CL:AIRE

Use of the Definition of Waste: Development Industry - Code of Practice (DoW CoP) in London & the South East

Summary

The Environment Agency (EA) and Contaminated Land: Applications in Real Environments (CL:AIRE) undertook a research project to provide an analysis of the Definition of Waste: Development Industry Code of Practice (DoW CoP) use in London and the South East. The project focused on the impact the use of the DoW CoP is having on materials reuse and sustainable remediation of brownfield land in London and the South East.

The objectives of the research were to show how the DoW CoP is contributing to:-

- more brownfield land being reused;
- resources being managed more sustainably;
- use of more sustainable remediation practices; and
- carbon reductions.

The project was split into two phases; the first phase consisted of an audit of 32 projects in London and the South East. The main aim of Phase 1 was to show that the DoW CoP is contributing to more land being reused.
Phase 1 was also used to:-

- Gain information to demonstrate that the DoW CoP is being applied as it is intended;
- Identify where the DoW CoP could be improved; and
- Encourage development of future work.

The results of Phase 1 showed that the number of DoW CoP declarations submitted nationally since 2011 is 591, 20% of which were in London and the South East. Approximately 1,950,000m^3 of material has been reused amongst this 20%. (Table 7, Definition of Waste: Development Industry Code of Practice - Audit Report).

Many positive attributes were identified during the audit these included quick response times, accurate referencing, clear schematic diagrams of material movements and comprehensive tracking systems. Positive feedback was received from the majority of Qualified Persons stating their support for the Code of Practice and enthusiasm for auditing.

The audit highlighted some general issues relating to poor/improper data management and referencing, missing information/documentation, limited contact points for auditors and confusion between Route A and Route B scenarios. In comparison, positive outcomes included some high-quality data management/referencing, detailed and well structured project documents/sections, and positive feedback from Qualified Persons.

The outcomes of the audit gave rise to the following recommendations -

- **Create a model Materials Management Plan template**

- **Revise some Materials Management Plan questions** to prevent insufficient information submission. Place more emphasis on the questions relating to the verification reports to stress the importance of these sections.

- **Provide other document templates to help** project teams to create documents in compliance with best practice.

- **Audit reminders –** The **Materials Management Plan** should emphasise that documents should be accessible by the QP and various project team members so that they are ready for audit. This could reduce response times, allowing more time for auditing and checking.

- **Data access –** Declarations that are held by or are accessible to CL:AIRE may eliminate initial project delays or confusion.

- **Audit time-scales -** More frequent auditing would be in keeping with the growth of the DoW CoP and increase in number of declarations.

- **Training -** The audit highlights the need for more training for QPs.

In the second phase, basic sustainability assessments were undertaken comparing material management using the DoW CoP with an alternative option (Dig & Dump). Three projects which were audited in the first phase were selected for the Phase 2 sustainability assessment. Each of these projects fell under a separate DoW CoP scenario (Site of Origin, Direct Transfer and Cluster).

Sustainable benefits of using the DoW CoP were found to include:-

- All three projects reduced greenhouse gas emissions (Site of Origin=13,962 kg CO_2e, Direct Transfer=310 kg CO_2e, Cluster=7,128 kg CO_2e.

- Significant fuel savings. The Site of Origin project saved 9,674 litres whilst the Direct Transfer and Cluster projects saved 259 litres and 5,946 litres respectively.

- Significant Financial Savings. The three projects in this assessment saved over an estimated £1.5million.

- Reduction in vehicle journeys. The Site of Origin project saved 447 vehicle journeys, the Direct Transfer project saved 192 journeys and the Cluster project saved 1,534 journeys by using the DoW CoP instead of Dig & Dump.

The sustainability assessments carried out in Phase 2 of this research has shown that the DoW CoP is frequently a more sustainable materials management option than the traditional Dig & Dump. This has been particularly emphasised by the financial savings that projects would incur by using the DoW CoP.

The variety of projects within this assessment (e.g. different DoW CoP scenarios, different types and volumes of material, varying degrees of treatment) have also demonstrated that the DoW CoP is applicable in a wide range of conditions.

All projects could have utilised the CL:AIRE Register of Materials (www.claire.co.uk - projects/ initiatives – CoP register of materials) to link with other nearby sites. CL:AIRE keeps a free register of materials which may fall within the DoWCoP. It aims to link material holders with service providers or organisations requiring materials in order to make the process of finding project partners an easier and quicker process. By using this service the sustainability benefits achieved could have been increased further.

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Phase 1 Audit Report

1 Introduction

The Environment Agency and Contaminated Land: Applications in Real Environments (CL:AIRE) undertook a research project to deliver an analysis of the Definition of Waste: Development Industry Code of Practice (DoW CoP) use in London and the South East. The project focused on the impact the use of the DoW CoP is having on materials reuse and sustainable remediation of brownfield land in London and the South East.

The project is expected to deliver evidence showing how use of the DoW CoP within London and the South East is contributing towards protecting and improving land quality.

This document outlines the purpose, process and results of an audit which forms the first phase of the wider project. The audit aims to assess the impact the use of the DoW CoP is having on excavated materials reuse and sustainable remediation of brownfield land in London and the South East.

2 Purpose of the Audit

Auditing a number of DoW CoP projects has a variety of uses to both the Environment Agency and CL:AIRE.

The main purposes of the audit were to:

- Gain information to demonstrate that the DoW CoP is being applied as it is intended;
- Identify where the DoW CoP could be improved; and
- Encourage development of future work.

The DoW CoP is intended to be used as guidance which “sets out good practice for the development industry” (DoW CoP 1.1, 2011). It describes an auditable system to prove that best practice is being used. Best practice is expected to be demonstrated in audited projects.

3 Aims and objectives

The main aim of Phase 1 was to show that the DoW CoP is contributing to more land being reused.

Phase 1 also aimed to:-

- Assess how the DoW CoP is being implemented and how risks to the environment are being managed;
- Identify problems and the priority by which they should be addressed;
- Gather information to assist in the assessment of sustainability performance, for the purposes of reporting on:
    - A project’s environmental performance in minimising the production of waste materials;
    - The environmental performances of an organisation (such as an industrial facility or government agency) to a client, stakeholder and/or community group.

The outputs of the audit phase are expected to give an indication of the performance of projects in London and the South East. This may also be representative of the national picture and show how the DoW CoP is contributing to sustainable land remediation. The project is also expected to deliver evidence of how the DoW CoP is contributing to the Waste Framework Directive's (WFD) commitment to recover 70% of construction and demolition waste to by 2020 (Waste Framework Directive, 2008; European Commission 2012)

4 When is an audit required?

The EA's aim is to "encourage the appropriate remediation of brownfield land" and "reduce the amount of material that is sent for disposal" (Environment Agency Position Statement, 2008). The EA's position statement identifies materials managed in accordance with the DoW CoP as materials that are unlikely to be waste. The position statement also refers to the purpose of audit to "ensure that human health and the environment continue to be protected".

Paragraph 3.41 of the DoW CoP document also refers to the process of random auditing which should take place each year to assess the overall effectiveness of the DoW CoP. In previous audits, up to 18 projects have been audited; the results of these led to the launch of Version 2 of the DoW CoP.

5 Audit Process

Thirty five projects were selected for audit. This figure was derived using sample size statistics (Table 1; Raosoft, 2004). The total number of projects (London & South East) using the DoW CoP between February 2011- July 2013 is 118. Note: The launch of Version 2 of the DoW CoP March 2011 governed the decision to consider declarations from February 2011 onwards only.

Table 1: Sample size statistics

Total Number	118
Confidence Level	90%
Margin of Error	5%
Response Distribution	95%
Sample Size	37

Note: Data generated using Raosoft software (2004)

It was considered important to audit all 4 Cluster projects, therefore the sample size was reduced from the calculated 37 to 35 to allow extra time and consideration as these projects can be more complex than other scenarios. However, upon receipt of project declarations, auditors realised that not all 4 of these assumed cluster projects were cluster scenarios. This is due to treatment facilities being listed as Hub sites on the initial database received by auditors when in fact they may just be Soil Treatment Facilities (STFs) on the Site of Origin. By the time this was realised, auditing and communication with Qualified Persons was well underway therefore the sample size was kept at 35, which equates to 30% of the total (118).

Table 2 shows a breakdown of the number of projects to be audited respective of the year and DoW CoP category.

Table 2: Breakdown of selected projects

Year	Total No. of Projects	Site of Origin	Direct Transfer	Cluster
2011	9	7	1	0
2012	10	6	3	0
2013	16	7	7	1
Total	35	20	11	1

6 Project Documents

Initial contact was made via email on August 1st 2013 to the persons acting as Qualified Person (QP) on each project. The email outlined the purpose of the audit, the documents and evidence required and the time frame in which they should be sent (2 weeks/by August 16th 2013).

Projects selected for audit were asked to supply all relevant project documents which were submitted to the QP and as such formed the basis for the declaration being signed. They were to include as a minimum:

Materials Management Plan (MMP) including supporting data/investigation/assessment documents, contingency arrangements and the verification plan. (Please see section 3.2 of the DoW CoP)

MMP Tracking System which shows an auditable trail of evidence to show material is not waste. (Please see section 3.2.1 of the DoW CoP)

A copy of the declaration by a registered Qualified Person (Please see section 3.3.1 of the DoW CoP)

Verification Report - outlining an auditable trail of measures taken to show materials and wastes have gone to the correct destination and documenting any changes that occurred. It was anticipated that verification reports may not be available for projects that are still ongoing. **Any further correspondence / documentation / evidence** that demonstrates procedural compliance with the DoW CoP to classify materials as non-waste, especially any correspondence with the local regulator. A full copy of the email is appended as Appendix A.

7 Auditing

The process of auditing a project involved following the questions in the MMP and performing a gap analysis. A project which was able to fully answer all the questions of the audit and provide all supporting evidence was considered a good project e.g. Question: “Please describe or provide copies of the required specification(s) for the materials to be reused on each site”. Answer: “The material being transferred from Site A to Site B must be of a particular geotechnical and chemical nature in compliance with existing material at site B. See paragraph 1.1 page 4 of ‘Specification’ document.”

This process was repeated for all 32 projects and each project was colour-coded to depict whether they were good (green), satisfactory (amber) or need improvement (red). The initial 35 projects were reduced to 32 due to lack of response from 3 QPs.

A project was labeled '**good**' if:-

- All documents were present; and
- Documents were referenced and organised clearly; and
- Continuous efforts to work to best practice were evident.

A project was labeled '**satisfactory**' if:-

- All documents were present; but
- Documents were not referenced or presented clearly; and/or
- Efforts to work to best practice were only evident some of the time.

A project was labeled as '**needing improvement'** if:-

- Documents were missing; and/or
- Documents were not referenced, organised or presented clearly; and/or
- Efforts to work to best practice were only evident some of the time.

Projects with missing information were revisited and QPs were contacted requesting the information.

Concluding comments were made and recorded in the master audit spreadsheet. These comments focused on the project's ability to comply with best practice outlined in CLR11 (2004), BS10175 (2011), Verification of Remediation and Land Contamination (2010) and the EA Position Statement (2011).

Regular meetings with the Environment Agency were held to provide consistent feedback and updates.

8 Audit Time-scales

All Qualified Persons for each project were contacted on August 1st 2013 and the same deadline for responses was given to each project (August 16th 2013). This was to ensure no advantage/disadvantage was given to any project during initial contact.

9 Results – Responses and Time-scales

The number of projects that were finally audited was 32 of the 35 initially proposed. This was due to a lack of response from 3 QPs. Among the 32, response times were varied; some QPs returned documents the same day or the same week and others took over a month.

Table 3 shows the percentage of projects that submitted a full set of documents per week. Some projects returning documents 4 weeks after the deadline had issues regarding the release/ distribution of documents. Some of these had significant contact with the auditor throughout. Many projects returned the majority of documents prior to or shortly after the deadline. Occasionally there was a document missing which was sent at a later date. This prevented the audit from being finished as a complete set of documents were needed to finish the audit. The following table is based on the return of a complete set of documents.

Table 3: Percentage of weekly responses returning complete set of documents

End of week date	No. of weeks after initial contact	% full document return	Cumulative return (%)
09/08/2013	1	6.25	6.25
16/08/2013 (deadline)	2	18.75	25.00
23/08/2013	3	12.5	37.50
30/08/2013	4	28.12	65.62
06/09/2013	5	9.38	75.00
13/09/2013	6	12.50	87.50
20/09/2013	7	0.00	87.5
27/09/2013	8	6.25	93.75
04/10/2013	9	6.25	100.00

The percentage of responses shows an initial peak at the deadline (18.85 %) and 2 weeks after the deadline (28.12%). This suggests that the 2 week deadline was not long enough and a longer (4 week) deadline may be more appropriate. Though, the peak at 4 weeks represents a number of projects which returned missing documents that were not initially sent. Therefore weeks 2 to 4 acted as a reminder period, giving QPs another chance to send the documents. The percentage received 5 to 6 weeks after the initial response, is relatively high due to a number of people returning from annual leave in early September.

10 Results – Statistics

The following tables show the statistical information relevant to this project including the number of declarations in both London and the South East, number of projects audited and volumes of material. There are also tables to show the number of projects that were considered ‘good’, ‘satisfactory’ and ‘in need of improvement’.

The total number of declarations submitted between February 2009 and July 2013 across England and Wales was 725. Since April 2011 (Version 2), which has been the focus of this audit, there have been 591 declarations submitted in England and Wales. The percentage of declarations submitted in London and the South East has remained at approximately 20% since both 2009 (Version 1) and 2011 (Version 2). Table 4 shows the proportion of these declarations in London and the South East.

Table 4: Number of declarations submitted in London and the South East since 2009 and 2011

	No. of Declarations since 2009	% of national total (725)	No. of Declarations since 2011	% of national total (591)
South East	102	14.1	80	13.6
London	45	6.2	38	6.4
London and South East	147	20.3	118	20.0

In comparison to other regions in England, and Wales, a high percentage of declarations have been submitted in London and the South East since both 2009 and 2011 (Figures 1 and 2). Since 2009, London and the South East together with the North West and the South West have been the most frequent users of the Code of Practice. A percentage breakdown is shown in Figure 1.

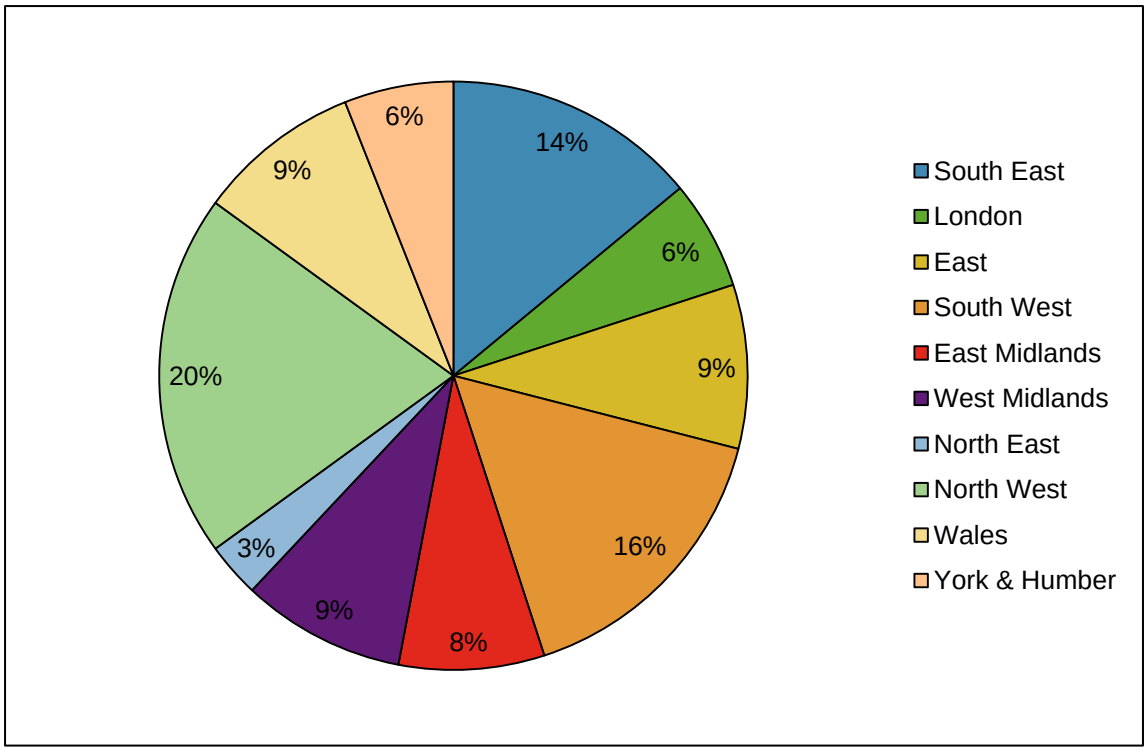

Figure 1: Percentage of total DoW CoP declarations by region since 2009

Taking into consideration declarations only submitted since 2011 (Version 2), London and the South East hold the highest percentage of regions in England, and Wales (Figure 2).

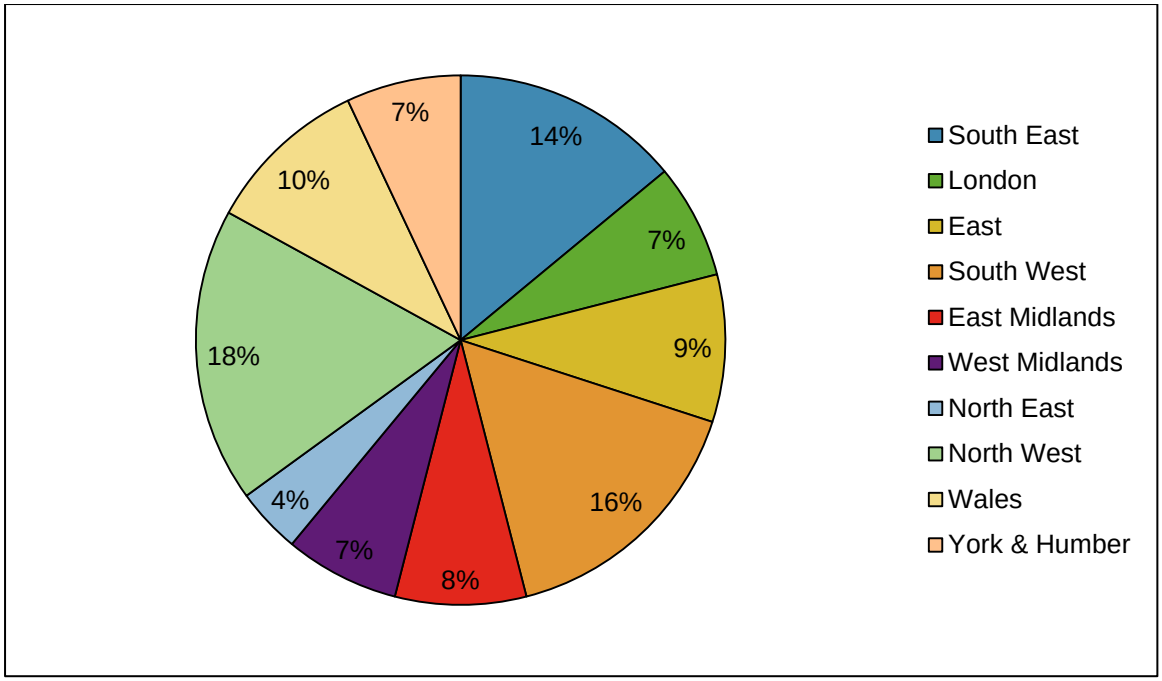

Figure 2: Percentage of total DoW CoP declarations by region since 2011

The volume of material reused under the DoW CoP in London and the South East since 2011 is approximately 1.9 million cubic metres (Table 5). As a percentage of the total volume reused in England and Wales since 2011, London and the South East account for 19.3% (Table 5). It is important to note that the data in Table 5 is conservative due to unavailability of material volume data prior to 2012, when it was not required to state the information on the declaration.

Table 5: Volume (m^3) of material reused – April 2012 - July 2013

Area	Volume (m^3)	% of total in England & Wales
England & Wales	9,394,100	
London & South East	1,918,741	19.3

Table 6 shows a breakdown of material reused in London and the South East. Figure 3 shows this graphically. It is important to note that material volume data was unavailable for all projects in 2011 and for two projects in 2012.

Table 6: Total volume & tonnes of material reused – February 2011- July 2013

Region(s)	Volume (m^3)	Tonnes (assuming 1.5 multiplier)
London & South East	1,978,432	2,967,648
London	592,052	888,078
South East	1,386,380	2,079,570

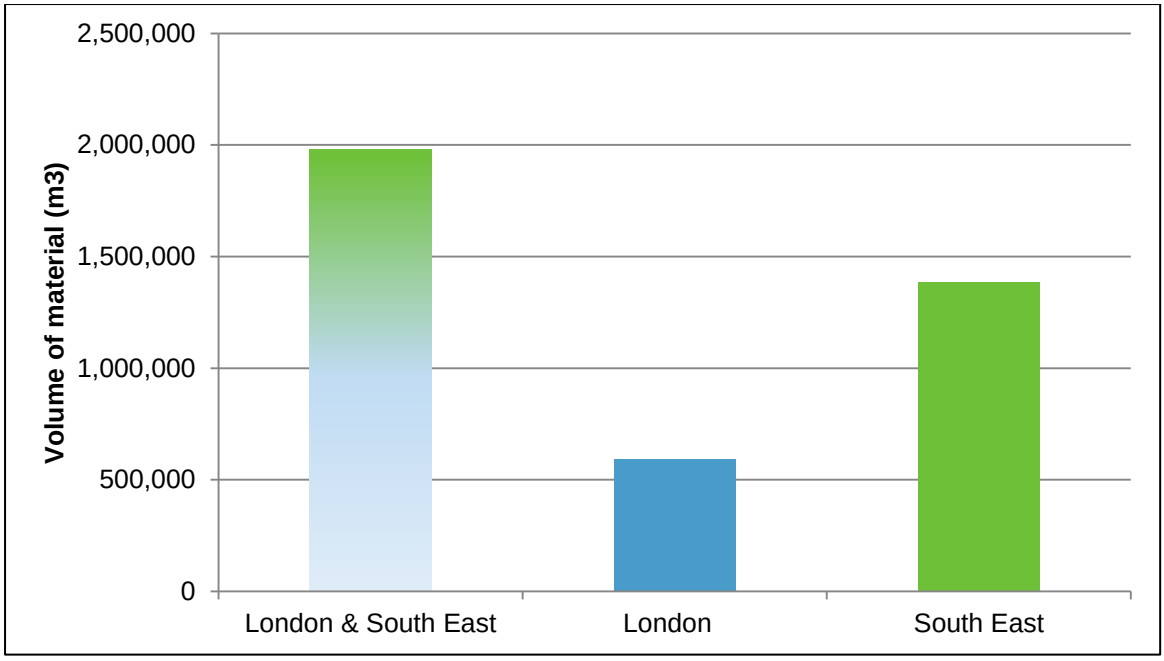

Figure 3: Volume of material reused from February 2011- July 2013

Though the proportion of Site of Origin projects audited was larger than other scenarios, the volume of material reused is greatest in Direct Transfer projects (shown in Table 7 and Figure 4). Approximately 475,000 m^3 of material cannot be accounted for in Table 7 due to projects not audited due to lack of response. The 475,000 m^3 of material belongs to 1 project in London in which the scenario was Site of Origin.

Table 7: Volume of material reused by audited projects (London & South East)

Scenario	Volume (m^3)	% of total
Site of Origin	171,112	15.9
Direct Transfer	435,598	40.5
Cluster	394,400	36.6
Combination	74,542	6.9
Total (32 projects)	1,075,652	100

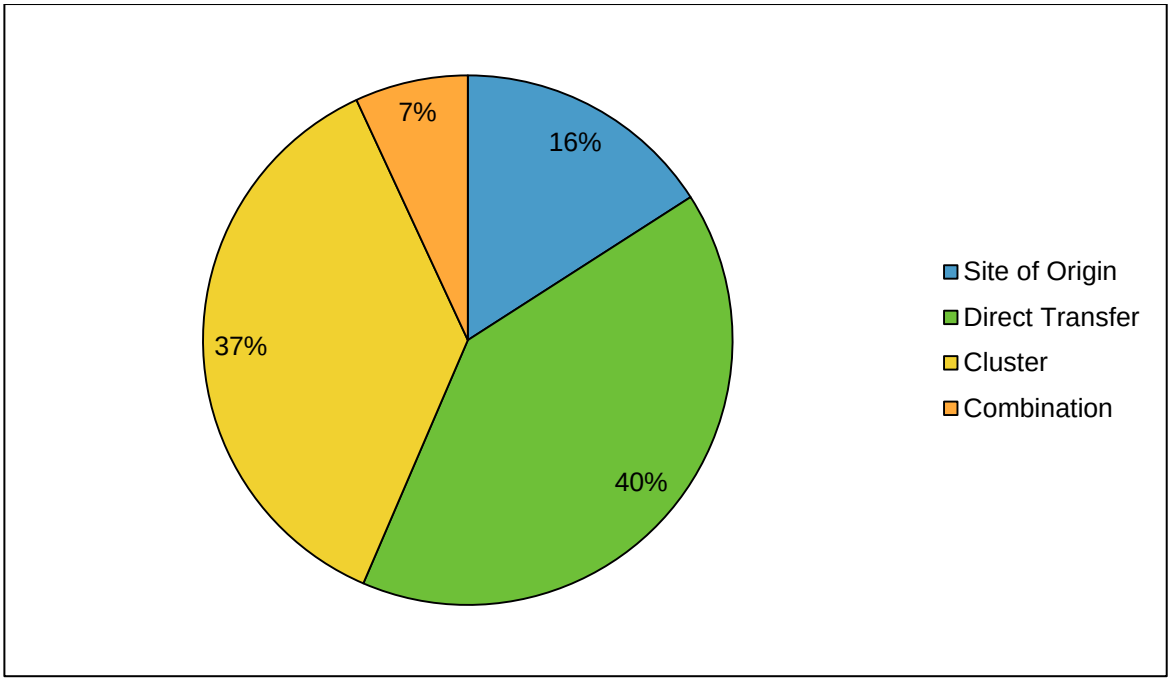

Figure 4: Percentage of material reused in each scenario of the 32 projects audited

The final number of projects audited was 32. Table 8 shows a breakdown of these projects.

Table 8: Final number of projects audited by year, region and scenario.

No. of Projects Audited (actual)	Site of Origin	Direct Transfer	Cluster	Combination	
2011	London	2	0	0	0
	SE	3	1	0	1
2012	London	2	0	0	0
	SE	4	3	0	1
2013	London	1	2	0	0
	SE	5	5	1	1

Of the Site of Origin projects audited, 53% used in-house QPs. Of the Direct Transfer projects, 46% used in-house QPs. In total, of all the projects audited, 50% used in-house QPs. Having an in-house QP did not appear to affect the quality of projects e.g. 80% of Site of Origin projects that used in-house QPs were ‘good’ projects, the remainder were ‘satisfactory’. In comparison, 67% of the Direct Transfer projects that used in-house QPs ‘needed improvement’, the remainder were satisfactory. This suggests that improvements are needed within the Direct Transfer scenario and that having an in-house QP does not necessarily reduce the quality of a project.

11 Results - Site of Origin

There were 17 Site of Origin projects in the 32 audited projects. Five of these were in London. The majority of projects audited used the Site of Origin scenario (53%). Table 9 shows the audit results for the Site of Origin scenario.

Table 9: Breakdown of projects in the Site of Origin scenario

Level	No. of projects
Good	10
Satisfactory	5
Improvement needed	2

The positive comments associated with the 'good' projects were:

- Well organised and clear referencing
- Immediate or fast response times
- All documents supplied
- All sections of the MMP answered and relevant

The minor issues arising within 'satisfactory' projects were found to be:

- Tracking system unsatisfactorily described
- Contingency and tracking systems too brief
- Unclear questions in the MMP
- Inadequate referencing and data management.
- Verification sections missing

The major issues arising within projects 'needing improvement' were found to be:

- Missing documents e.g. risk assessments.
- Unsatisfactory referencing and data management.
- Reference made to contamination however questions in the MMP relating to contamination were answered 'not applicable'.
- Not answered questions in the MMP

12 Results - Direct Transfer

There were 11 Direct Transfer projects out of the 32 Audited projects with the findings varying between satisfactory and improvement needed categories. There were no projects considered to be good in the Direct Transfer scenario. The lack of good projects in the Direct Transfer category could be a representation of incomplete understanding of this scenario. Table 10 shows this breakdown.

Table 10: Breakdown of projects in the Direct Transfer scenario

Level	No. of Projects
Good	0
Satisfactory	4
Improvement needed	7

The minor issues arising within the 'satisfactory' projects were found to be:

- Poor referencing and data management
- Inadequately described e.g. tracking system, contingency sections
- Vague information and poor presentation
- Limited evidence for questions in the MMP and brief answers

The major issues arising within the projects needing improvement were found to be:

- Route B (contamination is not present) is selected on declaration but contamination is mentioned in supporting documents. Little evidence to delineate contamination and prove that route B was the best option
- Poor data management and referencing
- Missing documents e.g. design statement, tracking system, verification sections
- MMP not answered clearly
- Multiple projects under 1 declaration; up to 4 donor sites but information not present for all sites.

13 Results - Combination

The combination projects comprised both Direct Transfer and Site of Origin scenarios within the same declaration therefore they were categorised separately as multiple materials movements may be taking place. There were 3 combination projects out of the 32 audited sites.

Table 11: Breakdown of projects - Combination scenario

Level	No. of Projects
Good	1
Satisfactory	1
Improvement needed	1

The comments associated with the good project were:

- Most sections of the MMP answered clearly and in detail
- Supporting evidence provided where necessary
- Detailed verification plan

The minor issues associated with the 'satisfactory' projects were:

- Order of MMP was changed with some questions removed from original template
- Important documents supplied but not referenced in the MMP e.g. specification
- Brief answers in MMP

14 Results - Cluster

Upon receipt of declarations for projects being audited, it was found that the 4 projects initially thought to be Clusters were reduced to just one. The 3 that were incorrectly categorised as Cluster projects were in fact either combination scenarios or complex site of origins with treatment taking place on site. These appeared to be Clusters in the raw database with often a hub site address given. Nonetheless, there was 1 Cluster project amongst the 32 audited and it was assessed as 'good'.

The comments associated with this project were:

- Files well organised
- Generally, documents referenced clearly and information supported by relevant evidence; however
- On occasion, multiple referencing e.g. two Appendix B's but different documents so unclear which one was being referred to.

15 Positive Audit Findings

Many positive attributes were identified during the audit. These are listed below:-

- Quick response times and all documents returned upon initial request.
- Documents titled with an appropriate title and exactly as referenced in the MMP making them easy to locate e.g. answer in MMP states 'See section 1.2 of document titled Phase 1 Risk Assessment'.
- Very clear schematic diagrams of material movements – some projects showed this extremely well allowing the auditor to immediately understand the project and refer back to the schematic easily during audit.
- Some comprehensive tracking systems in place showing project teams are trying to work to best practice and provide the relevant evidence.
- Highlighting exact sections within a document which relate to the MMP relieving the auditor from scanning through large documents for small pieces of information.
- Positive feedback and comments from the majority of QPs stating their support for the Code of Practice and enthusiasm over an audit of their work.
- The reuse of almost 2 million cubic metres of material in London and the South East (Table 5).

16 General Audit Issues

There were common findings across the 32 projects which could highlight deeper issues regarding the understanding of the DoW CoP by the project teams. These common problems can be used to encourage improvements in the DoW CoP and the proposed Version 3. The key findings are listed below in order of frequency (1 being the most frequent problem):-

1. **Inadequate data management** – this was evident in all 32 projects to varying extents. It manifested as unclear or complicated document titles e.g. a series of letters and numbers. Often supporting documents were supplied but not referenced/poorly referenced within the MMP. This forced auditors to locate the relevant documents and sections, without which the MMP answers were incomplete. This delayed auditing time significantly; the need to designate time to briefly read, rename and organise documents more appropriately was not anticipated. Document organisation and referencing was expected to be of a good standard upon receipt of the documents.

2. **Missing information** – The tracking and contingency sections in particular were consistently answered poorly, often with no answers at all. This may be associated with the lack of clarity with these questions e.g. Q22a of the MMP in particular, was often not answered as it appears that 22b, c, d and e are sub-questions which would be the answers to 22a. It is not clear that 22a is, in its own, a separate question and needs to be answered as well as the other 4.

   Q22a. For all sites please describe the tracking system to be employed to monitor materials movements.
   Where contamination is suspected or known to be present
   State the procedures put in place to:
   22b. Prevent contaminants not suitable for the treatment process being accepted;
   22c. Prevent cross contamination of materials not in need of treatment, wastes awaiting treatment and treated materials;
   22d. Demonstrate that materials that do not require treatment and successfully treated materials reach their specific destination and;
   22e. Ensure that waste for offsite disposal or treatment is properly characterised and goes to the correct facility

3. **Limited contacts** – Only 1 person (the QP) was available for contact within each project for all the relevant information. In the event that a QP was away on

annual leave or no longer had access to documents, it proved difficult to track down the documents. This consumed time at the start of the auditing project which was not factored in to the initial time-scales. It also placed a burden on QPs requiring significant cooperation from them, even though they had not previously been told they would be approached during audit.

4. **Missing verification reports** – 27 out of 32 projects did not have verification reports. It is unclear as to how many of these should have a verification report i.e. the project is still ongoing. To improve the auditing process, CL:AIRE or the EA could be notified when a project has ended, thus it would be a requirement for that project to provide a verification report during audit. Conversely, if it was known that a project being audited was ongoing there would not be a requirement for them to supply a verification report.

5. **Route A or Route B confusion** – Often the information supplied in the MMP and supporting documents do not match the route chosen on the declaration. This suggests that more information or training may be needed to help a project team when choosing route A or route B.

Some of the minor issues raised during audit were as follows:-

- Not enough information in the raw data sheet e.g. details of the developers, which scenario the project is (Site of Origin, Direct Transfer, Cluster, or Combination).
- Brief and carelessly compiled MMPs often with irrelevant answers.
- Documents all compiled into 1 e.g. MMP form and all supporting documents submitted as 1 document (some were over 1000 pages)

17 Audit Recommendations

Based upon the findings of the audit the following recommendations are proposed for future development of the DoW CoP –

- **MMP template** - this would prove to be beneficial for both the project teams preparing the MMP, CL:AIRE staff and the auditor. A model MMP would allow the auditor to clearly distinguish between a satisfactory and unsatisfactory answer or reference. The model MMP could be downloaded and viewed by project teams before starting a project using the DoW CoP. It is anticipated that this could reduce the level of confusion or broadness in answering a question and provide a more common and familiar format for the auditor and project teams to follow

- **MMP questions** – these need to be revised:-
  - Particularly questions that ask for copies OR relevant extracts. Some projects have opted to just provide a short relevant extract, however a small extract is insufficient for the auditor to gain a satisfactory insight into the project. Full documents should be supplied with the MMP with the relevant sections simply highlighted and referenced clearly. This allows the auditor to read different sections of the document which may aid their understanding of the project.
  - Other questions that should be revised include the contingency sections which were collectively answered poorly. Emphasis should be made on the importance of these sections and the necessity for contracts and evidence to be supplied as opposed to just the name of the company who is liable.

- **Other document templates -** these should be made available for download similar to the current MMP template. This provides more guidance for project teams to create documents in compliance with best practice. If necessary CLR11,

and other documents e.g. BS10175, should be referred to more heavily in DoW CoP guidance to encourage project teams to follow the DoW CoP more closely.

- **Audit reminders –** Project teams can be reminded of audits in various ways including Q25 of MMP which asks 'Where, and in what form, are records to be kept?' This question should emphasise that documents should be accessible by the QP and various project team members so that they are ready for audit. This could reduce response times, allowing more time for auditing and checking.

    - Reminders could also be posted in the CL:AIRE electronic newsletter, or in personal emails to QPs prior to audit. QPs can also be asked to remind project teams, or, project teams can be contacted directly.

    - A reminder may be necessary to send out 2-3 months in advance to all project teams and QPs ensuring that a member of the project is available during the time of audit. Alternatively, a different time of year should be considered for auditing.

    - Furthermore, the number of people contacted for the information required for audit was just 1 (QP). A variety of contacts per project may eliminate extensive response times and limitations with availability of delegates.

- **Data access –** Declarations that are held by or are accessible to CL:AIRE may eliminate initial project delays or confusion. For example, the simple information stated on the declaration would allow the auditor to know:-
    - Which scenario the project is (Site of Origin, Direct Transfer, Combination or Cluster) and whether it is route A or B.

    - The volume of material being moved (allowing statistical analysis of money savings and total soil movements to be made).

    - The name and address of the project (allowing the auditor to map the project and carry out statistics regarding regions and frequency of DoW CoP use).

    - Name and address of developer (allowing the auditor to record which projects may be using the DoW CoP multiple times, aiding the generation of case studies and examples of best practice).

    - QP name and address.

    - List of documents specific to that project that the QP has seen.

- **Audit time-scales -** More frequent auditing, (perhaps annually) would be in keeping with the growth of the DoW CoP and increase in number of declarations.
- **Training -** The audit highlights the need for more training for QPs. This could be available as a second phase of training after the current 1 day training course which introduces the DoW.

    - The second phase training could allow people to use what they have learned in the 1 day training course and apply it to case study scenarios. It could focus on what should be reviewed by the QP before a project is signed off and the level of quality a project should achieve e.g. well organised and referenced documents. Again, this may allow the QPs to become familiar with the documents they should be seeing. This in turn could increase the number of well organised and 'good' projects that are completed and thus reduce audit time.

- A two tier QP sign off could allow for second reviewing, a second opinion and less pressure on a single QP checking documents.

- Greater care required when compiling the MMP including more detailed answers.

- Relevant sections of documents should be referenced e.g. page and paragraph number rather than entire document which sometimes were up to 1000 pages.

18 Reliance and limitations

For confidentiality reasons, no specific project or QP is referred to in this report. This report summarises the outcomes of DoW CoP audits in London and the South East (2013) and should be considered as guidance to help improve the DoW CoP and the performance of those involved in its use. It is important to note that the role of the auditor is not the same as a QP. The auditor's aim has been to ensure that documents supporting the DoW CoP are a) supplied and; b) relevant to the DoW.

19 References

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Phase 2 Sustainability Assessments

1 Introduction

CL:AIRE and the Environment Agency (EA) have undertaken a research project on the use of the Definition of Waste: Development Industry Code of Practice (DoW CoP) in London and the South East.

Phase 2 of the research project aims to show how the DoW CoP is contributing to:-

- resources being managed more sustainably;
- use of more sustainable remediation practices; and
- carbon reductions in land reuse projects.

The findings of the project audit report (Phase 1) have shown that 118 projects have used the DoW CoP in London and the South East since 2011 and approximately 1,950,000m^3 of material has been reused amongst these projects (Table 7, Definition of Waste: Development Industry Code of Practice - Audit Report).

In the second phase, basic sustainability assessments were undertaken comparing material management using the DoW CoP with an alternative option (Dig & Dump). Three projects which were audited in the first phase were selected for the Phase 2 sustainability assessment. Each of these projects falls under a separate DoW CoP scenario (Site of Origin, Direct Transfer and Cluster).

This document outlines the methods involved in the sustainability assessment of a Site of Origin project in Sussex, a Direct Transfer project in London and a Cluster project in Berkshire. See Table 7 in the Definition of Waste: Development Industry Code of Practice - Audit Report for a breakdown of materials reuse amongst DoW CoP scenarios.

2 Sustainability Assessment

Environmental, social and economic factors are interconnected and form the basis of sustainable development (Environment Agency, 2014; Committee on Sustainability Assessment, 2013; DEFRA, 2013).

A sustainability assessment is defined by the EA as a process which “provides for the systematic identification and evaluation of the economic, social and environmental impacts of a proposal” (Environment Agency, 2014). For this study, some of the main principles of the UK’s Sustainable Remediation Forum (SuRF-UK) were used to undertake a sustainability assessment.

Using environmental, social and economic indicators the three projects were analysed for evidence of sustainable practice, against a hypothetical alternative option (Dig & Dump). This option was chosen as an alternative as it was seen as the most likely route for projects, had they not had the option to use the DoW CoP. It also represents the traditional approach to managing waste materials. The assessment aims to demonstrate the factors stated in Paragraph 1.2 of this document.

Whilst SuRF-UK principles were used, the framework process was not followed too rigidly. This allowed for flexibility in the assessment e.g. consideration of both quantitative and qualitative measures, which was useful in undertaking a project specific assessment where only limited information was available. The assessment procedure used is therefore specific to this study with general aspects of SuRF-UK incorporated.

Project Boundaries

The factors assessed were limited to the indicators in Tables 1, 2 and 3 of this document. The focus was on factors which were different in each scenario for example those associated with sending material to landfill using Dig & Dump versus reusing material on-site with the DoW CoP.

Aspects which may have been the same under both options were not considered in the sustainability assessment as they would be attributed with the same sustainability benefits, in which case a comparison cannot be made. Haulage costs were left outside the boundaries of this assessment as they are variable and dependent on information which was not available.

Only carbon emissions from transport were considered, as vehicles are the dominant source (Department of Energy and Climate Change, 2014). Carbon emitted from the remediation, landfill or aggregate supplier activities was not involved in the assessment as adequate information was not available.

Greatest accuracy and detail in sustainability assessments is achieved through early design and planning. This allows the necessary information to be recorded and reported. These sustainability assessments were carried out retrospectively, projects which were assessed we not aware of this process would occur during their design. This limited the information and data that was available.

3 Methodology

The sustainability assessment process involved the following:-

1. A selection of three projects based on the results of the first phase (audit phase). These three were representative of the projects that were audited across London and the South East i.e. geographically, by scenario and size of project.

2. Based on the information available in the project documents, three categories from each element (environmental, social and economic) were chosen with the intention that they could be altered, removed or added to during the assessment. For example, each element was to have at least one category and at most three.

3. Project teams were contacted and informed that their projects were being taken forward to Phase 2. It was also agreed that further correspondence and information may be needed from them to compile the case studies.

4. Projects were reviewed in depth and information which related to indicators was retrieved from the project documents submitted for audit, and recorded in the assessment spreadsheet.

5. Project teams were then contacted for any further information that could help the assessment. Having reviewed existing information against indicators, the research team were able to ask for more specific information at this stage.

6. Each category was given a score (out of 5) which represented the number of ‘good’ characteristics each management option might achieve. Scores were totaled at the end, showing which materials management option was most favourable.

4 Environmental Indicators

Table 1 shows the environmental indicators assessed. These were selected to identify the main environmental benefits and costs of using the DoW CoP. They were seen to be most applicable to an environmental assessment of excavated material management. They addressed the aims of the project (Paragraph 1.2 of this document).

Table 1: Environmental Indicators

Category	Indicator
Air	• Emissions that may affect climate change / air quality, or considerations that may allow overall reduction in impact on climate change e.g.: • Greenhouse gases (e.g. CO_2, CH_4, N_2O, O_3, VOCs, ozone depleting substances etc.) • Particulates (PM5, PM10)
Soil & Ground conditions	• Changes in physical, chemical, biological soil condition that affects the ecosystem function, goods or services provided by soils (improvements OR deteriorations). May include: - Soil quality (chemistry) - Water filtration & purification processes (incl. sediment generation or reduction) - Soil structure and/or organic matter content or quality - Erosion and soil stability (incl. drainage) - Geotechnical properties (incl. compaction) - Impact/benefits to sites of special geological interest e.g. SSSIs and geoparks - Conservation/Environmental Management/Ecology
Natural Resources & Waste	• Impacts/benefits for: • Land and waste resources • Use of primary resources/substitution of primary resources within the project/external to it (inc. raw and recycled aggregates) • Use of energy/fuels taking into account their type/origin and the possibility of generating renewable energy by the project • Handling of materials on-site, off-site and waste disposal resources • Water abstraction, use and disposal

5 Social Indicators

Table 2 shows the social indicators that were assessed. These were selected to assess the social benefits and costs of using the DoW CoP and were expected to give a better understanding of how projects are managed under the DoW CoP. This included data management and record keeping which was one of the major issues highlighted in Phase 1 of this research project (Definition of Waste: Development Industry Code of Practice - Audit Report, 2014). The indicators also address some of the overall aims and objectives of the project as shown in Paragraph 1.2.

Table 2: Social Indicators

Category	Indicator
Human Health & Safety	• Risk management performance of the project (long term) in terms of delivery of mitigation of unacceptable human health risks • Risk management performance of project (short term) in terms of duration of remediation works, incl. consideration of: • Site workers, site neighbours and the public • Remediation works and ancillary operations (incl. process emissions such as bio aerosols, allergens, PM10, impacts from operating machinery/traffic movements, excavation, etc)
Neighbourhood & Locality	• Impacts/benefits to local areas (tangible amenity changes), including: • Effects from dust, light, noise, odour and vibrations during works and associated with traffic, including both working-day and night/weekend operations
Uncertainty & Evidence	• Robustness of sustainability appraisal for each option considered • Quality of investigation, assessments (incl. sustainability) and plans, and their ability to cope with variation. Accuracy of record taking and storage. • Requirements for validation/verification • Degree to which robust site-specific risk-based remedial criteria are established (justified & realistic CSM versus unnecessarily conservative and/or precautionary assumptions/data)

6 Economic Indicators

Table 3 shows the economic indicators that were assessed. They were selected to assess the economic benefits and costs of using the DoW CoP. These were expected to highlight the volume of material being reused (as a reflection of results from the first phase, (Definition of Waste: Development Industry Code of Practice - Audit Report, 2014) and the cost of this under the Dig & Dump option in comparison with the DoW CoP.

Table 3: Economic Indicators

Category	Indicator
Direct Economic Costs & Benefits	• Direct financial costs and benefits of remediation for organization • Consequences of capital and operation costs, and sensitivity to alteration e.g.: • Costs associated with the works (incl. operation and any ongoing monitoring, regulator costs, planning, permits licences) • Uplift in site value to facilitate future development or investment • Liability discharge
Project Lifespan & Flexibility	• Duration of the risk management (remediation) benefit) • Factors affecting chances of success of the remediation works and issues that may affect works, incl. community, contractual, environmental, procurement and technological risks • Ability of project to respond to changing circumstances, including discovery of additional contamination/material, different soil materials, or time-scales

A Sustainability Assessment comparing the use of the Definition of Waste: Development Industry Code of Practice Site of Origin Project against Dig & Dump in Sussex, England

Key Facts

- Volume of stockpile: 5,600m3
- Volume of material reused: 4,530m3
- Type of material: made ground with asbestos fragment

Key Benefits

Environmental:-

- CO_2 emissions saved: 11,594 kgCO_2
- Total GHG emissions saved: 14,000 kgCO_2e

Social:-

- 20 mile radius of local populated area saved from exposure to project works
- 447 vehicle journeys saved
- 21,481 road vehicle miles saved

Economic:-

- Landfill costs saved (tax + gate fees): £159,683
- New material costs saved: £101,925
- Fuel costs saved: £24,490
- Total money saved (including extra DoW CoP costs): £284,703

7. Phase 1 Audit Results

Phase 1 of this research involved the audit of 32 materials reuse projects which used the Definition of Waste: Development Industry Code of Practice (DoW CoP), across London & the South East.

The results of Phase 1 showed this project demonstrated compliance with the DoW CoP by providing evidence for the information required in the Materials Management Plan (MMP). The quality of data organisation and presentation was high making this project easy to understand and follow by the audit team.

8. Aims & Objectives

The project was selected for Phase 2 of the research, a sustainability assessment. During this phase, the project was analysed for evidence of the DoW CoP facilitating:-

- Sustainable management of resources
- Better use of sustainable land remediation practices; and
- Significant carbon reductions.

9. Sustainability Assessment

A sustainability assessment is defined by the Environment Agency (EA) as a process which "provides for the systematic identification and evaluation of the economic, social and environmental impacts of a proposal" (Environment Agency, 2014). For this study, some of the main principles of the UK's Sustainable Remediation Forum (SuRF-UK) were used to undertake a sustainability assessment. Using environmental, social and economic indicators this project was analysed for evidence of sustainable practice, against a hypothetical alternative option (Dig & Dump). This option was chosen as an alternative as it was seen as the most likely route for projects, had they not had the option to use the DoW CoP. It also represents the traditional approach to managing waste materials.

Assumptions

For this project, the Site of Origin scenario was compared with an option involving buying new backfill to replace existing made ground sent to landfill. This option was considered to be an alternative which may have been used, in the absence of the DoW CoP. See Appendix 1 for the full assessment.

For the purpose of comparison, it was assumed that the same size and type of tipper truck was used in each project. A typical 8 wheel 4 axle tipper truck with a maximum capacity of approximately 19.5 tonnes was assumed for road use. For on-site use a 6 wheeled articulated dump truck with 22 tonnes maximum carrying capacity was assumed. All trucks were assumed to be carrying 100% laden weight unless stated otherwise.

10. Project Background

This project involved a residential development of land adjacent to a hospital in Sussex. The project used the Site of Origin scenario of the DoW CoP to move a stockpile of material from one part of the site to another. 5,600m^3 of excavated material, some of which contained asbestos fragments and fibres, was segregated and reduced to 4,530m^3 to fill a void of 4,957m^3.

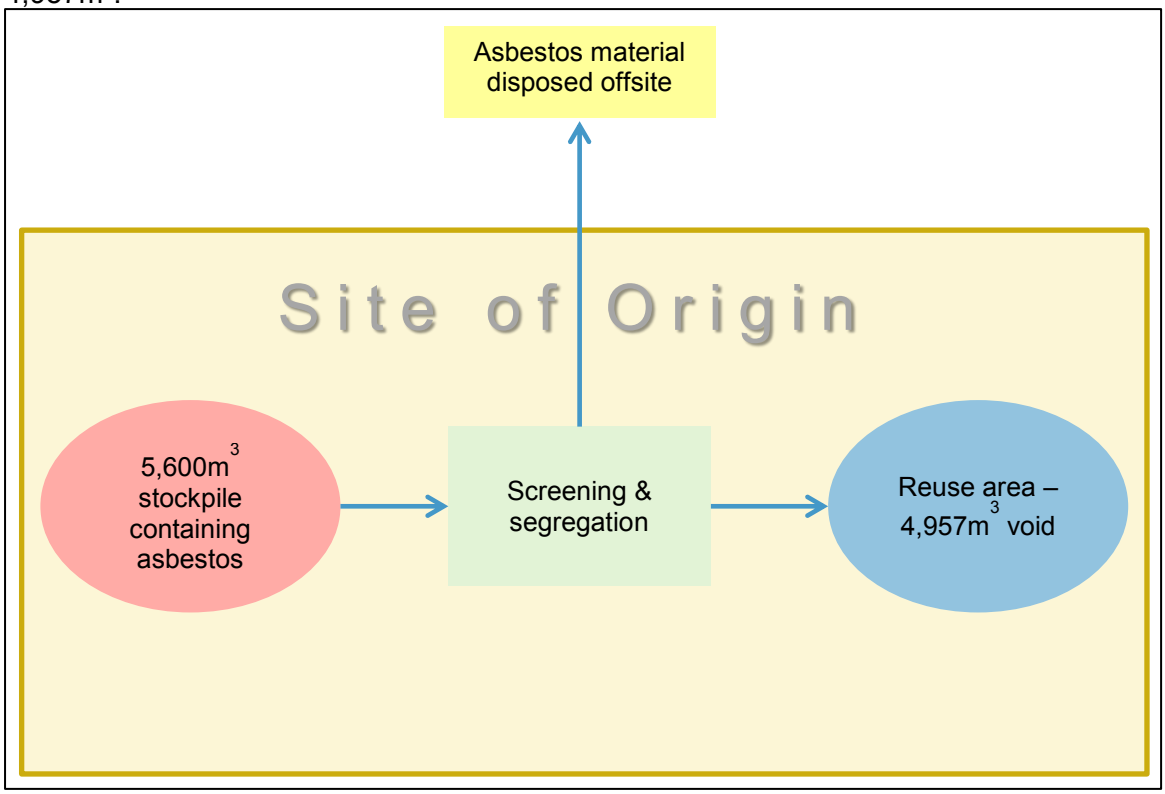

Figure 1: Site of Origin Process of Works

Once visible asbestos materials were removed from the stockpile, the material was tested to check that it was suitable for reuse. It was then backfilled into the void and a capping layer added (see Figure 1 for the process of works).

11. Assessment Boundaries

Table 4 outlines the boundaries for the sustainability assessment for the Site of Origin project. Defining the boundaries was a key stage prior to assessment and its importance is stated in Surf-UK Annex 1 (CL:AIRE, 2011[b]).

There was less focus on factors which were the same in both options. For example, it was considered most likely that screening/segregating would also have occurred under Dig & Dump as it is a typical procedure in the event of asbestos identification, and is not specific to the DoW CoP. This process would have allowed the project team to identify asbestos containing material that was not suitable for use and send it to landfill, as they did using the DoW CoP. Therefore costs associated with screening/segregating and sending unsuitable asbestos material to landfill were considered the same under both options and were not assessed. Instead, the focus was placed on differences between the two options.

Information from the Department of Energy and Climate Change (2014) states that transport is the 2nd largest source of CO_2 in the UK behind energy supply, whilst waste management and industrial processes rank 6th and 7th respectively. Therefore CO_2 emissions from vehicles were the main focus in this assessment rather than CO_2 from remediation or other sources. Furthermore, the comparative scenario to remediation emissions is landfill emissions, for which data is not available.

Greenhouse gas emissions from landfill were also assumed to be significantly higher than emissions from treatment facilities therefore this was not assessed further on a quantitative basis. As well as CO_2, other greenhouse gases (methane) and vehicle engine emitters (nitrous oxides and particulate matter) were considered.

Table 4: Assessment Boundaries

	DoW CoP	Dig & Dump
Similarities (factors not assessed)	-Haulage fees due to variability making them an unreliable estimation	
	-CO_2 and greenhouse gases from remediation	
	-Costs of workers i.e. salaries	
	-Cost of screening/segregating	
Differences (factors assessed)	-Volumes of excavated material reused on-site	-Volumes of excavated material sent to landfill
	-Excavated material reused on-site	-New material bought from aggregate supplier
	-CO_2 and greenhouse gases from vehicle mileage	
	-Documentation and evidence required	

12. Summary of Results

Table 5 summarises the sustainability assessment for this project. The major elements are environmental, social and economic. These have smaller, more specific categories and indicators within them which were reviewed and assessed to ascertain which were applicable for this project.

The qualitative assessment was undertaken using a simple scoring system which represented the number of positive factors for each option. For example, under the environmental element, category “Air”, the DoW CoP scored 3 and the alternative (Dig & Dump) 2. This means that under this category the DoW CoP had 3 positive factors and the Dig & Dump had 2. These scores have been totaled to give an overall result for each element. The full qualitative assessment is shown in Appendix 1.

Table 5: Sustainability Assessment Summary

Element	Category	DoW CoP	Dig & Dump
Environmental	Air	3	2
	Soil & ground	2	4
	Natural resources & waste	3	1
	TOTAL SCORE	**8**	**7**
	RESULT	√	**0**
Social	Human health & safety	5	5
	Neighbourhood & locality	3	1
	Uncertainty & evidence	7	0
	TOTAL SCORE	**15**	**6**
	RESULT	√	**0**
Economic	Direct economic costs & benefits	3	2
	Project lifespan & flexibility	4	2
	TOTAL SCORE	**7**	**4**
	RESULT	√	**0**

Environmental Indicators

Air

An estimated 57 kg CO_2 were emitted from vehicles using the DoW CoP in comparison with an estimated 11,651 kg CO_2 if the alternative option was used. The total greenhouse gas (GHG) emissions including CO_2, CH_4 and N_2O for the DoW CoP option were 62 kg CO_2e compared with 14,024 kg CO_2e estimated for the alternative option (see Appendices 3 and 5 for full calculations).

As well as greenhouse gases, air quality gases were estimated. These included NO_2, SO_2, and particulate matter (PM-10 and PM-2.5). An estimated 43.50 kg of NO_2 was saved by using the DoW CoP instead of Dig & Dump. 0.043 kg of SO_2, 0.709 kg of PM-10 and 0.687 kg of PM-2.5 were also saved. NOx and SOx have adverse health and environmental effects including damage to the photosynthesis process in plants, production of acid rain and respiratory problems in humans (Environmental Protection Agency, 2011). Particulates also cause respiratory and lung problems in humans. Furthermore, truck emissions in this project would be spread over a wider area if the Dig & Dump option was taken. Tipper trucks would be travelling approximately 20 miles from the project site through towns, spreading the emissions throughout this area (see Figure 2 for vehicle routes).

It is estimated that approximately 21,576 vehicle miles (Table 3) would have been driven taking material to landfill and bringing new material in under the Dig & Dump option. In comparison, 95 vehicle miles are estimated to have been driven moving material within the Site of Origin, under the DoW CoP. This substantial saving (21,481) in vehicle miles means the project did not emit as much CO_2 or other greenhouse gases by using the DoW CoP.

Using the DoW CoP, this project saved an estimated 447 vehicle journeys, which otherwise would have been made to landfill and aggregate suppliers using Dig & Dump. There may have been an increased number of smaller load vehicle movements on-site under the DoW CoP, as the project documents state that smaller loads were used. Yet using Dig & Dump would have involved more vehicle journeys and miles overall (see Figure 2 for vehicle routes).

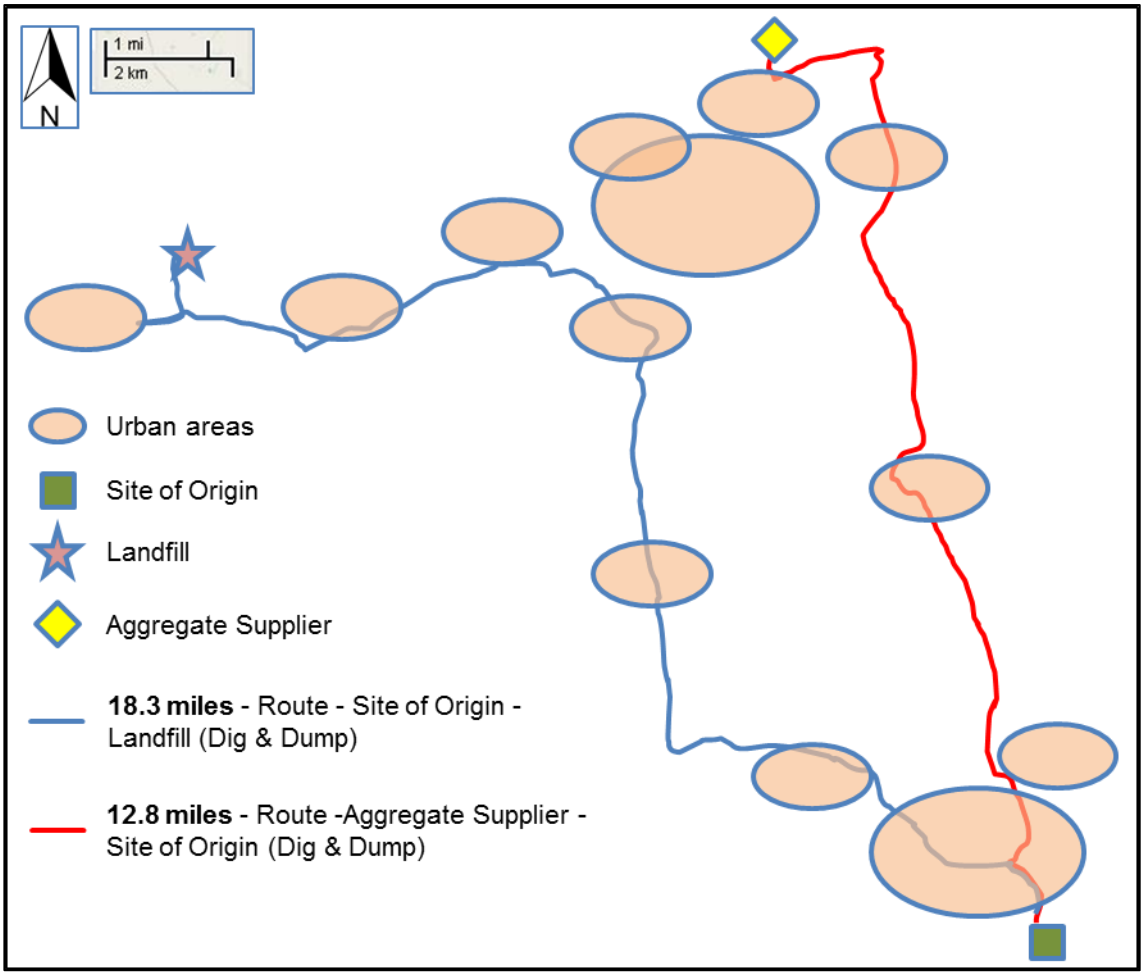

Figure 2: Vehicle Routes – Dig & Dump Option

Environmental measures to reduce and prevent air pollution such as air quality testing, dust and air pollution control are stated in the project documentation under the DoW CoP. It is assumed that similar measures would be taken if the Dig & Dump option was being used. Project sites must ensure they are complying with the Air Quality (standards) Regulations (2010) and Air Quality (England) Regulations (2000). Additionally, this project is based in a district which is declared as an Air Quality Management Area by the Local Authority (Defra, 2014[a]). The area is therefore more sensitive and this places greater importance on air quality management for the project team.

Soil & Ground Conditions

It is assumed both options would require screening and segregating (see section 5 – Assessment Boundaries). For the DoW CoP option asbestos levels need to be acceptable for the reuse area. For the Dig & Dump option, asbestos material would need to be segregated out and sent to a specialist landfill. Under the DoW CoP option, visual asbestos was removed but small asbestos fibres and elevated levels of benzo(a)pyrene remained in the soil. Therefore, in terms of the removal of contamination, Dig & Dump could perform better as all material is removed and transported to a purpose engineered waste handling facility leaving fewer contaminants remaining on the Site of Origin.

Natural Resources & Waste

The Dig & Dump option increases the strain on landfills for space, and a burden on local quarries and aggregate suppliers for raw material. This option does not comply with the Government's aim to recover 70% of construction and demolition waste by 2020 (European Commission, 2014). The DoW CoP option utilises existing material and puts less strain on natural resources. The DoW CoP "promotes the use of materials in accordance with the

waste hierarchy" (CL:AIRE, 2011[a]), whereas in this respect disposal of material to landfill is considered the least favoured option.

Both road truck and tipper truck fuel consumption were estimated for both soil management options to show which option used fuel more efficiently. Vehicles in the DoW CoP option were estimated to have used 43 litres of fuel for the 95 miles travelled. In comparison vehicles for the Dig & Dump option used an estimated 9,717 litres of fuel for 21,576 miles travelled. These figures are based on half of the journey miles being travelled at 100% laden and the other half travelled at 0% laden, for both options. However, if vehicles spent more time idling and moving at 0% laden, the use of fuels may be less efficient. This would be more likely under the DoW CoP as there is a much shorter distance (0.1 miles) to travel within a confined space on the Site of Origin.

Social Indicators

Human Health & Safety

The risk management approach within each option differs. Dig & Dump involves all material being removed from the site therefore any associated risks are also removed. With the DoW CoP option, the material is reused on-site therefore contaminants may remain in the soil. To mitigate any risk, the project used a thick capping layer to break the pollutant linkage between the pathway and receptor.

The risk assessment under the DoW CoP option is site specific, allowing particular hotspots of contamination to be identified and mitigated. However, the lack of a site specific risk assessment in the Dig & Dump option could result in unnecessarily precautionary excavation of wider areas, not just hotspots.

It is assumed that safety measures taken on-site under the DoW CoP approach would be similar to those taken if the Dig & Dump option was used e.g. site workers were certified in the area they were managing, safety equipment such as hazard signs and personal protective equipment were used at all times.

The project documents state that dump truck loads were minimised during transportation. Whilst this may decrease accidents related to heavy plant stability, it does not eradicate accidents which may occur from increased heavy plant movements. The assumption with the Dig & Dump option is that dump truck loads would have been kept at the 100% laden capacity of 19.5 tonnes as there are longer distances to travel on roads. This assumption has been supported by CL:AIRE industry members. The risk of a Heavy Goods Vehicle accident occurring is thus greater with Dig & Dump and the risk is posed to a wider area (see Figure 2 for the area which vehicle routes cover).

Neighbourhood & Locality

The Dig & Dump option would require approximately 1,394 journeys on public roads (congestion) spanning 18.1 miles (see Figure 2) to move excavated material to landfill and bring in new material. The DoW CoP option has movements spanning less than 1 mile on privately used roads. In addition to this, the alternative option would introduce a range of greenhouse gases to a wider area radius. Investigation into the local area has shown that there are a number of villages with settlements, colleges and primary schools which would have been exposed to vehicle emissions (these areas are highlighted in Figure 2). These would include carbon dioxide, methane and nitrous oxides as well as Particulate Matter which have negative respiratory effects on humans.

Uncertainty & Evidence

The DoW CoP requires more extensive planning/preparatory documents (e.g. risk assessment, site investigation). Whilst this may require more time and money, it allows the

project team to gain a better understanding of the subsurface and engineering design. Such information is not as extensive with Dig & Dump so risks may be less well understood.

As well as planning/preparatory documents, the DoW CoP requires project teams to complete a verification plan and report upon completion of the works. This provides an audit trail to show materials have gone to the correct destination.

Economic Indicators

Direct Costs & Benefits

The sustainability assessment was used to estimate the difference in financial costs between the two options. Costs which were the same for both options e.g. screening and segregation costs were not assessed.

The cost of transporting all 4,530m^3 of material to landfill would have been an estimated £159,683 assuming material would have been segregated and sent as non-hazardous waste. This would then require the project to purchase new backfill material from a local aggregate supplier. The estimated cost of this is approximately £101,925 at £15 per tonne. Fuel costs under Dig & Dump are estimated to have been approximately £24,597. In total, direct financial costs associated with the Dig & Dump option would be approximately £286,205.

Indirect financial costs from using the DoW CoP may include DoW CoP training for some of the project team. It is assumed that project teams would need to spend time initially becoming familiar with the DoW CoP as it requires a higher level of understanding of land management techniques than Dig & Dump (e.g. compliance with CLR11 and BS10175). Excluding screening/segregation and other on-site operational costs which would be the same for both options, the direct and indirect financial costs associated with the DoW CoP option equal at least £1,502. This includes a Qualified Person fee, DoW CoP training for one person and fuel costs.

In terms of remaining site liabilities, the Dig & Dump option is assessed more favourably as it removes all the contaminated material from the site.

Lifespan & Flexibility

Although flexibility was not entirely demonstrated with this project due to a strict work schedule with few contingency plans, there is generally more flexibility associated with the DoW CoP option. For example, the material in this project contained asbestos which, using the DoW CoP, was not a major problem and did not stop or delay works. However, asbestos containing material would be more difficult to deal with if the material was to be sent to landfill due to the restrictions surrounding this (Environment Agency, 2010).

DoW CoP project timescales could be longer than Dig & Dump due to the necessary planning involved e.g. preparation of the MMP including contingency and tracking sections. However, for this particular project, the time used in planning and preparation may be saved elsewhere such as vehicle movements.

13. Project Savings

Table 6 below highlights the key savings for this project using the DoW CoP.

Table 6: Project Costs & Savings using the DoW CoP

	DoW CoP (Costs)	Dig & Dump (Costs)	Savings using DoW CoP
Environmental & Social costs & savings			
No. of vehicle journeys	945	1,392	447
No. of vehicle road miles	95	21,576	21,481
CO_2 emissions (kg CO_2)	57	11,651	11,594
GHG emissions (kg CO_2e)	62	14,024	13,962
Fuel Consumption (litres)	43	9,717	9,674
Economic costs & savings			
DoW CoP training (£395 pp)	395		260,213
Qualified Person (£) 500 per day	1,000		
Removal to landfill & purchase of new material (£)		261,608	
Fuel cost (£)	107	24,597	24,490
Total financial costs including fuel (£)	1,502	286,205	284,703

14. Lessons Learnt

By using the DoW CoP the project was able to demonstrate a large number of environmental, social and economic benefits.

The DoW CoP requires a contingency plan to be completed prior to works commencing however this project lacked a detailed contingency plan. The contingency section of the MMP asks the project team what will happen if there is a delay and documents for this project stated that work would stop if any problem or hazard was encountered. Therefore it was clear that contingency was not considered fully before the project started which could have led to delays.

This project could have considered a Cluster approach under the DoW CoP with a treatment Hub on-site, allowing the segregation and sorting of asbestos to take place. The project could then have linked with other local projects, which would convey the sustainability benefits to a larger number of sites.

15. Conclusions

A sustainability assessment (reviewing environmental, social and economic indicators) was carried out comparing the use of the DoW CoP with a Dig & Dump option. The assessment showed that, for this Site of Origin project, using the DoW CoP was considered to be more sustainable.

Environmental

When considering the 'soil and ground conditions' category, the comparison of environmental indicators in the sustainability assessment showed that there was a small difference between the DoW CoP and the Dig & Dump option (see Table 5 for scores). This was due to the fact that both methods would require the same treatment processes i.e. the removal of asbestos from the stockpile before anything could be carried out. As a result, screening and segregation would be undertaken for both options to bring asbestos levels down to acceptable levels. Environmentally, both options make an effort to improve the ground and soil conditions.

The differences lie with the emissions to air and the use of natural resources and waste. Using the DoW CoP, the project saved a substantial amount of CO_2 (Section 6) and total greenhouse gas emissions. This project saved an estimated 11,594 kg CO_2, which is analogous to a hatchback car driving over 110,000km (typical car emissions = 0.102 kg CO_2 / km).

Natural resources are used more efficiently with the DoW CoP as material is reused rather than sent to disposal and new material bought. These categories show that the original aims and objectives have been met. By using the DoW CoP, this project has demonstrated sustainable management of resources and significant carbon reductions.

Social

This project showed social benefits for both the DoW CoP and alternative options. An advantage of Dig & Dump was that the risk is completely removed from the site and placed in a carefully controlled and managed waste disposal facility (landfill). The DoW CoP option on the other hand, still reduced the level of asbestos on-site and brought materials back into beneficial use. Using the DoW CoP, this project has reduced the risk of any direct (accidents) or indirect (air quality) dangers to the surrounding area, and has kept risks to a confined and managed site.

The DoW CoP demonstrates that the use of materials links with the original objectives so even though contamination may remain on-site, best practice ensures it is recorded and well understood. A verification plan or report would not be required using the Dig & Dump option so this information would not be available.

The social indicators were ultimately in favour of the DoW CoP. Due to the extensive planning and investigation that the DoW CoP encourages, projects have a better understanding of the ground and subsurface conditions, allowing for a better overall understanding of the site. With this planning in place, including a site specific risk assessment, particular areas of contamination can be identified and removed as opposed to unnecessary disposal of excessive volumes of material.

In terms of human health and safety, the DoW CoP limits hazardous construction activity to the site itself. The site is restricted from the public, and vehicle movements only made within the restricted area. In comparison to this, the alternative option would require vehicle movements to be made over a wider area. This poses a greater risk to the local public through road accidents, dust and air emissions.

Economic

The economic benefits of the DoW CoP were shown to strongly outweigh those of the alternative option, with cost savings of approximately £284,703 (Section 6). The sustainability assessment has shown that the DoW CoP was the only economically viable option when comparing it with landfill.

Though overall financial costs are in favour of the DoW CoP, there are higher planning costs involved. For example, preparation of all the documents in compliance with Model Procedures for the Management of Land Contamination (CLR11) (Environment Agency, 2004) as well as DoW CoP training (voluntary) and Qualified Person (mandatory) fees. However, these initial planning costs from use of the DoW CoP result in significant project savings.

The overall assessment showed that the DoW CoP approach was a more sustainable and viable option for this project under each environmental, social and economic element. In particular, the economic cost savings indicate that the project may have been significantly delayed or not gone ahead at all without the DoW CoP. By using the DoW CoP, this project has ensured that more land is being reused and returned to beneficial use.

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A Sustainability Assessment comparing the use of the Definition of Waste: Development Industry Code of Practice Direct Transfer Project against Dig & Dump in South West London

Key Facts

- Volume of material reused: 1,250m^3
- Type of material: clean, naturally occurring

Key Benefits

Environmental:-

- CO_2 emissions saved: 259 kg CO_2
- Total GHG emissions saved: 310 kg CO_2e

Social:-

- 192 vehicle journeys saved
- Flood area protected
- Extensive evidence/documentation in place

Economic:-

- Landfill costs saved (tax & gate fees): 44,063
- New material costs saved: £28,125
- Fuel costs saved: £656
- Total financial costs saved (inc. extra DoW CoP costs: £71,449

17. Phase 1 Audit Results

Phase 1 of this research involved the audit of 32 materials reuse projects across London & the South East, under the Definition of Waste: Development Industry Code of Practice (DoW CoP).

This project demonstrated compliance with the DoW CoP by showing evidence for the information required in the Materials Management Plan (MMP).

Consideration of sustainability was shown with the use of a carbon calculator and assessment into the effects of works on the local community. The project showed efforts of working to best practice and achieving a non-waste status.

18. Aims & Objectives

The project was selected for Phase 2 of the research, a sustainability assessment. During this phase, the project was analysed for evidence of the DoW CoP facilitating:-

- Sustainable management of resources
- Better use of sustainable land remediation practices; and
- Significant carbon reductions.

19. Sustainability Assessment

A sustainability assessment is defined by the Environment Agency (EA) as a process which "provides for the systematic identification and evaluation of the economic, social and environmental impacts of a proposal" (Environment Agency, 2014). For this study, some of the main principles of the UK's Sustainable Remediation Forum (SuRF-UK) (CL:AIRE, 2011[b]) were used to undertake a sustainability assessment. Using environmental, social and economic indicators this project was analysed for evidence of sustainable practice, against a hypothetical alternative option (Dig & Dump). This option was chosen as an alternative as it was seen as the most likely route for projects had they not had the option to use the DoW CoP. It also represents the traditional approach to managing waste excavated materials.

Assumptions

For this project, the Direct Transfer scenario involved moving excavated material from a Donor Site (which had a surplus of excavated material) to a Receiver Site (which was in need of material). In the comparative option (Dig & Dump), the Donor Site may have transported its material to landfill and the Receiver Site may have bought new material from a local aggregate supplier. The sustainability assessment therefore involved a comparison between the actual situation and the alternative situation (landfilling and buying). See Appendix 1 for the full assessment.

For the purpose of comparison, it was assumed that the same size and type of tipper truck was used in each project. A typical 8 wheel 4 axle tipper truck with a maximum capacity of approximately 19.5 tonnes was assumed for road use. All trucks were assumed to be carrying 100% laden weight unless stated otherwise.

20. Project Background

This project involved the Direct Transfer of clean naturally occurring material from a site in West London to a flood embankment development in South West London. The project used the Direct Transfer scenario of the DoW CoP to bring 1,250m^3 of excavated material to the flood embankment site (see Figure 3). There was reuse of material on-site to facilitate the large scale development and the DoW CoP was used for a small portion of the project. The Direct Transfer scenario was incorporated within a larger project and was shown to be simple to use and effective for the volume of material required.

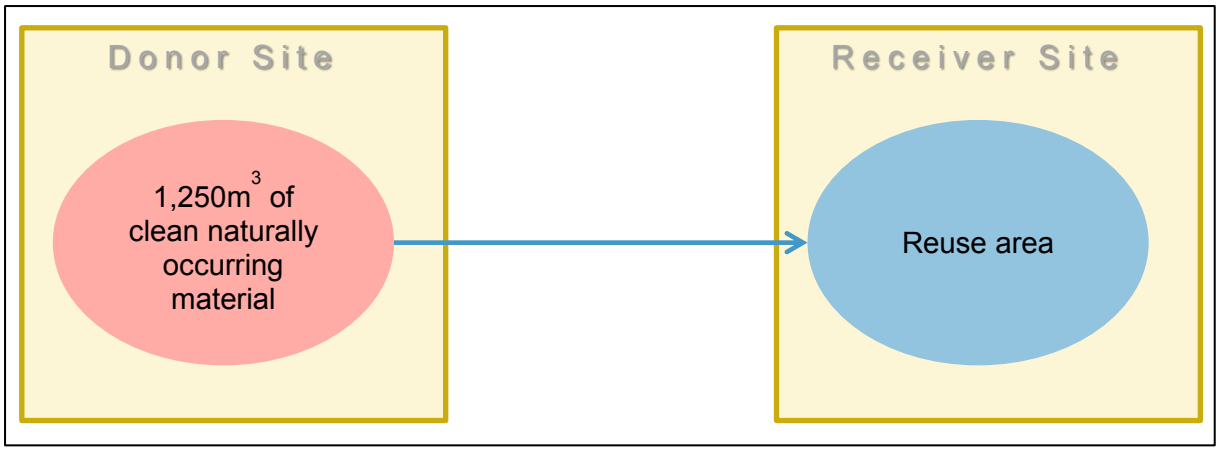

Figure 3: Direct Transfer Process of Works

21. Assessment Boundaries

Table 7 outlines the boundaries for the sustainability assessment for the Direct Transfer project. Defining the boundaries was a key stage prior to assessment and the importance of it is stated in Surf-UK Annex 1 (CL:AIRE, 2011[b]). This sustainability assessment is based on the factors which were distinct between the two options. The factors which were considered to be the same under both options were therefore not assessed.

There was less focus on factors which were the same in both options. For example the haulage fees would have been the same under both scenarios and therefore were not considered. Instead, the focus was placed on differences between the two options.

Information from the Department of Energy and Climate Change (2014) states that transport is the second largest source of CO2 in the UK behind energy supply, whilst waste management and industrial processes rank 6th and 7th respectively. Therefore CO2 emissions from vehicles were the main focus in this assessment rather than CO2 from other sources. As well as carbon dioxide, other greenhouse gases (methane) and vehicle engine emitters (nitrous oxides and particulate matter) were considered.

Table 7: Assessment Boundaries

	DoW CoP	**Dig & Dump**
Similarities (factors not assessed)	Any haulage fees due to their variability making them an unreliable estimation	
	-Costs of workers i.e. salaries	
Differences (factors assessed)	-Material from Donor Site sent to a Receiver site	- Material from Donor Site sent to landfill
	-Material brought in from Donor Site	- New material bought from aggregate supplier
	-CO_2 and greenhouse gases from vehicle mileage	
	-Documentation and evidence required	

22. Summary of Results

Table 8 summarises the sustainability assessment for this project. The major elements are environmental, social and economic. These have smaller, more specific categories and indicators within them which were reviewed and assessed to ascertain which were applicable for this project.

The qualitative assessment was undertaken using a simple scoring system representing the number of positive factors for each option. For example, under the environmental element, category “Air”, the DoW CoP scored 3 and the Dig & Dump alternative 0. This means that under this category the DoW CoP was assessed to have 3 positive factors and the Dig & Dump alternative had no positive factors. These scores have been totaled to give an overall result for each element. The full qualitative assessment is shown in Appendix 1.

Table 8: Sustainability Assessment Summary

Element	Category	DoW CoP	Dig & Dump
Environmental	Air	3	0
	Soil & ground	4	0
	Natural resources & waste	4	0
	TOTAL SCORE	**11**	**0**
	RESULT	√	**0**
Social	Human health & safety	2	1
	Neighbourhood & locality	1	0
	Uncertainty & evidence	7	2
	TOTAL SCORE	**10**	**3**
	RESULT	√	**0**
Economic	Direct economic costs & benefits	6	0
	Project lifespan & flexibility	4	0
	TOTAL SCORE	**10**	**0**
	RESULT	√	**0**

Environmental Indicators

Air

The project team used a carbon calculator during the planning stage. This highlighted how use of the DoW CoP could minimise vehicle miles, carbon emissions and traffic nuisance.

Under the DoW CoP, this project saved an estimated 192 vehicle journeys. Whilst the vehicle routes (Figure 4) are not significantly different in each option, the DoW CoP option eliminated journeys from the aggregate supplier to the Receiver Site. An estimated 259 kg CO_2 and 310 kg CO_2e of greenhouse gas emissions were saved using the DoW CoP. As well as greenhouse gases, air quality gases were estimated. These included NO_2, SO_2, and particulate matter (PM-10 and PM-2.5). An estimated 1.162 kg of NO_2 was saved by using the DoW CoP instead of Dig & Dump. 0.006 kg of SO_2, 0.015 kg of PM-10 and 0.022kg of PM-2.5 were also saved. NOx and SOx have adverse health and environmental effects including damage to the photosynthesis process in plants, production of acid rain and respiratory problems in people (Environmental Protection Agency, 2011). Particulates also

cause respiratory and lung problems in humans. This project is based in a district which has an Air Quality Management Area declared by the Local Authority (Defra, 2014[a]). The area is therefore more sensitive and this places greater importance on air quality management by the project team.

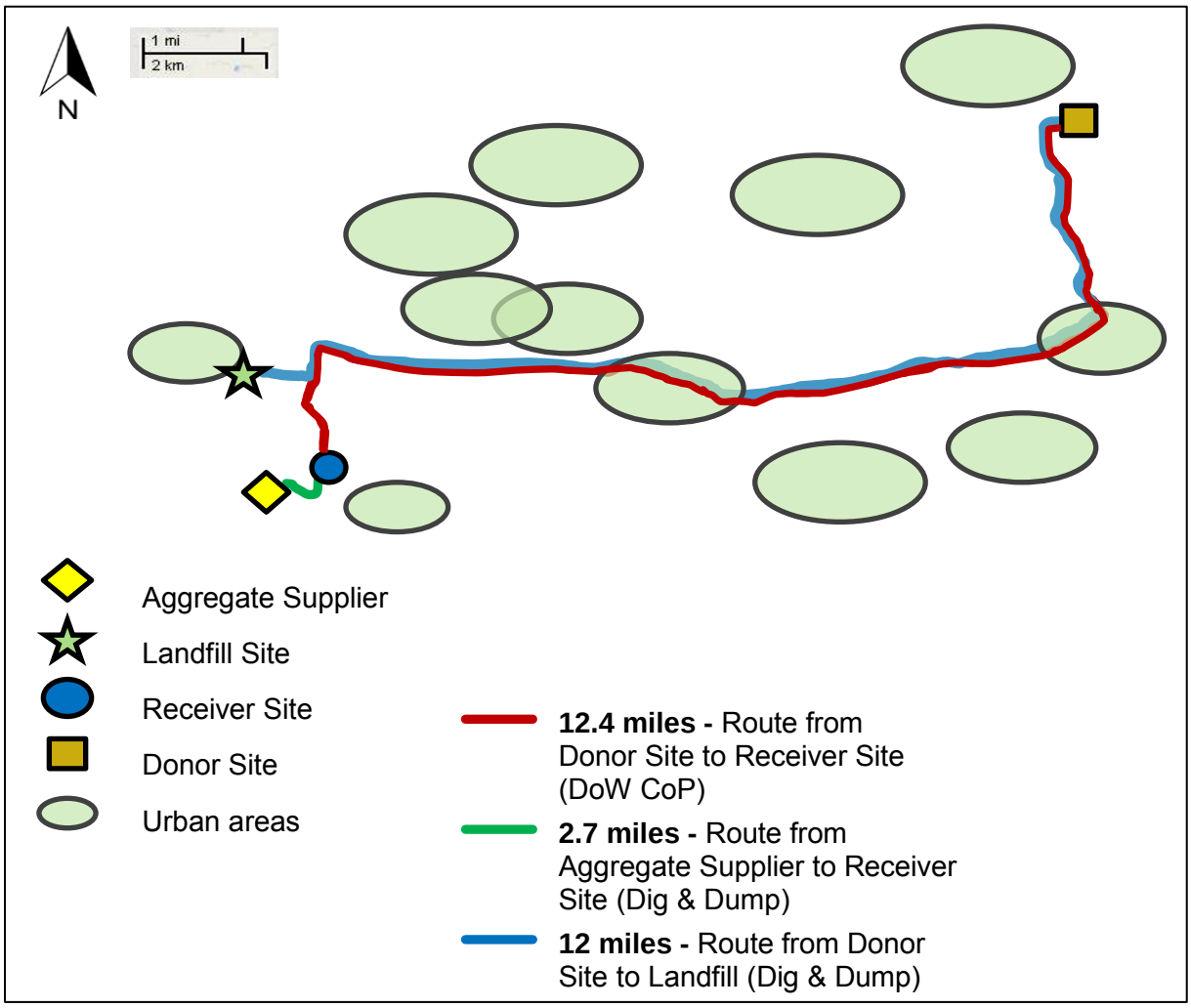

Figure 4: Vehicle movements – DoW CoP and Dig & Dump

Soil & Ground Conditions

The proposed flood embankment works were required to reduce flood risk and improve soil and ground conditions at this site. Documents for this project stated that the DoW CoP was the only financially viable option, therefore without it the flood embankment works may have been delayed or not taken place at all. This would have posed a greater environmental risk to the local area.

For both the DoW CoP and Dig & Dump options, the material being brought in to the Receiver Site would require proof that is was geotechnically and chemically suitable for use at that specific location. With the DoW CoP option, there is more information available about the site where the material is derived as the DoW CoP requires a desk top study, visual and olfactory inspection during excavation, site investigation and testing, enhancing the suitability and homogeneity at the site. (CL:AIRE, 2011[a]). There is a requirement for similar information for the Receiver Site including a risk assessment; less detailed information might be available using Dig & Dump.

Natural Resources & Waste

The Dig & Dump option puts a strain on landfills for space, and a burden on local quarries and aggregate suppliers for raw material. The DoW CoP option utilises existing material and therefore minimises the use of natural resources. The DoW CoP "promotes the use of materials in accordance with the waste hierarchy" (CL:AIRE, 2011[a]). Disposal of material to landfill is considered the least favoured option in this regard.

Less vehicle fuel is used with the DoW CoP option (1,038 litres) in comparison to an estimated 1,297 litres for vehicles for the Dig & Dump option.

Social Indicators

Human Health and Safety

Although both options would require vehicle movements through populated areas, the DoW CoP option involved less vehicle journeys (192 less) and therefore the risk from heavy vehicle accidents was reduced, as less time would have been spent on the roads.

It is assumed that safety measures taken on-site using the DoW CoP approach would be similar to those taken if the Dig & Dump option was used e.g. site workers are certified in the area they are managing, safety equipment such as hazard signs and personal protective equipment used at all times.

Neighbourhood & Locality

Correspondence from the project team states that an assessment on the impacts of site works on local people and neighbours was carried out, showing that the local community were considered. This type of assessment may also have been done using the Dig & Dump option, though it is a specific aim of the DoW CoP to "protect human health and the environment" (CL:AIRE, 2011[a]). Vehicles under the DoW CoP were estimated to travel 576 total less miles than the Dig & Dump option.

Uncertainty & Evidence

Information from the local council states that the area has been subjected to flooding on a number of occasions over the recent years therefore there was a clear need for these works. Correspondence with the project team states that the DoW CoP was the only viable option, as other import options had high costs associated with them. If the DoW CoP was not available, the Receiver Site may have had to obtain an environmental permit to bring material in from another source. This could have delayed the project and placed a greater risk on the local area from flooding.

Project time-scales may have been shorter under the Dig & Dump option as there would not be the necessity to wait for a Receiver Site to become available to make the transfer. Furthermore, the volume of soil required as well as appropriate geotechnical and chemical conditions have to be met.

As well as planning/preparatory documents, the DoW CoP requires project teams to complete a verification plan and report upon completion of the works. This provides an audit trail to show materials have gone to the correct destination and that the use of materials links with the original objectives. A verification plan or report would not be required using the Dig & Dump option, therefore the project does not have the ability to track its work, but perhaps more importantly to learn and improve. However production of a verification plan and report requires extra time and money.

Economic Indicators

Direct Costs & Benefits

The cost of disposing all 1,250m^3 of material to landfill and buying new material would have been an estimated £72,188. This cost involves the Donor Site moving its excess material to landfill (est. £44,063 including taxes and gate fees), and buying new material from a local supplier (est. £28,125). Using the DoW CoP, this project saved an estimated £71,449 including fuel costs.

As the area at the Receiver Site was in an area of flood risk, information on local house prices was identified to help understand the financial implications had the flood defence works not gone ahead. The average price of a house in this area which could have been damaged in floods without these works taking place is approximately £200,000 (www.home.co.uk). The value of the site and local area may have decreased as the flood risk increased.

Project Lifespan & Flexibility

The DoW CoP option encourages separate projects and companies to work together whereas the Dig & Dump option would mean that projects are working in isolation. Companies linking in this way, may also be able link together efficiently on future projects. Therefore one successful DoW CoP project may result in a series of future projects each accruing their own sustainability benefits.

23. Project Savings

Table 9 below highlights the key savings for this project using the DoW CoP.

Table 9: Project Costs & Savings using the DoW CoP

	DoW CoP (Costs)	Dig & Dump (Costs)	Savings by using DoW CoP
Environmental & Social costs & savings			
No. of vehicle journeys	192	384	192
No. of vehicle road miles	2,304	2,880	576
CO_2 emissions (kg CO_2)	1,073	1,296	259
GHG emissions (kg CO_2e)	1,244	1,554	310
Fuel Consumption (litres)	1,038	1,297	259
Economic costs & savings			
DoW CoP training (£395 pp)	395		70,793
Qualified Person (£) 500 per day	1,000		
Removal to landfill & purchase of new material (£)		72,188	
Fuel cost (£)	2,627	3,283	656
Total financial costs including fuel (£)	4,022	75,471	71,449

24. Lessons Learnt

This project demonstrated a good options appraisal prior to works commencing which aided the decision to use the DoW CoP. The DoW CoP was assessed as the only viable option when taking into consideration financial costs; however the project still estimated the carbon emissions, traffic movements and effects on the local community and used this to show the DoW CoP was also favourable with respect to these factors.

This project could have used the DoW CoP Register of Materials (RoM). The RoM is a free online database that lists projects with a surplus or need for materials to facilitate efficient identification of Donor/Receiver sites. It is not known how long it took for both sites to locate each other and agree to transfer the material, but the RoM could have made the search easier and more efficient.

25. Conclusions

A sustainability assessment (reviewing environmental, social and economic indicators) was carried out comparing the use of the DoW CoP with a Dig & Dump option. The assessment showed that, for this Direct Transfer project, using the DoW CoP was considered more sustainable than Dig & Dump.

Environmental

This project saved greenhouse gas and air quality gas emissions by using the DoW CoP (see Appendix 5). The DoW CoP, project saved san estimated 259 kg CO_2. which is analogous to a hatchback car driving over 2,500km (typical car emissions = 0.102 kg CO_2 / km). Air quality gas emissions are important, particularly in declared Air Quality Management Areas, such as the borough in this project. Furthermore, this assessment category has demonstrated that there were significant carbon reductions in the project by using the DoW CoP, which satisfies the original objectives of Phase 2.

The project at the Receiver Site was able to optimise the homogeneity of the site by importing material from a Donor Site using the DoW CoP. This leads to a more suitable ground engineering design and less potential future disturbance at the site.

Social

The DoW CoP requirement for a larger number of more detailed planning/preparatory documents results in project teams having more information available at each site. This aids and improves their understanding of the material. They also provide the project with an audit trail of works which can be used after the project to track the work and improve for future projects.

The ground and surface conditions at both sites may be better understood using the DoW CoP as more detailed information is available.

Vehicle journey times may have been less using the DoW CoP (depending on local congestion), reducing the affect on the local community from noise, dust and vibrations.

Economic

The economic benefits of using the DoW CoP, shown by the figures in Section 6.3, form the basis of the project's decision to use the DoW CoP. Moving a small volume of material to landfill would have been economically unviable.

Though overall financial costs are in favour of the DoW CoP, there are higher planning costs involved. For example, preparation of all the documents in compliance with Model

Procedures for the Management of Land Contamination (CLR11) (Environment Agency, 2004) as well as DoW CoP training (voluntary) and Qualified Person (mandatory) fees. However, these initial planning costs under the DoW CoP save the project large amounts of money overall.

The total savings for this project were an estimated £71,449 (Section 7) versus Dig & Dump. Without these savings the project may have been delayed or forced to stop, in which case flood embankment development works would not have taken place. This could have had subsequent environmental and social implications if the area was unprotected and flooding had occurred. There would also have been further economic effects including damage to properties and the local area.

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A Sustainability Assessment comparing the use of the Definition of Waste: Development Industry Code of Practice Cluster Project against Dig & Dump in Berkshire

Key Facts

Volume of material reused: 394,422m^3

- Type of material coming from Donor site: clean, inert
- Type of material at Hub site: former landfill, C&D waste including inert waste and quarry overburden

Key Benefits

Environment:-

- CO_2 emissions saved: 5,940 kg CO_2
- Total GHG emissions saved: 7,128 kg CO_2e
- Less strain on landfills and aggregate suppliers

Social:-

- Extensive planning documentation and evidence in place
- 13,201 less miles driven = shorter time-scales

Economic:-

- Landfill savings (tax & gate fees): £697,574
- New material cost savings: £445,260
- Fuel cost savings: £15,049
- Total financial cost savings: £1,156,488

27. Phase 1 Audit Results

Phase 1 of this research involved the audit of 32 materials reuse projects across London & the South East, under the DoW CoP. The results of Phase 1 showed that this project achieved a high standard of document management and organisation as well as extensive information readily available in compliance with the Materials Management Plan (MMP) under the DoW CoP (Definition of Waste: Development Industry Code of Practice Audit Report).

28. Aims & Objectives

The project was selected for Phase 2 of the research, a sustainability assessment. During this phase, the project was analysed for evidence of the DoW CoP facilitating:-

- Sustainable management of resources
- Better use of sustainable land remediation practices; and
- Significant carbon reductions.

29. Sustainability Assessment

A sustainability assessment is defined by the Environment Agency (EA) as a process which "provides for the systematic identification and evaluation of the economic, social and environmental impacts of a proposal" (Environment Agency, 2014). For this assessment, some of the main principles of the UK's Sustainable Remediation Forum (SuRF-UK) (CL:AIRE, 2011[b]) were used. Using environmental, social and economic indicators this project was analysed for evidence of sustainable practice, against a hypothetical Dig & Dump option. This option was chosen as an alternative as it was seen as a viable route for projects had they not had the option to use the DoW CoP. It also represents the traditional approach to managing excavated waste materials.

Assumptions

For this project, the Cluster scenario involved excavating, treating and reusing material on-site. Some of this former landfill material (wood, plastics and rubble) could not be screened and segregated to the risk assessed reuse criteria and was disposed of off-site. Material was imported from a Donor Site (which had a surplus of excavated material) to fill the deficit of material at the Hub Site. In the comparative option (Dig & Dump), the Donor Site may have transported this material to landfill and the Hub Site may have purchased new material from a local aggregate supplier. It is assumed however that treatment of material at the Hub Site would still have taken place under the Dig & Dump option as the volume (394,422m^3) would have cost substantial amounts to send to landfill. The sustainability assessment involved a comparison between the actual situation and the alternative situation (landfilling and buying). See Appendix 1 for the full assessment.

There was less focus on factors which were the same in both options. For example haulage fees and worker salaries would have cost the same under both options and therefore were not considered. Instead, the focus was placed on differences between the two options.

For the purpose of comparison, it was assumed that the same size and type of tipper truck was used in each project. A typical 8 wheel 4 axle tipper truck with a maximum capacity of approximately 19.5 tonnes was assumed for road use. For on-site use a 6 wheeled articulated dump truck with 22 tonnes maximum carrying capacity was assumed. All trucks were assumed to be carrying 100% laden weight unless stated otherwise.

30. Project Background

This project involved the transfer and reuse of material utilising the Cluster scenario of the Definition of Waste: Development Industry Code of Practice (DoW CoP). There was a transfer of 19,965m^3 of clean, naturally occurring material from the Donor Site to the Hub Site where it was used as part of a residential development.

The Hub Site comprised former excavated gravel pits subsequently filled with industrial/commercial waste. The works at the Hub Site involved phased excavation of these pits mainly comprising rubble, wood and aggregates as well as inert waste and quarry overburden. Excavated material was treated (screening, soil washing and biopiling) to make it suitable for reuse in the residential development (see Figure 5 for process of works).

Material that was reused on-site included inert natural clay cap, natural ground, material processed through treatment and suitable material imported from the Donor Site (19,965m^3).

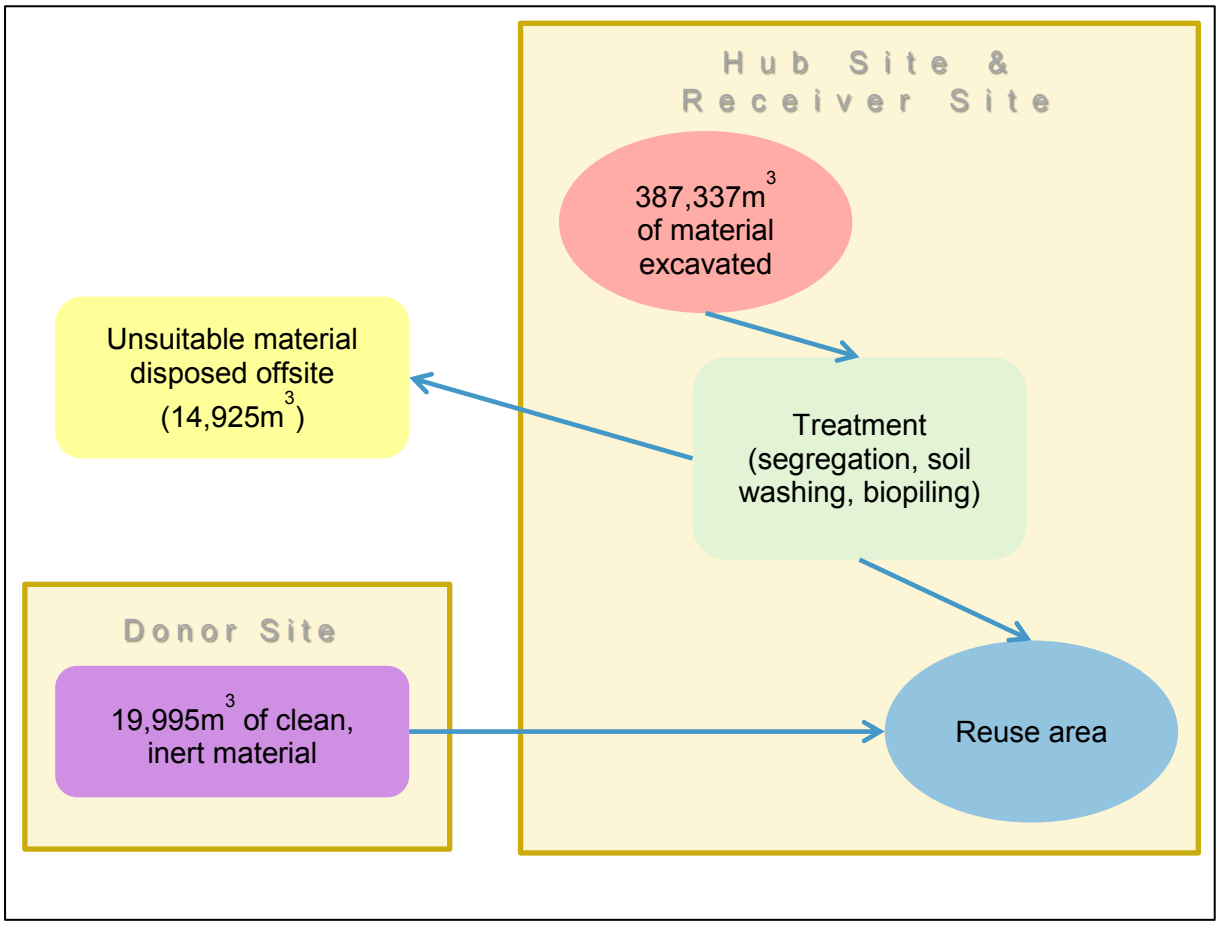

Figure 5: Cluster Process of Works

31. Assessment Boundaries

Table 10 outlines the boundaries for the sustainability assessment for the Cluster project. Defining the boundaries was a key stage prior to assessment and the importance of it is stated in Surf-UK Annex 1 (CL:AIRE, 2011[b]). The factors which were considered to be the same under both options were therefore not assessed. This sustainability assessment is based on the factors which were distinct between the two options.

Information from the Department of Energy and Climate Change (2014) states that transport is the second largest source of CO_2 in the UK behind energy supply, whilst waste management and industrial processes rank 6th and 7th respectively. Therefore CO_2 emissions from vehicles were the main focus in this assessment rather than CO_2 from remediation or other sources. Furthermore, the comparative scenario to remediation emissions is landfill emissions, for which data is not available. Greenhouse gas emissions from landfill were also assumed to be significantly higher than emissions from treatment facilities therefore this was not assessed further on a quantitative basis. As well as carbon dioxide, other greenhouse gases (methane) and vehicle engine emitters (nitrous oxides and particulate matter) were considered.

Table 10: Assessment Boundaries

	DoW CoP	Dig & Dump
Similarities (factors not assessed)	-Treatment of excavated landfill material at Hub Site	
	-Concentration of CO_2 and greenhouse gases emitted from treatment Hub.	
	-Cost of treatment of excavated landfill material at Hub Site	
	-Costs of workers i.e. salaries	
	-Any haulage fees due to their variability making them an unreliable estimation	
	-Environmental Permit fee	
Differences (factors assessed)	-Material imported from Donor Site	-Material imported from aggregate supplier
	-Material at Donor Site reused at Hub Site.	-Material at Donor Site sent to landfill
	-CO_2 and greenhouse gases from vehicle mileage	
	- Documentation and evidence required	

32. Summary of Results

Table 11 summarises the sustainability assessment for this project. The major elements are environmental, social and economic. These have smaller, more specific categories and indicators within them which were reviewed and assessed to ascertain which were applicable for this project. The qualitative assessment was undertaken using a simple scoring system representing the number of positive factors for each option. For example, under the environmental element, category “Air”, the DoW CoP scored 4 and the Dig & Dump alternative 1. This means that the DoW CoP was assessed to have 4 positive factors whereas the Dig & Dump had 1. These scores have been totaled to give an overall result for each element. The full qualitative assessment is shown in Appendix 1.

Environmental Indicators

Air

By using the DoW CoP, this project saved an estimated 1,534 vehicle journeys and prevented an estimated 5,940 kg of CO_2 emissions and 7,128 kg CO_2e of greenhouse gas emissions. This is of particular importance as the project is located in a declared Air Quality Management Area (Defra, 2014). As well as greenhouse gases, air quality gases were estimated. These include NO_2, SO_2, and particulate matter (PM-10 and PM-2.5). An estimated 27 kg of NO_2 were saved by using the DoW CoP instead of Dig & Dump. 0.14 kg of PM-10 and 0.39 kg of PM-2.5 were also saved. NOx and SOx have adverse health and environmental effects including damage to the photosynthesis process in plants, production of acid rain and respiratory problems in people. Particulates also cause respiratory and lung problems in humans (Environmental Protection Agency, 2011).

Table 11: Sustainability Assessment Summary

Element	Category	DoW CoP	Dig & Dump Alternative
Environmental	Air	4	1
	Soil & ground	1	0
	Natural resources & waste	3	1
	TOTAL SCORE	**8**	**3**
	RESULT	√	**0**
Social	Human health & safety	1	3
	Neighbourhood & locality	1	0
	Uncertainty & evidence	10	2
	TOTAL SCORE	**12**	**5**
	RESULT	√	**0**
Economic	Direct economic costs & benefits	4	1
	Project lifespan & flexibility	3	0
	TOTAL SCORE	7	1
	RESULT	√	**0**

The works involved excavation of a former landfill which may have had a risk of gas generation. Project documents show evidence for working in compliance with a gas generation management plan to minimise the risk. There is also extensive information on dust and odour generation from the works taking place showing a high level of consideration of air quality. It is assumed however, that soil treatment works on the Hub Site (segregating, soil washing and biopiling) would also have taken place under the Dig & Dump option therefore such risks and impacts would have been similar under both scenarios.

Whilst Figure 6 shows that vehicle movements using Dig & Dump are longer than those under the DoW CoP (13,201 miles longer), there are still a number of vehicle movements being made on the Hub Site under the DoW CoP. These vehicle movements on the Hub Site may even be increased due to increased handling within a small space. Workers within a contained site may be more prone to vehicle accidents from congestion or machinery accidents from the number of operations taking place. This may lead them to be more cautious with material handling e.g. move large loads of material in two or more loads. These movements within a smaller space may also involve a large amount of time spent idling, therefore the greenhouse gas emission savings are not as large as appears when considering vehicle mileage.

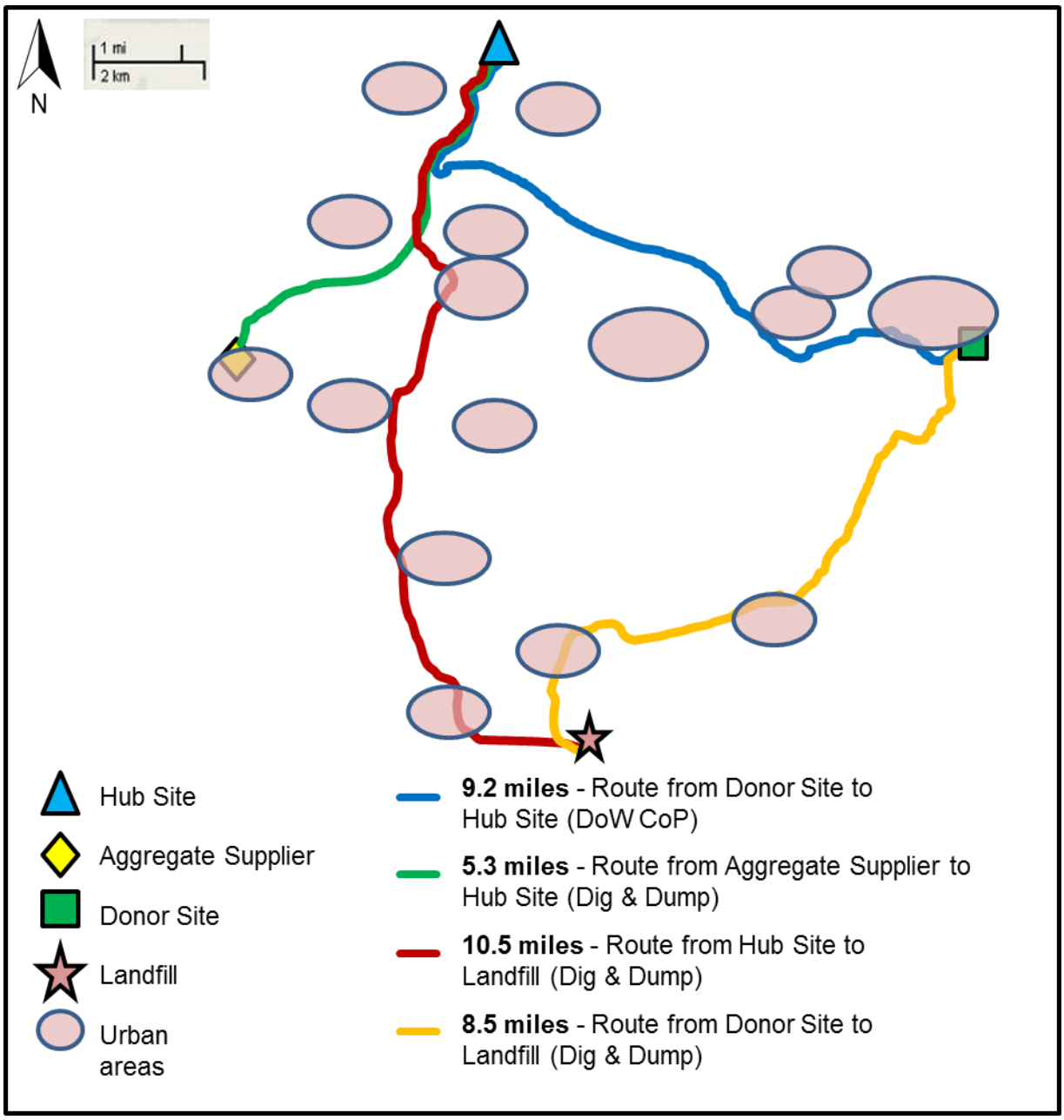

Figure 6: Vehicle routes DoW CoP and Dig & Dump

Soil & Ground Conditions

Both management options would involve excavation, treatment and reuse of landfill material on the Hub Site. As a result, soil and ground conditions under both options would be improved for the purpose of residential development.

The DoW CoP option involves importing locally sourced, clean and naturally occurring material. The MMP of the DoW CoP requires there to be detailed information present about the origin, type and conditions of the material that is to be imported. The material must prove to be geotechnically and chemically suitable for use at the site it is going to (Hub Site in this case). Using the DoW CoP, this received geologically compatible material from a relatively short distance away, maintaining homogeneity at the Receiver Site. In comparison, the information required to import material from an aggregate supplier is not as extensive as that under the DoW CoP. Therefore material may not be as geologically compatible or suitable for use at the Receiver Site.

Natural Resources & Waste

The DoW CoP "promotes the use of materials in accordance with the waste hierarchy" (CL:AIRE, 2011[a]). Disposal of material to landfill is considered the least favoured option in this regard.

The Dig & Dump option puts a strain on landfills for space and a burden on local quarries and aggregate suppliers for raw material. The DoW CoP option utilises existing material and therefore minimises the use of natural resources. It is important to note, however, that using the DoW CoP does not ensure that all material will be reused and there will be no waste. A contingency plan is a fundamental element of a DoW CoP project and reflects that even with tight planning, unforeseen circumstances can arise. In this project, 14,965m^3 of material was sent off-site for disposal, after being screened. It is assumed the same amount of material (if not more from less thorough sorting) would have been sent to disposal under the Dig & Dump option, therefore this factor was not assessed.

Using the DoW CoP, an estimated 25,440 litres of fuel were used in the project. This includes all journeys from the Donor Site to the Hub Site as well as on-site journeys at the Hub Site. In comparison, it is estimated 31,386 litres would have been used using Dig & Dump. This includes journeys from the Donor Site to landfill, aggregate supplier to Hub Site and any on-site movements. Therefore an estimated 5,946 litres of fuel were saved by using the DoW CoP..

Social Indicators

Human Health & Safety

An estimated 13,201 more miles are driven using the Dig & Dump option compared with the DoW CoP. This equates to 1,534 extra journeys over a wider public area. Therefore the Dig & Dump option, this project could pose a greater risk to public human health and safety with increased local vehicle movements. The DoW CoP approach, on the contrary, minimises vehicle movements on public roads and involves more movements on-site in a private area, restricted from the public. Whilst this may pose less risk to the public, there could be a greater risk to on-site workers under the DoW CoP. The project took this into consideration and limited vehicle movement to 10 per day to reduce on-site accidents. The site was also split into phases or sections to make it easier to manage for project teams and workers.

In terms of risk management, the two options are fairly equal as they would both involve remediation on-site and new material brought in for the same end use (residential development). The documents for this project e.g. environmental control, management and monitoring assessments demonstrate good risk management. It is assumed that the same practices would be used for the Dig & Dump approach.

It is also assumed that safety measures taken on-site under the DoW CoP approach would be similar to those taken if the Dig & Dump option was used e.g. site workers are certified in the area they are managing, safety equipment such as hazard signs and personal protective equipment are used at all times.

Neighbourhood & Locality

This project showed efforts to minimise nuisance to the local public. Topsoils and subsoils were stripped and placed as berms around the site to improve the visual appearance of the site and reduce noise. The treatment plant was operated at the centre of the site, as far away as possible from the local public. As mentioned above, vehicle movements were limited to 10 per day for site worker safety, but this also minimised congestion around the site for the neighbourhood. Haulage routes were agreed so that vehicles were not operating during school or work rush hours and small roads were not congested. A public liaison event took place before the project to ensure local people were informed of the works. Similar

measures may have been taken under Dig & Dump, therefore this section is neither in favour of DoW CoP or Dig & Dump. Instead it shows how the project team were working towards social sustainability.

Uncertainty & Evidence

Extensive information is required by the DoW CoP option including a desk top study and site investigation of the Donor Site. These documents provide detailed information about the geotechnical and chemical nature of the material. Furthermore, there is a high level of control associated with the DoW CoP where visual and olfactory inspections of incoming material are a requirement. This gives the Hub Site confidence and reassurance in the quality of the material. This subsequently forms the basis for which material is transferred to the site where it is known to be suitable for reuse due to the supporting information. Extensive and detailed information such as this is not required under Dig & Dump, for material imported from an aggregate supplier. This could reduce the confidence in the quality of the material.

This project, in particular, used a soil audit system which showed a trail of materials reuse. This provides sufficient evidence for future parties showing where the material came from and the processes it underwent to finally be reused at this site. This was an example of where the project demonstrated working to best practice under the DoW CoP, which is beyond the usual approach under Dig & Dump. An extension of this is the requirement for the project to have a verification plan and report in place under the DoW CoP. The benefit of having this information is that the project has an auditable trail of works which can be traced after the project has ended. Such information is not required under the Dig & Dump therefore the project would be less likely to record lessons learnt, as well as track their process.

Economic Indicators

Direct Costs & Benefits

This project saved an estimated £1,156,488 by using the DoW CoP. These savings include transportation fees, landfill and new material costs and fixed costs associated with the project e.g. DoW CoP training, Qualified Person (QP) fee). Haulage fees were excluded from these savings due to market variability which limited the likelihood of obtaining an accurate cost. The project saved £445,260 in new material costs and £697,574 in landfill tax and gate fees (see Appendix 6 for breakdown). Both options would require treatment and Environmental Permit costs therefore this aspect has not been incorporated into the assessment calculations.

There would be an estimated 1,534 more journeys under the Dig & Dump option with 13,201 more miles driven. The extra time spent on these journeys would incur further financial cost to the project (haulage fees), as well as increasing the project time.

Whilst the extensive documentation under the DoW CoP has social benefits (outlined in Section 5.2-Uncertainty & Evidence), it costs the project to produce them and so the planning and preparatory costs using the DoW CoP may be higher than under Dig & Dump. Preparation of the documents to demonstrate compliance with Model Procedures for the Management of Land Contamination (CLR11) (Environment Agency, 2004) as well as DoW CoP training (voluntary) and Qualified Person (mandatory) fees may lead to higher planning costs under the DoW CoP. However, these initial planning costs under the DoW CoP are negligible when compared with the overall savings of the DoW CoP.

Project Lifespan & Flexibility

The DoW CoP option encourages separate projects and companies to work together whereas the Dig & Dump option could mean that projects work in isolation. Companies linking in this way, may be able work together efficiently on future projects. The DoW CoP encourages projects to think beyond the site boundaries, therefore one successful DoW CoP project may result in a series of future projects each accruing their own sustainability benefits.

The DoW CoP allows a degree of flexibility, particularly with Cluster projects. Additional new sites can be added to the project with a new declaration. This can be beneficial if there is a change in circumstance at the Hub Site. A potential deficit or surplus can be addressed by locating a new Donor or Receiver site. In comparison, the Dig & Dump option would not allow such flexibility. If new material was needed, it would have to be bought from a supplier resulting in greater project costs not included in the original budget.

33. Project Costs & Savings

Table 12 below highlights the key savings for this project using the DoW CoP.

Table 12: Project Costs & Savings using the DoW CoP

	DoW CoP (Costs)	Dig & Dump (Costs)	Savings by using DoW CoP
Environmental & Social costs & savings			
No. of vehicle journeys	56,828	58,362	1,534
No. of vehicle road miles	56,511	69,712	13,201
CO_2 emissions (kg CO_2)	25,431	31,371	5,940
GHG emissions (kg CO_2e)	30,516	37,644	7,128
Fuel Consumption (litres)	25,440	31,386	5,946
Economic costs & savings			
DoW CoP training (£395 pp)	395		1,141,439
Qualified Person (£) 500 per day	1000		
Removal to landfill & purchase of new material (£)		1,142,834	
Fuel cost (£)	64,423	79,472	15,049
Total financial costs including fuel (£)	65,818	1,222,306	1,156,488

34. Lessons Learnt

This project showed that, by using the DoW CoP, it is possible to successfully and efficiently link two sites together and transfer material between them, with plenty of early planning, under the DoW CoP. However the project could have benefited further from using the CL:AIRE Register of Materials (RoM). This online database, available free on the CL:AIRE website, holds live information on Donor, Receiver and Hub sites across England and Wales. By using this service, either the Donor or Hub sites in this project could have found each other more quickly and efficiently. They could also have identified more sites which could have joined the Cluster, further increasing the sustainability benefits.

35. Conclusions

A sustainability assessment was carried out comparing use of the DoW CoP in a Cluster project against a Dig & Dump alternative.

This project involved a large amount of material treatment work (managing the arisings from the site of origin) which would have been similar for both options. Even so, use of the DoW CoP has been shown to created significant sustainability benefits.

Environmental

Environmentally, both the DoW CoP and Dig & Dump options involve treatment which would have improved soil and ground conditions on the Hub Site. However, using the DoW CoP, this project saved significant greenhouse gas emissions in including 5,940 kg CO_2, which is analogous to a hatchback car driving over 58,000km (typical car emissions = 0.102 kg CO_2 / km). The assessment of this category showed the use of the DoW CoP has contributed to significant carbon reductions, which satisfies the original objectives of Phase 2.

Using the DoW CoP also puts less strain on natural resources including aggregate suppliers and landfills. The alternative option does not comply with the Government's aim to recover 70% of construction and demolition waste by 2020 (European Commission, 2014). This category shows that the DoW CoP has contributed to a more sustainable management of resources, meeting the aims and objectives of Phase 2.

Social

The DoW CoP requirement for a larger number of more detailed planning/preparatory documents results in project teams having more information available at each site. This aids and improves their understanding of the material. They also provide the project with an audit trail of works which can be used after the project to track the work and improve for future projects.

This project showed particular strengths in the 'uncertainty and evidence' category, with extensive information in place which goes beyond the requirement of the DoW CoP. This extra information demonstrated efforts of working to best practice and allowed for more information to be available to support the sustainability assessment.

Risks would have been removed under both options as it is assumed that treatment on the Hub Site would also have taken place under Dig & Dump. The clean, naturally occurring material at the Donor Site could have been sent to landfill under Dig & Dump but the DoW CoP encourages its reuse at another site and early planning that is required and encouraged with the DoW CoP increases the chances of this being possible.

Economic

The main financial costs (fuel, DoW CoP training and QP fee) of using the DoW CoP were estimated to be £65,818 and significantly lower than costs (fuel, new material fee, landfill taxes and gate fees) associated with Dig & Dump (£1,222,306). In addition to this, time-scales using the DoW CoP were estimated to be shorter than those of Dig & Dump due to reduced vehicle mileage. The financial benefits of the project using the DoW CoP significantly outweigh those under Dig & Dump. In addition to the positive financial savings, the DoW CoP brought increased flexibility and chances of success to the project.

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37. Phase 2 Conclusions

The objectives of Phase 2 were to assess whether:-

- resources are being managed more sustainably;
- there is use of more sustainable remediation practices; and
- carbon reductions in land reuse projects.

Where the sustainability assessment found evidence of these objectives they are highlighted in bold after the following paragraphs.

Environmental Indicators

Air

The environmental indicators for this assessment included air, soil & ground conditions, and natural resources & waste.

The main benefit of using the DoW CoP for all three projects with regards the air indicator was the reduction in CO_2 and greenhouse gas emissions in comparison with Dig & Dump (see Figure 7).

The Site of Origin project saved the most CO_2 (11,594 kg CO_2) followed by the Cluster project (5,940 kg CO_2) and finally the Direct Transfer project (259 kg CO_2). These figures are due to the differences in vehicle mileage between the DoW CoP and Dig & Dump for each of the projects. For example, the Site of Origin project saved 21,481 vehicle miles by using the DoW CoP because it was able to reuse material from the same site rather than travelling longer distances to dispose of and purchase new material.

The Direct Transfer project showed lower savings in CO_2 emissions as some of the vehicle routes were the same under both DoW CoP and Dig & Dump.

The Cluster project saved vehicle miles and CO_2 by excavating, treating and reusing material on the Hub Site, however it saved less than the Site of Origin as it still required some material to be taken to landfill off-site and new material brought in from a supplier.

All three projects saved CO_2 and greenhouse gas emissions (Site of Origin=13,962 kg CO_2e, Direct Transfer=310 kg CO_2e, Cluster=7,128 kg CO_2e) by using the DoW CoP instead of Dig & Dump. The negative atmospheric and human health impacts of gases and particulates released from vehicle engines were therefore reduced. (**Carbon Reductions)**

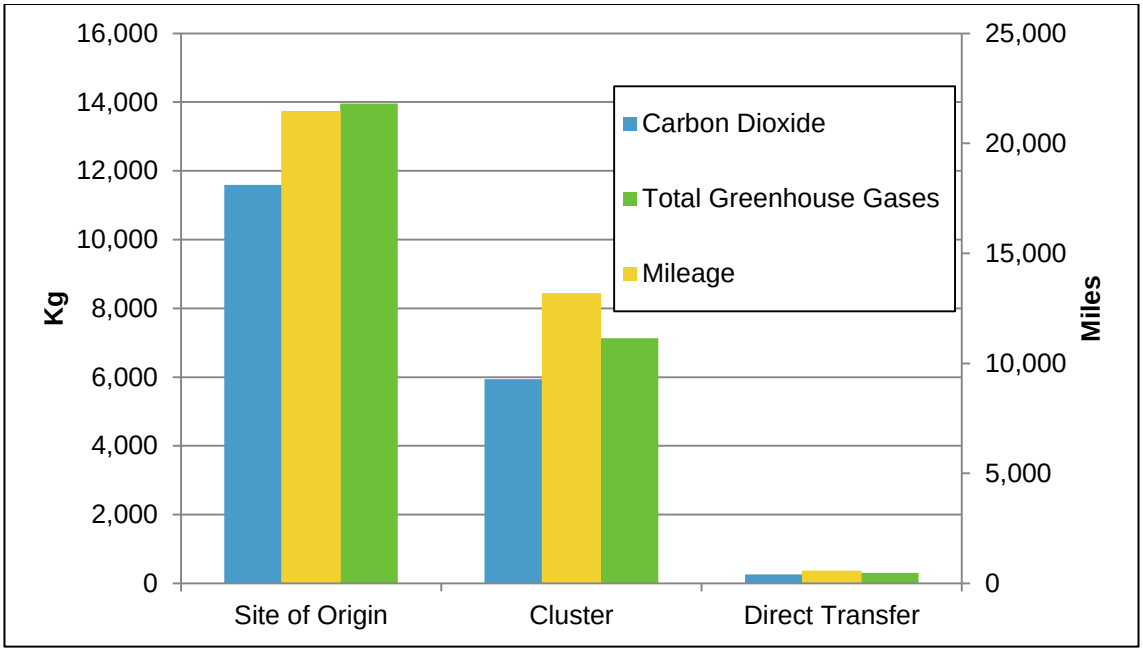

Figure 7 – Project savings from using the DoW CoP

The projects often showed efforts to take air quality into consideration including testing, dust and pollution control (Site of Origin project), carbon calculator (Direct Transfer project) and extensive information on dust and odours (Cluster project). However it was considered that these would also likely have taken place under the Dig & Dump approach and were neither an advantage of the DoW CoP or Dig & Dump. Instead, these measures taken by all three projects showed efforts towards using best practice and environmental sustainability.

Soil & Ground Conditions

Positive evidence for this indicator was found for both the DoW CoP and Dig & Dump options. Where treatment (anything from screening to bioremediation) was involved e.g. the Site of Origin and Cluster projects, it was assumed that some treatment would also have been carried out using the Dig & Dump option. Therefore, soil and ground conditions at project sites would be improved under both scenarios.

The DoW CoP requirements for material to be provably geotechnically and chemically suitable, means project teams can ensure that material coming from a Donor site is more geologically compatible with material at the Receiver site.

This was particularly shown by the Direct Transfer project which transferred clean naturally occurring material from one site to another. The extensive information required when using the DoW CoP, gaves the project teams significantly more data than would be available from an aggregate supplier. This should lead to greater homogeneity at the Receiver site, once material has been imported. (**Sustainable Remediation)**

Natural Resources & Waste

This indicator was strongly in favour of the DoW CoP largely due to landfill being the least favourable option under the waste hierarchy. All three projects achieved a higher level of sustainability by using the DoW CoP. The Dig & Dump option would not have complied with Defra and the Government's aim to recover 70% of construction and demolition waste by 2020 (European Commission, 2014).

It was estimated that the projects saved a significant amount of vehicle fuel by using the DoW CoP. The Site of Origin project saved 9,674 litres of fuel whilst the Direct Transfer and Cluster projects saved 259 litres and 5,946 litres of fuel respectively. Again, it is estimated that the Site of Origin saved the most fuel due to the large difference in number of vehicle miles travelled, however all three projects saved fuel by using the DoW CoP. (**Resources managed sustainably)**

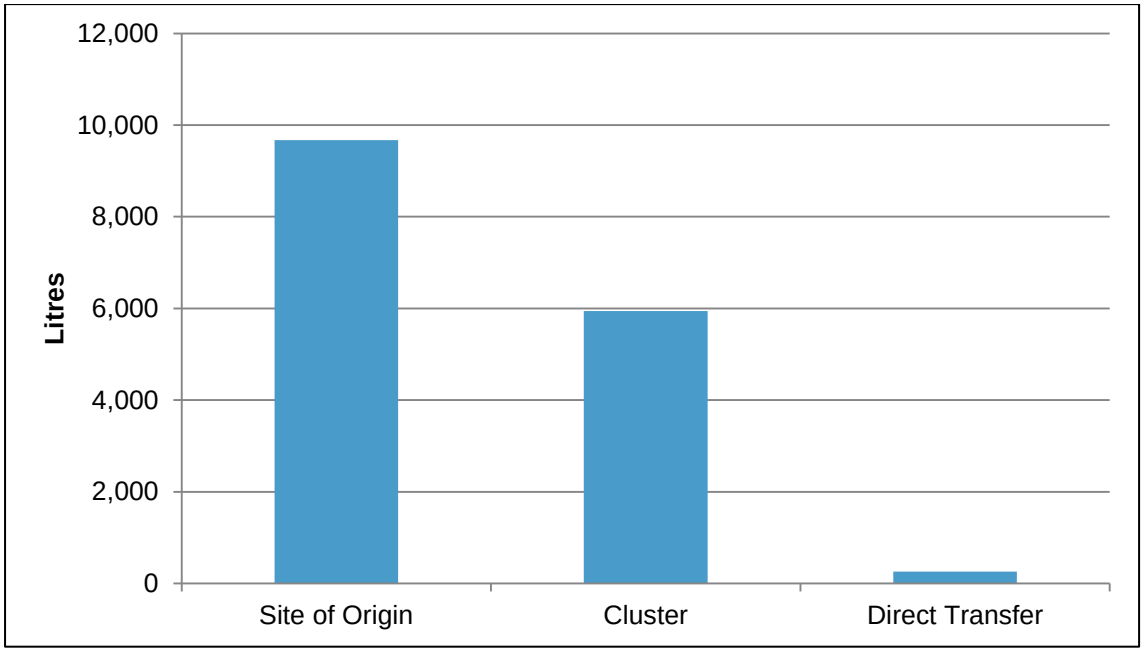

Figure 8 – Fuel saved using the DoW CoP

Social Indicators

Human Health & Safety

Use of the DoW CoP demonstrated large reductions in vehicle journeys in comparison to the dig and dump scenario. For example, the Site of Origin project saved 447 vehicle journeys, the Direct Transfer project saved 192 journeys and the Cluster project saved 1,534 journeys by using the DoW CoP instead of Dig & Dump. This indicates that vehicles would spend less time on the local roads roads using the DoW CoP, and therefore there is a lower risk of heavy vehicle accidents and dust pollution to the local public. (**Sustainable Remediation)**

When considering risk removal and mitigation, the Dig & Dump option could be seen to achieve slightly more advantages than the DoW CoP option. If a site is contaminated, using the Dig & Dump option it would be excavated and material in its entirety would be removed to landfill. Using the DoW CoP, a risk based approach is taken and material, the material may be excavated, segregated and then reinstated on site.

Neighbourhood & Locality

As well as decreasing the health and safety risk to the local area, the lower number of vehicle journeys under the DoW CoP would result in less nuisance caused to the local area from congestion and noise. By using the DoW CoP, the Site of Origin project saved a 30 mile area of local towns from being impacted by extra traffic. (**Sustainable Remediation)**

Project time-scales would have been shorter under the DoW CoP, particularly if a project was awaiting an Environmental Permit for treatment under the Dig & Dump option. Shorter time-scales would be more favourable for the local communities, decreasing the time that the area is affected by construction works. (**Sustainable Remediation)**

Uncertainty & Evidence

This indicator represents one of the key components of the DoW CoP. The nature and process of the DoW CoP requires and encourages the presence of detailed project documentation.

The MMP under the DoW CoP requires projects to provide information such as a desk top study, site investigation and chemical testing at a Donor site. It also requires a design statement or remediation strategy as well as site specific risk assessments in compliance with CLR11.

The DoW CoP also goes beyond CLR11 (and beyond the usual approach under Dig & Dump) and requires project teams to have a contingency plan and tracking system in place as well as produce a verification plan and report. (**Sustainable Remediation)**

The benefit of having such information (e.g. MMP, contingency plans) is that the project has an auditable trail of works which can be traced once it is complete. This information also helps the project run to schedule, specification, on budget and to the standards planned. It ensures there are measures in place if a problem (project slippage) arises, prior to the project commencing. (**Sustainable Remediation)**

This indicator also counters the human health and safety indicator because although contamination may remain on site, best practice under the DoW CoP ensures it is recorded and well understood.
Economic Indicators

Direct Costs & Benefits

The economic benefits of using the DoW CoP significantly outweigh those of the traditional Dig & Dump option. The economic benefits are illustrated in Figure 9. Together the three projects in this assessment saved over an estimated £1.5million.

The Site of Origin saved £284,703, the Direct Transfer saved £71,449 and the Cluster saved £1,156,488.

Without the DoW CoP, these projects may have been delayed whilst extra funding was sourced or in the worst case, may not have taken place at all. (**More brownfield land reused, Sustainable Remediation)**

These overall cost savings can be further broken down to show that the DoW CoP was saving the projects money at each financial stage, rather than just as a whole. In terms of fuel costs, the Cluster project saved an estimated £15,049, the Site of Origin saved £24,409, and the Direct Transfer £656.

In addition to this, the removal of the 5,600m^3 stockpile on the Site of Origin and the purchase of 4,530m^3 to fill the void could have cost the project a further £261,608. For the Direct Transfer project, the cost of landfilling and purchasing 1,250m^3 of material could have cost the project an estimated £72,188.

Finally, the same costs for disposing of and purchasing 19,965m^3 of material under the Cluster project could have cost £1,141,420. (**Resources managed sustainably)**

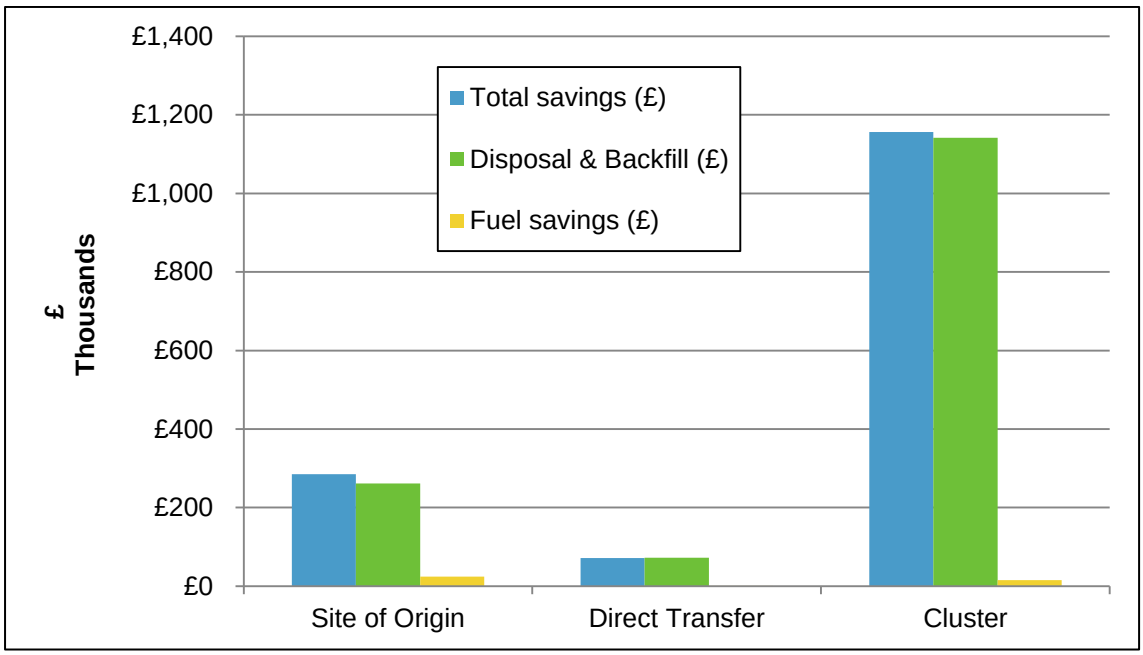

Figure 9 – Economic benefits using the DoW CoP

Although there may be initial planning costs for all the documentation required to follow CLR11 under the DoW CoP, the overall financial costs are significantly lower than the Dig & Dump.

Lifespan & Flexibility

There is generally more flexibility for projects by using the DoW CoP. For example, the requirement for more material under a Cluster scenario could be mitigated with a new Donor site and new declaration for the addition of that site to the overall project. The requirement for more material under the Dig & Dump option could elicit financial strains and delay or stop the project. (**More brownfield land reused)**

The lifespan (i.e. how long a project can successfully continue) and success of the projects in this assessment were increased by using the DoW CoP, particularly for those that involved pairing up with another site. For example, the Direct Transfer and Cluster scenarios involved transfer of material from a Donor site. (**Sustainable Remediation)**

The relationship gained between the two sites/two companies could be beneficial for future work or an extension of current work. Greater interaction between companies and projects which use the DoWCoP will foster similar approaches in the future on new projects. The DoW CoP encourages projects and companies to think beyond the confines of their own site.

38. Final Comments

The objectives of Phase 2 were to assess whether:-

- resources are being managed more sustainably;
- there is use of more sustainable remediation practices; and
- carbon reductions in land reuse projects.

The sustainability assessments of each project have shown that the above actions are being realised by using the DoW CoP.

The DoW CoP has been shown to be frequently a more sustainable materials management option than the traditional Dig & Dump. This has been particularly demonstrated by the financial savings that projects can achieve from use of the DoW CoP.

The DoW CoP has also been shown to be more environmentally and socially sustainable than the Dig & Dump for all three projects.

The variety of projects within this assessment (e.g. different DoW CoP scenarios, different types and volumes of material, varying degrees of treatment) has demonstrated that the DoW CoP is applicable to a wide range of conditions.

Use of tools such as the CL:AIRE Register of Materials might have further increased the benefits realised and spread them beyond the sites within this research.

39. References

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Appendix 1: Site of Origin Project Sustainability Assessment

Element	Category	Indicators	DoW CoP Option		Alternative Option (Dig & Dump)	
Environmental	Air	Emissions that may affect climate change or air quality, or considerations that may allow overall reduction in impact on climate change e.g.: - Greenhouse gases (e.g. CO_2, CH_4, N_2O, O_3, VOCs, ozone depleting substances etc.) - NOx, SOx - Particulates (PM2.5, PM10)	-No vehicle movements between sites - Site of Origin project. -Material covers for dump trucks reducing dust emissions (Work Sequence, Safety Method Statement) -Random air tests carried out - work is to stop if hazardous levels are reached.	-Est. CO_2 emissions = 62 kg CO_2 (see Appendix 3) -Est. total GHG emissions = 68 kg CO_2e (see Appendix 3) -The Safety Method Statement for this project states that dump truck loads will be reduced on-site to make handling easier and increase safety, therefore a greater number of journeys need to be made to move all the material = increased CO_2 emissions.	-Material covers may also be used to transport to landfill, reducing dust emissions -Air quality tests may be required if the Dig & Dump option is used as segregation of asbestos fragments would still be taking place. Though it is not a requirement to carry out air testing. Reference: "This does not require air monitoring on every job, if an estimate of degree of exposure can be made based on experience of similar past tasks or published guidance" .http://www.hse.gov.uk/asbestos/regulations.htm	-Est. CO_2 emissions = 11,714 kg CO_2 (see Appendix 5) -Est. total GHG emissions = 14,068 kg CO_2e (see Appendix 5) -Emissions (particulates, N_2O, NOx, SOx) from trucks spread over a wider area not just site of origin. These are harmful to human health and reduce air quality over a larger area. Vehicles are moving through sensitive areas which are not restricted to the public e.g. schools.
			3		2	
	Soil & ground conditions	Changes in physical, chemical, biological soil condition that affects the ecosystem function, goods or services provided by soils (these may be improvements OR deteriorations). May include: - Soil quality (chemistry) - Water filtration and purification processes (inc. sediment generation or reduction) - Soil structure and/or organic matter content or quality - Erosion and soil stability (inc. drainage) - Geotechnical properties (inc. compaction) - Impact/benefits to sites of special geological interest e.g. SSSIs and geoparks - Conservation/ Environmental Management/ Ecology	-Screening and segregation to remove foreign material inc. asbestos and improve soil quality. -Vehicle routes marked with pegs to prevent vehicles running into the spoil and cross contamination. -Imported soil is to comply with BS 3882:1994 standards.	-Thicker capping layer to prevent contamination from high levels of benzo(a)pyrene however benzo(a)pyrene still left in the ground.	-Screening and segregation to remove foreign material inc. asbestos and improve soil quality -Imported soil is to comply with BS 3882:1994 standards -All problematic material would be excavated from project site and sent to landfill, including that containing benzo(a)pyrene therefore: -project site would have fewer contaminants if material was excavated and sent to landfill.	-Contaminated material is not reduced or improved, it is just moved from one place to another, albeit a specifically engineered and managed site (landfill).
			2		4	

*Note: Green text indicates factors which are considered to be the same under both DoW CoP and Dig & Dump therefore cancel each other out and are not considered in the scoring system. Nonetheless, it was important to note these factors as they often demonstrated a high standard of works and often related to remediation at the Hub site which was a large part of the project.

Appendix 1: Site of Origin Project Sustainability Assessment

Element	Category	Indicators	DoW CoP Option		Alternative Option (Dig & Dump)	
Environmental	Natural resources & waste	Impacts/benefits for: - Land and waste resources - Use of primary resources and substitution of primary resources within the project or external to it (including raw and recycled aggregates) - Use of energy/fuels taking into account their type/origin and the possibility of generating renewable energy by the project - Handling of materials on-site, off-site and waste disposal resources - Water abstraction, use and disposal	-DoW CoP encourages reuse of resources (excavated material): -Not buying raw material/natural resources -Not using raw material/natural resources from local quarries -No strain is put on landfill (waste resource) where space is becoming increasingly limited -Use of fuels/energy is more efficient in the DoW CoP option (see Figure 2 - estimated less CO_2 and less fuel consumed) -This option supports Defra and governments aim to recover 70% of construction and demolition waste by 2020 (WFD, 2008; European Commission, 2012)	-Increased materials handling as a larger number of short journeys are made on-site (Est. 25% more).	-Less handling of materials - simple excavation>loading>dump at landfill process.	-Dig & Dump option does not encourage reuse of resources and materials: -Potential strain put on local aggregate and building resources suppliers - Potential strain put on quarries to supply material to project site where material has been excavated. -Strain put on landfill (waste resource) where space is becoming increasingly limited. -This option goes against Defra and governments aim to recover 70% of construction and demolition waste by 2020 (WFD, 2008; European Commission, 2012) -Use of fuels is less efficient with this option (see Figure 2 for mileage)
			3		1	
		TOTAL SCORE	**8**		**7**	
		RESULT	✓		✗	

Element	Category	Indicator	DoW CoP Option		Alternative Option (Dig & Dump)	
Social	Human health & safety	Risk management performance of the project (long term) in terms of delivery of mitigation of unacceptable human health risks	-An effort to manage long term risks by implementing a thicker capping layer to prevent contamination from high levels of benzo(a)pyrene. -All the planning documents associated with the DoW option allow project teams to have a better understanding of the subsurface and engineering design improving risk management performance.	-No documentation to show that long term monitoring of the site will be carried out, particularly as benzo(a)pyrene is being left in the soil. -Pollutant linkage has been intercepted between pathway and receptor using thick capping layer, but source is not removed.	-The Dig & Dump option ensures that all material containing contamination (asbestos or benzo(a)pyrene) is removed from the project site in its entirety therefore: -The long term risks at the project site are mitigated as the source is removed. -Landfill is typically a well monitored, strictly supervised site - it is of concern on a governmental level therefore long term management and data should be of a high standard.	-The problem is just moved from one location to another, so although risks at site of origin are completely removed, there is an introduction of new risk to landfill site.
			2		3	
		Risk management performance of project (short term) in terms of duration of remediation works, inc. consideration of: -Site workers, site neighbours and the public -Remediation works and ancillary operations (inc. process emissions such as bio-aerosols, allergens, PM10, impacts from operating machinery/traffic movements, excavation, etc.)	Minor safety measures: -All site workers to be certified and appropriately trained. -Safety equipment includes: signage, hazard warning tape, pedestrian barriers, and labelled asbestos bags. -PPE to be worn. -Site works comply with Health and Safety Executive 1991. -Vehicle routes to be marked with pegs and a drawing - updated as areas are filled. Major safety measures: -Import soil to comply with BS 3882:1994 standards. -All equipment leaving site - decontamination process. -Dump truck loads - minimised (not overfill) and a cover placed while transported - Easier to manage.	-Segregation/sorting machinery operating on-site - increased safety risk from this. - Increased vehicle movements on-site making site more congested and posing greater risk of accidents to site workers and machinery.	-It is presumed that similar on-site safety precautions would be taken if the Dig & Dump option was chosen therefore assume the following minor safety measures: -All site workers to be certified and appropriately trained. -Safety equipment includes: signage, hazard warning tape, pedestrian barriers, and labelled asbestos bags. -PPE to be worn at all times. -Site works comply with typical landfill safety practices Major safety measures: -Import soil to comply with BS 3882:1994 standards -Less/ no on-site vehicle movements compared with the DoW CoP option reducing risk of on-site congestion and accidents.	-It is assumed that dump truck loads are not minimised with this option as longer, off site journeys are being made - site workers may be handling larger volumes of material on road reducing safety. -Segregation/ sorting machinery operating on-site - increased safety risk. -Project may not mark vehicle routes on-site with pegs if Dig & Dump option is chosen as the vehicle movements on-site are less complicated. i.e. with the Dig & Dump option, it appears simple so projects may use less safety precautions
			3		2	
	Neighbourhood & locality	Impacts/benefits to local areas (tangible amenity changes), including: -Effects from dust, light, noise, odour and vibrations during works and associated with traffic, including both working-day and night/weekend operations	-Third parties are denied access from site preventing in harm to human health from contamination or hazardous works. -Regular cleaning of site and access roads. -A dust suppression system set up around site to control dust during works.	-Time-scales longer than dig and dump.	-Time-scales shorter than DoW option	-Neighbourhoods from a wider radius are affected as journey to landfill is 18.3 miles away - increased congestion, noise, and dust in this wider radius -Adding to deterioration of land at landfill affecting communities surrounding landfill, if not managed properly
			3		1	

Appendix 1: Site of Origin Project Sustainability Assessment

Element	Category	Indicator	DoW CoP Option		Alternative Option (Dig & Dump)	
Social	Uncertainty & evidence	Robustness of sustainability appraisal for each option considered	-DoW CoP "promotes the use of materials in accordance with the waste hierarchy" - DoW CoP document p.6	-No evidence of an options appraisal for remediation option or reasons to choose DoW CoP. Essentially a DoW vs. Landfill (or alternative option) kind of assessment should have been considered by the project to justify their choice.		-Dig & Dump option would most likely come last in a sustainable options appraisal therefore if the project still reached a Dig & Dump option whilst using a sustainability options appraisal, the level of robustness would be low.
			1		0	
		-Quality of investigation, assessments (inc. sustainability) and plans, and their ability to cope with variation. Accuracy of record taking and storage.	-Soil tested for contaminants against Atkins ATRisk levels -Extensive documentation required for DoW CoP Site of Origin scenario: Remediation Strategy, MMP, Desk Top Study, Site Investigation, CSM, Risk Assessment, Verification Plan and Verification Report. (Appendix 1, DoW CoP document)			-No extensive investigation of ground/ site needs to take place in order to landfill material - simple check against WAC. -Not much documentation required for this option compared with DoW CoP option meaning quality of investigation decreases.
			2		0	
		-Requirements for validation/ verification	-Validation Plan in place -outlines nature, type and frequency of site inspections and information on testing. -Verification report to be completed showing project remediation complies with RMS.	-Verification report not sent although RMS states it will be completed.		-The Dig & Dump option does not require a validation plan and verification report to be completed.
			2		0	
		-Degree to which robust site-specific risk-based remedial criteria are established (justified & realistic CSM versus unnecessarily conservative and/or precautionary assumptions/data)	-Basic risk screening in place which shows there is a better understanding of the site and material therefore more material can be reused. -Risk assessment is site specific			-Contamination source is not removed from environment - simply moved to another site. -This option may be seen as unnecessarily precautionary - material can be recovered and reused - but instead is sent to landfill. No risk assessment required.
			2		0	
		TOTAL SCORE	**15**		**6**	
		RESULT	✓		**×**	

Appendix 1: Site of Origin Project Sustainability Assessment

Element	Category	Indicator	DoW CoP Option		Alternative Option (Dig & Dump)	
Economic	Direct Economic Costs & Benefits	-Direct financial costs and benefits of remediation for organisation	-DoW CoP is free -No direct cost of disposal (excluding fuel, operation and workers) -No direct cost of gaining new material (excluding fuel, operation and workers)	- Screening/segregating cost (incorporated into cost of employees, asbestos screener may be paid a higher rate) or they might have called in asbestos surveyors.		- Screening/segregating cost (incorporated into cost of employees, asbestos screener may be paid a higher rate) or they might have called in asbestos surveyors. -Estimated landfill cost assuming 6,795 tonnes of material sent through as non hazardous (£2.50 per tonne, ref: HMRC; £21 per tonne gate fee) = approx. £160,000 (See Appendix 6) -Cost of new material = £15 per tonne (average figure from internet search of gravel, clays and sands) = £101,925 (See Appendix 6) -Total estimated landfill and new material cost for project= £261,608 (excluding segregation costs) (Appendix 6)
			3		0	
		-Consequences of capital and operation costs, and sensitivity to alteration e.g.: -Costs associated with the works (inc. operation and any ongoing monitoring, regulator costs, planning, permits licences) -Uplift in site value to facilitate future development or investment	- No positive characteristics as secondary costs for DoW CoP are expected to be the same, if not more than Dig & Dump option. This is because a new initiative is being used and understood = training. Also DoW CoP requires projects to work to best practice so they may incur higher safety, operational and maintenance costs to keep standards high.	-DoW CoP training for staff (£395 pp -Est. fuel costs = £119 (See Table 3) -Cost of qualified person to review work – est. £500 per day for 2 days = £1000 -Safety equipment -Safety training that all staff require -PPE -Operation costs. -Maintenance costs. -The Safety Method Statement for this project states that dump truck loads on-site will be reduced so that they are safer and easier to handle. This means that a greater number of journeys are required to move all the material increasing fuel costs.	-No training for project teams required in order to use landfill	-Safety equipment -Training e.g. asbestos training -PPE -Operation costs. -Maintenance costs. -Est. fuel costs = £24,709. (See Table 3)
			0		1	
		-Liability discharge		-Material containing contamination not completely removed from site therefore site is liable for future risks - project company may also be liable.	-Risk is completely removed from site therefore it is not liable in the future - all responsibility is passed to landfill site.	
			0		1	

Element	Category	Indicator	DoW CoP Option		Alternative Option (Dig & Dump)	
Economic	Project Lifespan & Flexibility	-Duration of the risk management (remediation) benefit)		-The development works at the Site of Origin will take longer with DoW CoP option as on-site processes include excavation, segregation, material movement, backfilling and capping.	-The development works at the Site of Origin will take less time with the Dig & Dump option as on-site activities only include excavation and moving off-site.	
			0		1	
		-Factors affecting chances of success of the remediation works and issues that may affect works, inc. community, contractual, environmental, procurement and technological risks	-DoW CoP requires there to be a contingency plan which means there should be alternative options in place if the project slips = more chance of success. -DoW CoP option requires all contract and planning issues to be dealt with and prepared upfront - increasing chances of success. -DoW CoP option may be supported more widely by local authorities and governing bodies as it complies with the waste hierarchy and UK's objectives to recover 70% of construction and demolition waste by 2020 (European Commission, 2012). Greater support = more chances of success. -The flexibility of the DoW CoP allows the presence of asbestos to be dealt with relatively easily - i.e. asbestos being present doesn't stop the project form going ahead and its chances of success.	-Need Qualified Person to review work and approve it as well as the EA - what if they say no after all the time and money has gone into preparing MMP and documents. - Cost of QP.	-Preparation costs associated with sending to landfill are broad i.e. soil tests are required for all types of material movement and waste disposal so essentially if the landfill rejects their material - their prep work will still be useful.	-Need to pay for material testing to show landfill that material is acceptable - they could say no after time and money has been spent on testing. -Less flexibility and no contingency required. Project may then have to spend time and money approaching another landfill. -This option may be less favoured by local authorities and governing bodies as it is the least favourable option according to the waste hierarchy and does not comply with UK's objectives to recover 70% of construction and demolition waste by 2020 (European Commission, 2012) - less support = less chance of success.
			4		1	
		-Ability of project to respond to changing circumstances, including discovery of additional contamination/material, different soil materials, or time-scales		-All work is to be carried out as per agreed programme (Supervision and Personnel, Safety Method Statement) -If any unexpected material is found, work will stop (Work Sequence, Safety Method Statement) - The DoW CoP SHOULD be flexible, this is one of the main benefits of using it - but this project has not allowed for flexibility.		-No flexibility with work sequence/ lack of contingency
			0		0	
		TOTAL SCORE	**7**		**4**	
		RESULT	✓		✗	

SoO Appendix 2: Project Calculations using the DoW CoP		
Haulage route	0.1	miles (mi)
Volume of material being reused	4,530	cubic metres (m3)
Estimated volume in tonnes (assuming 1.5 multiplier, source: HMRC, 2014)	6,795	tonnes (ton)
Average capacity of an on site dump truck (tonnes) (source: *) 100% laden	22	tonnes (ton)
Est. average capacity of an on site dump truck (tonnes) on Site of Origin - loads minimised for this project (Safety Method Statement)	18	tonnes (ton)
Est. number of journeys made on site to move all material	378	
Multiply by 2 for return journey	755	
Est. total number of journeys made on site - 25% increase from more material handling/movements	**944**	
Est. miles travelled at 0% laden	47	miles (mi)
Est. miles travelled at 100% laden	47	miles (mi)
Est. total miles travelled on site	**94**	miles (mi)
Est. fuel cost at £1.14 per mile. (source: HGVUK, 2014)	107	pounds (£)
Average fuel consumption of on site truck at 0%	3.20	miles per litre (MPL)
Average fuel consumption of on site truck at 100%	1.70	miles per litre (MPL)
Est. fuel consumption for this project at 0% laden	15	litres (l)
Est. fuel consumption for this project at 100% laden	28	litres (l)
Total	**43**	**litres (l)**

*Information on capacity, size and type of road and dump trucks was collected from CL:AIRE industry members

Source

HGVUK, 2014

Available from

http://www.hgvuk.com/07/22/cost-of-fuel-per-mile-set-to-rise-for-hgvs/

SoO Appendix 3: Greenhouse Gas emissions using the DoW CoP								
					Air Quality gases			
	CO2	**CH4**	**N2O**	**Total GHG**	**NOx**	**SO2**	**PM10**	**PM2.5**
	(kg co2)	(kg co2e)	(kg co2e)	(kg co2e)	**(kg)**	**(kg)**	**(kg)**	**(kg)**
Ave. GHG emitted at 0% laden per vehicle mile	0.48	0.0003	0.0062	0.59				
Ave. GHG emitted at 100% laden per vehicle mile	0.70	0.0003	0.0062	0.70	0.002025	0.000002	0.000033	0.000032
Est. GHG emitted at 0% laden for this project	23	0.014	0.294	27.63				
Est. GHG emitted at 100% laden for this project	33	0.014	0.294	33.23	0.1911	0.0002	0.0031	0.0030
Est. total GHG emitted for this project	56	0.028	0.589	60.86	0.1911	0.0002	0.0031	0.0030

Source	Available from
Defra, 2013	http://archive.defra.gov.uk/environment/business/reporting/pdf/110819-guidelines-ghg-conversion-facto
Defra, 2011	http://naei.defra.gov.uk/data/ef-transport

SoO Appendix 4: Project Calculations using Dig & Dump			
Site of Origin - Landfill distance		18	miles (mi)
Aggregate supplier - Site of Origin distance		13	miles (mi)
	Total	**31**	miles (mi)
Volume of material being reused		4,530	cubic metres (m3)
Est. weight of material (assuming 1.5 multiplier, source: HMRC,2014)		6,795	tonnes (ton)
Ave. capacity of 8 wheel 4 axle road truck at 100% laden (source: *)		19.5	tonnes (ton)
Est. number of journeys made from Site of Origin - Landfill		348	
Multiply by 2 for return journey		696	
Est. number of journeys made from aggregate supplier - Site of Origin		348	
Multiply by 2 for return journey		696	
Total		**1,392**	
Est. total distance to take all material from Site of Origin to landfill		12,528	miles (mi)
Est. total distance - new material from aggregate supplier to Site of Origin		9,048	miles (mi)
Total distance travelled in this project		**21,576**	miles (mi)
Est. miles travelled at 0% laden		10,788	miles (mi)
Est. miles travelled at 100% laden		10,788	miles (mi)
Ave. fuel consumption at 0% laden		3.2	miles per litre (MPL)
Ave. fuel consumption at 100% laden		1.7	miles per litre (MPL)
Est. fuel consumption for this project at 0% laden		3,371	litres (l)
Est. fuel consumption for this project at 100% laden		6,346	litres (l)
Total		**9,717**	**litres (l)**

*Information on capacity, size and type of road and dump trucks was collected from CL:AIRE industry members

Source	Available from
Defra, 2013	http://archive.defra.gov.uk/environment/business/reporting/pdf/110819-guidelines-ghg-conversion-fa
HMRC	http://www.hmrc.gov.uk/rates/landfill-tax.htm

SoO Appendix 5: Greenhouse Gas emissions using Dig & Dump

					Air Quality gases			
	CO2	CH4	N2O	Total GHG	NOx	SO2	PM10	PM2.5
	(kg co2)	(kg co2e)	(kg co2e)	(kg co2e)	(kg)	(kg)	(kg)	(kg)
Ave. GHG emitted at 0% laden per vehicle mile	0.48	0.0003	0.0062	0.59				
Ave. GHG emitted at 100% laden per vehicle mile	0.60	0.0003	0.0062	0.71	0.002025	0.000002	0.000033	0.000032
Est. GHG emitted at 0% laden	5,230	3	67	6,318				
Est. GHG emitted at 100% laden	6,430	3	67	7,686	43.69	0.05	0.71	0.68
Est. total GHG emitted	11,661	6	135	14,004	43.69	0.05	0.71	0.68

(Figures rounded to appropriate decimal places)

Source	Available from
Defra, 2013	http://archive.defra.gov.uk/environment/business/reporting/pdf/110819-
Defra, 2011	http://naei.defra.gov.uk/data/ef-transport

SoO Appendix 6: Financial Costs under the Alternative Option (Dig & Dump)		
Volume of material being reused	4,530	cubic metres (m3)
Est. weight (assuming 1.5 multiplier, source: HMRC)	6,795	tonnes (ton)
Avg. non hazardous gate fee in 2012 per tonne (source:WRAP,2013)	21	pounds (£)
Avg. non hazardous landfill tax in 2012 per tonne (source:HMRC,2014)	2.5	pounds (£)
Gate fee cost to project	142,695	pounds (£)
Landfil tax cost to project	16,988	pounds (£)
Total landfill costs to project	159,683	pounds (£)
Avg. cost of new material per tonne	15	pounds (£)
Total cost of new material for project	101,925	pounds (£)
Total landfill + new material costs to this project	**261,608**	pounds (£)
Est. fuel costs at £1.14 per mile. (source: HGVUK,2013)	24,597	pounds (£)

Source	Available from
HMRC, 2014	http://www.hmrc.gov.uk/rates/landfill-tax.htm
WRAP, 2013	http://www.wrap.org.uk/sites/files/wrap/Gate_Fees_Report_2013_h%20%282%29.pdf
HGVUK, 2014	http://www.hgvuk.com/07/22/cost-of-fuel-per-mile-set-to-rise-for-hgvs/

Appendix 1: Direct Transfer Project Sustainability Assessment

Element	Category	Indicator	DoW CoP Option		Alternative Option (Dig & Dump)	
Environmental	Air	Emissions that may affect climate change or air quality or considerations that may allow overall reduction in impact on climate change e.g.: - Greenhouse gases (e.g. CO_2, CH_4, N_2O, O_3, VOCs, ozone depleting substances etc.) - NOx, SOx - Particulates (PM2.5, PM10)	-Mileage from donor to receiver (12.4mi) was 2.3miles less than the alternative Dig & Dump option. -Project team placed importance on minimising carbon footprint and traffic nuisance. -Carbon calculator was completed	-CO_2 emission = Est. 1,073 kg CO_2 -GHG emissions = Est. 1,287 kg CO_2e		-Mileage for the alternative option = 14.7miles which is greater than the DoW option -CO_2 emission = Est. 1,272 kg CO_2 -GHG emissions = Est. 1,525 kg CO_2e
			3		0	
	Soil & Ground Conditions	Changes in physical, chemical, biological soil condition that affects the ecosystem function, goods or services provided by soils (these may be improvements OR deteriorations). May include: - Soil quality (chemistry) - Water filtration and purification processes (inc. sediment generation or reduction) - Soil structure and/or organic matter content or quality - Erosion and soil stability (inc. drainage) - Geotechnical properties (inc. compaction) - Impact/benefits to sites of special geological interest e.g. SSSIs and geoparks - Conservation/Environmental Management/Ecology	-Flood defence works taking place are a requirement of the Environment Agency (EA) to reduce local flood risk and improve soil and ground conditions -Materials imported have been tested and are geotechnically and chemically coherent to those at receiver site. Locally sourced clay so the same as that on Receiver Site. -Environmental Action Plan was completed. -The material being brought in through the DoW CoP is clean naturally occurring material and must show this in documentation prior to transfer		-Material imported may be tested to prove suitability.	-There is no requirement to submit or carry out donor site investigations for landfill -This option does not follow CLR11 -Material brought in may be clean but may not be naturally occurring
			4		0	

*Note: Green text indicates factors which are considered to be the same under both DoW CoP and Dig & Dump therefore cancel each other out and are not considered in the scoring system. Nonetheless, it was important to note these factors as they often demonstrated a high standard of works and often related to remediation at the Hub site which was a large part of the project.

Appendix 1: Direct Transfer Project Sustainability Assessment

Element	Category	Indicator	DoW CoP Option		Alternative Option (Dig & Dump)	
Environmental	Natural Resources & Waste	Impacts/benefits for: - Land and waste resources - Use of primary resources and substitution of primary resources within the project or external to it (including raw and recycled aggregates) - Use of energy/fuels taking into account their type/origin and the possibility of generating renewable energy by the project - Handling of materials on-site, off-site and waste disposal resources - Water abstraction, use and disposal	-DoW CoP encourages reuse of resources (excavated material): -Reduced use of raw material/natural resources. -Less strain is put on landfill (waste resource) where space is increasingly limited -Use of fuels/energy is more efficient in the DoW CoP option (see Appendix 2)			-Landfill option does not encourage reuse of resources and materials: -Potential strain put on local aggregate and building resources suppliers -Strain put on landfill (waste resource) where space is becoming increasingly limited. -This option goes against DEFRA and governments aim to recover 70% of construction and demolition waste by 2020 (WFD, 2008; European Commission, 2012) -Use of fuels is less efficient with this option (323 litres compared with 262 litres for the DoW CoP)
			4		0	
		TOTAL SCORE	11		0	
		RESULT	✓		✗	

Appendix 1: Direct Transfer Project Sustainability Assessment

Element	Category	Indicator	DoW CoP Option		Alternative Option (Dig & Dump)	
Social	Human health & safety	Risk management performance of the project (long term) in terms of delivery of mitigation of unacceptable human health risks	-Without the DoW CoP (being the most viable option, as expressed by the project team) this project may not have gone ahead leading to increased flooding in the area, damage to properties, risk to human health and safety.			-Project may have been delayed under this option due to excessive financial costs for a small volume of material -Therefore risks from flooding would still exist in the local area.
			1		0	
		Risk management performance of project (short term) in terms of duration of remediation works, inc. consideration of: -Site workers, site neighbours and the public -Remediation works and ancillary operations (inc. process emissions such as bio-aerosols, allergens, PM10, impacts from operating machinery/traffic movements, excavation, etc.)	-This project took into consideration the performance of the project and the sustainability factors prior to bringing in new material. The decision to use the DoW CoP was based on the fact that there would be less traffic movements, carbon emissions.		-The aggregate supplier is very close (2.7 miles) from the Receiver Site so potentially bigger loads could have been brought in, quicker time-scales etc.	
			1		1	

Appendix 1: Direct Transfer Project Sustainability Assessment

Element	Category	Indicator	DoW CoP Option		Alternative Option (Dig & Dump)	
Social	Neighbourhood & locality	Impacts/benefits to local areas (tangible amenity changes), including: -Effects from dust, light, noise, odour and vibrations during works and associated with traffic, including both working-day and night/weekend operations	- An assessment of the effects of site works on locals and neighbours was done	-The vehicle journey from Donor to Receiver goes through quite heavily populated areas, large towns which could cause traffic disruptions. In comparison to the journey from the aggregate supplier to the receiver site which is 2.7 miles, this journey under the DoW CoP may affect more people (dust, noise, vibrations and vehicle emissions).		-Slightly more miles travelled with this option and twice as many journeys to be made therefore there may be more dust, noise and traffic pollution causing disruption to the local area. -Figure 2 shows that using this option would require vehicle movements over a wider geographical area spreading dust, noise and vehicle emission pollution.
			1		0	
	Uncertainty & evidence	Robustness of sustainability appraisal for each option considered	-This project considered sustainability factors before making a decision of which soils management option to use. The DoW CoP was chosen because fewer miles were travelled reducing carbon emissions and traffic nuisance. Financially, it was "the only practical option".			
			1		0	
		-Quality of investigation, assessments (inc. sustainability) and plans, and their ability to cope with variation. Accuracy of record taking and storage.	-Ground investigation carried out at donor site so better information about incoming material available. -Soil samples taken at donor site to test suitability -BS 5930 (1999) procedures followed -The information gathered is maintained for future reference			-No extensive investigation of ground/site needs to take place in order to landfill material - simple check against WAC.
			4		0	
		-Requirements for validation/verification	-A verification plan and report is required for this option, showing an auditable trail of work and that work has followed the objectives outlined in the design strategy.		-No verification plan required under this option	-No verification required so project does not have the ability to learn and improve from its work, as well as track the process of works
			1		1	

Appendix 1: Direct Transfer Project Sustainability Assessment

Element	Category	Indicator	DoW CoP Option		Alternative Option (Dig & Dump)	
Social		-Degree to which robust site-specific risk-based remedial criteria are established (justified & realistic CSM versus unnecessarily conservative and/or precautionary assumptions/data)	-Site specific risk assessment is done so that there is a better understanding of the conditions at the site and material being brought in can be geotechnically and chemically suitable.		-A risk assessment is not required/needed under this option	-No risk assessment required – the aggregate supplier provides the material needed. This may lead to complications if the ground at the Receiver Site is not properly understood.
			1		1	
		TOTAL SCORE	10		3	
		RESULT	✓		✗	

Appendix 1: Direct Transfer Project Sustainability Assessment

Element	Category	Indicator	DoW CoP Option		Alternative Option (Dig & Dump)	
Economic	Direct Economic Costs & Benefits	-Direct financial costs and benefits of remediation for organisation	-This project has saved an estimated £71,297 by using the DoW CoP -Est. £504 in fuel costs. -Est. £70,793 from landfill fees and removing the need to buy new material. -Half the number of vehicle journeys so less time spent on roads = less money	-Estimated fuel cost = £2,718		-Increased cost to the project from having to landfill material AND buy from local aggregate supplier rather than receive it free from a donor site. -Total cost of land-filling and buying new material estimated to be £72,188 -Estimated fuel cost = £3,223
			4		0	
		-Consequences of capital and operation costs, and sensitivity to alteration e.g.: -Costs associated with the works (inc. operation and any ongoing monitoring, regulator costs, planning, permits licences) -Uplift in site value to facilitate future development or investment	-Flood defence works improve or maintain the site value and value of local area	-Planning costs relatively high for the small volume of material imported under the DoW		
			1		0	
		-Liability discharge	-Average cost of houses in this area is £200,000 (http://www.home.co.uk/guides/house_prices_report.htm?location=stanwell&lastyear=1) - flood protection is able to go ahead more quickly under the DoW CoP and save further damage to local properties.			-If the project was left incomplete due to financial costs under this option being too high, the local area and the receiver site would have a great number of long term risks related to flooding. -The local property prices may decrease due to the flood risk and no safety measures in place
			1		0	

Appendix 1: Direct Transfer Project Sustainability Assessment

Element	Category	Indicator	DoW CoP Option		Alternative Option (Dig & Dump)	
Economic	Project Lifespan & Flexibility	-Duration of the risk management (remediation) benefit)				
			0		0	
		-Factors affecting chances of success of the remediation works and issues that may affect works, inc. community, contractual, environmental, procurement and technological risks	-DoW CoP was the only practical option due to restrictions and prices surrounding other waste permits. -DoW CoP allows flexibility around material movements i.e. projects can work to each other's time scales and compromise on when to transfer material, how quickly, how much at a time etc. -Through the DoW CoP the project at the Receiver Site has gained a new 'contact' within the industry - the Donor Site. This may encourage future liaising and success of further projects. Both parties have increased their network within industry which could help them at another time.		-This option allows little flexibility. The project would have to bring new material in under the rules at the aggregate supplier. They may have particular working hours which do not always fit with the hours at the Receiver Site, and there would be less compromise on this. -In comparison to the DoW CoP this project does encourage different companies and projects to liaise with each other. Each party would work alone and not networking.
			3		0	
		-Ability of project to respond to changing circumstances, including discovery of additional contamination/material, different soil materials, or time-scales	-More flexibility with the DoW CoP e.g. the project was reusing material on-site under a waste permit. The need for more material arose midway through the project, at which point the decision to bring material in under the DoW CoP was made.		-Less flexibility than DoW option	
			1		0	
		TOTAL SCORE	10		0	
		RESULT	✓		✗	

DT Appendix 2: Project Calculations using the DoW CoP		
Haulage route donor site to receiver site	12	miles (mi)
Volume of material being reused	1,250	cubic metres (m3)
Est. weight (assuming 1.5 multiplier, source: HMRC)	1,875	tonnes (ton.)
Ave. capacity of an 8 wheel 4 axle road truck (source: *) 100% l	19.5	tonnes (ton.)
Est. number of journeys made from Donor to Receiver	96	
Multiply by 2 for return journey	192	
Est. miles travelled at 0% laden	1,192	miles (mi)
Est. miles travelled at 100% laden	1,192	miles (mi)
Total	**2,385**	**miles (mi)**
Est. fuel cost at £1.14 per mile. (source: HGVUK, 2014)	2,718	pounds (£)
Ave. fuel consumption at 0% laden	3.2	miles per litre (MPL)
Ave. fuel consumption at 100% laden	1.7	miles per litre (MPL)
Est. fuel consumption at 0% laden	373	litres (l)
Est. fuel consumption at 100% laden	701	litres (l)
Total	**1,074**	**litres (l)**

*Information on capacity, size and type of road and dump trucks was collected from CL:AIRE industry members

Source	Available from
Defra, 2013	http://archive.defra.gov.uk/environment/business/reporting/pdf/110819-guidelines-ghg-conversion-factors.pdf
HMRC	http://www.hmrc.gov.uk/rates/landfill-tax.htm
HGVUK, 2104	http://www.hgvuk.com/07/22/cost-of-fuel-per-mile-set-to-rise-for-hgvs/
Department for Transport	Coyle. M, 2007. Effects of payload on the fuel consumption of trucks. Research for the Department for Transport (DfT) funded through the Department for Environment, Food and Rural Affairs (Defra) Aggregate Levy Sustainability Fund (ALSF).

DT Appendix 3: Greenhouse Gas emissions using the DoW CoP								
					Air Quality gases			
	CO2	CH4	N2O	Total GHG	NOx	SO2	PM10	PM2.5
	(kg co2)	(kg co2e)	(kg co2e)	(kg co2e)	(kg)	(kg)	(kg)	(kg)
Ave. GHG emitted at 0% laden per vehicle mile	0.42	0.0002	0.0048	0.50				
Ave. GHG emitted at 100% laden per vehicle mile	0.48	0.0002	0.0048	0.58	0.002025	0.000002	0.000033	0.000032
Est. GHG emitted at 0% laden	501	0.26	5.73	599				
Est. GHG emitted at 100%	572	0.26	5.73	688	4.83	0.01	0.08	0.08
Est. total GHG emitted	1,073	0.52	11.46	1,287	4.83	0.01	0.08	0.08

Source	Available from
Defra, 2013	http://archive.defra.gov.uk/environment/business/reporting/pdf/110819-guidelines-ghg-conversion-factors.pdf
Defra, 2011	http://naei.defra.gov.uk/data/ef-transport

DT Appendix 4: Project Calculations using Dig & Dump		
Donor site to landfill distance	12	miles(mi)
Aggregate supplier - Receiver distance	3	miles(mi)
Total	**15**	
Volume of material being reused	1,250	cubic metres (m3)
Estimated volume in tonnes (assuming 1.5 multiplier, source: HMRC, 2014)	1,875	
Average capacity of an 8 wheel 4 axle road truck 100% laden (source: *)	19.5	tonnes (ton.)
Est. number of journeys made from Donor Site - Landfill	96	
Est. number of journeys made from aggregate supplier -Receiver Site	96	
Total	**192**	
Multiply by 2 for return journey	385	
Est. total distance to take all material from Donor site to landfill	2,308	miles (mi)
Est. total distance to take all material and bring new material from aggregate supplier to Site of Origin	577	miles (mi)
Total	**2,885**	**miles (mi)**
Est. miles travelled at 0% laden	1,442	miles (mi)
Est. miles travelled at 100% laden	1,442	miles (mi)
Average fuel consumption at 0% laden	3.2	miles per litre (MPL)
Average fuel consumption at 100% laden	1.7	miles per litre (MPL)
Est. fuel consumption for this project at 0% laden	451	litres (l)
Est. fuel consumption for this project at 100% laden	848	litres (l)
Total	**1,299**	**litres (l)**

*Information on capacity, size and type of road and dump trucks was collected from CL:AIRE industry members

Source	**Available from**
Defra, 2011	http://naei.defra.gov.uk/data/ef-transport
Defra, 2013	http://archive.defra.gov.uk/environment/business/reporting/pdf/110819-guidelines-ghg-conversion-factors.pdf
HMRC	http://www.hmrc.gov.uk/rates/landfill-tax.htm
Department for Transport	(DfT)

DT Appendix 5: Greenhouse Gas emissions using Dig & Dump

					Air Quality gases			
	CO2	CH4	N2O	Total GHG	NOx	SO2	PM10	PM2.5
	(kg co2)	(kg co2e)	(kg co2e)	(kg co2e)	(kg)	(kg)	(kg)	(kg)
Ave. GHG emitted at 0% laden per vehicle mile	0.4200	0.0002	0.0048	0.5020				
Ave. GHG emitted at 100% laden per vehicle mile	0.4800	0.0002	0.0048	0.5770	0.002025	0.000002	0.000033	0.000032
Est. tptal GHG emitted at 0% laden	606	0.32	6.93	724				
Est. total GHG emitted at 100% laden	692	0.32	6.93	832	5.841	0.007	0.095	0.091
Est. total GHG emitted	1,298	0.63	13.86	1,556	5.841	0.007	0.095	0.091

Source	Available from
Defra, 2013	http://archive.defra.gov.uk/environment/business/reporting/pdf/110819-guidelines-ghg-conversion-factors.pdf
Defra, 2011	http://naei.defra.gov.uk/data/ef-transport

DT Appendix 6: Financial costs using Dig & Dump		
Volume of material being reused	1,250	cubic metres (m3)
Est. volume in tonnes (assuming 1.5 multiplier, source: HMRC,	1,875	tonnes (ton.)
Avg. non hazardous gate fee in 2012 per tonne (source: WRAP,	21	pounds (£)
Avg. non hazardous landfill tax in 2012 per tonne (source: HMR	2.5	pounds (£)
Gate fee cost to project	39,375	pounds (£)
Landfil tax cost to project	4,688	pounds (£)
Total landfill costs to project	**44,063**	pounds (£)
Avg. cost of new material per tonne	15	pounds (£)
Total cost of new material for project	**28,125**	pounds (£)
Total landfill + new material costs to this project	**72,188**	pounds (£)
Est. fuel costs at £1.14 per mile. (source: HGVUK, 2014)	3,288	pounds (£)

Source	Available from
HMRC, 2014	http://www.hmrc.gov.uk/rates/landfill-tax.htm
WRAP, 2013	http://www.wrap.org.uk/sites/files/wrap/Gate_Fees_Report_2013_h%20%282%29.pdf
HGVUK, 2014	http://www.hgvuk.com/07/22/cost-of-fuel-per-mile-set-to-rise-for-hgvs/

Element	Category	Indicators	DoW CoP Option		Alternative Option (Dig & Dump)	
Environmental	Air	Emissions that may affect climate change or air quality, or considerations that may allow overall reduction in impact on climate change e.g.: - Greenhouse gases (e.g. CO_2, CH_4, N_2O, O_3, VOCs, ozone depleting substances etc.) - NOx, SOx - Particulates (PM2.5, PM10)	-Comprehensive management of materials throughout works to minimise risk of gas generation in accordance with landfill gas management plan. -Est. 5,944 Kg CO_2 saved by using DoW CoP instead of Dig & Dump. -Est. 7,132 Kg CO_2e of Greenhouse Gases saved by using DoW CoP instead of Dig & Dump. -Extensive information on dust and odour generation including rose plots showing wind direction and dispersion of dust.	-Odour and dust emissions from remediation activities. -The project has estimated there will be 200 more HGV movements on local roads per day.	-It is assumed that similar information and monitoring would be available for dust and odour under the Dig & Dump option, where on-site treatment would most likely still take place. -It is also assumed that a gas management would be done under Dig & Dump as treatment would still take place.	-Est. 5,944 Kg CO_2 more emitted under this option. -1,533 more vehicle journeys under the Dig & Dump option
			3		1	
	Soil & ground conditions	Changes in physical, chemical, biological soil condition that affects the ecosystem function, goods or services provided by soils (these may be improvements OR deteriorations). May include: - Soil quality (chemistry) - Water filtration and purification processes (inc. sediment generation or reduction) - Soil structure and/or organic matter content or quality - Erosion and soil stability (inc. drainage) - Geotechnical properties (inc. compaction) - Impact/benefits to sites of special geological interest e.g. SSSIs and geoparks - Conservation/ Environmental Management/ Ecology	-Excavation and treatment of former landfill - improving current ground conditions. -Ground quality improvement works include: excavation of wastes from biodegradable landfills, physical processing, soil washing, soil treatment. -Ecological Impact Assessment prepared which highlights management controls and mitigation measure e.g. 3 tree preservation orders, river exclusion zone, reptile fencing. -The difference with using DoW CoP is that material is locally sourced from another site and has to be proven to be geotechnically and geochemically suitable for use at the Hub site, therefore soils may be more compatible and less prone to future geological problems.	-Soil washing produces contaminated sludge - further management for this required.	-It is assumed that on-site treatment would take place under the Dig & Dump because excavating almost 400,000m^3 of material and sending it all to landfill would not have been financially possible therefore the following still apply under this option: -Excavation and treatment of former landfill - improving current ground conditions. -Ground quality improvement works include: excavation of wastes from biodegradable landfills, physical processing, soil washing, soil treatment. -Ecological Impact Assessment prepared which highlights management controls and mitigation measure e.g. 3 tree preservation orders, river exclusion zone, reptile fencing.	-New material is bought from a supplier which may not be as geotechnically and chemically matched to the material at the Hub site as if material was locally sourced under DoW CoP. -In order to find supplier with suitable material, there may be a need to travel further increasing mileage -Soil washing produces contaminated sludge - further management for this required.
			1		0	

*Note: Green text indicates factors which are considered to be the same under both DoW CoP and Dig & Dump therefore cancel each other out and are not considered in the scoring system. Nonetheless, it was important to note these factors as they often demonstrated a high standard of works and often related to remediation at the Hub site which was a large part of the project.

Indicator	Category	Issues to Consider	DoW CoP Option		Alternative Option (Dig & Dump)	
Environmental	Natural resources & waste	Impacts/benefits for: - Land and waste resources - Use of primary resources and substitution of primary resources within the project or external to it (including raw and recycled aggregates) - Use of energy/fuels taking into account their type/origin and the possibility of generating renewable energy by the project - Handling of materials on-site, off-site and waste disposal resources - Water abstraction, use and disposal	-Leachate removal from landfill waste during excavation - protection of ground and surface water as well as soils. -Less strain on landfill -Less strain on aggregate supplier -This option supports Defra and governments aim to recover 70% of construction and demolition waste by 2020 (European Commission, 2012)	-Off-site disposal for materials not suitable for reuse on-site -there is still disposal to landfill taking place under this option, not all is being reused. -Remediation methods e.g. Soil washing requires water treatment plant - strain on local water resources.	-Leachate removal from landfill waste during excavation - protection of ground and surface water as well as soils.	-Strain on local aggregate suppliers for material -Strain on landfills -This option goes against DEFRA and governments aim to recover 70% of construction and demolition waste by 2020 (European Commission, 2012)
			3		0	
		TOTAL SCORE	7		1	
		RESULT	✓		✗	

Indicator	Category	Issues to Consider	DoW CoP Option		Alternative Option (Dig & Dump)	
Social	Human health & safety	Risk management performance of the project (long term) in terms of delivery of mitigation of unacceptable human health risks	-Environmental management, control and monitoring taking place after works- working to best practice and ensuring future risks are controlled and minimised	-Soil washing produces fines (a large quantity of these would reduce the efficiency of the remediation process).	-In terms of risk management, the two options are fairly equal as they would both entail remediation on-site and new material brought in for the same end use. The project documents outline good risk management e.g. environmental control, management and monitoring and it is assumed that the same practices would be used under the Dig & Dump.	-More vehicle movements through populated areas, affecting a wider area with traffic and pollution -Soil washing produces fines (a large quantity of these would reduce the efficiency of the remediation process).
			1		1	
		Risk management performance of project (short term) in terms of duration of remediation works, inc. consideration of: -Site workers, site neighbours and the public -Remediation works and ancillary operations (inc. process emissions such as bio-aerosols, allergens, PM10, impacts from operating machinery/traffic movements, excavation, etc.)	-Comprehensive management of materials throughout works to minimise risk of gas generation in accordance with landfill gas management plan, minimising short term risk. -A phased approach to remediation works taken - site divided up into sections and different phases of work. Smaller sections are easier to handle and manage increasing safety of workers and performance of project. Phased approach will allow for construction to commence at the earliest opportunity, reducing overall time-scales of the project. -Each of the 3 phases is further split into 7 different cells of land so that remediation is carried out in manageable cells. -Max 10 vehicle movements per day - ensuring worker and site safety - provides realistic timetable so works can be done on time		-Comprehensive management of materials throughout works to minimise risk of gas generation in accordance with landfill gas management plan, minimising short term risk. -A phased approach to remediation works taken - site divided up into sections and different phases of work. Smaller sections are easier to handle and manage increasing safety of workers and performance of project. Phased approach will allow for construction to commence at the earliest opportunity, reducing overall time-scales of the project.-Each of the 3 phases is further split into 7 different cells of land so that remediation is carried out in manageable cells. -Max 10 vehicle movements per day - ensuring worker and site safety - provides realistic timetable so works can be done on time -This option may require less careful management/fewer site workers to do the excavation/ removal. -Lower risk of accidents and congestion as there's less on-site activity	
			0		2	

Indicator	Category	Issues to Consider	DoW CoP Option		Alternative Option (Dig & Dump)	
Social	Neighbourhood & locality	Impacts/benefits to local areas (tangible amenity changes), including: -Effects from dust, light, noise, odour and vibrations during works and associated with traffic, including both working-day and night/weekend operations	-Topsoils and subsoils stripped and placed as berms with seeded grass around the soil treatment site - improving visual surroundings and reducing noise and dust for local community. -Public liaison taking place after works. -Plant store located in the centre of site - as far as possible from sensitive residential noise receptors. -Vehicle movements limited to 10 per day decreasing traffic congestion on and around site. -Agreed haulage route so vehicles only use major roads in the area and do not block small roads and vehicles not operating during school and work rush hours. -Vegetation stripped back and stockpiled (for later composting) - act as noise barrier around site. -Less vehicle journeys than Dig & Dump therefore decreased project time-scales and public disturbance	-Remediation activities can be noisy and take a longer time than just excavating and removing material	-Topsoils and subsoils stripped and placed as berms with seeded grass around the soil treatment site - improving visual surroundings and reducing noise and dust for local community. -Public liaison taking place after works. -Plant store located in the centre of site - as far as possible from sensitive residential noise receptors. -Vehicle movements limited to 10 per day decreasing traffic congestion on and around site. -Agreed haulage route so vehicles only use major roads in the area and do not block small roads and vehicles not operating during school and work rush hours. -Vegetation stripped back and stockpiled (for later composting) - act as noise barrier around site.	-1,533 more vehicle journeys under this option therefore project time-scales may be longer and cause more public disturbance
			1		0	

Indicator	Category	Issues to Consider	DoW CoP Option		Alternative Option (Dig & Dump)	
Social	Uncertainty & evidence	Robustness of sustainability appraisal for each option considered				
			0		0	
		-Quality of investigation, assessments (inc. sustainability) and plans, and their ability to cope with variation. Accuracy of record taking and storage.	-Remediation validation report written in accordance with CLR11 Model Procedures -Prior to commencement of works, a number of documents e.g. tracking system and contingency plan were prepared which are a requirement under the DoW CoP and aim to provide more certainty and evidence to the project. -Additional site investigation was done and in the case of this project it confirmed the absence of biodegradable waste which was not confirmed in the first site investigation - extra information and working to best practice is encouraged by the DoW CoP. -Soil audit undertaken - audit able system of materials reuse – this is a form of tracking system which is a requirement of the DoW CoP and is beneficial to the project to systematically track the works. -Extensive investigation prior to works commencing e.g. establishment of welfare and compound area, site survey, site clearance, organising waste processing and stockpiling areas, temporary haul road construction, temporary lagoon construction, additional site investigation, topographic survey	-Documents such as a tracking system may not be required under Dig & Dump due to the simplicity of the process. -Extensive investigation prior to works commencing e.g. establishment of welfare and compound area, site survey, site clearance, organising waste processing and stockpiling areas, temporary haul road construction, temporary lagoon construction, additional site investigation, topographic survey	-Project documentation may not be as extensive under Dig & Dump as the detail is not required. In comparison the DoW CoP forces projects to have a wide variety of information that is also of high quality (best practice)
			4		1	

Indicator	Category	Issues to Consider	DoW CoP Option		Alternative Option (Dig & Dump)	
Social	Uncertainty & evidence	-Requirements for validation/ verification	-Materials reinstated in accordance with Earthworks Specification. -Validation requirements for project include: validation of excavations, TOC validation of reinstated materials, chemical and geotechnical validation. Incoming materials may be under higher scrutiny under DoW CoP to ensure on appropriate materials are reused. -The DoW CoP specifically requires there to be a verification plan and verification report (these are sections of the MMP) so it is a compulsory requirement of the DoW CoP whereas it is not under Dig & Dump		-Validation/verification would probably not be necessary under Dig & Dump for the landfilled and imported material however some form of verification would most likely be in place after treatment. -Materials reinstated in accordance with Earthworks Specification.	-No verification required so project has less ability to learn and improve from its work, as well as track the process of works
			2		1	
		-Degree to which robust site-specific risk-based remedial criteria are established (justified & realistic CSM versus unnecessarily conservative and/or precautionary assumptions/data)	- DoW CoP encourages and requires site specific investigations to be done at the Donor site to prove that the material is suitable for reuse at the Hub site. The site investigation including testing and a desk top study would demonstrate how much of the stockpile is suitable to be reused. If there is no requirement to transfer the material and therefore no requirement to carry out such investigations, the material may all be sent to landfill as excess when in actual fact it is clean enough to be reused. Hence DoW CoP encourages the reuse of more material through its requirements for robust site specific investigation. -A post-remediation Conceptual Site Model was done in this project - robust approach which aids future redevelopment which may take place on this site -Hub site area split into sections or phases so that CSMs are more specific and representative of the site.		-Hub site area split into sections or phases so that CSMs are more specific and representative of the site.	-This option may be seen as unnecessarily precautionary and not site specific as clean material from Donor site is just sent to landfill rather than being reused.
			2		0	
		TOTAL SCORE	10		5	
		RESULT	✓		✗	

Indicator	Category	Issues to Consider	DoW CoP Option		Alternative Option (Dig & Dump)	
Economic	Direct Economic Costs & Benefits	-Direct financial costs and benefits of remediation for organisation	-Est. financial costs would be £65,638 compared with £1,222,115 million under the Dig & Dump. These costs include DoW CoP training, Qualified Person fee, transport costs and landfill/new material taxes and fees. Using DoW CoP could save approximately £1,156,477 - of this £697,562 saved in landfill tax and gate fees	-Cost of remediation: excavation, physical processing, soil washing, soil treatment, reinstatement and re-profiling -Maximum of 10 vehicle movements per day limiting project and increasing time-scales and duration of works. More time = more money. -Environmental Permit cost required to have a treatment hub on-site. -Cost of Qualified Person and DoW CoP training		-Using Dig & Dump for this project would cost the project teams an estimated £1,222,115 -Cost of remediation: excavation, physical processing, soil washing, soil treatment, reinstatement and re-profiling -Maximum of 10 vehicle movements per day limiting project and increasing time-scales and duration of works. More time = more money. -Environmental Permit cost required to have a treatment hub on-site. -Cost of new material= £445,253
			2		0	
		-Consequences of capital and operation costs, and sensitivity to alteration e.g.: -Costs associated with the works (inc. operation and any ongoing monitoring, regulator costs, planning, permits licences) -Uplift in site value to facilitate future development or investment	-Est. financial costs would be £65,638 compared with £1,222,115 million under the Dig & Dump. These costs include DoW CoP training, Qualified Person fee, transport costs and landfill/new material taxes and fees. Using DoW CoP could save approximately £1,156,477 - of this £697,562 saved in landfill tax and gate fees	-Cost of remediation: excavation, physical processing, soil washing, soil treatment, reinstatement and re-profiling -Maximum of 10 vehicle movements per day limiting project and increasing time-scales and duration of works. More time = more money. -Environmental Permit cost required to have a treatment hub on-site. -Cost of Qualified Person and DoW CoP training		-Using Dig & Dump for this project would cost the project teams an estimated £1,222,115 -Cost of remediation: excavation, physical processing, soil washing, soil treatment, reinstatement and re-profiling -Maximum of 10 vehicle movements per day limiting project and increasing time-scales and duration of works. More time = more money. -Environmental Permit cost required to have a treatment hub on-site. -Cost of new material= £445,253
			1		1	
		-Liability discharge	-Lots of investigation and assessment done prior to works including additional site investigation saving money in the long term (i.e. less monitoring) and liability to further works			-If the project was left incomplete due to financial costs under this option being too high, the local area and the receiver site would have a great number of long term risks related to flooding. -Potential for high disposal costs to delay or restrict the project.
			1		0	

SO Appendix 1: Cluster Type Project Sustainability Assessment

Indicator	Category	Issues to Consider	DoW CoP Option		Alternative Option (Dig & Dump)	
Economic	Project Lifespan & Flexibility	-Duration of the risk management (remediation) benefit)				
			0		0	
		-Factors affecting chances of success of the remediation works and issues that may affect works, inc. community, contractual, environmental, procurement and technological risks	-This project encourages different project teams and companies to liaise with each other and form relationships. This could be useful in future if further join work is needed or simply boosting networking opportunities for companies. There could also be a potential to link other sites to the project.			
			1		0	
		-Ability of project to respond to changing circumstances, including discovery of additional contamination/material, different soil materials, or time-scales	-Cluster project under the DoW CoP is flexible, allowing donor sites to be added to the project at different times. -The DoW CoP offers more flexibility to the Donor site in the event that surplus materials were identified or if contaminant impacted materials were encountered.		-Project would be fairly inflexible under the Dig & Dump - would have to work to the time-scales of the landfill and aggregate supplier. - In the event of changing volume requirement, new material would be a significant extra cost and require transport to landfill - unexpected costs like this could have negative impacts on project time-scales and success.	
			2		0	
		TOTAL SCORE	7		1	
		RESULT	✓		✗	

Cluster Appendix 2: Project Calculations using the DoW CoP		
Fixed known values - known from either external sources or project documents		
Volume of material excavated on-site	383,337	cubic metres (m3)
In tonnes	575,006	tonnes (ton.)
TOTAL material available on-site	374,633	cubic metres (m3)
In tonnes	561,950	tonnes (ton.)
Total volume of material brought in from donor	19,789	cubic metres (m3)
In tonnes	29,684	tonnes (ton.)
TOTAL material reused inc. on-site material and that from donor site	**394,422**	**cubic metres (m3)**
Total weight of material	**591,633**	**tonnes (ton.)**
Ave. weight capacity - 8 wheel 4 axle road truck (source: *) 100% laden	19.5	tonnes (ton.)
Ave. capacity - on-site dump truck (tonnes) (source: *) 100% laden	22	tonnes (ton.)
Donor - Hub mileage (off-site mileage)		
Haulage route from Donor site to Hub site	9.2	miles (mi)
Est. number of journeys made from Donor to Hub Site	1,522	
Multiply by 2 for return journey	3,044	
Est. miles travelled at 0% laden	14,005	miles (mi)
Est. miles travelled at 100% laden	14,005	miles (mi)
Total miles from Donor to Hub site	**28,009**	**miles (mi)**
Hub site (on-site mileage)		
Length of Hub Site	850	metres (m)
Width of Hub Site	260	metres (m)
Length of Hub Site	0.53	miles (mi)
Width of Hub Site	0.16	miles (mi)
Area of Hub Site	0.08	square miles (mi ^2)
Est. number of journeys made on-site	26,892	
Multiply by 2 for return journey	53,785	
Est. TOTAL miles travelled on Hub Site (length of site assumed)	**28,345**	**miles (mi)**
Est. miles at 0% laden	14,172	miles (mi)
Est. miles at 100% laden	14,172	miles (mi)
Combining on-site and off-site mileage for TOTAL project mileage		
Total no. of vehicle journeys for this project	**56,829**	
Total miles travelled for this project	**56,354**	**miles (mi)**
Est. total miles at 0% laden	28,177	miles (mi)
Est. total miles at 100% laden	28,177	miles (mi)
Fuel cost and consumption		
Est. fuel cost at £1.14 per mile. (source: HGVUK, 2014)	64,243	pounds (£)
Ave. fuel consumption of road truck at 0% laden	3.2	miles per litre (MPL)
Ave. fuel consumption of road truck at 100% laden	1.7	miles per litre (MPL)
Est. fuel consumption for road trucks for this project at 0% laden	4,376	litres (l)
Est. fuel consumption for road trucks for this project at 100% laden	8,238	litres (l)
Total	12,614	litres (l)
Ave. fuel consumption of on-site truck at 0% laden	0.31	litres per mile (LPM)
Ave. fuel consumption of on-site truck at 100% laden	0.59	litres per mile (LPM)
Est. fuel consumption at 0% laden	4,429	litres (l)
Est. fuel consumptionat 100% laden	8,337	litres (l)
Total	12,765	litres (l)
Total fuel consumption for project	**25,380**	**litres (l)**

*Information on capacity, size and type of road and dump trucks was collected from CL:AIRE industry members

Source	Available from
Defra, 2013	http://archive.defra.gov.uk/environment/business/reporting/pdf/110819-guidelines-ghg-conversion-factors.pdf
HMRC	http://www.hmrc.gov.uk/rates/landfill-tax.htm
HGVUK, 2014	http://www.hgvuk.com/07/22/cost-of-fuel-per-mile-set-to-rise-for-hgvs/
Department for Transport	Coyle. M, 2007. Effects of payload on the fuel consumption of trucks. Research for the Department for Transport (DfT)

Cluster Appendix 3: Greenhouse Gas emissions using the DoW CoP

					Air Quality gases			
	CO2	CH4	N2O	Total GHG	NOx	SO2	PM10	PM2.5
	(kg co2)	(kg co2e)	(kg co2e)	(kg co2e)	(kg)	(kg)	(kg)	(kg)
Ave. GHG emitted per mile at 0% laden (Defra)	0.42	0.0002	0.0048	0.5				
Ave. GHG emitted per mile at 100% laden (Defra)	0.48	0.0002	0.0048	0.58	0.002025	0.000002	0.000033	0.000032
Est. GHG emitted at 0% laden	11,834	6	135	14,088				
Est. GHG emitted at 100% laden	13,525	6	135	16,343	114	0.14	1.85	1.78
Est. total GHG emitted	**25,359**	**11**	**270**	**30,431**	114	0.14	1.85	1.78

Source	Available from
Defra, 2013	http://archive.defra.gov.uk/environment/business/reporting/pdf/110819-guidelines-ghg-conversion-factors.pdf
Defra, 2011	http://naei.defra.gov.uk/data/ef-transport

Cluster Appendix 4: Project Calculations using Dig & Dump		
Haulage route Donor site to Landfill	8.5	miles (mi)
Haulage route Hub site to Landfill	10.5	miles (mi)
Haulage route Aggregate Supplier to Hub site	5.3	miles (mi)
Total	24.3	miles (mi)
Material that would have been sent to landfill		
Material from donor that would have been sent to landfill	19,789	cubic metres (m3)
Total weight of material that would have been sent to landfill - Dig & Dump	**29,684**	**tonnes (ton.)**
Assumption - Donor site does not need anymore material -disposal only. Dig & Dump - Hub site excavates, treats and reuses the same amount of material as with the DoW CoP. Hub site would require material from aggregate supplier using Dig & Dump (e.g material it would have got from the Donor - DoW CoP)		
Material excavated, treated and reused on Hub site	383,337	cubic metres (m3)
In tonnes	575,006	tonnes (ton.)
Material that would have been bought from aggregate supplier		
New material that would have been required at Hub site	19,789	cubic metres (m3)
In tonnes	**29,684**	**tonnes (ton.)**
Ave. capacity - 8 wheel 4 axle road truck (source: *) 100% laden	19.5	tonnes (ton.)
Ave. capacity - on-site dump truck (tonnes) (source: *) 100% laden	22	tonnes (ton.)
Off-site Mileage		
Est. number of journeys - Donor to Landfill	1,522	
Multiply by 2 for return journey	3,044	
Est. number of miles - Donor to Landfill	**25,878**	**miles (mi)**
Est. number of journeys made - Aggregate Supplier to Hub site	1,522	
Multiply by 2 for return journey	3,044	
Est. number of miles from Aggregate Supplier to Hub site	**16,136**	**miles (mi)**
On-site Mileage		
Length of Hub Site	850	metres (m)
Width of Hub Site	260	metres (m)
Length of Hub Site	0.53	miles (mi)
Width of Hub Site	0.16	miles (mi)
Area of Hub Site	0.08	square miles (mi ^2)
Est. number of journeys made on site - Dig & Dump	26,137	
Multiply by 2 for return journey	52,273	
Est. TOTAL miles travelled on Hub Site (max. distances assumed)	**27,548**	**miles (mi)**
Est. miles at 0% laden	13,774	miles (mi)
Est. miles at 100% laden	13,774	miles (mi)
Combined on-site and off-site mileage to give TOTAL project mileage		
Total number of vehicle journeys - Dig & Dump	**58,362**	
Total miles travelled - Dig & Dump	**69,562**	**miles (mi)**
Est. miles travelled at 0% laden	34,781	miles (mi)
Est. miles travelled at 100% laden	34,781	miles (mi)
Fuel cost and consumption		
Est. fuel cost at £1.14 per mile. (HGVUK, 2014)	79,300	pounds (£)
Average fuel consumption at 0% laden for road truck	3.2	miles per litre (MPL)
Average fuel consumption at 100% laden for road truck	1.7	miles per litre (MPL)
Est. fuel consumption for road trucks for this project at 0% laden	6,565	Litres (l)
Est. fuel consumption for road trucks for this project at 100% laden	12,357	Litres (l)
Total road truck fuel consumption	**18,922**	**Litres (l)**
Average fuel consumption of on-site truck at 0% laden	0.31	litres per mile (LPM)
Average fuel consumption of on-site truck at 100% laden	0.59	litres per mile (LPM)
Est. fuel consumption for this project at 0% laden	4,304	
Est. fuel consumption for this project at 100% laden	8,102	
Total on-site truck fuel consumption	**12,407**	**Litres (l)**
Total fuel consumption for project	**31,328**	**Litres (l)**

*Information on capacity, size and type of road and dump trucks was collected from CL:AIRE industry members

Source	Available from
Defra, 2013	http://archive.defra.gov.uk/environment/business/reporting/pdf/110819-guidelines-ghg-conversion-factors.pdf
HMRC	http://www.hmrc.gov.uk/rates/landfill-tax.htm
Department for Transport	Coyle. M, 2007. Effects of payload on the fuel consumption of trucks. Research for the Department for Transport (DfT) .

Cluster Appendix 5: Greenhouse Gas emissions using Dig & Dump

						Air Quality gases			
		CO2	CH4	N2O	Total GHG	NOx	SO2	PM10	PM2.5
		(kg co2)	(kg co2e)	(kg co2e)	(kg co2e)	(kg)	(kg)	(kg)	(kg)
Ave. GHG emitted per mile at 0% laden (Defra)		0.42	0.0002	0.0048	0.50				
Ave. GHG emitted per mile at 100% laden (Defra)		0.48	0.0002	0.0048	0.58	0.002025	0.000002	0.000033	0.000032
Est. GHG emitted at 0% laden		14,608	7	167	17,390				
Est. GHG emitted at 100% laden		16,695	7	167	20,173	141	0.2	2	2.2
Est. total GHG emitted		**31,303**	**14**	**726**	**37,563**	141	0.2	2	2.2

(Figures rounded to appropriate decimal places)

Source	Available from
Defra, 2013	http://archive.defra.gov.uk/environment/business/reporting/pdf/110819-guidelines-ghg-conversion-factors.pdf
Defra, 2011	http://naei.defra.gov.uk/data/ef-transport

Cluster Appendix 6: Financial costs under Dig & Dump - Non hazardous material		
Volume of non-hazardous material	19,789	cubic metres (m3)
Est. volume in tonnes (assuming 1.5 multiplier, source: HMRC, 2014)	29,684	tonnes (ton.)
Avg. non hazardous gate fee in 2012 per tonne (source:WRAP, 2013)	21	pounds (£)
Avg. non hazardous landfill tax in 2012 per tonne (source:HMRC, 2014)	2.5	pounds (£)
Gate fee cost to project	623,354	pounds (£)
Landfil tax cost to project	74,209	pounds (£)
Total landfill costs to project	**697,562**	**pounds (£)**

Source	Available from
HMRC, 2014	http://www.hmrc.gov.uk/rates/landfill-tax.htm
WRAP, 2013	http://www.wrap.org.uk/sites/files/wrap/Gate_Fees_Report_2013_h%20%282%29.pdf
HGVUK, 2014	http://www.hgvuk.com/07/22/cost-of-fuel-per-mile-set-to-rise-for-hgvs/

Cluster Appendix 7: Financial costs of new material using Dig & Dump		
Avg. cost of new material per tonne (average price gathered from a number of quarry and aggregate sites)	15	pounds (£)
Total cost of new material for project	**445,253**	**pounds (£)**
TOTAL financial costs to project		
Total landfill + new material costs to this project	**1,142,815**	**pounds (£)**
Est. fuel costs at £1.14 per mile. (HGVUK, 2014)	**79,300**	**pounds (£)**
TOTAL haulage costs to this project under Dig & Dump (excluding haulage fee)	**1,222,115**	**pounds (£)**

(Figures rounded to appropriate decimal places)

Source	Available from
HMRC, 2014	http://www.hmrc.gov.uk/rates/landfill-tax.htm
WRAP, 2013	http://www.wrap.org.uk/sites/files/wrap/Gate_Fees_Report_2013_h%20%282%29.pdf
HGVUK, 2014	http://www.hgvuk.com/07/22/cost-of-fuel-per-mile-set-to-rise-for-hgvs/