - 4	0.125 - 0.25
Medium dense	10 - 30	Medium stiff	4 - 8	0.25 - 0.5
Dense	30 - 50	Stiff	8 - 15	0.5 - 1.0
Very dense	>50	Very Stiff	15 - 30	1.0 - 2.0
		Hard	>30	>2.0

### Moisture

Dry Little perceptible moisture.

Sl. Moist Some perceptible moisture, probably below optimum.

Moist Probably near optimum moisture content.

Wet Much perceptible moisture, probably above optimum.

### Minor Constituents

Not identified in description

Slightly (clayey, silty, etc.)

Clayey, silty, sandy, gravelly

Very (clayey, silty, etc.)

### Estimated Percentage

0 - 5





5 - 12

12 - 30




30 - 50

## Sampling Symbols

### BORING AND PUSH-PROBE SYMBOLS

-  Recovery
-  No Recovery
-  Temporarily Screened Interval
- PID Photoionization Detector Reading
- W Water Sample
-  Sample Submitted for Chemical Analysis
- NS No Sheen
- SS Slight Sheen
- MS Moderate Sheen
- HS Heavy Sheen
- BF Biogenic Film

### TEST PIT SOIL SAMPLES

-  Grab (Jar)
-  Bag
-  Shelby Tube

## Key to Exploration Logs

Pilot Test Report  
Deschutes County Demolition Landfill  
Bend, Oregon



Apex Companies, LLC  
3015 SW First Avenue  
Portland, Oregon 97201

Project Number	2112-03
June 2016	

Figure  
**Key**



Boring Details and Notes:

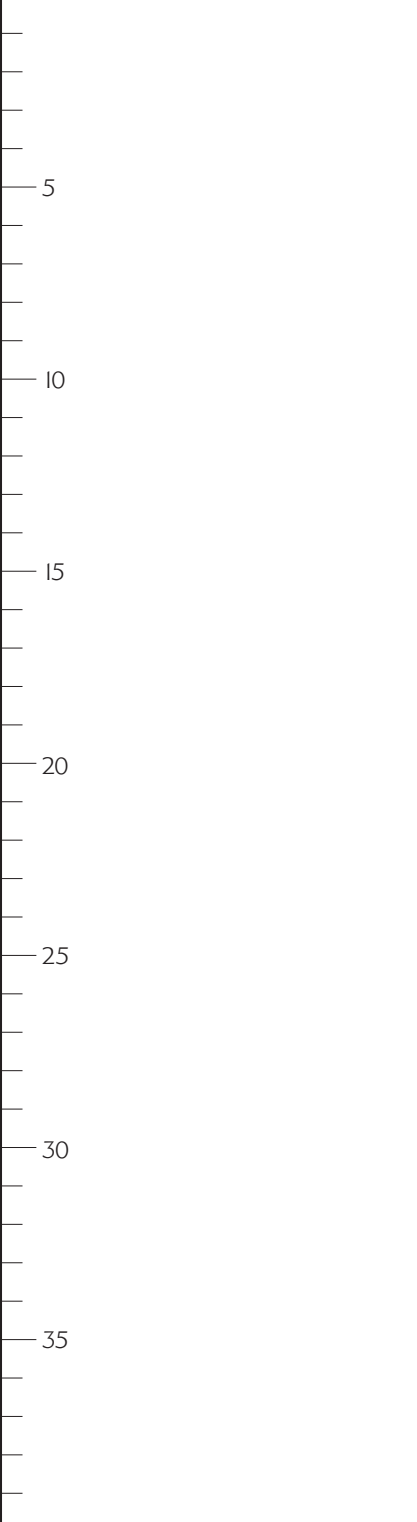
Depth, feet	PID	Methane	Lithologic Description
—	<.5	0	Cinder overburden
—			Debris starts; still mostly topsoil and sawdust.
5	<.5	0	Mix wood waste. finished boards, roots, and slats, (~80% dirt/sawdust, 15-20% wood).
10	6.3	0	Some particle board. Lots of fines.
15			Some CDW. Crushed water heater.
20	<.5	0	Sawdust. Sill contains wood waste with fines. Bunched wire.
25	<.5	0	Mostly sawdust.~15-20% other wood debris.
25			2 to 3 large logs removed.
30	<.5	0	28-30' Sawdust with CDW. Box spring wire and plastic sheeting.
30			Bottom of Test Pit at 30.0' BGS.





Boring Details and Notes:

Depth, feet	PID	Methane	Lithologic Description
5	<5	0	2' overburden — Debris starts; sawdust (~80%), boards (~20%; 1 x 0.5").
10	<5	0	— Crushed plastic drum. Some boulders ~5-6 total. — Acetone-like odor. 56.5 ppm on soil pile.
56.5	0	0	Bottom of Test Pit at 13.0' BGS.





Boring Details and Notes:

Depth, feet	PID	Methane	Lithologic Description
			1' overburden
			Debris starts; fine sawdust (medium brown to light yellow). Crushed poly drum, no odor. Drum is filled with sawdust.
<5	0		
5			
<5	0		Bright orang/yellow sawdust and wood pulp, (~90% sawdust, 10% fiber boards).
<5	0		
10			Becomes dark brown sawdust.
<5	0		
<5	0		Slight odor noticed. No measurements of spikes in PID. Very light ammonia-like odor.
15			
<5	0		Wood debris increasing (~20%).
<5	0		
20			Bright orang/yellow sawdust, (~90% sawdust, ~10% wood debris).
<5	0		
25			
<5	0		Medium brown and yellow sawdust. Trace to no wood debris from 25-30'.
30			
			Bottom of Test Pit at 30.0' BGS.
35			



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Portland, Oregon 97201

Pilot Test Report  
Deschutes County Demolition Landfill  
Bend, Oregon

Test Pit Number: **1-4**

Project Number: **2112-03**

Logged By: **C. Clough**

Date: **April 19, 2016**

Site Conditions: --

Drilling Contractor: **Taylor NW**

Excavator: **CAT 336F**

Sampler Type: **Excavator**

Depth to Water (ATD): --

Surface Elevation: **Not Measured**

Boring Details and Notes:

Depth, feet

PID

Methane

**Lithologic Description**

5

10

15

20

25

30

35

<.5

<.5

<.5

<.5

6" topsoil with vegetation.  
— Red and tan silt with sand.  
— Reddish-brown sand with silt.

— Same as above. Some metal bands visible in SE corner of test pit sidewall.  
No wood or sawdust in test pit.

Bottom of Test Pit at 18.0' BGS.

5

10

15

20

25

30

35



Boring Details and Notes:

Depth, feet	PID	Methane	Lithologic Description
			18" overburden soils.
<5	0		Woody debris, mill spoils, tree roots. Woods are mixed with soils. Wood is charred.
5	<5	0	
			Solid drum located. No odor or PID.
<5	0		Tires mixed with soil. Trace to no wood debris.
10	<5	0	
			Same as above. Test pit steams after each scoop is removed.
<5	0		
15	<5	0	
			Same as above. Additional demolition waste also present (safety cones, plastic, etc.)
<5	0		
20	<5	0	
			Same as above. Trace wood present. All charred. Possibly some sawdust in soils.
<5	0		
25	<5	0	
			Same as above. Wood increasing. 25% tires, 5-10% 1x2 finished boards, 5-10% sawdust, rest is soils.
30			
			Bottom of Test Pit at 27.0' BGS.
35			



Boring Details and Notes:

Depth, feet	PID	Methane	Lithologic Description
			2-3' of overburden. Trace sawdust.
0	<.5	0	Woody debris (mill ends, particle board, and sawdust) mixed with soils.
5			Sawdust increasing with trace metal scraps.
5	<.5	0	Sawdust continues to increase, (70% sawdust, 20% wood, 10% soils and metal).
10	<.5	0	Metal and plastic debris mixed with sawdust. 2 large logs.
15			Sawdust with trace metals and plastic.
20			Dark gray tuff encountered.
23.0			Bottom of Test Pit at 23.0' BGS.



Boring Details and Notes:

Depth, feet	PID	Methane	Lithologic Description	
			Minimal cover soils.	
	<.5	0	Dark red sawdust. mixed wood and CDW (soil liners, concrete, etc.) present.	
5	<.5	0	Wood and logs mixed with sawdust, (~80% sawdust, 15% wood) with some CDW (~5%).	5
	<.5	0	A solid drum was located. No odor or PID.	
10			Sawdust increasing.	10
15	<.5	0	Sawdust with some woody debris (~80%/20%). Trace CDW.	15
20	<.5	0	Same as above.	20
	<.5	0	CDW increasing. (80% sawdust, 10% CDW, 10% wood). A hardened epoxy and tar-like substance were also found. De minimus quantity.	
25				25
	<.5	0		
30			Bottom of Test Pit at 30.0' BGS.	30
35				35



Apex Companies, LLC  
3015 SW First Avenue  
Portland, Oregon 97201

Pilot Test Report  
Deschutes County Demolition Landfill  
Bend, Oregon

Test Pit Number: **1-8**

Project Number: **2112-03**

Logged By: **C. Clough**

Date: **April 20, 2016**

Site Conditions: --

Drilling Contractor: **Taylor NW**

Excavator: **CAT 336F**

Sampler Type: **Excavator**

Depth to Water (ATD): --

Surface Elevation: **Not Measured**

Boring Details and Notes:

Depth, feet	PID	Methane	Lithologic Description
			2' of topsoils with vegetation.
<5	0		Boards with medium brown/red-brown sawdust. Boards appear burnt. (75% sawdust, 25% wood).
5			
<5	0		Sawdust. increasing.
10			
<5	0		Materials are primarily sawdust with occasional large quantity of wood for limited duration. Over 5' internal wood (~75-80% to 20-25% wood). Possibly in lifts. Wood still appears burnt.
15			
<5	0		Becomes shredded/chipped dark red-brown wood chips wit sawdust.
20			
<5	0		Light yellow-tan sawdust with burnt wood boards. Trace shredded rubber/tire present.
25			
<5	0		Same as above. Large wood logs. Very wet.
30			
<5	0		Burnt wood debris mixed with yellow sawdust.
35			
<5	0		Metal bands present, (~70% sawdust, 20% burnt wood, 10% metal).
			Bottom of Test Pit at 30.0' BGS.



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Pilot Test Report  
Deschutes County Demolition Landfill  
Bend, Oregon

Test Pit Number: **1-9**

Project Number: **2112-03**

Logged By: **C. Clough**

Date: **April 20, 2016**

Site Conditions: --

Drilling Contractor: **Taylor NW**

Excavator: **CAT 336F**

Sampler Type: **Excavator**

Depth to Water (ATD): --

Surface Elevation: **Not Measured**

Boring Details and Notes:

Depth, feet	PID	Methane	Lithologic Description
			5' of overburden with vegetation.
5	<.5	0	Wood, concrete, and sawdust mix, (~60% sawdust, 15-20% wood, 20-25% concrete). Wood appears charred/burnt.
10	<.5	0	Same as above.
15	<.5	0	Increasing CDW. Concrete, metal, and plastic. ~20-25% of volume.
20	<.5	0	Same as above.
			Dark gray tuff.
			Bottom of Test Pit at 19.5' BGS.





Boring Details and Notes:

Depth, feet	PID	Methane	Lithologic Description
			2' of overburden soils.
			Sawdust and soil mixture.
5	<.5	0	Wood increases to ~20%. No to trace CDW.
			Light yellow sawdust with wood debris (finished boards and mill ends).
10	<.5	0	Same as above.
15			Dark gray tuff.
			Bottom of Test Pit at 16' BGS.
20			
25			
30			
35			



Boring Details and Notes:

Depth, feet	PID	Methane	Lithologic Description
			2' of overburden soils.
5	<5	0	Dark red sawdust with trace wood (logs/mill ends).
10	<5	0	Red-brown sawdust with charred 1x2 wooden boards. ~80% sawdust to 20% wood. Material is very moist.
15	<5	0	Becomes yellow sawdust. Some wood not charred. Soil increasing.
20	<5	0	Medium brown sawdust/soil mixed with ~15% wood debris.
25	<5	0	Same as above. Tire and other trace CDW present. Metal wire also encountered.
30	<5	0	Same as above. CDW increasing. Tires, metal banding/wires, ~10% plastic.
35	<5	0	Same as above.



Boring Details and Notes:

Depth, feet	PID	Methane	Lithologic Description
			18" of overburden.
5	<.5	0	Sawdust and soils mixed with tree roots and trace metal sheeting, plastic, and metal wire.
			Same as above. Wood debris becomes finished boards (less natural wood).
10	<.5	0	Sawdust with concrete, plastic sheeting, and some wood debris, (80% sawdust, 10% CDW, 10% wood).
15	<.5	0	Sawdust 15-17'.
20	<.5	0	Sawdust (60%) with wood debris (30%) and CDW (10%).
25	<.5	0	Same as above.
30	<.5	0	Same as above.
31			Bottom of Test Pit at 31' BGS.
35	<.5	0	



Boring Details and Notes:

Depth, feet	PID	Methane	Lithologic Description
			Overburden soils with vegetation.
			Soil with sawdust and some wood.
5	<.5	0	Yellow sawdust with CDW (concrete blocks, metal, and plastic) and trace wood, (70% sawdust, 15-20% CDW, 5-15% wood).
	<.5	0	CDW becomes household debris (toys, appliances, wallboard, etc.).
10			Same as above.
			Roofing shingles encountered (2' thick). Some roofing felt present.
15			Returns to CDW/Sawdust mix.
20	<.5	0	Same as above.
25			Bottom of Test Pit at 23' BGS. <i>During cut digging, more construction waste was encountered that could be ACM. Hole was discontinued to avoid disturbance of materials.</i>
30			
35	<.5	0	



Boring Details and Notes:

Depth, feet	PID	Methane	Lithologic Description
5	<.5	0	<p>Overburden</p> <p>Dark red-brown sawdust with mixed CDW. Some plywood present. Wood seems changed, (80% sawdust, 15% wood, 5% CDW). Crushed paint cans and metal conduit. Some tires.</p>
10	<.5	0	<p>Light yellow sawdust increasing. Slight ammonia-like odor.</p>
15	<.5	0	<p>Same as above. Sawdust becomes medium brown. CDW increasing.</p>
20	<.5	0	<p>Same as above. Layers of light yellow sawdust between material, consistent with above descriptions.</p>
25	<.5	0	<p>Dark gray tuff.</p>
30	<.5	0	<p>Bottom of Test Pit at 27' BGS.</p> <p><i>An occasional ammonia-like odor was present.</i></p> <p><i>No reading or spikes on PID.</i></p>
35	<.5	0	



Boring Details and Notes:

Depth, feet	PID	Methane	Lithologic Description	
			Overburden	
0	<.5	0	Dark red-brown sawdust with mixed CDW. Some plywood present. Wood seems changed, (80% sawdust, 15% wood, 5% CDW). Crushed paint cans and metal conduit. Some tires.	0
5				5
10	<.5	0	Light yellow sawdust increasing. Slight ammonia-like odor.	10
15	<.5	0	Dark brown-black soil with CDW (hot water heater, doors, metal wire).	15
20	<.5	0	Same as above.	20
			Bottom of Test Pit at 20' BGS.	
25				25
30				30
35	<.5	0		35



Boring Details and Notes:

Depth, feet	PID	Methane	Lithologic Description	
			Overburden soils with vegetation.	
			Dark gray soils and sawdust with trace charred boards and plastic CDW.	
5	<5	0		5
			Light yellow sawdust increasing. Slight odor.	
	<5	0		
			CDW and wood increasing.	
10	<5	0		10
			Dark brown sawdust with wood, plastic, glass, and metal, (~70% sawdust, 20% CDW, 10% wood/tree roots).	
	<5	0		
15	<5	0		15
			Plastic parts/forms increasing.	
	<5	0		
20	<5	0		20
			Same as above.	
			Bottom of Test Pit at 24' BGS.	
			<i>Slight odor noted. PID spiked at 2.8 ppm but otherwise remained at 0 ppm in breathing space.</i>	
25				25
30				30
35	<5	0		35



Boring Details and Notes:

Depth, feet	PID	Methane	Lithologic Description	
5 10 15 20 25 30 35	<5 0		<p>Overburden soils with vegetation.</p> <p>Soils and sawdust (90%) and CDW (~10%). CDW is mostly hoses, plastic, metal, and concrete. De minimis quantities of asphalt shingles encountered. No felt visible.</p> <p>Wood increasing. Mostly tree roots and trimmings.</p> <p>Miscellaneous debris encountered (hub caps, metal wheels, wire, and large concrete pieces).</p> <p>Compressed yellow sawdust increasing.</p> <p>Cardboard and paper visible. Metal banding increasing.</p> <p>Bottom of Test Pit at 29' BGS.</p>	5 10 15 20 25 30 35



Figure 6-1 - Estimate of Area 1 Fill Volumes with Sectional Cuts

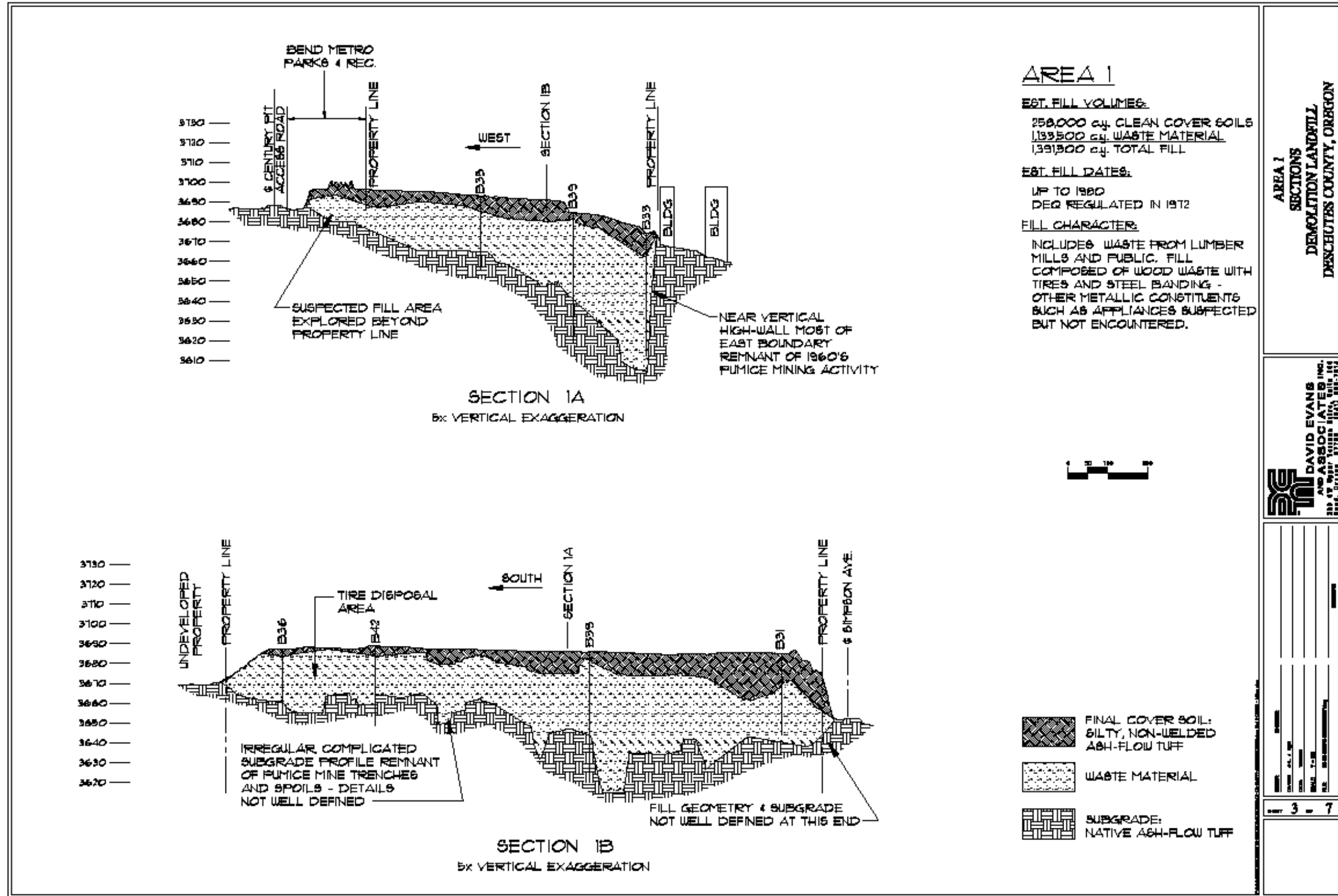
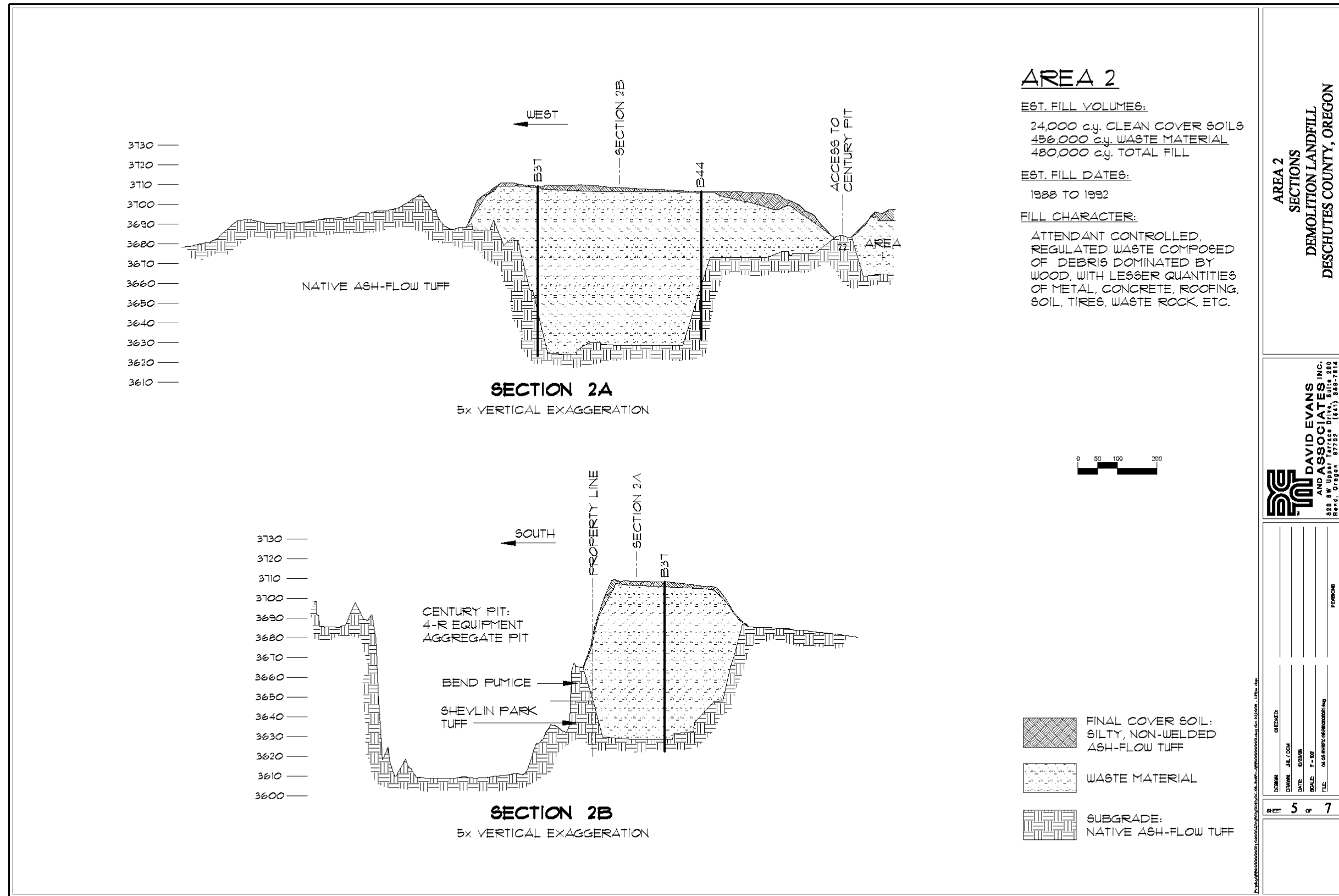


Figure 6-2 - Estimate of Area 2 Fill Volumes with Sectional Cuts





***Appendix B***


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**Photographs**

**APPENDIX B  
PHOTOGRAPH LOG**

**Project Name:** Pilot Study Report  
**Project Number:** 2112-03

**Client:** Deschutes County  
**Location:** Bend, Oregon

<b>Photo No:</b> 1	
<b>Photo Date:</b> 4/18/16	
<b>Orientation:</b> --	
<b>Description:</b>  Typical excavation sequence: excavation to 23 feet.	

<b>Photo No:</b> 2	
<b>Photo Date:</b> 4/18/16	
<b>Orientation:</b> South	
<b>Description:</b>  Typical excavation sequence: benching to 7 feet.	




## APPENDIX B PHOTOGRAPH LOG

**Project Name:** Pilot Study Report  
**Project Number:** 2112-03

**Client:** Deschutes County  
**Location:** Bend, Oregon


<b>Photo No:</b> 3	
<b>Photo Date:</b> 4/18/16	
<b>Orientation:</b> South	
<b>Description:</b> Typical excavation sequence: excavator on bench, excavation to 30 feet.	


<b>Photo No:</b> 4	
<b>Photo Date:</b> 4/20/16	
<b>Orientation:</b> --	
<b>Description:</b> Area 1 typical waste.	

**APPENDIX B  
PHOTOGRAPH LOG**

**Project Name:** Pilot Study Report  
**Project Number:** 2112-03

**Client:** Deschutes County  
**Location:** Bend, Oregon

<b>Photo No:</b> 5	
<b>Photo Date:</b> 4/20/16	
<b>Orientation:</b> South	
<b>Description:</b> Area 1 typical waste.	


<b>Photo No:</b> 6	
<b>Photo Date:</b> 4/20/16	
<b>Orientation:</b> North	
<b>Description:</b> Area 1 test pit profile.	




**APPENDIX B  
PHOTOGRAPH LOG**

**Project Name:** Pilot Study Report  
**Project Number:** 2112-03

**Client:** Deschutes County  
**Location:** Bend, Oregon

<b>Photo No:</b> 7	
<b>Photo Date:</b> 4/25/16	
<b>Orientation:</b> --	
<b>Description:</b> Area 2 Test pit profile.	


<b>Photo No:</b> 8	
<b>Photo Date:</b> 4/25/16	
<b>Orientation:</b> --	
<b>Description:</b> Area 2 waste pile.	




**APPENDIX B  
PHOTOGRAPH LOG**

**Project Name:** Pilot Study Report  
**Project Number:** 2112-03

**Client:** Deschutes County  
**Location:** Bend, Oregon

<b>Photo No:</b> 9	
<b>Photo Date:</b> 4/22/16	
<b>Orientation:</b> --	
<b>Description:</b> Area 1 mixed waste for screening.	


<b>Photo No:</b> 10	
<b>Photo Date:</b> 4/22/16	
<b>Orientation:</b> North	
<b>Description:</b> Area 1 wood waste after screening.	

**APPENDIX B  
PHOTOGRAPH LOG**

**Project Name:** Pilot Study Report  
**Project Number:** 2112-03

**Client:** Deschutes County  
**Location:** Bend, Oregon

<b>Photo No:</b> 11	
<b>Photo Date:</b> 4/22/16	
<b>Orientation:</b> South	
<b>Description:</b> Area 1 fines after screening.	

<b>Photo No:</b> 12	
<b>Photo Date:</b> 4/27/16	
<b>Orientation:</b> South	
<b>Description:</b> Load of Area 1 wood waste for processing at MRF.	




**APPENDIX B  
PHOTOGRAPH LOG**

**Project Name:** Pilot Study Report  
**Project Number:** 2112-03

**Client:** Deschutes County  
**Location:** Bend, Oregon


<b>Photo No:</b> 13	
<b>Photo Date:</b> 4/30/16	
<b>Orientation:</b> --	
<b>Description:</b> Area 1 wood waste at MRF.	


<b>Photo No:</b> 14	
<b>Photo Date:</b> 4/30/16	
<b>Orientation:</b> --	
<b>Description:</b> Area 2 mixed waste at MRF.	

## APPENDIX B PHOTOGRAPH LOG

**Project Name:** Pilot Study Report  
**Project Number:** 2112-03

**Client:** Deschutes County  
**Location:** Bend, Oregon

<b>Photo No:</b> 15	
<b>Photo Date:</b> 4/30/16	
<b>Orientation:</b> --	
<b>Description:</b> MRF sorting line.	


<b>Photo No:</b> 16	
<b>Photo Date:</b> 4/30/16	
<b>Orientation:</b> --	
<b>Description:</b> Fines (< 1 inch).	




## APPENDIX B PHOTOGRAPH LOG

**Project Name:** Pilot Study Report  
**Project Number:** 2112-03

**Client:** Deschutes County  
**Location:** Bend, Oregon


<b>Photo No:</b> 17	
<b>Photo Date:</b> 4/30/16	
<b>Orientation:</b> --	
<b>Description:</b> Sorted wood waste loaded for transport to chipper.	

<b>Photo No:</b> 18	
<b>Photo Date:</b> 5/9/16	
<b>Orientation:</b> --	
<b>Description:</b> Sorted wood waste at chipper.	

**APPENDIX B  
PHOTOGRAPH LOG**

**Project Name:** Pilot Study Report  
**Project Number:** 2112-03

**Client:** Deschutes County  
**Location:** Bend, Oregon

<b>Photo No:</b> 19	
<b>Photo Date:</b> 5/9/16	
<b>Orientation:</b> --	
<b>Description:</b> Chipping process.	

<b>Photo No:</b> 20	
<b>Photo Date:</b> 5/19/16	
<b>Orientation:</b> --	
<b>Description:</b> Wood chip pile.	

## ***Appendix C***

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### **Literature Excerpts**

Figure 12: Wood Chip Proximate, Ions, and Hg Analysis (N = 23).

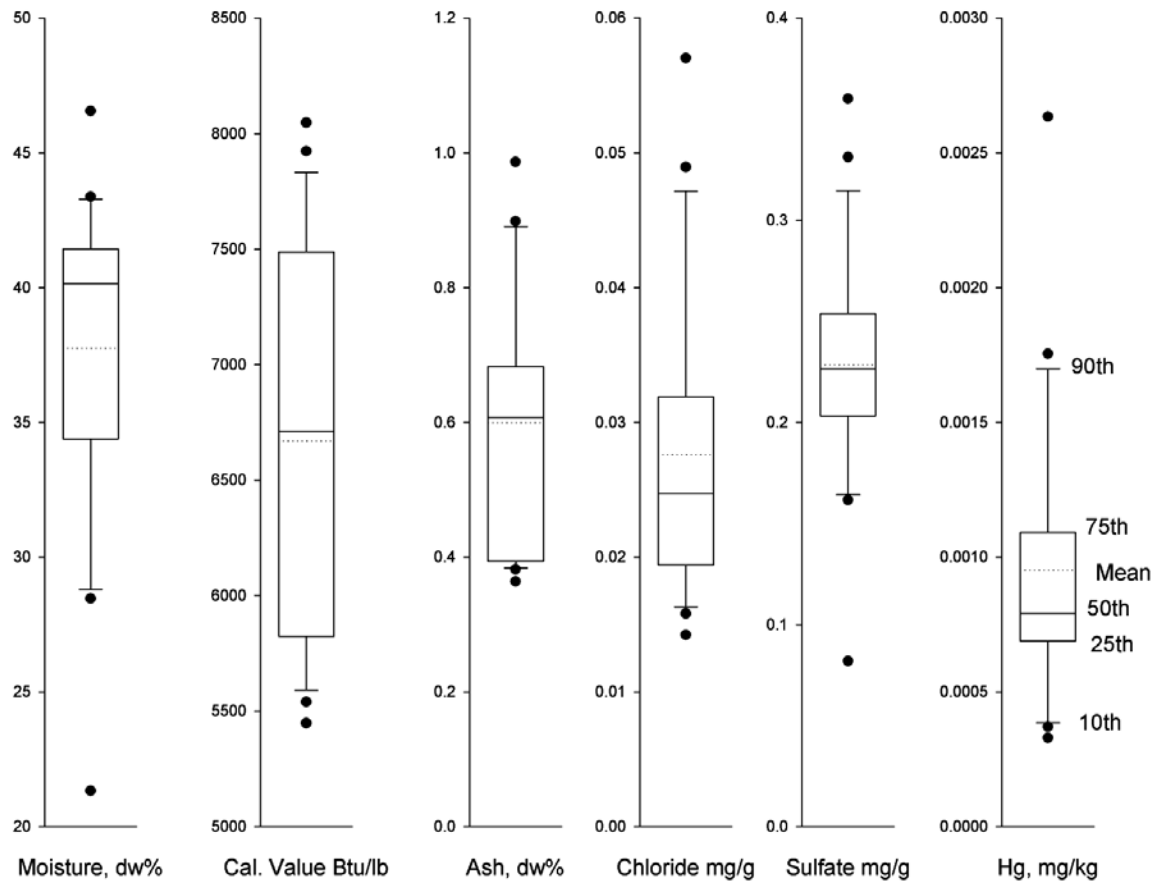




Figure 13: Wood Chip ICP-MS Analysis, mg/kg ash.

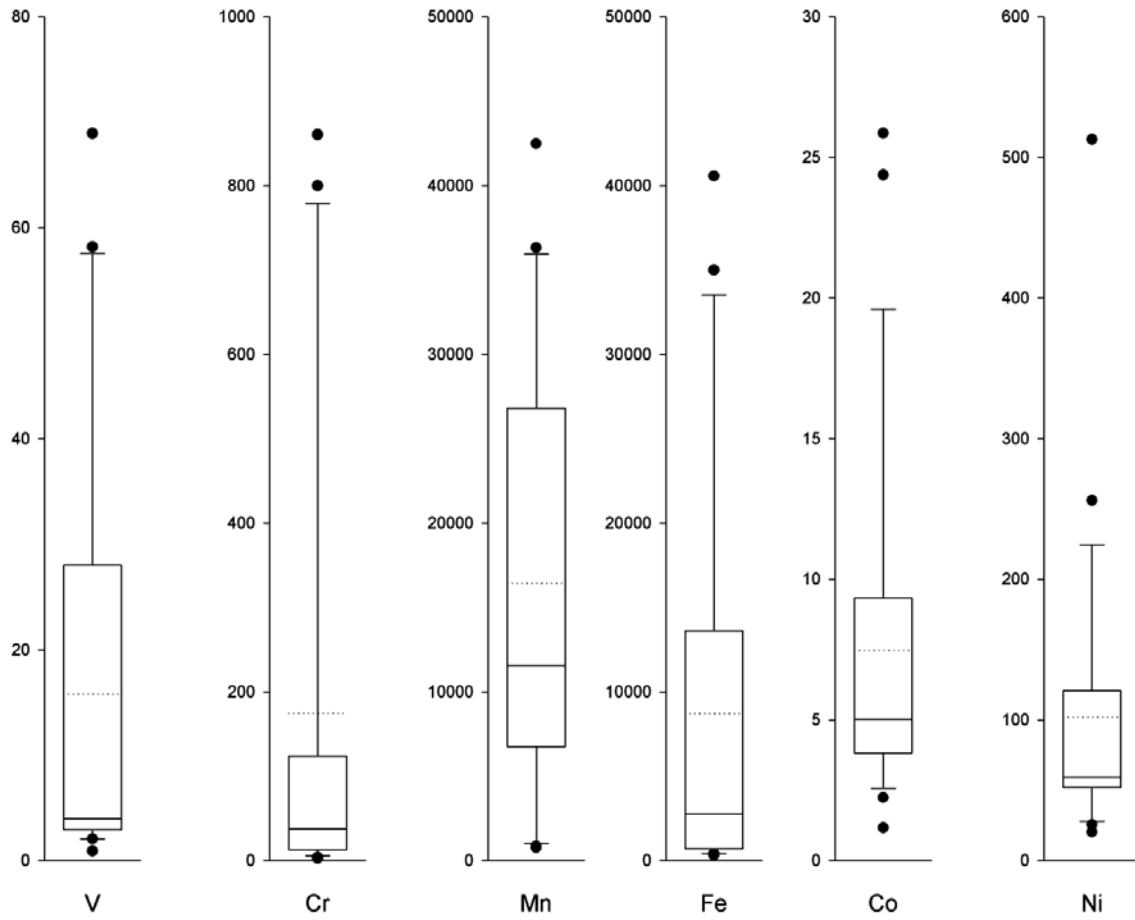
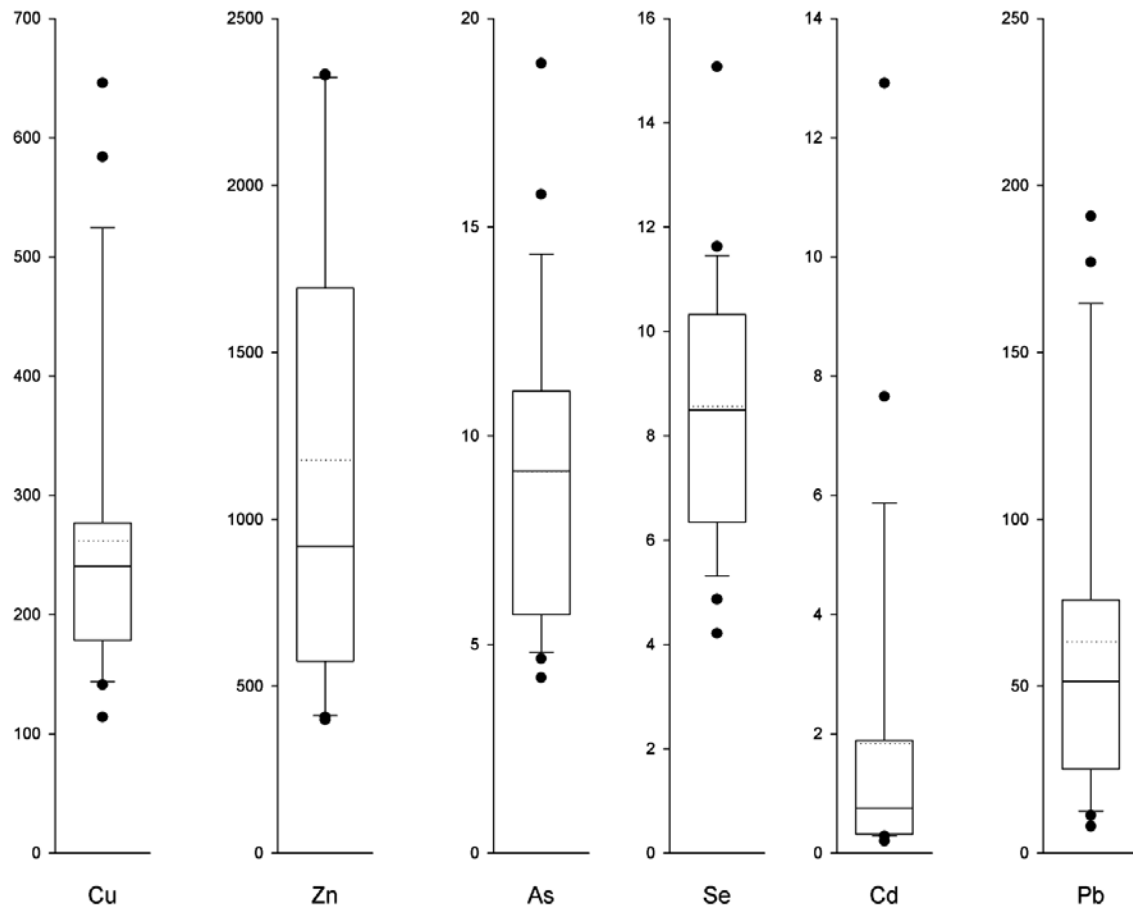


Figure 14: Wood Chip ICP-MS Analysis, mg/kg ash.



Moisture in the wood chips ranged from dry to green (21 to 47 percent). Calorific value had a substantial range, from 5500 to 8000 Btu/lb. Moisture is a major factor in calorific value; Figure 15 shows the regression of calorific value versus percent moisture, with  $R^2 = 0.44$ . Ash ranged from 0.4 to 1 percent dry weight.