Annex 2: Key recommendations and modelling for waste reduction

This Annex accompanies the SID5 report for the Defra funded project 'Understanding and Predicting Construction Waste' (WR0111). It focuses on waste modelling at a County level and a project level using the benchmarks that have been generated and providing recommendations based on this modelling.

County level modelling

As part of this project, Hertfordshire County Council was contacted in order to undertake some waste modelling on predicted residential development for 2001 to 2020. This would provide the Council with information on waste amounts and types, and provide interested parties with demonstrable evidence of how the benchmarks can be used to predict waste arisings and produce recommendations for waste management.

The East of England Plan Panel Report 2004[1] (submitted to the Secretary of State June 2006) gives recommendations on the development of housing from 2001 to 2021. The panel's recommendations for Hertfordshire are summarised in Table 1 below.

Area/District	H1 Panel	Number of dwellings recommended (5 year indicative phases)							
		2001-2006		2006-2011		2011-2016		2016-2021	
		2001-2006	per annum	2006-2011	per annum	2011-2016	per annum	2016-2021	per annum
Broxbourne	5,600	1,150	230	1,500	300	1,500	300	1,500	300
Dacorum	12,000	2,650	530	3,100	620	3,100	620	3,100	620
East Herts	12,000	2,500	500	3,150	630	3,150	630	3,150	630
Hertsmere	5,000	1,100	220	1,300	260	1,300	260	1,300	260
North Herts	7,800	2,550	510	1,750	350	1,750	350	1,750	350
St Albans	7,200	1,650	330	1,850	370	1,850	370	1,850	370
Stevenage	14,400	1,950	390	4,150	830	4,150	830	4,150	830
Three Rivers	4,000	1,100	220	950	190	950	190	950	190
Watford	5,200	1,000	200	1,400	280	1,400	280	1,400	280
Welwyn Hatfield	10,000	2,400	480	2,550	510	2,550	510	2,550	510
Hertfordshire	83,200	18,050	3,610	21,700	4,340	21,700	4,340	21,700	4,340

Table 1: Recommended housing development for Hertfordshire, 2001-2021

These figures can be used together with an assumption of the average floor area per dwelling and the performance indicator of m^3 waste per 100 m^2 of floor area to provide an estimate of the waste arising from the construction of these dwellings. It has been assumed that the average dwelling is 90 m^2 and that 15.3 m^3 of waste is produced per 100 m^2 of floor area for new-build residential projects. This benchmark has been produced from the SMARTwaste system and is based on 116 residential projects completed by the end of August 2008. The predicted waste arising from the recommended housing development is summarised in Table 2.

[1] East of England Plan 2004, Examination in Public, Panel Report, June 2006
http://www.gos.gov.uk/goee/docs/193657/193668/East_of_England_Plan_Examin1.pdf

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Predicted waste arising, m^3	Total 2001 - 2021	2001-2006	waste pa	2006-2011	waste pa	2011-2016	waste pa	2016-2021	waste pa
Broxbourne	77,112	15,836	3,167	20,655	4,131	20,655	4,131	20,655	4,131
Dacorum	165,240	36,491	7,298	42,687	8,537	42,687	8,537	42,687	8,537
East Herts	165,240	34,425	6,885	43,376	8,675	43,376	8,675	43,376	8,675
Hertsmere	68,850	15,147	3,029	17,901	3,580	17,901	3,580	17,901	3,580
North Herts	107,406	35,114	7,023	24,098	4,820	24,098	4,820	24,098	4,820
St Albans	99,144	22,721	4,544	25,475	5,095	25,475	5,095	25,475	5,095
Stevenage	198,288	26,852	5,370	57,146	11,429	57,146	11,429	57,146	11,429
Three Rivers	55,080	15,147	3,029	13,082	2,616	13,082	2,616	13,082	2,616
Watford	71,604	13,770	2,754	19,278	3,856	19,278	3,856	19,278	3,856
Welwyn Hatfield	137,700	33,048	6,610	35,114	7,023	35,114	7,023	35,114	7,023
Hertfordshire	**1,145,664**	**248,549**	**49,710**	**298,809**	**59,762**	**298,809**	**59,762**	**298,809**	**59,762**

Table 2: Predicted m^3 waste arising from recommended housing development 2001-2021

In addition, the predicted waste arisings can be estimated using the benchmark of 8.0 tonnes waste per $100m^2$ of floor area. This figure has been calculated from the same dataset as the volume benchmark figure. The predicted waste arisings are shown in Table 3 and Figure 1.

Predicted waste arising, Tonnes	Total, 2001-2021	2001-2006	waste pa	2006-2011	waste pa	2011-2016	waste pa	2016-2021	waste pa
Broxbourne	40,320	8,280	1,656	10,800	2,160	10,800	2,160	10,800	2,160
Dacorum	86,400	19,080	3,816	22,320	4,464	22,320	4,464	22,320	4,464
East Herts	86,400	18,000	3,600	22,680	4,536	22,680	4,536	22,680	4,536
Hertsmere	36,000	7,920	1,584	9,360	1,872	9,360	1,872	9,360	1,872
North Herts	56,160	18,360	3,672	12,600	2,520	12,600	2,520	12,600	2,520
St Albans	51,840	11,880	2,376	13,320	2,664	13,320	2,664	13,320	2,664
Stevenage	103,680	14,040	2,808	29,880	5,976	29,880	5,976	29,880	5,976
Three Rivers	28,800	7,920	1,584	6,840	1,368	6,840	1,368	6,840	1,368
Watford	37,440	7,200	1,440	10,080	2,016	10,080	2,016	10,080	2,016
Welwyn Hatfield	72,000	17,280	3,456	18,360	3,672	18,360	3,672	18,360	3,672
Hertfordshire	**599,040**	**129,960**	**25,992**	**156,240**	**31,248**	**156,240**	**31,248**	**156,240**	**31,248**

Table 3: Predicted Tonnes waste arising from recommended housing development 2001-2021

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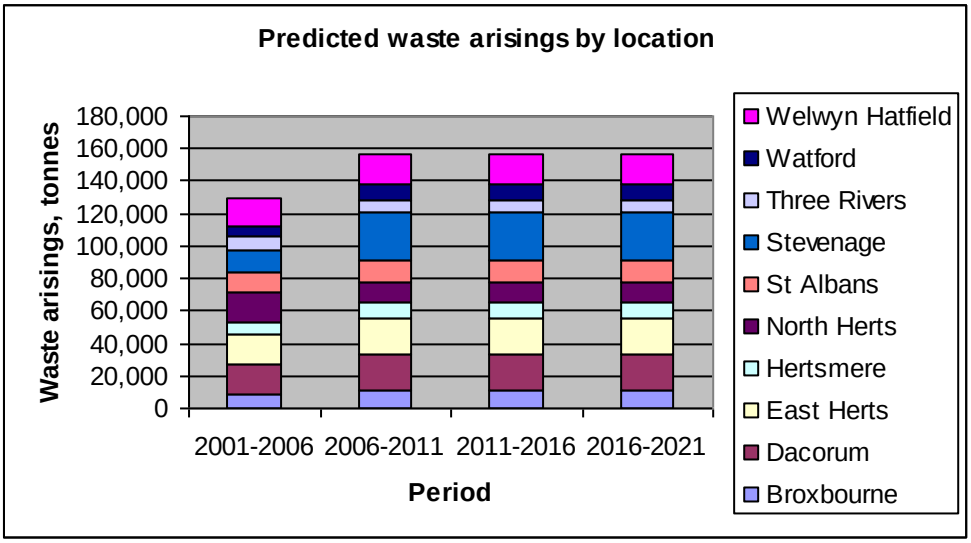

Figure 1: Predicted waste arisings by location in tonnes

If the best practice KPI (4.7 tonnes/100m^2) is applied as shown on Figure 2 then the predicted amount of waste generated falls sharply for each District; it is almost halved. This obviously has a significant impact in terms of the amount of waste available for recovery.

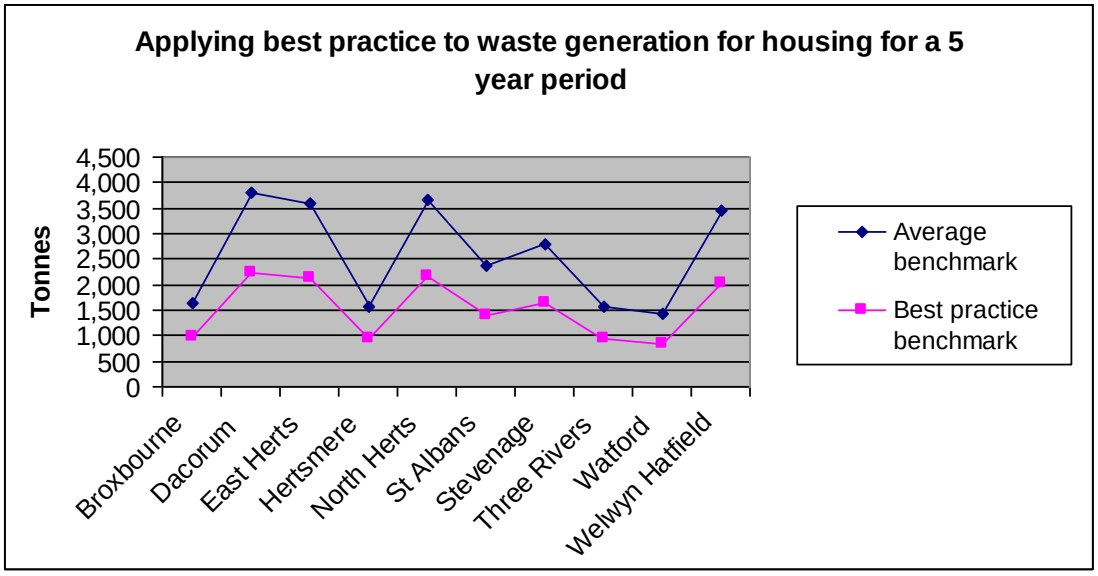

Figure 2: Application of best practice KPI for housing over a 5 year period

Further detailed predictions of the types of waste arising can be estimated using the breakdown of m^3 of waste per 100 m^2 for different waste types. A summary of the predicted waste arisings in m^3 for Hertfordshire is given in Table 4.

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	m^3 of waste								
Waste type	**Total, 2001-2021**	**2001-2006**	**pa**	**2006-2011**	**pa**	**2011-2016**	**pa**	**2016-2021**	**pa**
Canteen/office/ad-hoc	129,542	28,104	5,621	33,787	6,757	33,787	6,757	33,787	6,757
Ceramics/bricks	107,827	23,393	4,679	28,123	5,625	28,123	5,625	28,123	5,625
Concrete	142,272	30,866	6,173	37,107	7,421	37,107	7,421	37,107	7,421
Electrical equipment	11,232	2,437	487	2,930	586	2,930	586	2,930	586
Furniture	5,990	1,300	260	1,562	312	1,562	312	1,562	312
Hazardous	4,493	975	195	1,172	234	1,172	234	1,172	234
Inert	50,170	10,884	2,177	13,085	2,617	13,085	2,617	13,085	2,617
Insulation	81,619	17,707	3,541	21,288	4,258	21,288	4,258	21,288	4,258
Liquids and Oils	3,744	812	162	977	195	977	195	977	195
Metals	44,179	9,585	1,917	11,523	2,305	11,523	2,305	11,523	2,305
Packaging	202,925	44,024	8,805	52,926	10,585	52,926	10,585	52,926	10,585
Plaster/cement	140,026	30,378	6,076	36,521	7,304	36,521	7,304	36,521	7,304
Plastics	78,624	17,057	3,411	20,507	4,101	20,507	4,101	20,507	4,101
Timber	141,523	30,703	6,141	36,912	7,382	36,912	7,382	36,912	7,382
Total	**1,144,166**	**248,224**	**49,645**	**298,418**	**59,684**	**298,418**	**59,684**	**298,418**	**59,684**

Table 4: Predicted waste arisings by waste type from proposed residential development 2001-2021

Again the waste arisings in tonnes can be predicted and these are shown in Table 5 and Figure 3.

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	Tonnes of waste								
Waste type	**Total waste, 2001-2021**	**2001-2006**	**Waste pa**	**2006-2011**	**Waste pa**	**2011-2016**	**Waste pa**	**2016-2021**	**Waste pa**
Canteen/office/ ad-hoc	137,256	29,777	5,955	35,799	7,160	35,799	7,160	35,799	7,160
Ceramics/bricks	110,947	24,070	4,814	28,937	5,787	28,937	5,787	28,937	5,787
Concrete	163,209	35,408	7,082	42,568	8,514	42,568	8,514	42,568	8,514
Electrical equipment	7,987	1,733	347	2,083	417	2,083	417	2,083	417
Furniture	2,984	647	129	778	156	778	156	778	156
Hazardous	939	204	41	245	49	245	49	245	49
Inert	51,888	11,257	2,251	13,533	2,707	13,533	2,707	13,533	2,707
Insulation	72,309	15,687	3,137	18,859	3,772	18,859	3,772	18,859	3,772
Liquids and Oils	234	51	10	61	12	61	12	61	12
Metals	39,479	8,565	1,713	10,297	2,059	10,297	2,059	10,297	2,059
Packaging	193,140	41,901	8,380	50,374	10,075	50,374	10,075	50,374	10,075
Plaster/cement	131,304	28,486	5,697	34,246	6,849	34,246	6,849	34,246	6,849
Plastics	76,859	16,674	3,335	20,046	4,009	20,046	4,009	20,046	4,009
Timber	117,808	25,558	5,112	30,726	6,145	30,726	6,145	30,726	6,145

Table 5: Predicted waste arisings by waste type from proposed residential development 2001-2021 (Tonnes)

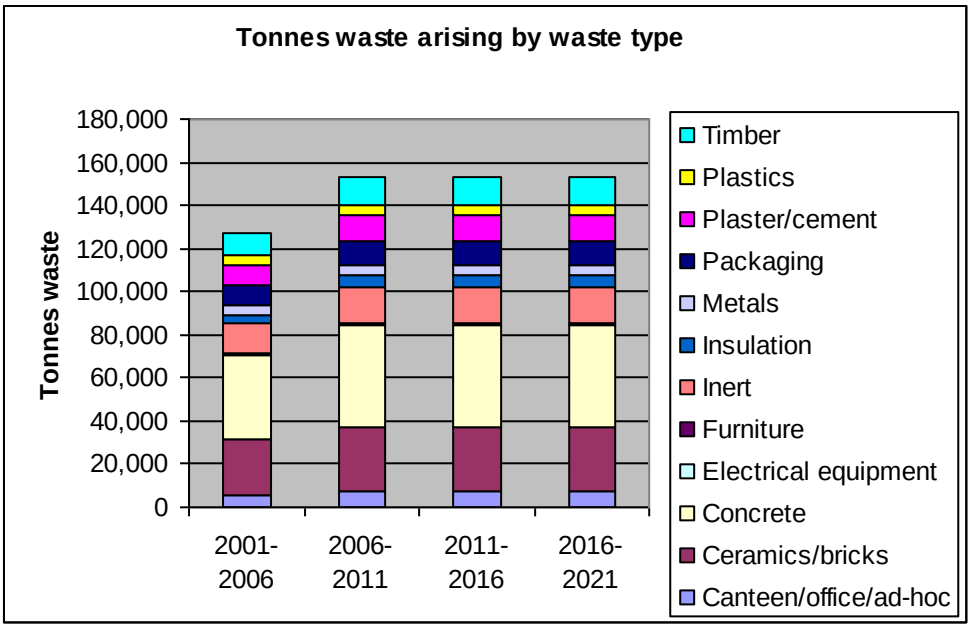

Figure 3: Waste arising by waste type

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Comparison of predicted construction and demolition waste with Hertfordshire County Councils Minerals and Waste Development Framework

Independent consultants, appointed by the County Council, reviewed the key waste streams in Hertfordshire to enable the council to identify the type and size of waste management facilities needed in Hertfordshire[2]. An estimate of construction and demolition waste arisings from Hertfordshire was calculated using the estimated quantity of Construction and Demolition waste in the East of England 2003/4[3,4] and a calculation of the percentage of East of England waste from Hertfordshire (12% of regional total). This gives a figure for construction and demolition waste arisings deposited/treated at licensed facilities in Hertfordshire of 1,532,000 tonnes.

In Hertfordshire's Waste Core Strategy Submission[5] (Appendix C), forecasts for Construction and Demolition waste are given and these are summarised in Table 6 below.

Waste stream	2005	2010	2015	2020
Construction and Demolition waste	2,715,380	3,072,203	3,476,916	3,932,679

Table 6: Forecast Construction and Demolition waste in Tonnes for Hertfordshire

These figures are significantly higher than those calculated above for residential development (599,000 tonnes in total from 2001-2020) but they include all sources of construction and demolition waste. At present it has not been possible to predict waste arisings from sources other than residential development such as retail, office, education and civil engineering projects due to the lack of data in terms of the number and types of other construction projects being built at a County level.

Project specific waste arisings

The waste arisings have been modelled at a project level for the proposed development of Wheathampstead Education Centre, Butterfield Road, Wheathampstead. This involves the demolition of existing buildings and redevelopment of the site for residential use. The proposed project is for the construction of residential units at a density of 30 dwellings per hectare and associated access, i.e. roads and pavements.

Demolition of existing buildings

The site totals approximately 2.23 hectares and the total built area is approximately 5440 m^2. A benchmark figure of 18.9 m^3 waste per 100 m^2 floor area has been calculated based on 17 demolition projects. Applying this figure to the floor area of the existing buildings gives predicted waste arising of 10,282 m^3. However it should be noted that these benchmarks should be used with caution as the amount and type of waste generated by demolition activities is obviously dependant upon the type of structure being demolished.

[2] HCC Waste Arisings Review and Waste Flow Modelling, November 2005, Entec UK Ltd, http://www.hertsdirect.org/infobase/docs/pdfstore/war2008.pdf
[3] ODPM (2002) Survey of Arisings and Use of Construction and Demolition Waste. http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/page/odpm_plan_606333.hcsp
[4] ODPM (2005) Survey of Arisings and Use of Construction , Demolition and Excavation Waste as Aggregate in 2003. http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/page/odpm_plan_032244.pdf
[5] Hertfordshire Minerals and Waste Development Framework, Waste Core Strategy Submission, January 2008 https://www.hertsdirect.org/infobase/docs/pdfstore/wastecorstr08.pdf

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Construction of new housing
The site is to be redeveloped and it is proposed to build 73 residential units. Assuming an average floor area of 90m^2 and using the KPI of m^3 waste/100m^2 floor area for each waste type the waste arisings can be predicted. The predicted waste arisings in m^3 and tonnes are shown in Table 7.

Waste type	Predicted waste arising, m^3	Predicted waste arising, tonnes
Canteen/office/ad-hoc	113.66	23.91
Ceramics/bricks	94.61	102.49
Concrete	124.83	158.73
Electrical equipment	9.86	2.56
Furniture	5.26	0.92
Hazardous	3.94	3.15
Inert	44.02	54.99
Insulation	71.61	17.94
Liquids and Oils	3.29	0.59
Metals	38.76	16.36
Packaging	178.05	37.45
Plaster/cement	122.86	40.54
Plastics	68.99	15.97
Timber	124.17	42.25
Grand Total	**1003.90**	**519.03**

Table 7: Predicted waste arisings from construction of 73 dwellings

If we apply the best practice KPI for residential developments (4.4 tonnes/100m^2) to this development then the overall wastage would be reduced from 519 tonnes to 309 tonnes; a reduction of over a third. Applying good practice (7 tonnes/100m^2) would save a further 80 tonnes.

Key recommendations for waste reduction
Both the modelling at the County and project level clearly show the impact of reducing waste in terms of waste amount by implementing good and best practice benchmarks. There are also additional cost savings in terms of the direct disposal costs and materials costs as well as a reduction in environmental impact. In terms of waste reduction it is important to apply the following recommendations:

Design and the use of materials
Design should play an important part in achieving waste reduction in the built environment. However, there are a multitude of considerations in addition to waste reduction that take priority. These include areas such as the design life, whole life cost, skills, time, operational energy and water use, visual appeal and life cycle impacts of materials. For waste reduction to be considered effectively then it needs to be embedded within this overall design decision making to avoid being a sidelined activity. Areas where attention needs to be paid include:

- Designing the building/lay out to reduce the overall amount of material resource usage e.g. consider floor areas, reduction in number of materials, avoid complex designs and encourage ‘straight’ lines etc; this will eliminate waste being produced. Obviously buildings and systems are not usually designed with the sole purpose to

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eliminate waste but avoidance of waste can be achieved within an overall design/sustainability framework.
- Designing out waste within the new build/fit out processes by using products/materials that aid waste reduction e.g. standard sizes, prefabrication, dry trades etc; this will minimise the amount of waste arising from installing these products/materials.
- Designing products/systems/buildings that are adaptable for further uses or can be disassembled; this would require working closely with manufacturers at their product design stage e.g. use of equipment which can be 'debranded', leasing systems.

It is important that designers are kept informed in terms of the amount of waste generated onsite and the cause of this waste; the KPIs should be regularly communicated to the design team. If a designer knows how much waste was generated from a particular specification then this can be targeted in the future. In terms of the benchmarks, designers can play an important part in reducing the offcuts of materials which are largely from timber, insulation, plasterboard and flooring products by specifying appropriate sizes.

The choice of materials on a project should have an impact on the amount of waste that is likely to be produced and therefore the amount that can be reduced. In the context of life cycle assessment, waste issues form part of the overall assessment. Life cycle assessment (LCA) is basically the combined effect of single impacts. If these issues are separated and focussed on without this overall context, there is a danger that the overall environmental impact could increase. It is important that waste reduction is considered, within the wider sustainable consumption and production agenda. In terms of material selection then the proposed approach would significantly address waste reduction:

- overall life cycle impact to be considered as a first priority
- single impacts to be focussed on and improvements made
- reiteration of overall life cycle impacts following single impact improvements

Onsite practices

Contractors and subcontractors are critical in terms of waste reduction; it is essential for contractors to have an understanding of the type and amount of waste being generated, the cost of the waste and the amount of materials that have actually been used within the build to implement waste reduction and set an appropriate baseline. Then appropriate targets can be set using the benchmarks this project has developed for either a project overall or for key waste types. Other targets can include providing a maximum wastage allowance for materials used – this requires knowledge of how many materials are used on a project and how many are subsequently wasted.

Any targets set should also involve the supply chain and a full understanding in terms of subcontractors and the wastage they generate is required. Site Waste Management Plans are an effective tool in developing this information and should include within them:

- Collection of data and subsequent review of data
- Increasing awareness through training/toolbox talks
- Looking at onsite procedures e.g. material storage, logistics
- Working with waste management companies including provision of waste equipment onsite
- Working with the supply chain on areas such as over ordering, packaging etc
- Feeding back recommendations (based on cost and environmental impact) to the project team
- Integrating recommendations with company policies and procedures

Knowing the amount and type of waste being generated has an important impact on what can be realistically achieved for the recovery of the materials/products. In terms of actual onsite management, contractors need to consider good storage, logistics – encouraging just in time deliveries, the use of consolidation centres and workmanship.

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The introduction of Site Waste Management Plans from April 2008 provides a good foundation upon which to encourage waste reduction throughout the supply chain. In the first few years it is likely that businesses will focus upon demonstrating compliance with the legislation and associated policies, such as the Code for Sustainable Homes. However, with the inclusion of a carbon and cost focus (BRE have recently developed the 'True Cost of Waste Calculator') it is anticipated that waste reduction will be a more attractive proposition. The logic in applying carbon calculation mainly derives from the reduction in embodied energy from using fewer materials. Carbon benefits from recycling are likely to be far less significant when compared to not producing the waste in the first place. This saving should be made much more obvious, which along with the better cost savings should eventually promote waste reduction within a framework of overall sustainability i.e. avoiding the trap of focussing on a single sustainability issue. Using these benchmarks provides a means of measuring this waste reduction.

Better information is needed to facilitate waste reduction. There is little point presenting the construction sector with generic targets to reduce waste unless these are accompanied by more specific guidance and data on who is accountable for which aspect of the waste stream.

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