Reinforcement of LV Services

ED2 Engineering Justification Paper Addendum

ED2-LRE-SPEN-001-CV2-EJP-ADD

Issue	Date	Comments
Issue 0.1	Aug 2022	Internal Draft for Review
Issue 0.2	Aug 2022	Internal Draft with Comments Addressed
Issue 1 0	Aug 2022	First Issue Draft Determination Response

Scheme Name	Reinforcement of LV Services		
PCFM Cost Type	Load Related		
Activity	Secondary Reinforcement		
Primary Investment Driver	Thermal and Voltage Constraints		
Reference	ED2-LRE-SPEN-001-CV2-EJP-ADD		
Output Type	CV2		
Cost	SPD £65 554m	SPM £35.928m	
Delivery Year	2023-2028		
Reporting Table	CV2		
Outputs included in ED1	~~Yes~~/No		
Business Plan Section	Develop the Network of the Future		
Primary Annex	Annex 4A.22 LV Services and Cut Outs Strategy		
Spend Apportionment	**ED1**	**ED2**	**ED3**
	£m	**£101.481m**	**£m**

	Proposed by	Endorsed by	Approved by
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Signature	kp.Singh		
Date	23/08/2022	23/08/2022	23/08/2022

1 Purpose

This addendum has been prepared to provide additional information and justification to ED2-LRE-SPEN 001-CV2 EJP Reinforcement of LV Services EJP following receipt of RIIO-ED2 Draft Determination The content of this addendum is in response to comments and feedback provided by Ofgem as to the "Unjustified" status of the EJP. The purpose of this document is to support Ofgem's assessment for Final Determination including supporting any associated impact on engineering adjustments within Ofgem's financial modelling.

2 Ofgem Comments & Feedback

2.1 RIIO-ED2 Draft Determinations SPEN Annex

The following comments are taken from Table 25 of *"RIIO-ED2 Draft Determination SPEN Annex"*.

Ofgem Comment - Unjustified. We agree with SPEN's needs case to reinforce LV looped services. We are concerned that SPEN's proposal includes intervention on assets forecast to be overloaded out to 2050.

Ofgem Identified Risks - While we agree in principle that SPEN's proposed approach will yield programme efficiency gains, we consider the uncertainty in the needs case for intervention at the individual property level a significant risk in SPEN's proposal. There is also a risk of LCT uptake forecasting inaccuracies out to 2050.

2.2 Summary of Any Ofgem Supplementary Question Post Final Submission

On 24th January 2022, Ofgem sought explanation on the following in SQ SPEN 018:

- SPEN approach in calculating the total volume needing intervention
- Confirmation if volumes are linked to EV/HP uptake in ED2, or if brought forward where efficient (e.g., forecast ED3 interventions). If applicable, a breakdown of this split.
- SPEN forecast % of interventions estimated to have a 3-phase supply.

On 28th February 2022, Ofgem sought further explanation on the following in SQ SPEN 083:

- SPEN approach to grouping of LV service intervention.
- SPEN view on advantages of proactive approach

SPEN provided a full response to both supplementary questions, details of which are included in Sections 4 1 and 4 2

2.3 Summary of SPEN Supplementary Question Post Draft Determination

Ofgem and SPEN held a Load Related bi-lateral meeting on 19/07/2022 regarding clarification of comments on the Looped services EJP and strategy detailing proactive replacement of looped service plans. Based on the bi-lateral meeting feedback SPEN submitted supplementary questions providing clarification around comments on the EJP Details of post draft determination SQ's along with Ofgem response are included in Appendix 4 3 and 4 4

3 Additional Justification

3.1 Background

Our RIIO-ED2 plan includes a targeted replacement programme replacing at least 43.4k looped services in areas where we are more certain of requirements. This provides a coordinated approach which will reduce customer impact, reduce delays, and is more cost-effective. In areas with less certainty on LCT uptake/timing we will continue to upgrade services as LCTs connect.

Within Appendix 1 of the Draft Determination SPEN Annex, the EJP ED2-LRE-SPEN-001 CV2-EJP detailing our proactive LV services interventions was assessed as 'unjustified' with the following identified risk: "We are concerned that SPEN's proposal includes intervention on assets forecast to be overloaded out to 2050. While we agree in principle that SPEN's proposed approach will yield programme efficiency gains, we consider the uncertainty in the needs case for intervention at the individual property level a significant risk in SPEN's proposal. There is also a risk of LCT uptake forecasting inaccuracies out to 2050."

The methodology and rationale behind our LV service cable intervention programme are explained in Annex 4A 22 and EJP ED2 LRE-SPEN-001-CV2 EJP, with further information provided during the final submission SQ process1.

This addendum aims to provide a summary of our approach, how we have formulated our plans and why we believe this is the most appropriate option for our customers.

3.2 The Scale of the Challenge

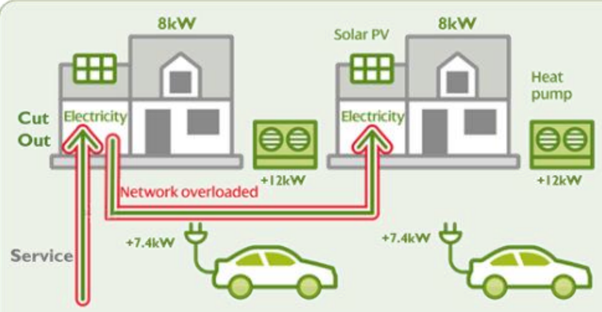
Over 561,000 of our customers are supplied by looped services, presenting a barrier to these customers adopting LCTs.

As these assets are located in customer's homes, they carry a high consequence of failure and safety risk if they are overloaded If we do not intervene, customers will experience severe restrictions and power cuts, network infrastructure may be damaged, and there is an increased safety risk

With a typical looped service, assets could experience up to 3 times their safe rating and be dangerously overloaded which is shown in Figure 3-1. For example, a typical property supplied by a

[1] SQs: SPEN018 and SPEN083

looped service has an 80A cut-out (18.4kW) fed via a 25mm service cable (24kW). Many properties have lower rated equipment due to age and size



- A typical modern property has an 80A cut-out (**18.4kW**) fed via a 25mm service cable (**24kW**)
- Assets can experience up to **3x** their safe rating and be **dangerously overloaded**
- **Cannot be managed by smart charging / flexibility** due to the scale of overload

Single House	Utilisation	
	Cut out	Service
Peak Load	43%	33%
+ 1 EV	84%	64%
+ 1 Heat Pump	109%	83%

Looped Service	Utilisation	
	Cut out	Service
Peak Load	87%	67%
+2 EV *	167%	128%
+2 EV *, +2 HP	298%	228%

Figure 3-1. Example of a typical looped service

If we do not upgrade these services, we will become a barrier to the uptake of LCTs Other options such as flexibility are not viable due to the scale of the overload and level of enduring constraint. To resolve this, we need to replace the cables and cut-out units.

3.3 How we established which looped services require intervention in RIIO-ED2

We analysed our range of configurations of service cables and cut out units across our network to identify those that would require intervention to enable customer decarbonisation.2 This grouped and assessed the ability of common service configurations to accommodate the increase in household maximum demand. We did this for various scenarios, to take account of the range of property types, heat pump ratings etc.

This analysis showed that looped services need to be replaced where those customers adopt EV chargers or heat pumps. To identify these looped service interventions, we established and combine two datasets:

1) Which LV sites are served by looped service cables?
2) Which houses will get EV chargers and heat pumps, and in what timeframes?

For the first dataset, we had already developed a full connectivity model of the LV network as part of the NAVI project. Using this, we were able to run a trace algorithm to identify every property served by a looped service cable. To establish the second dataset, we developed two innovative forecasting

[2] Annex 4A 22, section 5.1 2

tools: EV-Up and Heat-Up. By analysing spatial, demographic, and socioeconomic data, these predict the likelihood of EV and heat pump uptake for every household we serve. (See section 3.6.1 of the EJP for more information)

Our Engineering Net Zero (ENZ) Model combines these two datasets and provides a risk weighting for each individual Meter Service Position. These individual risk weightings per property are aggregated to give a total risk per individual LV feeder and HV/LV substation. Our intervention program is prioritised based on this risk weighting (see Appendix A of the EJP).

Section 3.6.2 of the EJP provides overview maps of network areas with uptake of LCTs coincident with Looped Services A regional area example of this is shown in Figure 3 2

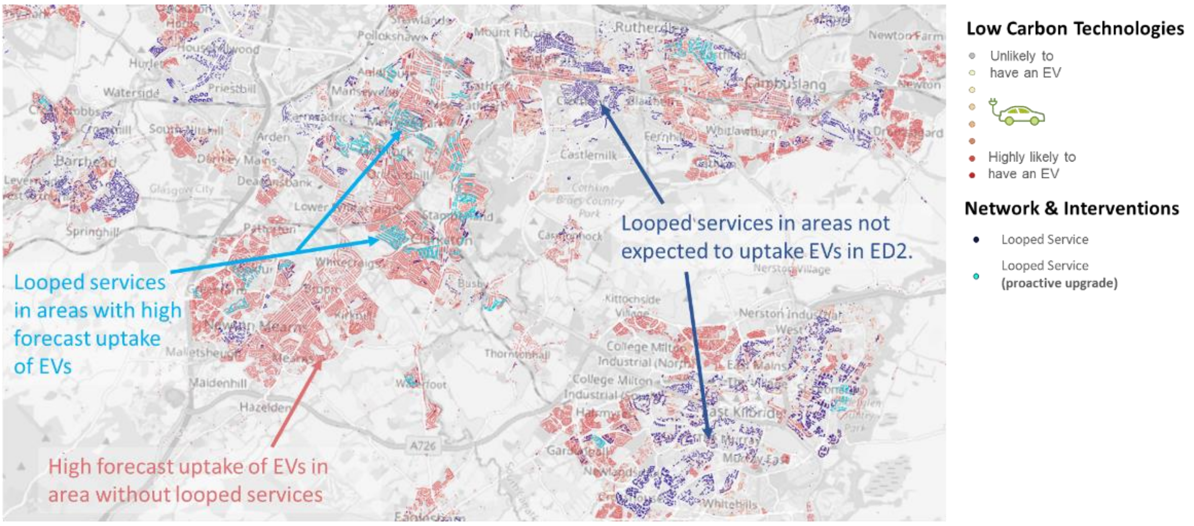


Figure 3 2 LCTs coincident with Looped Services in the Glasgow South area, in 2028, under our Baseline uptake scenario

This gives us confidence that we are only requesting interventions in areas where we have greater confidence over requirements within the RIIO-ED2 period.

3.4 Options considered

Do Nothing: This option is rejected. If we do not intervene, customers will experience severe restrictions and power cuts, network infrastructure may be damaged, and there is a significantly increased safety risk

Flexibility services: This option is rejected. Due to the level of overload domestic flexibility services or time of use tariff solutions are unable to provide assurance that individual looped services would remain safely within limits.

Energy efficiency: This option is rejected. On its own energy efficiency measures don't deliver sufficient peak demand reduction to avoid service cable replacement We will keep thermal energy efficiency under review as a solution, especially as certainty around heat decarbonisation increases.

Demand limiting devices: This option is rejected We have discounted demand limiting devices, as they are not currently available for multiple properties, they do not deliver what our customers want, and they result in a permanent and enduring limit on how these customers consume electricity. This would limit the likelihood of these customers decarbonising, and the ability of these customers to participate in the energy transition.

Unlooping is the only solution that accommodates the forecast increase in customer demand and enables our customers to decarbonise.

3.5 Delivery strategy: Proactive replacement is more efficient

The scale of the challenge requires us to take a coordinated area-by-area approach.

This coordinated proactive replacement programme is more efficient than individually replacing service cables in response to customer LCT connections. We wouldn't be able to deliver as many reactive interventions as by their nature they are unplanned and can't be coordinated. For example, if network assessments show that 20 LV looped service cables within a single street will need to be replaced over a few years, if we reactively intervened when each was exceeded this would result in 20 individual trips to that street to upgrade each looped service cable separately. In contrast, a coordinated proactive approach means we only make one trip.

A predominately reactive delivery strategy was discounted because it would not be deliverable, we would be overwhelmed by this approach. Our reactive approach in RIIO-ED1 has already become challenging. As uptakes accelerate this approach would risk introducing significant delays for these customers adopting LCTs and would be unable to scale to facilitate baseline levels let alone higher uptakes. Furthermore, it stores up an even greater bow-wave of future delivery challenges beyond RIIO-ED2 when the uptake rates are expected to be most rapid.

For RIIO-ED2 we have grouped delivery together per LV feeder. This means that when intervening on looped services on an LV feeder we will take the opportunity to also replace all other looped services on that LV feeder where we believe these will require replacement beyond ED2.

The advantages of this approach are:

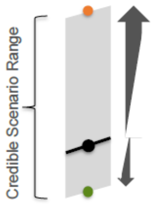
1. It is more cost efficient as we can share overheads (e.g., travel time to site, transporting equipment from our depot etc), so reducing the time and cost overhead per intervention.

2. It better delivers on our customers' priorities and enables customer decarbonization as the capacity is much more likely to already be there when customers need it (our customers told us they did not want to have to wait before using LCTs at full capacity)
3 It is safer for customers, as there is less likelihood of looped services being overloaded and dangerously failing.
4. It reduces the noise pollution, dust pollution, and disruption to customers that result from digging up pavements and roads as we are doing it all at once rather than multiple times.
5. It enables us to coordinate these works with other work programmes (e.g., LV mains replacement); and
6 It better enables Net Zero, as it would be a much greater challenge to deliver the volume of interventions needed for Net Zero with an individual reactive approach due to the additional time/intervention required.

Our proactive delivery strategy is required to meet the deliverability challenge. Our rate of looped service interventions needs to increase over fifty-fold from RIIO-ED1. We can only deliver this volume of interventions in RIIO-ED2 and beyond if we deliver them efficiently. Our feeder-by-feeder approach is key to this

Within our baseline plan, we have included 43,384 looped service interventions 36,072 (83%) of these are forecast to exceed capacity within RIIO ED2 due to LCT uptake The remaining 7,312 (17%) are due to LCT uptake after RIIO-ED2. This 17% has been brought forward to RIIO-ED2 as it is more efficient and less disruptive to customers to deliver them in RIIO-ED2 than to wait until after RIIO-ED2. Approximately half of these 17% would be expected to be required in RIIO-ED3 and 87% of them by the end of RIIO-ED4. There are also 2,225 looped services on the LV feeders being proactively intervened on where we have not included them in our plans because the need for them to be replaced is unlikely (for example, where they don't have a driveway and are unlikely to adopt a heat-pump).

The LV Services volume driver will play an important role to enable flexing from baseline to higher scenarios. Within section 6.6 of the EJP, we detail the scale of investment that would be required across the future scenario pathways, with up to 78.4k interventions required under the highest scenario.



	SPD		SPM		SPEN	
2028	Volumes	£m	Volumes	£m	Volumes	£m
High	50.3k	117.60	28.1k	65.40	78.4k	183.00
Baseline	27.9k	65.55	15.4k	35.93	43.3k	101.48
Low	25.5k	59.78	15.4k	35.93	40.9k	95.71

Figure 3-3: Scale of investment

3.6 Consideration of 3-phase services

The largest single-phase supply we provide is 100A. Customers will likely exceed this where they install two or more LCTs. To future proof interventions we plan to use 3-phase equipment as standard. The detailed assessments within the EJP and CBA focused on this consideration and consequently needed to consider our DFES uptakes out to 2050. A sensitivity on the robustness of our findings was undertaken.

The incremental cost of installing a 3 phase service at the time of installation is small in comparison to the cost of future upgrade. The EJP CBA answers the question: while we have a trench open in the customer's driveway should we install a 1-phase cable, or 3-phase cable?

Using 1-phase installations would risk many of these being replaced before end-of-life. In contrast, our 'touch the network once' approach is more cost efficient, less disruptive to customers, and helps avoid undeliverable spikes of work in subsequent years. We tested the financial sensitivity of our proposed approach using 3-phase replacements as standard:

- 3-phase replacements would have to become at least 63% more expensive than single-phase replacements for this to no longer be the best approach. The incremental cost of a 3-phase compared to a single phase replacement is ca 5%. This is due to the higher cost of the cable and cut out fuse unit Given their proportion of the overall cost, it is unlikely the 63% threshold will be exceeded.
- Only 12% of these customers would need a 3-phase supply at some point by 2050 for this approach to be more financially efficient than installing single-phase as standard and reactively upgrading specific customers to 3-phase. For comparison, the most conservative EV and heat pump DFES forecasts show 53% of these customers will have at least two LCTs by 2050, justifying our approach.

Given this sensitivity analysis, and considering customer disruption, safety, and deliverability in future years, we are confident that our approach of using 3 phase as standard is the most economic and coordinated approach.

3.7 Additional sensitivity studies

Following discussions in our LRE bi lateral, we have undertaken additional CBA sensitivity studies comparing the economic case for a purely reactive approach relative to that of a proactive approach to identify the optimal tipping points. These assessments exclude the impacts of delivery constraints in the purely reactive approach.

This identifies that with 17% of interventions brought forward, the NPV reaches break-even if the proactive costs are 4% cheaper than the reactive approach. We tested the robustness of this finding by also assessing across a range of proportions of interventions that are consequentially brought forward

Reactive cost as % of Proactive cost (columns); % Interventions that are consequentially brought forward (rows)

-12.2	100%	101%	102%	103%	104%	105%	106%	107%	108%	109%	110%	111%	112%	113%	114%	115%	116%	117%	118%	119%	120%
1%	-0.72	2.51	5.80	9.15	12.57	16.05	19.59	23.20	26.88	30.61	34.41	38.28	42.21	46.20	50.26	54.38	58.56	62.81	67.13	71.50	75.95
2%	1.43	1.78	5.05	8.39	11.79	15.26	18.79	22.38	26.04	29.76	33.55	37.40	41.31	45.29	49.33	53.43	57.60	61.83	66.13	70.49	74.91
3%	-2.15	1.05	4.31	7.63	11.02	14.47	17.98	21.56	25.20	28.91	32.68	36.51	40.41	44.37	48.39	52.48	56.63	60.85	65.13	69.47	73.88
4%	-2.87	0.31	3.56	6.87	10.24	13.68	17.18	20.74	24.37	28.06	31.81	35.63	39.51	43.45	47.46	51.53	55.67	59.87	64.13	68.46	72.85
5%	-3.59	-0.42	2.81	6.11	9.46	12.89	16.37	19.92	23.53	27.20	30.94	34.74	38.61	42.54	46.53	50.59	54.71	58.89	63.13	67.44	71.81
6%	-4.30	-1.15	2.07	5.35	8.69	12.10	15.57	19.10	22.69	26.35	30.08	33.86	37.71	41.62	45.60	49.64	53.74	57.91	62.13	66.43	70.78
7%	-5.02	-1.88	1.32	4.59	7.91	11.31	14.76	18.28	21.86	25.50	29.21	32.98	36.81	40.71	44.67	48.69	52.78	56.92	61.14	65.41	69.75
8%	-5.74	-2.61	0.57	3.83	7.14	10.51	13.95	17.46	21.02	24.65	28.34	32.09	35.91	39.79	43.74	47.74	51.81	55.94	60.14	64.40	68.72
9%	-6.45	-3.34	-0.17	3.06	6.36	9.72	13.15	16.63	20.18	23.80	27.47	31.21	35.01	38.88	42.80	46.79	50.85	54.96	59.14	63.38	67.68
10%	-7.17	-4.08	-0.92	2.30	5.59	8.93	12.34	15.81	19.35	22.95	26.61	30.33	34.11	37.96	41.87	45.84	49.88	53.98	58.14	62.37	66.65
11%	-7.89	-4.81	-1.66	1.54	4.81	8.14	11.54	14.99	18.51	22.09	25.74	29.44	33.21	37.05	40.94	44.90	48.92	53.00	57.14	61.35	65.62
12%	-8.60	-5.54	-2.41	0.78	4.04	7.35	10.73	14.17	17.68	21 24	24.87	28.56	32.31	36.13	40.01	43.95	47.95	52.02	56.14	60.33	64.59
13%	-9.32	-6.27	-3.16	0.02	3.26	6.56	9.93	13.35	16.84	20.39	24.00	27.68	31.41	35.21	39.08	43.00	46.99	51.03	55.15	59.32	63.55
14%	-10.04	-7.00	-3.90	-0.74	2.48	5.77	9.12	12.53	16.00	19.54	23.13	26.79	30.51	34.30	38.14	42.05	46.02	50.05	54.15	58.30	62.52
15%	10.76	-7.73	4.65	-1.50	1.71	4.98	8.31	11.71	15.17	18.69	22.27	25.91	29.62	33.38	37.21	41.10	45.06	49.07	53.15	57.29	61.49
16%	-11.47	-8.46	-5.39	-2.26	0.93	4.19	7.51	10.89	14.33	17.83	21.40	25.03	28.72	32.47	36.28	40.15	44.09	48.09	52.15	56.27	60.46
17%	-12.19	-9.20	-6.14	-3.02	0.16	3.40	6.70	10.07	13.49	16.98	20.53	24.14	27.82	31.55	35.35	39.21	43.13	47.11	51.15	55.26	59.42
18%	-12.91	-9.93	-6.89	-3.78	-0.62	2.61	5.90	9.25	12.66	16.13	19.66	23.26	26.92	30.64	34.42	38.26	42.16	46.13	50.15	54.24	58.39
19%	-13.62	-10.66	-7.63	-4.54	-1.39	1.82	5.09	8.43	11.82	15.28	18.80	22.38	26.02	29.72	33.48	37.31	41.20	45.15	49.16	53.23	57.36
20%	14.34	-11.39	-8.38	-5.30	-2.17	1.03	4.29	7.60	10.98	14.43	17.93	21.49	25.12	28.80	32.55	36.36	40.23	44.16	48.16	52.21	56.33
21%	-15.06	-12.12	-9.12	-6.06	-2.94	0.24	3.48	6.78	10.15	13.57	17.06	20.61	24.22	27.89	31.62	35.41	39.27	43.18	47.16	51.20	55.29

Reactive approach is cheaper — Proactive approach is cheaper

Figure 3-4: Sensitivity studies Reactive vs Proactive Case 1

A similar sweep also considered a scenario where not all interventions that were brought forward ended up adopting an LCT. This pessimistically considers 1 in 4 brough forward interventions as not adopting an LCT At this rate, considering 17% of interventions brought forward, the NPV reaches break-even when the proactive costs are 8% cheaper

Reactive cost as % of Proactive cost

% Interventions that are consequentially brought forward

-22.7	100%	101%	102%	103%	104%	105%	106%	107%	108%	109%	110%	111%	112%	113%	114%	115%	116%	117%	118%	119%	120%
1%	-1.34	1.88	5.15	8.49	11.90	15.37	18.90	22.49	26.15	29.88	33.66	37.52	41.43	45.41	49.45	53.56	57.73	61.97	66.26	70.63	75.05
2%	-2.67	0.51	3.76	7.08	10.45	13.89	17.40	20.96	24.59	28.29	32.05	35.87	39.75	43.70	47.72	51.79	55.93	60.14	64.40	68.73	73.13
3%	4.01	-0.85	2.37	5.66	9.01	12.42	15.89	19.43	23.04	26.70	30.43	34.22	38.08	42.00	45.98	50.03	54.13	58.31	62.54	66.84	71.20
4%	-5.35	-2.21	0.98	4.24	7.56	10.95	14.39	17.90	21.48	25.11	28.81	32.58	36.40	40.29	44.24	48.26	52.34	56.48	60.68	64.95	69.28
5%	-6.68	-3.58	-0.41	2.82	6.12	9.47	12.89	16.37	19.92	23.53	27.20	30.93	34.73	38.58	42.51	46.49	50.54	54.65	58.82	63.06	67.36
6%	-8.02	-4.94	-1.80	1.40	4.67	8.00	11.39	14.84	18.36	21.94	25.58	29.28	33.05	36.88	40.77	44.72	48.74	52.82	56.96	61.16	65.43
7%	-9.35	-6.30	-3.19	-0.01	3.22	6.53	9.89	13.31	16.80	20.35	23.96	27.64	31.37	35.17	39.03	42.96	46.94	50.99	55.10	59.27	63.51
8%	-10.69	-7.67	-4.58	-1.43	1.78	5.05	8.39	11.78	15.24	18.76	22.35	25.99	29.70	33.47	37.30	41.19	45.14	49.16	53.24	57.38	61.58
9%	-12.03	-9.03	-5.97	-2.85	0.33	3.58	6.88	10.25	13.68	17.17	20.73	24.34	28.02	31.76	35.56	39.42	43.35	47.33	51.38	55.49	59.66
10%	-13.36	-10.39	-7.36	-4.27	-1.11	2.11	5.38	8.72	12.12	15.59	19.11	22.70	26.34	30.05	33.82	37.65	41.55	45.50	49.52	53.59	57.73
11%	-14.70	-11.76	-8.75	-5.68	-2.56	0.63	3.88	7.19	10.57	14.00	17.49	21.05	24.67	28.35	32.09	35.89	39.75	43.67	47.66	51.70	55.81
12%	-16.04	-13.12	-10.14	-7.10	-4.00	-0.84	2.38	5.66	9.01	12.41	15.88	19.40	22.99	26.64	30.35	34.12	37.95	41.84	45.80	49.81	53.88
13%	-17.37	-14.48	11.53	-8.52	-5.45	-2.32	0.88	4.13	7.45	10.82	14.26	17.76	21.31	24.93	28.61	32.35	36.15	40.01	43.93	47.92	51.96
14%	-18.71	-15.85	-12.92	-9.94	-6.89	-3.79	-0.62	2.60	5.89	9.24	12.64	16.11	19.64	23.23	26.88	30.58	34.35	38.18	42.07	46.02	50.04
15%	-20.05	-17.21	-14.31	-11.36	-8.34	-5.26	-2.12	1.07	4.33	7.65	11.03	14.46	17.96	21.52	25.14	28.82	32.56	36.35	40.21	44.13	48.11
16%	-21.38	-18.57	15.70	-12.77	-9.78	-6.74	-3.63	-0.46	2.77	6.06	9.41	12.82	16.29	19.81	23.40	27.05	30.76	34.52	38.35	42.24	46.19
17%	-22.72	-19.94	-17.09	-14.19	-11.23	-8.21	-5.13	-1.99	1.21	4.47	7.79	11.17	14.61	18.11	21.66	25.28	28.96	32.70	36.49	40.35	44.26
18%	-24.06	-21.30	-18.48	-15.61	-12.68	-9.68	-6.63	-3.52	-0.35	2.88	6.17	9.52	12.93	16.40	19.93	23.51	27.16	30.87	34.63	38.45	42.34
19%	-25.39	-22.66	-19.87	-17.03	-14.12	-11.16	-8.13	-5.05	-1.90	1.30	4.56	7.88	11.26	14.69	18.19	21.75	25.36	29.04	32.77	36.56	40.41
20%	-26.73	-24.03	-21.26	-18.44	-15.57	-12.63	-9.63	-6.58	-3.46	-0.29	2.94	6.23	9.58	12.99	16.45	19.98	23.56	27.21	30.91	34.67	38.49
21%	-28.06	-25.39	-22.66	-19.86	-17.01	-14.10	-11.13	-8.11	-5.02	-1.88	1.32	4.58	7.90	11.28	14.72	18.21	21.77	25.38	29.05	32.78	36.56

Reactive approach is cheaper

Proactive approach is cheaper

Figure 3-5: Sensitivity studies Reactive vs Proactive Case 2

The level of efficiencies gained through a proactive approach will vary significantly scheme-by-scheme based on a range of factors including the number of interventions which can be coordinated per individual area, how much excavation resource can be shared, and whether other costs such as traffic management measures can avoid being repeated. As well as experiencing significant delivery challenges, we estimate a reactive approach to be between 15% 25% more expensive than a proactive approach

These sensitivity assessments demonstrate the efficiencies of the proactive approach significantly outweigh the cost of bringing the interventions forward, this demonstrates that this is a low regrets activity and provides further justification for our proactive approach.

4 Appendix

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