Bembridge and St Helens Harbour Association

APPRAISAL OF THE ENVIRONMENT OF BEMBRIDGE HARBOUR

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PART 6 WATER QUALITY

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6.1 SUMMARY AND AIMS

6.1.1 SUMMARY

Using data supplied by the National Rivers Authority and Southern Water an assessment has been made of some of the factors affecting Bembridge harbour water quality. Possible future measurements are suggested and general conclusions are drawn.

The purpose of this report is to assess the magnitude and the variations of some of the factors affecting the Harbour water quality. To do this use has been made of water quality measurements taken by the National Rivers Authority (NRA) in and adjacent to the Harbour and measurements taken by Southern Water Services at the St Helens and Brading treatment plants. Both have kindly supplied this data.

6.1.2 AIMS

1. To obtain and consider data about the quality of water in Bembridge Harbour.

2. To consider factors affecting the inflow and outflow of water from various sources.

3. To establish whether action needs to be taken to maintain or improve water quality.

6.2 BEMBRIDGE HARBOUR (Fig 6:1)

Bembridge Harbour including the millpond has an area at high tide of approximately 40 hectares. To this must be added the `outer harbour' of approximately 70 hectares in area, comprising the region between the entrance and the ledges just beyond the sea mark. Both these areas constitute the estuary of the Yar which enters the Harbour at the extreme west end.

The character of the Harbour is primarily governed by two parameters -- the tidal state and the state of water flow in the Yar.

6.3 MEASUREMENTS (Fig 6:1)

The NRA measurements were from samples taken at three locations shown in figure 6.1; at the weed grid in the Yar (3), at the Harbour Master's pontoon (2) and at Duver Beach (1). These samples are near-surface local samples and subject to local conditions.

The Yar and Harbour samples were taken about once a month all year at various tidal states and usually between 9 a.m. and 3 p.m.

The Duver Beach samples were taken in the bathing season, once a week, at various tidal states and between 10 a.m. and 11 a.m.

The Southern Water measurements were taken from samples of the final effluent about once a week, while influent flow measurements were continuously monitored.

Bearing in mind the limitations, some of the measurements obtained will now be considered. With one exception the data shown graphically is that from samples at the Harbour Master's pontoon (the `Harbour'), location 2, Fig 6:1. The exception is Fig 6:4 (faecal coliform) which uses data from Duver

6.4 CONSIDERATION OF RESULTS

6.4.1 Salinity -- chloride (Fig 6:2)

In fresh water the amount of chloride present is often a measure of sewage pollution. However, the high levels in the samples in the Harbour are obviously mostly due to sea water. A typical near-surface open sea salinity in temperate latitudes is about 3.5 to 3.6 percent.

The values shown in figure 6.2. are indicative as to what is to be expected in the Harbour. There is an upper level which slowly increases with the onset of summer to a maximum at high tide of about 20 gm chloride per litre (equivalent to approximately 3.8% salinity) and there is a lower level which is, perhaps, indicative of the salinity in dry weather with the sluices open, which rises more steeply to about 19 gm/l as the flow in the river ceases. Then, with the onset of autumnal rains, the values decrease and when the river is in flood the state of the tide makes little difference. The singular low points in May and October were due to rain storms at those times.

6.4.2 Biological oxygen demand (Fig 6:3)

Biological Oxygen Demand (BOD) is one of the important measures of pollution and, more importantly, of the ability of a body of water to cleanse itself by the bacterial oxidation of organic pollutants.

In this measurement the sample is diluted with water containing a known amount of oxygen and the loss of oxygen is measured after the sample has stood for 5 days at 20C. The lower the loss the lower the BOD and the less pollution. For reference, the BOD of raw sewage is about 400, a typical river 1--3 and tap water 1.

As shown in figure 6:3. the BOD measured clusters between 1 and 2. If one uses a bit of `creative analysis' a seasonal variation may possibly be seen. There are two points of BOD = 5 but this is not considered exceptional for an estuary of this type.

On the whole, the BOD levels in the Yar are slightly higher (1.1 to 2.4). Data on the final effluent from the Brading and St Helens Sewage Treatment plants for the periods 7/93 to 6/94 show wide and rapid variations in BOD in the range 3 to 18. There does not seem to be much correlation between BOD variation in the Yar with those measured in the St Helens effluent; there are perhaps too few data points with common dates.

6.4.3 Faecal Coliforms (Fig 6:4)

As the name implies, this is a prime measurement of pollution of water by sanitary sewage. The measurement is obtained by counting coliforms grown on a greatly diluted sample in a culture at 27C. For reference, the count for secondary treated effluent is on the order of 40 to 50 thousand and tap water is zero.

The faecal coliform count is one of the measurements used to determine if a beach has passed for the EC `blue flag', the criteria being that in each of 20 samples taken during the bathing season the count must be less than 2000 per 100 ml.

Shown in figure 6:4 are the faecal coliform counts at Duver Beach, location 1, Fig 6:1, sampled once a week during the bathing season. The shaded rectangle contains points below 100 per 100 ml (12 in 1992, 9 in 1993 and 5 to July, 1994). Also shown are six measurements of samples taken in the Harbour, location 2, Fig 6:1.

As can be seen, most of the counts are well below the EC limit. However, the higher exceptional points cannot be ignored. They are to be expected, given the location of sewage outfalls in the area. They usually occur after rains when any treatment plants are bypassed or overwhelmed and the outfalls near Duver Beach are flushed out. As the samples are only taken once a week at one point, it is a matter of weather, tide and luck whether the pollution is recorded or missed.

The Bembridge Harbour points indicate what probably happens to the beach after the season ends, when flood waters extend out to the sea.

6.4.4 Nitrogen -- nitrates and nitrites (Fig 6:5)

The sources of nitrates and nitrites in the water are many, but perhaps the two of major concern are the aerobic oxidation of sewage ammonical nitrogen and agricultural fertilizers. Whatever their original source, the nitrates and nitrites are of concern as they promote the growth of algae.

Shown in figure 6.5 is the measure of total nitrates and nitrites in the water sampled at the pontoon, given in mg. of nitrogen per litre. There seems to be a definite seasonal trend in both the upper and lower values with minima in the summer months. A graph of data from samples taken from the Yar at the grid shows a similar but more exaggerated form with upper levels of 5 to 6 mg. per litre in the rainy season. The lower levels are near those sampled in the Harbour.

6.4.5 Nitrogen -- ammonical

Ammonical nitrogen is a measure of sewage pollution. Bembridge Harbour measurements vary between .04 and .22 g of nitrogen per litre, as do the Yar sample measurements. If the measurements between June and December

1993 are compared with each other and with the more numerous measurements of the St Helens treatment plant effluent (which varies between .06 and 4.1 mg/l) some correlation is found between the effluent and Yar measurements, but none with the Harbour samples.

6.4.6 temperature (Fig 6:6)

The water temperature affects the solubility of gaseous oxygen in water; the solubility at 5C is 1.4 times that at 20C. This can radically affect the ability of a body of water to support life. Higher temperatures will also increase evaporation, and thus, salinity. Typical near-surface open sea temperatures in temperate latitudes will vary from about 4C to 14C.

As is to be expected, the near-surface water temperature shown in figure 6.6 varies more or less sinusoidally with the seasons from a minimum of 5C to a maximum of 20C.

6.4.7 Dissolved oxygen (Fig 6:7)

The level of gaseous oxygen dissolved in water is a measure of its ability to sustain higher aquatic life: fish require 2 to 5 ml of oxygen per litre. Typical near-surface open sea values for dissolved oxygen are about 5 to 6 ml/l.

As shown in figure 6:7 the dissolved oxygen as sampled in the Harbour is usually in the range of 82 to 99 percent of saturation, with a possible seasonal variation (high in spring and low in late summer). Such high percentages are to be expected in near surface water. Also to be expected are supersaturation values at times of high photosynthesis and lower values at night.

Using the temperature variation shown in figure 6:6 the calculated range of dissolved oxygen would be approximately 6 to 7 ml/l in winter and 4 to 5 ml/l in summer. The 67% sample would give a value of 3.7 ml/l. It must be remembered that all samples taken were near surface in daylight.

6.4.8 Orthophosphates

The sources of most orthophosphates in water are detergents and fertilisers so they are almost ubiquitous to streams today where they serve as nutrients for algae.

The phosphates must be removed from sewage by chemical means, which is rarely done in Britain today. The EC may in the future put limits on discharges containing phosphates.

In the Harbour, data indicates values of between .02 and.11 mg. of phosphorus per litre for 85 percent of the samples. There are four exceptional points (two as high as 0.5 mg/l). Readings before and after indicate these are sudden occurrences lasting only a few days at most. A sample taken on 14.10.93 (.25 mg/l) also has a high nitrate reading (2.81 mg/l) and all indications of flood conditions. With the other three points flood indications are missing and no Yar samples were taken near their time.

6.5 SEDIMENT

Sediments -- silt, sand and organic solids are the bane of Bembridge Harbour. The results are clearly seen and have been measured periodically. A comparison of the most recent surveys (the last sponsored by the Association) indicate that perhaps the silting in the higher regions is slowing down and what is now happening is a filling up of low spots.

No measurements of the silt load in the Yar have been made and any estimates can only be made using measurements from other (and much larger) rivers.

What happens to sediment depends upon its size. Very small particles of inorganic sediment (less than .01 mm in size) pack tightly together and are difficult to erode, but transport easily and stay in suspension even in still waters. Very large particles (larger than 5mm) are difficult to move, transport only at high velocities and deposit easily. They may bump along the bottom. Particles in the range .03 to .3mm erode more easily, transport over a fair velocity range and fall from suspension while moving at reasonable velocities.

6.6 SEWERS AND CESSPITS (Fig 6:1)

6.6.1 Sanitary sewers

On the Bembridge side the Southern Water sanitary sewer ends opposite the Bembridge Sailing Club. Private sewers are tied into it as far down as Coombes. This sewage is pumped up the hill and is discharged at the Lifeboat outfall.

From beyond Coombes to the Yar, cesspits and septic tanks are used. These are regularly inspected. The area from the BHYC to the Yar will very soon be connected with the St Helens sewage system. It is also planned that all housing between the Yar bridge and the mill pond which is not already connected with the St Helens system will be so in the near future.

In southern parts of the Duver fronting on the Harbour the buildings use their own private systems (cesspits or septic tanks).

The buildings in the northern Duver fronting on the beach and the Nodes Point Holiday Camp use private treatment plants with outfalls into the beach area. It is planned to soon intercept these outfalls and pump the effluent to Seaview for transfer to Ryde for treatment and disposal.

6.6.2 Storm drains

On the Bembridge side a main storm drain comes down the hill and has an outfall near the Point. The Embankment Road drains on the water side go directly into the Harbour. Along the road the downspouts go either to the rear and drain into the lagoons or onto hard forecourts and drain into the road.

In St Helens at the foot of Mill Road is a largish outfall which was once a spring fed stream, but today acts as a storm drain and, inadvertently, as a sanitary sewer, and is probably the source of the noxious pollution of the small inlet and the adjacent mill pond. The small stream entering the northern end of the mill pond acts also as a storm drain and may contain some agricultural runoff when it rains. All about the Harbour are numerous hard areas which drain directly into the Harbour and which also serve as drains for downspout water. There are also many small unseen and/or unknown storm drains or gullies about the Harbour.

In the Harbour itself the two sources of minor sanitary sewage are the houseboats and the boats in the Marina. The latter source, the Marina, should be diminished by the building of the new Marina facilities which will be connected with the St Helens system.

6.6.3 Treatment plants

There are two major sewage treatment plants emptying into the lower Yar -- at Brading and St. Helens. Both are secondary treatment plants. Both have tanks which hold back for treatment the first (and worst) excess intake during heavy rains. Further excess bypasses treatment and is discharged into the Yar.

For the St Helens plant the BOD samples range from 2.3 to 18 while the measured influent flow ranges from 393 to 1986 cubic metres per day, with a `normal' value of approximately 450 cubic metres.

The Brading plant BOD samples range from 3.1 to 18 while the measured influent flow ranges from 73 to 683 cubic metres per day with a `normal' value of about 250 cubic metres.

6.7 POSSIBLE FUTURE MEASUREMENTS

It would be of much interest to have a measure of the silt load of the Yar in flood and the corresponding load at the Harbour entrance. This is almost impossible to obtain because of the number of data points required and the expense of the equipment. However, some measure of the silt load could be taken in the more quiescent areas of the Harbour using filters and a microbalance or by means of optical determination of samples.

Measurement of the electrical conductivity of samples taken in conjunction with the chloride measurements indicate a linear relationship between the two. This opens the possibility of using a crude conductivity meter to monitor the salinity.

The cost of making full analyses of samples taken at other locations in the Harbour and taken at the same time as NRA samples should be investigated.

Any measurements should wait until the new bridge/sluice is in full operation.

6.8 CONCLUSION

A cursory survey of the data indicates that about 30% of the samples have statistically exceptional readings in BOD, nitrates, phosphates etc., mostly during the rainy season. If one also notes in the 40 ha. harbour those known localised pollution black spots, one arrives (by assuming that the data applies to the whole harbour) at a rather simplistic statement: that perhaps about 70% of the time about 70% of the harbour water has a level of water quality which might be considered acceptable in view of the commercial, recreational and residential usage of the harbour, i.e., BOD < 2.0, nitrates < 2mg/l, phosphates < 0.25 mg/l, faecal coliforms < 2000/100ml, salinity > 2.5%.

Hopefully, the planned extensions of the St Helens sewer system will eliminate some black spots, and increased awareness by harbour users will lessen others. Care must also be taken to avoid introducing any new possible pollution sources.

Since `70% of the time' depends much upon the Yar, the weather and building and agricultural practices, little improvement in this percentage can be expected, but the magnitude of excursion might be lessened.

It must also be remembered that a pollution load is not swept clean away by the flow of the flooded Yar or in a single ebb of the tide, but diminishes exponentially with each tidal flushing.

After the new sluice/ bridge and the sewer system extensions are in place, more measurements at more locations in the harbour should be made, either by point samplings or by marine biological methods.

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