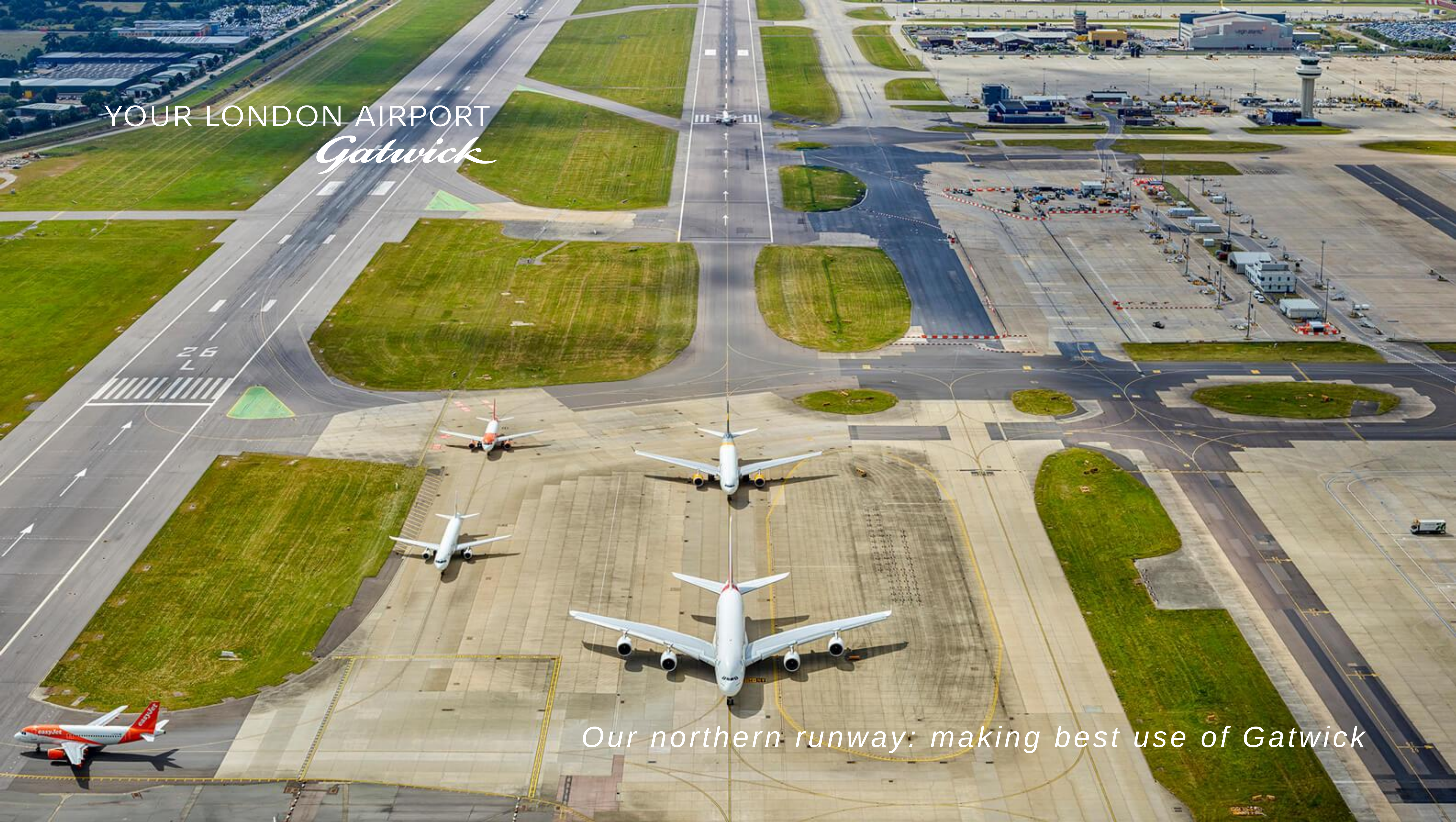

Preliminary Environmental Information Report
Appendix 11.9.3: Geomorphology Assessment

September 2021

Table of Contents

1 Introduction

1.1 General

1.1.1 This document forms Appendix 11.9.3 of the Preliminary Environmental Information Report (PEIR) prepared on behalf of Gatwick Airport Limited (GAL). The PEIR presents the preliminary findings of the Environmental Impact Assessment (EIA) process for the proposal to make best use of Gatwick Airport's existing runways (referred to within this report as 'the Project'). The Project proposes alterations to the existing northern runway which, together with the lifting of the current restrictions on its use, would enable dual runway operations. The Project includes the development of a range of infrastructure and facilities which, with the alterations to the northern runway, would enable the airport passenger and aircraft operations to increase. Further details regarding the components of the Project can be found in the Chapter 5: Project Description of the PEIR.

1.1.2 This document provides the detail of the geomorphology assessment for the Project, including the baseline study and impact assessment.

2 Study area

2.1.1 There are four watercourses that have the potential to be directly or indirectly impacted by the Project and these have been defined as the fluvial geomorphological receptors. A study area has been defined that covers the catchments of the receptors and a smaller site study area has been defined based on the channels that will be directly impacted by the Project. The watercourses all sit within the Mole management catchment of the Thames River Basin District. The watercourses identified as receptors include:

- River Mole;
- Gatwick Stream;
- Crawter's Brook;
- Burstow Stream; and
- Burstow Stream Tributary.

2.1.2 These watercourses are identified in Figure 11.4.1 of the PEIR.

2.1.3 Design changes (including a reduction in the extent of flood mitigation measures) between the scoping and PEIR stages of reporting mean that the following watercourses will now be scoped out of the PEIR, given that they are no longer considered to be impacted by the Project:

- Withy Brook; and
- Man's Brook.

2.1.4 Design changes include the removal of Withy Brook flood compensation area.

2.1.5 Other watercourses scoped out of this assessment include Hookwood Common Brook and Spencer's Gill (tributaries of the River Mole), Dolby Brook (tributary of Man's Brook), and Crawter's Brook Tributary (tributary of Crawter's Brook).

3 Methodology for baseline studies

3.1 Desktop Study

3.1.1 The baseline study included a fluvial geomorphology assessment undertaken at a catchment scale. The catchment extents of each watercourse have been used as the extent of a desk-based review of conditions (PEIR Chapter 11, Figure 11.2.1). This provides an overview of the catchments and how they currently function, and summary information on historical changes. This information then feeds into the more detailed baseline. The following are the key data sources used for this desk study:

- Environment Agency Catchment Data Explorer (Environment Agency, 2018);
- Thames River Basin District Management Plan (Department for Environment, Food and Rural Affairs (Defra), 2015);
- Ordnance Survey (OS) mapping;
- Geology maps (British Geological Survey, 2019);
- Historical maps (National Library of Scotland, 2019); and,
- Hydrological information (Centre of Ecology and Hydrology, 2019).

3.2 Site Specific Surveys

3.2.1 A geomorphological walkover survey was undertaken of the site study area within the Project Site Boundary to develop a more detailed baseline of channel characteristics on the watercourses which are potentially impacted by the Project (PEIR Chapter 11, Figure 11.4.1). The survey took place in September 2019 and water levels were above average following a prolonged period of heavy rainfall. As a result, the beds and part of the banks were not visible. However, some information on the banks, physical processes and existing pressures was recorded, and photographs were taken on site to supplement this. Therefore, sufficient information was obtained to fully assess effects of relevance to this study.

3.2.2 No geomorphological walkover has been undertaken on Burstow Stream at this stage. Prior to the latest design (March 2021), Burstow Stream was scoped out of the assessment based on the reduced extent of the highways works. Burstow Stream has been scoped into this assessment, and a further site visit to collect detailed baseline information will be undertaken and reported in the Environmental Statement (ES).

3.3 Methodology for Impact Assessment

3.3.1 The potential geomorphological impacts of the Project and flood risk mitigation components were identified for each watercourse. The baseline assessment was taken to be indicative of the current morphological condition of the watercourses. Descriptions of the potential effects of construction and operational activities were outlined using expert judgment of fluvial geomorphological processes. The Water Environment (Water Framework Directive) (England and Wales) Regulations (WER) 2017 water body status was used to infer sensitivity to Project impacts where relevant (Table 3.3.1). For water bodies not designated under the Directive, sensitivity is assigned based on diversity of morphological features and processes, state of natural equilibrium, and extent of artificial modification or anthropogenic influence. A qualitative assessment of the magnitude of the impacts was established using expert judgement with reference to GIS information, baseline conditions (including existing morphological pressures) and the proposed design with embedded mitigation. The magnitude of the impact was determined in a matrix which combines the duration and scale of the impact into a qualitative descriptor (Table 3.3.2 and Table 3.3.3). The significance of the effect was then determined in a matrix which combines sensitivity and magnitude into a qualitative descriptor (PEIR Chapter 11, Table 11.4.6.). Where a range of significance levels are presented in the matrix, the final assessment for each effect is based upon expert judgement.

Table 3.3.1 Sensitivity criteria for receptors

Sensitivity	Criteria
Very High	Watercourse having a 'High' (or potential to achieve 'High') WER status. Non WER classified watercourses may be applicable if they demonstrate qualities such as: a channel in stable equilibrium and exhibiting a range of natural morphological features (such as pools, riffles and bars); diversity in morphological processes reflects unconstrained natural function; free from artificial modification or anthropogenic influence.
High	Watercourse having a 'Good' (or potential to achieve 'Good') WER status. Non WER classified watercourses may be applicable if they demonstrate qualities such as: a channel achieving near-stable equilibrium and exhibiting a range of natural morphological features (such as pools, riffles and bars); diversity in morphological processes reflects relatively unconstrained natural function, with minor artificial modification or anthropogenic influence.
Medium	Watercourse having a less than 'Good' (or potential to achieve 'Good') WER status. Non WER classified watercourses may be applicable if they include channels currently showing signs of historical or existing modification and artificial constraints, and/or attempting to recover to a natural equilibrium and exhibiting a limited range of natural morphological features (such as pools, riffles and bars).
Low	Minor local watercourses not having WER status. A channel currently showing signs of extensive historical or existing modification and artificial constraints. There is no evidence of diverse fluvial processes and morphology and active recovery to a natural equilibrium.
Negligible	Minor ephemeral drains and channels

Table 3.3.2 Magnitude of impact criteria

Duration of impact	Scale of impact (km)					
	<0.1	0.1- 0.5	0.5 to < 1.5	1.5 to < 5	5 to < 10	> 10
	Negligible	**Very Small**	**Small**	**Medium**	**Large**	**Very Large**
Short term:1 to 12 months	Negligible	Negligible	Low	Low	Medium	Medium
Medium term: 1 to 5 years	Negligible	Low	Low	Medium	Medium	High
Long term: Over 5 years	Negligible	Low	Medium	Medium	High	High

Table 3.3.3 Magnitude of impact criteria definitions

Magnitude of Impact	Criteria
High	Works will impact the geomorphology at a waterbody scale.
Medium	Works will impact the geomorphology at a multi-reach scale.
Low	Works will impact the geomorphology at a reach scale.
Negligible	Works will impact the geomorphology at a local scale.
No change	Works will have no impact on geomorphology.

4 Current Baseline

4.1 Catchment Overview

4.1.1 The River Mole originates south of Crawley in West Sussex and flows through Surrey for approximately 80 km before reaching the Thames at Molesey. The catchment of the River Mole has an area of 512 km^2, and forms five per cent of the Thames catchment area (Environment Agency, 2018). The watercourses scoped into this assessment are in sub-catchments of the River Mole, including the Mole (upstream of Horley), Gatwick Stream, and Burstow Stream.

4.1.2 The catchment terrain of the watercourses is dominated by the Low Weald topography of the Wealden Basin, and underlain by Wealden Group clay. Surface geology mainly comprises alluvium and river terrace sands and gravels (BGS, 2019).

4.1.3 The River Mole sub-catchment area upstream of Horley is approximately 30 km^2, and includes urban areas of Crawley and Three Bridges, and Gatwick (Environment Agency, 2018). The Mole forms at the confluence of the tributaries of Ifield Brook and Baldhorns Brook, north of Crawley, where it flows north-eastwards through mainly rural land, receiving runoff from field drains. This section of the watercourse has a naturally meandering planform and wide channel of approximately 5 metre width.

4.1.4 At the southern perimeter of Gatwick, the River Mole is joined by Crawter's Brook. Crawter's Brook is a narrow stream of approximately 2 m width which rises in Tilgate Forest in the south and flows northwards through Crawley via a network of culverts and open channels towards the southern perimeter of the airport. The watercourse is realigned westwards along a straightened channel to meet the Mole. The River Mole then runs via a culvert and siphon under the existing main and northern runways. North of the runways, the River Mole re-emerges from the culvert and siphon and is joined by Man's Brook, a small 2-4-metre-wide stream which rises at Tilgate and flows through agricultural land to the east. The River Mole has been realigned around the northern perimeter of the airport, confined in a low valley between the airport infrastructure and urban residential areas. The River Mole is culverted under the A23, at which point it meets the confluence with Gatwick Stream.

4.1.5 Gatwick Stream is a tributary of the River Mole. It rises in Worth Forest below Clays Lake in West Sussex and flows northwards through Tilgate Forest, through Maidenbower, Three Bridges and Tinsley Green to the confluence with the River Mole. Tilgate Brook is a tributary of Gatwick Stream, approximately 300 metres in length. Crawley Sewage Treatment Works (STW), operated by Thames Water, is located to the east of the Gatwick Stream, downstream of Crawley. Gatwick Stream is approximately 8 km in length, with a catchment area of 14 km^2 (Environment Agency, 2018). The river planform is sinuous as it flows through Tinsley Green: a mixture of wooded area and parkland. The width of the channel typically measures 4-5 metres along this section.

4.1.6 Downstream of the STW, the watercourse passes through a culvert under the Brighton-London mainline railway and flows northwards along an engineered straightened course adjacent to the A23. The watercourse is narrower at this point with an approximate width of 3 metres. The watercourse is culverted under the South Terminal building and under Airport Way, where it re-emerges into Riverside Garden Park, to the north of the A23, as a 900-metre-long section of natural meandering channel. Downstream, the watercourse is straightened as it flows between the A23 and residential areas, before joining the River Mole to the east of Longbridge Roundabout.

4.1.7 Burstow Stream is a tributary of the River Mole. It rises at Crawley Down in Sussex, flowing through predominantly rural areas and the urban area of Copthorne, joining the River Mole at Horley. Burstow Stream is approximately 2 km away from the airport, however, a small section which flows under the M23 motorway and a tributary is within the study area. Burstow Stream Tributary is a tributary of the Burstow Stream. It is a small channel fed by several drains from agricultural land and road drains. The stream is typically less than 2 metres in width. Current OS mapping indicates the stream originates south of Horley as a drain along Balcombe Road and is culverted under the M23 motorway. The stream flows mostly in an open channel through the residential area east of Horley.

4.2 Historical Change Analysis

4.2.1 To identify historical geomorphological and land use changes, a series of digitised pre-WWII 1:10,560 scale OS maps and post-WWII 1:25,000 scale OS maps have been used in GIS, available through the National Library of Scotland (National Library of Scotland, 2019). The results are presented Table 4.2.1.

4.2.2 Historical OS mapping pre-1913 shows the land use within the study area was predominately rural, including agricultural land around the River Mole, Crawter's Brook and Burstow Stream tributary. Gatwick Stream flowed through a mixture of wooded area and parkland.

4.2.3 Since the 1930s, all receptors have been significantly modified, which predominately relate to the expansion of the airport and creation of associated transport links. The most significant changes include the realignment of the River Mole for construction of the North Terminal during the 1980s (Table 4.2.1, locations 11-12), various modifications to the course of Crawter's Brook since the 1950s (Table 4.2.1, locations 5-6, 14) and straightening of Gatwick Stream in the 1930s (Table 4.2.1, location 3).

Table 4.2.1: Historical Analysis of Watercourses in Study Area

Location	Date	Comment
1	Pre-1900	The River Mole was originally split into two channels to power the (now disused) Horley Mill since about the 13th century. The channel was again modified to form one channel in the following century post 1959 after the mill's closure.
2	1935	The confluence between the River Mole and Gatwick Stream was severed by construction of the A23. The River Mole was straightened downstream in alignment with the A23.
3		Gatwick Stream was straightened to allow for the construction of the A23.
4	1945-1955	Unnamed tributary of the River Mole is removed following airport expansion.
5	1945-1960	Crawter's Brook was realigned to join the River Mole further upstream for construction of the runway.
6		A channel alongside the runway was constructed to connect the River Mole and Crawter's Brook, north of the runway.

Location	Date	Comment
7		The River Mole was culverted under the runway.
8	1970s	Burstow Stream culverted for construction of the M23.
9	1980s	The remaining channel of Crawter's Brook, north of the runway, was removed for construction of the North Terminal. The connecting channel to the River Mole adjacent to the runway was also removed.
10		Man's Brook was shortened to join the new channel of the River Mole further upstream to make way for the North Terminal
11		The River Mole was realigned half a kilometre northwest from its original position for construction of the North Terminal
12		The River Mole was realigned along an existing stream (Westfield Farm), encircling ancient woodland (Brockley Wood)
13	1960-2000	The confluence between Burstow Stream and its tributary was modified.
14		Crawter's Brook straightened again at far west of airside perimeter.
15	Post-2000	The Mole biodiversity area was created upstream of Man's Brook, which included naturalisation of the watercourse and ecological improvements.
16		Gatwick Stream flood attenuation and grasslands scheme helping to prevent flooding in areas downstream. The main channel was enhanced with natural river features such as pool, fast flowing areas and native wetland. Control gates were added to enable excess water to collect in the low-lying grassland.

4.3 Site Channel Characteristics

4.3.1 The site visit was undertaken after a short period of exceptionally wet weather. Water levels were higher than typical by approximately 0.5 metres on the River Mole and Gatwick Stream; therefore, the riverbed and bedforms were not clearly visible during the survey. Table 4.3.1 to Table 4.3.4 include a detailed description of channel characteristics and photos of the watercourses surveyed. Channel dimensions provided were measured using cross-sectional data on Flood Modeller, unless otherwise stated. It is intended to repeat the site visit to update this assessment and inform the ES.

Crawter's Brook – Gatwick Airside to Confluence with the River Mole

Table 4.3.1: Crawter's Brook Site Characteristics

Representative image	Description
 Photo 1: Mid-channel vegetated bars  Photo 2: Damaged gabion mattresses  Photo 3: Bank erosion downstream of gabions	The valley is broad and formed in Wealden Clay and localised areas of river terrace superficial deposits. The floodplain is constrained on either side by the airport Perimeter Road South and fence and grassy strip to the south on the left bank, and the airport main runway to the north on the right bank. The floodplain is also constrained to the north adjacent to the bank top by a low (<0.5 m) narrow (approximately 1 metre) grassy embankment along its length. The channel itself is covered by netting crossing from the bank top. The channel baseflow width is typically approximately 4 metres and bank top channel width is approximately 12 metres. Bank height varies from 3-4 metres, and depth is <1 metre. This section of Crawter's Brook has been heavily modified and straightened for its entire length. It is a trapezoidal channel with relatively steep uniform banks and uniform flow types. The channel banks consist of clay and made ground, including concrete rubble and brick but are largely undefended and stable. Bedforms visible include mid-channel vegetated bars dispersed through the upstream length of the channel (Photo 1), formed of reeds and long grasses, and one instance of large woody debris in the channel. The bed and bedform materials were not visible during the site survey. Channel form and flows become increasingly uniform downstream, with sediment having dropped out further upstream to form the vegetated bars. Left and right bank characteristics are similar in that the riparian vegetation consists of mostly continuous coarse grasses and sparse small shrubs in the upstream extent. Some woody debris from shrubs is within the channel, resulting in localised changes in flow patterns. Vegetation is patchy in places where the channel banks are defended by concrete lining and geotextiles, particularly at Old Brighton Road South bridge. Both vegetation density and the number of vegetated bars decreases downstream. Slightly beyond the Old Brighton Road South road bridge (adjacent to Perimeter Road South) on the outside bend of the channel, a section of gabion mattresses on the right bank is significantly damaged, with cobbles having come loose from the cages, likely as result of high discharge events (Photo 3). This area appears to have experienced erosion in the past. Downstream of these defences on the right bank, localised active erosion continues to occur, where clay and made ground rubble has crumbled away from the bank side (Photo 3). In these areas, the bank has become over-steepened resulting in the destabilisation of the bank formed of unconsolidated materials. Observations indicate that animal burrowing may be resulting in erosion of bank top material under the netting. Erosion on the right bank occurs for 300 metres downstream. Existing pressures include five outfalls on the left bank, three bridges including concrete abutments and sloping masonry on adjacent banks, deteriorated geotextiles, vertical concrete walls at the confluence with the River Mole before being culverted under the runway, two slipways with gates, and one concrete drain structure with vertical concrete walls.

The Mole – Runway crossing to Confluence with Gatwick Stream

Table 4.3.2: River Mole Site Characteristics

Representative image	Description
 Photo 1: Mid-channel vegetated bar  Photo 2: Embankment view from right bank  Photo 3: Concrete lined outfall structure set into the right bank	The valley is broad and formed in Wealden Clay and alluvium superficial deposits. The valley is marginally steeper to the west of the Mole where limestone bands in the Wealden Clay have formed low hills. The River Mole has been re-routed and modified following airport expansion, and it is now situated west of its original natural course. Embankments have been built up along much of the channel length to form an 'artificial valley' which channels the water between the surrounding infrastructure. The floodplain is constrained left (west) of the channel by an artificial pond (Pond A) as the River Mole exits the runway culvert, and downstream of Man's Brook by Horley/Charlwood Road, Povey Cross Road and the settlement of Hookwood. The floodplain on the right of the channel is constrained by airport infrastructure, including hangars, the long stay car park, and two artificial ponds (Pond D and Pond M). Deciduous woodland is planted on the valley sides along the edge of the floodplain. The floodplain is up to 150 metres wide upstream of Man's Brook and narrows to 40-70 metres width downstream. On exiting the culvert, the River Mole flows around a sharp >90º bend into a 300-metre straightened section of channel with embankments on either side. Downstream, the River Mole has been re-naturalised to create a biodiversity area, where the river has been engineered with a sinuous planform and wider floodplain with public access along the left bank of the river. Downstream of Man's Brook, the river planform decreases in sinuosity, and is straightened as it flows around the perimeter of the long stay car park to the confluence with Gatwick Stream. Channel bankfull width is typically between 4-7 metres and the bank heights are typically approximately 1 metre. The channel banks are gently graded and formed in clay. Bedforms include large mid-channel vegetated bars dispersed throughout the length of the channel, formed of reeds and long grasses, and numerous instances of large woody debris in the channel, resulting in non-uniform flow types (Photo 1). The bed and bedform materials were not clearly visible during the site survey due to high water levels and turbidity. Left and right bank characteristics are similar in that the riparian vegetation includes mostly continuous coarse grasses on the sloping embankments, and scattered shrubs and small deciduous trees along the channel sides (Photo 2). Long grasses and reeds dominate the upstream banks and floodplain. Tree density increases downstream, particularly on the right bank. Given the high-water levels, there was no observable erosion of the banks. Water was frequently over-topping the banks and footpath on the floodplain. Existing pressures include an outfall on the right bank near the A23 road crossing, two bridges including concrete abutments and sloping masonry on the right bank of the sharp bend after the runway culvert. Pond D also releases water from a concrete lined outfall structure on the right bank (Photo 3).

Gatwick Stream – Tinsley Bridge to Confluence with the Mole

Table 4.3.3: Gatwick Stream Site Characteristics

Representative image	Description
 Photo 1: Netting over the Gatwick Stream  Photo 2: Erosion of vertical right bank and scattered vegetation  Photo 3: Gabion mattresses and erosion of bank	The valley is broad and formed in Wealden Clay and Upper Tunbridge Sands bedrock and alluvium superficial deposits. The floodplain of Gatwick Stream can be considered in three sections. From Tinsley Bridge to the Brighton-London mainline railway the river has been almost entirely realigned as part of the Upper Mole flood attenuation scheme. The channel is constrained by embankments on both sides, and control gates allow the low-lying grasslands to the left of the channel to collect excess water during extreme flood events. The channel itself is covered by netting crossing from the bank top (Photo 1). The eastern floodplain is also constrained by Crawley STW. Between the railway and Riverside Garden Park, the floodplain is entirely constrained and disconnected by the A23, pathway and railway which are parallel to the watercourse. Gatwick Stream is also culverted beneath the railway crossing, Gatwick Airport South Terminal, and the A23 crossing. Through Riverside Garden Park to the confluence with the Mole, the floodplain is mostly constrained on the right (north) of the watercourse by residential properties, whilst the left side is mostly unconstrained. The channel bankfull width is between 4-6 metres and bank top channel width varies between 9-11 metres. Depth is typically <1 metre and bank height varies from 1-3 metres. Between Tinsley Bridge and the railway, the channel has a sinuous planform with relatively steep banks and varied flow types. The channel is actively meandering. The channel banks consist of clay and sandy soil. Bedforms include vegetated mid-channel bars dispersed along its length, formed of reeds and long grasses, and numerous instances of woody debris in the channel giving rise to areas of faster flow and pools. The bed and bedform materials were not clearly visible during the site survey due to high water levels and turbidity. Riparian vegetation mainly comprised of continuous deciduous trees and Himalayan Balsam upstream of the realigned section, and coarse grasses and small shrubs downstream. The vegetation was stripped from near-vertical sections of the right bank that are actively eroding (Photo 2). Vegetated bars are also encouraging erosion of both banks by pushing the flow towards the banks. There is one outfall on the right bank and the river is culverted downstream near Crawley Sewage Treatment Works (STW). From the culverted section under the railway to Riverside Garden Park, the river is straight with relatively steep, root-bound clay banks and mainly uniform flow types. Between the railway culvert and Pond E, the channel is concrete lined. Immediately downstream of the concrete lining, the bed level drops where the river has scoured the natural bed and banks. Gabion mattresses protect both banks along this section (Photo 3). The bed and bedform materials were not clearly visible during the site survey due to high water levels and turbidity, however, cobbles were noted downstream of the gabion mattresses. Riparian vegetation included a dense mixture of shrubs and deciduous trees lining both banks. Woody debris was visible in the channel, varying the flow patterns locally. There was no other evidence of bank erosion. The river is canalised by vertical concrete walls and concrete lining before flowing through the South Terminal culvert. The channel briefly re-emerges through a short naturalised wooded section, with one outfall and pipe crossing, before flowing under the A23. Through Riverside Garden Park, the channel is sinuous with moderately steep root-bound clay banks and varied flow types. The banks and bed are concrete lined as the river exits the A23 culvert, flowing over a weir structure. Along the right bank the banks appear over-steepened in sections with evidence of erosion (Photo 4). Several small sections of the right bank are protected by brick walls as they abut gardens of residential properties. The bed and bedform materials were not clearly visible during the site survey due to high water levels and turbidity. Riparian vegetation includes continuous mature deciduous woodland and shrubs. Woody debris was visible in the channel, varying the flow patterns locally. The channel is straightened for 370 metres before meeting the confluence with the River Mole.

Representative image	Description
 Photo 4: Over-steepened banks along straightened section	

Burstow Stream Tributary – M23 Road Bridge Crossing

Table 4.3.4: Burstow Stream Tributary Site Characteristics

Representative image	Description
 Photo 1: Concrete lined channel from culvert  Photo 2: Pipe crossing close to culvert	The valley is broad and formed in Wealden Clay bedrock and widespread river terrace superficial deposits. The floodplain is constrained and dissected by the M23 road crossing, formed of a high embankment which crosses the path of the stream perpendicularly, and the Balcombe Road and residential properties which abut the left side of the channel. Observations on site indicate that the channel has a bank top channel width between 1-2 metres, and bank height is <1 metre. This section of Burstow Stream tributary has been heavily modified to accommodate the road embankment into which it is culverted. The channel banks are relatively steep suggesting the channel has been deepened in the past. During the site visit, discharge was low, and water was not flowing, suggesting that the channel is dry for most of the year. There were no notable bedforms and the bed material was mostly covered by thick deposits of leaf litter. Downstream beyond the culvert there were gravels and silts within the bed substrate amongst the leaf litter. Both left and right bank characteristics show the banks are formed of root-bound clay further upstream and downstream of the culvert. Riparian vegetation consisted of a high density of continuous shrubs and deciduous trees on the bank top, which cause the stream to be overgrown and shaded. The channel is concrete lined for several metres from the culvert both upstream and downstream (Photo 1). Existing pressures include the culvert under the M23 embankment and a pipe crossing close to south side of culvert (Photo 2). No survey has currently been undertaken for Burstow Stream, however this information will be collected for the ES.

5 Future baseline

5.1 Initial Construction Phase: 2024-2029

5.1.1 It is anticipated that climate change would not have a significant impact on the geomorphology before 2029 when compared to the baseline assessment. Therefore, no climate change effects have been considered for the initial construction phase. There will be some evolution of the watercourses due to natural adjustment.

5.2 First Full Year of Opening: 2029

5.2.1 It is anticipated that airport growth and any effects from climate change would not have a significant effect on geomorphology when compared to the baseline assessment. Therefore, changes to the baseline are not expected for the first year of opening (2029), with exception for continued evolution of the watercourses due to natural adjustment.

5.3 Interim Assessment Year: 2032

5.3.1 It is anticipated that airport growth and any effects from climate change would not have a significant effect on geomorphology when compared to the baseline assessment. Therefore, changes to the baseline are not expected for the interim assessment year (2032), with exception for continued evolution of the watercourses due to natural adjustment.

5.4 Design Year: 2038

Evolution due to Climate Change

5.4.1 Over a medium to long-term time period, climate change could potentially alter the hydrological regime of the watercourses. Increased frequency/severity of droughts and floods could potentially lead to the watercourses adjusting to different patterns of erosion and deposition. However, it is likely that the adjustment would remain localised and of relatively low magnitude given the modified channel types.

Evolution due to Natural Adjustment.

5.4.2 The River Mole and Gatwick Stream are currently exhibiting some evidence of channel adjustment. These channels have been assessed as having a low to moderate energy, with limited competence to actively move the course of the planform. It is anticipated that if left undisturbed, the watercourses would continue to adjust slowly laterally and potentially through incision within the defined wider corridor so that over time the baseline will change. The remaining watercourses in the study area exhibited less evidence of adjustment, with lower energies, and are considered unlikely to adjust significantly so channel adjustment is not expected.

Evolution due to Meeting Policy Objectives

5.4.3 The Thames River Basin Management Plan (RBMP) provides details of the anticipated ecological status (which is partly dependent on stream morphology) for the WER water bodies within the study area by 2027 (Defra, 2015). It is anticipated that WER water body status and the quality elements (including hydromorphology) would improve with implementation of local measures specified by the Thames RBMP. It is therefore anticipated that some of the lower quality (poor and moderate) WER water bodies will begin to move towards good status/potential by the design year.

5.4.4 The Thames RBMP outlines future local measures in the River Mole catchment, these are listed in full in Appendix 11.9.2: WER Assessment. Of note are the following which could lead to improvement in individual quality elements: tackling non-native species, removal of fish barriers, and restoration of more natural morphology where man-made modifications exist (Defra, 2015).

6 Mitigation

6.1 Initial Construction Phase: 2024-2029

6.1.1 Construction impacts would be mitigated through best practice measures outlined in the Code of Construction Practice (CoCP). The implementation of these measures would lessen the magnitude of the impact, for example by reducing the amount of fine sediment washed into the channel downstream of the works. This will reduce the length of the channel adversely impacted and the duration of impact.

6.1.2 Diversion of the River Mole would begin in 2024 and would require excavation and earthworks along a 400-metre length of the existing channel. Best practice measures implemented through the CoCP and the offline construction of the diversion channel would reduce the release of fine sediments to the channel and downstream and reduce the likelihood of any unexpected large-scale change. The length of the channel adversely impacted, and duration of the impact would be reduced. The works will deliver an overall improvement to the geomorphology of the watercourse through re-meandering and naturalisation of the channel.

6.1.3 Construction of the Museum Field FCA and the East of Museum Field FCA would begin in 2024 and would involve lowering the existing ground level by up to 3.5 metres and 1.8 metres, respectively. The floodplain compensation areas would connect to the watercourse by lowering the stream bank of the River Mole. Construction impacts should be mitigated through best practice measures outlined in the CoCP. For example, this would include reducing the amount of fine sediment washed downstream in the River Mole.

6.1.4 Construction impacts associated to lowering of car park X to provide a compensatory floodplain storage area and extension to the River Mole culvert and siphon will also be mitigated through best practice measures outlined in the CoCP.

6.2 First Full Year of Opening: 2029

6.2.1 During the first full year of opening, impacts to the geomorphology would be caused through construction of the South Terminal and North Terminal surface access arrangements which would begin in 2029. This would involve extension of Burstow Stream tributary culvert. It would also involve development in the floodplain, and new and modified outfalls connecting to highway drainage attenuation basins on Burstow Stream Tributary and Burstow Stream. Ongoing adjustment of the geomorphology is expected to continue as the watercourses adapts and adjust to construction works associated with various watercourses. Best practice measures to mitigate the construction impacts would continue to control the impacts.

6.3 Interim Assessment Year: 2032

6.3.1 Impacts to the geomorphology of the channels during this time would be caused through construction of the Longbridge Roundabout surface access arrangements which would begin in 2031. This would involve widening the existing overbridge at the River Mole by 5-6 metres, development in the floodplain to accommodate widening and modifications to the A23 and two outfalls connecting to highway drainage attenuation basins. Best practice measures to mitigate the construction impacts would continue to control the impacts, for example minimising riparian vegetation clearance to maintain bank stability.

6.4 Design Year: 2038

6.4.1 During the design year, impacts to the geomorphology of the channels would be caused through construction of the Gatwick Stream flood compensation area which would begin in 2036, and through operational activities. The works to create the Gatwick Stream flood compensation area would involve lowering the existing ground level by up to 5 metres. The floodplain compensation area would connect to the watercourse by lowering the stream bank. Construction impacts should be mitigated through best practice measures outlined in the CoCP. For example, the amount of fine sediments washed downstream would be reduced. This would reduce the length of the channel adversely impacted and the duration of impact.

6.4.2 Operational activities have the potential to impact on the geomorphology of the watercourses. These impacts are associated with the flood risk mitigation which includes channel diversion, creation of flood storage areas and extension of culverts. Impacts are also associated with the change to road layouts, as part of the Project works, which involve the extension of culverts. The impact of these elements can be reduced through the implementation of the following design recommendations that have been incorporated in principal at this stage and should be developed as the design develops:

- Flood compensation areas:
  - Varied bank form where banks are being lowered/altered to improve natural variance of flow in the channel.
  - Ecological planting to restore natural vegetation to the floodplain.
  - Soft/bio engineering would be used in preference to concrete where natural banks require protection at the connecting spillways to the new flood compensation areas, e.g. pre-seeded coir matting. Provides opportunity to re-plant riparian vegetation and stabilise the bank.
- Channel diversion:
  - Timing of works to allow diversion channel to vegetate over before flow is initiated to reduce likelihood large-scale change and release of fine sediments downstream.
  - Varied cross sections to mimic natural process, bed and bank forms.
  - Addition of suitable substrate.
  - Suitable river type for the bed gradient of the realignment to maintain sediment transport capability.
  - Creation of a more natural planform to improve floodplain coupling and flow regime.
  - Multiple stage channel to ensure natural and varied flow conditions (not only the 1:100-year flow).
  - Movement of sediment downstream if deposition occurs along diversion (maintenance).
- Culvert extension:
  - Depress invert to maintain sediment transport capability.
  - Keep natural bed gradient.
  - Designed with splayed wing walls to reduce the light and dark barrier.
  - Inclusion of baffles or low flow channel to retain sediment in the culvert and create suitable depth of flow under a range of conditions.

6.4.3 Other geomorphological impacts related to access arrangements can be offset by improvements and environmental enhancement in other areas of the catchment. Such embedded mitigation includes landscaping and ecological planting on the newly created floodplain compensation areas.

6.5 Monitoring

6.5.1 Regular monitoring of any change to the channel bed and banks could be undertaken, particularly in the vicinity of the River Mole channel diversion, following completion of the Project. This could be undertaken using fixed point photography. If negative change occurs, appropriate mitigation should be implemented. It is anticipated that monitoring will be included as a requirement in the DCO.

7 Impact Assessment

7.1 Assessment of Effects

7.1.1 The effects of the Project on the water environment along with a methodology as to how the effects have been assessed are presented within Chapter 11: Water Environment, Section 11.4. A summary of the effects on geomorphological elements during the construction and operational phases of the development are summarised below. These effects have been assessed with the mitigation outlined in Section 6 in place.

7.2 Initial Construction Phase: 2024-2029

7.2.1 This section considers the potential effects of the activities that are likely to be carried out during initial construction phase of the Project. The construction activities are outlined in the PEIR Chapter 5: Project Description. Each receptor has been assessed for the impacts in Table 7.2.1.

Table 7.2.1: Initial Construction Phase Impacts for Geomorphology

Description of Impact	Receptor	Duration	Sensitivity of Receptor	Magnitude of Impact	Significance of Effect
General construction activities relating to the Project have potential impacts on all watercourses. These may include: ▪ Increase to suspended sediment loads due to channel disturbance from working in the channel, and runoff from construction areas. Impacts sediment transport and bed substrate downstream. This would have a localised impact on the geomorphology of the channel due to the CoCP mitigation that will be put in place, that reduces the release of fine sediment into the channel, for example through use of a silt barrier or filter fence. ▪ Localised increase in potential for erosion of bed and banks due to excavation and earthworks, and removal of riparian vegetation. The CoCP mitigation would also reduce the potential for erosion by use of temporary bank and bed protection and re-establishment of riparian vegetation, where necessary. ▪ Localised loss of and damage to riparian vegetation due to vegetation clearance. The CoCP mitigation reduces the impact by re-establishment of riparian vegetation and minimising area impacted. ▪ Localised disruption of quantity and dynamics of flow and sediment supply, due to changes in bed and bank form during construction. The CoCP mitigation reduces the impact by minimising the area impacted and protecting bed and banks where necessary.	River Mole	Medium-term	High	Negligible Adverse	Minor Adverse
	Gatwick Stream	Medium-term	High	Negligible Adverse	Minor Adverse
	Crawter's Brook	Medium-term	High	Negligible Adverse	Minor Adverse
	Burstow Stream Tributary	Medium-term	Low	Negligible Adverse	Negligible Adverse
	Burstow Stream	Medium-term	Medium	Negligible Adverse	Minor Adverse
Construction of the River Mole diversion may require excavation and earthworks along a 400-metre length of existing channel. These activities may impact the existing watercourse by: ▪ Localised destabilisation of banks due to bank top loading and ground vibration. The CoCP mitigation follows best practice measures which would minimise works on the bank top and reduce the potential for instability using temporary bank and bed protection, where necessary. ▪ Localised damage to bank face due to modification and removal of bank material. The impacts are localised as the works only require a small section of bank for connecting the channel to the diversion channel.	River Mole	Medium-term	High	Low Adverse	Minor Adverse

Description of Impact	Receptor	Duration	Sensitivity of Receptor	Magnitude of Impact	Significance of Effect
▪ Local to reach scale loss of natural bed forms and materials due to infilled original channel. The CoCP mitigation would involve addition of suitable substrate to the diversion channel to create the natural bed conditions for the given river type. ▪ Local destabilisation of banks due to vegetation clearance, as vegetation binds the bank material and draws water. The CoCP mitigation reduces the duration and scale of the impact by re-establishment of riparian vegetation following works and by minimising the area impacted. ▪ Change in the quantity and dynamics of flow and sediment supply, due to changes in bed and bank form, channel planform, cross-section and gradients, as the channel adjusts. Best practice measures implemented through the CoCP and the offline construction of the diversion channel would reduce the release of fine sediments to the channel and downstream and reduce the likelihood of any unexpected large-scale change. The length of the channel adversely impacted, and duration of the impact would be reduced with offline construction of the channel diversion and implementation of best practice measures through the CoCP. Although natural bed and bank forms in the existing channel would be lost, the works would deliver an overall improvement to the geomorphology of the watercourse through re-meandering and naturalisation of the diversion channel. Therefore, the overall significance is Minor Adverse.					
Construction of the culvert extension and re-provisioning of the siphon north of runway would have the permanent effect of loss of existing bed and bank form and material, and riparian vegetation. This can result in localised disruption of quantity and dynamics of flow and sediment supply. The CoCP mitigation reduces the impact by re-establishment of riparian vegetation and minimising area impacted. The area potentially impacted is also relatively small, and part of the existing culvert would be replaced. There is the potential increase to suspended sediment loads due to channel disturbance from working in the channel. This would have a localised impact on the geomorphology of the channel due to the CoCP mitigation that will be put in place to reduce these effects.	River Mole	Medium-term	High	Negligible Adverse	Minor Adverse
The construction of the Museum Field flood compensation area (FCA) would involve lowering the existing ground level on the floodplain by up to approximately 3.5 metres below ground level. The FCA would connect to the River Mole via a spillway which would involve lowering the watercourse bank. These activities may impact the watercourse by: ▪ Localised damage to bank face due to modification and removal of bank material. The impacts would be localised as the works would only require a small section of bank for the spillway connection. The CoCP mitigation would also reduce the impact by minimising the area impacted and replacing natural bank material, where possible. ▪ Localised loss of natural bed forms and materials due to excavation works. The impacts would be localised as the works only require a small section of bed for the spillway connection. The CoCP mitigation would also reduce the impact by minimising the area impacted and replacing natural bed material, where possible. ▪ Destabilisation of banks due to vegetation clearance, as vegetation binds the bank material and draws water. The impacts would be localised as the works only require a small section of bank for the spillway connection. The CoCP mitigation also reduces the duration and scale of the impact by re-establishment of riparian vegetation following works and by minimising the area impacted. ▪ Localised disruption of quantity and dynamics of flow and sediment supply, and release of fine sediments into the channel. This would occur due to changes in bed and bank form, channel planform, cross-section and gradients as the channel adjusts. The impacts would be localised as the works only require a small section of bank and bed for the spillway connection. This would have a temporary and localised impact on the	River Mole	Medium-term	High	Low Adverse	Minor Adverse

Description of Impact	Receptor	Duration	Sensitivity of Receptor	Magnitude of Impact	Significance of Effect
geomorphology of the channel due to the CoCP mitigation that would be put in place, which would reduce the release of fine sediment into the channel, e.g. through use of silt barriers or filter fences during construction. The impacts would be localised and mostly temporary with the provision of best practice measures adopted through the CoCP, therefore the overall significance would be Minor Adverse.					
The construction of a new flood compensation area is proposed between the River Mole diversion and Museum Field, also known as East of Museum Field, FCA 3. This would require lowering of the ground levels on the floodplain by up to approximately 1.8 metres below ground level. The area is expected to be returned to grassland following completion of the excavation works. These activities would have the effect of increased sediment loading within the River Mole during construction. The impact would be localised as the FCA is set back from the watercourse and implementation CoCP mitigation would reduce the release of fine sediments entering the channel. The spillway from Museum Field is anticipated to pass through FCA 3, connecting to the River Mole. Impacts on the watercourse are localised around the construction of the spillway, which are part of the Museum Field FCA.	River Mole	Medium-term	High	Negligible Adverse	Minor Adverse
The works to provide a compensatory floodplain storage area in car park X, south of Crawter's Brook, would involve lowering of the car park ground level by a depth of up to 2.5 metres. The flood compensation area would connect to the River Mole downstream via an outfall structure, which may take the form of a flapped culvert. The construction of the outfall headwall would impact the watercourse by: ▪ localised damage to bank face due to modification and removal of bank material as the works only require a small area of the bank for the outfall. ▪ temporary release of fine sediments into the watercourse and sediment pollution. This would have a localised impact on the geomorphology of the channel due to the CoCP mitigation that would be put in place, which reduces the release of fine sediment into the channel.	River Mole	Medium-term	High	Negligible Adverse	Minor Adverse
Ground lowering and increase of the depth of water in the floodplain in car park X would have the effect of increased sediment loading within Crawter's Brook during construction. The impact would be localised as the car park is set back from the watercourse and implementation CoCP mitigation would reduce the release of find sediments entering the channel.	Crawter's Brook	Short-term	High	Negligible Adverse	Minor Adverse

7.3 First Full Year of Opening: 2029

7.3.1 This section considers the potential effects of the activities that are likely to be carried out during first full year of opening of the Project. The activities are outlined in the PEIR Chapter 5: Project Description. The receptor has been assessed for the impacts in Table 7.3.1.

Table 7.3.1: First Full Year of Opening Impacts for Geomorphology

Description of Impact	Receptor	Duration	Sensitivity of Receptor	Magnitude of Impact	Significance of Effect
Construction of new surface access arrangements (South Terminal) would involve the M23 road widening and culvert extension on Burstow Stream Tributary, and an attenuation pond adjacent to Balcombe Road with flow control on the outfall drain to Burstow Stream Tributary downstream of the culvert. These activities may impact the watercourse by localised disruption of quantity and dynamics of flow and sediment supply. This would occur due to changes in bank and bed form, channel cross-section and gradient, temporary release of fine sediments into the watercourse and sediment pollution runoff from construction areas. The impacts would be localised as the works	Burstow Stream Tributary	Short-term	Low	Negligible Adverse	Minor Adverse

Description of Impact	Receptor	Duration	Sensitivity of Receptor	Magnitude of Impact	Significance of Effect
only require a small section of bank for culvert extension and concrete headwall for the outfall, and there is existing concrete lining along the upstream and downstream of the culvert. The impacts would be mostly temporary with the provision of best practice measures adopted through the CoCP.					
Construction of new surface access arrangements (South Terminal) would involve widening of the M23 spur, and modification and improvements to the existing attenuation pond, and the drains and outfalls which connect to Burstow Stream. These activities may impact the watercourse by localised disruption of quantity and dynamics of flow and sediment supply. This would occur due to changes in bank form and temporary release of fine sediments into the watercourse and sediment pollution runoff from construction areas. The impacts would be localised as the works only require a small section of bank for the outfall, and modifications on the floodplain are setback from the watercourse. The impacts would be mostly temporary with the provision of best practice measures adopted through the CoCP.	Burstow Stream	Short-term	Medium	Negligible Adverse	Minor Adverse
Construction of new surface access arrangements (North Terminal) would be setback from the watercourse, however there is the potential for sediment pollution due to runoff from construction areas. Outfalls will be constructed on the River Mole and Gatwick Stream connecting to a highway drainage attenuation tank and pond, respectively. The construction of the outfall headwalls would impact the watercourse by localised disruption of quantity and dynamics of flow and sediment supply. This would occur due to: ▪ localised damage to bank face due to modification and removal of bank material and riparian vegetation as the works only require a small area of the bank for the outfall ▪ temporary release of fine sediments into the watercourse and sediment pollution runoff from construction areas This would have a localised impact on the geomorphology of the channel due to the CoCP mitigation that would be put in place, that reduces the release of fine sediment into the channel.	Gatwick Stream, River Mole	Short-term	High	Negligible Adverse	Minor Adverse
Construction of new surface access arrangements at Longbridge Roundabout would include widening the existing overbridge at the River Mole by 5-6 metres, development in the floodplain to accommodate widening and modifications to the A23, and two concrete headwalls for the new outfalls connecting the highway drainage attenuation basins. The construction of the outfall headwall would impact the watercourse by localised disruption of quantity and dynamics of flow and sediment supply. This would occur due to: ▪ localised damage to bank face due to modification and removal of bank material and riparian vegetation as the works only require a small area of the bank for the outfall ▪ temporary release of fine sediments into the watercourse and sediment pollution runoff from construction areas This would have a localised impact on the geomorphology of the channel due to the CoCP mitigation that would be put in place. The effects would be minor adverse which is not significant.	River Mole	Short-term	High	Negligible Adverse	Minor Adverse
Change to the geomorphology of the watercourse is expected to continue as the watercourses adapt and adjust to associated construction works. Best practice measures to mitigate the construction impacts through the CoCP would continue to control the impacts, as described in Section 7.2.	River Mole, Gatwick Stream, Crawter's Brook, Burstow Stream Tributary, Burstow Stream	Medium-term	High to Low	Negligible Adverse	Minor Adverse - Gatwick Stream, River Mole and Crawter's Brook, Burstow Stream Negligible – Burstow Stream Tributary

7.4 Interim Assessment Year: 2032

7.4.1 This section considers the potential effects of the activities that are likely to be carried out during the interim assessment year of the project. The activities are outlined in the PEIR Chapter 5: Project Description. The receptor has been assessed for the impacts in Table 7.4.1.

Table 7.4.1: Interim Assessment Year Impacts for Geomorphology

Description of Impact	Receptor	Duration	Sensitivity of Receptor	Magnitude of Impact	Significance of Effect
The construction of the east of Gatwick Stream FCA would involve lowering the existing ground level by up to 5 metres and lowering of the stream bank to connect the watercourse to the FCA. These construction activities may impact the watercourse by: ▪ Localised damage to bank face due to modification and removal of bank material. The impacts are localised as the works only require a small section of bank for the spillway connection. The CoCP mitigation will also reduce the impact by minimising the area impacted and replacing natural bank material, where possible. ▪ Localised loss of natural bed forms and materials due to excavation works. The impacts would be localised as the works only require a small section of bed for the spillway connection. The CoCP mitigation would also reduce the impact by minimising the area impacted and replacing natural bed material, where possible. ▪ Destabilisation of banks due to vegetation clearance, as vegetation binds the bank material and draws water. The impacts are localised as the works only require a small section of bank for the spillway connection. The CoCP mitigation would also reduce the duration and scale of the impact by re-establishment of riparian vegetation following works and by minimising the area impacted. ▪ Localised disruption of quantity and dynamics of flow and sediment supply, and release of fine sediments into the channel. This would occur due to changes in bed and bank form, channel planform, cross-section and gradients, as the channel adjusts. The impacts would be localised as the works only require a small section of bank and bed for the spillway connection. This would have a temporary and localised impact on the geomorphology of the channel due to the CoCP mitigation that will be put in place, which reduces the release of fine sediment into the channel, eg through use of silt barriers or filter fences during construction. The impacts would be localised and mostly temporary with the provision of best practice measures adopted through the CoCP, therefore the overall significance is Minor Adverse.	Gatwick Stream	Medium-term	High	Low Adverse	Minor Adverse
Change to the geomorphology of the watercourse is expected to continue as the watercourses adapt and adjust to associated construction works. Best practice measures to mitigate the construction impacts through the CoCP would continue to control the impacts, as described in Section 7.2.	River Mole, Gatwick Stream, Crawter's Brook, Burstow Stream, Burstow Stream Tributary	Medium-term	High to Low	Negligible Adverse	Minor Adverse - Gatwick Stream, River Mole and Crawter's Brook, Burstow Stream Negligible – Burstow Stream Tributary

7.5 Design Year: 2038

7.5.1 This section mainly considers the potential effects of the operational activities and are considered long-term impacts. Often it is difficult to quantify the magnitude of long term impacts due to the timescales over which they may occur and the resilience of the environment to adapt to future changes, therefore expert judgement is used to undertake the assessment. Each receptor has been assessed for the impacts in Table 7.5.1.

Table 7.5.1: Design Year Impacts for Geomorphology

Description of Impact	Receptor	Duration	Sensitivity of Receptor	Magnitude of Impact	Significance of Effect
Gatwick Stream flood compensation area and connecting spillway					
Creation of the flood storage area and connecting spillway would improve floodplain-channel coupling during flood conditions. Lowering the banks for connecting the spillway to the flood storage area has the effect of localised loss of existing bank form. However, the impact would be reduced with mitigation designed to vary bank form where banks are being lowered/altered, which would maintain or improve natural variance of flow in the channel. Ground lowering and planting of grassland in flood storage areas has the effect of loss of natural floodplain vegetation. These alterations to the baseline could encourage erosion of the banks and bed along the connecting spillway during flood events. The scale impacts would be reduced with mitigation including ecological planting to restore natural vegetation to the floodplain and use of soft/bio engineered bank protection if banks need to be protected. The length of bank impacted is relatively small and the flood storage area is set back from the watercourse. Furthermore, enough time would have passed since the construction phase for the river to naturally adjust and for vegetation to establish on the banks to aid bank stability. Therefore, the significance of the impact is Minor Adverse.	Gatwick Stream	Long-term	High	Low Adverse	Minor Adverse
Diversion of the Mole north of runway in two-stage channel					
Reinstatement of a more naturalised planform and morphology of the section of the River Mole has the long-term effect of improving the flow regime and channel diversity along the section of the diversion and downstream. Floodplain improvements and re-meandering improves floodplain-coupling. Planting of natural floodplain vegetation has the effect of improving riparian habitats and improving bank stability, downstream sediment dynamics and flow regime. The impacts would improve the geomorphology of the watercourse at a multi-reach scale, as many of the impacts would affect the watercourse downstream, e.g. sediment dynamics and flow regime. The effect would also be long-term and therefore significance of the impact is considered Moderate Beneficial.	River Mole	Long-term	High	Medium Beneficial	Moderate Beneficial
There is potential for reduction in water velocity along the river diversion, which may cause deposition at this location, and sediment starvation and erosion downstream. These changes would arise due to the changes in cross-sectional form and channel gradient. Detailed design work on the diversion channel mitigates these effects. This mitigation would include creating a suitable river type for the bed gradient of the realignment to maintain sediment transport capability; and, a multiple stage channel to ensure natural and varied flow conditions; creation of varied cross-sections to mimic natural process, bed and bank forms; and, addition of suitable substrate. The impact is local to reach scale, however with appropriate design of the diversion channel, the scale of the impact would be reduced. Natural channel adjustment would also be expected during the operational phase. Therefore, the overall significance of the impact is Minor Adverse.	River Mole	Long-term	High	Low Adverse	Minor Adverse

Description of Impact	Receptor	Duration	Sensitivity of Receptor	Magnitude of Impact	Significance of Effect
Culvert extension and re-provisioning of siphon north of runway					
Extension of the culvert and concrete channel lining would have the permanent effect of loss of existing bed and bank form and material, and riparian vegetation. The homogeneity of the new channel cross-section creates the potential for loss of natural variance in velocities and secondary flows cells, leading to changes in velocity and geomorphological processes. The area potentially impacted is relatively small, and part of the existing culvert would be replaced. Provision of the River Mole diversion channel and other culvert design features (Section 6.4) would act to mitigate these effects.	River Mole	Long-term	High	Negligible Adverse	Minor Adverse
Flood compensation area in Museum Field and connecting spillway					
Creation of the flood compensation area and connecting spillway would improve floodplain-channel coupling during flood conditions. Lowering the banks for connecting the spillway to the flood compensation area has the effect of localised loss of existing bank form. However, the impact would be reduced with mitigation designed to vary bank form where banks are being lowered/altered, which would maintain or improve natural variance of flow in the channel. Ground lowering and planting of grassland in the flood storage area has the effect of loss of natural floodplain vegetation. These alterations to the baseline could encourage erosion of the banks and bed along the connecting spillway during flood events. The scale of impacts would be reduced with mitigation including ecological planting to restore natural vegetation to the floodplain and use of soft/bio engineered bank protection if banks need to be protected. The length of bank impacted would be relatively small and not entirely natural, and the flood storage area is set back from the watercourse. Furthermore, enough time would have passed since the construction phase for the river to naturally adjust and for vegetation to establish on the banks to aid bank stability. Therefore, the significance of the impact is Minor Adverse.	River Mole	Long-term	High	Low Adverse	Minor Adverse
Creation of the flood compensation area at FCA 3, East of Museum Field, would improve floodplain-channel coupling during flood conditions. Ground lowering in the flood storage area has the effect of loss of natural floodplain vegetation, which could encourage erosion of the FCA and spillway bed during flood conditions, inputting eroded sediment into the watercourse. The scale of impacts would be reduced with mitigation including ecological planting to restore natural vegetation to the floodplain. Furthermore, enough time would have passed since the construction phase for vegetation to establish. Therefore, the significance of the impact is Negligible Adverse.	River Mole	Long--term	High	Negligible Adverse	Minor Adverse
Flood attenuation and ground lowering in Car Park X					
Ground lowering and increase to depth of water in the floodplain in Car Park X has the effect of reduction in area of floodplain-channel coupling. The area impacted is relatively small and set back from the watercourse.	Crawter's Brook	Long-term	High	Negligible Adverse	Minor Adverse
Construction of the outfall headwall from the compensatory floodplain storage area has the effect of loss of existing banks and localised changes to sediment transfer and flow patterns in the channel. The length of channel impacted is relatively small.	River Mole	Long-term	High	Negligible Adverse	Minor Adverse
New surface access arrangements					
New surface access arrangements (North Terminal) Permanent change to the baseline would include loss of floodplain and natural vegetation due to encroachment of highway footprint onto existing natural floodplain. The footprint is set back from the watercourse.	Gatwick Stream, River Mole	Long-term	High	Negligible Adverse	Minor Adverse

Description of Impact	Receptor	Duration	Sensitivity of Receptor	Magnitude of Impact	Significance of Effect
Construction of the outfall headwall from the highway drainage attenuation tank and pond has the effect of loss of natural banks and localised changes to sediment transfer and flow patterns in the channel. Flow control on the outfall drain and filtering of pollutants would reduce the impact on flow and sediment transfer. The length of channel impacted is relatively small.					
New surface access arrangements (South Terminal) Permanent change to the baseline would include loss of natural bed and bank form, and riparian vegetation due to the M23 road widening and culvert extension. Homogeneity of the channel cross-section has the potential for loss of natural variance in velocities and secondary flow cells, leading to changes in velocity and geomorphological processes. There is existing concrete lining along the upstream and downstream of the culvert on Burstow Stream Tributary and only a relatively small area is potentially impacted on both watercourses. Permanent loss of natural banks and localised changes to sediment transfer and flow patterns in the channel would occur due to creation of a new concrete outfall headwall connecting the highway drainage attenuation pond adjacent to Balcombe Road. Flow control on the outfall drain and filtering of pollutants would reduce the impact on flow and sediment transfer. The length of channel impacted is relatively small.	Burstow Stream Tributary	Long-term	Low	Negligible Adverse	Negligible Adverse
New surface access arrangements (South Terminal) Permanent loss of existing banks and localised changes to sediment transfer and flow patterns in the channel would occur due to modifications and improvements the existing attenuation pond, drains and outfall connecting to the Burstow Stream. Flow control on the outfall drain and filtering of pollutants would reduce the impact on flow and sediment transfer. Permanent change to the baseline would also include loss of floodplain and natural vegetation due to encroachment of highways footprint onto existing natural floodplain. The length of channel impacted is relatively small as existing structures will be modified and/or improved. The works on the floodplain are setback from the watercourse.	Burstow Stream	Long-term	Medium	Negligible Adverse	Minor Adverse
New surface access arrangements (Longbridge Roundabout) Permanent change to the baseline would include loss of floodplain and natural vegetation due to encroachment of highway footprint onto existing natural floodplain. Permanent change to the baseline would also include loss of natural bed and bank form, localised changes to sediment transfer and flow patterns, and loss natural riparian vegetation, due to the widening and modifications on the existing overbridge and two concrete outfall headwalls connecting the highway drainage attenuation basins. Flow control on the outfall drain and filtering of pollutants would reduce the impact on flow and sediment transfer. The length of channel impacted is relatively small.	River Mole	Long-term	High	Negligible Adverse	Minor Adverse

8 Summary

8.1.1 This assessment evaluates the potential impacts of the Project and the embedded flood mitigation measures on the geomorphology of watercourses in the study area, during the construction and operational phases of the Project. The assessment found that during the initial construction phase of the Project, there would be minor adverse impacts on the River Mole associated to construction of the channel diversion and creation of flood compensation areas which are part of the embedded flood mitigation. The effects would be temporary, however, and the channel diversion works would deliver an overall improvement to the geomorphology of the watercourse, supporting WER objectives during operation. There would be negligible to minor adverse impacts during construction works, including creation of the compensatory floodplain storage area in car park X and extension of the River Mole syphon and culvert. These impacts assume the provision of mitigation and best practice measures through the CoCP. During the first full year of operation, there would be a negligible to minor adverse impact on the watercourses as they adapt and adjust to associated construction works. There would be minor adverse impacts through the construction of the new surface access arrangements at the South Terminal and North Terminal, with the provision of mitigation and best practice measures through the CoCP. During the interim assessment year of the Project, there would be minor adverse impacts on the Gatwick Stream associated to construction of the Gatwick Stream flood compensation area, with the provision of mitigation and best practice measures through the CoCP. During the design year, there would be minor to negligible adverse impacts associated to operational activities on the watercourses. These relate to the River Mole channel diversion, flood compensation areas and culvert extensions. There would be a moderate beneficial impact on the River Mole with the implementation of the mitigation proposed and further detailed design work. Other remaining impacts on the watercourses associated to the Project, such as new access arrangements, would be offset by improvements and environmental enhancement in other areas of the catchment, as part of the embedded mitigation.

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10 Glossary

10.1 List of Acronyms

Table 10.1.1: List of Acronyms

Term	Definition
CoCP	Code of Construction Practice
DCO	Development Consent Order
Defra	Department for Environment, Food and Rural Affairs
EIA	Environmental Impact Assessment
FCA	Flood compensation area
GAL	Gatwick Airport Limited
OS	Ordnance Survey
PEIR	Preliminary Environmental Information Report
RBMP	River Basin Management Plan
STW	Sewage Treatment Works
WER	Water Environment (Water Framework Directive) (England and Wales) Regulations (WER) 2017
WFD	Water Framework Directive

10.2 Glossary of terms

Table 10.2.1: Glossary (adapted from Osterkamp, 2008; Environment Agency, 2009)

Term	Description
Adjustment	The tendency of stream channels to change in size and shape in response to the changing effects of water, sediment, dissolved solids, and organic matter that alter them or pass through them.
Bank	A sloping margin of a natural, stream-formed, alluvial channel that confines discharge during non-flood flow. Designation of a right or left bank is done when looking in the downstream direction.
Bank material	The sediment of which the mostly sloping sides, or banks, of a stream channel are formed; like bed material, it is mostly

Term	Description
	indicative of the suspended-load transported by streams during non-flood periods.
Bars	In-channel sediment of relatively coarse bed material, typically coarse sand through cobbles in size, that is generally deposited during the recession of a high flow and is mostly exposed during periods of low flow. Bars may become vegetated when stable.
Bed	Bottom surface of a watercourse upon which water and sediment moves during periods of discharge.
Bed material	Sediment of which the mostly horizontal bed of a stream channel is formed; it is mostly indicative of the bed-load sizes transported by the stream
Catchment	The area from which precipitation contributes to the flow in a borehole spring, river or lake. This includes tributaries and the areas they drain.
Channel	A natural, or constructed, passageway or depression of perceptible linear extent containing continuously or periodically flowing water and sediment, or a connecting link between two bodies of water.
Channel erosion	Detachment and transport, possibly followed quickly by re-deposition, of channel bed or bank material by concentrated flow in areas of open-channel flow.
Conveyance	A measure of the amount of water that can pass through a stream-channel section without spilling onto higher surfaces as flood flow.
Deposition	Accumulation into beds or irregular masses of loose sediment or other rock material by any natural agent.
Discharge	The movement downstream per unit length of channel of a volume of water; water discharge is given in volume per unit time, typically cubic meters per second ($m^3 s^{-1}$).
Disturbance	Any short-term alteration, natural or imposed, of the land surface that results in a change of

Term	Description
	geomorphic, hydrologic, or biological processes from a state of approximate equilibrium to one of relative instability.
Good status	WFD status achieved by a surface water body when both the ecological status and its chemical status are at least good.
Gradient	The rate of elevation change between two specified sites of horizontal distance measured along the thalweg of the channel; it is generally expressed as a non-dimensional number ($m\ m^{-1}$).
Hydromorphology	Describes the hydrological and geomorphological processes and attributes of surface water bodies.
Morphology	Describes the physical form and condition of a surface water body, for example the width, depth and perimeter of a river channel, the structure and condition of the riverbed and bank.
Pressures	Human activities such as abstraction, effluent discharges or engineering works that have the potential to have adverse effects on the water environment.
Restoration	Applied to stream corridors that have been altered through human activity, is the attempt to recreate the adjusted physical and biological conditions that were present prior to the alteration.
Riparian vegetation	Vegetation in part of the fluvial landscape inundated or saturated by flood flows; the area consists of all surfaces of active fluvial landforms up through the floodplain.
River Basin Management Plan	For each River Basin District, the Water Environment (Water Framework Directive) (England and Wales) Regulations (WER) 2017 requires a River Basin Management Plan to be published. These are plans that set out the environmental objectives for all the water bodies within the River Basin District and how they will be achieved. The plans will be based upon a detailed analysis

Term	Description
	of the pressures on the water bodies and an assessment of their impacts. The plans are reviewed and updated every six years.
Status	The physical, chemical, biological, or ecological quality of a waterbody.
Suspended sediment	Sediment moved in suspension in water and is maintained in suspension by the upward component of turbulent currents or by colloidal suspension.