# KIMBERLY-CLARK, FLINT SITE

## Effluent temperature investigation – November 2013

EPR/BJ9703IM/V003

## INTRODUCTION

Kimberly-Clark (KC) operates a tissue manufacturing plant at Flint, Flintshire, which discharges effluent to the Dee Estuary as defined in the above environmental permit. Following a site visit by Natural Resources Wales on the 4th September 2013 a PPC Contact Report was issued stating the following:

> *A breach of temperature limit was reported on 04/06/13 and since then raw water has been added to cool the effluent. It is recognised that this is not BAT, but it does minimise the impact of warm water on the estuary at the discharge point. An acceptable solution is needed for long term control of the effluent temperature and Kimberly Clark now need to look at all the options and put a proposal to Natural Resources Wales.*
>
> *Factors to be considered are:*
>
> - *Impact of 30° discharge on the Dee estuary when compared to 25°.*
> - *Different options for cooling, pre and post ETP*
> - *Environmental cost / benefit of methods*
>
> ***Action:*** *Provide a justified proposal for not reducing the temperature emission limit, and showing how the current limit will be met, to NRW by the end of Dec 2013 .*

This report has been produced in response to the above action.

## OUTFALL CHARACTERISATION

The KC Flint Site is located at National Grid reference SJ236735 and the associated effluent discharge pipe leaves the site underground at the North boundary, runs under the A548 and the railway, and continues underground to Flint Point. The final discharge is at grid reference SJ246741. The outfall is fitted with four diffuser ports with invert levels below –2.0 AOD, ensuring it is underwater at all times. The current outfall design follows the recommendations described in the NRA Report EAR 90/16 1990. This involved extending the pipe out into deeper water and increasing the number of discharge ports to four in order to improve the dispersion of the discharge. The discharge is also limited to the period of high water + 30 minutes (start) and high water + 150 minutes (stop).

The maximum permitted effluent flow rate is 500 l/s with a maximum discharge total of 3,182 $m^3$/tide during each 2 hour discharge window. Typical maximum discharge rates are now 440 l/s with a maximum discharge volume of 1,800 $m^3$/tide (KC data 2012 -13). With the closure of Delyn Mill in April 2013 the total effluent discharge from the mill has reduced from 850,000 $m^3$/yr to 520,000 $m^3$/yr.

MB/2013

The effluent is assumed to have no salinity. With temperatures of 25°C or 30°C, the density will be somewhat less than 1,000 kg/m$^3$.These values and the data used for the temperature modelling are summarised in Table 1.0.

Table 1.0 – Key parameters used in the dispersion assessment

| | |
|---|---|
| Effluent flow rate (typical) | 440 l/s |
| Effluent flow rate (maximum) | 500 l/s |
| Effluent density at 25°C | 997.0 kg/m$^3$ |
| Effluent density at 30°C | 995.6 kg/m$^3$ |
| Dee Estuary temperature (max summer)[1] | 20.61 °C |
| Dee Estuary temperature (min summer) | 11.69 °C |
| River density, typical summer | 1015.3 kg/m$^3$ |
| Specific heat capacity of water | 4.18 kJ/kg°C |

[1] Temperature taken from EA data for SJ 24600 74400

The average water depth, and current speeds used in the dispersion assessment are shown in Table 2.0.

## DISPERSION ASSESSMENT

For the purpose of this report a simplistic thermal energy balance was used to estimate the rise of river water temperature when adding a known volume of effluent. The model assumed a worst case scenario of maximum discharge flow (500 l/s) and was repeated for a typical discharge flow (440 ls). In addition the model assumes that there is no heat loss along the length of the discharge pipe i.e. the effluent temperature measured at the KC discharge pump is the same as the effluent temperature at the final discharge point.

Table 2.0 – Dispersion Assessment

| Time[2] | Average Current Speed (m/sec)[1] | 30 min Excursion (m) | Depth (m)[1] | Width (m)[1] | Segment Volume (m$^3$) | Average Effluent Volume (m$^3$) | Dilution Factor | Temperature rise (°C) |
|---|---|---|---|---|---|---|---|---|
| **30°C Temperature & 500 l/s** | | | | | | | | |
| HW +30 to +60 | 0.11 | 198 | 3.55 | 500 | 351450 | 900 | 391 | 0.075 |
| HW +60 to +90 | 0.2 | 360 | 3.4 | 500 | 612000 | 900 | 680 | 0.063 |
| HW +90 to +120 | 0.25 | 450 | 3.15 | 500 | 708750 | 900 | 787 | 0.036 |
| HW +120 to +150 | 0.27 | 486 | 2.9 | 250 | 352350 | 900 | 392 | 0.075 |
| **25°C Temperature & 500 l/s** | | | | | | | | |
| HW +30 to +60 | 0.11 | 198 | 3.55 | 500 | 351450 | 900 | 391 | 0.063 |
| HW +60 to +90 | 0.2 | 360 | 3.4 | 500 | 612000 | 900 | 680 | 0.036 |
| HW +90 to +120 | 0.25 | 450 | 3.15 | 500 | 708750 | 900 | 787 | 0.031 |
| HW +120 to +150 | 0.27 | 486 | 2.9 | 250 | 352350 | 900 | 392 | 0.062 |
| **30°C Temperature & 440 l/s** | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| HW +30 to +60 | 0.11 | 198 | 3.55 | 500 | 351450 | 792 | 444 | 0.066 |
| HW +60 to +90 | 0.2 | 360 | 3.4 | 500 | 612000 | 792 | 773 | 0.055 |
| HW +90 to +120 | 0.25 | 450 | 3.15 | 500 | 708750 | 792 | 894 | 0.033 |
| HW +120 to +150 | 0.27 | 486 | 2.9 | 250 | 352350 | 792 | 445 | 0.066 |
| **25°C Temperature & 440 l/s** | | | | | | | | |
| HW +30 to +60 | 0.11 | 198 | 3.55 | 500 | 351450 | 792 | 444 | 0.055 |
| HW +60 to +90 | 0.2 | 360 | 3.4 | 500 | 612000 | 792 | 773 | 0.038 |
| HW +90 to +120 | 0.25 | 450 | 3.15 | 500 | 708750 | 792 | 894 | 0.027 |
| HW +120 to +150 | 0.27 | 486 | 2.9 | 250 | 352350 | 792 | 445 | 0.055 |

Note[1] The average current speed, depth and width data is taken from the NRA Report EAR 90/16.

Note[2] Time periods refer to the ranges high water plus 30 to 60 minutes etc.

Using the data shown in Table 2.0 the maximum predicted estuary temperatures for an effluent discharge at 30°C and 25°C can be calculated as shown below:

Table 2.1 – Maximum Predicted Estuary Temperature Rise

| | Temperature Rise | Estuary Temperature |
|---|---|---|
| Discharge – 500 l/s at 30°C | 0.075°C | 20.685°C |
| Discharge – 500 l/s at 25°C | 0.063°C | 20.673°C |

## LOCAL HABITAT

The Dee has become one of the most regulated rivers in Europe, and is an area of significant nature conservation interest. The estuary, which covers approximately 13,000 hectares, is made up of intertidal sands, mudflats and extensive grazed and ungrazed saltmarsh. These form the habitats for a diversity of wading birds and wildfowl, making the Dee estuary one of Britain's major ornithological sites. The site as a whole is designated a Site of Special Scientific Interest (SSSI), a Special Protection Area (SPA), a Special Area of Conservation (SAC), and a Ramsar site (an internationally important wetland) mainly for its ornithological value.

The invertebrate rich mudflats form the feeding grounds for thousands of shore birds and the saltmarshes are the nesting grounds for many breeding birds. The estuary is an internationally important wintering ground for wading birds, with average peaks of over 115,000. Of the 30 species of wading birds and 27 species of wildfowl regularly recorded in Britain, 26 waders and 27 species of wildfowl have been recorded in the Dee estuary. The estuary is most important as a refuelling point for migratory birds. Many thousands of wading birds use the Dee to rest and feed before continuing their journey between Africa and the Arctic.

The site encompasses three RSPB reserves; Gayton Sands, Point of Ayr and Oakenholt Marsh. At the head of the estuary is the Connah's Quay Nature Reserve, which comprises a series of bunded lagoons with large numbers of cormorants. The Shotton Steelwork's Reserve has a famous common tern colony with well over 2,000 pairs of tern nesting on the artificial islands.

The Wirral shore of the estuary contains some areas of brackish marsh. This is the home of one of Britain's rarest amphibians, the Natterjack Toad. The Natterjack is restricted to a few sites in Britain and the breeding colony on the Dee estuary is the most southerly on the west coast. A non-breeding population of approximately 350 grey seals feed in the outer estuary and often haul out on the West Hoyle Bank. The fisheries of the Dee are of national importance; the estuary has salmon net fishery and sea fisheries of economic significance. Elsewhere the area is notable for the wide range of species present. Salmon, sea trout, brown trout and coarse fish are widespread. The Dee is noted for the good numbers and large size of its grayling.

## IMPACT ASSESSMENT

Treated effluent from the KC site discharges during high tide into the Dee Estuary. As outlined above the estuary is of international importance, particularly in relation to its bird population. The KC effluent outfall is situated at the boundary between the inner and outer estuaries, but as the consent restricts the discharge to a two hour period on the ebb tide, the inner estuary (being upstream) will be unaffected. The sensitive areas of the estuary are not affected by the discharge. The nearest area is the RSPB reserve at Oakenholt, approximately one kilometre away. However, this is upstream of the outfall, and the nearest sensitive area downstream is the cockle bank between Bagillt and Greenfield (approximately two kilometres away). The above data indicates that even with the low current velocities at the start of the discharge (0.11m/s), the dilution factor is almost 400 even under neap tide conditions. This calculation is based on a 30 minute period after which the excursion is only 200 metres. Two kilometres away the dilution will obviously be much greater.

Several of the fish species identified in the Dee Estuary are known to be migratory, including sea trout and salmon. These species are of particular importance because not only are they often valuable fisheries targets but also because they use the entire length of the river and estuary at critical life stages and therefore the whole population is potentially vulnerable to interventions which disrupt migration. These fish also connect the deep ocean to the river catchment and can be important sources of marine nutrients to otherwise nutritionally poor areas high in river systems.

Investigations into the migratory species suggest that fish passing through the area will not be affected by localised temperature anomalies, especially when these are confined to a relatively small area of the available estuary volume, as shown by the predicted plume sizes in Table 2.0. The worst case modelling scenarios assuming maximum discharge at 30°C give a result of elevated temperature plume (<0.1°C above ambient) local to the outfall, whereas the estuary is > 1,000m wide at this point. Likewise, the resident fish populations are unlikely to be impacted by the small volume elevated plume.

The predicted extent of elevated temperature plume from the outfall resulting from discharges at 30°C is not expected to result in significant adverse impacts on the sensitive environmental receptors in the vicinity of the site. Data in Table 2.1 also shows that there is negligible (0.012°C) difference in the temperature of the plume for a 25°C or 30°C discharge.

It should also be noted that with the closure of Delyn Mill in 2013 the total effluent discharge volume has reduced considerably. This has the result of significantly reducing the average discharge time per tide. With an average flow per tide of 1,300 $m^3$ the discharge time per tide is < 1 hour meaning that any impact associated with the discharge at high water '+120 to +150' is not realised.

## MEETING A 30°C LIMIT

If the current 30°C temperature limit for the effluent discharge is maintained then KC propose to meet this limit through the following techniques:

1. From the 1st May to the 1st September of each year, and when the activated sludge temperature rises to ≥ 31.0°C, the two existing surface aerators in the activated sludge tank will automatically be switched on between the hours of 22:00 to 04:00.The blower supplying air to the activated sludge tank will remain switched off whilst the surface aerators are running. The surface aerators will remain on this cycle throughout the above period unless the activated sludge temperature drops below 31.0°C, whereupon the surface aerators will be switched off.
   Note: Owing to temperature losses across the activated sludge plant a 31.0°C temperature limit in the activated sludge tank equates to a temperature of 29°C for the final treated effluent.
2. If the use of the surface aerator is triggered, and in addition to this evaporative cooling, raw water will be added directly into the treated effluent tank. The maximum addition rate of raw water will be 180m$^3$/hr. Before the end of May 2014 KC will install an automatic control valve in the raw water line feeding the treated effluent tank. This will allow the flow of raw water into the treated effluent tank to be automatically adjusted depending upon the temperature of the final effluent, reducing the raw water addition rate below the current maximum of 180m$^3$/hr. It is anticipated that the on-going addition of raw water in 2014 would be a temporary solution whilst investigations into Option 3 (below) are investigated.
3. During 2014 KC will investigate the possibility of installing a floating, splash aerator in the final treated water tank in order to cool the final effluent. KC have successfully installed similar systems in other European mills (Rouen, VSE).

## CONCLUSION

Overall, the predictions for discharge at 25°C and at 30°C are similar, taking into account uncertainties in predictions around high water.

The predicted extent of elevated temperature plumes from the outfall is not expected to result in significant adverse impacts on the sensitive environmental receptors on the vicinity of the site for either a 25°C or 30°C effluent discharge. The increase in environmental impact when discharging at 25°C vs 30°C is also considered to be negligible given the 0.012°C increase when discharging at 30°C. A 30°C temperature limit on the effluent discharge can be adhered to by using the techniques described above.

Although not within the scope of this report outline process designs have shown that to reduce the effluent discharge from 30°C to 25°C equates to a cooling load of approximately 3,000 kW. This would require the installation of a significant evaporative cooling tower or refrigeration plant, both of which would considerably add to the site energy load. Given the environmental impacts (energy use) associated with cooling the effluent from 30°C to 25°C, and the lack of significant adverse impacts when discharging at 30°C, KC believe that maintaining a discharge limit of 30°C represents BAT (when compared to a 25°C discharge limit).

Cyfoeth Naturiol Cymru
Natural Resources Wales

**To:** Soper, Alison
**Cc:** Bedford, Julie
**Subject:** FW: Coleshill Temperature Consent
**Date:** 20 November 2013 14:21:49
**Attachments:** image001.png
KC Coleshill Temperature Modelling 2013.pdf

Julie,

Please can this go on EDRM.

Thanks,
Alison

**From:** Linkman, Andrew [mailto:alinkman@kcc.com]
**Sent:** 20 November 2013 13:13
**To:** Soper, Alison
**Cc:** Petrie, Mel
**Subject:** Coleshill Temperature Consent

Good Afternoon Alison

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*Factors to be considered are:*

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***Action:** Provide a justified proposal for not reducing the temperature emission limit, and showing how the current limit will be met, to NRW by the end of Dec 2013 .*

The attached report has been produced in response to the above action.

If you need any further information please do not hesitate to contact me.

Regards
***Andy Linkman CMIOSH***
Safety and Environmental Coordinator

***The condition of a work area and the Safety and Environmental standards of the employees is a reflection of the leader. Change starts with the Leader-So what standard do you set when you go on the floor?***

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