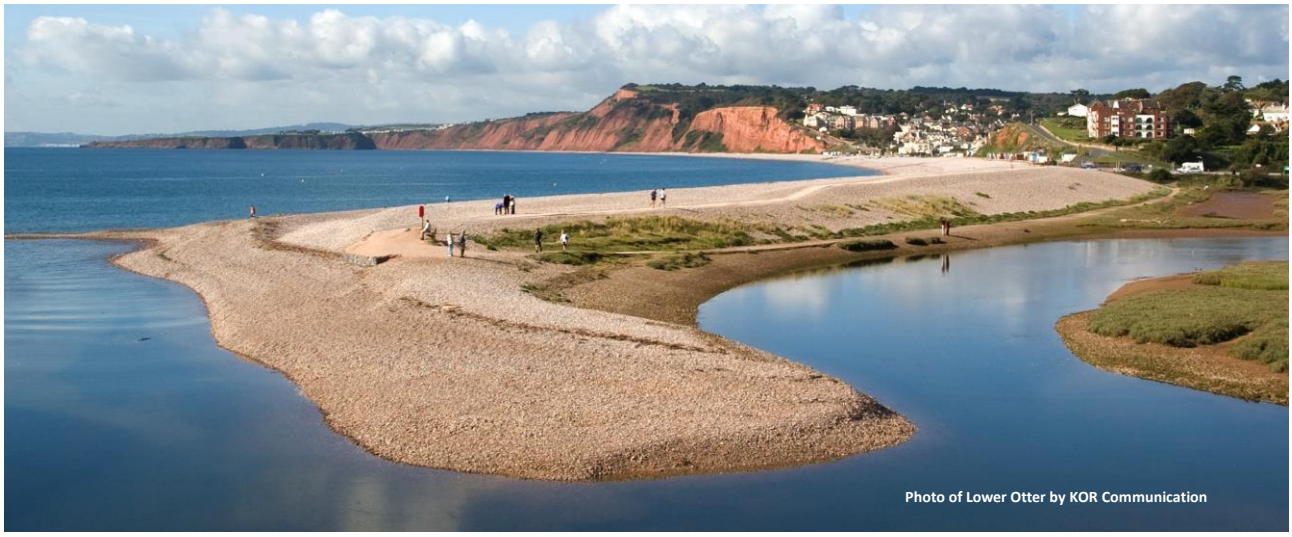


Promoting Adaptation to Changing Coasts (PACCo)

Lower Otter restoration project – case study of the disused tip

Date: December 2022

Version: 5

Document version control and final sign-off:

Version #	Date	Description	Author (s)	Reviewed by	Approved by
1	31/05/2022	First draft	Ben Fouqué	Kendal Archer	
2	06/06/2022	Second draft	Ben Fouqué	Lydia Burgess-Gamble	
3	29/06/2022	Third draft	Ben Fouqué	Kendal Archer	
4	29/07/2022	Fourth draft	Ben Fouqué	Lydia Burgess-Gamble	Lydia Burgess- Gamble
5	06/12/2022	Final report	Ben Fouqué	Lydia Burgess-Gamble	Lydia Burgess- Gamble

Published by:
Environment Agency
Horizon House, Deanery Road,
Bristol BS1 5AH

This report should be cited as:

Fouqué, B., 2022. Promoting Adaptation to Changing Coasts – Lower Otter restoration project case study of the disused tip. Environment Agency, Horizon House, Bristol.

Further copies of this report are available here: Promoting Adaptation to Changing Coasts (pacco-interreg.com)

Author(s):
Ben Fouqué

Keywords:
PACCo, LORP, historical landfill, flood risk, erosion

Consultant:
Not applicable.

Work package lead:
Camille Simon (Conservatoire du littoral)

Contents

Figure

Maps

Photos

Foreword

The Promoting Adaptation to Changing Coasts (PACCo) project is a cross-border initiative which is financially supported by the INTERREG VA France (Channel) England programme co-financed by the European Regional Development Fund.

The broad aim of PACCo is to demonstrate that it is possible to work with stakeholders in estuarine regions to deliver a range of benefits for people and the environment by adapting pre-emptively to climate change. It has a total value of €27.2m, with €18.8m coming from the European Regional Development Fund (ERDF).

The project focuses on two pilot sites: the Lower Otter Valley, East Devon, England and the Saâne Valley in Normandy, France.

For more information see: Promoting Adaptation to Changing Coasts (pacco-interreg.com)

Acknowledgements

I would like to express my gratitude to Clinton Devon Estates for sharing their archives on the disused landfill which enabled the writing of the case study and especially Kendal Archer and Sam Bridgewater for reviewing the draft.

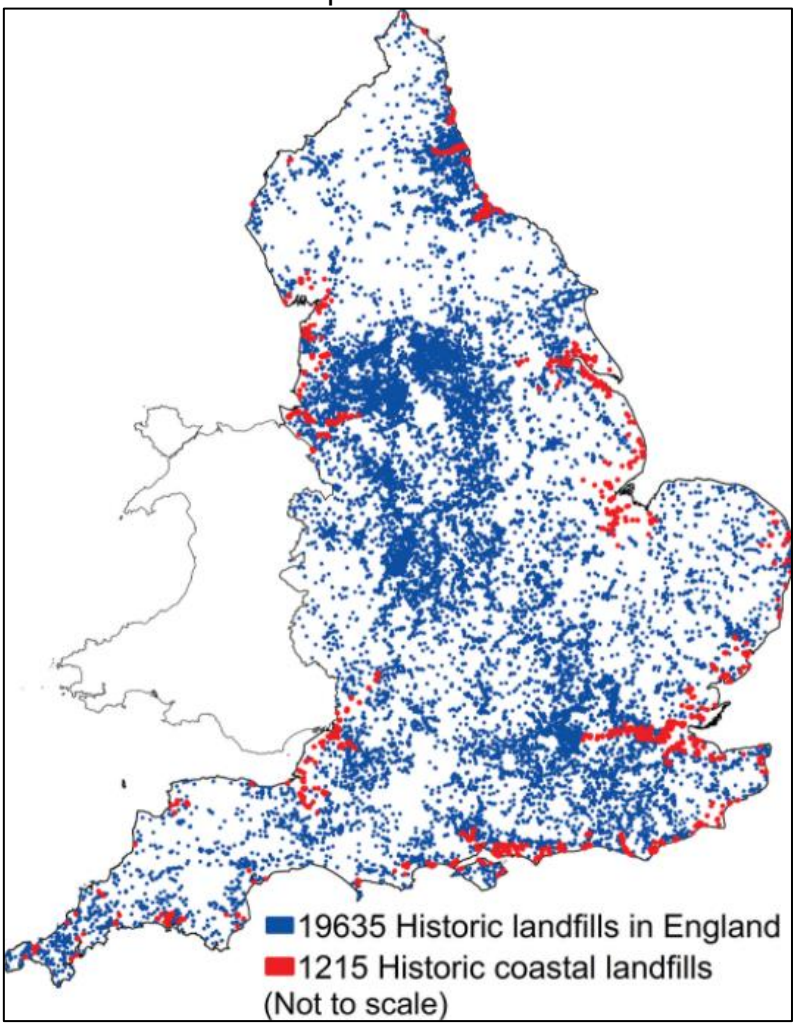
I would also like to thank the Environment Agency's PACCo team, especially Lydia Burgess-Gamble, Mike Williams and Megan Rimmer for sharing their knowledge and assisting me in the writing of this document.

Finally, I am also grateful to Jacobs for sharing their design information and drawings. I am also grateful to Kier for sharing photos I would like to particularly thank Bernard Biel from Kier for taking the time to visit the site with me, answering my questions and providing details on the construction.

1. Lower Otter restoration project – case study of the disused landfill

1.1 Introduction

Historical landfills located in coastal areas have been largely implemented around Europe and England (Map 1). During the 20th century burying waste in uncontrolled landfill sites was the preferred method of waste disposal and little was known about how it would affect human health and the environment. Most of these landfills pre-date environmental regulations. Many of them are now disused and leave a legacy for future generations to manage. Whilst today, waste management is implemented in our society and well understood, this was not the case in the past.



Map 1. Location of historic landfill sites in UK (Source: Brand et al., 2017)

With the climate changing and the sea level rising, historical landfills are now under threat. Coastal and river (fluvial) flooding, as well as erosion, are expected to become more frequent, with increased intensity. These events will further impact landfill sites. For example, in England studies have found that more than 1200 sites are at risk of tidal

flooding and/or erosion (Queen Mary University of London, 2018), generating a concern surrounding the release of harmful contaminants and the impact on water quality. These coastal tips are frequently found on sites where managed realignment is planned and therefore need removal or the mitigation of their potentially harmful contents. Managing these threats is not easy and requires knowledge, funding and engineering techniques.
In the Lower Otter valley, a disused tip is located within the flood plain. This is a short case study which describes how the historic landfill has been protected as part of the Lower Otter Restoration Project (LORP). In this report the terms landfill and tip are used interchangeably.

1.2 Background

Working on two pilot sites that face similar challenges (the Otter Estuary in Devon & Saâne Valley in Normandy), the Promoting Adaptation to Changing Coasts project (referred to as the PACCo project) is a landscape scale project that addresses the risks of climate change to coastal communities and promotes the needs and benefits of early adaptation.
It aims to demonstrate that it is possible to work with stakeholders in estuarine regions to deliver a range of benefits for people and the environment by adapting pre-emptively to climate change.

PACCo will:

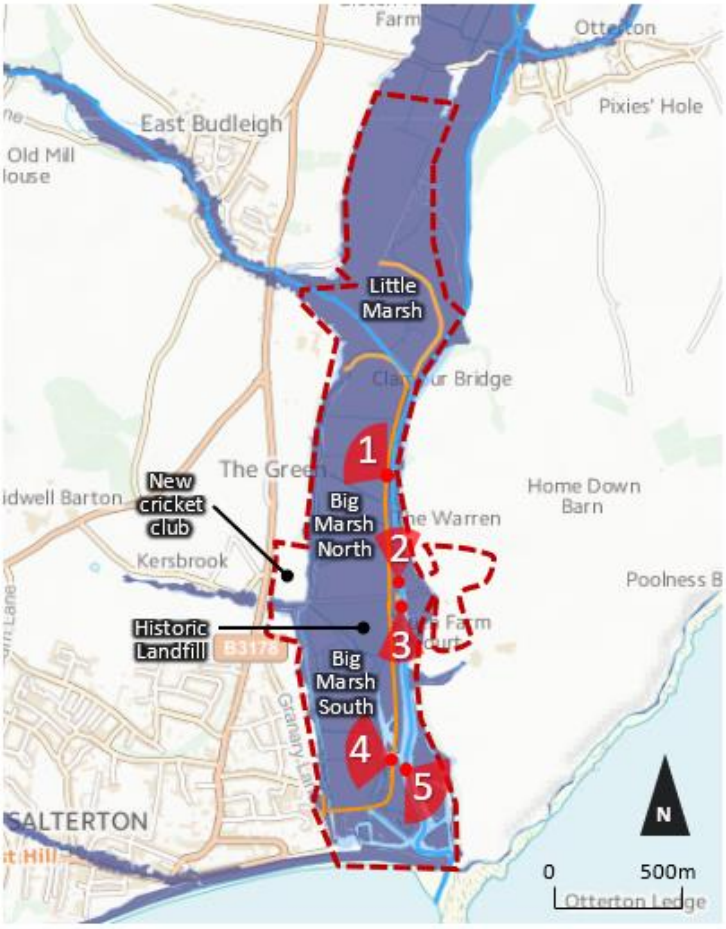
- Restore 100ha of inter-tidal and wetland habitat, which will provide biodiversity, ecosystem services and socioeconomic benefits (Map 2).
- Showcase how to work with nature to provide pre-emptive adaptation to the impacts of climate change.

The outputs of PACCo will be used to influence policy makers at national and EU level.
As part of the PACCo project, UK partners are delivering a 55ha habitat creation project on the Lower Otter in Devon (Map 3), this involves the:

- Reconnection of the River Otter to its floodplain to restore 55ha of intertidal habitat.
- Construction of a road bridge and a footbridge
- Protection of a historic tip
- Relocation of a cricket pitch

Reconnecting a river to its flood plain involves addressing a number of historical human-made environmental threats and the landfill is one of these. Without mitigation and consideration of the risks, it will impact the project outcome.

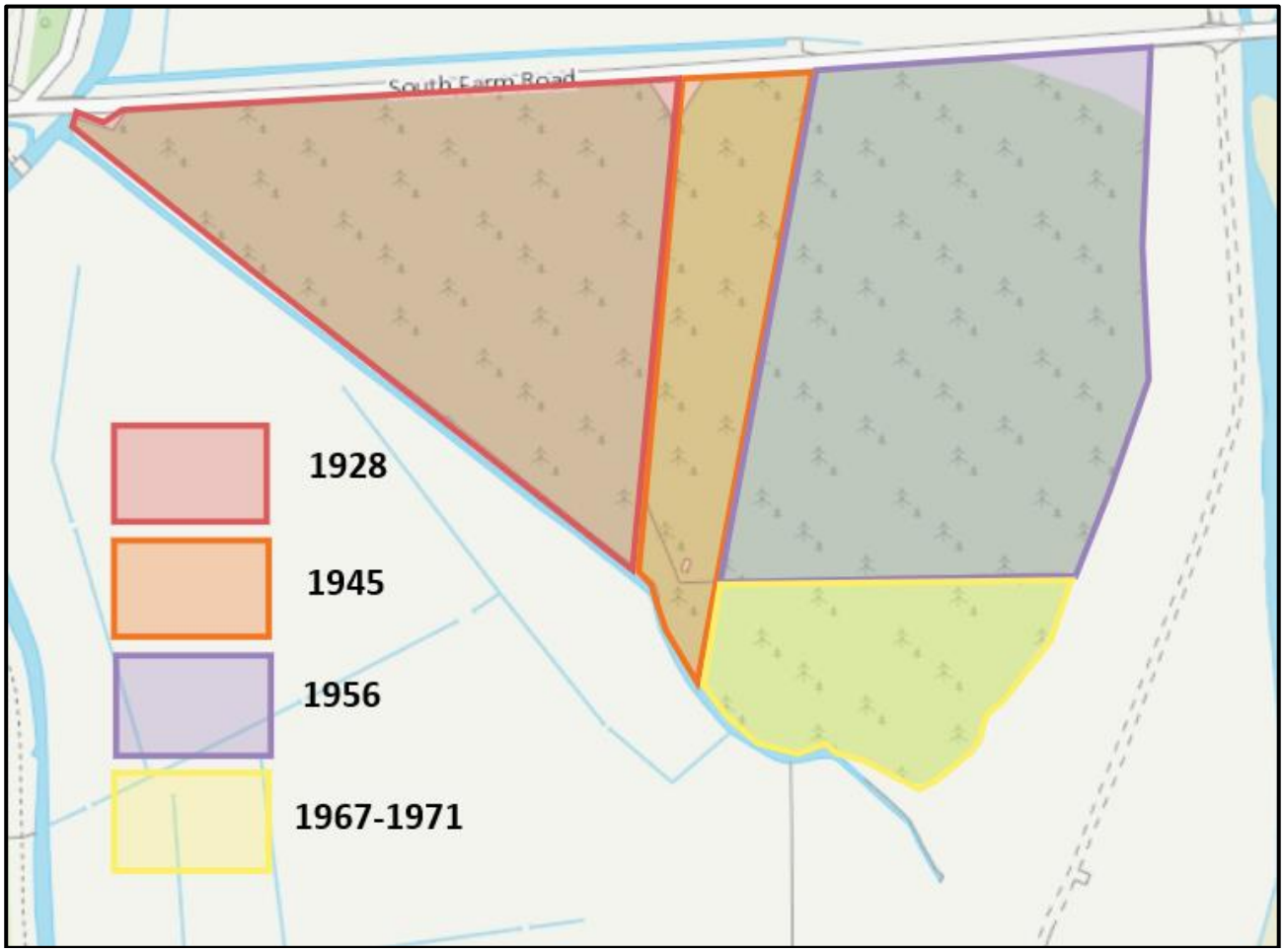
Map 2. Location of the two climate change adaptation projects which form part of PACCo



Map 3. Lower Otter restoration project site map (Source: Environment Agency, 2021)

1.3 History of the Lower Otter tip

The now disused Lower Otter tip is located along the southern edge of South Farm Road. It was first used in 1928 and gradually spread over the course of its use. This expansion accelerated from the 1970s during the last few years of the tip's use, as the amount of household waste produced began to increase. Map 4 shows the evolution of the tip.



Map 4. Evolution of the tip between 1927 and 1978 (Source: Easimap with data from Ordnance Survey, Environment Agency, 2022)

Historical refuse tips and their contents are usually not well documented, and the Lower Otter tip is no exception. It is only after its closure that regulations were introduced which require tip owners to record the types and quantities of waste and their geographic location. Communication documents between the local council and Clinton Devon Estates trace the evolution of the tip from 1928 until 1978 when it was closed.

In 1928, a proposal of a licence was made to the council from Clinton Devon Estates to use the land along South Farm Road as a tip. In the proposal the land would be divided into two areas located on the west of South Farm Road. The first part was to be used until the refuse reached 1.5 meters (5 feet) high and then allowed to settle whilst the second section was used. The total refuse tip size was approximatively 8000m^2 (2 acres).

In 1945 a new proposal was made by Budleigh Salterton Town Council to extend the tip. Further communication about the extension between the council and the Estate was undertaken between 1946 and 1952. A new licence agreement was drawn up. For the first

time a document mentioned information about the contents of the tip. The tip would be filled in layers, with the bottom layer comprised of tins and indestructible items. This layer would then be covered by a layer of cinders, dirt and refuse. The surface layer should have been topsoil, however the layer of topsoil was dismissed by the town council. With the help of a medical officer, the council showed that the tip did not represent any problems to public health. The licence regarding the extension was granted in autumn 1952.

The tip was full by 1956 and further land was applied for, which was granted the same year by Clinton Devon Estates.

During the same time, records showed complaints from Clinton Devon Estates and the adjacent farmer. The tip was described as being in a very bad state, uneven, infested by weeds and growing small trees which affected the adjacent land.

A further complaint about the tip was reported to Clinton Devon Estates in 1966. The complaint was about the deposit of fish offal which created flies and an odour problem for the adjoining neighbours. The issue was rejected by the council, which determined that it was due to the presence of the nearby marshes, however fish waste from local companies was never meant to be tipped at this site. The tip should only have been used for household waste and not for commercial purposes. This led to a disagreement between the Town Council and Clinton Devon Estates on the use of the tip. This problem was echoed in the press. No action was undertaken by either party and fish waste continued to be buried at this site.

The period between 1967 and 1971 marked a new evolution for the tip. The council offered to hand back the original tip to Clinton Devon Estates. A new extension was planned to bring it near the bank along the River Otter towards the east of South Farm Road. Litigation about the tip contents began again between both parties. The first section of the tip was capped with topsoil and handed back to Clinton Devon Estates, after which they planted trees.

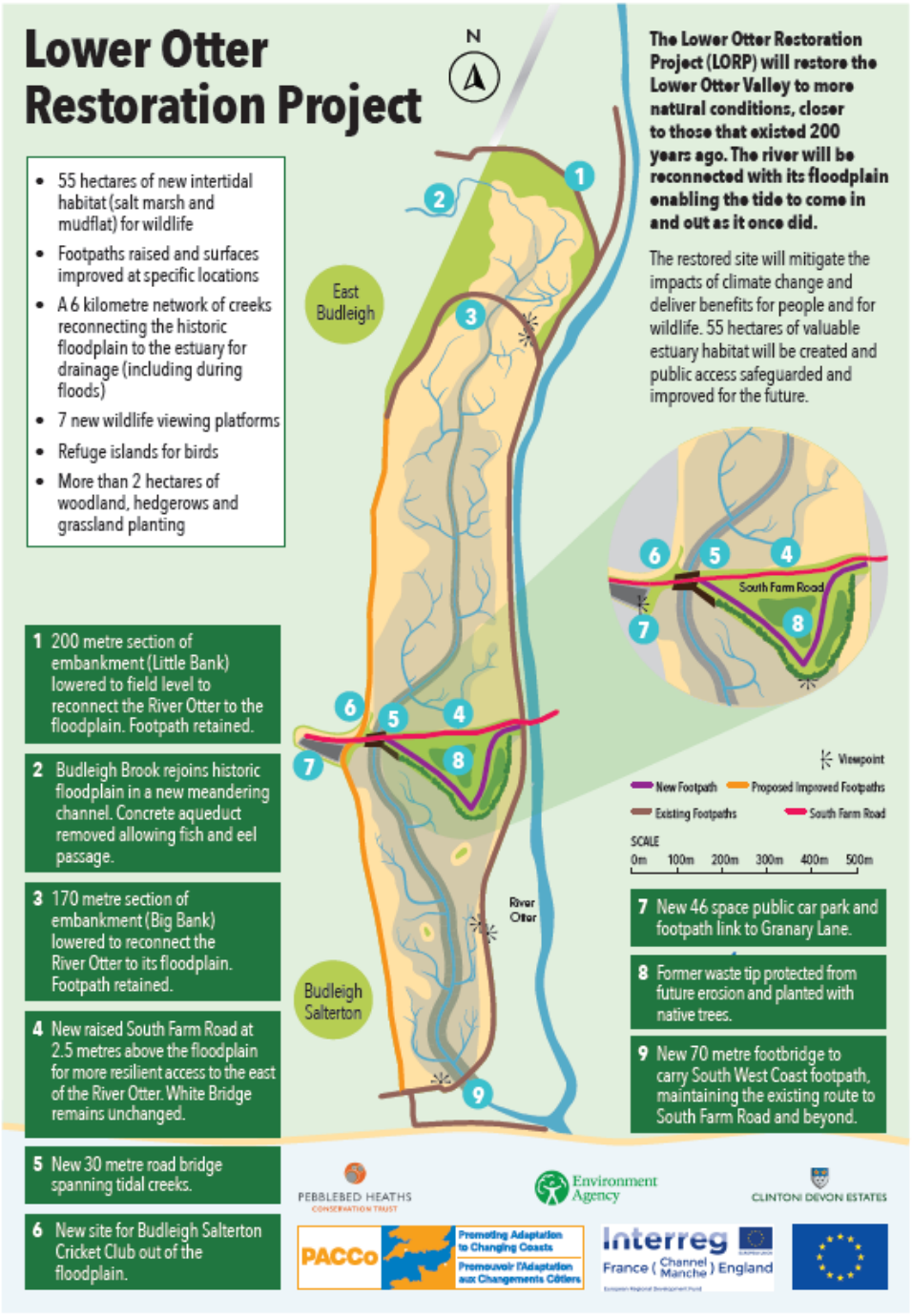
1968 is a key year. Records of communication between the Estate and the council showed the impact of flooding on the tip. Rubbish was carried onto the adjacent farmland by the floods. The closure process of the tip and reinstatement discussion started in 1976. Final closure is estimated to have been in 1978. The closure of the tip aligned with government reformation (Local Government Act 1972) which integrated local councils; Budleigh Salterton Urban District Council was integrated into East Devon District Council. It is likely that the new unified council revised their waste management sites across the district at this time.

In 1993, concerns about the liability of the Estate were raised. The location of the landfill is near water abstraction boreholes which creates a potential risk of water contamination. It was concerning as the contents of the tip could not be known for certain. It is evident that the tip could have contained material harmful to the environment and human health. The licence drawn up in the 1950’s stated that no waste of offensive nature should be tipped in the area, however knowledge of what constitutes a “harmful substance or material” has changed over the years.

1.4 Project study

The Lower Otter Restoration Project has been thoroughly studied and a long list of options created in order to select the most suitable long-term design for the site as a whole (Map 5). These options were narrowed down to four to be taken forward for discussion:

- Full scale restoration
- Assisted natural recovery
- Big and Little Marsh floodplain restoration
- Big Marsh South floodplain restoration



Map 5. Lower Otter scheme overview plan (Source: Environment Agency, 2022)

Depending on the option chosen, one of two approaches could be used; either to fully remove the landfill (full restoration option) or partially remove and cap the landfill. The preferred option was the restoration of Big and Little Marsh therefore the landfill would be partly removed in the west corner to reconnect South Big Marsh to North Big Marsh, which will then restore the floodplain. This option would also require a new road. Thus, as part of LORP, South Farm Road would be rebuilt on the northern boundary of the landfill. The remaining part of the tip would receive additional fill material to cap the waste material.

The reasons for dismissing the option of complete landfill removal are the associated financial costs, the need to identify a suitable alternative refuse site and the risks to any removal contractors. The dismissal of this option also allows the use of the current landscape for the community to enjoy.

1.5 Consultation and engagement

There has been extensive stakeholder consultation and public engagement throughout the design of the scheme since 2013. Several public consultations were held at community centres and at both parish and town council meetings. These meetings were the platforms for any public concerns to be raised.

In 2016, members of Budleigh Salterton community raised questions around the risks associated with the former landfill at an engagement meeting. The main concern was the potential pollution created by leakage from the tip but concerns also included risks associated with the project construction activities.

Further concerns were written on the planning application platform where local residents stressed their opinions and worries over the possible impacts on the landfill site from the reconnection of the floodplain.

The historic landfill was listed as receiving mainly inert and household waste but also a small amount of industrial and commercial waste. The definition of ‘waste’ when the landfill was operating between 1928 and 1978 is not the same as the current definition. The classification of wastes was not the same at the time of tipping as the classifications of different waste today. This is not surprising given that the waste hierarchy was only introduced in Europe in 1975. It was only with the Landfill Regulations of 2002 that restrictions were introduced on the disposal of different classifications of waste (hazardous, non-hazardous or inert) within the same landfill. This change in definition enhanced the local community’s concerns.

Public perception of the landfill was that it was a source of contamination that could cause harm to human health, water and the environment. Public concern was both understandable and expected, however the presence of the disused landfill and its associated risks were known to the project and its presence considered during the project development. Prior to the expression of public concern standard procedure ground investigations as well as searches on the landfill’s contents had already been planned to understand the type of waste buried. A report from the ground investigation was produced to ensure legal compliance and to understand, eliminate and reduce the risks around the contaminated land and aid in providing a suitable design (see section 1.6). This report was also provided to the public to reassure them that their concerns were being addressed in a transparent way.

1.6 Ground investigation and risks

In 2017, a ground investigation survey was undertaken at the site to obtain geo-technical and geo-environmental information to aid in the planning of the construction works associated with the Lower Otter Restoration Project. This involved digging more than twenty trial pits at the location of the former tip.
Findings showed that the key features of the landfill were:

- Up to 3.00m of made ground comprising landfill material.
- A thin or absent capping layer.
- A lack of engineered liner.
- The landfill lies directly on superficial deposits including:
  - 3.00 - 4.00m of saltmarsh deposits, comprised of soft/weak clay, silt and fine sand.
  - 2.00 - 3.00m of beach deposits, comprised of coarse sand and gravel.
- The underlying bedrock is highly weathered sandstone formation.

Laboratory analysis was undertaken on landfill materials, groundwater and surface water in and around the landfill. Leachate[1] analysis was undertaken on some of the trial pits to determine if any harmful substances could enter the environment from the landfill.
Some of the soil and leachate test results exceeded the guideline's safe value for a public park and the groundwater drinking water protected area. These values were used to assess the risk to human health from land contamination. It was assessed that the exceedance may be linked with the presence of near surface salt waters.

In some locations the high-test result values were related to waste materials within the landfill. For example, on the eastern part of the site, contaminants such as hydrocarbons (part of petroleum products) were found. This was confirmed by the sample descriptions from the trial pit which recorded the presence of asphalt and exhaust pipes. Small deposits of asbestos were also recorded in some locations within the eastern landfill. This area corresponds to the most recent part of the landfill being used.

A report was created following the ground investigation works and the potential risks were analysed throughout the project. The potential risks of contamination were considered to be moderate to low. The risk was at its highest during the construction phase.
Groundwater contamination risks were described as low because adjacent high ground and corresponding groundwater level mean that the tip is located at the bottom of the groundwater gradient and experiences upward water pressure. As such it would be highly unlikely that contamination from the landfill would impact the groundwater quality of the public water supplies.
The purpose of the report was to inform the design in order to mitigate any potential risk to the environment and human health.

Finally, the report also stated that given the age of the landfill, the partial layer of capping and the infrequent cover of permeable materials, mobile contaminants have been diluted and dispersed and are therefore likely to have already been removed from the landfill.

[1] Leachate is the liquid produced when water percolates through soil and consequentially contains dissolved and suspended materials.

1.7 Design, risk and mitigation

In the past, the surface of the landfill had been partially capped before its closure. As part of the Lower Otter Restoration Project, it was necessary to consider how to minimise the risk of contamination from the landfill during and after construction.
The design selected aimed to limit ground disturbance. This was challenging because the project involved the:

- Creation of a 30-meter span highway bridge
- Construction of a raised embankment which will host the new South Farm Road
- Creation of a footpath and viewing platforms
- Planting of new grasslands and woodland habitat, on the remaining landfill.

Designers and engineers faced several potential risks which could have had consequences during the construction phase of the project and also in the long term.

These risks included:

- Contamination of surface water due to the migration of contaminants from South Farm Road's historic landfill into the new creek channel during construction. The new creek channel developed on the western edge of the floodplain could also create a pathway which would allow movement of groundwater contamination from the landfill to the new tidal creek channel.
- Long term contamination of ground water and surface water because of the tip's erosion. Erosion due to regular tidal flows into the site through the breach could expose contaminants at the edge of the landfill as well as expose old inert waste materials which could impact the aesthetics of the site. The scheme, without mitigation in place, could increase erosion around the landfill, especially during flood events.
- Impact to human health associated with the change of use of the landfill. The introduction of a footpath and viewing platforms that will be built on top of the old tip could lead to a higher possibility that visitors are in contact with contaminated soil.

To allow the daily tidal inundations, a new creek connecting the Southern Big Marsh to Northern Big Marsh needed to be excavated. This was achieved by removing some of the tip materials on the north-west end of the tip and building a 30-meter span bridge. The proposed design required the excavation and removal of 1500m^3 of contaminated earth.

To mitigate the risk of contamination during and after construction, temporary work was designed and implemented to create an impermeable barrier between the new main creek and the landfill. Sheet piles were used to safely cap off exposed sections of the landfill material. This design provided a suitable barrier against ground water seepage as well as a safe working area for the workers.

As a consequence of the design, the channel cross-section is reduced at the bridge location. This creates high velocity and unusual flow patterns due to the presence of piers and abutments. Erosion and scour are very likely and engineering solutions needed to be implemented. For this reason, the design included the use of riprap. Riprap is an effective solution to protect the landfill from erosion where large stones interlock to form a revetment to limit erosion and dissipate water flow energy.

The New South Farm Road was raised and built partly on the northern boundary of the landfill by importing and compacting cohesive soil[2]. The new 2.5m raised road capped this section of the tip whilst providing a new road for the local community, which was raised well above the floodplain. The design of the new bank eliminated the need for deep excavation and therefore reduced the disturbance of waste. A geotextile warning layer was placed over the ground to ensure any future work does not disturb the landfill (Photo 1).

On the remainder of the landfill large trees were removed and the stumps shredded. The root balls were left in place to avoid any excavation. The cover layer of the landfill will therefore be improved. Clean soil was re-used from other areas of the scheme to cover the landfill to a depth of between 0.3 and 0.8m. This enabled the re-use of material from elsewhere on site. The clean cover also means that future maintenance works (up to the new cover depth) will not encounter contamination and will not fall under the Control of Asbestos Regulations 2012. Additional soil was placed around the edge of the landfill site. This method employed a more natural engineering approach by creating a low gradient slope to avoid erosion. Planting and seeding have been carried out over the area and two new footpaths have been created. Figure 1 shows the landfill design.

Photo 1. Orange warning geotextile under the new bank (Source: Environment Agency)

[2] Cohesive soil: Soil with a high clay content and cohesive strength.

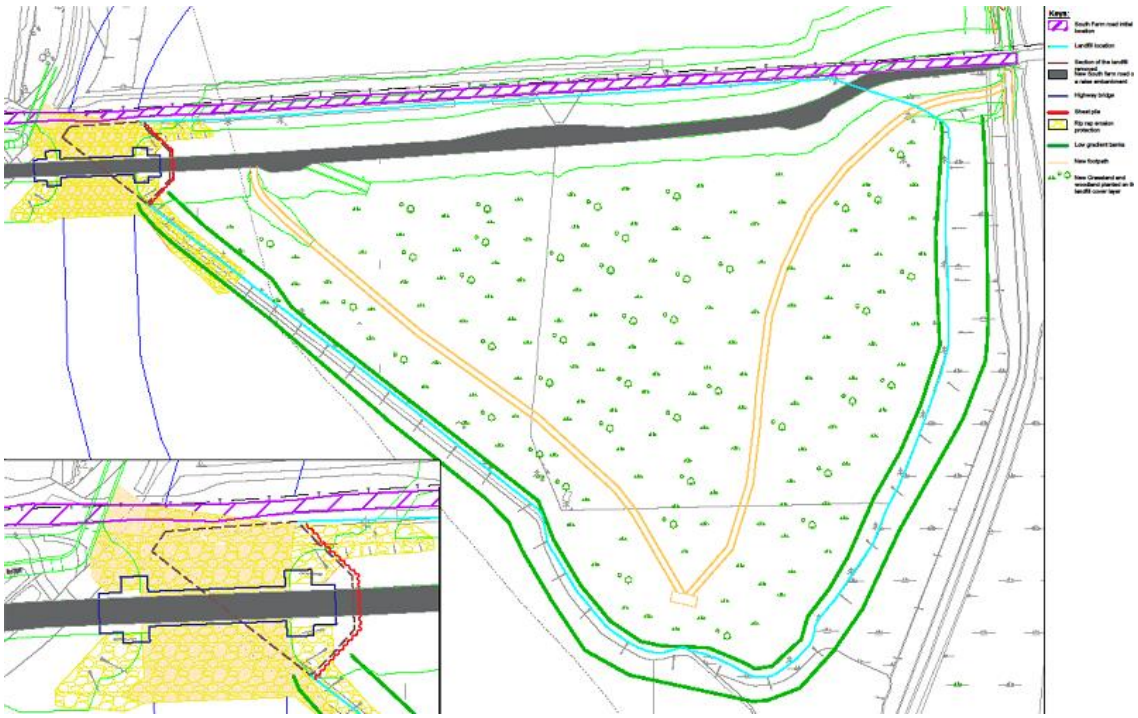


Figure 1. Landfill design (Source: Environment Agency with data from Jacobs)

1.8 Construction and mitigation

The main risk regarding the landfill was that potential contaminants would be released during excavation works, causing public health or environmental impacts. The project design intentionally limited the amount of excavation around the site, nevertheless, construction of the new highway bridge required some soil removal. Due to the potential for asbestos present, the work fell under the Control of Asbestos Regulation 2012 (CAR2012). This removed material, due to its composition and related risks, could not be reused on site and had to be tested and disposed of in a suitable facility. The contractor provided a risk assessment and subsequent mitigation methods for the removal of contaminated soil as well as the potential of encountering asbestos on the landfill site.

The earth work at the bridge location was carried out following relevant regulations (Photo 2 and 3). A specialist contractor was used for this operation. The ground was dampened prior to work starting to eliminate any airborne materials. All employees involved in the work were trained to follow the required regulations. The area was isolated from the site and was secured with specific signage. The contractors wore special PPE (personal protective equipment) as required by the CAR2012, such as respiratory protection and protective coveralls which provide defence against airborne particles and fibres, splash and spray.

A decontamination unit was set up near the area of work and a dust suppression system installed to mitigate the risk of airborne particles being generated by the excavation.

Photo 2. Excavated material controlled for asbestos (Source: Kier)

Photo 3. Excavation of contaminated area (Source: Kier)

Other landfill hazards were present in the form of debris and broken glass lying on the ground. It was imperative that the contractor ensured that appropriate PPE was worn at all times to minimise risk to onsite workers.

The new South Farm Road design required ‘surcharging’ – this involved bringing in materials and spreading them on top of the future road and bank to create an additional layer of soil. The additional weight of this material (left for 4 months) accelerated the settlement of the bank. This solution was required as a result of limited time available to complete the project. Breaching the main embankment could only occur if the road was completed and operational.

One of the risks with this design was the potential for ground water and surface water contamination, with contaminants migrating into the groundwater due to the compression of the existing landfill. This risk was identified during the design and planning phase where the need for monitoring was also identified. A monitoring plan was drawn up in order to meet planning conditions. It included monitoring the ground and surface water monthly. This was necessary to ensure contaminants remained within the landfill area and did not leach into the environment. The monitoring started two months prior to the surcharging of the road and continued until the end of the surcharge period. No contamination was discovered.

If monitoring had shown significant variances from baseline, mitigation measures would have needed to be implemented. Mitigation may involve intercepting groundwater and surface water to capture pollutants allowing them to be treated or disposed of.

1.9 Long-term management and maintenance

After the Lower Otter embankments are breached in Spring 2023, the 55ha site will be inundated twice daily at high tide. This was fully considered when designing the tip's protection works, because inundation and the movement of water has the potential to cause damage to its ground.

Studies were undertaken during the design to assess the potential impacts on the tip of inundation and how it may be exacerbated due to climate change. The study compared the previous tip layout to the new scheme layout. By raising the level of the tip and capping the upper layer, the tip is subject to less flooding (fluvial and tidal), both now and in the future.

If the Lower Otter Restoration Project was not developed, the landfill would be subject to more frequent flooding and submersion due to rising sea levels and more frequent fluvial flood events caused by climate change. The Lower Otter Restoration Project was designed to reduce the occurrence of flooding over the landfill, as well as reduce erosion and mobilisation of contaminants through percolation[3].

The scheme will be beneficial for geology and soil health. It will create a more natural river system and increased flood protection, which in turn will help to prevent pollution.
The improvement of the landfill edge will also reduce the need for long-term maintenance. Any geomorphological changes post breach still need to be monitored and inspected. The new section of road and bridge on South Farm Road will be maintained by Devon County Council. The management of the upper ground of the tip and vegetation will be undertaken by Clinton Devon Estates. A maintenance and operations manual will be provided to the landowners, highlighting any potential risks.

1.10 Conclusion

The Lower Otter disused tip is representative of many of the coastal tips dotted around the UK and more widely in Europe. The tip and its associated environmental and health issues has enabled an important case study which will benefit us when we inevitably must manage other, similar landfill sites.

Although formerly a public waste facility, liability for the tip lies with Clinton Devon Estates as the landowner. Without the PACCo project, the tip would have remained a significant environmental and public health liability. Risks (particularly those associated with flooding) would have increased in the future as sea levels rise. Funding would have had to be sourced to protect it from erosion in the event of a likely future unplanned breach to the flood embankment. This risk is real as a catastrophic breach resulting from high tides nearly occurred in 2018. Funding from the British Government and the European Regional Development Fund (via Interreg) has allowed the former landfill to be better protected from climate change with environmental and public health and safety risk within the Lower Otter valley reduced as a result.

[3] Percolation: Movement of water going slowly through the pore of soil

Public concern, the potential for contaminated leachate and the prominent public setting are likely to be issues mirrored at other locations. Lessons learned surrounding transparent communication, historical tip management, sensitive and protective construction techniques, method costs and understanding the impact of increased flooding will prove invaluable when planning future projects. It has been necessary to resolve problems in both a pragmatic and sympathetic way, which will hopefully provide a template for future processes.

Furthermore, it is critical that these areas are subject to long-term monitoring and any necessary future maintenance.

1.11 Further reading

Brand, J.H., Spencer, K.L., O'Shea, F.T., and Lindsay, J.E. 2018. Potential pollution risks of historic landfills on low-lying coasts and estuaries. WIREs Water, 5: e1264. doi: 10.1002/wat2.1264

CIRIA, 2013. *Guidance on the management of landfill sites and land contamination on eroding or low-lying coastlines (C718F).* Ciria, London.

Environment Agency, 2020. *Lower Otter restoration project – Environmental Statement.* Environment Agency, Horizon House, Bristol.

Environment Agency, 2021. *Exe estuary habitat delivery project (Lower Otter restoration project – Full Business Case.* Environment Agency, Manley House, Exeter.

Queen Mary University of London, 2018. *Eroding our future – pollution from historic landfills threatens our coastlines.* Queen Mary, London.

United Kingdom legislation, 2012. *The Control of Asbestos Regulations 2012*.