HYDROGEOLOGICAL AND HYDROLOGICAL IMPACT ASSESSMENT FOR THE EXTRACTION OF DOLOMITE FROM EXTENSION AREAS, AN EXTENSION IN THE DURATION OF OPERATIONS AND REVISED RESTORATION SCHEME AT WHITWELL QUARRY, DERBYSHIRE.

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1. Introduction

1.1 MJCA is commissioned by Tarmac, a CRH company, to undertake an assessment of the potential impacts on water resources together with a flood risk assessment associated with the extraction of mineral in four proposed extension areas to the Whitwell Quarry Complex and an extension in time for the completion of the extraction and restoration operations for the whole quarry site. This report has been prepared for inclusion with an Environmental Statement which will be submitted with the planning application for the proposed development. An updated restoration scheme is included in the planning application based on the currently consented restoration principles and incorporating the new extraction areas as well as the most up to date materials balance information. For the purpose of this report the area the subject of the planning application is referred to as the site and is shown on Figure HIA1.

1.2 Whitwell Quarry Complex is centred on National Grid Reference (NGR) SK 53240 75254 to the south of Whitwell village and north east of Creswell in Derbyshire. Access to the site is from Crags Road which runs north to south between the main quarry and the eastern quarry area. The northern part of the site is crossed by the Robin Hood railway line which runs between Nottingham and Worksop. The railway runs south west to north east through a tunnel at the site (Figure HIA1).

1.3 Whitwell Quarry Complex incorporating the application site includes the main quarry located to the south of the railway line, the northern quarry located to the north of the railway line, the tunnel area around the railway, the eastern quarry area located to the east of Crags Road and the four proposed extensions together with the minerals processing area including the readymix concrete plant and site access and exit. The main quarry is generally rectangular in shape orientated in a north west to south east direction. The four extension areas comprise a north, a north east, an east and a south east extension. Whitwell Quarry Complex includes the Whitwell Lime Works adjacent to the minerals processing area, however, the Whitwell Lime Works is not within the operating control of the Applicant and is not included in the application area (Figures HIA1 and HIA2). The application boundary covers an area of approximately 191ha. The site layout including the four extension areas is shown on Figure HIA2.

1.4 The topography of the site falls from approximately 115 metres above Ordnance Datum (mAOD) in the north to approximately 90mAOD in the west, 75mAOD in the
south and approximately 60mAOD in the east. The land falls towards the surrounding watercourses comprising the River Wollen to the west and south west, the Millwood Brook to the south and east and the Millash Brook to the north east. A more detailed description of the watercourses is provided in Section 4 of this report. The area around the site is predominantly rural with scattered settlements and woodland. The former Whitwell Colliery was located adjacent to the north east of the site. The associated Whitwell Tip colliery spoil tip is located to the north of the eastern quarry area and Belph Tip colliery spoil tip is located on the eastern quarry area of the site. The former Creswell Colliery was located approximately 1km south west of the site. Whitwell Sewage Treatment Works is located between the site and Millash Brook to the north of the eastern quarry area.

1.5 The majority of the main quarry at the site has been excavated and is partially backfilled with quarry waste, kiln dust from the adjacent limestone kiln and colliery spoil. Aggregates stockpiles are located in the main quarry area. Colliery spoil is gradually being transferred from Belph Tip in the eastern quarry area to the main quarry floor in order to expose the mineral in the eastern quarry area and to create the restoration profile for the quarry. The placement of colliery spoil from Belph Tip in the eastern quarry area in the main quarry is the subject of Environmental Permit number NPSGWA000008. The remaining extraction areas in the main quarry are at the southern and north eastern extents as well as the mineral around the railway tunnel.

1.6 It is proposed that operation of the quarry will continue as consented currently and including the four extension areas with restoration consistent with the updated scheme. Approximately 1 million tonnes of dolomitic limestone (dolomite) is extracted from Whitwell Quarry each year. At present parts of the site the subject of a ROMP are consented to operate until November 2019 and the areas of the site the subject of a separate planning permission are consented to operate to 2025. The site is restored progressively using materials generated as part of the site activities including overburden, kiln residues and colliery spoil. The overall Whitwell Quarry Complex will be restored to a mixture of land uses including ecological enhancement. Agricultural land will be created together with areas of conservation limestone grassland, three lakes, fen and woodland as well as the establishment of new hedgerows. Rock faces will be retained in places to leave the dolomite strata
exposed mirroring some of the natural features of the locality. Taking into account
the remaining reserves and the proposed extension areas, it is proposed that the life
of the site will extend to 2040 with final restoration completed by 2043.

1.7 Water is pumped from the quarry to facilitate mineral extraction and the placement of
restoration materials under dry conditions. The pumped water is discharged to the
surface water system. The water discharges are the subject of Environmental Permit
reference BL3242. It is proposed that these dewatering activities will continue during
the operation of the proposed extension areas and restoration as necessary.

1.8 A detailed description of the site and the proposed development together with a policy
review are presented in the planning application documents including the Planning
Statement and the Environmental Statement. This report should be read in
conjunction with the planning application documents. The baseline geology,
hydrogeology and hydrology at and in the vicinity of the site are presented in this
report. The potential impacts of the proposed development on water resources has
been assessed and the results of the assessment are presented in this report. A
qualitative flood risk assessment has been undertaken and the results are presented
in this report. Mitigation measures are proposed where necessary.
2. Geology

2.1 The geology of the site is taken from the British Geological Survey (BGS) 1:50,000 scale Sheet 100 Sheffield, the BGS memoir entitled ‘Geology of the country around Sheffield’ (Reference 1), sheets SK 57 NW and SK 57 SW of the 1:10,000 series BGS geological maps and the records of boreholes drilled in the vicinity of the site. Superficial Quaternary Head deposits comprising clayey sands and silt are present in the vicinity of the site beneath the Millash Brook to the north east of the site, the Millwood Brook to the south and east of the site, the River Wollen to the west of the site and Crags Pond to the south of the site. No further superficial deposits are recorded at or in the vicinity of the site.

2.2 The solid geology in the vicinity of the site comprises the Permian Edlington Formation (formerly the Middle Permian Marl) consisting of mudstone and sandstone which outcrop in a small area in the north west of the site where the railway enters the site, along the north and western site boundary north of the railway, beneath the colliery spoil tip in Belph Tip in the east of the site and in a small area adjacent to the western site boundary south of the railway. The Edlington Formation is not present across the majority of the site with the main outcrop located approximately 200m east of the site. Whitwell Quarry is excavated into the Permian Cadeby Formation which underlies the Edlington Formation. The Cadeby Formation comprises dolostone, referred to as dolomite for the purpose of this report, (formerly the Lower Magnesian Limestone) which overlies the calcareous mudstone of the Cadeby Formation (formerly the Lower Permian Marl). The Cadeby Formation is underlain by the Permian Yellow Sands Formation (formerly the Basal Permian Sands). The Permian strata overlies unconformably the Carboniferous Pennine Middle Coal Measures Formation. The Pennine Middle Coal Measures Formation comprise a cyclical sequence of mudstones, siltstones, sandstones and coal seams. The unconformity between the Permian and Carboniferous strata is angular. The geology in the vicinity of the site is presented on Figure HIA3 and summarised in Table HIA1.

2.3 Based on BGS borehole information, the Cadeby Formation dolomite is between approximately 23m and 37m thick in the vicinity of the site and the Cadeby Formation calcareous mudstone is between approximately 16m and 18m thick in the vicinity of the site. The Yellow Sands Formation, where present, is between approximately 0.2m and 1.5m thick in the vicinity of the site. The base of Whitwell Quarry generally
is at the contact between the Cadeby Formation dolomite and the Cadeby Formation calcareous mudstone.

2.4 The Permian strata generally are horizontal or dip to the east at an angle of between 1° and 2° in the vicinity of the site. The underlying Pennine Middle Coal Measures are folded and faulted in the region. In places the faulting in the Pennine Middle Coal Measures extends into the Permian strata including at the Park Hall Fault and the Creswell Fault in the vicinity of the site. The Park Hall Fault trends generally north west to south east and cuts though the Permian Strata across the centre of the main quarry. The throw on the Park Hall Fault in the Permian Strata is reported as approximately 30m to the south in the vicinity of Clowne which is approximately 2km west of the application area. Based on the records of boreholes drilled in the vicinity of the site it is considered that the throw on the Park Hall Fault may be less in the vicinity of the site. The Creswell Fault diverges from the Park Hill Fault approximately 300m west north west of the site and runs north west to south east close to and parallel with the western boundary of the site.

2.5 Whitwell Quarry was designated as a Regionally Important Geological and Geomorphological Site (RIGS) in 1993. RIGS are non-statutory designations. The site was designated for petrology interest in respect of the dolomitic limestone and for educational interest as an active quarry. Creswell Crags Site of Special Scientific Interest (SSSI) is located approximately 30m south of the site at the closest point. SSSI are statutory designations. Creswell Crags SSSI is cited as a site of national and international importance for Quaternary studies with Pleistocene cave deposits together with associated subaerial and fluvial sediments filling the open Creswell Gorge. Hollinhill and Markland Grips SSSI is located approximately 1km west of the site. Hollinhill and Markland Grips SSSI is cited as part of a series of sites centred on Creswell Crags SSSI which are of interest for Quaternary deposits.
3. **Hydrogeology**

3.1 It is reported in the Major Aquifer Properties Handbook (Reference 2) that the hydraulic conductivity of the Cadeby Formation dolomite matrix in the Yorkshire and Nottinghamshire area ranges between $3.6 \times 10^{-9} \text{m/s}$ and $9.8 \times 10^{-6} \text{m/s}$. It is also reported in the Major Aquifer Properties Handbook that transmissivity values recorded in the Yorkshire and Nottinghamshire area from pump tests range from approximately $6 \text{m}^2/\text{day}$ to $4300 \text{m}^2/\text{day}$ which based on an approximate aquifer thickness of $30 \text{m}$ equates to hydraulic conductivities of approximately $2.3 \times 10^{-6} \text{m/s}$ to $1.6 \times 10^{-3} \text{m/s}$. Based on the significant variation in the estimates of hydraulic conductivity it is likely that groundwater flow in the Cadeby Formation dolomite is dominated by fissure flow and that intergranular flow in the matrix is low generally. It is likely that the calcareous mudstone of the Cadeby Formation underlying the dolomite has a low permeability minimising the vertical flow of groundwater from the dolomite to the underlying Yellow Sands Formation, where present, and Pennine Middle Coal Measures. It is likely that the Yellow Sands Formation and the sandstones of the Pennine Middle Coal Measures have a moderate permeability.

3.2 Based on the Environment Agency aquifer designation maps the Quaternary Head deposits are designated as a Secondary Undifferentiated aquifer, the Edlington Formation is designated as a Secondary B aquifer, the Cadeby Formation together with the Yellow Sands Formation are designated as Principal aquifers and the Middle Pennine Coal Measures are designated as a Secondary A aquifer. The aquifer designs are summarised in Table HIA1.

3.3 The groundwater levels in the Cadeby Formation dolomite at the boreholes in the vicinity of the site are monitored monthly and are reviewed on an annual basis consistent with the current planning permissions and Environmental Permits for the Whitwell Quarry Complex. The most recent annual review is presented in a report dated March 2015. An electronic copy of the March 2015 report is provided at Appendix A to this report. The next annual review report is being prepared currently and will be submitted to the Environment Agency in 2016. From a preliminary review of the data there are no significant changes in recently recorded groundwater levels compared with the annual review presented in the report dated March 2015. Hydrographs of groundwater levels in the boreholes in the vicinity of Whitwell Quarry Complex taken from the March 2015 report are presented on Figure HIA4. The
locations of the groundwater monitoring boreholes are shown on Figure HIA2 together with groundwater contours interpolated from groundwater levels recorded in May 2013. Data from May 2013 have been selected for presentation as they include a water level recorded in May 2013 in the lagoon in the south of the main quarry in proximity to the quarry sump.

3.4 With the exception of borehole 95/5 which has a response zone in the colliery spoil on Whitwell Tip the boreholes have response zones in the Cadeby Formation dolomite. Generally the hydrographs show that groundwater levels fluctuate seasonally by up to approximately 4m. The highest groundwater levels are recorded at borehole HWF02/C1 to the north west of the site with the minimum groundwater levels recorded generally at boreholes P4 and HN06/C1 to the south east of the site. The groundwater contours show that flow in the Cadeby Formation dolomite at and in the vicinity of the site generally is towards the south east and east with a component of groundwater flow towards the quarry sump in the immediate vicinity of the quarry sump. The interpolated contours show that the impact of the quarry dewatering on groundwater levels decreases with distance from the quarry.

3.5 Water from groundwater dewatering together with surface water in the quarry is pumped from the main quarry sump to settlement lagoons and discharged to the Millash Brook to the north east of the quarry works at permitted discharge point W2 (Figure HIA2). In addition, water is pumped from the quarry sump and discharged to the River Wollen to the south west of the quarry at permitted discharge point W3 (Figure HIA2). Currently water is not discharged to the River Wollen to the west of the site at permitted discharge point W1 (Figure HIA2). It is anticipated that discharge point W1 will be utilised once mineral extraction recommences in the northern quarry. An application to vary Environmental Permit reference BL3242 will be submitted to the Environment Agency shortly to change the discharge volumes permitted at discharge points W1 and W3 and to include a fourth discharge point (W4) to the Millwood Brook to the east of the site for the management of water in the eastern quarry once mineral extraction extends below the groundwater level in this area of the site.

3.6 It is considered that the lateral extent of the groundwater level depression will be limited by leakage to the groundwater from the surrounding watercourses. Following restoration of the quarry groundwater pumping will cease and groundwater levels in
the vicinity of the quarry will recover. It is anticipated that following recovery of the groundwater levels, groundwater flow will be generally towards the south east consistent with the groundwater flow direction outside the area of influence of the current dewatering. In previous assessments it has been concluded that the predicted recovery levels for groundwater are 68.5m above Ordnance Datum (mAOD) to the south of the Whitwell Quarry Complex, 78mAOD in the centre of the Whitwell Quarry Complex and 88mAOD to the north of the Whitwell Quarry Complex (References 3 and 4). It is considered that following the recovery of the groundwater levels, groundwater in the vicinity of the quarry area will provide base flow to the River Wollen as it does currently and that this may extend to the Millwood Brook and the Millash Brook.

3.7 The site is not located over a Source Protection Zone. Based on records obtained from the Environment Agency in 2016 there are four licensed groundwater abstractions within 3km of the site. The closest abstraction is located approximately 1.4km south east of the site and is used for horticulture. One abstraction is located approximately 2.9km to the north east of the site and one abstraction is located approximately 2.9km to the south east of the site. These abstractions are used for spray irrigation, general farming and domestic use. One abstraction is located approximately 3.0km to the north west of the site and is used for spray irrigation of a golf course. The locations of the licensed groundwater abstractions are shown on Figure HIA1. Details of the licensed groundwater abstractions are presented at Appendix B.

3.8 Bolsover District Council and North East Derbyshire District Council hold records for two private water supply boreholes located approximately 2.9km and 3.0km north north east of the site. Bolsover District Council, North East Derbyshire District Council and Bassetlaw District Council have confirmed that they hold no further records of private water abstractions within 3km of the site. It is understood that during previous private water abstraction searches carried out in 2001 and 2005 properties identified as having private water abstractions located at Crags Lodge, Hennymoor Farm and Cresswell Crags Visitor Centre approximately 250m south east, 350m south east and 550m east south east of the site respectively and in the grounds of Welbeck Abbey approximately 2.5km south east of the site do not comprise the locations of the private water supply source. It has been clarified by
Bolsover District Council, North East Derbyshire District Council and Bassetlaw District Council that the private water supply to these properties is sourced from a borehole located approximately 5.7km east south east of the site on the Welbeck Estate. The locations of the private groundwater abstractions within 3km of the site are shown on Figure HIA1. There are no reported impacts from the current quarry operations on any of the licensed or private water abstractions in the vicinity of the site. It is considered likely that the abstractions are located outside of the area of influence of the current dewatering.

3.9 The site is located in the area covered by the Idle and Torne Abstraction Licensing Strategy (ALS) (Reference 5). The site is located in the Bolsover Groundwater Management Unit. Based on the Idle and Torne ALS with respect to future applications for the abstraction of groundwater from the Cadeby Formation dolomite it is stated that “no further consumptive licences will be granted” and the “Groundwater unit balance shows more water has been abstracted based on recent amounts than the amount available”.

3.10 The groundwater at and in the vicinity of the site was classified by the Environment Agency in 2009 under the Water Framework Directive (WFD) as “Good” with respect to quantitative quality and “Poor” with respect to chemical quality. The predicted classification for 2015 remained “Good” and “Poor” respectively. The River Basin Management Plans (RBMP) on which the classifications are based are being reviewed and updated by the Environment Agency currently with respect to the current WFD classifications and predicted classifications in the future. The RBMP relevant to the site comprises the Humber River Basin District.

3.11 The groundwater quality in the vicinity of the site is reviewed on an annual basis consistent with the current planning permissions and Environmental Permits for the Whitwell Quarry Complex. The most recent annual review is presented in a report dated March 2015 (Appendix A). The next annual review report is being prepared currently and will be submitted to the Environment Agency in 2016. From a preliminary review of the recent data there are no significant changes in groundwater quality compared with the annual review presented in the report dated March 2015. In general, for all of the determinands and all of the borehole locations monitored the results for the groundwater quality monitoring show that there are no significant
variations in groundwater quality down hydraulic gradient of the site compared with up hydraulic gradient.

3.12 In general the concentrations of chloride, sulphate, potassium, cadmium and zinc and values of electrical conductivity recorded in the groundwater round and to the south of the Belph Tip area of the site are higher than the concentrations and values recorded round the rest of the site. There has been no significant increasing trend recorded in the concentrations and values recorded in the groundwater at the site over the period reviewed. In the most recent annual review of the monitoring data there is no evidence of deterioration of groundwater quality as a result of quarrying activities or the placement of colliery spoil in the quarry at Whitwell Quarry Complex.
4. Hydrology

4.1 Whitwell Quarry is located in the catchment of the River Poulter. Millwood Brook is a tributary of the River Poulter and flows generally west to east approximately 250m south of the site. The Millwood Book joins the Great Lake in Welbeck Park approximately 1.4km east of the site. The River Poulter joins the Great Lake approximately 4.5km south east of the site. The River Wollen which is a tributary of the Millwood Brook flows generally north to south approximately 300m west of the site turning eastwards to confluence with the Millwood Brook approximately 250m south of the site. The Millwood Brook then flows east to the south of the site through Crags Pond approximately 200m south of the site at the closest point and then flows generally south to north approximately 500m east of the eastern quarry area. The Millash Brook which is a tributary of the Millwood Brook flows generally west to east along the northern boundary of the eastern quarry area to the confluence with Millwood Brook approximately 450m east of the site. The watercourses and ponds in the vicinity of the site are shown on Figures HIA1 and HIA2.

4.2 Based on information provided by the Environment Agency the site is situated in Flood Zone 1. Flood zones are defined in the National Planning Policy Framework (NPPF) and associated Flood Risk and Coastal Change Planning Practice Guidance to the NPPF with Flood Zone 1 comprising land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding. The flood zones designated by the Environment Agency at and in the vicinity of the site are presented at Appendix C. Further details on flood risk at and in the vicinity of the site are presented in Section 6 of this report.

4.3 Surface water runoff and incident rainfall entering the extraction area either soaks away or accumulates in the lowest part of the quarry where it is pumped from the main quarry sump and through a series of settlement lagoons and discharged into the Millash Brook to the north east of the quarry works at a permitted discharge point W2 (Figure HIA2). The settlement lagoons receive surface water runoff from the Whitwell Lime Works as well as the site. In addition, water is pumped from the quarry sump and discharged to the River Wollen to the south west of the quarry at permitted discharge point W3 (Figure HIA2). Surface water runoff from Belph Tip is directed to a new settlement lagoon at the east of the extraction area which is being constructed currently.
4.4 Currently water is not discharged to the River Wollen to the west of the site at permitted discharge point W1 (Figure HIA2). It is anticipated that discharge point W1 will be utilised once mineral extraction recommences in the northern quarry. As stated in Section 3 of this report, an application to vary Environmental Permit reference BL3242 will be submitted to the Environment Agency shortly to change the discharge volumes permitted at discharge points W1 and W3 and to include a fourth discharge point (W4) to the Millwood Brook to the east of the site for the management of water levels in the eastern quarry once mineral extraction extends below the groundwater level in this area of the site.

4.5 Surface water flows are monitored weekly in the watercourses round the site and reviewed on an annual basis consistent with the current planning permissions for the Whitwell Quarry Complex. The flow monitoring locations are shown on Figure HIA2. From the most recent annual review (Appendix A) flows in the River Wollen range from approximately 0.01m³/s to 0.52m³/s. Flows in the Millwood Brook upstream of the confluence with the River Wollen at monitoring location MB1 range from no flow to approximately 0.08m³/s. Flows in the Millwood Brook downstream of the confluence with the River Wollen and downstream of Crags Pond at monitoring location MB2 range from approximately 0.01m³/s to 0.62m³/s. Flows in the Millash Brook just upstream of the confluence with the Millwood Brook at monitoring location MLB1 range from approximately 0.005m³/s to 0.132m³/s. From the most recent annual review there is no consistent evidence that dewatering of the quarry is affecting significantly flow in the watercourses round the site. The next annual review report is being prepared currently and will be submitted to the Environment Agency in 2016. From a preliminary review of the recent data there are no significant changes in the surface water flows compared with the annual review presented in the report dated March 2015.

4.6 Based on the groundwater levels recorded at the site and topographical information from Ordnance Survey maps along the watercourses, the groundwater levels in the dolomite of the Cadeby Formation underlying the River Wollen are higher than or similar to the level of the watercourse. The groundwater levels in the dolomite of the Cadeby Formation underlying the Millwood Brook and the Millash Brook are lower than the level of the watercourses. The watercourses and Crags Pond are underlain by Quaternary Head deposits comprising clayey sand and silt. It is likely that the
Head deposits limit the continuity of the water in the watercourses with the groundwater in the underlying dolomite of the Cadeby Formation and support the water in the watercourses where the groundwater is significantly lower than the level of the watercourse such as in the Millwood Brook and the Millash Brook.

4.7 Surface water levels are monitored monthly in Crags Pond and reviewed on an annual basis consistent with the current planning permissions for the Whitwell Quarry Complex. The location of the surface water level monitoring gaugeboard is shown on Figure HIA2. From the most recent annual review (Appendix A), the water level in the pond is in the order of 67m AOD compared with groundwater levels in the order of 60m AOD to 65m AOD recorded in the vicinity of the pond (Figure HIA2). The next annual review report is being prepared currently and will be submitted to the Environment Agency in 2016. From a preliminary review of the data there are no significant changes in the surface water level in Crags Pond compared with the annual review presented in the report dated March 2015. Based on the groundwater levels recorded at the site, topographical information and the water levels recorded in the pond, it is considered that the water in Crags Pond is not in hydraulic continuity with the groundwater in the underlying Cadeby Formation. It is likely that water in the pond is supported by the Head deposits limiting the continuity with the groundwater in the underlying dolomite of the Cadeby Formation.

4.8 The River Wollen, the Millwood Brook and the Millash Brook were classified by the Environment Agency in 2009 under the WFD as “Bad” with respect to ecological quality and are not assessed for chemical quality under the WFD classifications. The predicted classification for 2015 was “Poor” with respect to ecological quality. The RBMP on which the classifications are based are being reviewed and updated by the Environment Agency currently with respect to the current WFD classifications and predicted classifications in the future. The RBMP relevant to the site comprises the Humber River Basin District.

4.9 The quality of the surface water in the River Wollen, Millwood Brook, Millash Brook, the quarry sump, the water discharge points and in the lagoons in the eastern quarry area is monitored by Tarmac and the data are reviewed on an annual basis consistent with the current planning permissions and Environmental Permits for the Whitwell Quarry Complex. From the most recent annual review (Appendix A), surface water sampled from lagoons in the eastern quarry area have low pH, elevated
concentrations of ammoniacal nitrogen, sulphate and metals and elevated electrical conductivity when compared with the background groundwater conditions in the Cadeby Formation dolomite aquifer or background surface water conditions upstream of the site in the watercourses. From the monitoring data reviewed the conditions in surface water in the lagoons in the eastern quarry area, quarrying activities and the deposition in Whitwell Quarry of colliery spoil from Belph Tip is not having a significant impact on surface water quality at or in the vicinity of the site. The next annual review report is being prepared currently and will be submitted to the Environment Agency in 2016. From a preliminary review of the recent data there are no significant changes in surface water quality compared with the annual review presented in the report dated March 2015.

4.10 Based on records obtained from the Environment Agency in 2016 there are eight licensed surface water abstractions within 3km of the site. Seven of the abstractions are from the Millwood Brook or Great Lake adjacent to or downstream from the site and the closest of which is located approximately 250m south of the site. The eighth abstraction is from a pond located approximately 1.6km south east of the site. All of the abstractions are for agricultural use. The locations of the licensed surface water abstractions are shown on Figure HIA1. Details of the licensed surface water abstractions are presented at Appendix B. Bolsover District Council, North East Derbyshire District Council and Bassetlaw District Council have confirmed that they hold no records of private surface water abstractions in the vicinity of Whitwell Quarry Complex. From the most recent annual review (Appendix A) there is no consistent evidence that quarrying activities are affecting significantly flow or water quality in the watercourses round the site hence are unlikely to affect significantly the surface water abstractions. There are no reported impacts from the current quarry operations on any of the licensed or private water abstractions in the vicinity of the site.

4.11 The site is located in the area covered by the Idle and Torne Abstraction Licensing Strategy (ALS) (Reference 5). The site is closest to the Upper River Poulter Assessment Point in respect of the assessment of whether water is available for further abstraction. Based on the Idle and Torne ALS with respect to future applications for the abstraction of surface water from the Poulter catchment it is stated that “The catchment is closed to any further consumptive abstraction from both surface water and groundwater and new licences are not available.” It is stated in
the ALS that the conditions may not apply “if the abstraction is non-consumptive (i.e. it doesn’t result in a loss of water to any part of the catchment)” or “if the licence results in an overall environmental benefit”.

4.12 There are two SSSI of ecological interest within 3km of the site. The SSSI closest to the site is the Hollinhill and Markland Grips SSSI which is located approximately 1km west of the site. In addition to the geological citation referred to in Section 2 of this report, the SSSI comprises flora specific to magnesian limestone (dolomite) environments some of which comprise water dependant species. The Ginny Spring SSSI is located approximately 2.8km north of the site and comprises flora specific to magnesian limestone (dolomite) environments including water dependant species. The locations of the SSSIs are shown on Figure HIA1. It is likely that the SSSIs are located outside of the area of influence of the current dewatering. There are no reported impacts from the current quarry operations on any of the SSSIs in the vicinity of the site.
5. Water resources impact assessment

5.1 Consistent with current operations dewatering of the quarry will continue during the operation of the four extension areas to facilitate mineral extraction and the placement of restoration materials under dry conditions. The regulation of the discharge of pumped water to the surface water system will continue under an Environmental Permit regulated by the Environment Agency. The proposed extension areas are not to a lower level than the current consented mineral extraction. It will not be necessary to increase the rate of dewatering as a result of the proposed extensions.

5.2 It is considered that continued dewatering during the operation and restoration of the small areas of additional reserve in the extension areas and the extension of time of operations at the site will not have a significant impact on the hydrogeological and hydrological regime in the vicinity of the site compared with the currently consented operations at the site. There is no consistent evidence currently that the consented operations at the site are having a significant impact on groundwater quality, surface water levels, surface water flows or surface water quality in the vicinity of the site. Groundwater levels are affected by dewatering in proximity to the quarry sump.

5.3 Consistent with current operations no storage of fuel or lubricants will take place within the extraction area. There is a potential risk to the quality of groundwater and surface water from the use of fuel and lubricants, oils and antifreeze at the plant site. Consistent with current practice all fuel and lubricants, oils and antifreeze will be stored at the plant site in bunded areas to contain spillage and refuelling at the plant site will be undertaken in accordance with the company environmental procedures to minimise risk of spillage. No maintenance of vehicles or storage of fuels, lubricants or antifreeze will take place in the proposed extension areas hence it is considered that there is no significant risk of fuels or lubricants entering the groundwater or surface water system.

5.4 The overall Whitwell Quarry Complex will be restored to a mixture of land uses including ecological enhancement. Agricultural land will be created together with areas of conservation limestone grassland, three lakes, fen and woodland as well as the establishment of new hedgerows. Rock faces will be retained in places to leave the dolomite strata exposed mirroring some of the natural features of the locality. The
retention of these exposed faces will allow the continued benefit of the current RIGS designation of the site for use as an educational resource.

5.5 Following restoration of the site groundwater controls will cease and the groundwater levels in proximity to the sump will recover. The base of the quarry is below the natural groundwater table. On cessation of groundwater control groundwater will enter the quarry. One of the aims of the restoration design is to minimise the extent of water bodies in the final restoration. The final landform will depend on the availability of materials to raise ground levels above the groundwater table. Consistent with the currently approved proposals a new ridge line will be created in the main quarry area to link the high ground around the adjacent Whitwell Lime Works area with the ridge located north of Creswell Crags. A valley landform will be created which will run generally north to south through the site. The proposed restoration scheme is presented at Appendix D.

5.6 Consistent with the previously approved restoration scheme it is proposed that the detailed restoration scheme is the subject of a condition of the planning consent for submission to an agreement with the Mineral Planning Authority at the appropriate stages of development of the quarry. The outline surface water scheme for the proposed restoration comprises the formation of Whitwell Lake north of the railway line with the water level controlled at approximately 80.5m AOD by an overflow point beneath the railway leading to a small stream constructed flowing southwards through the valley landform from Whitwell Lake and discharging to Creswell Lake proposed in the south of the site. The water level in Creswell Lake will be controlled at approximately 64m AOD by an overflow point beneath Crag Road leading to Belph Lake proposed in the eastern quarry area. The water level in Belph Lake will be controlled at approximately 61m AOD to 62m AOD. It is proposed that the discharge from the site to the Millwood Brook will be controlled to the greenfield runoff rate. On this basis it is considered that the restoration of the site will not have a significant impact on the hydrogeological and hydrological regime in the vicinity of the site.

5.7 The operation and restoration of the small areas of additional reserve and the extension of time of operations at the site will not have a significant impact on Creswell Crags SSSI and the associated SSSIs designated for geological interest.
5.8 It is considered that the operation and restoration of the small areas of additional reserve and the extension of time of operations at the site will not have a significant impact on the hydrogeological and hydrological regime in the vicinity of the site hence on the licensed and private water abstractions or the ecological SSSIs in the vicinity of the site.

5.9 It is proposed that groundwater level monitoring continues at the boreholes at and in the vicinity of the site to monitor the impact of the quarry dewatering on groundwater levels. It is proposed that the monitoring of surface water flows in the watercourses round the site continues to confirm that dewatering of the quarry is not adversely affecting flow in the watercourses round the site. The proposed groundwater level and surface water flow monitoring is presented in the table below. It is proposed that groundwater and surface water quality monitoring will continue at and in the vicinity of the site consistent with the Environmental Permits for the site.

**Proposed groundwater level and surface water flow monitoring**

<table>
<thead>
<tr>
<th>Location*</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Groundwater level</strong></td>
<td></td>
</tr>
<tr>
<td>Boreholes 95/1, 95/7, 95/6, B01/14, B02/14, P1, P2 (replacement), P3, P4, HN06/C1 and HFW02/C1</td>
<td>Monthly, Daily for 2 weeks before any planned change in the pumping regime and weekly for 4 weeks after any planned change in the pumping regime.</td>
</tr>
<tr>
<td><strong>Surface water flow</strong></td>
<td>Weekly</td>
</tr>
<tr>
<td>RW1, RW2, MB1, MB2, MB3, MLB1 and the rate of discharge from the quarry sump</td>
<td>Daily for 2 weeks before and for 4 weeks after any planned change in the pumping regime.</td>
</tr>
</tbody>
</table>

*The monitoring locations are shown on Figure HIA2 (drawing reference TAR/WTE/01-16/19190)
6. Flood risk assessment

6.1 The potential impacts of the proposed operation and restoration of the four extension areas of Whitwell Quarry and the extension of time of operations at the site on surface water flow and flood risk have been assessed in accordance with the National Planning Policy Framework (NPPF), the Flood Risk and Coastal Change Planning Practice Guidance to the NPPF, Environment Agency Flood Risk Assessment (FRA) Guidance Note 1 (Development within a Critical Drainage area or greater than 1 hectare (ha) in Flood Zone 1) (Reference 6), Derbyshire County Council Preliminary Flood Risk Assessment (DCCPFRA) (Reference 7), Nottinghamshire Preliminary Flood Risk Assessment (NPFRA) (Reference 8), Chesterfield, Bolsover and North East Derbyshire Strategic Flood Risk Assessment (CBNED SFRA) (Reference 9) and Bassetlaw District Council Strategic Flood Risk Assessment (BSFRA) (reference 10). The site is located in the Derbyshire County Council area but close to the boundary with Nottinghamshire County Council hence the relevant flood risk documents from both counties have been reviewed. The site is located in the Bolsover District Council area but close to the boundary of Bassetlaw District Council hence the relevant flood risk documents from both districts have been reviewed.

Flood zone designation

6.2 Flood zone Designations are shown on the plan provided by the Environment Agency and presented at Appendix C. The proposed extraction area is located in Flood Zone 1 which is defined in the Flood Risk and Coastal Change Planning Practice Guidance to the NPPF as land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding. The floodplain of the Millash Brook shown on the Environment Agency plan does not follow the course of the brook but this is a printing or presentation error. If it is assumed that the floodplain of the Millash Brook does follow the course of the brook then it is likely that a small area along the north eastern boundary of the eastern quarry area of the site is located in Flood Zone 2 and 3. No changes to the currently consented activities in the eastern area of the site are proposed as part of this application. Flood Zone 2 comprises land assessed as having between a 1 in 100 and a 1 in 1000 annual probability of flooding from rivers or between a 1 in 200 and a 1 in 1000 annual probability of flooding from the sea. Flood Zone 3 comprises land assessed as having a 1 in 100 or greater annual probability of river flooding; or land having a 1 in 200 or greater annual probability of
sea flooding. The Environment Agency Flood Zone map comprises detailed local
data from modelling and mapping studies with information from a national model of
England and Wales.

**Flooding from groundwater**

6.3 Information on groundwater flooding is presented in the Historical Flooding Table at
Appendix A to the CBNED SFRA for the Bolsover District (References 9). It is
understood that there is no history of flooding by groundwater at the site. No historical
flooding events from groundwater are recorded in the Bolsover District within an
approximate 1km radius of the site. There are no historical flooding events from
groundwater reported in the BSFRA in the Bassetlaw District within 1km of the site.

6.4 With the exception of groundwater levels at borehole 95/7 located adjacent to the
River Wollen, groundwater levels at and in the vicinity of the site are all more than
4m below ground level. Based on the groundwater levels recorded in the boreholes
located at and in the vicinity of the site, the topography in the vicinity of the site, the
locations of the watercourses in the valleys round the site and a review of historical
maps it is considered that there is no significant risk of flooding from groundwater at
and in the vicinity of the site.

**Flooding from surface water, sewers and drains, canals and reservoirs**

6.5 Based on information on the Environment Agency website, patchy areas in the base
of the main quarry and the northern quarry are shown as high to low risk of flooding
from surface water with an area of low risk of surface water flooding associated with
the lagoon in the eastern quarry area as would be expected. Patchy areas of the
adjacent Whitwell Lime Works and at one location on Crags Road adjacent to the
works are shown as high to low risk of flooding from surface water. The majority of
areas shown as high to low risk of flooding from surface water in the vicinity of the
site are associated with the surrounding watercourses.

6.6 There are no historical flooding events reported in the BSFRA in the Bassetlaw
District within 1km of the site. Locations of historical flooding events are presented
at Appendix A of the CBNED SFRA for the Bolsover District (Reference 9). There
has been no significant historical flooding events within the site boundary. There are
nine historical flooding events recorded within 1km of the site boundary. Six of the
nine flood events occurred in 2007. Three of the six events were from multiple sources recorded in Creswell and are recorded as surface water runoff and land drainage sources with one including a fluvial source comprising the River Wollen. The one flood event which occurred in Whitwell Village was where the Millash Brook enters a culvert at the western limit of Whitwell. One of the flood events was on a road adjacent to the River Wollen upstream of Creswell and the site. The remaining flood event recorded in 2007 is from an unknown source in fields to the north of the River Wollen and to the west of the site.

6.7 As stated in Section 4 of this report, surface water runoff and incident rainfall entering the site either soaks away or accumulates in the lowest part of the quarry in the south of the site where it is pumped from the quarry sump to permitted discharge points. There are no reported impacts on flooding from the current quarry operations.

6.8 The three recorded flood events not specified as occurring in 2007 are for unknown dates and comprise flooding from sewers. One was located in Whitwell Village and two were located in Creswell. Based on the information presented in the CBNEDC SFRA, the incidents of sewer flooding are small and isolated in nature. It is understood that flooding of sewers in Bolsover District is related to inadequate capacity or maintenance problems such as blockages rather than high water levels in watercourses backing up (Reference 9). It is considered that the risk of flooding at the site from sewers is negligible as it is understood that the site is not connected to the sewer system and is located at distance from the areas affected by flooding from sewers identified in the CBNEDDC SFRA.

6.9 Based on information presented on the Environment Agency website the site is not located in an area at risk from flooding from reservoirs which comprises land defined as the largest area that might be flooded if a reservoir were to fail and release the water it holds. There no canals located in the vicinity of the site. It is considered that there is a negligible risk of flooding from canals or reservoirs at and in the vicinity of the site.

**The sequential and exception tests**

6.10 The sequential test is set out in the Planning Practice Guidance for Flood Risk and Coastal Change with the objective of steering new development to areas with the
lowest probability of flooding. Flood risk vulnerability classifications of land use are defined in Table 2 and appropriate land uses are defined in Table 3 of Flood Risk and Coastal Change Planning Practice Guidance to the NPPF for each of the flood zones defined by the Environment Agency. Mineral working and processing is defined as a less vulnerable land use in Table 2 of the guidance. Less vulnerable land uses are appropriate in all flood zones with the exception of Flood Zone 3b. As the site is located in Flood Zone 1 the proposed development meets the requirements of the sequential test as Flood Zone 1 is the area with the lowest probability of flooding hence it is not necessary to apply the exception test.

6.11 The small area along the north eastern boundary of the eastern quarry area which may be located in flood zone 2 and 3 of the Millash Brook is in an area which has been restored hence will not change as a result of the proposed development in the application.

Flood risk and the proposed development

6.12 The proposed development including the restoration proposals is described in detail in the Environmental Statement and is summarised in Section 1 of this report. A plan showing the results of a topographical survey of the site carried out in December 2015 is presented at Appendix E.

6.13 There will be no areas of hard standing developed on site as part of the proposals hence there will be no significant increase in surface water runoff as a result of the proposed development. During the proposed development mineral extraction will take place in a series of phases. During proposed operations of the mineral extraction in the four extensions and during restoration dewatering will continue to facilitate mineral extraction and the placement of restoration materials under dry conditions. It will not be necessary to increase the rate of dewatering as a result of the proposed extensions or restoration. As is the current situation, surface water runoff and incident rainfall entering the site will either soak away or accumulate in the lowest part of the quarry in the south of the site where it will be pumped from the quarry sump to permitted discharge points. It is considered that continued dewatering during the operation and restoration of the small areas of additional reserve in the extension areas and the extension of time of operations at the site will not have a
significant impact on flooding in the vicinity of the site compared with the consented operations at the site which Tarmac have permission for currently.

6.14 The overall Whitwell Quarry Complex will be restored to a mixture of land uses including ecological enhancement. Agricultural land will be created together with areas of conservation limestone grassland, three lakes, fen and woodland as well as the establishment of new hedgerows. Rock faces will be retained in places to leave the dolomite strata exposed mirroring some of the natural features of the locality.

6.15 Following restoration of the site groundwater controls will cease and the groundwater levels will recover with groundwater entering the quarry where restored levels are below rest groundwater levels. Surface water runoff and incident rainfall entering the site will either soak away or enter the water management system in the restored site. The outline surface water scheme is set out in Section 5 of this report. The water level in Whitwell Lake will be controlled by the overflow to the main quarry at a level of 80.5m AOD below the level of the diverted railway bench hence minimising the risk of flooding of the railway. It is proposed that the discharge from the water management scheme to the Millwood Brook will be controlled to the greenfield runoff rate. On this basis it is considered that the restoration of the site will not have a significant impact on flooding in the vicinity of the site.

6.16 Following restoration of the quarry groundwater pumping will cease and groundwater levels in the vicinity of the quarry will recover. It is considered that following the recovery of the groundwater levels, groundwater in the vicinity of the quarry area will provide base flow to the River Wollen as it does currently and that this may extend to the Millwood Brook and the Millash Brook. Based on the topography in the vicinity of the site, the locations of the watercourses in the valleys round the site and a review of historical maps it is considered unlikely that there will be a significant increase in the risk of groundwater flooding in the vicinity of the site as a result of the extensions to Whitwell Quarry.

Residual flood risk

6.17 The proposed development will not result in a significant increase in flood risk at or in the vicinity of the site. During mineral extraction there will be an increase in flood storage capacity at the site. In the long term as restoration will include a surface
water system with the discharged controlled to the greenfield runoff rate there will be no increase in flood risk at or in the vicinity of the site as a result of the proposed development.
7. References


<table>
<thead>
<tr>
<th>Stratigraphy</th>
<th>Current geological formation nomenclature</th>
<th>Previous geological formation nomenclature</th>
<th>Aquifer designation&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
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<td>Quaternary</td>
<td>Head</td>
<td>Head</td>
<td>Secondary undifferentiated</td>
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<tr>
<td></td>
<td>Edlington Formation</td>
<td>Middle Permian Marl</td>
<td>Secondary B aquifer</td>
</tr>
<tr>
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<td>Cadeby Formation – dolomite</td>
<td>Lower Magnesian Limestone</td>
<td>Principal aquifer</td>
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<tr>
<td></td>
<td>Cadeby Formation – calcareous mudstone</td>
<td>Lower Permian Marl</td>
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</tr>
<tr>
<td>Angular unconformity</td>
<td>Yellow Sands Formation</td>
<td>Basal Permian Sands</td>
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<tr>
<td>Carboniferous</td>
<td>Pennine Middle Coal Measures</td>
<td>Upper Coal Measures</td>
<td>Secondary A aquifer</td>
</tr>
</tbody>
</table>

<sup>1</sup> Information taken from the Environment Agency website
Figure HIA4
Groundwater levels recorded at and in the vicinity of the site between October 1991 and November 2014 and rainfall recorded at Gleadthorpe between February 2001 and December 2014