Biological, chemical and nutrient water quality data from 1995 to 2016 are presented, showing different water quality classes that rivers achieved historically and most recently in 2016.
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1.0 General Introduction

This report presents river quality as measured over the period Spring 2015 to Autumn 2016. This report is the sixth detailing long term monitoring on the rivers and streams of the Isle of Man. The first was the “The River Quality Baseline Survey” issued in 1998, which presented results from surveys carried out between 1995 and 1998. The second was “River Quality 2000” issued in 2002. The third was the “River Quality 2005” and two interim monitoring reports in 2009 and 2013 have also been produced. Comparisons have been made between the results from the first three reports to allow comment on long-term river quality changes however due to limited data from 2015 and 2016 the data cannot be compared to previous years.

The data used in this report has been treated in a similar manner to that collected by the regulatory bodies in England, Wales and Northern Ireland, whereby a “General Quality Assessment” (GQA) category is calculated from the data for a number of aspects including biological, chemical and nutrient status. This presents a “snapshot” of environmental quality for the major rivers and streams of the island and allows comparison with any future surveys on the Isle of Man and surveys from the United Kingdom.

2.0 Rivers of the Isle of Man

The protocol of the “Water Quality 2000” report where the Island is split into four geographical regions has been followed. The four regions are based on river catchment areas; East, South, North and West. The Eastern region has significant urban and industrial areas with a relatively large number of inland sewage treatment works; and streams in the Laxey area are impacted by disused mining sites. The Southern region is dominated by livestock and agriculture. The Northern region can be split into two geographically distinct areas, the first being the Sulby River catchment which drains the slopes of the Island’s mountain (Snaefell, 2037 ft), through Sulby reservoir. The second being the flat Northern plain which has slow flowing watercourses akin to dykes and ditches. The Western Region is dominated by the River Neb, of which a tributary, the Foxdale Stream is impacted by disused mining sites. A number of small streams outside the main Neb catchment drain sewage effluent discharges from Ballaugh, Kirk Michael and Glen Maye.

The catchment details including the number of sampling sites, drainage area and sampled lengths are shown in Table 1.
Table 1. Catchment and Sample Details

<table>
<thead>
<tr>
<th>Region</th>
<th>Catchment</th>
<th>Drainage Area (km²)</th>
<th>Sampled Length (km)</th>
<th>Sampling Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East</td>
<td>Glass</td>
<td>38.8</td>
<td>18.8</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Dhoo</td>
<td>33.5</td>
<td>13.6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Laxey</td>
<td>24.6</td>
<td>11.4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Groudle</td>
<td>12.6</td>
<td>9.4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Middle</td>
<td>7.5</td>
<td>5.0</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Baldrine</td>
<td>2.9</td>
<td>2.0</td>
<td>1</td>
</tr>
<tr>
<td>South</td>
<td>Colby</td>
<td>13.2</td>
<td>5.6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Silverburn</td>
<td>29.2</td>
<td>16.2</td>
<td>5</td>
</tr>
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<td></td>
<td>Poylvaash</td>
<td>4.7</td>
<td>0.1</td>
<td>1</td>
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<tr>
<td></td>
<td>Ballabeg</td>
<td>5.9</td>
<td>3.5</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Glashen Stream</td>
<td>4.0</td>
<td>0.1</td>
<td>1</td>
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<td></td>
<td>Santonburn</td>
<td>17.9</td>
<td>9.2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Crogga</td>
<td>4.0</td>
<td>3.8</td>
<td>3</td>
</tr>
<tr>
<td>West</td>
<td>Neb (inc. Foxdale)</td>
<td>55.4</td>
<td>23.7</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Glen Maye</td>
<td>14.6</td>
<td>6.4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Mooar</td>
<td>6.1</td>
<td>4.1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Kirk Michael</td>
<td>7.8</td>
<td>4.8</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Ballaugh</td>
<td>14.6</td>
<td>4.6</td>
<td>1</td>
</tr>
<tr>
<td>North</td>
<td>Lhen</td>
<td>22</td>
<td>6.2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Auldyn</td>
<td>12.3</td>
<td>7.8</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Sulby</td>
<td>57.8</td>
<td>24.0</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Cornaa</td>
<td>18.7</td>
<td>7.0</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>408.1</td>
<td>187.3</td>
<td>81</td>
</tr>
</tbody>
</table>

The locations of the sampling points were chosen in consideration of known discharges and location of confluences. While the vast majority of sampling sites have remained the same during each sampling period, a few sites have been added or removed over the years to cope with the changing discharge regimes.

Figure 1 details all of the 81 sampling site locations across the Island monitored during the summer sampling programme. For the spring and autumn programmes approximately 27 sites are monitored, the sites are spread across the island focusing on key areas. Some additional sites may be included depending on recent pollution incidents or other environmental impacts.
Figure 1. Location of sampling sites across the Isle of Man
3.0 General Quality System

River quality is assessed by the measurement of a group of factors (biological, chemical and nutrient, under the General Quality Assessment scheme (GQA)), which when considered together provide a comprehensive representation of overall river quality. These factors also consider the density of the biological community living in the riverbed and the chemical constituents associated with discharges, run off and the geology within the river catchment. The GQA scheme provides a method for comparing river quality from one river to another and for observing changes through time. The methods used in this report follow the GQA scheme as previously used by the regulatory authorities in England, Wales, Scotland and Northern Ireland. EU and UK agencies have now moved to an ‘Ecological and Chemical Status Assessment’.

Quality assurance is provided by Five Rivers Environmental Consultancy who processed the biological samples and is audited by the Environment Agency. All of their ecologists are part of the Chartered Institute of Ecology and Environmental Management (CIEEM). For water chemistry samples, the United Kingdom Accreditation Service (UKAS) assures quality levels of the analytical laboratory.

For all of the figures below showing the classifications for each category the same colour coding has been used to determine the best grade to worse. The best grade is shown in **BLUE** and the worst grade shown in **RED**. This has been done to avoid confusion as Chemistry and Biology are rated from ‘Very Good’ to ‘Very Poor’ and Nutrients are rated ‘Very Low’ to ‘Very High’.

3.1 Biology

Samples are taken of macro-invertebrates which inhabit the riverbed. Macro-invertebrates do not move far and respond to everything in the water, as well as to physical damage to their habitat. Macro-invertebrates can be affected by pollutants that occur infrequently, or in low concentrations which may be missed by chemical sampling.

There are two systems which can be used to classify the ecological health of a watercourse through the invertebrate type, abundance and environmental data. The Biological Monitoring Working Party (BMWP) score system and RIVPACS (River Invertebrate Prediction Accreditation System) / RICT (River Invertebrate Classification Tool). Both systems can be used however RIVPACS/RICTS requires additional environmental data on each site to allow a direct comparison of the water bodies.

The Biological Monitoring Working Party (BMWP) score system provides an index of river water quality based on aquatic macro-invertebrates. The score allocated to each taxon was set by a group of expert river biologists on the basis of their collective experience of the taxon’s sensitivity to organic pollution. The results have been graded according to the BMWP category.
interpretation ranging from ‘Very Good’ to ‘Very Poor’. BMWP is used when environmental data has not been collected at the sample site.

The River Invertebrate Prediction Accreditation System (RIVPACS) / River Invertebrate Classification Tool (RICT) compares the sampled rivers with data from rivers of a similar physical nature but devoid of any pollution stress. The results from this comparative exercise allow a river stretch to be graded into one of six grades ranging from grade A (Very Good) to grade F (Bad). Full details of the method are given in Appendix 1; this system is not ideal for many of the small, spatey streams in the Isle of Man, which have highly variable flow regimes, it is currently the best system available and the results are relatively robust.

3.2 Chemistry

Samples of river water are taken three times per year from the sample sites as used for the Biological GQA described above, with some additions. These samples are analysed for a number of determinants including Dissolved Oxygen, Biochemical Oxygen Demand and Ammonia which together indicate the organic pollution levels in the river. Organic pollution is probably the commonest form of pollution and derives from sewage treatment works and farms.

Under the GQA chemical analysis the water quality is ranked from grade A (Very Good) to grade F (Bad). Full details of the method are presented in Appendix 2.

3.3 Nutrients

The same samples of river water as used for the Chemical GQA described above are further analysed for nitrate and phosphate. These substances are commonly termed “nutrients” and high concentrations of these nutrients can cause increased organic enrichment or eutrophication with excessive plant and algal growths. The main sources of these substances are land run off from agricultural fertiliser, animal excrement and detergent from sewage effluent.

As before the results obtained from the analysis of these substances allow the river to be graded into one of six grades ranging from grade one (Very Low) to grade six (Excessively High or Very High). However, grades for nitrate and phosphate are kept separate and reported individually. Full details of the method are presented in Appendix 3.
4.0 Environmental Implications

4.1 Sewage Treatment Works and Septic Tanks

Any effluent discharged into streams, rivers and the sea from a sewage treatment plant requires a “licence to discharge” which contains conditions on the concentration of particular parameters to ensure environmental protection. Limits are set for biochemical oxygen demand, suspended solids, ammonia, pH and a descriptive condition describing no visible signs of oils and grease. These limits are determined by the effluent quality quoted by the specific companies who develop the sewage treatment works.

If a sewage treatment plant is not working efficiently there could be an increase in biochemical oxygen demand, suspended solids or ammonia present downstream of the discharge. The cumulative effect of these discharges can lower the classification of a section of the river. Elevated concentrations of phosphate are also common due to the use of detergents in households.

The elevated concentrations of the parameters mentioned above can cause a reduction of oxygen present in the watercourses which can lead to death of fish and aquatic invertebrates.

Effluent from septic tanks is not treated aerobically and therefore contains elevated levels of biochemical oxygen demand, suspended solids and ammonia. The majority of septic tanks that have been found to discharge to watercourses have been upgraded to sewage treatment plants as under the Water Pollution Act 1993 only treated sewage effluent can be discharged to a watercourse. Septic tank effluent can only be discharge to land via a soak-away.

When determining the discharge method using a soak-away or partial soak-away is preferred over a direct discharge to the watercourse. However not all land is suitable for a soak-away to be installed so percolation tests have to be undertaken to determine the suitability.

4.2 Agricultural Land Run Off

Pollution from agricultural land run off occurs when too much manure or artificial fertiliser is applied to the land during adverse weather or if the land is saturated and does not require the additional nutrients. Agricultural land run off can increase the concentrations of phosphate, nitrates or ammonia depending on the product that is applied to the land. The increase of nutrients within the watercourse can cause eutrophication which is when the body of water becomes overly enriched with minerals and nutrients that induce excessive growth of plants and algae. The eutrophication of a body of water will deplete the oxygen levels which can cause fish to die.
Appropriate application of manure or artificial fertilisers can prevent agricultural run-off. Other ways to reduce water enrichment include the use of buffer strips, managing livestock and applying products more than 10m from watercourse. Such buffer strips also help to control solids run off from agricultural land into streams which can cause smothering of habitats for invertebrates and damage fish spawning areas.

5.0 Biological General Quality Assessment

5.1 General Situation

For the biological analysis the 2015 and 2016 samples have been analysed using the BMWP (Biological Monitoring Working Party) classification. BMWP classification is a procedure for measuring water quality using families of macro invertebrates as biological indicators. The BMWP is analysed using five categories; very good, good, moderate, poor and very poor. River Invertebrate Prediction Accreditation System (RIVPACS) / River Invertebrate Classification Tool (RICT) system was developed to classify the ecological quality of rivers taking into account the environmental data and invertebrate data. For the 2015 and 2016 data mentioned in this section RICT analysis was not an option as the associated environmental data sheets were not completed.

Comparison with previous years data is unable to be completed with the 2015 and 2016 data as not all sites were monitored during the specified seasons (spring, summer and autumn). With the limited data available conclusions are difficult to make and further samples need to be collected for analysis. This will be completed over the next couple of years and should assist with identifying long term trends across the island.

Throughout 2018 biological samples have been collected from all 26 sites during the spring, summer and autumn. Whilst collecting the samples environmental data sheets have also been completed to allow for more detailed analysis to be undertaken on these samples. By using RIVPAC/RICT analysis it will enable rivers to be compared to smaller streams as it uses an observed over expected ratio to allow a direct comparison also taking into account the environmental data.
5.2 Eastern Region - Biological GQA

The River Dhoo recorded a variety of classifications from ‘Good’ to ‘Poor’. There are significant sewage effluent discharges into the River Dhoo. The Middle River recorded ‘Poor’ classification which has discharges from industrial effluent and leachate seepage from historic landfills. The River Glass recorded ‘Good’ classification around the Dairy discharge sites. Upstream of Injebreck reservoir ‘Poor’ classification was recorded. Groudle Stream recorded ‘Good’ classification and Laxey River recorded ‘Moderate’ classification. Laxey River is subject to the heavy metal contamination from historic mining within the catchment.

Figure 2. Biological Classification - Eastern Region
5.3 Southern Region - Biological GQA

Most of the rivers recorded ‘Moderate’ classification and the Crogga River recorded ‘Good’ status. Due to the low number of biological samples taken from this region it is difficult to interpret the results.

Figure 3. Biological Classification - Southern Region
5.4 Northern Region - Biological GQA

Due to the low number of samples and only two sites having biological samples taken it is difficult to interpret the results for this region. Ellanbane and Glen Auldyn were classified as ‘Moderate’. There are significant sewage treatment discharges and surface water run-off from agricultural land in these areas.

Figure 4. Biological Classification - Northern Region
5.5 Western Region - Biological GQA

Five sites were sampled within the Western region. Mooar Stream recorded ‘Good’ status along with the upper section of the Foxdale Stream. The upper section of the River Neb around Glen Helen recorded ‘Moderate’ classification. There are significant discharges of treated sewage effluent in these catchments. The lower section of the River Neb recorded ‘Poor’ status and is subject to contamination from the historic mining activity upstream.

Figure 5. Biological Classification - Western Region
6.0 Chemical General Quality Assessment

6.1 General Situation

The chemical water quality across the Isle of Man has improved slightly since 1995 and with more of an improvement between 2000 and 2016. Since 2000 the sampled rivers achieving ‘Very Good’ or ‘Good’ GQA classification has increased from 91% to 99% in 2016.

To ensure the high quality of the Isle of Man’s rivers regular monitoring needs to be continued to assess the status of the watercourses and identify any areas of concern. Continued vigilance to protect the watercourses from potential pollution is very important and will assist with achieving the high water quality which the island values.

Table 2. Chemical quality of rivers 1995 to 2016

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Very Good</td>
<td>83</td>
<td>74</td>
<td>69</td>
<td>80</td>
<td>88</td>
</tr>
<tr>
<td>b</td>
<td>Good</td>
<td>15</td>
<td>14</td>
<td>22</td>
<td>15</td>
<td>11</td>
</tr>
<tr>
<td>c</td>
<td>Fairly Good</td>
<td>2</td>
<td>10</td>
<td>6</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>d</td>
<td>Fair</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>e</td>
<td>Poor</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>f</td>
<td>Bad</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
6.2 Eastern Region - Chemical GQA

Chemical water quality recorded ‘Good’ in the Middle River where there are significant discharges from industry, sewage treatment works and landfill leachate seepage. The upper section of the River Glass recorded ‘Good’ classification where the catchment is subject to significant agricultural activity.

Overall the chemistry quality in the Eastern region is of ‘Very Good’ status which the IRIS system will have contributed to achieving these results. The Laxey River shows ‘Very Good’ status but the GQA scheme does not take into account heavy metal pollution which is likely in this area due to the past mining activities within the valley.

Figure 6. Chemical Classification - Eastern Region
6.3 Southern Region - Chemical GQA

In the Southern region overall the river water quality is of ‘Very Good’ quality in the majority of the sampled rivers. The high water quality is likely to have been influenced by the IRIS system which collects and treats the sewage in the Southern and Eastern regions. Poolivaish Stream recorded elevated BOD where there is significant agricultural influence in the catchment. At the Ballawoods site on the Santonburn the chemical water quality decreased to ‘Good’ classification where the catchment is subject to significant agricultural activity. At the top section of the Crogga River in the location of Mount Murray Golf Club there is a decrease of water quality to ‘Good’. Further downstream the watercourse water quality measured an improvement.

Figure 7. Chemical Classification - Southern Region
6.4 Northern Region - Chemical GQA

Chemistry quality in the Northern region shows ‘Very Good’ quality in the majority of the rivers with a slight decrease in quality in the area of Glen Auldyn near to Milntown and Lhergyhenny upstream of the Sulby Reservoir. The Glen Auldyn catchment has discharges from septic tanks and private sewage treatment works.

Figure 8. Chemical Classification - Northern Region
6.5 Western Region - Chemical GQA

For the Western region the Chemistry results again show the high quality water with all of the sampled areas being classified as ‘Very Good’ in the GQA classification. It is important to note that heavy metal pollution is not taken into account which is known in the area from the dis-used mines which leach into the surrounding environment and accumulate within the River Neb and Foxdale Stream.

Figure 9. Chemical Classification - Western Region
6.6 Comparison to previous years

Compared to previous years, overall the chemistry water quality has improved with fewer areas being classified as ‘Good’ or lower GQA status. The percentage of ‘Very Good’ classification has increased from 69% between 2000 and 2002 to 88% between 2015 and 2016.

In the Southern and Eastern regions the improvement in water quality is probably due to the IRIS system. In the Northern and Western regions there is less of a difference in water quality but in particular the Lhen Trench has improved in water quality from ‘Fairly Good/Good’ status to ‘Very Good’ which could be due to a reduction in agricultural inputs. The weather during monitoring, in particular rainfall, is also likely to affect the water quality results.

![Figure 10. Yearly Comparison of Chemical River Quality](image-url)
7.0 Nutrient General Quality Assessment - Nitrate

7.1 General Situation

Nitrate is derived from land run off containing artificial fertiliser and farm slurry spreading and it is also a constituent of fully treated sewage effluent. In the latest survey, 96% of rivers were in the best three classes ('Very Low', 'Low' and 'Moderately Low') which is slightly worse than the previous two studies at 99%. However there has been an increase in the percentage of the highest quality 'Very Low' classified sites from 47% to 54%.

Table 3. Nitrate quality of rivers 1995 to 2016

<table>
<thead>
<tr>
<th>Grade</th>
<th>Quality</th>
<th>1995 to 1998 River Length %</th>
<th>1998 to 2000 River Length %</th>
<th>2000 to 2002 River Length %</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Very low</td>
<td>41</td>
<td>42</td>
<td>49</td>
</tr>
<tr>
<td>b</td>
<td>Low</td>
<td>28</td>
<td>28</td>
<td>23</td>
</tr>
<tr>
<td>c</td>
<td>Moderately Low</td>
<td>29</td>
<td>28</td>
<td>27</td>
</tr>
<tr>
<td>d</td>
<td>Moderate</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>e</td>
<td>High</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>f</td>
<td>Very High</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grade</th>
<th>Quality</th>
<th>2003 to 2005 River Length %</th>
<th>2015 to 2016 River Length %</th>
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<td>a</td>
<td>Very low</td>
<td>47</td>
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<td>b</td>
<td>Low</td>
<td>28</td>
<td>35</td>
</tr>
<tr>
<td>c</td>
<td>Moderately Low</td>
<td>24</td>
<td>7</td>
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<tr>
<td>d</td>
<td>Moderate</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>e</td>
<td>High</td>
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</tr>
<tr>
<td>f</td>
<td>Very High</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>
7.2 Eastern Region - Nitrate

Concentrations of nitrate vary across the Eastern region ranging from very low to moderately low. There are increased concentrations of nitrate in the River Glass, River Dhoo, Baldrine and Groudle Stream which have significant discharges from private sewage treatment works in the more remote areas and agricultural land run off. Landfill leachate also discharges into the Middle River.

Figure 11. Nitrate Classification - Eastern Region
7.3 Southern Region - Nitrate

Levels are generally moderately low to very low in the Southern Region where there are significant discharges from agricultural run-off, industrial effluent and sewage effluent from private sewage treatment works. However the installation of the IRIS system has reduced the number of private sewage treatment works in the region and is likely to be a significant factor in reducing the concentration of nitrate in the majority of the water courses compared to previous years.

Figure 12. Nitrate Classification - Southern Region
7.4 Northern Region - Nitrate

The concentrations of nitrate are very low across the majority of the Northern region with elevated concentrations in the Lhen Trench and Cornaa River. The Lhen Trench and Cornaa River are surrounded by agricultural land so run-off into nearby watercourses may be a factor.

Figure 13. Nitrate Classification - Northern Region
7.5 Western Region - Nitrate

As found in the North, levels of nitrate are very low or low.

Figure 14. Nitrate Classification - Western Region
7.6 Comparison to previous years - Nitrate

Since 1998 there has been a reduction in the concentration of nitrates in the sampled watercourses across the island. Between 1995 and 1998 only 41% achieved ‘Very Low’ classification however between 2015 and 2016 54% achieved ‘Very Low’ classification.

Between 1995 and 1998 over 25% were classified as ‘Moderately Low/Moderate’ however between 2015 and 2016 only 11% achieved this.

Overall the concentration of nitrates in the sampled watercourse has decreased over the years and with more work with stakeholders in the problem areas the percentage of ‘Very Low’ classification should increase.

![Yearly Comparison of Nitrate Levels in Rivers](image)

Figure 15. Yearly Comparison of Nitrate Levels in Rivers
8.0 Nutrient General Quality Assessment - Phosphate

8.1 General Situation

Phosphate originates mainly from sewage effluent and artificial agricultural fertilisers. The concentration of phosphate has decreased with 89% of sites achieving ‘Very Low’ classification. All of the sites in 2015 and 2016 achieved ‘Moderate’ or above GQA classification – an improvement on previous results.

Table 4. Phosphate quality of rivers 1995 to 2016

<table>
<thead>
<tr>
<th>Grade</th>
<th>Quality</th>
<th>1995 to 1998 River Length %</th>
<th>1998 to 2000 River Length %</th>
<th>2000 to 2002 River Length %</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Very low</td>
<td>88</td>
<td>80</td>
<td>82</td>
</tr>
<tr>
<td>b</td>
<td>Low</td>
<td>1</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>c</td>
<td>Moderate</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>d</td>
<td>High</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>e</td>
<td>Very High</td>
<td>7</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>f</td>
<td>Excessively High</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grade</th>
<th>Quality</th>
<th>2003 to 2005 River Length %</th>
<th>2015 to 2016 River Length %</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Very low</td>
<td>86</td>
<td>89</td>
</tr>
<tr>
<td>b</td>
<td>Low</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>c</td>
<td>Moderate</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>d</td>
<td>High</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>e</td>
<td>Very High</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>f</td>
<td>Excessively High</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
8.2 Eastern Region - Phosphate

In the Eastern region the River Dhoo and the upper section of the River Glass show elevated phosphate levels indicating enrichment. Local discharges include from the MUA sewage treatment works in some of the expanding villages and from an increasing number of private sewage treatment works. Since this data was collected the MUA have upgraded the sewage treatment works at Ballagarey on the River Dhoo which should improve the phosphate concentration around Glen Vine and Greeba. The remaining rivers in the region have very low concentrations of phosphate.

Figure 16. Phosphate Classification - Eastern Region
8.3 Southern Region - Phosphate

The Southern region shows very low concentrations of phosphates across the regional which may be influenced by the reduction in private sewage treatment works due to the IRIS system. The connection of Southern region to the IRIS system has coincided with a very significant reduction in the amount of phosphates measured in these watercourses.

![Figure 17. Phosphate Classification - Southern Region](image-url)
8.4 Northern Region - Phosphate

The Northern Region has very low phosphate levels throughout, probably due to low numbers of private sewage treatment works discharging into the watercourses and the low density of population. There is slightly elevated phosphate levels in the Cornaa River where discharges include the fish farm at Ballaglass.

Figure 18. Phosphate Classification - Northern Region
8.5 Western Region - Phosphate

Very low concentrations of phosphates are seen across the Western region with the elevated watercourse being reported as part of the Eastern region. There are slightly higher phosphate levels at Glen Maye and Foxdale where discharges include treated sewage effluent and agricultural run-off.
8.6 Comparison to previous years - Phosphate

Overall the concentrations of phosphates have decreased across the island most likely due to the increase in regional sewage treatment works which are reducing the number of private sewage treatment works discharging their effluent into nearby watercourses. The effluent quality has improved which is reducing the loading in the watercourses, to maintain this effective maintenance of sewage treatment works and monitoring of water discharge quality is recommended.

As you can see from Figure 19 the reduction of phosphates in the sampled watercourses is evident with 89% of rivers being classified as ‘Very Low’ and only 2% at ‘Moderate. Additional monitoring around the River Dhoo and River Glass in the Eastern region is required to identify the source of the phosphates and reduce the concentrations.

Figure 20. Yearly Comparison of Phosphate Levels in Rivers
9.0 Conclusions

Overall, the river water quality across the Isle of Man has improved since 1995 and with further improvements of Regional Sewage Treatment System phase 2 should continue to improve. The Isle of Man Government objective of working towards achieving EU Bathing Water Directive 2006 standards should aid the continuing improvement across the island.

The number of sites which has achieved ‘Very Good’ GQA chemical classification has increased by 8% since the 2005 monitoring. Nitrate concentrations have reduced significantly in the last decade from 75% of sites achieving ‘Very Low’ classification to 89%. There has also been an improvement in the concentration of phosphates across the Isle of Man in the last decade increasing from 91% achieving ‘Very Low’ classification to 98%.

Further work is still required to maintain and improve all of the watercourses across the Isle of Man.

10.0 Further Work

Continual seasonal monitoring needs to be carried out to assess water quality in the Isle of Man’s rivers. Areas where there is a reduction in water quality need to be identified and investigated. Additional or relocation of monitoring locations may assist in determining potential sources of pollution resulting in poor water quality in the Lhen Trench.

The results of more complete biological monitoring in accordance with RIVPACS during 2018 will be required before determining with more confidence whether there is poor biological water quality in the River Dhoo, Middle River and River Neb as indicated in this report. This is because these assessments have largely been ranked based on the Biological Monitoring Working Party Score System.

Additional monitoring sites are recommended for the rivers which discharge into Port Erin Bay and Gansey Bay just NE of Port St Mary as these discharge into bathing waters.

Additional monitoring of Intestinal Enterococci and E.Coli should be considered to assist in assessing the potential effect of river discharges on bathing water quality, to assist in the Isle of Man Government’s drive towards compliance with the 2006 EU Bathing Water Directive.

Assessment of the implications of moving from the General Quality Standard (GQS) to new ‘Ecological and Chemical Status Assessment’ to determine river water quality as now utilised by the EU/UK should be considered by the Department.
11.0 Appendices

11.1 Appendix 1 – General Quality Assessment of Rivers Biology

The biological scheme is based on the macro-invertebrate communities of rivers. Macro-invertebrates are small animals that can be seen with the naked eye and include insects such as mayflies, caddis-flies, snails, shrimps, worms and many others. Macro-invertebrates are useful for biological assessment because they are found in all fresh waters, do not move far and respond to everything in the water, as well as to physical damage to their habitat. They can be affected by pollutants that occur infrequently or in very low concentrations and which may be missed by chemical sampling.

The variety of macro-invertebrates differs from site to site and from river to river even when there is no pollution or physical disturbance. This is because they are affected by the size, slope, altitude and geographical location of the watercourse, the nature of the streambed, the river flow and the geology of the catchment. Because of such differences, it is best to describe biological quality as the difference between the macro-invertebrate communities actually found in the river and that which would be expected under natural conditions.

We use a computer-based system called RIVPACS (River Invertebrate Prediction and Classification System) to predict the macro invertebrates that would be found if the river was unpolluted and undamaged.

The rivers and streams of the Isle of Man support a less diverse biological community than those in the UK which were used in setting up the RIVPACS database. Therefore a version of RIVPACS based on similar less diverse fauna from Northern Ireland was used for the treatment of local data. While this is still not perfect because of the more diverse fauna found in Northern Island than the Isle of Man, it is the best available technique currently available for assessing the Island’s biological water quality.

Because there are 4,000 species of aquatic macro-invertebrates in the British Isles, the analysis of the samples has to be simplified, so we do not identify individual species but only the major types (taxa), mostly at the family taxonomic level. A key piece of information is the number of different taxa. A fall in the number of taxa is a general index of ecological damage, including overall pollution (organic, toxic and physical pollution such as siltation, and damage to habitats or the river channel). For consistency, we only consider the taxa used in the BMWP (Biological Monitoring Working Party) system. In the BMWP System, a numerical value has been assigned to 80+ different taxa (known as the BMWP-scoring families) according to their sensitivity or tolerance to organic pollution. The average of the values for each taxon in a sample, known as ASPT (average score per taxon) is a stable and reliable index of organic pollution. Values lower than expected indicate organic pollution.
The most useful way of summarising the biological data was found to be one that combined the number of taxa and the ASPT. The best quality is indicated by a diverse variety of taxa, especially those that are sensitive to pollution. Poorer quality is indicated by a smaller than expected number of taxa, particularly those that are sensitive to pollution. Organic pollution sometimes encourages an increased abundance of the few taxa that can tolerate it. RIVPACS is used to predict the number of taxa and the ASPT that would be expected at each site if the site was unstressed by pollution. We combine the results from samples collected in spring and autumn to take account of seasonal variations. Both ASPT and number of taxa in the samples are divided by the equivalent values predicted by RIVPACS so that they are expressed as the proportion of their value when environmental quality is good. These proportional values are called Ecological Quality Indices (EQIs).

An EQI of about 1 indicates that the ASPT or number of taxa in the sample collected from the site was the same as that predicted for the site by RIVPACS. From this we infer that the site is not damaged ecologically and that it is not polluted. Lower values of EQI indicate that the environment is damaged or the river is polluted. Occasionally, we get EQIs greater than 1: these indicate that the site is of better ecological quality than the average for an unpolluted or undamaged site of that type. EQIs enable us to compare the biological quality at different sites and rivers on a common scale, unaffected by the natural differences in the macro-invertebrates that they can support.

**Classification**

The biological grades are based on the values of the EQIs set out in Table A. The grade assigned to a site is whichever one is the poorest, based on either EQI for ASPT or EQI for the number of taxa.

In setting up a system that applies to all types of rivers we started from the fact that it is easy to recognise the best and worst quality. The system represented by Table A started out as a consensus of industry biologists on the optimal, yet simple, way of giving the appropriate grade to rivers recognised as poor or bad. We then drew up a similar consensus for rivers of best quality. Between the extremes of very good and bad we chose intermediate grades that allow us to detect and report gradual changes so that we can act on deteriorations before they go too far. Although the biology of these intermediate grades will differ from site to site in terms of the actual taxa that are present, the grades will reflect the relative position of the sites on a common scale between the best and worst possible quality.

**Grade a – very good**

The biology is similar to (or better than) that expected for an average, unpolluted river of this size, type and location. There is a high diversity of families, usually with several species in each. It is rare to find a dominance of any one family.
Grade b – good
The biology shows minor differences from Grade 'a' and falls a little short of that expected for an unpolluted river of this size, type and location. There may be a small reduction in the number of families that are sensitive to pollution, and a moderate increase in the number of individuals in the families that tolerate pollution (like worms and midges). This may indicate the first signs of organic pollution.

Grade c – fairly good
The biology is worse than that expected for an unpolluted river of this size, type and location. Many of the sensitive families are absent or the number of individuals is reduced, and in many cases there is a marked rise in the numbers of individuals in the families that tolerate pollution.

Grade d – fair
The biology shows considerable differences from that expected for an unpolluted river of this size, type and location. Sensitive families are scarce and contain only small numbers of individuals. There may be a range of those families that tolerate pollution and some of these may have high numbers of individuals.

Grade e – poor
The biology is restricted to animals that tolerate pollution with some families dominant in terms of the numbers of individuals. Sensitive families will be rare or absent.

Grade f – bad
The biology is limited to a small number of very tolerant families, often only worms, midge larvae, leeches and the water hog-louse. These may be present in very high numbers but even these may be missing if the pollution is toxic. In the very worst case there may be no life present in the river.

Methods

A consistent discipline is adopted across the British Isles for sampling and analysis. This includes systems for auditing and controlling the quality of the data. Each biological site corresponds to a stretch of river also characterised by a chemical site. Although the biological and chemical sites are not always coincident, they are subject to the same water quality, and as far as possible not separated by tributaries, discharges, weirs or other potential influences on water quality. Two biological samples are collected, one in spring (March to May) and one in autumn (September to November). Strictly defined protocols are followed to ensure that the data are comparable throughout the British Isles, and compatible with RIVPACS. To take account of natural seasonal variations, the lists of families from samples collected in spring and autumn are pooled for the calculation of ASPT and the number of taxa at each site. The samples are collected by three-minutes of active sampling with a kick net. Every sample is supplemented with a one-minute visual search for individual animals living on the water surface or attached to rocks, logs or vegetation. All the samples are analysed in laboratories. The methods used to wash and sort
the samples have been standardised as far as possible. Environmental measurements collected for RIVPACS comprise the width and depth of the stream, the alkalinity of the water and the percentage cover on the riverbed of boulders, gravel, sand and silt. RIVPACS uses annual averages based on measurements taken in spring, summer and autumn.

Environmental measurements for RIVPACS are collected with every biological sample and once in the summer so that we can check that the measurements on which the predictions are based are still representative. RIVPACS also uses information from maps about the sampling site. This includes the grid reference, the slope of the river, its altitude and the distance of the site from the source of the river.

A scheme of quality control is established in the laboratory, to ensure that an average of no more than two taxa was missed in each sample. This involves re-inspecting 10% of all samples. There is also an independent audit in which samples are reanalysed by biologists from the RIVPACS Team at the Centre for Ecology and Hydrology in Dorset every year. When introduced, these were the first systematic schemes for measuring and controlling the analytical quality of ecological surveys of this type and size anywhere in the world. All the procedures are documented in full to provide additional quality assurance. A common and unavoidable source of error is that a biologist may fail to notice all the taxa collected. The animals are often difficult to spot amongst the vegetation, gravel, silt or detritus collected with the sample. This error is much more likely than that of recording a taxon that is not in the sample. This introduces a bias and means that our assessments of biology tend to be pessimistic estimates of the true quality of the river.

11.2 Appendix 2 – General Quality Assessment of Rivers Chemistry

The industry method for classifying the water quality of rivers and canals is known as the General Quality Assessment scheme (GQA). It is designed to provide an accurate and consistent assessment of the state of water quality and changes in this state over time. The scheme consists of separate windows on water quality. The Chemical GQA describes quality in terms of chemical measurements which detect the most common types of pollution. It allocates one of six grades (A to F). The process is set out below.

To each sampling site, we assign the stretch of river that the site will characterise. In the main, these sites, and the monitoring, are the same as those used to take decisions on developments that may affect water quality - discharges, abstractions and changes in land use.

We use only the results from the routine pre-planned sampling programmes. To avoid bias we ignore any extra data collected for special surveys or in response to incidents.
Sites are sampled 3 times a year. We use the data collected over three years and this produces 9 samples per site, the best that can be achieved with resources available.

The percentiles are calculated from the samples for biochemical oxygen demand, dissolved oxygen and ammonia and the results are compared with the standards in Table B1. A grade is assigned to each river length according to the worst determinant.

The grade is defined in Table B1 by standards for biochemical oxygen demand (BOD), ammonia and dissolved oxygen. These determinants are indicators of pollution that apply to all rivers, first because of the widespread risk of pollution from sewage or farms, and second because of the toxicity of ammonia and the requirement for dissolved oxygen for aquatic life, including fish. Table B2 describes the general characteristics of each grade.

<table>
<thead>
<tr>
<th>GQA Grade</th>
<th>Dissolved Oxygen (%) saturation</th>
<th>Biochemical Oxygen Demand (mg/l)</th>
<th>Ammonia (mgN/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10-percentile</td>
<td>90-percentile</td>
<td>90-percentile</td>
</tr>
<tr>
<td>A</td>
<td>80</td>
<td>2.5</td>
<td>0.25</td>
</tr>
<tr>
<td>B</td>
<td>70</td>
<td>4</td>
<td>0.6</td>
</tr>
<tr>
<td>C</td>
<td>60</td>
<td>6</td>
<td>1.3</td>
</tr>
<tr>
<td>D</td>
<td>50</td>
<td>8</td>
<td>2.5</td>
</tr>
<tr>
<td>E</td>
<td>20</td>
<td>15</td>
<td>9.0</td>
</tr>
<tr>
<td>F</td>
<td>&lt;20</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chemical Grade</th>
<th>Likely uses and characteristics *</th>
</tr>
</thead>
<tbody>
<tr>
<td>A – Very Good</td>
<td>All abstractions</td>
</tr>
<tr>
<td></td>
<td>Very good salmonid fisheries</td>
</tr>
<tr>
<td></td>
<td>Cyprinid fisheries</td>
</tr>
<tr>
<td></td>
<td>Natural ecosystems</td>
</tr>
<tr>
<td>B – Good</td>
<td>All abstractions</td>
</tr>
<tr>
<td></td>
<td>Salmonid fisheries</td>
</tr>
<tr>
<td></td>
<td>Cyprinid fisheries</td>
</tr>
<tr>
<td></td>
<td>Ecosystems at or close to natural</td>
</tr>
<tr>
<td>C – Fairly Good</td>
<td>Potable supply after advanced treatment</td>
</tr>
<tr>
<td></td>
<td>Other abstractions</td>
</tr>
<tr>
<td></td>
<td>Good cyprinid fisheries</td>
</tr>
<tr>
<td></td>
<td>Natural ecosystems, or those corresponding to good cyprinid fisheries</td>
</tr>
<tr>
<td>D – Fair</td>
<td>Potable supply after advanced treatment</td>
</tr>
<tr>
<td></td>
<td>Other abstractions</td>
</tr>
</tbody>
</table>
Fair cyprinid fisheries
Impacted ecosystems

| E – Poor | Low grade abstraction for industry
Fish absent or sporadically present, vulnerable to pollution **
Impoverished ecosystems ** |
| F – Bad | Very polluted rivers which may cause nuisance
Severely restricted ecosystems |

* Provided other standards are met
** Where the grade is caused by discharges of organic pollution

11.3 Appendix 3 – General Quality Assessment of Rivers Nutrients

Methods

The same samples collected for Chemical GQA classification described in Appendix 2 above are further analysed for the nutrients Nitrate and Phosphate. The statistic used is the mean over a three-year period.

Classification

A grade from 1 to 6 is allocated for both phosphate and nitrate. These are not combined into a single nutrients grade. In this respect it differs from the chemical classification, which combines factors into a single grade. This cannot be done for nutrients. There are no set ‘good’ or ‘bad’ concentrations for nutrients in rivers in the way that we describe chemical and biological quality. Rivers with different topography have naturally different concentrations of nutrients. ‘Very low’ nutrient concentrations, for example, are not necessarily good or bad; the classifications merely states that concentrations in this river are very low relative to other rivers

Phosphate grades

The table below gives the limit for each phosphate grade, i.e. averages less than 0.02 mgP/l are graded class 1. The description given uses common terms to distinguish between the classes.

<table>
<thead>
<tr>
<th>Classification for phosphate</th>
<th>Grade limit (mgP/l) Mean</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&lt; 0.02</td>
<td>Very low</td>
</tr>
<tr>
<td>2</td>
<td>&gt; 0.02 to 0.06</td>
<td>Low</td>
</tr>
<tr>
<td>3</td>
<td>&gt; 0.06 to 0.1</td>
<td>Moderate</td>
</tr>
<tr>
<td>4</td>
<td>&gt; 0.1 to 0.2</td>
<td>High</td>
</tr>
<tr>
<td>5</td>
<td>&gt; 0.2 to 1.0</td>
<td>Very High</td>
</tr>
<tr>
<td>6</td>
<td>&gt; 1.0</td>
<td>Excessively High</td>
</tr>
</tbody>
</table>
The descriptors used relate to the concentrations in the grades. ‘High’ descriptions are used for all the grades where the average is more than 0.1 mg/l. This is the concentration considered indicative of possible existing or future problems of ‘eutrophication’. (This is the term given to the enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, causing accelerated growth of algae and higher plant forms to produce an undesirable disturbance to the balance of organisms present in the water and the quality of the water concerned.) High concentrations of phosphate do not necessarily mean that the river is eutrophic. Other factors have to be taken into account such as the amount and type of algae present, flow rates, and dissolved oxygen concentrations.

**Nitrate grades**

The table below gives the limits for each grade. For example, grade 2 is assigned to averages between 5 and 10 mg NO3/l. The descriptors use common terms to distinguish between the grades.

<table>
<thead>
<tr>
<th>Classification for phosphate</th>
<th>Grade limit (mgP/l) Mean</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&lt; 5</td>
<td>Very low</td>
</tr>
<tr>
<td>2</td>
<td>&gt; 5 to 10</td>
<td>Low</td>
</tr>
<tr>
<td>3</td>
<td>&gt; 10 to 20</td>
<td>Moderately low</td>
</tr>
<tr>
<td>4</td>
<td>&gt; 20 to 30</td>
<td>Moderate</td>
</tr>
<tr>
<td>5</td>
<td>&gt; 30 to 40</td>
<td>High</td>
</tr>
<tr>
<td>6</td>
<td>&gt; 40</td>
<td>Very High</td>
</tr>
</tbody>
</table>

The descriptors relate to the nitrate concentrations in each class. ‘High’ concentrations refer to average concentrations above 30 mg/l. This limit very roughly corresponds with a 95 percentile limit of 50 mg/l which is used in the EC Drinking Water Directive and the EC Nitrate Directive. There is, however, no direct comparison because the methods used to calculate the 95 percentile for the purposes of these Directives are strictly laid down and cannot be estimated from average concentrations over three years.