RESOURCE AND WASTE SOLUTIONS PARTNERSHIP

Review of TPH and Lead Concentrations in Screenings from Heavy Melting Scrap

CELSA Steel

Final Report
April 2018

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Summary

CELSA Steel operates an electric arc furnace (EAF) based steel-making process at the Cardiff plant, taking in approximately 1.2M tonnes of scrap steel each year. Approximately half the scrap input is heavy melting steel (HMS), which is the predominant source of the foreign materials (known as fines or 'sweepings') delivered with the scrap steel. The steel is separated from each load, leaving the fines / 'sweepings' that are then further physically processed to recover steel and non-ferrous metals.

In July 2016, Resource and Waste Solutions (RWSP) reported on a detailed sampling programme to characterise these fines / 'sweepings'. This concluded that the waste was non-hazardous. This classification was agreed by Natural Resources Wales (NRW) who subsequently issued a Compliance Assessment Report requiring the following actions to be completed by Celsa every 18 months to ensure that there is no overall change to the waste classification over time:

- Ensure the levels of TPHs in the scrap screenings remain at a level that supports a non-hazardous classification;
- Lead levels are assessed to ensure no significant deterioration; and
- Where high TPH levels are identified to be associated with specific scrap suppliers appropriate action is taken.

The current sampling and analysis exercise has been designed specifically to meet these requirements.

RWSP drafted a sampling strategy and statement setting out the background and the broad principles of the input sampling. This was followed up with a detailed sampling plan, which follows the principles set out in Appendix D of WM3. The vast majority of deliveries of HMS1 & 2 are from five suppliers. The sampling plan reflected this with multiple samples taken from the largest suppliers.

The sampling took place from 12:00 to 18:00 on 26th and from 08:00 to 14:00 on 27th March 2018. A mobile screener was used to screen a total of 18 different loads and the fines produced were sampled, weighed, further screened to 10mm and sent for analysis. The sample represented 24% of the HMS1&2 deliveries on those days.

Overall the concentrations of TPHs and lead have reduced since the 2016 sampling exercise. The levels of TPHs in the HMS1 & 2 screenings are still at a level that supports the previous non-hazardous assessment. The results show the average concentration fell from 10,600 mg/kg in 2016 to 9,000 mg/kg in 2018.

The results for lead show a significant improvement, with the average lead concentration reducing from 923 mg/kg to 448 mg/kg.

Due to the variation in concentrations of TPHs found , we recommend that the next (2019) sampling exercise should include more than one sample from the three suppliers with the highest levels of TPHs to establish whether the higher levels detected in the current exercise are part of ‘natural’ variability, or systemic.

1. Introduction

Resource and Waste Solutions (RWSP) has been commissioned by CELSA Steel to provide on-going support with the classification and management of the fines / 'sweepings' from the screening of scrap metal prior to the smelting process at the CELSA Tremorfa Works, Cardiff.

CELSA Steel operates an electric arc furnace (EAF) based steel-making process at the Cardiff plant, taking in approximately 1.2M tonnes of scrap steel each year. This scrap comes from a range of different sources and approximately half is heavy melting steel (HMS), which is the predominant source of the foreign materials delivered to the plant as part of the delivery of scrap steel. The steel is separated from each load, leaving the fines / 'sweepings' that are then further physically processed to recover steel and non-ferrous metals.

Between February and July 2016, RWSP carried out a detailed sampling programme to characterise the fines / 'sweepings' and determine the most appropriate List of Wastes (LoW) code. There was dialogue with Natural Resources Wales (NRW) throughout the sampling programme and particularly following the submission of the detailed waste classification assessment (26th July 2016), NRW made the following observation in a Compliance Assessment Report (CAR_NRW0023809):

- the report was comprehensive and represented an appropriately detailed assessment of the stockpiled and recently produced screenings.
- NRW was satisfied that there is no evidence presented in the report that indicated the waste is hazardous based on the assessment undertaken.
- NRW concurred, based on the information in the report, that the most appropriate LoW coding for the waste is 19 12 12.

However, given the nature of the waste stream and to ensure that there is no overall change to the waste classification over time, NRW required the following actions to be completed every 18 months:

- Ensure the levels of TPHs in the scrap screenings remain at a level that supports a non-hazardous classification;
- Lead levels are assessed to ensure no significant deterioration; and
- Where high TPH levels are identified to be associated with specific scrap suppliers appropriate action is taken.

The current sampling and analysis exercise has been designed specifically to meet these requirements from the Compliance Assessment Report.

Review of specific components in scrap screenings

The original sampling campaign in 2016, considered both stockpiled screenings and the screenings from input material. RWSP proposed to NRW that the review of the specific components in scrap screenings focused solely on the current input, as the stockpile sampling was originally undertaken because there was little or no analysis of the historical deposits.

NRW confirmed that they were satisfied with the approach and that the main purpose of the exercise should be to ensure that there has not been an increase in those components of specific interest i.e. TPH and lead. The new data can then be compared directly with the previous 'input' results.

2. Sampling

2016 Hazardous Waste Assessment

The 2016 hazardous waste assessment concluded for the incoming material, that as the petroleum groups were identified as lubricating oil and diesel in a ratio of 80:20, the diesel content is below the concentrations that would make it hazardous. For the lubricating oil, the relevant marker, a DMSO extract for the five input samples tested, gave results in the range 0.12% to 0.53% relative to the TPH concentration, below the 3% threshold for this test. Therefore HP7 Carcinogenic was discounted and this waste was classified as non-hazardous and assigned List of Wastes (LoW) code 19 12 12.

Based on the Compliance Assessment Report and subsequent communications with NRW the objectives of the review sampling should be:

- to ensure that there has not been an increase in those components of specific interest i.e. TPH and lead; and
- to compare the new results for these components directly with the previous 'input' results.

Incoming Material Sampling Plan

RWSP drafted a sampling strategy and statement setting out the background and the broad principles of the input sampling. This was followed by the development of a sampling plan (attached at Annex A), which followed the principles set out in Appendix D of WM3.

Sampling

The sampling took place on 26th and 27th March 2018. Scrap steel is received both by road and rail from 06:00 to 18:00 each day. The exercise used the mobile screener used for contrast loads in order to achieve minimum of 16 loads representing one day's loads but spread over two days. The sampling exercise began at approximately 12:00 on the first day and continued until approximately 18:00. On the second day, sampling began at approximately 08:00 and was completed by 14:00.

Sampling Process, Screening and Weighing

The sampling was undertaken by the same personnel who carried out the April 2016 Sampling Campaign, following the same method.

Concrete hardstanding was used as a base for the scales and to carry out the screening/containerisation. Each of the trugs and buckets were weighed and then labelled with an identification number/letter and its tare weight, see Figure 1 .

Figure 1 Labelling of buckets and trugs

Celsa supplied RWSP with weights and suppliers of HMS1 & 2 for 2017. There were 40 suppliers of HMS1 & 2 in 2017 but 84% of this input came from the top five and 98% from the top 16 companies. RWSP produced a representative list of scrap steel suppliers based on the annual input for 2017 and the forecast deliveries for the two days of sampling to ensure that more samples were taken from those suppliers delivering the most HMS1&2. The list was given to Celsa staff and vehicles carrying HMS1 & 2 were selected by the weighbridge operator on arrival.

Selected vehicles were directed to a separate area where they unloaded. The load was then transferred to the screener hopper using a 360 degree excavator with a grab and a wheeled loading shovel and the screener operated to screen out the fines.

When the load had been screened, pointed shovels were used to take representative samples from the pile of fines and place this waste into a bucket. When each bucket contained sufficient waste, generally between 3kg and 8kg, it was taken back to the concrete pad. The number of the bucket used for each sample was recorded, the bucket of waste weighed and the gross weight recorded. The contents of the bucket were then carefully sieved, a portion at a time, through a 10mm circular sieve into a 40 litre plastic trug. The oversize material (i.e. the material not passing through the 10mm sieve), was placed into another plastic trug, once as much loose material had been removed as practicable. When the screening was complete, any easily identifiable oversize pieces of waste (e.g. copper wire) in the screened material were also transferred to the trug with the oversize material. The identification of the trugs were recorded, along with the gross weights of each container of fines and oversize.

After weighing, a portion of fines was transferred to laboratory containers and each sealed and labelled. Following a visual assessment, see Section 3, the oversize was discarded.

The process was checked by adding together the net weights of the fines and oversize portions and comparing this total to the net weight of the sample as taken. These figures are provided in Annex B.

Over the two days a total of 18 individual samples from different loads was taken. This represented 24% of the HMS1&2 loads.

3. Assessment of Oversize

Oversize material screened from samples

The nature of the oversize material was very variable in material, items and size. During sample screening considerable effort was made to remove any undersize material adhering to oversize items such that the level of contamination of the oversize was minimal. The oversize material identified by RWSP consisted of pieces of wood, foam rubber, aluminum, copper, brass, steel, rubber and plastic, with the identifiable items including plastic sheathed copper wire and plumbing fittings, small pieces of printed circuit board, rubber bushes and metal components such as car parts etc., as shown in Figure 2

Figure 2 Oversize material from incoming loads

Container base diameter = 34 cm

4. Laboratory Analysis

Chemical analysis of samples was undertaken by i2 Analytical Ltd. All eighteen samples were analysed for lead and TPH C10 - C40.

The samples provided to the laboratory by RWSP were screened on site to remove as much of the oversize material (greater than 10mm) with minimal contamination of the oversize.

Derivation of determinands levels for the *in situ* waste from the laboratory results

The laboratory has MCERTS accreditation for the analyses undertaken but this requires reporting relative to the weight of the sample dried to constant weight. To determine whether or not a waste is hazardous, it is the waste as produced or in situ that needs to be evaluated. Therefore the laboratory results need be corrected to an '*as received*' figure by adjusting for any material greater than 10mm and moisture content and then further adjusted to take account of the weight of the oversize material which was not sent to the laboratory.

Therefore, the sample preparation process can be summarised as follows:

Waste sample as taken – Oversize content	=	Sample sent to laboratory
Sample sent to laboratory – Material >10 mm	=	Sample for analysis
Sample for analysis – Moisture content	=	Dry weight (for MCERTS reporting)

Thus the analytical results provided by the laboratory were adjusted by RWSP to produce the concentrations of the determinands in the material as received by the laboratory.

$$V(wet) = V(dry) \times (1 - (\% \, Moisture \, content/100))$$

Where *V* is the value of any determinand, followed by:

$$V(lab \, received) = V(wet) \times (1 - (\% \; > 10 \, mm \, content/100))$$

These results then needed to be corrected, by RWSP, for the oversize fraction to give the concentrations of the determinands in the incoming waste sample, as follows:

$$V(waste) = V(lab \, received) \times (1 - (\% \, \text{oversize}/100))$$

The full analytical results are provided in Annex C

5. Comparison of 2018 Lead and TPH results with 2016 results

The main purpose of the sampling exercise is to comply with NRW's requirement to ensure that there has not been an increase in those components of specific interest, (TPHs and lead), and to allow new data to be compared directly with the previous 'input' results.

Table 1 provides the comparison of lead and TPH concentrations from the two sampling campaigns.

Comparison of Lead Concentrations				Comparison of TPH C10 - C40 Concentrations			
April 2016 Sampling Campaign		March 2018 Sampling Campaign		April 2016 Sampling Campaign		March 2018 Sampling Campaign	
Sample Reference	Lead (mg/kg)	Sample Reference	Lead (mg/kg)	Sample Reference	TPH C10-C40 (mg/kg)	Sample Reference	TPH C10-C40 (mg/kg)
IN1	350	CS07/IN/001	2,151	IN1	6,684	CS07/IN/001	7,757
IN2	318	CS07/IN/002	172	IN2	6,361	CS07/IN/002	6,320
IN3	1,663	CS07/IN/003	406	IN3	3,780	CS07/IN/003	9,612
IN4	n/a	CS07/IN/004	760	IN4	18,900	CS07/IN/004	19,555
IN5	n/a	CS07/IN/005	554	IN5	7,623	CS07/IN/005	10,728
IN6	n/a	CS07/IN/006	703	IN6	8,060	CS07/IN/006	9,370
IN7	1,324	CS07/IN/007	404	IN7	12,176	CS07/IN/007	18,333
IN8	n/a	CS07/IN/008	304	IN8	15,450	CS07/IN/008	17,066
IN9	n/a	CS07/IN/009	384	IN9	7,817	CS07/IN/009	10,190
IN10	n/a	CS07/IN/010	310	IN10	15,387	CS07/IN/010	10,327
IN11	1,219	CS07/IN/011	138	IN11	21,479	CS07/IN/011	6,641
IN12	n/a	CS07/IN/012	66	IN12	13,787	CS07/IN/012	2,688
IN13	n/a	CS07/IN/013	355	IN13	16,273	CS07/IN/013	9,278
IN14	n/a	CS07/IN/014	260	IN14	6,458	CS07/IN/014	3,891
IN15	n/a	CS07/IN/015	140	IN15	6,570	CS07/IN/015	4,379
IN15	n/a	CS07/IN/016	365	IN15	7,508	CS07/IN/016	5,653
R1	664	CS07/IN/017	305	R1	5,590	CS07/IN/017	8,265
R2	n/a	CS07/IN/018	285	R2	8,806	CS07/IN/018	2,547
R3	n/a			R3	12,922		
Min	**318**	**Min**	**66**	**Min**	**3,780**	**Min**	**2,547**
Max	**1,663**	**Max**	**2,151**	**Max**	**21,479**	**Max**	**19,555**
Average	**923**	**Average**	**448**	**Average**	**10,612**	**Average**	**9,033**

Table 1 Comparison of April 2016 Sampling Campaign results with March 2018 Sampling Campaign results

Assessment of lead concentrations

In the April 2016 sampling campaign, five samples were analysed for lead; however in the March 2018 sampling campaign, all 18 samples have been tested for lead to address NRW's requirements to ensure that there has been no significant deterioration (i.e. increase) in the lead concentrations.

The results show a significant improvement in the lead concentration:

- In 2016, 3 of the 5 samples showed lead levels in excess of 1,200 mg/kg, in 2018 only one of the 18 samples showed lead levels in excess of 1,200 mg/kg.
- The average lead concentration has reduced from 923 mg/kg to 448 mg/kg, less than half the previous average concentration.

It should be noted that the maximum value in 2018 results is 30% higher than the maximum value in 2016. However, with the larger data set it can be seen that this figure (2,151mg/kg) is a clear outlier, but should be kept under review. A second load for this supplier was sampled, CS07/IN/013, for which the lead concentration was below the average at 355 mg/kg.

Assessment of TPH concentrations

In both sampling campaigns, all samples were analysed for TPHs. NRW required Celsa to establish that levels of TPHs in the scrap screenings remain at a level that supported the previous assessment.

The results show an improvement in the levels of TPHs across an all measures:

- The proportion of samples in excess of 10,000 mg/kg: in 2016, 8 of the 19 samples showed lead levels in excess of 10,000 mg/kg, in 2018 6 the 18 samples showed TPH levels in excess of 10,000 mg/kg. Only 3 of the 2018 samples had TPH concentrations in excess of 12,500 mg/kg compared to 7 samples in 2016.
- Both the minimum and maximum concentrations were lower in 2018 compared to 2016.
- The average concentration fell from 10,600 mg/kg in 2016 to 9,000 mg/kg in 2018.

Scrap suppliers TPH levels

As outlined above, the sampling of suppliers was designed to be as representative as possible of the number of loads received from Celsa's different suppliers during 2017. Table 2 provides a summary of the number of samples by supplier and the minimum, maximum and average TPH concentrations.

Supplier	Number of Sample	Minimum TPH Concentration	Maximum TPH Concentration	Average TPH Concentration
Supplier A	2	7,757	9,278	8,517
Supplier B	2	4,379	6,320	5,349
Supplier C	3	2,688	9,612	6,855
Supplier D	1	19,555	19,555	n/a
Supplier E	1	10,728	10,728	n/a
Supplier F	2	5,653	9,370	7,512
Supplier G	1	18,333	18,333	n/a
Supplier H	2	2,547	17,066	9,807
Supplier I	3	3,891	10,327	8,136
Supplier J	1	6,641	6,641	n/a

Table 2 March 2018 Sampling Campaign: TPH results by Supplier

The vast majority of deliveries of HMS1 & 2 are from five suppliers. The sampling reflected this with multiple samples taken from the largest suppliers. None of the supplier for whom two or more loads were sampled had average TPH concentrations in excess of 10,000 mg/kg.

Of the four suppliers who only had one load sampled, two had the two highest TPH concentrations: Supplier D and Supplier G: these suppliers were the fourth and sixth largest suppliers of HMS1 & 2 in 2017, providing 5.5% and 2.8% respectively of the input.

6. Conclusions and Recommendations

Conclusions

The levels of TPHs in the HMS1 & 2 screenings are at a level that supports the previous non-hazardous assessment. The results show the average concentration fell from 10,600 mg/kg in 2016 to 9,000 mg/kg in 2018.

The results show a significant improvement in the lead concentration, with the average lead concentration reducing from 923 mg/kg to 448 mg/kg.

There is substantial variation in concentrations of TPHs with concentrations more than double the average found in single loads from three suppliers.

Recommendations

Subject to NRW's response to this report, a follow-up sampling exercise is carried out between April and September 2019 to meet their requirements.

This sampling exercise should include more than one sample from the three suppliers with the highest levels of TPHs to establish whether the higher levels detected in the current exercise are part of 'natural' variability, or systemic.

Annex A: Sampling Strategy, Statement and Plan for Incoming Waste

Sampling strategy and statement – current input

Introduction

The purpose of this statement is to set out the principles to be adopted for the development of the sampling plan and subsequent sampling for the incoming HMS 1&2 scrap that gives rise to the sweepings at Celsa Steel, Cardiff.

Background

Celsa Steel operates an electric arc furnace (EAF) based steel-making process at the Cardiff plant, taking in approximately 1.2M tonnes of scrap steel each year. This scrap comes from a range of different sources and approximately half is heavy melting steel (HMS), which is the predominant source of foreign materials delivered to the plant in the scrap steel. The steel is separated from each load leaving the fines / 'sweepings' which then undergo further physical processing to recover steel and non-ferrous metals.

The process flow diagram for the sweepings is shown in Figure 1.

In 2016, RWSP undertook a major sampling exercise to characterise the sweepings. This assessment resulted in a non-hazardous classification for the waste.

Technical Guidance WM3 states that: '*The sampling plan often has to balance achievable reliability and the cost of sampling.* Therefore, given that approximately 30,000 tonnes of sweepings are received in the 1.2 million tonnes of scrap delivered to CELSA Steel each year, the sampling plan will be designed to balance the level of analysis and its reliability against on-going costs.

Outline of the plan and sampling

This sampling statement and the subsequent plan will comply with the principles set out Annex D of the Technical Guidance WM3. The technical goals will be to:

- confirm whether the waste is mixture of two or more subpopulations;
- determine the concentration of any hazardous substance present; and
- assess the relevant hazardous properties of the waste.

In the sampling plan each of these technical goals will be further broken down into detailed instructions and technical specifications that will cover:

- define the population(s) to be sampled;

- the sampling approach;
- the constituents to be studied;
- the scale; and
- the statistical approach chosen.

Every working day Celsa Steel receives approximately 150 loads, each containing approximately 25 tonne of scrap steel. Approximately half of this input is HMS1 & 2, which contains the fines/sweepings contamination. Sampling will take place over two consecutive days. The intention is to sample the fines/sweepings from selected HMS 1 & 2 loads on these two days.

The sampling will be designed to obtain incremental samples of each load sampled that represent the load. Samples will be taken from the undersize fraction from a mobile screener through which the whole of each selected load will be processed.

Dealing with oversize material in samples

Although they are the product of screening, the sweepings almost invariably contain larger items which the laboratory cannot deal with. These are part of the waste and need to be accounted for. Samples will therefore be weighed on site and any oversize material that will not fit into the sample containers removed and both parts reweighed.

Combining samples

The incremental samples will be combined into between 16 and 24 samples (one sample for each load) for analysis of the two key components: lead and total petroleum hydrocarbons.

Analysis

Both the initial sampling exercises have shown that the only potential problems appears to lie with petroleum hydrocarbon (TPH) and lead contamination. It is therefore proposed that all samples sent to the laboratory will be analysed for TPHs and lead.

Depending on the levels found, composite samples may be further subjected to a GC-MS scan to determine the petroleum groups present and/or analysed for DMSO extract.

These approaches allow the hazardous waste assessment to use the criteria in WM3 related to the use of 'marker compounds' to confirm or discount the carcinogenic and mutagenic properties of the TPHs present.

One in four samples (up to a maximum of six) will also be analysed for the full hazardous suite (e.g. cyanide, metals, asbestos etc.).

Statistics

Analysis of the previous (raw) results shows the following results for lead and TPHs.

Lead

Minimum	Maximum	Average (6 samples)	Standard deviation	90% Confidence Interval	
318.05	1,663.42	922.92	558.24	463.7	1382.1

TPHs

Minimum	Maximum	Average (6 samples)	Standard deviation	90% Confidence Interval	
3,780.28	21,479.25	10,612.13	5,044.52	8,605.48	12,619.12

These are analytical results from each sample, adjusted for oversize and moisture but not adjusted to take into account the nature of the oil etc. We consider that, given similar results, fewer than ten samples would be required to demonstrate 95% confidence that the waste was non-hazardous. However, given that we don't know whether the waste has changed, we will endeavour to take 16 or more samples to be analysed for lead and TPHs. Part of these samples will also be combined into between 4 and 6 composites that will be analysed for a full hazard suite plus asbestos.

Depending on the levels founds, some or all of the composites may subsequently be analysed using GC-MS to type the TPHs and subsequently a DMSO extract.

Sampling Plan

Sampling plan for updated waste classification and assessment of fines/sweepings/steriles	
Reference: CS/07/001 Date prepared: 22 March 2018 Prepared by: Terry Coleman Reviewed by: Nigel Naisbitt Prepared for: Celsa Steel, Cardiff	
Involved Parties	Celsa Steel
Objective	Basic characterisation and hazard assessment
Objectives and Technical Goals	To obtain samples of fines/sweepings from the current input of HMS1 & 2 scrap steel to Celsa for subsequent analysis to determine whether the input is hazardous or non-hazardous waste and also to assess whether there is any undue hazard associated with its further processing.

Background information	Approximately 150 loads of scrap steel are received each day at Celsa Steel's EAF plant, Rover Way, Cardiff. The scrap steel varies in quality and in the amount of contamination. The highest contamination is in approximately half the loads (75) that are classified as heavy melting steel (HMS1 and 2). The fines arise from the processing of scrap steel input. Lorry loads of steel mainly classified as HMS1 and 2 are delivered to Celsa contaminated with non-steel wastes, consisting of earth, rubber, plastic, non-ferrous metal and stones and collectively known as fines/sweepings. These are also contaminated with petroleum hydrocarbons (TPHs). Deliveries begin at approx. 6:00 and cease at 18:00 each day. Loads are directed to the appropriate bay according to type of steel, where they are discharged. The scrap is selected by a 360° hydraulic excavator and shaken to loosen and remove dirt etc. adhering to the scrap; this scrap is deposited into the appropriate bay ready for loading into the EAF. The soil/dirt and other contaminants are moved periodically to a second area where larger items (mainly steel) are screened out with by a 360° hydraulic excavator with a riddle bucket. The smaller sized output from this process is then loaded into a screen with magnetic separation. The fines from this secondary screen are those that are transported to the stockpile. Additionally, some loads are diverted from the normal loading bay and the whole load is run through screening, these are known as contrast loads and are designed to check the amount of fines in the incoming material. The fines from this process are also stockpiled in the same place.
Level of testing	Basic characterisation
Constituents to be tested	Focus on lead and TPHs but also BTEX, PAHs, PCBs, heavy metals including Hg, As, Sb and Se, pH, acidity/alkalinity and CN.
Health and Safety Precautions/Access restrictions	Trained screener operator. PPE including safety helmets, boots, gloves, eye-protection and high visibility jackets. Operation to be supervised by a member of Celsa Steel staff.

Technical Assessment	
Populations and subpopulations	There are several potential sub-populations in the input. These are: • The different suppliers/sites delivering HMS 1 and 2; • The outputs from contrast load screening; and • The outputs from the riddle bucket and screening. The last two populations will be identical. While the first is expected to be broadly similar, because they come from similar origins, we will endeavour to sample different suppliers, because they have different provenances, which could affect the concentration of potentially hazardous substances.
Variability and causes	The fines arise from different suppliers, albeit from similar processes and so could vary.
Scale of sampling	Ultimately this will be determined by the ability to screen loads to produce fines. It is proposed to sample approximately 16 to 24 loads spread over two days. Each initial sample will be approx. 5kg.
Practical Instructions and sampling method	
Name of organisation and sampler	Resource and Waste Solutions, Terry Coleman and Nigel Naisbitt
Other parties present	Celsa operational staff
Identify sampling place and points	Celsa Steel, 82 Seawall Road, Cardiff, CF24 5TH.
Statistical approach to be used	Structured, systematic sampling.
Sampling pattern and approach	Incoming loads to be divided into subpopulations by origin. Sampling of each for a regular number of loads.
Sampling equipment	See Appendix 1.
Sample details	Several samples will taken from the output from the screening process. These (or part of these after mixing) will be weighed and screened to remove oversize materials and the separate weights recorded. The fines portion will be thoroughly mixed before a suitably sized sample for laboratory analysis is obtained. Note that the screening process is required because the waste will contain quantities of materials that are uncontaminated and cannot be analysed due to their size (e.g. ferrous and non-ferrous metals, rubber, plastic, stones). Each sample will be weighed and then screened to separate any oversize materials

	(approx. >10mm). Each portion will then be weighed and the total checked. A photograph will be taken of the oversize in each case.
Requirements for sample reduction/on-site determinations	As above, each sample will be screened to remove oversize materials. Both parts will be separately weighed and recorded. Appropriate laboratory containers will be filled with the fines portion, labelled and recorded.
Sample ref number methodology	CS07/IN/XXX
Anticipated restrictions or limitations that may impact on sample reliability	May need to depart from sampling pattern, e.g. for operational reasons.
Subsampling method	Each sample will be coned and quartered to reduce to laboratory size.
Packaging	Laboratory sample jars packed in bubble wrap in closed cool boxes.
Preservation	Closed cool boxes dispatched to analytical laboratory on the day following the sampling exercise.
Transport method	Courier/overnight delivery
Transport company	TBA
Analytical Laboratory	I2 laboratories, Watford
Contact name	Jason Hines

Annex A1: Equipment used

RWSP personnel have been given an intensive safety briefing by Celsa staff and instructed on the use of the two-way radio system.

The equipment to be used will be as follows:

- Mobile screener
- Four 14 litre plastic buckets;
- Four 40 litre plastic trugs;
- Electronic scales, capable of weighing up to 50kg to $\pm$ 1 g.
- Small pointed shovels
- 10mm sieves
- Tarpaulins
- Marker pen
- Sample containers and jars
- Appropriate safety equipment, including hi-visibility jackets, protective footwear and gloves, safety helmet and safety glasses.

Annex B: Sample numbers, weights, percentage over and undersize and errors

Sample Ref	Net total (g)	Net oversize (g)	Net undersize (g)	Proportion of oversize	Proportion of undersize	Check total (g)	Difference
CS07/IN/001	9,182	5,232	3,932	57.0%	42.8%	9,805	0.18%
CS07/IN/002	9,577	6,062	3,479	63.3%	36.3%	10,184	0.35%
CS07/IN/003	13,967	6,793	7,116	48.6%	50.9%	14,552	0.40%
CS07/IN/004	8,174	2,627	5,534	32.1%	67.7%	8,802	0.15%
CS07/IN/005	10,003	5,878	4,106	58.8%	41.0%	10,625	0.18%
CS07/IN/006	7,332	2,509	4,802	34.2%	65.5%	7,952	0.26%
CS07/IN/007	9,069	3,385	5,664	37.3%	62.5%	9,690	0.21%
CS07/IN/008	9,464	3,659	5,771	38.7%	61.0%	10,071	0.34%
CS07/IN/009	11,167	3,475	7,658	31.1%	68.6%	11,774	0.29%
CS07/IN/010	7,905	2,908	4,971	36.8%	62.9%	8,520	0.30%
CS07/IN/011	9,225	6,482	2,716	70.3%	29.4%	9,839	0.27%
CS07/IN/012	8,975	7,305	1,666	81.4%	18.6%	9,612	0.04%
CS07/IN/013	10,062	5,052	4,920	50.2%	48.9%	10,613	0.84%
CS07/IN/014	10,513	6,203	4,272	59.0%	40.6%	11,116	0.34%
CS07/IN/015	7,799	5,630	2,104	72.2%	27.0%	8,375	0.77%
CS07/IN/016	9,607	5,698	3,805	59.3%	39.6%	10,144	1.01%
CS07/IN/017	9,173	5,741	3,413	62.6%	37.2%	9,795	0.19%
CS07/IN/018	10,255	6,553	3,656	63.9%	35.7%	10,850	0.42%

Annex C: Analytical Results and Corrections for Moisture and Oversize

Samples details		Analytical Parameter	Units	Limit of detection	Accreditation Status	i2 Analytical analysis	i2 Analytical analysis corrected for moisture	Moisture corrected i2 Analytical analysis corrected for oversize
Lab Sample Number	934609	Oversize	%	N/a	N/a	57		
Sample Reference	CS07/IN/001	Stone Content	%	0.1	NONE	< 0.1		
Supplier	Supplier A	Moisture Content	%	N/A	NONE	18		
Photographs	3757 to 3759	Total mass of sample received	kg	0.001	NONE	1.1		
Date Sampled	26/03/2018	Lead (aqua regia extractable)	mg/kg	1	MCERTS	6,100	5,002	2,151
Time Taken	12:23	TPH C10 - C40	mg/kg	10	MCERTS	22,000	18,040	7,757
Lab Sample Number	934610	Oversize	%	N/a	N/a	63.3		
Sample Reference	CS07/IN/002	Stone Content	%	0.1	NONE	< 0.1		
Supplier	Supplier B	Moisture Content	%	N/A	NONE	18		
Photographs	3760 to 3762	Total mass of sample received	kg	0.001	NONE	1.2		
Date Sampled	26/03/2018	Lead (aqua regia extractable)	mg/kg	1	MCERTS	570	467	172
Time Taken	12:41	TPH C10 - C40	mg/kg	10	MCERTS	21,000	17,220	6,320
Lab Sample Number	934611	Oversize	%	N/a	N/a	48.6		
Sample Reference	CS07/IN/003	Stone Content	%	0.1	NONE	< 0.1		
Supplier	Supplier C	Moisture Content	%	N/A	NONE	15		
Photographs	3763 to 3764	Total mass of sample received	kg	0.001	NONE	1.5		
Date Sampled	26/03/2018	Lead (aqua regia extractable)	mg/kg	1	MCERTS	930	791	406
Time Taken	13:02	TPH C10 - C40	mg/kg	10	MCERTS	22,000	18,700	9,612
Lab Sample Number	934612	Oversize	%	N/a	N/a	32.1		
Sample Reference	CS07/IN/004	Stone Content	%	0.1	NONE	< 0.1		
Supplier	Supplier D	Moisture Content	%	N/A	NONE	20		
Photographs	3765 to 3767	Total mass of sample received	kg	0.001	NONE	1.1		
Date Sampled	26/03/2018	Lead (aqua regia extractable)	mg/kg	1	MCERTS	1,400	1,120	760
Time Taken	13:39	TPH C10 - C40	mg/kg	10	MCERTS	36,000	28,800	19,555

Samples details		Analytical Parameter	Units	Limit of detection	Accreditation Status	i2 Analytical analysis	i2 Analytical analysis corrected for moisture	Moisture corrected i2 Analytical analysis corrected for oversize
Lab Sample Number	934613	Oversize	%	N/a	N/a	58.8		
Sample Reference	CS07/IN/005	Stone Content	%	0.1	NONE	< 0.1		
Supplier	Supplier E	Moisture Content	%	N/A	NONE	16		
Photographs	G3768 to 3770	Total mass of sample received	kg	0.001	NONE	1.2		
Date Sampled	26/03/2018	Lead (aqua regia extractable)	mg/kg	1	MCERTS	1,600	1,344	554
Time Taken	14:55	TPH C10 - C40	mg/kg	10	MCERTS	31,000	26,040	10,728
Lab Sample Number	934614	Oversize	%	N/a	N/a	34.2		
Sample Reference	CS07/IN/006	Stone Content	%	0.1	NONE	< 0.1		
Supplier	Supplier F	Moisture Content	%	N/A	NONE	11		
Photographs	G3771 to 3772	Total mass of sample received	kg	0.001	NONE	1.2		
Date Sampled	26/03/2018	Lead (aqua regia extractable)	mg/kg	1	MCERTS	1,200	1,068	703
Time Taken	15:28	TPH C10 - C40	mg/kg	10	MCERTS	16,000	14,240	9,370
Lab Sample Number	934615	Oversize	%	N/a	N/a	37.3		
Sample Reference	CS07/IN/007	Stone Content	%	0.1	NONE	< 0.1		
Supplier	Supplier G	Moisture Content	%	N/A	NONE	14		
Photographs	3773 to 3775	Total mass of sample received	kg	0.001	NONE	1.1		
Date Sampled	26/03/2018	Lead (aqua regia extractable)	mg/kg	1	MCERTS	750	645	404
Time Taken	15:58	TPH C10 - C40	mg/kg	10	MCERTS	34,000	29,240	18,333
Lab Sample Number	934616	Oversize	%	N/a	N/a	38.7		
Sample Reference	CS07/IN/008	Stone Content	%	0.1	NONE	< 0.1		
Supplier	Supplier H	Moisture Content	%	N/A	NONE	13		
Photographs	3776 to 3777	Total mass of sample received	kg	0.001	NONE	1.1		
Date Sampled	26/03/2018	Lead (aqua regia extractable)	mg/kg	1	MCERTS	570	496	304
Time Taken	16:26	TPH C10 - C40	mg/kg	10	MCERTS	32,000	27,840	17,066
Lab Sample Number	934617	Oversize	%	N/a	N/a	31.1		
Sample Reference	CS07/IN/009	Stone Content	%	0.1	NONE	< 0.1		
Supplier	Supplier I	Moisture Content	%	N/A	NONE	13		
Photographs	3778 to 3779	Total mass of sample received	kg	0.001	NONE	1.1		
Date Sampled	26/03/2018	Lead (aqua regia extractable)	mg/kg	1	MCERTS	640	557	384
Time Taken	17:00	TPH C10 - C40	mg/kg	10	MCERTS	17,000	14,790	10,190

Samples details		Analytical Parameter	Units	Limit of detection	Accreditation Status	i2 Analytical analysis	i2 Analytical analysis corrected for moisture	Moisture corrected i2 Analytical analysis corrected for oversize
Lab Sample Number	934618	Oversize	%	N/a	N/a	36.8		
Sample Reference	CS07/IN/010	Stone Content	%	0.1	NONE	< 0.1		
Supplier	Supplier I	Moisture Content	%	N/A	NONE	14		
Photographs	3780 to 3781	Total mass of sample received	kg	0.001	NONE	1.1		
Date Sampled	26/03/2018	Lead (aqua regia extractable)	mg/kg	1	MCERTS	570	490	310
Time Taken	17:30	TPH C10 - C40	mg/kg	10	MCERTS	19,000	16,340	10,327
Lab Sample Number	934619	Oversize	%	N/a	N/a	70.3		
Sample Reference	CS07/IN/011	Stone Content	%	0.1	NONE	< 0.1		
Supplier	Supplier J	Moisture Content	%	N/A	NONE	14		
Photographs	3782 to 3783	Total mass of sample received	kg	0.001	NONE	1.6		
Date Sampled	27/03/2018	Lead (aqua regia extractable)	mg/kg	1	MCERTS	540	464	138
Time Taken	08:35	TPH C10 - C40	mg/kg	10	MCERTS	26,000	22,360	6,641
Lab Sample Number	934620	Oversize	%	N/a	N/a	81.4		
Sample Reference	CS07/IN/012	Stone Content	%	0.1	NONE	< 0.1		
Supplier	Supplier C	Moisture Content	%	N/A	NONE	15		
Photographs	3784 to 3785	Total mass of sample received	kg	0.001	NONE	1.4		
Date Sampled	27/03/2018	Lead (aqua regia extractable)	mg/kg	1	MCERTS	420	357	66
Time Taken	09:04	TPH C10 - C40	mg/kg	10	MCERTS	17,000	14,450	2,688
Lab Sample Number	934621	Oversize	%	N/a	N/a	50.2		
Sample Reference	CS07/IN/013	Stone Content	%	0.1	NONE	< 0.1		
Supplier	Supplier A	Moisture Content	%	N/A	NONE	19		
Photographs	3786 to 3787	Total mass of sample received	kg	0.001	NONE	1.9		
Date Sampled	27/03/2018	Lead (aqua regia extractable)	mg/kg	1	MCERTS	880	713	355
Time Taken	09:43	TPH C10 - C40	mg/kg	10	MCERTS	23000	18,630	9,278
Lab Sample Number	934622	Oversize	%	N/a	N/a	59		
Sample Reference	CS07/IN/014	Stone Content	%	0.1	NONE	< 0.1		
Supplier	Supplier I	Moisture Content	%	N/A	NONE	27		
Photographs	3788 to 3789	Total mass of sample received	kg	0.001	NONE	1.7		
Date Sampled	27/03/2018	Lead (aqua regia extractable)	mg/kg	1	MCERTS	870	635	260
Time Taken	10:21	TPH C10 - C40	mg/kg	10	MCERTS	13,000	9,490	3,891

Samples details		Analytical Parameter	Units	Limit of detection	Accreditation Status	i2 Analytical analysis	i2 Analytical analysis corrected for moisture	Moisture corrected i2 Analytical analysis corrected for oversize
Lab Sample Number	934623	Oversize	%	N/a	N/a	72.2		
Sample Reference	CS07/IN/015	Stone Content	%	0.1	NONE	< 0.1		
Supplier	Supplier B	Moisture Content	%	N/A	NONE	25		
Photographs	3790 to 3791	Total mass of sample received	kg	0.001	NONE	1.6		
Date Sampled	27/03/2018	Lead (aqua regia extractable)	mg/kg	1	MCERTS	670	503	140
Time Taken	11:33	TPH C10 - C40	mg/kg	10	MCERTS	21,000	15,750	4,379
Lab Sample Number	934624	Oversize	%	N/a	N/a	39.6		
Sample Reference	CS07/IN/016	Stone Content	%	0.1	NONE	< 0.1		
Supplier	Supplier F	Moisture Content	%	N/A	NONE	28		
Photographs	3792 to 3793	Total mass of sample received	kg	0.001	NONE	1.7		
Date Sampled	27/03/2018	Lead (aqua regia extractable)	mg/kg	1	MCERTS	840	605	365
Time Taken	12:28	TPH C10 - C40	mg/kg	10	MCERTS	13,000	9,360	5,653
Lab Sample Number	934625	Oversize	%	N/a	N/a	62.6		
Sample Reference	CS07/IN/017	Stone Content	%	0.1	NONE	< 0.1		
Supplier	Supplier C	Moisture Content	%	N/A	NONE	15		
Photographs	3794 to 3795	Total mass of sample received	kg	0.001	NONE	1.2		
Date Sampled	27/03/2018	Lead (aqua regia extractable)	mg/kg	1	MCERTS	960	816	305
Time Taken	12:51	TPH C10 - C40	mg/kg	10	MCERTS	26,000	22,100	8,265
Lab Sample Number	934626	Oversize	%	N/a	N/a	63.9		
Sample Reference	CS07/IN/018	Stone Content	%	0.1	NONE	< 0.1		
Supplier	Supplier H	Moisture Content	%	N/A	NONE	16		
Photographs	3796 to 3797	Total mass of sample received	kg	0.001	NONE	1.5		
Date Sampled	27/03/2018	Lead (aqua regia extractable)	mg/kg	1	MCERTS	940	790	285
Time Taken	13:12	TPH C10 - C40	mg/kg	10	MCERTS	8,400	7,056	2,547

Notes:
1) i2 Analytical Ltd: Analytical Report Number: 18-80645
2) Oversize values taken from Annex B