

2. Project development

2.1. Strategic context

Following the devastating winter floods of 2013-14 the former Environment Secretary Owen Paterson requested a single, overarching plan be developed which will guide water and land management policies and investment on the Somerset Levels and Moors over the next 20 years. Known as the Somerset Levels and Moors 20 Year Flood Action Plan¹, the plan was published in March 2014 and set out six key objectives to tackle flooding in the region:

- Reduce the frequency, depth and duration of flooding
- Maintain access for communities and businesses
- Increase resilience to flooding for families, agriculture, businesses, communities and wildlife
- Make the most of the special characteristics of the Somerset Levels and Moors (the internationally important biodiversity, environment and cultural heritage)
- Ensure strategic transport connectivity, both within Somerset and through the county to the South West peninsula
- Promote business confidence and growth

As part of the Action Plan, a number of recommendations were outlined, including dredging and river management actions, land management actions, urban water management and building local resilience to flooding.

One of the key elements identified in the plan was the need to increase the capacity of the Sowy and KSD, recognising that this solution will reduce the need for additional pumping at Dunball during future flooding events.

2.2. Consideration of alternatives

2.2.1. Strategic level alternatives considered for the full River Sowy and King's Sedgemoor Drain Enhancements Scheme

'Do nothing' scenario

In the absence of any works to increase the capacity of the Sowy and KSD system, housing, businesses and infrastructure within the Parrett and Tone Moors will continue to be at risk of flooding under extreme winter events.

'Do something' capacity enhancement options

Between 2014 and 2016 we carried out an investigation into the different options to enhance the capacity of the Sowy and the KSD, allowing the system to carry more water without increasing the risk to property and infrastructure. In order to enhance the capacity of the system, we considered three main aspects: enhanced operation, enhanced capacity and floodplain storage. This investigation came up with seven options, as listed below, which could be combined in different ways to provide a solution.

- Option A – enhanced operation. This option involves increased opening of the Monk’s Leaze Clyce (sluice) to divert more water from the Parrett into the Sowey and KSD during high flows.
- Option B – enhanced capacity: KSD simple improvements at Dunball. This option involves resolving an existing constriction at the A38 Bridge.
- Option C – enhanced capacity: channel widening. This involves the Sowey/KSD being widened by up to 30%, which would increase the water carrying capacity in the channel by up to 75%.
- Option D – enhanced capacity: bank raising/set-back. This involves either raising and extending the existing embankments that run along the sides of significant lengths of the Sowey and KSD or setting-back the embankments to provide a wider area of land for high flows to run through.
- Option E – enhanced capacity: floodplain storage/water spreading. This option assumes that it would be acceptable to increase flooding in some parts of the moors through the Sowey/KSD system, particularly during tide-lock periods (when high tides prevent river discharge at Dunball) and if we use option A (enhanced operation).
- Option F – enhanced capacity: KSD comprehensive improvements at Dunball. This requires a complete rebuild of the KSD outlet at Dunball, including: widening the approach channel to Dunball; increasing the capacity of the Dunball gravity outlet sluice; and extending the span or replacing the old A38 (southbound) bridge.
- Option G – Enhanced Capacity: sub-option G1 Dunball temporary pumps. This involves the temporary installation of pumps from Holland at Dunball to continue to evacuate water when the sluice is tide locked; and sub-option G2 Dunball permanent pumps. This will involve developing a permanent pumping station at the Dunball sluice.

Key economic, environmental and technical considerations associated with option A and each of the options B to G are provided in Table 2.1.

Table 2.1 Strategic level options appraisal summary (replicated from Environment Agency, 2016)

Option		Requirements	Cost	Benefits and risks
A	Enhanced operation	Agreement of landowners and stakeholders to open Monk's Leaze Clyce whilst spillways are running. (The clyce is normally closed when the spillways run)	Costs of associated options as described	<ul style="list-style-type: none"> • Average > 5 day reduction in flood duration in Parrett and Tone moors. • Requires that pumps are positioned at Dunball if flood risk to the Sowey/KSD floodplain is to be minimised, or that river widening (option C or D) compensates for the need to pump
B	KSD simple improvements at Dunball Choose between option B or F	<ul style="list-style-type: none"> • Remove concrete obstruction from A38 bridge (if not already done) • Channel/bridge fluming • Widening constricted channel 	£4-7 million	<ul style="list-style-type: none"> • Protect highways network. • More efficient outlet at Dunball. • Modest flood reduction impact at the top end of the KSD system.
C	Channel widening (by up to 30%): <ul style="list-style-type: none"> • up to 2m wider on Sowey 	<ul style="list-style-type: none"> • Over 9km of Sowey • Over 9km of KSD (this may not be necessary if pumps at Dunball) • Could increase flow capacity to around 	£4-7 million	<ul style="list-style-type: none"> • Less flooding in Sowey-KSD floodplain. • Fewer summer floods. • Greater operational flexibility i.e. we can put through more water without creating more flood in flood plain

Option		Requirements	Cost	Benefits and risks
	<ul style="list-style-type: none"> up to 8m wider on KSD 	20m ³ /s, though 30m ³ /s may be possible		<ul style="list-style-type: none"> Impact on conservation sites and archaeology from ground works. Impact on conservation requirements. Impact on stewardship payments if less water is on the land.
D	Bank raising or extension in the lower section of the system	<ul style="list-style-type: none"> Infill low spots (as part of channel widening) More extensive raising or extending banks 	£4-7 million	<ul style="list-style-type: none"> As for option C Additional structures required
E	Floodplain storage / water spreading	<ul style="list-style-type: none"> Potential storage downstream of Beer Wall based on conservation areas Agreement from landowners 	Unconfirmed at the time of publication	<ul style="list-style-type: none"> Obtaining agreements takes time. Storing water here has limited value during bigger and longer floods. Benefit to wildlife and eco-tourism through improved conservation opportunities.
F	KSD comprehensive improvements at Dunball	<ul style="list-style-type: none"> Replacement Fully widening constricted channel Improvements to Dunball basin 	> £10 million (as for option B but larger scale)	<ul style="list-style-type: none"> Costs are significant Will provide robust foundation for other system improvements in future

Option		Requirements	Cost	Benefits and risks
		<ul style="list-style-type: none"> • Upgrade/expansion of tidal sluice bridge extension 		
G	Dunball pumps	<ul style="list-style-type: none"> • Temporary pumps (15m³/s), or • Permanent pumps with total capacity from 10 to 40m³/s 	<ul style="list-style-type: none"> • Temporary: ~£0.7 million (assumed 10 weeks operation per annum) • Pumping station: £5 – 20 million 	<ul style="list-style-type: none"> • Similar benefits to option C • May be alternative to channel improvements in KSD (option F) • High energy/operational/maintenance

These seven options were put forward for public consultation in December 2014. The enhanced capacity options (other than option E) support option A (enhanced operation) by minimising flooding within the Sowy/KSD system flood plain either by allowing water to be pumped out of the system when the KSD is tide locked (option G) or by increasing the capacity of the Sowy/KSD system (options B and C).

In February 2015, we published a public consultation feedback report, which outlined the next steps. In total, we received 101 responses to the consultation, with opinions relatively evenly spread across all options A to G, with a very slight preference for options A, B and C. Further detail regarding consultation undertaken to date in support of the Proposed Scheme is provided in Chapter 4.

‘Do something’ capacity enhancement scenarios

The Options Appraisal Report for the full River Sowy and King’s Sedgemoor Drain Enhancements Scheme (CH2MHill, unpublished) considered three different packages of individual options (as described above) which met the defined scheme objective as set out below:

‘The objective is to develop a flood management scheme that will:

- Safely divert additional flood waters from the River Parrett and hence allow more rapid drainage of the complex Parrett and Tone Moors area of the Somerset Levels in the future
- Allow the Sowy/KSD system to accommodate more floodwater from uncontrolled overtopping of the Parrett spillways’

The three packages of options considered², termed scenarios, are set out below.

- Scenario 2: ‘Mid-range’. Option A as described in Table 2.1, combined with widening of the existing channel and/or raising/setting back of the existing informal flood embankments to achieve a capacity increase of up to 40% (i.e. up to 24m³/s) within the Sowy/KSD system (options C and D as described in Table 2.1) and also potentially with sub-option G1.
- Scenario 3: ‘Comprehensive scheme’. Options as described under scenario 2 except more extensive channel widening and bank raising works, in addition with installation of permanent pumps at Dunball (sub-option G2) and comprehensive improvements to the KSD (option F). This scenario will increase the capacity of the Sowy/KSD system by at least 75% (i.e. up to 30 m³/s).
- Alternative scenario ‘Land management’. Option E as described in Table 2.1 (floodplain storage/water spreading down stream of Beer Wall). Flood storage / water spreading to reduce flood peaks is an alternative or complementary measure to those described above to increase flow capacity.

Separately, the SRA also endorsed a separate study in 2015, led by conservation representatives with support from the Environment Agency and others. This involved

² A fourth scenario (Scenario 1) which comprised many of the measures identified under option B was also considered at an early stage of the options appraisal process, however it was decided to progress with these measures independently and in advance of the River Sowy and King’s Sedgemoor Enhancements Scheme

engagement with farmers and landowners to canvass views on potential future changes in flood management, centred on flood storage / water spreading within the Sowy/KSD system and upland management measures. It concluded that there was limited appetite for flood spreading at the present time (see Appendix G for further information).

The options appraisal process for the River Sowy and King's Sedgemoor Drain Enhancements Scheme considered these three scenarios against criteria for cost effectiveness, deliverability, flood risk benefit and land management (i.e. risks to nature conservation sites, archaeology and sustainability concerns). Through this process 'Scenario 2 'Mid-range' (capacity enhancements of 20-40% or up to 24m³/s) was identified the preferred option for the full River Sowy and King's Sedgemoor Drain Enhancements Scheme. This option meets the required criteria for deliverability, cost effectiveness and land management, allows routine annual flooding and does not prejudice future scenarios for flood storage / water spreading in the Sowy/KSD corridor (i.e. future implementation of the alternative scenario described above).

Subsequent to completion of the strategic level options appraisal process for the River Sowy and King's Sedgemoor Drain Enhancements Scheme, several further programmes and schemes have been implemented. These seek to help improve flood resilience on the Somerset Levels and Moors using natural flood management approaches and further explore the feasibility of implementing whole floodplain approaches. These include the Hills to Levels, Co-Adapt and Land Management and Water Storage Auction projects, for which further information is provided in Appendix G. Implementation of the preferred option for the River Sowy and King's Sedgemoor Drain Enhancements Scheme will not prejudice potential longer-term management options such as those being explored under these projects in the future.

2.2.2. Project level design alternatives considered for the Proposed Scheme

The Proposed Scheme constitutes Phase 1 of the full River Sowy and King's Sedgemoor Drain Enhancement Scheme. The Proposed Scheme involves the re-profiling of existing flood embankments along the Sowy and KSD between Monk's Leaze Clyce and Parchey Bridge, along with small-scale channel widening works through the creation of WFD enhancement features (embayment, two-stage channel and back waters). As part of the design development for the Proposed Scheme the following alternatives were considered:

- Source of fill material required to support raising of the existing informal flood embankments
- Transport method for material required for bank raising within the Lower Sowy and Upper Sowy
- Slope and crest width of re-profiled flood embankments
- Location of WFD enhancement features

The alternatives considered at each stage, and the reason for taking the preferred design forward, are discussed in further detail below.

Source of fill material required to support raising of the existing informal flood embankments

The following design alternatives were considered with respect to sourcing of the fill material required for re-profiling of the existing informal flood embankments along the Sowy and KSD to meet the required design profile.

1. *Obtain material from channel widening and/or creation of Water Framework Directive (WFD) enhancement features.* Material could be won from the left and right channel bank of the Sowy and KSD through channel widening, however the geology of this area comprises peat and silt underlain by clay and prior experience suggests the unconsolidated nature of material won from the channel makes it unsuitable for engineering uses unless subject to a significant (at least six months) period of drying out.
2. *Obtain material through re-profiling of existing flood embankments.* There is sufficient material available within the existing informal flood banks on the KSD and Upper Sowy to win material required for bank raising from areas of the existing informal flood embankments where current height and/or width exceeds the target design height or width. Under this approach a cut-fill balance could be achieved for the Proposed Scheme on the KSD, Lower Sowy between the A361 and A372 (Beer Wall) and Upper Sowy, however an alternative source of material will be required for raising of the existing flood embankments on the Lower Sowy between the A361 and A372 (Beer Wall).
3. *Import material from alternative source(s), potentially including borrow pits at Chilton Trinity (3a) or import under CL:AIRE CoP (3b).* This option will minimise disturbance to habitats, wildlife and landowners adjoining the scheme by reducing the requirement for topsoil strip within the construction footprint. This option was also the most cost-effective option.

Option 1 was discarded at an early stage of the design process on the basis that previous experience suggests that material won from the channel bank will be peaty and unconsolidated and would require a significant drying out period before it would be suitable for use in bank raising in a structural capacity.

The final design uses option 2 for the KSD and option 3b for the Lower and Upper Sowy. There are two relatively small areas towards the far north of the KSD where the existing informal flood embankments are particularly high and wide (see Figure 3.1, Appendix A) and can be re-profiled to generate fill material for bank raising along the remainder of the KSD. The existing informal flood embankments on the Sowy are generally smaller with significantly less potential to generate fill material, and therefore material will be imported for bank re-profiling in these areas.

Transport of material required for bank raising within the Lower Sowy and Upper Sowy

Three different potential methods were considered for the transport of fill material for re-profiling of the existing informal flood embankments on the Upper and Lower Sowy from either the KSD or from remote sources under CL:AIRE CoP. The three options initially considered were:

1. *Barge along the Sowy and KSD:* this option would minimise the degree of ground disturbance through vehicle tracking

2. *Road haulage via tractor and trailer (8t (tonne) capacity)*: this option could make a positive contribution to the local economy as it provides an opportunity to employ local agricultural businesses
3. *Road haulage via Heavy Goods Vehicle (HGV) (20t capacity)*: this option would reduce the required number of movements, to and from site

Option 1 was found not to be feasible due to space limitations (there is insufficient space on KSD for two barges to pass side by side), combined with the requirement to complete construction within a relatively narrow window of three months in the late summer and early autumn in order to minimise risks to environmental receptors.

The more limited load capacity and speed of tractors and with trailers compared to HGVs means that to meet the available programme window a proportion of the fill material required must be transported by HGVs. However, to minimise impacts on residents and other road users, it is proposed to use HGVs for material transferred to the site access points directly on the A372 and A361 only, with tractor with trailers used for haulage along minor roads and access routes.

Design of re-profiled flood embankments

Design alternatives of the target profile for the raised flood embankments are considered in the following subsections.

Slope of landward bank of re-profiled flood embankments

Options considered for design of the landward slope of the re-profiled embankments included:

- 1:3 slope
- 1:5 slope

A 1:3 back slope is the minimum slope angle required to reduce the risk of instability and to provide safe access for maintenance equipment. A 1:3 back slope will also minimise the requirement for land take from adjoining landowners where the scheme passes through land parcels which we do not own. However, much of the land adjoining the Proposed Scheme is under agricultural use and grazed by cattle which utilise the Sowy as a water source. Using a 1:5 back-slope for the re-profiled flood banks will reduce the potential for slope failure due to cattle poaching, and therefore this option was taken forward.

Crest width of re-profiled flood embankments

Options considered for the design crest width for the re-profiled embankments include:

- 3m crest width (requires 2m control zone³ to either side of the embankment for safety reasons)
- 4m crest width

To minimise the need to win material on site and/or import of material, the 3m crest width option has been taken forward for the majority of the scheme except in

³ A minimum distance of 2m maintained between the foot of the embankment and a water course for safety reasons

localised areas where there is insufficient space to provide a 2m control zone³ either side of the re-profiled embankment, and therefore a 4m crest width is required.

Locations of WFD enhancement features

The proposed WFD enhancement features (embayments, two-stage channels and backwaters) are located within land that we own to avoid land-take impacts on adjacent land owners. Preliminary results from the spring water vole survey undertaken in 2019 (see Chapter 7 for further details, and Appendix F) and the Cultural Heritage Desk Based Assessment (CHDBA) prepared in 2016 (see Chapter 8 and Appendix O) were utilised to identify potential locations which:

- Minimised impacts to known and unknown buried archaeology by avoiding high risk areas such as the Scheduled Monument at Sutton Hams and areas immediately to the north and south of the A361 near Greylake where a late Bronze age brushwood trackway, Bronze Age piles and cut roundwood and burtle beds are known to be present (see Chapter 8 for further detail).
- Benefits water vole by creating new good quality habitat in areas currently identified as sub-optimal (see Chapter 7 and Appendix F for further detail).

Using these principles, 15 potential locations for WFD enhancements were identified at an early stage of design on the right bank of the KSD and Lower Sowy and presented within the PEIR.

Following completion of further geoarchaeological and ecological survey work in 2019 and 2020 (second water vole survey, tree bat potential survey and badger survey) the WFD enhancement feature locations were further refined using the principles outlined above. Placement and dimensions of embayments, two-stage channels and back waters were designed to avoid any tree loss or impacts on badger setts.