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SuRF-UK bulletin

SuRF-UK bulletins provide examples of carrying out a sustainability assessment whilst undertaking a project.

Helpston Contaminated Land Project

1. INTRODUCTION/NATURE OF ASSESSMENT

The two former dilute and disperse waste disposal sites; Ailworth Road and Ben Johnson's Pit were located on the Jurassic Limestone aquifer, with both sites causing significant groundwater contamination.

This is a retrospective review of a previous remediation options appraisal assessment, how it would have differed had the SuRF-UK framework been used and also explores the benefits SuRF-UK framework can bring.

The appraisal was undertaken at stage A and B. The land continues in its current use so the establishment of a sustainable remediation strategy and remedial technique selection was important.

2. SITE CONTEXT

In the 1980s, two unlined domestic and industrial waste landfill sites (Ailsworth Road and Ben Johnson's Pit) were established in former limestone quarries. They are located approximately 2km south of the village of Helpston and 8km to the northwest of Peterborough city centre. Operations were permitted under the Control of Pollution Act (CoPA) 1974. The practice at the time was that any leachate would dilute and disperse in the underlying Jurassic limestone aquifer and would be limited by the Marholm-Tinwell fault to the east of the landfills. This has led to significant groundwater pollution and such waste management practice would be illegal today. The CoPA permissions under which the site operated did not contain any "surrender conditions" so the operators were able to walk away from the site without any continued liability under CoPA.

The two landfills were used for the disposal of a range of materials, including a waste agricultural pesticide called mecoprop, which was disposed of in liquid (aqueous solution) form to a number of infiltration trenches within the waste facility. This has since leaked into the local aquifer causing widespread groundwater pollution, impacting a public water supply abstraction and has resulted in a mecoprop plume impacting a zone of aquifer around 8km^2 in area. This was first detected by the water company in their abstraction borehole in 1987. The water company installed activated carbon filters to treat the abstracted water while the then National Rivers Authority started an investigation to determine its source. After its formation, the Environment Agency continued these investigations and by 1996 an interim management strategy (incorporating a pilot pump and treat plant) was set up using powers under Section 161 of the Water Resources Act 1991 until a final remediation strategy was agreed.

Part 2A of the Environmental Protection Act came into force on 1st April 2000 and on 13th August 2001 Peterborough City Council determined both sites as Contaminated Land. As the significant pollutant linkages were to the scheduled Lincolnshire Limestone aquifer the Council also

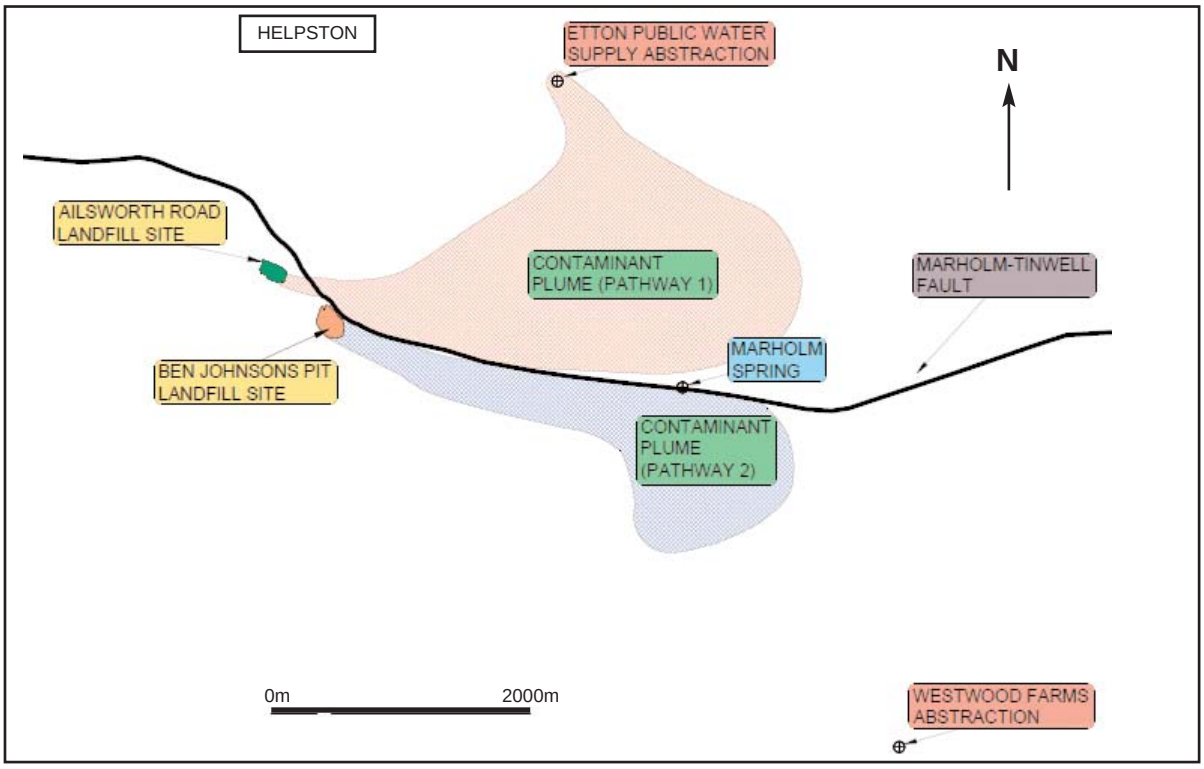

Figure 1: Helpston location map showing the modelled extent of contamination

designated both sites as Special Sites on 30th August 2001. This meant that the Environment Agency became the enforcing authority and had a duty to require remediation to be carried out.

The project objective was to break the pollutant linkage and remedy as far as practicable any pollution that had occurred. The objective, specifically for both sites, was:

"to improve the quality of the groundwater resources of the Lincolnshire Limestone Aquifer system abstracted at Etton public water supply, at other licensed and unlicensed groundwater abstraction boreholes and at groundwater discharge points, such as wild-bores, currently impacted by contamination originating from Ben Johnson's Pit and Ailsworth Road former waste disposal sites as soon as practically possible and at least cost"

Based on Environment Agency guidance on the natural attenuation of groundwater contamination[1], a remediation strategy should aim to be completed within one generation, or 30 years, mirroring the policy of sustainability proposed by the Environment Agency at that time.

The aquifer is unconfined to the west of the fault and confined to the east of the fault. The Jurassic limestone aquifer is a principal aquifer and an extremely important water resource. The Environment Agency, in the Catchment Abstraction Management Plans, has classed the aquifer to be fully committed and over abstracted.

The objectives needed to be measurable, so a timescale for remediation of the landfill area and the confined aquifer were agreed and split into two periods:

- **Period 1: Active remediation**, where the contaminant (i.e. mecoprop) concentrations in the vicinity of the landfills are lowered to a pre-determined target concentration within 30 years. Thereafter contaminant concentrations in the confined aquifer are capable of being controlled by natural attenuation, so groundwater quality at Etton meets current drinking water standards and environmental quality standards at surface water discharge points.

- **Period 2: Monitored Natural Attenuation.** Following active remediation, any residual contamination should naturally attenuate within a period of 30 years, such that concentrations throughout the confined aquifer system are below drinking water standards for mecoprop.

Compliance with these objectives will mean compliance with the remedial objectives.

The former pits are located entirely within privately owned land, in a rural area used predominantly for agriculture and recreation. Within the vicinity of the pits, there are some protected species present (badgers and great crested newts), and neighbouring and nearby sites benefit from county wildlife site status. There are relatively few people either living near or visiting the site, other than tenant farmers and the landowners. Roads in the vicinity of the site support heavy agricultural machinery and extensive local traffic. The end-use is likely to remain the same with limited public access.

3. THE SUSTAINABILITY ASSESSMENT PROCESS

The Environment Agency has a duty under Part 2A (EPA 1990) to require remediation to be carried out. The Environment Agency also has a general legal obligation to consider sustainability:

"It shall be the principal aim of the Agency in discharging its function so to protect or enhance the environment, taken as a whole, as to make the contribution towards attaining the objective of achieving sustainable development" (section 4, Environment Act, 1995)

A three-stage process was used to review the remediation options. Each stage looked at the technical and economic feasibility of each option with increasing detail. Uneconomic and technically infeasible options were dropped at the end of each stage. There were over twenty different remediation options/packages considered throughout the three stage approach. For this assessment the final stage III options are used. The remediation options considered in Stage III review are in Table 1.

Table 1: Stage III remediation options

Remediation Option	Description
Option A	Minimum Intervention with no abstraction from Etton and Northborough. No remediation in the vicinity of Ben Johnson's or Ailsworth Road landfills.
Option B	Minimum Intervention with the water company operating Etton and Northborough at a combined abstraction of 9000m^3/day (Etton at 5000m^3/d, Northborough at 4000m^3/d). No remediation in the vicinity of Ben Johnson's or Ailsworth Road landfills.
Option C	Scavenging close to the Marholm-Tinwell fault[2].
Option D	Scavenging at Werrington Junction[2].
Option E	Excavate the most contaminated waste from Ben Johnson's Pit and Ailsworth Road landfills and deposit in a new lined landfill at nearby Swaddywell Quarry.
Option F	Pump and treat system around both landfills.
Option G	Pump and treat system with a leachate collection system around both landfills.
Option H	Pump and treat system with a leachate collection system for Ben Johnson Pit with *in situ* biological treatment and back-up pump and treat system down-gradient of Ailsworth Road.

The key parties involved in the remediation options appraisal are shown in Table 2.

[1] Guidance on the Assessment and Monitoring of Natural Attenuation of Contaminants in Groundwater, Environment Agency R&D Publication 95, 2000

[2] Scavenging boreholes abstract contaminated groundwater at some location between the Source (i.e. the landfills) and the receptor (Etton/Northborough/Werrington Junction). The abstracted groundwater will be treated and then either discharged to a surface water course or re-injected to groundwater. Scavenging boreholes are designed to intercept contaminated groundwater (break the pathway to abstraction boreholes and/or wider aquifer impact) and thus do not remove mass from the source.

Table 2: Interested parties

Interested Party	Interest in project
Water Company	The water company operate the public water supplies and as a result have to treat groundwater contaminated by the former landfills. They would benefit from receiving a more secure, uncontaminated groundwater resource.
Local Authority	Interested in the details of the Remediation Scheme for the following aspects: planning permission conditions; ecology; long term management of the site; impacts on private licensed abstractions; and delivery of their Part 2A strategy.
Landowner	Interested in any works undertaken at the site and the long-term management of the site.
DEFRA	Funder of Contaminated land Capital Projects (Orphan sites). Ensure appropriate use of public monies.
Environment Agency	Ensure unacceptable risks to human health and the environment (including controlled waters) associated with Part 2A significant pollutant linkages are managed in an effective, durable and reasonable manner.

The Stage III review in 2000 consisted of a detailed economic analysis of the remediation strategies. This included an economic evaluation of all costs and benefits (social, economic and environmental) that can be easily quantified; and a non-monetised appraisal (qualitative) of all costs and benefits during and following remediation that could not be quantified. Table 3 shows the quantitative and qualitative assessment boundaries.

Table 3: Quantitative and qualitative assessment boundaries

Quantitative Assessment of Direct Costs & Benefits	Qualitative Assessment of the Non-monetary Impacts
Costs: •Capital costs •Health & Safety Costs (i.e. expenditure required to ensure Ben Johnson's Pit cannot be accessed by the public, where a potential health risk exists); •Remediation Scheme operation and maintenance costs •Public Water Supply Treatment Costs •Private Water Supply Treatment costs (adjusted over time) •Environment Agency costs Benefits: •Land value •Residual value •Groundwater value	•The environmental impacts during and following remediation, both positive and negative •Intergeneration equity issue including transfer of pollution to next generation (i.e. the status of the significant pollutant linkages after 30 years); •Impact on land property values (following remediation); •Recreational benefits that may accrue from remediation; •Impact of contamination on business competitiveness; and •Impact on non-use values (or the benefit of knowing that the pollution has or has not been addressed).

4. THE QUALITATIVE ASSESSMENT OF THE NON-MONETARY VALUES

As a simple means of comparison, a total score for each remedial strategy/option was calculated. This total score included the weighting of impacts, as follows:

- the highest weighting was given to the impact to the environment (weighting from 2 to 3) and intergeneration equity (weighting = 3).
- the lowest weighting (weighting =1) were given to:
  - the noise/air pollution as this is a relatively remote area;
  - business competitiveness as there were very few industries in the area reliant on groundwater and the main industry (water supply) had currently no competition in the area;
  - recreational benefits (may occur once remediation is complete); and
  - the gains on non-use[3] value (because the groundwater is fully utilised in a closed groundwater management unit).
- the land and property values have been assigned a weighting of 2.

Using the weighting system, the lowest ranking options from the qualitative assessment were the "do nothing" options, since these options have very limited positive impacts, other than the job creation resulting from monitoring of the contaminated plume. The highest ranked options are the pump-and-treat options, although the re-excavate and dispose option has been attributed a very similar score. The score for the scavenging options are not much greater than the "do nothing" options, primarily because scavenging is seen as a short-term groundwater protection measure but generates little wider environmental benefit.

5. QUANTITATIVE ASSESSMENT

A cost benefit analysis (CBA) was carried out in accordance with HM Treasury 'Green Book' Guidelines and Environment Agency guidance on the cost-benefit assessment of land and groundwater contamination.

It was necessary to conduct a sensitivity analysis to test the outcomes of the CBA with different values for those variables which cannot be predicted with certainty (i.e. discount rate, capital costs, economic value of groundwater).

The SuRF-UK indicators are listed in Table 4. The indicators that were included in the original assessment are highlighted in bold. These were assessed in the following ways:

- Social 1 and Economic 1 and 2 were part of the quantitative assessment. This was done by quantification of option costs and benefits in money terms, where feasible and appropriate, and determination of net present values within a CBA framework; and
- Environmental 1, 3, 4, Social 3 and 5 and Economic 2 were all part of the qualitative assessment. The qualitative assessment of relevant factors not amenable to monetisation adopted a multi-criteria analysis approach whereby impacts were appraised within a ranking and scoring framework.

[3] Economic value of the existence of uncontaminated groundwater even though the individual may not actually utilise the resource

Table 4: SuRF-UK Indicators

Environmental	Social	Economic
1. Impacts on air	**1. Impacts on human health and safety**	**1. Direct economic costs and benefits**
2. Impacts on soil	2. Ethical and equity considerations	**2. Indirect economic costs and benefits**
3. Impacts on water	**3. Impacts on neighbourhoods or regions**	3. Employment and capital gain
4. Impacts on ecology	4. Community involvement and satisfaction	4. Gearing
5. Use of natural resources and generation of wastes	**5. Compliance with policy objectives and strategies**	5. Life-span and 'project risks'
6. Intrusiveness	6. Uncertainty and evidence	6. Project flexibility

Table 5 (on page 5) is a summary table of weighting and ranking of non-monetised impacts (qualitative assessment), the cost benefit analysis results (quantitative assessment) and the combined ranking results.

6. THE SUSTAINABILITY ASSESSMENT OUTCOMES

The most economically beneficial options are through treatment at scavenger boreholes at Werrington Junction (Option C) or minimum intervention at Etton (Option B). This is because the marginal cost of groundwater was relatively low (£0.15/m^3) at the time of the assessment. The groundwater resource recovery obtained from the options that stop groundwater contaminants from migrating into the principal aquifer (Options C, E, F, G and H) does not increase the monetary benefits to such an extent that the capital investment in remediation is recovered from the improvement in groundwater quality. In addition the economic assessment does not properly address the intergenerational equity issues, where the most economic options do not remove the source of the contamination at the landfills, and thus would need to be operated beyond the 30 year economic period.

To combine the qualitative and quantitative ranking scores (see Table 5), the most advantageous options are shown in Table 6.

The overall remediation strategy adopted after a more detailed analysis was:

1. A pump and treat system to contain the contamination to the west of the Marholm-Tinwell fault and to contribute to mass recovery. This pump and treat system is to operate for 30 years unless other remediation techniques/research and development accelerate the remediation;
2. The development of "source removal options" within the containment area to accelerate the remediation process such that the remedial targets are achieved within 30 years; and
3. A monitored natural attenuation strategy for the contaminated groundwater within the confined limestone aquifer, coupled with the continued abstraction and treatment of water at the public water supply boreholes.

Table 6: Combined results

Combined Ranking	Remediation Option	Description
1st	Option H	Pump and treat system with a leachate collection system for Ben Johnson Pit with *in situ* biological treatment and back-up pump and treat system down-gradient of Ailsworth Road
2nd	Option G	Pump and treat system with a leachate collection system around both landfills
3rd	Option D	Scavenging at Werrington Junction
4th	Option B	Minimum Intervention with AWS operating Etton and Northborough at a combined abstraction of 9000m^3/day (Etton at 5000m^3/d, Northborough at 4000m^3/d). No remediation in the vicinity of Ben Johnson's or Ailsworth Road landfills
5th	Option F	Pump and treat system around both landfills
6th	Option E	Excavate the most contaminated waste from Ben Johnson's Pit and Ailsworth Road landfills and deposit in a new lined landfill at nearby Swaddywell Quarry
7th	Option C	Scavenging close to the Marholm-Tinwell fault
8th	Option A	Minimum Intervention with no abstraction from Etton and Northborough. No remediation in the vicinity of Ben Johnson's or Ailsworth Road landfills

If this project was new and undertook a sustainability assessment, it would have undergone a similar process to the original assessment. The SuRF-UK framework would have made the initial process easier by determining which indicators to consider and providing a framework for discussion with all interested parties. The assessment would have probably considered Environmental 1 in more detail to include climate change and include Environmental 5 (including use of natural resources and generation of wastes) given updated Environment Agency policies. However, reviewing the original assessment and policies these indicators are unlikely to have changed the overall decision.

The main issue with groundwater schemes, as highlighted during the original monetary assessment is that the unit value of groundwater is poorly understood and was assumed to be relatively low (£0.15/m^3). For sustainability assessments of groundwater contamination, the Environment Agency is developing a clear approach to valuing groundwater that fully recognises its resource value. This will ensure that proper weight is given to this factor when optimising the sustainability of remediation schemes.

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Table 5: Summary Table of Weighting and Ranking of Non-monetisable impacts (Qualitative Assessment), the Cost Analysis Results (Quantitative Assessment) and the Combined Ranking Results

Remediation Option	Description of Option	Noise & air pollution during remediation	Ecology during remediation	Ecology after remediation	Intergenerational equity	Business competitiveness after remediation	Land and Property Values after remediation	Recreation Benefits after remediation	Gains in non-use value	Total	Qualitative Ranking	Quantitative Ranking	Combined Ranking (by multiplying qualitative and quantitative)	Preferred Order of Remediation Options
		Environment 1 and Social 3	Environment 4	Environment 4	Social 5	Economic 2	Economic 2	Social 3	Economic 2					
Weight		1	2	3	3	1	1	1	1					
A	Minimum Intervention: No abstraction. No remediation.	0	0	-2	-2	-1	-1	0	-2	-16	8	6	48	8th
B	Minimum Intervention: Increased abstraction from Etton and Northborough No remediation	0	0	-1	-2	-1	-1	0	-1	-12	7	2	14	4th
C	Scavenge at the Marholm-Tinwell Fault	0	1	-1	-2	-1	0	0	0	-8	5	7	35	7th
D	Scavenge at Werrington Junction	0	1	-1	-2	-1	0	0	0	-8	5	1	5	3rd
E	Re-excavate and Dispose to New Landfill at Swaddywell Pit	-2	-2	2	1	1	2	2	1	+9	3	8	24	6th
F	Pump and Treat only	0	0	0	0	1	1	1	1	+4	4	5	20	5th
G	Pump and treat, with leachate recovery	-1	0	1	2	1	1	1	1	+12	1=	4	4	2nd
H	Pump and treat with leachate recovery and *in situ* treatment	-1	0	1	2	1	1	1	1	+12	1=	3	3	1st

Note: Scoring -2=strongly negative impact, +2 = strongly positive impact
Weighting: Highest weighting has been applied to reflect the Environment Agency's remedial objectives: protection of the environment and intergeneration equity of development.