City of Seattle Sampling Protocol for Characterizing Banned C&D Residual Materials

Objective

The objective of this protocol is to provide a method for determining the amount of banned materials in the residuals stream at certified C&D processing facilities that are processing loads of mixed C&D waste. Banned materials include:

- Concrete, asphalt paving, bricks (bans effective 2012)
- Metal, carpet, cardboard, plastic film wrap, new construction gypsum scrap (bans effective 2014)
- Unpainted/untreated wood, tear-off asphalt shingles (bans effective 2015)

This protocol defines the three main phases of weight-based sample characterization: sample selection, sample characterization, and analysis. Two appendices related to the weighing method follow this protocol: Appendix A-1: Material Definitions and Size Thresholds and Appendix A-2: Field Forms.

Field Work Preparation

Before beginning field work, prepare two sets of field forms:

- *Weight Based Data Form*: During sample selection and weight-based characterization, field staff will complete one of these forms for each characterized sample. The form captures information about the sample's material type composition, by weight. The form also asks field staff to note other relevant sample details, like residual stream of origin and date of sample collection.
- *Sample Placard*: The sample placard will identify each sample in photographs of the sample. The placard contains sample-specific information, including facility and residual stream of origin, sample collection date, and a unique sample id number, which identifies the sample in photographs and in analysis after the characterization.

Examples of these field forms are attached in Appendix A-2: Field Forms.

Sample Selection

At all facilities, use the following procedure to identify residual streams for sampling and to determine sample weights.

- **Identify all residual streams** at each individual facility, such as post-processing residual waste, Alternative Daily Cover (ADC) and "Industrial Waste Stabilizer (IWS). Residual streams are defined as any non-recyclable waste generated from mixed C&D processing that is disposed in a landfill or used as ADC or IWS. Each stream must have a known annual quantity. If annual quantities are not available, combine residual streams prior to sampling.

- For each residual stream, **determine particle size** by measuring the longest dimension in inches of the largest visible particles in the stream.
- **Determine sample weight** for each residual stream based on average particle size, as follows.
  - Fines less than 2": Excluded from sampling.
  - Particles greater than 2" and less than 6": 25 lbs.
  - Particles greater than 6" and less than 12": 100 lbs.
  - Particles greater than 12": 250-300 lbs.

Option 1: Stockpile Method

Perform the following sampling procedure at facilities with stockpiled residual streams. Sampling will occur before any particle size reduction of stockpiled residual streams.

1. Visually superimpose the 16-cell grid picture in Figure 1 below on the stockpiled residual streams. *(Please note that this is an overhead view, as if you were above the pile looking down on it.)*
2. Using a digital camera, take photo of stockpile prior to extracting grab samples to identify sampling cells.
3. Extract one grab sample each from three randomly selected sections of the stockpile of processing residual. Random cells are selected for sampling using the random number generator in Excel (function RANDBETWEEN). Cell numbers are preselected from the 16-cell grid prior to sampling. These three grab samples will be used to produce a single composite sample. Each grab sample should be approximately the same weight, and when added together, the three samples should generate a sample weight as specified above.
4. Place the three grab samples into a single container with a known tare weight. Suitable containers include steel bins and facility equipment such as the bucket of a loader.
5. Weigh the containerized sample using a truck scale or a commodity scale.
6. Determine the weight of the complete sample by subtracting the tare weight from the gross weight of the containerized sample.
7. Record the net weight of the complete sample on the *Sample Data Form* (see Appendix A-2: Field Forms).
8. Collect a minimum of eight to ten composite samples over the course of a processing shift. (Note: Eight composite samples will require extracting 24 individual grab samples from the residual stockpile. Ten composite samples will require 30 individual grab samples.).

Figure 1. Visual overlay for Stockpile Method showing "cells" of material

Option 2: Direct Load Method

Perform the following sampling procedure at facilities that load residual streams directly into a transport trailer or other container. At these facilities, extract samples from a minimum of 20 cubic yards of processing residual. Sampling will occur before any particle size reduction of the residual stream.

1. Level processing residual already loaded in a trailer to a uniform height and extend in one direction to create a roughly rectangular shape.
2. Visually superimpose the three dimensional grid pictured in Figure 2. Visual overlay for Direct Load Method showing "cells" of material on the processing residual. *(Please note that this is a side view, facing the left-hand side of the trailer*)
3. Using a digital camera, take photo of load prior to extracting grab samples to identify sampling cells.
4. Extract one grab sample from three randomly selected sections of the processing residual. Random cells are selected for sampling using the random number generator in Excel (function RANDBETWEEN). Cell numbers are preselected from the 16-cell grid prior to sampling. These three grab samples will be used to produce a single composite sample. Each individual grab sample should be approximately the same weight, and when added together, the three samples should generate a sample weight as specified above.
5. Complete the method by following Steps 4 through 8 of the stockpile method described above.

Figure 2. Visual overlay for Direct Load Method showing "cells" of material

Sample Characterization

Regardless of the sampling method used, perform the following sorting procedures at all C&D processing facilities, and document the resulting data and site observations on the *Weight Based Sample Data Form*. Refer to Appendix A-2: Field Forms for examples of field forms.

1. Take each complete sample to a safe sorting location away from vehicle and equipment traffic.
2. Tip the complete sample onto the ground.
3. Using a digital camera, take a picture of the sample in which a *Sample Placard* identifying the sample is visible.
4. Manually sort the complete sample in its entirety. During this sort, segregate out all of the banned materials that exceed the indicated dimensions noted in **Table 1** below. Ensure that no portion of the sample remains unsorted. Refer to Appendix A-1: Material Definitions and Size Thresholds for more detailed descriptions of each material.
5. After sorting the complete sample, measure the segregated materials to determine if they exceed the indicated dimensions. Tools such as a "check box" (a wooden frame in 6", 8", and 12" dimensions identified in **Table 1**) are useful for the quick measurement of segregated materials. Materials are placed in the check box frame to quickly estimate their size.
6. Place all of the materials that exceed the defined dimensions into separate containers (for example, concrete/asphalt/bricks in one container and metal in another container) where the weight of the individual container is known and can be subtracted from the sample weight. Plastic baskets or refuse cans are suitable for this purpose.
7. Use a scale with a minimum accuracy of 0.1 pounds to weigh each separate container.
8. Subtract the tare weights from the gross weights of each containerized material in order to determine the net weights of each.

9. Record the gross and tare weights for each of the recoverable materials on the *Weight Based Sample Data Form*.

Table 1. Banned material sizing

Material	Size Threshold
Concrete/asphalt paving/bricks	>6" in its longest dimension
Metal	>6" in its longest dimension
Carpet	12" in its **shortest** dimension
Cardboard	>8" in its longest dimension
Plastic film wrap	12" in its **shortest** dimension
New construction gypsum scrap	>6" in its longest dimension
Unpainted/untreated wood	>6" in its longest dimension
Tear-off shingles	>8" in its longest dimension

Analysis

Enter data from the Sample Data Forms completed throughout the sample characterization into a database. The database will use the following formulae to conduct the required analysis and generate detailed C&D residual composition estimates.

Composition Calculations

The composition estimates represent the ratio of each material's weight to the total sample weight. They are derived by adding each material's weight across all of the selected records and dividing by the sum of the total sample weight, as shown in the following equation:

$$r_j = \frac{\sum_i c_{ij}}{\sum_i w_i}$$

where:

c = weight of particular material type

w = sum of all material type weights

for *i* 1 to n

where *n* = number of selected samples

for *j* 1 to m

where *m* = number of components

The confidence interval for this estimate is derived in two steps. First, the variance around the estimate is calculated, accounting for the fact that the ratio includes two random variables (the material type and total sample weights). The variance of the ratio estimator equation follows:

$$\hat{V}_{r_j} = \left(\frac{1}{n}\right) \cdot \left(\frac{1}{\overline{w}^2}\right) \cdot \left(\frac{\sum_i \left(c_{ij} - r_j w_i\right)^2}{n-1}\right) \qquad \overline{w} = \frac{\sum_i w_i}{n}$$

Second, confidence intervals at the 90% confidence level are calculated for a material's mean as follows:

$$r_j \pm \left(t \cdot \sqrt{\hat{V}_{r_j}}\right)$$

where:

t = the value of the t-statistic (1.645) corresponding to a 90% confidence level

For more detail, please refer to Chapter 6 "Ratio, Regression and Difference Estimation" of *Elementary Survey Sampling* by R.L. Scheaffer, W. Mendenhall and L. Ott (PWS Publishers, 1986).

Appendix A-1: Material Definitions and Size Thresholds

This section lists the materials that are banned from the residual stream and the definitions for each.

Material	Size Threshold	Definition
Concrete/asphalt paving/bricks	> 6" in its longest dimension	*Concrete, asphalt paving, and bricks in pieces > 6" in its longest dimension. Concrete is defined as a hard material made from sand, gravel, aggregate, cement mix, and water. Asphalt means a black or brown, tar-like material mixed with aggregate used as a paving material. Both categories include materials containing steel mesh and/or reinforcement bars, or "rebar". Bricks are defined as complete or partial portions of bricks made of red clay material. Does not include other types of aggregate material.*
Metal	> 6" in its longest dimension	*Includes tin/steel food cans, major appliances, other ferrous, aluminum cans, and other non-ferrous metals in lengths > 6" in its longest dimension. Includes Mixed Recoverable Metal meaning composite, multi-metal products or products with non metal contaminants. The metal content must be more than 90% by weight of the material.*
Carpet	> 12"in its **shortest** dimension	*'Carpet' means flooring applications > 12" in its shortest dimension that is primarily constructed of a top visible surface of synthetic face fibers or yarns or tufts attached to a backing system derived from synthetic or natural materials. It includes broadloom and carpet tiles; it does not include a rug, pad, cushion, or underlayment. Material must be dry and free of excessive contamination such as paint, grease, grime, or dirt.*
Cardboard	> 8" in its longest dimension	*Cardboard > 8" in length in its longest dimension. Can have tape, staples and other fasteners*
Plastic film wrap	> 12" in its **shortest** dimension	*Plastic film used to package or wrap commercial and industrial products in dimensions > 12" in its **shortest** dimension. Examples include shrink-wrap, and building wrap/Tyvek packaging. Material must be dry and free of excessive contamination such as paint, grease, grime, or dirt.*
New construction gypsum scrap	> 6" in its longest dimension	*Unpainted gypsum wallboard or interior wall covering made of a sheet of gypsum sandwiched between paper layers in lengths > 6" in length in its longest dimension. Examples: This category includes used or unused, broken or whole sheets. Gypsum board may also be called sheetrock, drywall, plasterboard, gypboard, gyproc, or wallboard.*

Unpainted/untreated wood	> 6” in its longest dimension	*Includes unpainted/unstained new and demolition scrap dimensional lumber such as 2 x 4s, 2 x 6s, 2 x 12s, and other residual materials from framing and related construction activities, engineered wood, pallets and crates in lengths > 6” in its longest dimension. Such wood can have nails, screws and metal fasteners. It does not include particle board or laminated veneer wood.*
Tear-off Asphalt Roofing shingles	> 8” in its longest dimension	*Composite shingles composed of fiberglass or organic felts saturated with asphalt and covered with inert aggregates including asphalt shingles and attached roofing tar and tar paper in lengths > 8” in its longest dimension.*

Appendix A-2: Field Forms

Weight Based Sample Data Form

Step 1: Enter Data

Site: Site 1 Site 2 Site 3 Site 4

Residuals Stream (circle):

Mixed C&D MSW Bulky

Date: _____

Sample ID: _____

Step 2: Photograph Samples

Stockpile/Load PhotoTaken: ☐

Sample Photo Taken ☐

Step 3: Weigh and record sample weight.

Sample Net Weight: _____

Net Weight	Material Type
	Concrete/asphalt paving/bricks >6" (longest)
	Metal >6" (longest)
	Carpet >12" (shortest)
	Cardboard >8" (longest)
	Plastic film wrap >12" (shortest)
	New construction gypsum scrap >6" (longest)
	Unpainted/untreated wood >6" (longest)
	Tear-off shingles >8" (longest)
lbs	***Grand Total***

Sample Placard

Random Cells:
5 7 15

SAMPLE ID

W-1

RESIDUAL STREAM:
Mixed C&D

DATE:5/15/2013

Facility: Facility 1