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Flood Risk Assessment & Conceptual Sustainable Drainage Strategy For A Proposed Residential Development At Turner's Pasture Ness Grove, Cheadle, Stoke-on-Trent ST10 1UN

REPORT PREPARED ON BEHALF OF TURNER'S PASTURE LTD

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1. Introduction & Aims

Turner's Pasture is located in a residential setting on Ness Grove, Cheadle, Stoke-on-Trent ST10 1UN (see Plan 1). The OS grid reference for the site is SK 013 440. The site is currently an agricultural small holding and comprises residential dwellings and outbuildings surrounded by grassed pasture land. The site is owned by Turner's Pasture Ltd and it is understood that a Planning Application is to be submitted to the Local Authority for the development of 36 residential properties of variable size.

This report is concerned only with the parcel of land edged in red on Plan 1 – the site location plan. This irregular shaped parcel of land has an area of approximately 10,000m^2 (one hectare). Cecilly Brook is located to the west and south of the site and flows in a south easterly direction.

The ground level across the eastern half of the site (close to the entrance off Ness Grove) is typically 160.5m AOD. The land slopes fairly steeply down towards the southwest where ground elevations are typically 158 – 158.5m AOD. A topographical survey plan of the existing site is presented in Appendix 5.

Environment Agency flood maps and other information in Appendix 2 indicate that the site edged in red on the location plan is located largely within Flood Zone 1 (low flooding probability <0.1%), however, the western corner of the site lies within Flood Zone 2 (medium flooding probability 0.1% - 1%). Flood Zone 3 (high flooding probability >1%) overlaps very slightly with the site in the far western corner.

The Technical Guidance to the National Planning Policy Framework (ref 1) states that planning applications for development proposals of one hectare or greater in Flood Zone 1 and all proposals for new development in Flood Zones 2 and 3 should be accompanied by a Flood Risk Assessment (FRA).

This report therefore seeks to assess the risks of flooding from and to the future site land use (residential housing) with consideration of climate change and to identify how these flood risks will be managed in terms of site's redevelopment. The report will also outline the opportunities to reduce the probability and consequences of flooding and will provide conceptual recommendations for a sustainable urban drainage scheme.

2. Flood Risk Assessment

2.1. Site Flood Zones

Environment Agency flood maps and other information in Appendix 2 indicate that the site edged in red on the location plan is located largely within Flood Zone 1 (low flooding probability <0.1%), however, the western corner of the site comprising proposed plots 19, 20, 21 and part of plot 22 lies within Flood Zone 2 (medium flooding probability 0.1% - 1%). Flood Zone 3 (high flooding probability >1%) overlaps very slightly with the site in the far western corner at the bottom of the rear gardens of proposed plots 19 and 20. The developer should consider a slight modification to the housing layout, in order to avoid flood zone 3 totally.

Plan 2 shows the development proposals for the site with the Flood Zones adjacent to Cecilly Brook superimposed.

2.2. Source Of Flooding

The Environment Agency data presented in Appendix 2 shows that the source of potential flooding of land adjacent to Cecilly Brook is from overtopping of the brook embankments due to heavy rainfall in a 1:100 year event.

Environment Agency records indicate that part of the site (the low lying land adjacent to the brook) was flooded in 1977. A plan provided by Brian Reid Architects in Appendix 5 also shows the approximate extent of site flooding in 1953. This is based on evidence provided by the family residing at Turner's Pasture and shows that the flooding was restricted to the land adjacent to the brook (outside of the proposed residential development zone).

There are no Environment Agency flood defences along this stretch of watercourse affecting the site.

2.3. Predicted Flood Levels & The Impact Of Climate Change

Examination of the node points on the Environment Agency flood map in Appendix 2 would suggest that NODE POINT CB3617 in Cecilly Brook is the location which is most relevant to Turner's Pasture. This Node Point has a predicted flood level of **158.3m.AOD** at the 1% Annual Exceedance Probability (UD_100). The impact of climate change (20% increase in flows) on the predicted flood level has not yet been modeled by the Environment Agency.

In the absence of EA modeling data for the impact of climate change on the brook, a precautionary approach to the establishment of suitable minimum finished floor levels is suggested – subject to the approval of the EA and the Local Authority. It is anticipated that ground levels on the western half of the proposed site will be raised as a matter of course.

Peak Associates would suggest that a suitable precautionary approach to establishing minimum finished levels which take into account climate change would be to take the predicted flood level for an extreme flood in a 1 in 1000 year rainfall event (worst

case scenario) and add a 600mm freeboard allowance for proposed buildings and a 300mm freeboard allowance for roads, parking and pedestrian areas.

The predicted flood level for node point CB3617 in a 1:1000 year event is **158.4m AOD.**

The suggested minimum finished levels for the development are therefore:

(i) Minimum Finished Floor Level for houses = **159m. AOD**
(158.4m AOD + 600mm)

(ii) Minimum level for roads, parking and pedestrian areas = **158.7m. AOD**
(158.4m AOD + 300mm)

2.4. The Sequential & Exception Tests

In accordance with the Technical Guidance to the National Planning Policy Framework (ref 1), it is proposed that there will be no property development or raising of ground levels within the small Flood Zone 3 area on the site - i.e. adjacent to the brook in the far western corner. The 12.5m strip between the brook and the red boundary line at the southwest of the development will provide more than sufficient access for the EA in order to maintain sections of the brook channel as required.

Residential housing falls in the 'More Vulnerable' classification when referring to table D2 of the Technical Guidance to the National Planning Policy Framework (ref 1). When referring to table D3 of Technical Guidance, it is clear that the development of residential housing is appropriate in both Flood Zones 1 and 2 without the need for the exception test.

It is therefore proposed that, subject to constructing the houses and associated infrastructure at the minimum levels indicated in section 2.3 (with prior approval from the EA and LPA), there will be a zone of property development in Flood Zone 1 and in Flood Zone 2 in the western corner of the site and no property development on Flood Zone 3 (see Plan 2).

2.5. Risk Of Flooding From The Development

The existing site comprises small areas of hardstanding and larger areas of open grassed ground. It is anticipated that the redevelopment of the site will significantly increase the proportion of hardstanding through the construction of access roads, roofs, parking and pedestrian areas. This will inevitably contribute to a net increase in surface water runoff and flow velocity.

The developers of the site therefore have both obligation and opportunity to reduce the impact of the increased surface water runoff on the brook and those sites on the catchment downstream. Peak Associates have therefore provided a conceptual plan for the development of a sustainable drainage system (see section 3 and Plan 3).

2.6. Access & Egress

Whilst it is anticipated that the issue of safe access and egress will not be a problem at the site due to the location of the proposed central access road in Flood Zone 1, the establishment of a minimum finished level of 158.7m AOD for roads, parking and pedestrian areas will allow for safe access and egress of the site's users during an extreme flood event – as detailed in section 2.3. Access and egress will be via the central road on the proposed site.

It is not anticipated that there will be a need for a flood evacuation plan as part of the site's redevelopment.

2.7. Chanel Improvements & Maintaining Access To The Brook

There will be a need to maintain access along the bank of the brook in order that the EA can carry out maintenance work as and when necessary. There should therefore be no property development or land raising within the 12.5m strip between the brook and the red boundary line at the southwest of the development - in order to provide sufficient access for the EA to maintain sections of the brook channel as required.

The construction of a SUDS features such as a grassy swale and ponds/detention basins in the area outside of Flood Zone 2 to the south of the development (see section 3 and Plan 3) should meet with EA approval following consideration of the planning application. The outfall structure into the brook (downstream of the SUDS features) will also require the written consent of the EA. The discharge exit velocity from the SUDS features should not exceed the Greenfield runoff rate for a 1:30 year event (see section 3) or should be set at a rate to be agreed with the EA following consideration of the planning application. The outfall pipe to the brook should be angled with the direction of flow.

The existing river channel of Cecilly Brook is partially obstructed with vegetation and litter debris at several locations along the southern site boundary (see photo 9). It is therefore recommended that this debris is removed from the channel during the development phase of the site. This will free up the flow within the brook channel and will prevent localized flooding around the current obstruction points.

2.8. The Existing & Proposed Drainage Systems

The existing drainage system at the site comprises a 150mm diameter clay drain serving the existing residences at Turner's Pasture. This drain passes in an easterly direction via the existing site entrance to the public sewer located in Ness Grove. The drain is visible at a manhole located in the field at the west of the site (see photo 14). This manhole has an invert level of 1.3m BGL and it may be possible to utilise this existing connection to serve the foul drainage of the new properties.

The foul drainage serving the new properties will need to drain in an easterly direction towards the public sewers in Ness Grove. Confirmation of the proposed finished levels for the development will be required prior to the detailed design of the drainage

system. It is likely that there will be a need to pump foul water from the western part of the development over towards the east – subject to confirmation of available falls.

It is strongly advised that Pre-development advice is sought from Severn Trent Water at an early stage in order to confirm that there is sufficient spare capacity in the public foul sewers on Ness Grove to accommodate the anticipated foul flows and loads from the new development. A plan of the public sewers around the site is included in Appendix 3.

The surface water from the new development is to drain in a general westerly direction towards a series of sustainable drainage features located on the land to the south of the red boundary line (outside of Flood Zone 2) before discharging into Cecilly Brook (see section 3 and Plan 3). Permeable paving and filter drains should be used to encourage as much infiltration as possible.

2.9. Ground Conditions

The BGS map for the area (Sheet SK 04 SW Staffordshire – see Appendix 4) shows the geology at the site to be Westphalian A Coal Measures, comprising mainly mudstone and siltstone. These are overlain by boulder clay. Trial hole investigations carried out by Peak Associates on the shallow ground (0-0.5 metres depth) demonstrated that the shallow ground comprises a silty, sandy clay on the lower ground to the west of the site (see photo 13); but with a higher clay content to the east of the site on the higher ground.

However, annotation on the geological map for a temporary exposure immediately to the north of the site describes the exposed geology as clay with pebbles down to 1 metre below ground level (BGL), underlain by 1.5 metres of grey mudstone that overlies a silty sandstone. Additional information from the map shows the exposed bedrock to the south side of the stream to consist of dark coarse grained sandstone with angular pebbles. The geological map also shows a fault line running west-east across the site with the downthrow to the south side of the fault.

Saturated ground conditions are present on the eastern half of the development as shown in photos 4 and 5. This is thought to be a direct function of the shallow clay soils in this location. It is suggested that the developer may wish to introduce free draining granular material, prior to the construction of the dwellings and road.

3. Conceptual Plan for Development of Sustainable Drainage and Design Measures to Deal with Residual Flood Risk

The concept of a sustainable urban drainage system (SUDS) has been incorporated into the conceptual drainage system for the site in order to comply with the Flood and Water Management Act 2010. This will involve surface water retention features within the scheme that will retain rainwater for subsequent discharge to the watercourse at a slower rate of discharge. The Environment Agency have requested that the rate of discharge from the site is in line with the annual Greenfield runoff rate for the area, which has been calculated (using the UK SuDS on line tool) as 5

litres/sec. The aim of the SUDS scheme is to ensure that the proposed drainage from the site does not cause or add to any existing flooding issues in the area.

However, it is essential that such schemes do not compromise the new properties and present a risk of flooding upstream of the existing flood plain. The detailed design of the drainage scheme and SUDS should follow on from consideration of the planning application. The detailed designs must ensure storage of the runoff for 'the critical rainfall event' for the area whilst incorporating failsafe devices for rainfall events falling outside of this category. This will ensure compliance with the British Standard BS EN 752:2008: Drain and sewer systems outside buildings.

The features and success of the detailed SUDS design will be dependent on the local geology. The BGS map for the area (Sheet SK 04 SW Staffordshire) shows the geology at the site to be Westphalian A Coal Measures, comprising mainly mudstone and siltstone. These are overlain by boulder clay. Trial hole investigations carried out by Peak Associates on the shallow ground (0-0.5 metres depth) demonstrated that the shallow ground comprises a silty, sandy clay on the lower ground to the west of the site; but with a higher clay content to the east of the site on the higher ground.

However, annotation on the geological map for a temporary exposure immediately to the north of the site describes the exposed geology as clay with pebbles down to 1 metre below ground level (BGL), underlain by 1.5 metres of grey mudstone that overlies a silty sandstone. This land is now developed and any information from the developers on the ground conditions in this area would be invaluable. Additional information from the map shows the exposed bedrock to the south side of the stream to consist of dark coarse grained sandstone with angular pebbles. The geological map also shows a fault line running west-east across the site with the downthrow to the south side of the fault.

The conceptual SUDS design is presented on Plan 3. This shows the storage areas and proposed drainage routes off the site. The locations of all of the SUDs features are outside of any of the parts of the site that are within flood zone 3. Most are within flood zone 1; however the permeable pavements to the properties located to the western side of the development and some sections of the latter storage and outlet features do encroach on food zone 2.

The detailed design calculations and capacities have not been performed at this stage. Assuming that the conceptual design is acceptable to the Local Authority during consideration of the planning application, a more detailed design can subsequently be presented; in particular, infiltration tests will be required in order to determine the effectiveness and design of the proposed features. Reduced infiltration will require increased storage capacity to be incorporated within the SUDs features. The use of individual plot soakaways (if possible) may also help to reduce the required storage capacity of the SUDS features.

The final design may well require further consultation and agreement with the Authority's SAB; in particular for agreement on the critical storage event and the failsafe devices.

The conceptual design has attempted to ensure that all runoff will pass through two treatment trains, in accordance with CIRIA guidance. Plan 3 shows the main components of the drainage scheme to comprise permeable pavements on the drives and parking areas of the properties with suggested underground filter drains to catch the roof drainage. To the east of the site these link into a swale at the south of the development. It is recommended that the SUDS features incorporate underdrains of granular material to encourage infiltration into the subsoil. It is envisaged that the final downstream feature on the scheme will comprise a detention basin or shallow pond, prior to connecting into the stream. A suggestion for an overflow to a separate pond or basin to accommodate the 1:100 (+30% for climate change) year event has also been presented.

If the conceptual SUDS scheme is acceptable in principle to the Local Authority, the more detailed design of the SUDS should follow on from consideration of the planning application. The requirement for more detailed designs could therefore be dealt with by a planning condition and should be discussed with the Local Authority's SUDS Approving Body and the Environment Agency prior to finalising the scheme.

4. Conclusions & Recommendations

The site edged in red on the location plan is located largely within Flood Zone 1 (low flooding probability <0.1%), however, the western corner of the site comprising proposed plots 19, 20, 21 and part of plot 22 lies within Flood Zone 2 (medium flooding probability 0.1% - 1%). Flood Zone 3 (high flooding probability >1%) overlaps very slightly with the site in the far western corner at the bottom of the rear gardens of proposed plots 19 and 20.

The source of potential flooding of land adjacent to Cecilly Brook is from overtopping of the brook embankments due to heavy rainfall in a 1:100 year event. Environment Agency records indicate that part of the site (the low lying land adjacent to the brook) was flooded in 1977. There are no Environment Agency flood defences along this stretch of watercourse affecting the site.

Node Point CB3617 in Cecilly Brook has a predicted flood level of **158.3m.AOD** at the 1% Annual Exceedance Probability (UD_100). The impact of climate change (20% increase in flows) on the predicted flood level has not yet been modeled by the Environment Agency. Peak Associates would suggest that a suitable precautionary approach to establishing minimum finished levels which take into account climate change would be to take the predicted flood level for an extreme flood in a 1 in 1000 year rainfall event (worst case scenario) and add a 600mm freeboard allowance for proposed buildings and a 300mm freeboard allowance for roads, parking and pedestrian areas.

Subject to the approval of the Environment Agency and Local Authority, the minimum proposed finished levels for the development should be 159m.AOD for residential dwellings and 158.7m.AOD for roads, parking and pedestrian areas. The proposed development should not incorporate basements to the residential properties.

The conceptual proposal for the site is that: subject to constructing the houses and associated infrastructure at the levels indicated (with prior approval from the EA and LPA), there will be a zone of property development in both Flood Zones 1 and 2 at the site, with no property development or land raising on Flood Zone 3.

The 12.5m strip between the brook and the red boundary line at the south west of the development will be set aside for access for the Environment Agency in order to maintain sections of the brook channel as required.

The existing river channel of Cecilly Brook is partially obstructed with vegetation and litter debris at several locations along the southern site boundary. It is therefore recommended that this debris is removed from the channel during the development phase of the site. This will free up the flow within the brook channel and will prevent localized flooding around the current obstruction points.

It is strongly advised that Pre-development advice is sought from Severn Trent Water at an early stage in order to confirm that there is sufficient spare capacity in the public foul sewers on Ness Grove to accommodate the anticipated foul flows and loads from the new development.

The existing site comprises small areas of hardstanding and larger areas of open grassed ground. It is anticipated that the redevelopment of the site will significantly increase the proportion of hardstanding through the construction of access roads, roofs, parking and pedestrian areas. This will inevitably contribute to a net increase in surface water runoff and flow velocity. The developers of the site therefore have both obligation and opportunity to reduce the impact of the increased surface water runoff on the brook and those sites on the catchment downstream. Peak Associates have provided a conceptual plan for the development of a sustainable drainage system (see Plan 3) for consideration during the planning process.

The annual Greenfield runoff rate for the site, has been calculated as 5 litres/sec. The construction of a grassy swale and ponds/detention basins with a high level overflow into Cecilly Brook, coupled with the use of filter drains and permeable paving on the proposed parking areas should provide the necessary attenuation of flow in order to mimic natural surface water drainage conditions. These SUDS features must be designed to encourage infiltration into the ground where possible.

Saturated ground conditions are present on the eastern half of the development as shown in photos 4 and 5. This is thought to be a direct function of the shallow clay soils in this location. It is recommended that the shallow clay soils in the western half of the site are replaced where required, with free draining granular material, prior to the construction of the dwellings and road.

Following consideration of the planning application, percolation tests on the shallow ground should be undertaken as part of a more detailed future design and calculation process in order to accurately determine the precise nature and sizing of the appropriate SUDS features. Proposed finished levels for the development will also be required in order to finalise the designs for the site's drainage system.

The requirement for more detailed SUDS designs could be dealt with by a planning condition and should be discussed with the Local Authority's SUDS Approving Body and the Environment Agency prior to finalising the scheme.

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5. References

(i) Technical Guidance to the National Planning Policy Framework. Department for Communities and Local Government. March 2012.

(ii) BS EN 752:2008: Drain and sewer systems outside buildings.

(iii) www.uksuds.com

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