NICE – Options Appraisal Summary Table

JSM

A report from Nature Positive

Tender no. 2740293

nature positive

JULY 2023

General notes

Title:	**NICE – Options Appraisal Summary Table**
Client:	**JSM**
Issue Date:	**18th October 2023**
Issuing Office:	**Bath, UK**

Author:	**Dr Rossa Donovan**	**Project Manager**	**Date:**	**18th October 2023**
Reviewer:	**Dr Stephanie Wray**	**Technical Reviewer**	**Date:**	**18th October 2023**

Contents

1 Executive summary

Fluid-filled cables (FFCs) used in the high voltage electricity transmission system, operating at 66kV, 132kV, 275kV and 400kV, are buried in the ground in situations where overhead lines are not appropriate (e.g., for visual amenity reasons, or in urban areas).

Many of the fluid-filled cables in use were predominantly installed in the 1960's, 70's and 80's and have an average asset life of about 60 years. As such many FFCs are approaching the end of their useful life or have already been decommissioned.

The fluid used in FFCs is used to ensure the integrity of the main paper insulation and is either mineral naphthenic oil, linear alkylbenzene or a mixture. Mineral naphthenic oil is known to be toxic in aquatic ecosystems and can pollute aquifers, groundwater and freshwater bodies should the cables leak.

Until now, there have been two approaches used to decommission FFCs – they are either dug out of the ground via open trenches with cable components being recycled, or they are left in-situ after draining the majority of the cable fluid and capping the ends after which they are regularly monitored for deterioration and fluid leakage. While best efforts are made to remove all cable fluid when decommissioning redundant cables, it is not possible to remove all of it and many decommissioned cables contain residual amounts of fluid, which is why they are monitored periodically for leakage.

An innovative solution, called NICE (non-intrusive cable extraction), has been developed by JSM as an alternative to traditional cable decommissioning methods.

This report documents the outcomes of an appraisal of all three options presented as an Options Appraisal Summary Table using National Grid's approach for comparing options.

Of the three options, JSM's NICE solution was found to be, the safest, less environmentally damaging than the other two methods, more cost effective, and have fewer socio-economic impacts. A pilot study has demonstrated that the NICE solution is technically feasible and that it works well in most situations, especially for straight cable runs. As such, the NICE solution is considered to be best practice for decommissioning/removing FFCs.

2 Introduction

Fluid-filled cables (FFCs) are used in the high voltage electricity transmission system. Operating at 66kV, 132kV, 275kV and 400kV, FFCs are buried in the ground in situations where overhead lines are not appropriate (e.g., for visual amenity reasons, or on urban areas). It is estimated that there are 7,800km of underground fluid-filled cables (FFCs) in the UK, of which National Grid operates about 1,400km.

Many of the fluid-filled cables in use were predominantly installed in the 1960's, 70's and 80's and have an average asset life of about 60 years. As such many FFCs are approaching the end of their useful life or have already been decommissioned. The fluid used in FFCs is used to ensure the integrity of the main paper insulation and is either mineral naphthenic oil, linear alkylbenzene or a mixture. Mineral naphthenic oil is known to be toxic in aquatic ecosystems and can pollute aquifers, groundwater and freshwater bodies should the cables leak.

Until now, there have been two approaches used to decommission FFCs – they are either dug out of the ground via open trenches with cable components being recycled, or they are left in-situ after draining the majority of the cable fluid and capping the ends after which they are regularly monitored for deterioration and fluid leakage. While best efforts are made to remove all cable fluid when decommissioning redundant cables, it is not possible to remove all of it and many decommissioned cables contain residual amounts of fluid, which is why they are monitored periodically for leakage.

JSM is a utilities service provider that specialises in the delivery of integrated power and communications solutions. JSM has recently developed a solution, called NICE (non-intrusive cable extraction), which is an innovative method for removing decommissioned FFCs without the need for traditional open cut trenching for the entire length of the cable. Not only does this solution mitigate the environmental risks of leaving decommissioned cables buried, but it also enables cable components to be fully recycled. This is especially important given the price of metals, such as copper, and the push for better waste management and good circular economy practices.

JSM asked Nature Positive to carry out an options appraisal of the methods currently used in the electricity industry to decommission cable and their NICE method to compare how they differ across four categories: Health and Safety; Technical; Cost; Environment and Socio-economic. This report presents the results of the appraisal as an Options Appraisal Summary Table (OAST).

3 Options Appraisal Summary Table

3.1 Health and Safety

As with any cable buried, there is a risk of any parallel cables running alongside to induce a potentially harmful voltage on the metal components, which can give rise to electric shock should persons inadvertently come into contact with the cable metallic sheath or the main conductor, regardless of whether they are in service, out of service or disconnected from the substations. The risk can be mitigated in redundant cables by reducing the section lengths, however the risk is not completely removed, processes are put in place to manage the risk when work needs to be undertaken on the cables, however inadvertent contact could result in a harmful shock.

Health and Safety	Option 1: Excavate trench and remove fluid-filled cable (FFC)	Option 2: Leave FFC in situ, drain fluid, cap and monitor	Option 3: NICE JSM's no-dig method
Induced Voltage Electric Shock	Risk removed.	Risk to diggers working in close proximity to redundant cables and NG or third-party operatives carrying out the cable purging.	Risk removed.

3.2 Technical

Technical	Option 1: Excavate trench and remove fluid-filled cable (FFC)	Option 2: Leave FFC in situ, drain fluid, cap and monitor	Option 3: NICE JSM's no-dig method
Technical complexity	This option is not expected to cause any major technical challenges as it is already a tried and tested method.	This option is not expected to cause any major technical challenges as it is already a tried and tested method.	While this is a relatively new technique, trials have shown promising results – that it works well in most situations, particularly on straight cable runs.
Construction/delivery issues	Removal of cable using this technique will require significant amounts of machinery and labour, deployed	While this option will require less machinery and labour deployment than option 1, there will still be a requirement for digging pits at	This option is similar to option 2 except that there would no need to revisit pit locations to monitor

	over a long period of time across multiple land-holdings. The removal of the cable will negate the need for ongoing monitoring of cables, as required for option 2.	intervals along the route. This option does not remove the risk of fluid leaking from disused cables as not all the residual oil can be removed. Therefore, there will be a need to revisit the locations periodically to monitor residual cable fluid levels.	residual cable fluid levels.
Technology issues	None identified	None identified	None identified
Capacity issues	N/A	N/A	N/A
Network efficiencies/benefits	While this option does allow full recovery and recycling of redundant FFCs allowing scrap materials costs to be recouped, this method of cable recovery is the least efficient of all three options.	While this option requires less machine time and labour than option 1, it does not recover and recycle the cable materials which means scrap value cannot be recouped. In addition, this method requires regular monitoring in perpetuity.	This option requires similar levels of machine time and labour to option 2. However, there is no need for ongoing monitoring and the scrap value of the cable can be recouped.
Summary	**This option does not present any significant technical challenges but is the least efficient method of all 3 options.**	**This option does not present any significant technical challenges in that it is a tried and tested technique. It does, however, require ongoing monitoring which the other two options don't.**	**This option is a relatively new technique, but trials have shown promising results in most situations, particularly on straight cable runs. In situations where it is not possible to deploy the NICE solution (e.g., where there are multiple bends) options 1 or 2 may need to be employed.**

3.3 Cost

Cost	Option 1: Excavate trench and remove fluid-filled cable (FFC)	Option 2: Leave FFC in situ, drain fluid, cap and monitor	Option 3: NICE JSM's no-dig method
Capital cost	**££high** – this is likely to be the most expensive of 3 options.	**££moderate** – costs are likely to be lower than option 1, but higher than option 3 because the scrap value of the cable is not recouped.	**££low** – this is likely to be the cheapest option requiring the minimum amount of excavation and enabling the scrap value of the cable to be recouped.
Lifetime cost	N/A – no ongoing costs after cable removal	££low-moderate – will require ongoing monitoring and presumably cable removal eventually.	N/A – no ongoing costs after cable removal
Summary	**This is likely to be the most expensive option.**	**This is likely to be the mid-cost option.**	**This is likely to be the least expensive option.**

3.4 Environment

Environment	Option 1: Excavate trench and remove fluid-filled cable (FFC)	Option 2: Leave FFC in situ, drain fluid, cap and monitor	Option 3: NICE JSM's no-dig method
Description of option	This option involves digging an open cut trench along the length of the FFC route, removing the cable, backfilling the trench and making good.	This option involves digging pits at intervals, cutting the cable, draining off cable fluid and capping the cable which is then left in situ and monitored periodically for leakage of residual cable fluid.	This option involves digging 'launch' and 'receive' pits at intervals along the cable route, cutting the cable, draining off the cable fluid, removing the cable in sections using JSM's purpose-built cable de-bonding tool connected to the NICE rig. Recovered cables are then fully recycled and sub-surface cavities are backfilled with cement-bound sand (CBS) to mitigate subsidence risk or a duct is pulled through the cavity which can be used as a conduit for other services (e.g., telecoms).
Ecology	This option is likely to have the greatest **negative impact** on ecology as it will involve the destruction and disturbance of habitats along the trench route. Impacts will be greatest in areas of high biodiversity such as in sites designated for nature conservation (e.g., SSSIs and SACs), which often contain nationally important habitats.	This option will have a smaller impact than option 1, likely resulting in only a **minor negative impact**. It will still result in the destruction and disturbance of habitats but these will only likely occur in discrete locations, with the possibility that they will still occur in areas of high biodiversity such as in sites designated for nature conservation	This option will have a smaller impact than option 1 (and likely similar to option 2), likely resulting in only a **minor negative impact**. It will still result in the destruction and disturbance of habitats but these will only likely occur in discrete locations, with the possibility that they will still occur in areas of high biodiversity such as in sites designated for

	Many habitats are difficult and expensive to replicate/reinstate often taking years of aftercare to return them to close to pre-excavation conditions. In addition, the presence of long sections of trench will cause a barrier to the movement of protected and non-protected species alike which may interrupt their breeding lifecycles or their ability to access important foraging areas. This is especially significant when animals are raising their young when they require much larger foraging ranges to nourish their young. Open trenches also pose a danger of death or injury to animals that may become trapped in them.	(e.g., SSSIs and SACs), which often contain nationally important habitats. Habitat restoration measures will still be required although at a much smaller scale than in option 1. This method is unlikely to have any significant impacts on the movement of protected and non-protected species across the landscape. Without appropriate mitigation, there is still potential for death or injury of animals becoming trapped in access pits although this will be much reduced.	nature conservation (e.g., SSSIs and SACs), which often contain nationally important habitats. Habitat restoration measures will still be required although at a much smaller scale than in option 1. This method is unlikely to have any significant impacts on the movement of protected and non-protected species across the landscape. Without appropriate mitigation, there is still potential for death or injury of animals becoming trapped in access pits although this will be much reduced.
GHG emissions	This option is also likely to have the greatest **negative impact** on GHG emissions due to the amount of excavation required which will presumably be carried out by diesel powered machinery. This impact could be lessened by using biofuels. In addition, any transport of	This technique will produce fewer GHG emissions than option 1 due to the reduced excavation needs and reduced transport of muck/backfill to/from site. The use of biofuels to power machinery and vehicles could be used to reduce GHG emissions.	This technique will produce fewer GHG emissions than option 1 (and similar to option 2) due to the reduced excavation needs and reduced transport of muck/backfill to/from site. The use of biofuels to power machinery and vehicles could be used

	waste materials from site will likely create further GHG emissions given the likely use of diesel-powered trucks. Again, this impact could be reduced if trucks were powered by biodiesel.		to reduce GHG emissions.
Pollution to water	Assuming there is no escape of cable fluid during the removal of the cables there should be **no impact** on ground water. There is a chance that excavated soil could escape into waterways unless appropriate measures are put in place to prevent it.	With this option, FFCs are cut into sections, cable fluid is removed and the cable ends are then capped. The FFCs are left in situ and monitored periodically. The reason for the periodic monitoring is that it is not possible to extract all of the cable fluid and therefore a residual amount remains. Despite regular monitoring for fluid escape, there is always a chance that fluid may escape into the environment should any of the caps fail between inspection visits. The fluids used in FFCs are mineral naphthenic oil, linear alkylbenzene or a mixture, both of which have been provisionally determined as List 1 substances under the Groundwater Regulations national-fluid-filled-cable-operating-code-2015.pdf (energynetworks.org).	With this option, FFCs are cut into sections and then removed with measures taken to stabilise the cavity left by the cable. As part of this FFC fluid will need to be removed and assuming there is no escape of cable fluid during removal there should be no impact on ground water. Furthermore, with the cables removed, there will be no long-term risk to groundwater pollution.

		Their release into groundwater sensitive areas is likely to be problematic with the potential to contaminate groundwater (and therefore water supplies) and other groundwater-fed aquatic environments.	
Pollution to soil	Assuming there is no escape of cable fluid during the removal of the cables there should be **no impact** on soil or its associated biota.	While FFC fluid is only considered to be toxic in the aquatic environment, release to soil has the potential to contaminate groundwater and other groundwater-fed aquatic environments.	Assuming there is no escape of cable fluid during the removal of the cables there should be **no impact** on soil or its associated biota.
Pollution to air	Excavation of soil poses a risk of soil particles escaping into the environment due to wind erosion. In addition, particulates created from exhaust fumes have the potential to worsen air quality – this is the case for both fossil-fuel derived diesel and biofuels.	This option is likely to produce fewer emissions to air, either from wind erosion or exhaust fumes, than option 1.	This option is likely to produce fewer emissions to air, either from wind erosion or exhaust fumes, than option 1, with the outcome considered to be similar to option 2.
Waste	This option has the potential to produce significant amounts of waste with concrete and soil being taken away from site to landfill or for processing elsewhere. In addition, backfill materials need to be sourced and	This option is likely to produce much less waste than option 1. This option does not recover or recycle any of the cable components. Metals such as copper are finite commodities and are in high demand, therefore every effort must be	This option is likely to produce much less waste than option 1 and option 2. The method ensures that the cables are recovered with 100% of their component parts recycled. This is considered to be the most favourable option achievable in

	transported to site as part of the backfilling operation. The cable materials (oil, armoured layer, aluminium, copper and PVC sheathing can be fully recycled by using this technique.	made to recycle them where possible.	the waste hierarchy and represents good circular economy practice.
Noise	There is the potential for negative noise impacts using this technique as a result of the need for prolonged periods of excavation and the transport of materials to and from site. This has the potential to affect both human and animal receptors. While noise mitigation measures can be put in place to reduce the impacts of the noise, they aren't 100% effective and there will still be some residual noise-related impacts.	There is the potential for negative noise impacts using this technique as a result of the need for excavation and the transport of materials to and from site. Although, this will be much reduced compared to option 1. This has the potential to affect both human and animal receptors. While noise mitigation measures can be put in place to reduce the impacts of the noise, they aren't 100% effective and there will still be some residual noise-related impacts.	There is the potential for negative noise impacts using this technique as a result of the need for excavation and the transport of materials to and from site. Although, this will be much reduced compared to option 1. This has the potential to affect both human and animal receptors. While noise mitigation measures can be put in place to reduce the impacts of the noise, they aren't 100% effective and there will still be some residual noise-related impacts.
Disturbance/disruption	This option takes the longest amount of time to achieve and can affect large areas of land at the same time. This is likely to result in longer periods of disturbance to both humans and animals when compared with options 2 and 3. In addition, this method can result in economic disruption	This option is likely to cause less disturbance/disruption than option 1 and will affect smaller, more discrete areas. There is still likely to be some (although reduced compared to option 1) disruption/disturbance to humans and animals. The same can be said for economic disruption.	Disturbance/disruption levels are likely to be the same as option 2.

	due to road closures or disruption to agricultural land for example.		
Summary	**This is the most environmentally damaging option when compared with the other two options. This method will have the greatest negative impacts on ecology, produce the most waste, noise, GHG emissions, pollution to air and disturbance/disruption to animal and human receptors, and economic disruption. This method does enable the recovery and recycling of the cable and its components which is obviously desirable.**	**This option is potentially less damaging than option 1 and potentially more damaging than option 3. Environmental impacts are likely to be broadly similar to option 3 with regards to ecology, GHG emissions, pollution to air, noise and disturbance/disruption. However, the risk of FFC fluid escape to soil, groundwater and freshwater-fed aquatic environments and the missed opportunity to recycle redundant cable materials mean that this option is inferior to option 3.**	**This option is the least environmentally damaging of all 3 options. While there will be some negative impacts with respect to ecology, GHG emissions, noise, pollution to air and disturbance/disruption, these are likely to minor and mitigation measures can be used to minimise or avoid impacts. Pollution impacts to soil and water are considered unlikely provided appropriate measures are put in place to prevent the escape of cable oil into the environment. This method does enable the recovery and recycling of the cable and its components which is obviously desirable.**

3.5 Socio-economic

Socio-economics	Option 1: Excavate trench and remove fluid-filled cable (FFC)	Option 2: Leave FFC in situ, drain fluid, cap and monitor	Option 3: NICE JSM's no-dig method
Socio-economics	This option is likely to have the greatest negative socio-economic impact. Given that the method involves removal of the cable using an open trench method, it is likely to cause disruption for multiple landowners and the public. For example, where cables are located in agricultural land, this could have economic impacts due to reduced productivity. Where cables are located in roads, this could lead to road/lane closures which is likely to reduce traffic flow and increase journey times which may have minor negative impacts on the local economy as well as other impacts such as poorer air quality.	This option will have a smaller negative socio-economic impact than option 1. The range of impacts are likely to be the same although reduced in magnitude and duration. Repeated monitoring visits may have minor impacts. However, in the event of any fluid leaking from the cables and entering groundwater or freshwater bodies, there is a chance of additional long-term negative socio-economic impacts.	This option will have a smaller negative socio-economic impact than options 1 or 2. Where cavities are backfilled with ducts rather than CBS there is potential for a positive socio-economic impact as this will enable the laying of new cables with minimal disruption compared to current installation techniques.
Summary	**This option will have the greatest negative socio-economic impacts.**	**This option will have the second-greatest negative socio-economic impacts.**	**This option will have the smallest negative socio-economic impacts.**

4 OAST Summary Matrix

Category/Option	Option 1: Trench and remove	Option 2: Drain, cap and monitor	Option 3: NICE
Health & Safety	🟢	🔴	🟢
Technical	🔴	🟡	🟢
Cost	🔴	🟡	🟢
Environment	🔴	🟡	🟢
Socio-economic	🔴	🟡	🟢

Key:

🔴 Worst option

🟡 Second worst option

🟢 Best option

5 Conclusions

JSM's NICE solution was found to be the best option of the three options considered.

From a health and safety perspective, the NICE solution, along with option 1, completely removes potentially harmful electric shock risks from induced voltages.

Importantly, the NICE solution has the smallest environmental impact, mainly because damage to biodiversity is much reduced when compared to option 1 (excavate trench and remove FFC), but also because it removes the risk of fluid leakage and allows all materials to be recycled which is not possible with option 2 (drain FFC and leave in situ).

The NICE solution was also considered to be the most cost-effective of the three options. Given the high price of copper and other metals used in FFCs, the recovery and recycling of cables has been shown to more than offset the costs of cable removal in one of the pilot studies and has the potential to vastly reduce the costs of removing redundant cables across the network, when compared with options 1 and 2.

The NICE solution was also considered to have the least socio-economic impacts when compared to options 1 and 2.

Of the three options, JSM's NICE solution was found to be, the safest, less environmentally damaging than the other two methods, more cost effective, and have fewer socio-economic impacts. A pilot study has demonstrated that the NICE solution is technically feasible and that it works well in most situations, especially for straight cable runs. As such, the NICE solution is considered to be best practice for decommissioning/removing FFCs.