Flood Risk Advice for
Former Baxi site, Padiham,
and Stoneyholme site, Burnley

November 2009

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<tr>
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<tbody>
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Contract

This report describes work commissioned by Burnley Borough Council by email of 30 September 2009. Burnley Borough Council’s representative for the contract was Mark Mullany. Chris Smith of JBA Consulting carried out the work.

Prepared by ...................................... Chris Smith BSc PhD CEnv CSci MCIWEM MCMI
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Acknowledgments

The contribution of the Environment Agency in supplying the ISIS models and flood mapping for this project is acknowledged. Comments from the Environment Agency on the draft of this report are also acknowledged.


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Executive Summary

Flood Risk Advice

Flood risks to the proposed development sites at Padiham and Burnley town centre have been considered from:

- Rivers - using hydraulic models
- Surface water - using the Areas Susceptible to Surface Water Flooding map

This has involved using a combination of hydrological and hydraulic techniques closely aligned to those used by the Environment Agency in the area. Using flood risk data from these sources of flooding the implications for the proposed development sites have been considered using the guidance in PPS25.

Generic Guidelines

Both of the development sites discussed below would need to be accompanied by a site specific FRA in accordance with PPS25.

As well as the specific issues identified below development proposals should look at opportunities to incorporate sustainable drainage systems to reduce the risk of surface water flooding. Surface water run-off from these sites should not increase as a result of developments. Over attenuation of surface water may be a policy option on brownfield sites, i.e. reduce the rate / volume of surface water run-off from sites to reduce flood risk overall, as recommended in PPS25.

Former Baxi Factory Site

The site comprises the former Baxi factory and associated buildings. The site has an area of 8.5ha and was vacated in 2008. Also under Baxi ownership is an additional 7.08ha of Green Belt land adjoining the factory to the east which although not allocated for development could be included as part of a development for environmental enhancements and flood alleviation.

The site falls predominantly into Flood Zone 3a in both the Environment Agency's existing Flood Map and in the updated modelling work. Purely as a commercial development (Less Vulnerable) the site is suitable for development under the PPS25 Sequential Test.

Water depths on the site in the 1% AEP plus climate change event are typically less than 0.25m but may reach 0.5m in some areas. During a 0.1% AEP flood event depths may exceed 1m across much of the site. Given the relatively shallow depths during a 1% AEP plus climate change event and the availability of an Environment Agency flood warning service the site should be able to be developed safely for Less Vulnerable use.

The possibility has also been raised of some residential development being included in this development area. The inclusion of residential would change the vulnerability class from Less Vulnerable to More Vulnerable and the Exceptions Test would need to be passed. Water depths are relatively shallow in the 1% AEP plus climate change event but may exceed 1m across much of the site in the 0.1% AEP event. Whilst this is not ideal it would likely pass the Exception Test with an FRA showing appropriate mitigation measures and detail of access and egress. However, the northern part of the development site is within Flood Zone 1 and would be the most appropriate part of the site to accommodate any residential development.

Flood defences and flood alleviation options, possibly including the additional area of land to the east of the Baxi factory, would also need careful consideration as part of a detailed FRA. The defences upstream of the Baxi factory site may affect the flood risks through central Padiham.

Stoneyholme Site

The site includes a Lancashire County Council waste transfer site and land in Council ownership bounded by Rectory Road and Holme Road. The site is being proposed for use
as an Enterprise Park. The site is 2.43ha in area and expected to come forward in the short to medium term.

The existing Environment Agency Flood Maps show the south-west corner of the site to be within Flood Zone 3 and the western side of the site adjacent to the River Calder to be within Flood Zone 2. However, our new flood outlines show less extensive flooding with none of the site being within Flood Zone 3 and only the south western corner being within Flood Zone 2. The rest of the site is within Flood Zone 1. As the site is allocated for commercial development (Less Vulnerable) the site is suitable for development under the PPS25 Sequential Test.

The small part of the site adjacent to the river that is at risk of flooding in the 0.1% AEP flood event has relatively shallow water (<0.5m) so the site should be able to be developed safely with respect to flood risk.
# Contents

**EXECUTIVE SUMMARY**  

1 INTRODUCTION  

1.1 Introduction  

1.2 Planning Policy Statement 25 (PPS25)  

1.3 This study  

1.4 The River Calder catchment  

2 FORMER BAXI FACTORY, PADIHAM  

2.1 Fluvial risk  

3 STONEYHOLME ENTERPRISE PARK, BURNLEY  

3.1 Fluvial risk  

4 SURFACE WATER FLOOD RISK  

4.1 Surface Water Modelling  

5 PLANNING ADVICE  

5.1 Introduction  

5.2 Generic Guidelines  

5.3 Former Baxi Factory Site  

5.4 Stoneyholme Site
List of Figures

Figure 1: Current Environment Agency National Flood Map for the Former Baxi Site------1
Figure 2: Current Environment Agency National Flood Map for the Stoneyholme Site .........................................................................................................................................................2
Figure 3: Flood Outlines along the Lower Calder at the Former Baxi Factory ---------------5
Figure 4: Flood Depths across the Baxi site (1% AEP plus climate change) ---------------6
Figure 5: Flood Depths across the Baxi site (0.1% AEP) -----------------------------------6
Figure 6: Flood Outlines along the Upper Calder at the Burnley Sites -----------------------7
Figure 7: Flood Depths across Burnley Sites (1% AEP plus climate change) ---------------7
Figure 8: ASSWF for Padiham -------------------------------------------------------------8
Figure 9: ASSWF for Burnley --------------------------------------------------------------9

List of Tables

Table 1: Modelling Comparison -------------------------------------------------------------2
Table 2: Summary of the PPS25 Sequential Test -----------------------------------------------3
Table 3: Summary of the PPS25 Requirements for Sites-----------------------------------------10
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEP</td>
<td>Annual Exceedance Probability</td>
</tr>
<tr>
<td>BNC</td>
<td>Burnley Nelson and Colne</td>
</tr>
<tr>
<td>FEH</td>
<td>Flood Estimation Handbook</td>
</tr>
<tr>
<td>FSR</td>
<td>Flood Studies Report</td>
</tr>
<tr>
<td>JFLOW</td>
<td>2D overland flow model</td>
</tr>
<tr>
<td>LIDAR</td>
<td>Light Detection and Ranging</td>
</tr>
<tr>
<td>PPS25</td>
<td>Planning Policy Statement 2</td>
</tr>
<tr>
<td>SUDs</td>
<td>Sustainable Urban Drainage</td>
</tr>
<tr>
<td>S105</td>
<td>Section 105 Model</td>
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</table>
1 Introduction

1.1 Introduction

Burnley Borough Council has commissioned JBA Consulting to provide flood risk advice for two proposed development sites. The sites assessed in this study are of the former Baxi factory (and adjoining land) in Padiham and the proposed Stoneyholme Enterprise Park in Burnley.

The geographical extent and probability of flood risk is divided into zones within PPS25. These are termed Zone 1, Zone 2 and Zone 3, which may be further divided into Zone 3a and Zone 3b. These are defined on their probability of flooding using the Annual Exceedance Probability (AEP) or likelihood of flooding in any specific year. A 1% AEP event would correspond to a 1 in 100 year chance of flooding in any year. The Flood Zones are defined as:

- Zone 1 - Low Probability - less than 0.1% AEP of flooding
- Zone 2 - Medium Probability - between 0.1% and 1% AEP of flooding
- Zone 3a - High Probability - greater than 1% AEP of flooding
- Zone 3b - Functional Floodplain - typically considered greater than 5% AEP of flooding.

1.1.1 Former Baxi Factory, Padiham site

Figure 1 shows the proposed development sites and the Environment Agency's flood maps. The area proposed for development is marked in red. There is an adjacent area of Green Belt land under the same ownership that, although outside the AAD allocation, could be included in a wider development of flood alleviation and ecological enhancements.

Figure 1: Current Environment Agency National Flood Map for the Former Baxi Site

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The Former Baxi Factory comprises large factory buildings and associated other buildings. In the Padiham Area Action Plan the site is considered suitable for employment use, although alternative proposals have been put forward for mixed development of employment and some housing. Burnley BC also suggests that development on the site may provide opportunities to enhance the wildlife corridor and riverside walk to the south east. The site falls within the current Environment Agency's Flood Zone 3 and the
Sequential and Exception Tests would need to be passed for residential development to be approved.

1.1.2 Stoneyholme site

Figure 2 shows the proposed development site and the Environment Agency’s flood maps.

Figure 2: Current Environment Agency National Flood Map for the Stoneyholme Site

The site includes a Lancashire County Council waste transfer site and land in Council ownership bounded by Rectory Road and Holme Road. The site is being proposed for use as an Enterprise Park. The site is 2.43ha in area and expected to come forward in the short to medium term. A small proportion of the site is currently shown to be within Flood Zone 3.

1.1.3 Flood Risk Assessment

Although all of the sites are shown to be at least partly within the Environment Agency’s Flood Zone 3 outline (highest level of risk, see Figures 1 and 2), this study is based on the preliminary flood outlines from the Burnley, Nelson and Colne (BNC) Flood Risk Management Strategy. These are currently in draft form for the Environment Agency but once finalised should supersede the Flood Zone maps shown in Figures 1 and 2.

In order to move forward Burnley BC’s proposed development plans, the Environment Agency have agreed to let JBA Consulting use this new data. This study will use this information to assess flood risk to the sites and propose recommendations for the future development and the site specific Flood Risk Assessments (FRAs) that will be required.

The BNC Strategy models are based on revised hydrology, additional surveys and more detailed floodplain modelling which has produced more realistic flood outlines. A comparison of the modelling techniques used for the Environment Agency Flood Maps and the BNC Strategy flood outlines used in this study is shown below in Table 1.

Table 1: Modelling Comparison

<table>
<thead>
<tr>
<th>Approach</th>
<th>EA Flood Maps</th>
<th>BNC Strategy outlines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrology</td>
<td>Flood Studies Report</td>
<td>FEH Statistical Method</td>
</tr>
<tr>
<td>Flood outlines</td>
<td>Projected channel levels (1D)</td>
<td>Floodplain flow (2D)</td>
</tr>
<tr>
<td>1% AEP Flow</td>
<td>310 m³</td>
<td>212 m³</td>
</tr>
<tr>
<td>(Calder d/s of Green Brook confluence, Padiham)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Design flows and outlines have been calculated for the 1%, 1% climate change scenario (+20% flows) and the 0.1% AEP flood events. The mapping outputs will eventually be integrated into the Environment Agency Flood Zone maps. The 4% AEP flood event has also been considered.

The Environment Agency's national map showing Areas Susceptible to Surface Water Flooding has been used to assess the risk of flooding from other sources.

### 1.2 Planning Policy Statement 25 (PPS25)

Planning Policy Statement 25 Development and Flood Risk (PPS25) was issued in December 2006 and forms the framework for assessing the suitability of proposed developments with respect to flood risks.

The core of PPS25 is the Sequential Test, a summary of which is shown in Table 2. This indicates which categories of land use vulnerability are appropriate for which Flood Zone classification. It is against this test that we must assess the suitability of the proposed development areas in Burnley and Padiham.

#### Table 2: Summary of the PPS25 Sequential Test

<table>
<thead>
<tr>
<th>Flood Zone</th>
<th>Category</th>
<th>Essential Infrastructure</th>
<th>Highly Vulnerable</th>
<th>More Vulnerable</th>
<th>Less Vulnerable</th>
<th>Water Compatible Development</th>
</tr>
</thead>
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<tr>
<td>1</td>
<td>Less than 0.1% AEP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Between 1% and 0.1% AEP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3a</td>
<td>Greater than 1% AEP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3b</td>
<td>Greater than 5% AEP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Former Baxi site has proposals for some residential development although allocated for employment use. Given the proposal for housing this land use fits into the More Vulnerable classification (although consideration will also be given to the employment use (Less Vulnerable) classification). Therefore, this type of development will be acceptable if found to be within Flood Zones 1 and 2, but would require the Exception Test if within Flood Zone 3a and would be unacceptable in Flood Zone 3b.

The Stoneyholme site proposes employment, business or industrial land use. These are classed as Less Vulnerable. Therefore, if found to be within Flood Zones 1, 2 and 3a they would be acceptable, however, they would be unacceptable if found to be within Flood Zone 3b.

As stated above, the Exception Test may be required in order for the proposed residential development to be approved. To pass this requires three conditions to be satisfied:

- **a)** it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared. If the DPD has reached the ‘submission’ stage – see Figure 4 of PPS12: Local

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* River Calder and Darwen Catchment Flood Risk Mapping Investigation (JBA 2001)
Development Frameworks – the benefits of the development should contribute to the Core Strategy’s Sustainability Appraisal;

b) the development should be on developable previously-developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously-developed land;

c) a FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

In the following sections the proposed development sites in Burnley and Padiham are considered within the framework of PPS25.

1.3 This study

This study is to gain a greater understanding of the flood risk at the proposed development sites. Flooding at the following sites is considered in these sections:

- Section 2: Former Baxi site from the Lower Calder.
- Section 3: Stoneyholme site from the Upper Calder.
- Section 4: Surface water flooding to both sites.

Once the risks from these sources have been considered then the implications for the development sites under PPS25 will be presented in Section 5.

1.4 The River Calder catchment

The River Calder is a tributary of the Ribble which rises on high ground and flows through urban areas of industrial Lancashire.

The source of the Calder is on Thieveley Scout, a hill to the south-east of Burnley that rises to 449 m (at Thieveley Pike). The river has a small rural catchment which includes an area of former opencast mining before flowing through the town of Burnley. In Burnley, just upstream of the Stoneyholme site, the Calder is joined by the River Brun, draining the hills and moors to the west of Burnley.

Downstream of the Burnley development sites, the Calder is joined by its larger tributary, Pendle Water. Downstream of Pendle Water confluence, the Calder has a more rural catchment before it flows through Padiham and the Former Baxi factory site. In Padiham, Green Brook joins the Lower Calder this drains part of Padiham and western Burnley.

The annual average rainfall across the Calder catchments is approximately 1000-1200 mm. The combination of steep upland headwaters with substantial urban areas in a relatively wet and impermeable catchment means it is an area susceptible to flooding.
2 Former Baxi Factory, Padiham

2.1 Fluvial risk

The new model outlines for the Lower Calder are less extensive than the Environment Agency Flood Maps. The map shown in Figure 3 show the flood outlines for 1%+climate change and 0.1% AEP events. These flood outlines are based on existing flood defence infrastructure being in place. In Padiham this consists of extensive embankments upstream of the Baxi site and a wall behind the Council Offices.

For the 4% AEP event (Flood Zone 3b) flood flows remain in channel through Padiham. For planning purposes Flood Zone 3a is considered to be the 1% AEP event plus climate change (20% increase in 1% flows). The 1% + climate change flood outline is extensive across this site encompassing the main factory building and land close to the river. The additional area of Green Belt land is also predominantly within flood zone 3a. The flood water in this event leaves the channel both over the embankments upstream of the development site and from the river adjacent to the development site.

For the 0.1% AEP event (Flood Zone 2), shows a similar pattern to the 1%+climate change event but has a more extensive outline. There are some areas to the north of the site which remain outside the flood outline.

Figure 3: Flood Outlines along the Lower Calder at the Former Baxi Factory

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Figure 4 shows the estimated flood depths across the site for the 1% AEP plus climate change scenario. The majority of the former Baxi factory site could have flood depths of <0.25m. The flood depths derived for the 0.1% AEP flood event are greater at between 1.0 and 1.5m across the site of the former factory (Figure 5).

Within the former Baxi factory area the flood levels are 79.07 mAOD during the 0.1% AEP flood event and 78.18 mAOD during the 1%+climate change flood event.
One other point to note in this area is the impact of flood defences. There are defence embankments separating the river from the floodplain upstream of the Baxi site, including alongside the additional area marked on the maps above. There is also an informal defence embankment between the Baxi factory site and the additional area. There are no flood defences between the river and the actual Baxi factory site.

Without these embankments being in place the additional area floods more frequently and the flood extent through the Baxi factory site is slightly more extensive. Any development of the factory site and use of the additional area upstream would need to consider the continued action of these defences.
3 Stoneyholme Enterprise Park, Burnley

3.1 Fluvial risk

The new model outlines for the Upper Calder are less extensive than the existing Environment Agency Flood Maps. There is no formal flood defence infrastructure on this part of the River Calder. For the 4% AEP event (Flood Zone 3b) and 1% AEP plus climate change (Flood Zone 3a) flood flows remain in bank through this area of Burnley (Figure 6).

For the 0.1% AEP event (Flood Zone 2), flood water comes out of bank at the upstream end of the Stoneyholme site and affects a small area in the south west of the site.

Figure 6: Flood Outlines along the Upper Calder at the Burnley Sites

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Figure 7 below shows the potential flood depths across the site under the 0.1% AEP flood event. Flood depths across the site are generally shallow with only a small area being greater than 0.25m and nowhere exceeding 0.5m.

Figure 7: Flood Depths across Burnley Sites (1% AEP plus climate change)

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4 Surface Water Flood Risk

4.1 Surface Water Modelling

The national maps showing Areas Susceptible to Surface Water Flooding (ASSWF) were assessed for the development sites in question. The maps are based on a model which evenly distributes an extreme rainfall event over a digital ground model, which is cell-based. The rainfall inputs convert to flows which flow from higher cells to lower ones. This provides an indication of areas where surface water flooding is likely to occur. The maps show three categories marked as SWM1, SWM2 and SWM3 which correspond to increasing water depths during a 0.5% AEP rainfall event. SWM1 indicates depths of 0.1 to 0.3m, SWM2 from 0.3 to 1.0m and SWM3 greater than 1.0m.

Figures 8 and 9 show the likely locations of surface water flooding according to water depth (less, intermediate and more). In Padiham, the risk of surface water flooding is high at the former Baxi site. The areas at risk follow a similar flood outline as our fluvial climate change scenario (1% AEP plus climate change). In Burnley there is an area of surface water risk at the Stoneyholme site in the south western corner of the site (similar to the area affected by flood zone 2).

Figure 8: ASSWF for Padiham

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These outlines and depths are only indicative as they are based solely on topography and take no account of drainage systems. Therefore unless specific information is available to identify a problem at a particular site the aim should be to ensure development does not increase surface water runoff, and where possible utilise Sustainable Drainage Systems (SUDs).
5 Planning advice

5.1 Introduction

The Padiham and Burnley sites are now reviewed with regard to their suitability for development using the framework laid out in PPS25 as described in Section 1.2 of this report.

These recommendations have taken into consideration comments from the Environment Agency (dated 14/08/09) and their interpretation of what an appropriate flood risk baseline should be across Padiham and Burnley. For the purposes of the Level 2 SFRA the flood risk baseline have therefore been taken as the 1% AEP plus climate change outline.

The Table below presents a summary of each site and the need to undergo the Sequential or Exception Test based on its Flood Zone and types of land use.

Table 3: Summary of the PPS25 Requirements for Sites

<table>
<thead>
<tr>
<th>Site</th>
<th>Flood Zone baseline</th>
<th>More vulnerable</th>
<th>Less Vulnerable</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Sequential Test</td>
<td>Exception Test</td>
<td>Sequential Test</td>
</tr>
<tr>
<td>Former Baxi site</td>
<td>FZ3</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Stoneyholme</td>
<td>FZ2</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>

5.2 Generic Guidelines

Both of the development sites discussed below would need to be accompanied by a site specific FRA in accordance with PPS25.

As well as the specific issues identified below development proposals should look at opportunities to incorporate Sustainable Drainage Systems (SUDs) to reduce the risk of surface water flooding. Surface water run-off from these sites should not increase as a result of developments. Over attenuation of surface water may be a policy option on brownfield sites, i.e. reduce the rate / volume of surface water run-off from sites to reduce flood risk overall, as recommended in PPS25.

5.3 Former Baxi Factory Site

The site comprises the former Baxi factory and associated buildings. The site has an area of 8.5ha and was vacated in 2008. Also under Baxi ownership is an additional 7.08ha of Green Belt land adjoining the factory to the east which although not allocated for development could be included as part of a development for environmental enhancements and flood alleviation.

The site falls predominantly into Flood Zone 3a in both the Environment Agency's existing Flood Map and in the updated modelling work. Purely as a commercial development (Less Vulnerable) the site is suitable for development under the PPS25 Sequential Test.

Water depths on the site in the 1% AEP plus climate change event are typically less than 0.25m but may reach 0.5m in some areas. During a 0.1% AEP flood event depths may exceed 1m across much of the site. Given the relatively shallow depths during a 1% AEP plus climate change event and the availability of an Environment Agency flood warning service the site should be able to be developed safely for Less Vulnerable use.

The possibility has also been raised of some residential development being included in this development area. The inclusion of residential would change the vulnerability class from Less Vulnerable to More Vulnerable and the Exceptions Test would need to be passed. Water depths are relatively shallow in the 1% AEP plus climate change event but may exceed 1m across much of the site in the 0.1% AEP event. Whilst this is not ideal it would likely pass the Exception Test with an FRA showing appropriate mitigation measures and detail of access and egress. However, the northern part of the...
development site is within Flood Zone 1 and would be the most appropriate part of the site to accommodate any residential development.

Flood defences and flood alleviation options, possibly including the additional area of land to the east of the Baxi factory, would also need careful consideration as part of a detailed FRA. The defences upstream of the Baxi factory site may affect the flood risks through central Padiham.

5.4 Stoneyholme Site

The site includes a Lancashire County Council waste transfer site and land in Council ownership bounded by Rectory Road and Holme Road. The site is being proposed for use as an Enterprise Park. The site is 2.43ha in area and expected to come forward in the short to medium term.

The existing Environment Agency Flood Maps show the south-west corner of the site to be within Flood Zone 3 and the western side of the site adjacent to the River Calder to be within Flood Zone 2. However, our new flood outlines show less extensive flooding with none of the site being within Flood Zone 3 and only the south western corner being within Flood Zone 2. The rest of the site is within Flood Zone 1. As the site is allocated for commercial development (Less Vulnerable) the site is suitable for development under the PPS25 Sequential Test.

The small part of the site adjacent to the river that is at risk of flooding in the 0.1% AEP flood event has relatively shallow water (<0.5m) so the site should be able to be developed safely with respect to flood risk.
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