Lanson Microbe Ltd

Lanson Microbe Ltd, Omega 18 Hendra Vale
Launceston PL15 7HE Reg 09194422
Contact 01566 775230 Mob 07530894496
don@lansonmicrobe.co.uk

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Mr S Welsh
Dairy Partners (Wales) Ltd
The Creamery
Aberarad
Newcastle Emlyn
Carmarthenshire SA38 9DQ

Dear Steve

LANSON MICROBE LTD CONSULTANCY SERVICE

Re Environmental assessment of the treated effluent discharge from Dairy Partners (Cymru) Ltd on the Afon Teifi

Please find the report on the environmental impact of the treated effluent water to the Afon Teifi

This has been based on the study of the Geography of the area and water flows. Analyses were taken to determine the impact on the water.

Chemical analyses were carried out to determine the impact of the chemistry to the biology of the water and microbiology was also used as investigation tool.

Please feel free to contact me if there are areas in the report you wish to discuss.

Yours sincerely

Don Sharpe CBiol MRSB

ENVIRONMENTAL STUDY

THE IMPACT OF WATER FROM DAIRY PARTNERS' EFFLUENT PLANT ON THE AFON TEIFI

By D W SHARPE CBiol MRSB

INTRODUCTION.

The Afon Teifi is one of the longest river solely in Wales at 73-75 miles (120 km) long. It's source is in the Llyn Teifi, in one of several lakes in the north of Ceredigion in the Cambrian mountains at 455 m above sea level.

The river flows past Strata Florida, through Pontrhydfendigaid reaching the main river floor. It passes through Cors Goch Glanteifi (Cors Caron). It descends through pasture and cors meandering through farmland below this.

Over the next 30 miles, the Teifi meanders south west in an arc and passes through Tregaron, Llandewi, Brefi, Cwmann, Lampeter, Llanybydder, Llandysul, before it reaches Castell Newydd Emlyn (Newcastle Emlyn).

The Teifi is fed by a large number of afons (rivers) and nants (streams). This causes it to be a high flowing river because of the high rainfall.

The river becomes tidal below Lechryd, which is 19 miles below the effluent outfall (measured by the Teifi meanders) where the salinity increases dramatically. It descends through Cilgerran Gorge to Cardigan and widens into a broad estuary entering Cardigan Bay.

There is a rich range of wildlife on the lower parts of the river ranging from river crowfoot plants, multi-fruited mosses, wetland birds, otters and bottled-nosed dolphins have been seen. There is a range of domestic fish including trout as well as migratory salmon and sea trout. The Teifi is one of the rivers where Lampreys are found both river and sea lampreys present.

The Teifi and its tributaries flow through Ordovician and Silurian mudstones glaciated during ice ages to form the gently rolling hills and the land is fertile supporting sheep and dairy farming.

The catchment of the river is estimated to be 389 square miles (1008 square kilometres). I cannot find a record of flows at Newcastle Emlyn, but at Lechryd flows of 29 cu m per second are measured, with maximum flows of 373.6 cu m per second, which occurred on 18th October 1987.

Rainfall is 1,552 mm (61.1") annually in the upper reaches and 1,176 mm (46.3") annually in the lower reaches compared with a UK average of 1,101 (43.3") annually.

2 DESCRIPTION OF THE DAIRY

History

The site of the Dairy was originally part of the workhouse, which closed in about 1916. There has been a dairy on the site since at least 1922 when West Wales Farmers Dairy Society rented part of the property to make cheese. In 1931 Cow & Gate took over the premises to make dried milk products. They started making cheese in 1934 taking 500 (2270L) gallons of milk a day and increased over the years and by 1979 when Unigate sold the dairy to the Milk Marketing Board 92,000 gallons (418,000L) of milk were processed every day. The MMB operated the dairy until 1983 when it closed. Mann & Balkham made goats cheese until 1988 after which Dansco started making mozzarella cheese in 1989, which was taken over by Saputo and closed the factory in 2013.

Dairy Partners bought the site and re-started production of Mozzarella. They have invested heavily with improved facilities for milk intake, Mozzarella cooking and chilling and whey processing. They have invested in new modern processing equipment for the production of high quality cheese and whey processing and are in the process of investing in increased effluent plant.

The current milk processed is 420,000 L per day with the intention to increase milk to 528,000 L of milk per day in 2020. Although this increases water usage to the plant, because water is recovered from the whey process, water volumes will remain within the consent levels of 1030 cu m per day.

The processes involved in the Dairy consist of Milk intake, cream separation and milk standardisation; starter addition, mozzarella cook, brine chill, whey separation and concentration through membranes.

The separation process generates sweet cream and standardised milk. Excess cream is stored in tanks and sold separately.

Starter cultures and citric acid are added to the milk to make curds and whey. The whey is removed and sent for separate processes. The curds go forward to the cooking process.

The curds are cooked, extruded and shaped into brickettes and cooled by immersion in a brine tank where they progressively cool. Mozzarella blocks are further cooled by spraying the bath as it progresses along the bath. The brine is drained and the mozzarella is packaged for transfer to the Stroud site. Brine is cleaned using a filtration process the waste flows to the effluent plant.

Whey is centrifuged to remove whey cream, which is blended with milk and used in the cheese making process. Whey is then concentrated using membrane technology. Concentrated whey is stored in silos and dispatched to another site for further processing.

Water from RO permeate is so pure, it is blended with borehole and mains water where it is treated with chlorine dioxide. The recovered water is used to reduce water consumption on site.

All processes require cleaning using acid and caustic and foam materials. In the case of membranes enzyme cleaners are also required to assist in cleaning. All cleaning processes require water for rinsing and removing contamination. At present cleaning occurs over a seven-hour period but in future this will be reduced to 4 hours. Cleaning provides the majority of the water used on site.

The dairy collects water into drains and all processes flow into the effluent treatment plant. Water from the roofs flow to the lagoon adjacent to the Afon Arad. This is split into sections, with the first part collecting the water and the second half discharging the water providing the water is clear. This is protected using an inductive conductivity sensor and if out of spec the water is sent to the effluent plant. Only clean water flows into the Arad

All factory drains flow to a common collection point at the start of the effluent treatment plant, where they are pumped up to the balance tank. The balance tank is designed to correct the varying flows throughout the day and mix them. Potential pollutants such as acids and caustic are diluted and as mixing takes place the pH is neutralised.

3 DESCRIPTION OF THE PRESENT EFFLUENT PLANT.

Other than the reception pits, the majority of the effluent plant is sited on the opposite side of the Afon Arad. The raw liqor is pumped from the pits over to the balance tank.

The first part of the effluent plant was built some time in the 1950s or 60s. It consisted of a reception tank feeding two trickle filters TF 1 & TF 2 and they operate in series with sludge being returned to the front end.

Trickle filters are biological digestion plants and normally contain high levels of ammonia-oxidising bacteria. Because they are exposed to the elements and the surface area to volume is high, which means that rainfall can impact performance. They can be influenced by the extremes of weather. They perform poorly in cold weather and can be temperamental during times of high rainfall. At higher temperatures the bed can become blinded with fats and bacterial deposits. They are good at removing ammonia.

A balance tank was installed and a DAF plant to aid removal of fats. The pH of the process is corrected using either acid or caustic for pH correction to an optimum level. A coagulant is added to generate pin flocs, which are made larger by dosing polymer. This thickens the floc in the stirred tank, which are subsequently removed using a DAF (dissolved air flotation) plant. Milk and cheese fats are separated and sent to a storage tank removed at this stage for dispatch to anaerobic digestion off site. The present DAF pant is only able to operate at a flow rate of 17 cu m per hour, which equates to 408 cu m per day. This removes the fat allowing soluble material to be digested by the trickle filters. This means that the difference needs to removed by tanker.

From the DAF plant the liquor flows to a receiving tank, which is pumped up to the upper tank and from there it is sent to the distribution and sent to two trickle filters TF 1 & TF 2, which are run in series. The liquor flows to humus tanks, which separates the bacterial floc from the water.

The separated water is pumped to the discharge point beside the Teifi.

4 DESCRIPTION OF THE PROPOSED EFFLUENT PLANT AND HOW IT WILL IMPROVE THE EFFLUENT

The proposed process will improve current conditions and is designed to take the increase in cheese and whey production as well as improve plant performance. Because of increased volumes of balancing and aeration tank it will provide a more secure plant.

Balance Tank

The most important is the use of a large balance tank, which will allow the high volumes of water, involved in the cleaning process, to be stored in four hours without overflowing. It will prevent the plant from being overwhelmed or tankered away allowing steady flow through the DAF and biological plant.

DAF Plant

The DAF plant will be increased in size and allow the full flow of 43.3 cu m per hour. Because it is able to flow at 50 cu m per hour it allows for good removal of fat, cheese and suspended solids, reducing the risk of fat carry forward.

Aeration Plant

The plant will be supplied with an anoxic selector followed by an aeration tank of 1380 cu m. This uses fine-bubble aeration to increase biological digestion. It will allow for at least 2 days contact time for biological digestion.

DAF

Separation is carried out using a DAF plant with the sludge returned to the anoxic zone and the clean water flowing forward. This will require the use of a cationic polymer to separate the sludge.

Trickle Filters

There is the ability to retain the trickle filters and to use them to extend the plant in particular to aid ammonia removal. In the case of increased production they would run in parallel running after the DAF plant used to separated the sludge.

Final Filtration

I strongly recommend that a back-washable, AFM (Active Filtration Media) filter should be installed in the final to provide clean water with very low suspended solids. This has a nominal size of 5 micron but bacteria are attracted to the surface of the media. The backwash would be returned to the outlet of the first DAF.

Using AFM filtration will prevent foam caused by stressed bacteria from flowing to the Teifi and reduce the risk of bacteria causing damage to the fish.

AFM only require clean water for back washing. The backwash water is returned to the feed to the aeration system.

Monitoring

Increased automatic monitoring of the final will provide added security concerning conditions and may be a requirement by the NRW for continuation of current consent conditions.

5 POTENTIAL ISSUES SPECIFIC TO DAIRY PARTNERS CAPABLE OF POLLUTING THE AFON TEIFI.

There are a variety of materials, which could cause a river to become polluted. There are no heavy or toxic metals involved in the Dairy process and therefore can be eliminated.

The dairy uses steam, which is heated using gas although there is a back up of fuel oil. This is supplied directly to oil tank. Leakages of oil flowing to the effluent plant would be removed by the DAF plant and digested in the aeration tank.

Milk is a potential pollutant and it contains between 3-4% milk fat the remainder being 5% lactose sugars and 3.6% protein. The milk intake sends milk across to the factory. The tankers are cleaned with acid and caustic and water. Milk can be spilled at this stage but drains are directed to the waste treatment plant.

The milk is received, in the factory, where it is standardised and the excess cream is removed and sent to a storage silo where it is removed from site by tanker to another site. The separated milk is sent to the cheese process where separation takes place into curds and whey. The curds are made into cheese.

The whey is separated and whey cream is removed into a storage tank where it is transferred to a tank, from here it is fed back to the front end blending with milk for cheese making process. Whey is further treated by membrane processes concentrating it then chilling and storing it in silos. The whey is transferred to another site for further processing.

At each stage the process is cleaned, which involves either acid or caustic and water in some case foam cleaners. There are a range of cleaning materials, which have been examined and other than mineral acid and caustic, which become neutralised all other components are organic based and are degraded by the biological process.

Cheese and cheese fines are high in fat, which is separated by the first DAF process, the remainder digested by bacteria in the aeration tank. As whey is soluble, it is not removed by the DAF and relies upon bacterial digestion in the aeration tank. At present it is carried out first in the trickle filters, which are ambient temperature dependent and low in volume. The change to aeration reduces the problems of ambient temperature because growth rates will remain in the range of 15-25 °C.

All water used on site is treated with chlorine dioxide, which is generated using sodium chlorite and hydrochloric acid then reacted together. These are supplied into separate bunded tanks. Any residual chlorine dioxide becomes neutralised by the organic content of the biological process. Even with the Trickle Filter process, there was no detectable chlorine dioxide or chlorine in the final water. The new process having an increased biological capacity will reduce from this.

Acid and caustic from the plant start being neutralised by dilution in the balance tank. The biological process of fermentation produces acids, which reduce the caustic from cleans, while the process of aeration drives off carbon dioxide, which helps the pH to rise towards neutral.

The process in the DAF corrects the pH using mineral acid or caustic. Because of the processes involved, pH levels will remain in the region of pH 6.0 - 9.0. Chemical neutralisation is also followed by biological neutralisation, with bacteria reducing pH levels above 8 and air blowing through the biology causes the loss of carbon dioxide, which causes pH levels below pH6 to rise to above pH7. There is pH monitoring on the DAF plant.

Chemical buffering does take place. When a salt of a weak acid (lactic acid from milk forming its sodium salt) and a strong base (sodium hydroxide) are together, a natural buffering also takes place between the two.

There is little free bicarbonate alkalinity in the water, which is able to impact the river Teifi. Tests showed that alkalinity levels varied from 50-400 ppm. This is mainly from neutralised caustic rather than from natural bicarbonate. This does not alter the mineral balance of the Afon Teifi.

Salt is involved in the process of making cheese. The cheese is placed into brine baths after cooking and it is sprayed over the brine baths to aid cooling.

Salt is soluble in water and as such is not removed in the effluent process. There is a rise in chlorides in the water caused by this process. The impact of the chloride on the Afon Teifi has been assessed and details will be found later in the report. There is little impact on the river to the levels of chloride in the water because it only raised the chloride level along the bank for a few metres after which it became totally mixed and diluted.

Milk does contain calcium and this causes the calcium levels in the effluent in the water to be higher than the background in the river. However this has been assessed and there is little impact to the river overall at low levels while at high flows it is undetectable. The Calcium levels of the river vary depending on where the rainfall is and the quantity. All of these remain below 35 ppm total hardness Calcium Carbonate. The changes detected in the river only altered by 2 ppm, immediately after the outfall, after which it appeared unchanged from the remainder of the river.

Whey is the by-product of mozzarella cheese making. Whey is processed and concentrated using membrane systems, the water removed is pure enough to be used in the factory water supply reducing the amount of mains water. Whey is totally soluble in water and is not removed by the DAF process and has to be removed by the biological part of the effluent plant. High levels of whey do remove natural bicarbonate and these may need to be added to the effluent plant to prevent ammonia levels from increasing if high levels pass through to the aeration tank. There is a turbidity detection system in the whey plant to produce an alarm in the event of losses.

Enzyme cleaning agents are used in the cleaning of the membranes along with acid and caustic. These are discharged into the effluent treatment plant. Enzymes are diluted starting in the balance tank and broken down in the biological process and are no longer present in the final water.

Gas is used for the production of steam in the boiler plant. Fuel oil is retained as an emergency supply for steam production. This is contained in a tank. In the event of oil spill, the majority flows to the removed in the DAF plant.

There are refrigerants in use on site. Losses are rare and mainly lost in a gaseous form. Any water contaminated with oil containing refrigerant flow to the effluent treatment plant where it is removed mainly by the DAF plant.

The other considerations would be failure of power. In the event of power failure any waste flows by gravity to the first pit. Because the raw liquor is pumped across to the balance tank and the balance tank is pumped to the First DAF plant, the First DAF pumped to the biological stage and the final has to be pumped over the wear, power failure causes the plant to shut down and not overflow.

Improved continuous monitoring of the final will provide added surety of the plant integrity

6 MONITORNING OF THE AFON TEIFI

Samples were taken at a number of points in the Afon Teifi to determine the conditions in the river and the impact of water of the Dairy Partners effluent. This was split into chemical analyses and biological examination.

If we assume the flow of the river is half that at Lechryd, the minimum hourly flow would be 54,000 cu m per hour. Under these circumstances the maximum flow of 40 cu m per hour from the factory accounts for 0.074% of the river's flow. This is small in proportion to the total flow of the river.

This means that most issues are most likely to be localised to the discharge and is diluted in the river. The Teifi sweeps to the right within within 400 meters of the followed by a sharp hairpin bend to the right after a further 450 metres. After a further 800 metres the river bends sharply back on itself to the left. After which there are a number of islands and a weir across the river. Sampling across the river around the latter point showed that it was completely mixed.

Afon Arad flows into the Teifi before the outfall and there are a number of fresh water springs and un-named Nants flowing into the Teifi running down the hills on either side of the river.

No samples were taken after the bridge in Cestell Newydd Emlyn because I was uncertain where the sewage works discharge was, which could influence results by introducing chemicals such as phosphate or ammonia.

There are a number of parameters, on which the effluent is monitored. The Afon Teifi was examined both chemically and biologically and this allows me to determine the potential impact of increased flow through the effluent plant on the river.

PARAMETERS WHICH COULD IMPACT AFON TEIFI.

The parameters, which will impact the river are as follows:

Temperature,

pH,

Chloride,

BOD,

Ammonia,

Nitrate and Nitrite

Total phosphate,

Metals (Aluminium) Cadmium and Mercury.

Suspended solids.

6a TEMPERATURE

The temperature and pH are fixed entities and there is no consideration for altering these.

Temperature does impact the dissolved oxygen levels in the water and temperature levels above 25C are to be avoided.

Based on river flow rates of 500,000 cu m per hour the maximum potential flow of 40 cu m accounts for 0.008% of the river flow. This will have little impact on the river overall. It is likely to be much less than 0.1 $^{\circ}$ C even over the short flow by the bank below the discharge.

Based on current temperatures of the effluent, there will be no impact on the Afon Teifi.

6b CHLORIDE LEVELS.

One parameter is chloride, which is inert in water. Salt is present in the final water at relatively high levels in proportion to other components of the water. This occurs in the waste due to the brine chilling process of the mozzarella.

Chloride was found in the effluent treatment plant up to 3400 ppm as sodium chloride.

Chloride levels briefly increased from 15ppm to 30 ppm locally by the bank immediately after discharge.

All the levels of chloride levels further down stream remained at 15 ppm showing that there was little impact of chloride on the river due to dilution.

The brief increase of chloride to 30 ppm has no impact chemically on the river

All of these levels below 15 ppm would have no impact on the plant life, micro life on which invertebrates feed, and it has no impact on fish. The only theoretical impact is that of reduced oxygen levels due to increased chlorides. The only charts I can find about this start at water conductivities of 1000 microsiemens. This only reduces the oxygen content of the water by 0.004 ppm at temperatures between 0 - 20°C.

The Afon Teifi has a conductivity of 80-130 microsiemens and, at most, the conductivity increases due to chloride by 40 microsiemens and this occurs locally to outfall.

It can be concluded that the chloride levels from the factory have no impact on oxygen levels, plant life or micro-life, invertebrates or any aquatic life including fish.

Because fish are a mixture of migratory fish and fry, the changes of chloride are insufficient to impact the feeding, or migrating of fish or eels even if the level of chloride increased to 30 ppm, which is well over levels measured in the river at low flow.

There are no consent levels for chloride. But chloride is a useful comparison for other chemical components occurring from the effluent, which are at least 10 times lower and in most cases more than 100 less.

6c pH LEVELS OF THE EFFLUENT

The Afon Teifi had a pH of 6.8 - 6.9 above the factory outfall. There was no measurable increase in the pH of the river after the outfall to 6.9 at any points below in the river.

The pH of the river is close to neutral on the slightly acidic side.

Any effect only appears on the bank closest to the discharge for a few metres. The river took the majority of the flow and mixed it with the bulk of the river.

Extremes of acid or caustic upset the effluent biological processes and actions concerning these need to be written into procedures to ensure the final pH remains in consent.

6d BOD

BOD is an indication of organic material present in the effluent. At a level of 30 ppm this has little impact on the river and is quickly diluted. Organic material in the BOD is utilised by a range of bacteria in the water.

There is a bacterium commonly associated with effluent plants flowing into rivers, which goes under the name of "sewage fungus". In fact it is not a fungus but is a scavenging bacteria called *Sphaerotilus natans.* These are filamentous organisms. They can grow inside sheaths and often form slime or creamy white deposits and can look like sea-weed in flowing water. It is a versatile organism and doesn't require high levels of nutrients. It will also attract iron and manganese, which may be present in some spring waters in the area. In those cases it takes on a red-brown colouration.

Sphaerotilus natans was present in the concrete of the outfall on the bank.

I specifically examined the Afon Teifi for evidence of *Sphaerotilus* in the water after the outfall and was unable to find it. I also took samples and incubated them for 2 weeks at 20 ° C to determine whether they would develop.

Sphaerotilus only grew in the river samples taken after the outfall, but even these were at relatively low levels. Sphaerotilus failed to develop in any of the other river samples, which means that dilution is dissipating any organic material throughout the river. Higher BOD levels would cause the active growth of *Sphaerotilus.*

Another indicator for BOD is filamentous yeast. These are present in the current effluent plant and are found in the outfall among of a group of bacteria flocculating and settling in the water.

There were low levels of filamentous yeast in the sample taken after the outfall but was not identified in any other samples.

Bacteria tend to naturally coagulate in water. Bacterial floc levels were weak and relatively high immediately after the outfall becoming stronger the further down the river samples were taken. The larger flocs will settle in areas of low flow and act as food for protozoa and crustaceans.

Bacterial levels increased immediately after the outfall but further down stream was similar to those above the outfall.

Anaerobic bacteria were specifically looked for. These were absent in all samples from the river with the exception of the sample after the outfall. Spiral anaerobic bacteria were identified in the outfall water along with a filamentous bacterium called Beggiatoa, which grow using sulphur rather than oxygen. Beggiatoa were only present in the sample immediately after the outfall and absent in all others.

Stalked ciliates and Amoebae were present in the river feeding on bacteria. These are the start of the food chain that includes invertebrates, fish up to otters seals and dolphins.

The new effluent plant will have a longer retention time (for the biological stages) and will be better at reducing BOD levels and should provide consistent results.

BOD flowing to the river can form foam, which has developed due to bacteria producing a stress response and producing polysaccharides.

Foams containing polysaccharides float on the surfaces and may attach themselves to the edge of plants. In the event of contacting moss along the edge of the river, it may coat the moss and inhibit its growth.

I would expect the BOD consent to be reduced from 30 to 20 ppm in the future as the NRW re-assess sites.

6e AMMONIA

Ammonia has the potential to impact the river in two ways. High levels of ammonia damage fish gills, lower levels act as a nutrient source for bacterial growth. Where there is free oxygen available in water, there are bacteria, which oxidise the ammonia to nitrite and others, which oxidise that to nitrate. This is then usable by plants.

Ammonia levels were monitored on the Afon Teifi at a number of different points above and below the factory outfall. Levels of ammonia were low in the river being <0.01 ppm ammonia.

There was an increase in ammonia immediately after the outfall when the river ammonia level increased to 0.2 ppm briefly. All samples taken further down the river were all less than 0.05 ppm.

If the consent levels of 5ppm were to be imposed, this would reduce the local ammonia level to achieve <0.05 ppm ammonia, which is the target level within the river, even by the river bank by after the outfall.

Ammonia is oxidised by bacteria, in the water, first to nitrite then to nitrate. Plants utilise the nitrate present in the water for growth. So the level of ammonia detected is not toxic to fish, crustaceans, insects, algae or other plants.

Ammonia is produced in the plant by the breakdown of proteins. A group of bacteria classed as ammonia oxidising bacteria grow in aeration tanks and on trickle filters. Examination of the trickle filters showed ammonia oxidising bacteria to be present. However, they fix carbon from inorganic sources in the form of bicarbonate. This will have to be added to the plant on occasions to maintain carbonate levels, which will allow them to grow.

Samples from the Afon Teifi showed that that ammonia oxidising bacteria were naturally present flowing in the river.

It is possible that the new plant will have insufficient bacteria present and many prefer attached growth such as the stone media of Trickle Filters. In that case, the trickle filters could run in parallel. Bacteria would continue to be separated using the present humus tanks and polished using a filtration process.

There is no current ammonia consent but I expect the NRW to impose one in the near future. Especially since this may be covered by the reduction of pollution from point sources from treatment works.

6f NITRITE AND NITRATE

The plant's nitrite consent is 3 ppm (mg/L) in the final water.

It is unusual for an effluent plant to have a nitrite consent rather than ammonia or nitrate. There are many bacteria, which will oxidise nitrite to nitrate including ones which grow in your effluent plant and as well as ones, which take nitrite produced from ammonia and oxidise it to nitrate.

Nitrogen is one of the essential nutrients to make bacteria grow and dairy wastes are short of nitrogen, so conversion of nitrite to nitrate is an essential function of a group of bacteria so that the majority of bacteria can grow effectively.

The process of oxidation of ammonia to nitrate and nitrite to nitrate uses specific bacteria, which require oxygen and are temperature sensitive and stop growing below 8° C. The tank is likely to run between 20-25 °C so the bacteria are likely to be active. However many of them are slower growing than ones digesting organic materials and may require the addition of carbonate to promote the conversion of nitrite to nitrate.

The proposed new effluent plant is highly aerobic and has an oxygen meter controlling the level of oxygen in the aeration tank, so oxygen will not be limiting.

6g PHOSPHATE

Phosphate is of concern because of its ability to promote algal growth and cause eutrophication of rivers. There is currently no consent level applied to the waste. Phosphate levels were detected in the effluent samples.

When measured in the water below the outfall, levels of 0.2 ppm were present. Further down river before the bridge had phosphate levels of less than 0.05 ppm phosphate.

These phosphate levels are insufficient to cause eutrophication and are in line with the overall quality of the river.

There was no increase of algae in the samples taken after the effluent over the samples taken before. Algae tended to be short-branched filaments or individual single celled diatoms but no long streams of algae, which occur with higher levels of phosphate.

If a phosphate consent of 1 ppm were to be applied then phosphate levels would be < 0.05 ppm even below the outfall.

The proposed aeration plant uses fine-bubble aeration to remove phosphate biologically providing the anoxic zone is genuinely anoxic.

In the Teifi Management catchment survey, it refers to reducing pollution from continuous and intermittent discharges including additional treatment at works e.g. phosphate stripping.

It is possible that the water will need to be treated with ferric chloride to reduce phosphate to stringent consent levels. Because there are bacteria present, phosphate along with bacteria would be removed using a final AFM filter.

4h METALS

Metals are an issue in that they are toxic to large numbers of organisms and are carried up the food chain to fish, otters, seals and dolphins.

6 h (i)ALUMINIUM

Aluminium is inert at neutral pH levels and as long as the aluminium is in solution rather than particulate. There is no particulate aluminium used on site and any aluminium flowing from the plant is in solution. It is removed as part of the sludge in the DAF plant and is sent for anaerobic digestion.

Starting above pH 9, aluminium is a caustic solution of aluminium hydroxide. This would rapidly disperse in the river, it becomes neutralised and part of the inert materials in the river. Of greater concern is acid aluminium. Below pH 5, aluminium becomes highly positively charged. Acid aluminium is rapidly absorbed by animals and is hazardous to micro-organisms. It is toxic to protozoa, metazoan, invertebrates and fish.

Because the pH of the plant has the limits of pH6 - 9 and is normally in the neutral range of pH6 - 9, the aluminium is not in the hazardous form. Tests showed that the Afon Teifi had a pH of 6.8 - 6.9 so acid aluminium from the plant is a low risk hazard to wildlife.

We were unable to identify the absolute source of either cadmium or mercury from the plant. These will be investigated and eliminated.

6h (ii) CADMIUM

Cadmium is not present in the milk, cheese or whey, but is found as a trace element in salt, caustic soda and sodium hypochlorite. All of these are considered to be at safe levels with regards to be used as a food ingredient. Because salt is lost from the process and caustic is used in cleaning this appears in the effluent.

It is unknown the impact of the aeration plant will have on cadmium content of the water. It is likely that cadmium will be absorbed by some of the bacteria in the activated sludge process. Sludge will be removed and mixed with the DAF sludge and sent out for anaerobic digestion. There may be some residual bacteria carried over from the separation process. Under these circumstances, removal of bacteria by a final filtration process will help reduce potential cadmium discharge levels to the river.

If the final AFM filter had a section of carbon in the filter it would remove any residual cadmium from the water.

6h (iii) MERCURY

Mercury is not present in milk, cheese or whey but is found as a trace element in salt, sodium hypochlorite and may be found in caustic soda. Like cadmium the levels are considered to be at safe levels for a food ingredient. Because salt is lost from the process it introduces mercury into the effluent water. Some mercury may be absorbed by bacteria in the activated sludge process. This will be removed by blending it with DAF sludge and removed from site. A final filtration system using AFM is likely to remove any residual mercury present in bacteria. An AFM filter could have a section of carbon included to remove any residual mercury from the effluent.

6i SUSPENDED SOLIDS

Because suspended solids from the factory have passed through several stages of processing, they are almost exclusively a mixture of bacterial floc, free bacteria, algae and yeast with protozoa feeding on them. These in themselves do not cause problems in the river providing they are kept at a low level and providing they are aerobic bacteria. However, stressed bacteria excrete biopolymers, which produce small quantities of foam and these may be seen on the surface of the Teifi. Anaerobic bacteria use sulphur rather oxygen and excrete sulphide, which can be toxic.

One of the plants present in the Afon Teifi is the Bryophyte Cryphaea lamyana, which is protected in the upper reaches of the Teifi. These can become overwhelmed if high levels of bacteria and in particular filamentous bacteria form coatings on the surface. This would be a localised event because of the rapid dilution, which takes place very quickly.

Bacteria are negatively charged and if high levels of bacteria are present from the effluent, these can become attached to the gills of fish preventing good oxygen transfer. However, when they coagulate together, the charges are neutralised. This is often helped by the activity of protozoa, which were identified in the river and attached to bacterial flocs.

Bacterial flocs provide a much lower risk to the river and become part of the nutrition for protozoa, daphnia and crustaceans.

The present system uses trickle filters with suspended solids removed using the humus pits. At times of heavy loads or stress bacteria produce bio-polymers to protect themselves. These cause foaming as they carry free bacteria on their surfaces. These present a localised risk to bryophytes.

The process will alter using active aeration in a biological plant and DAF plant to remove suspended solids. There could be occasions when suspended solids will flow from this plant introducing bacteria into the river.

The installation of AFM (Activated Filter Media) filters in the final would ensure that suspended solids are maintained in consent levels and reduce suspended solids to well below 50 the current consent levels.

In the event of NRW imposing a stricter consent of 20 ppm (mg/L) the AFM filter would achieve these consent levels.

7 EMERGENCY PROCEDURES TO PREVENT CONTAMINATION OR POLLUTION.

There are a number of risks, which occur in the operation of a dairy and which could impact, overload the effluent plant or even cause a pollution incident.

These could be as simple as the accidental release of high levels of whey into the effluent system, which would exceed the ability of the plant to provide high quality water flowing to the river.

It could be the loss of high levels of acid or caustic.

It could involve the incorrect application of polymer (Anionic polymer rather than the Cationic polyer) to the final DAF so instead of thickening the bacterial sludge it disperses it causing bacterial overflow.

Most of these can be contained on site and either diverted to a storage tank but it may involve diverting water and interfering with production until the plant has recovered.

Procedures need to be written so the operators know what to do in the event of out of specification conditions.

Emergency procedures need to be written and put in place so that management and operators know what actions to take in the event of out of specification events or of pollution incidents.

This will include the following:

The responsible person on site and their deputy who will act in their absence.

The operators and who is to carry out remedial actions in their absence.

Out of hours contacts.

The person who will contact the emergency numbers at the NRW for assistance.

What action is to be carried out to prevent discharge.

In the event of a pollution incident a diary of events will need to be made identifying when the problem was identified and what actions have been taken. Records of conditions prior to the pollution event will be required.

8 BIOLOGY OF THE AFON TEIFI

The Arfon Teifi is a biologically clean river and is a SSSI and it is also designated a special area of conservation (SAC). The details are included at the end of the report.

The biology starts with microbiology. The river changes throughout the seasons. At times of high rainfall there is a high level of particulates and suspended solids flowing past the factory and flowing to the sea.

The Teifi is one of the named rivers for good fishing having populations of wild brown trout as well as migratory species of both sea trout and salmon by the angling association.

The Teifi is one of the few river sites containing bullhead Cottus goblo, not only in Wales but in the UK. These are bottom-feeding fish, which are at greater risk from pollution than other fish because they are more likely to contact "lower' life forms in the river.

The Teifi is also known for Brook Lamprey and River Lamprey. The Brook Lamprey are found further up river and in the tributaries of the Teifi. River Lamprey can be found in lower parts of the river.

Juveniles tend not to be in the main part of the river due to its high velocity. The river before Cestell Newydd Emlyn is on a flood plain (one of several on the river) and the land.

Like the bullhead, juvenile lamprey are bottom feeders and are at greater risk from pollution than migrating fish.

The changes in the effluent plant will provide increased capacity in biological digestion, improved separation, improved filtration and increased monitoring.

Details of SAC are found in section

9 CONCLUSION

Dairy Partners are fortunate in one way in that even when the Afon Teifi is at its lowest, the effluent only contributes 0.075% of the flow rate above Castell Newydd Emlyn. Under most conditions it only accounts for less than 0.01% of flow rates. This means that overall it is relatively insignificant other than as a point source of potential contaminants. In another way they are less fortunate because the river is both an SSSI and SAC. So whatever actions are taken must progressively improve discharge water quality.

This assessment has incorporated factors involved in production, cleaning materials and materials used on site as well as the water used. It has looked at the existing and proposed changes to the treatment plant. It has also looked at the impact of the chemistry on the treated effluent on the Afon Teifi.

It is clear that the present plant is not suitable for current production needs and have resulted in removal of liquor from site. The current biological plant (Trickle Filters) is based on 1950/60s technology and suffers from a relatively small volume and slows down during low ambient temperatures.

Proposals have been made for replacement of the current balance tank, DAF plant and the installation of a biological activated sludge plant, which will improve current conditions. However increased production in 2020 will challenge even the new plant.

Balance tanks and DAF plants are normally able to operate straight away provided they have been designed correctly without any concern. Aeration systems may take a time to get to correct conditions before they are fully operationally. During this time close scrutiny and monitoring will need to take place to ensure that out of specifications do not occur.

This will need to be repeated when milk intake increases and cheese production

Major pollution incidents from other sites have taken place in the Teifi, where fish have been killed. This could occur unless procedures are put into place to ensure that it does not happen. I would advise that these could be start being written before the plant is built.

Commissioning of the new plant will be a high-risk period and even if it is the fault of the contractor building the plant, ultimately the responsibility rests with Dairy Partners (Cymru) Ltd.

The water quality in the Teifi around Cestell Newydd Emlyn is considered to be good but there are point sources of pollution. Under these provisions phosphate is specifically mentioned but ammonia is likely to be added for improvement.

Increased continuous monitoring of the final water will provide assurance of the quality of the water flowing to the river and confirm the effectiveness of the effluent treatment plant.

10 AFON TEIFI SAC DESIGNATION.

Afon Teifi/ River Teifi

Designated Special Area of Conservation (SAC)

Country	Wales
Unitary Authority	West Wales and The Valleys
Centroid*	SN515508
Latitude	52.13583333
Longitude	-4.170833333
SAC EU Code	UK0012670
Status	Designated Special Area of Conservation (SAC)
Area (ha)	691.07

* This is the approximate central point of the SAC. In the case of large, linear or composite sites, t represent the location where a feature occurs within the SAC.

Location of Afon Teifi/ River Teifi SAC

General site character

- Tidal rivers, Estuaries, Mud flats, Sand flats, Lagoons (including saltwork basins) (20%)
- Salt marshes, Salt pastures, Salt steppes (1.7%)
- Inland water bodies (Standing water, Running water) (45.1%)
- Bogs, Marshes, Water fringed vegetation, Fens (8.9%)
- Heath, Scrub, Maquis and Garrigue, Phygrana (2.7%)
- Humid grassland, Mesophile grassland (1.7%)
- Improved grassland (7.5%)
- Broad-leaved deciduous woodland (10.5%)
- Inland rocks, Screes, Sands, Permanent Snow and ice (1.1%)
- Other land (including Towns, Villages, Roads, Waste places, Mines, Industrial sites) (0.8%)

Annex I habitats that are a primary reason for selection of this site

- **3260 Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation**
  The Teifi in west Wales is a large river flowing over hard rock, with some spectacular gorges in the lower section. It is mainly mesotrophic but also has oligotrophic sections in the upper reaches, and represents an outstanding example of a sub-type 3 river with water-crowfoot *Ranunculus* vegetation in western Britain. The river has a spatey flow regime, and in-stream vegetation is dominated by stream water-crowfoot *Ranunculus penicillatus* ssp. *penicillatus*, water-starworts *Callitriche hamulata* and *C. obtusangula* and the aquatic moss *Fontinalis squamosa* in a diverse macrophyte community characteristic of oligo-mesotrophic base-poor rocks. A small amount of *R. penicillatus* ssp. *pseudofluitans* is present where one tributary flows over base-rich rocks. The river is also noteworthy for an unusually low-gradient section flowing through Cors Caron, a large area of **7110 Active raised bog** that is an SAC in its own right.

Annex I habitats present as a qualifying feature, but not a primary reason for selection of this site

- **3130 Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoëto-Nanojuncetea**

Annex II species that are a primary reason for selection of this site

- **1096 Brook lamprey** *Lampetra planeri*
  The Teifi is a predominantly mesotrophic river in west Wales supporting a large population of **brook lamprey *Lampetra planeri***. A mixture of habitat and substrate types provides the combination of spawning gravels adjacent to silt beds that are favoured by this and other lamprey species. A large number of tributaries have been included in the SAC; these are thought to be important for lampreys in the Teifi because the main

channel is prone to severe floods that may result in washout of smaller ammocoetes.

- **1099** River lamprey *Lampetra fluviatilis*
  The Teifi is a large catchment of high conservation value in west Wales. It contains a healthy population of **river lamprey *Lampetra fluviatilis*.** The semi-natural channel containing a mixture of substrates and in-stream features provides excellent habitat for juvenile lampreys.

- **1106** Atlantic salmon *Salmo salar*
  The Teifi is a medium-sized mesotrophic river system in west Wales. In 1999 the **salmon *Salmo salar*** rod catch in the Teifi was the third-largest in Wales, and the system has not experienced the steep decline in stock numbers seen in many other rivers in the area. This is likely to reflect the high quality of the catchment, with a semi-natural channel largely unaffected by poor water quality or artificial barriers to migration. However, in common with many other Welsh rivers, acidification in the upper reaches is a cause for concern. In common with many other rivers in west Wales, grilse are the main stock component. There is a small traditional coracle fishery that exploits the salmon and sea trout *Salmo trutta trutta.*

- **1163** Bullhead *Cottus gobio*
  The Teifi represents **bullhead *Cottus gobio*** in west Wales. Water quality is generally good, and the diversity of semi-natural habitat and predominance of stony substrates provides excellent bullhead habitat throughout much of the catchment. Environment Agency electrofishing data shows this species to be widespread throughout the system. Bullheads show marked differences in growth and longevity between upland and lowland streams, and the Teifi includes sections representing both types of habitat.

- **1355** Otter *Lutra lutra*

The Teifi in west Wales holds **otter *Lutra lutra*** throughout much of its catchment. The river has suitable resting and breeding sites along its length. Evidence from surveys and sightings suggest the tidal reach is being increasingly used by otters.

- **1831** Floating water-plantain *Luronium natans*
  The Teifi is a mixed habitat supporting **floating water-plantain *Luronium natans*** at the western margins of its range in the UK. This species has been recorded in the nutrient-poor standing waters of the Teifi pools in the headwaters of the river. It has also been recorded in a moderately nutrient-rich stretch of the river immediately downstream of Cors Caron.

Annex II species present as a qualifying feature, but not a primary reason for site selection

- **1095** Sea lamprey *Petromyzon marinus*

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