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RE: FLOOD MITIGATION STRATEGY FOR THE PROPOSED DEVELOPMENT REFERRED TO AS LAND AT BRACKENWAY, FORMBY

An outline planning application (ref: DC/2018/00093) has been submitted by Taylor Wimpey UK Limited (the Applicant) which proposes a residential development on land known as Land at Brackenway in Formby. The planning application was submitted in January 2018 to Sefton Metropolitan Borough Council (SMBC). Since the application was submitted, discussions with SMBC as the Lead Local Flood Authority (LLFA) have been ongoing to refine the proposals for mitigation associated with the existing flood risk to properties on Hawksworth Drive located to the immediate south of the site.

The proposals for the development site include the provision of extensive flood compensation works, which successfully deal with the existing flood risk experienced at the site and ensure that there is no increase in flood risk elsewhere. However, it is acknowledged that the Hawksworth Drive area has been subject to flooding in the past due to surface water exceedance. Through further investigation by the Applicant's technical team and through discussions with the LLFA it is agreed that past flood events in this location are due to the existing sewer outfall located within Hawksworth Drive becoming tide locked at its outfall to Eight Acre Drain, meaning that it becomes blocked with raising water levels. As a result of these tide-locking occurrences of the sewer network, the manhole with the lowest cover level in the southern areas of Hawksworth Drive surcharges and results in flooding of the surrounding area. The purpose of this letter is to confirm the proposed strategy for Hawksworth Drive which have been discussed and agreed with the LLFA in order to provide a significant benefit to these properties on Hawksworth Drive in reducing this existing risk.

Existing flood risk issues

A flood event occurred on Hawksworth Drive in 2012 (determined to be equivalent to a 30-year rainfall event). The flood event was preceded by heavy persistent rain that continued during the flood event, this followed a particularly wet summer that had left the ground saturated. The first source of flooding was from the surface water system not being able to discharge into Eight Acre Drain due to high levels. The event resulted in four properties being flooded and there was some minor damage to the highway around a gully.

The second source of flooding came from Eight Acre Drain, overtopping the embankment at its lowest point close to the A565 and thereby circumnavigated the existing higher embankment adjacent to Hawksworth Drive. This water pooled behind the defence and flowed along the footpath running parallel to Eight Acre Drain.



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A flood investigation report¹ was carried out by SMBC following an event in September 2012. The report concluded that: *'The probable cause was that Eight Acre Drain was high, due to the significant amount of rainfall, which "tide" locked the highway drainage system which in turn was unable to discharge. Once the pipes had reached their capacity the water started to flow from the gullies into the highway, the water then pooled and found a low point in the pavement line and flowed down into the properties.'*

Rainfall data for this event has concluded that a significant amount of rain fell on to an already saturated area with approximately a 1 in 30-year return period. Based on the data available, flooding during this event occurred as a result of the high river levels in Eight Acre Drain, tide locking the surface water drainage system and overtopping close to the A565.

The report concluded that the flooding resulted from high river levels in Eight Acre Drain, tide locking the surface water drainage system and overtopping close to the A565. Key Points in relation to the flooding:

- It was a prolonged and heavy rainfall event;
- The land that flooded is low lying;
- The levels in the main river were high due to the rainfall;
- Reduced maintenance of the Brook may have contributed to the high water levels;
- The system was unable to discharge; and
- The Brook overtopped at a low point in the embankment
-

However, there are a number of recommendations suggested in the report in order to reduce the likelihood and impact of flooding in the future:

- Co-ordination of maintenance priorities and works between the Risk Management Authorities;
- The level of the low spot in the embankment should be raised to the same level as the rest of the embankment; and
- Investigate if there are flap valves/non return systems on the outfalls into Eight Acre Drain. And if not, consider the merit of installing them.

The first point is out of the control of Taylor Wimpey or the planning application for this site. The last two points are noted and deemed appropriate by RSK and Sefton Council (and the LLFA) and have therefore been the focus of further investigation along with other suitable mitigation options, as detailed below. It should be noted that the installation of any infrastructure on a United Utilities asset will require approval from United Utilities, so whilst the benefits are to be investigated it may not be deliverable unless a S106 agreement is signed.

Proposed flood compensation works

To facilitate the proposed development, a Flood Risk Assessment (FRA) has been prepared and submitted to support the application. The FRA as contained in Appendix 10.1 of the submitted ES Addendum (GVA HOW Planning, September 2018) sets out a composite flood risk and outline drainage strategy for the site. It sets out proposals for the control and management of flood risk and surface water run-off associated with the development proposals which will be further refined through detailed design. The strategy establishes that the principles for mitigation are acceptable in planning policy terms. There are no objections from statutory consultees such as the Environment Agency and the LLFA to the proposed strategy. The strategy

¹ Sefton Council (2012) Flood Investigation Report; Fouracres (Maghull), Sefton Lane (Maghull), Hawksworth Drive (Formby), Water Street (Thornton) and Moss Lane (Lydiate)

has been verified through hydraulic modelling which has been prior agreed with the Environmental Agency and the LLFA.

In summary, the proposals detailed in the FRA include the following measures;

- Ground modifications (raising levels proposed for residential development and lowering of levels to provide flood storage and attenuation on site).
- Lowering of Eight Acre Drain along sections of its northern bank to allow inundation of the flood storage area to occur during peak flood events.
- Directing flood and surface water away from Eight Acre Drain by severing the connections between the site and Eight Acre Drain.
- Limit surface water discharge rates to an agreed discharge run off rate.
- Discharge of surface water to retained ditch at greenfield runoff rates and directed to Wham Dyke away from Eight Acre Drain.
- Utilisation of a pumped system for surface water drainage to direct runoff away from Eight Acre Drain.
- Provision of on-site surface water storage in underground oversized pipes and a central swale.
- Utilisation of the flood storage compensation areas for flood water attenuation.

The FRA has also considered the nature of flood risk associated with existing residential properties, located to the immediate south of the site. The assessment has confirmed that these properties and in particular Hawksworth Drive are not at risk of fluvial flooding in either the existing baseline scenario or the post proposed development scenario. This is confirmed through the hydraulic model which confirms that the proposed development does not increase the risk of flooding off-site in all modelled scenarios.

It has been determined that the flood risk in the location of Hawksworth Drive is a result of existing surface water infrastructure that serves these properties which validates previous reports into the event of 2012. The existing sewer outfall is 'tide locked' at its outfall to Eight Acre Drain which becomes surcharged during periods of prolonged rainfall. Flooding events attributed to the surcharge outfall are shown to occur on the southern end of Hawksworth Drive on the manhole with the lowest cover level. The proposals have considered this existing flood risk issue and although this risk is associated with existing surface water infrastructure out of the Applicant's control, it has been demonstrated that the proposed flood risk and surface water strategy alleviates this existing risk through the following measures;

- Management of surface water and flood compensation entirely within the site area and discharge of all surface water from the development site which is directed to Wham Dyke in the north, offering a reduction of flood levels in Eight Acre Drain;
- The peak flood levels in Eight Acre Drain will be reduced by approximately 110mm during a 100-year event and approximately 120mm during a 1000-year event and the proposed ground modifications on site will ensure that any flood flows will be directed towards the flood compensation areas and not towards existing dwellings to the south;
- Infilling of existing north-south ditches to reduce flows towards Eight Acre Drain; and
- Lowering of land to the east of the development area (adjacent to the bypass) to provide areas of flood storage during extreme events.

Hard engineering options are proposed on the right bank (Hawksworth Drive) side of Eight Acre Drain;

- Increasing the length and height of the embankment/ bund in the vicinity of the bypass; and,

- High level outfalls from Hawksworth Drive and Deansgate Lane North allowing flood water from the highway to drain into Eight Acre Drain, subject to EA and Highways approval.

Soft engineering options are also proposed;

- De-silting of Hawksworth Drive surface water drainage network;
- De-silting of Eight Acre Drain and Wham Dyke culverts;
- Improvement and maintenance regime for Eight Acre Drain.

As noted above, these measures have previously been proposed by SMBC and the LLFA in order to provide a significant benefit to these properties on Hawksworth Drive. The application will offer a means by which these can be secured.

The onsite proposals will therefore reduce flood levels within Eight Acre Drain by reducing flows to the watercourse, achieved by severing the lateral field ditches, directing the surface water discharge from the site north towards Wham Dyke and through the creation of the flood compensation / storage areas to the south of Wham Dyke.

Hawksworth Drive hydraulic modelling

At the request of the LLFA, additional hydraulic modelling of the United Utilities (UU) surface water sewer network was undertaken to verify that the proposed measures as outlined above will provide a significant benefit to the Hawksworth Drive properties.

Through discussions with the LLFA, a MicroDrainage model has been developed for the existing situation (baseline) using data gathered from UU sewer records and additional survey carried out in the area, an illustration of the network and pipe references is included with this letter.

Baseline model run

The model was run using a surcharged outfall using the peak water level in Eight Acre Drain for the 30-year event of 5.935m AOD and a 30-year rainfall event falling on the network (this is the estimated return period for the flood event experienced in 2012, however the water level in Eight Acre Drain during this event is unknown). It should be noted that if a 'Do nothing' option is considered, then the impacts of climate change will increase the likelihood and severity of a flood event.

The results of this model run show a flood volume within the network area of **85.9m³**, this volume is experienced along a number of pipe lengths with the main areas of flooding experienced at the eastern end of Hawksworth Drive and Hawksworth Close. A full set of the MicroDrainage outputs are included with this letter. The principal reason for the flooding is due to the 'tide locking' of the outfall where the water level in Eight Acre Drain exceeds the invert of the outfall pipe. Due to the design of the network, this will be experienced under normal conditions as the invert of the outfall pipe is situated at or just below the existing bed level in the channel.

The table below details the modelled flood levels based on the representative pipe and compares this to the Finished Floor Levels (FFL) of the dwellings and the Garage Floor Levels (GFL) for the properties along Hawksworth Drive.

Hawksworth Drive House no				Dwellings	Garage
	FFL (m AOD)	GFL (m AOD)	Pre- development Q30 water level	Pre- development Q30 Internal Flood depths	Pre- development Q30 Internal Flood depths
37	6.15	5.99	6.003	no flooding	0.013
39	6.03	n/a	6.171	0.141	n/a
41	6.13	5.97	6.171	0.041	0.201
43	6.13	5.97	6.100	no flooding	0.130
45	6.10	n/a	6.100	no flooding	n/a
47	6.07	5.92	6.100	0.030	0.180
49	6.07	5.92	6.100	0.030	0.180
51	6.10	5.95	6.084	no flooding	0.134
53	6.09	5.94	6.084	no flooding	0.144
55	6.09	n/a	6.084	no flooding	n/a
57	6.12	5.97	6.084	no flooding	0.114
59	6.06	5.83	6.084	0.024	0.254

Post development, following flood compensation works on site

The baseline model was re-run using the same network details with a reduced 30 year surcharge level of 5.841m AOD. This level is obtained from the hydraulic modelling carried out and validated as fit for purpose by the Environment Agency during pre and post submission discussions.

As a result of reducing the peak water levels within the watercourse, the flood volume within the network has been reduced to **74.9m³**, a reduction of approximately 13% from the pre-development situation. This reduction in flood volume also reduces the flood depths along the network, thereby offering significant benefits to the residents along Hawksworth Drive and the surrounding area. A full set of the MircoDrainage outputs are included with this letter.

The table below details the modelled flood levels based on the representative pipe and compares this to the FFL's and the levels of the garages (GFL) for the properties along Hawksworth Drive.

Hawksworth Drive House no				Dwellings	Garage
	FFL (m AOD)	GFL (m AOD)	Post- development Q30 water level	Post- development Q30 Internal Flood depths	Post- development Q30 Internal Flood depths
37	6.15	5.99	5.975	no flooding	no flooding
39	6.03	n/a	6.171	0.141	n/a
41	6.13	5.97	6.171	0.041	0.201
43	6.13	5.97	6.099	no flooding	0.129
45	6.10	n/a	6.099	no flooding	n/a
47	6.07	5.92	6.099	0.029	0.179
49	6.07	5.92	6.099	0.029	0.179
51	6.10	5.95	6.078	no flooding	0.128
53	6.09	5.94	6.078	no flooding	0.138
55	6.09	n/a	6.078	no flooding	n/a
57	6.12	5.97	6.078	no flooding	0.108
59	6.06	5.83	6.078	0.018	0.248

High level overflows

In addition to the proposed flood compensation works on site a number of additional mitigation measures have been considered and modelled to demonstrate their effectiveness. Two high level overflows have been investigated, one opposite No. 37 Hawksworth Drive (Overflow option 1) and one opposite No. 60 Deansgate lane North (Overflow option 2). It has been assumed that these overflows consist of 150mm and 225mm diameter pipes offering a means by which flood water can enter the watercourse above the peak flood level. The invert of these overflows has been set with minimal cover, but also to ensure the invert is set above the flood water level reducing the risk of the outfalls becoming tide locked or backwater flow occurring. These overflows do allow some water to leave the network and enter Eight Acre Drain, with a further reduction in flood volumes by **4.7m³** when used in conjunction with the flood compensation proposals on the proposed development site.

Hawksworth Drive House no			Post- development Q30 water level with overflows 1 and 2	Dwellings	Garage
	FFL (m AOD)	GFL (m AOD)		Post- development Q30 Internal Flood depths	Post- development Q30 Internal Flood depths
37	6.15	5.99	5.966	no flooding	no flooding
39	6.03	n/a	6.176	0.146	n/a
41	6.13	5.97	6.176	0.046	0.206
43	6.13	5.97	6.099	no flooding	0.129
45	6.10	n/a	6.099	no flooding	n/a
47	6.07	5.92	6.099	0.029	0.179
49	6.07	5.92	6.099	0.029	0.179
51	6.10	5.95	6.074	no flooding	0.124
53	6.09	5.94	6.074	no flooding	0.134
55	6.09	n/a	6.074	no flooding	n/a
57	6.12	5.97	6.074	no flooding	0.104
59	6.06	5.83	6.074	0.014	0.244

Non-return valves

In addition to the high-level overflows, the option of a number of non-return valves has been considered. It should be noted that the installation of any infrastructure on a United Utilities asset will require approval from United Utilities, so whilst the benefits are to be investigated it may not be deliverable. As with the overflows, these may offer some benefit only due to the fact the water levels in Eight Acre Drain surcharge the outfall pipe and many the pipes within the network. It is the waterlevels in the watercourse which dominate the waterlevels in the surface water network on Hawksworth Drive as the inverts of many of the pipes are below the normal and flood water levels. There could an additional benefit of the valves to prevent water entering the drainage system during times where there is an elevated water level in Eight Acre Drain.

Extension of the flood bund

A recommendation from the Flood Investigation Report following the 2012 event was to extend the bund along the eastern edge of Eight Acre Drain to prevent flood waters affecting the rear of the properties along Hawksworth Drive. This option has been considered in the hydraulic modelling carried out on Eight Acre Drain and incorporated into the Flood Risk Assessment for the application. As a result of continuing this bund and tying into higher ground at the by-pass the 100 and 1000 year flood levels within Eight Acre Drain do not directly impact on the properties on Hawksworth Drive, this has been confirmed by the Environment Agency.

Managing a flood event

It should be acknowledged that the existing drainage system in Hawksworth Drive and as such it is proposed that a financial contribution is made for the provision of demountable and temporary flood defence measures. These measures will not reduce the frequency of a flood event but can be deployed during a flooding event to prevent water from entering the dwellings and can be removed once the flood event has receded.

Other options considered

A number of additional flood mitigation measures have been considered to try to improve the situation further on Hawksworth Drive but have been discounted for a number of reasons. These have included:

- Upsizing of the pipe network – this would offer additional attenuation in the network, however the surcharge level in Eight Acre Drain would result in inundation from the watercourse filling the network. In addition, due to the limited cover levels on the network, any increase in pipe sizing would further reduce this, risking damage to the pipes. Any works considered on the network would have to be carried out by UU as it is an adopted sewer system.
- Additional connection into adjacent surface water system – it is understood from SMBC that a network is located to the rear of No. 18 Turnacre. It is also understood that there are issues with a damaged pipe. Additional flows from Hawksworth Drive have the potential of increasing the pressure on this network and creating a flood risk issue to additional properties which may not currently be at risk, for this reason this option was not considered any further.
- Pumping Station – a small pump system was considered to lift the water in the network into Eight Acre Drain during times of surcharge. It is thought there is not sufficient space to offer this option and this would fall under the responsibility of UU. This option is being considered by UU who would possibly look at the option of adopting the pump station however it is understood that it is unlikely that UU would adopt such a system. The impacts of a pump have been modelled which demonstrates that the reduction in waterlevels are minimal and there is no benefit to offering this solution. In addition, pumping the water into Eight Acre Drain will raise the flood level in the watercourse, thus further limiting the outflow from the drainage system on Hawksworth Drive. A further option has been considered where the water is pumped into Wham Dyke, however this is a sensitive watercourse from an ecological perspective and therefore not possible.
- A theoretical situation has been modelled where there is no influence from Eight Acre Drain to demonstrate the efficiency of the existing surface water system on Hawksworth Drive. It should be made clear that the removal of water from Eight Acre Drain to below the existing invert of the drainage system is not deliverable, and this is only being considered to assess the existing drainage network. the results of this exercise show that 47.8m³ of flooding still occurs within the network and that waterlevels drop between 22mm and 35mm from the baseline situation. This demonstrates that the existing system is flawed as it has not been designed to the 30 year standard as required by the current version of Sewers for Adoption. What this exercise does consider is if that the mitigation being offered, particularly the reduction in water levels in Eight Acre Drain offer the best solution to the existing flooding issues on the network.

Summary of proposed works and benefits

The water levels using to surcharge the outfall pipe have been agreed with the EA through detailed modelling of the pre and post development situations. It is clear from the baseline MicroDrainage model and the historic flood event of 2012, that the UU surface water sewerage network is the principal reason for the flood risk issues on Hawksworth Drive. The work undertaken in this exercise has shown the existing system is flawed as it has not been designed to the 30 year standard as required by the current version of Sewers for Adoption. The pipes have been constructed with minimal cover levels and are surcharged from water from Eight Acre Drain under all but very dry conditions. The Invert of the outfall pipe is situated below the bed level of the watercourse and this results in a 'tide locked' outfall and water backing up into the network, this will in turn results in siltation issues and reducing the effectiveness to discharge surface water following a rainfall event. The modelling carried out on the surface water drainage network has demonstrated the severity of the issues when considering a 30-year rainfall event coinciding with a 30-year

event within Eight Acre Drain. The proposed onsite ground works offer the most significant benefit to the dwellings on Hawksworth Drive in terms of reducing flood risk, however then coupled with a high-level overflow there are additional benefits where the flood volumes are reduced by approximately 18% (30 year event).

This proposed scheme ensures that all significant mitigation measures outlined through the allocation process and furthered through this report are considered and implemented to provide a significant benefit to the Hawksworth Drive area:

1. The development proposals direct flows away from Eight Acre through the development;
2. The development proposals offer a number of additional measures which through extensive investigation demonstrate their suitability; and
3. The package of measures offers a significant benefit and without them flood risk remains.

It has been demonstrated that the greatest benefit in terms of flood risk reduction comes from the flood compensation works as part of the proposed development. This is due to the reduction in water levels in Eight Acre Drain allowing the Hawksworth Drive surface water system to discharge into the watercourse.

The non-return valves have negligible impact, however they will provide benefit should water levels in Eight Acre Drain be elevated. It should be noted that the installation of any infrastructure on a United Utilities asset will require approval from United Utilities, so whilst the benefits are to be investigated it may not be deliverable.

In addition to the 30 year event further flood modelling has shown that the 100 and 1000 year modelled post development flood levels in Eight Acre Drain are below the threshold levels on Hawksworth Drive, should an event in excess of this occur the proposed flood compensation works will provide added benefit by reducing the risk of flood water from Eight Acre Drain impacting on Hawksworth Drive.

To compliment the flood compensation works on the site, it is proposed to extend the bund along the southern bank of the watercourse to tie into higher levels along the by-pass. The crest level of this bund will be above the peak flood levels and will prevent water from flooding the area between the rear of No. 37 Hawksworth Drive and the by-pass. This is one of the recommendations from the flood investigation report.

The existing surface water drainage system is not fit for purpose and by offering this package of measures together with a responsive management system (part funded by S106 monies) this is a significant benefit as without these measures flood risk remains. Should the flood compensation works not be carried out the properties on Hawksworth Drive will experience MORE severe flooding than that of 2012 should a 100-year rainfall event occur when coinciding with a 100-year event in Eight Acre Drain.

Below is a list of the proposed measures to alleviate the flood risk on Hawksworth Drive:

Proposed mitigation	Benefit	How will the mitigation be secured?
On site flood compensation works	Reduces the peak water level in Eight Acre Drain for the equivalent flood event	Planning permission (condition)
Diversion of existing ditches on site	Reduces the flows entering Eight Acre Drain, thus further reducing the peak flood level	Planning permission (condition)

Directing surface water from the developed site away from Eight Acre Drain.	Reduces the flows entering Eight Acre Drain, thus further reducing the peak flood level	Planning permission (condition)
Extension of the flood bund	Prevents flood water from Eight Acre Drain directly impacting on the properties off Hawksworth Drive	Planning permission (condition) / Environment Agency consent / S106 Agreement with Highways Authority
Ditch Clearance works	Reducing the levels of silt in the channel, increasing the capacity and allowing greater flows	Planning permission (condition) / Environment Agency consent
High Level Overflows	Allows ponding water on the western side of Hawksworth Drive to enter Eight Acre Drain during times of high water levels in the channel	S106 agreement / Highways Authority
Non Return Valves on existing United Utilities Assets	Prevents backwater flow during times of elevated water levels in Eight Acre Drain	S106 agreement / United Utilities
Contribution towards demountable and temporary flood defence measures	These measures will not reduce the frequency of a flood event but can be deployed during a flooding event to prevent water from entering the dwellings.	S106 agreement

We trust this information is sufficient for your immediate needs, however please do not hesitate to contact the undersigned if you require any further information.

Yours sincerely

RSK LDE LIMITED



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