4.3. Results of odour dispersion modelling for the proposed Cork Harbour Main Drainage Scheme WWTP and Pumping stations operation and design

Aermod Prime was used to determine the overall odour impact of the proposed Cork Harbour Main Drainage Scheme WWTP and Pumping stations operation at as set out in odour impact criteria *Table 2.1* and *2.2*. The output data was analysed to calculate:

Ref Scenario 1:

- Predicted odour emission contribution of overall proposed Cork Harbour Main Drainage Scheme WWTP operation to surrounding population (*see Table 4.1*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 1.50 Ou_E m^{-3} (*see Figure 8.1*).
- Predicted odour emission contribution of overall proposed Cork Harbour Main Drainage Scheme WWTP operation to surrounding population (*see Table 4.1*), to odour plume dispersal at the 99.5th percentile for an odour concentration of less than or equal to 3.0 Ou_E m^{-3} (*see Figure 8.2*).
- Predicted odour emissions contribution of individual grouped Odour control units 1 to 5 to surrounding population (*see Table 4.1*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 0.30 Ou_E/m^3 (*see Figure 8.3*).
- Predicted odour emissions contribution of individual grouped Aeration, Secondary settlement and Storm water tankage sources to surrounding population (*see Table 4.1*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 1.50 Ou_E/m^3 (*see Figure 8.4*).

These odour impact criterions were chosen for the WWTP in order to ascertain the level of proposed impact to the surrounding residential and industrial population in the vicinity of the proposed WWTP.

Ref Scenario 2: These contours are selected in order to allow for representation of the results obtained from the dispersion modelling. The limit value in terms of odour impact criterion is less than 1.50 Ou_E/m^3 at the 98th percentile and less than 3.0 Ou_E/m^3 at the 99.5th percentile of hourly averages. Since the overall predicted odour emission rate from the five major pumping stations is low (due to the small nature and characteristics of the odour source), these odour contours were selected for illustrative purposes only to demonstrate the absence of odour impact and in addition, the contours for the 99.5th percentile are not presented.

- Predicted odour emission contribution of overall proposed Raffeen Pumping Station operation to surrounding population (*see Table 4.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 0.10 Ou_E m^{-3} (*see Figure 8.5*).
- Predicted odour emission contribution of overall proposed West beach Pumping Station operation to surrounding population (*see Table 4.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 0.30 Ou_E m^{-3} (*see Figure 8.6*).
- Predicted odour emission contribution of overall proposed Monkstown Pumping Station operation to surrounding population (*see Table 4.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 0.20 Ou_E m^{-3} (*see Figure 8.7*).
- Predicted odour emission contribution of overall proposed Church Road Pumping Station operation to surrounding population (*see Table 4.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 0.14 Ou_E m^{-3} (*see Figure 8.8*).
- Predicted odour emission contribution of overall proposed Carrigaloe Pumping Station operation to surrounding population (*see Table 4.2*), to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 0.10 Ou_E m^{-3} (*see Figure 8.9*).

Since the predicted odour emission rate from the pumping stations is low following the implementation of odour management systems (e.g. good design in terms of odour management, tight fitting covers, etc.), odour isopleths suitable for reporting clarity were chosen (i.e. actual impact

criterion is less than or equal to 1.50 Ou_E/m^3 at the 98th percentile of hourly averages over 5 years of meteorological data). All odour impact criterions chosen were in accordance with best international practice (*see Section 3.3.4*). Taking this low impact into account, there is no requirement to perform risk analysis using the 99.5th percentile assessment criterion, as the predicted odour impact criterion will always be below this level.

These computations give the odour concentration at each Cartesian grid receptor location that is predicted to be exceeded for 0.50% (44 hours) and 2% (175 hours) of a standard meteorological year.

This will allow for the predictive analysis of any potential impact on the neighbouring sensitive locations while the WWTP and Pumping stations are in operation. It will also allow the operators of the WWTP and Pumping station site to assess the effectiveness of their suggested odour abatement/minimisation strategies. The intensity of the odour from two or more sources of the WWTP operation will depend on the strength of the initial odour threshold concentration from the sources and the distance downwind at which the prediction and/or measurement is being made. Where the odour emission plumes from a number of sources combine downwind, then the predicted odour concentrations may be higher than that resulting from an individual emission source. It is important to note that various odour sources have different odour characters. This is important when assessing those odour sources to minimise and/or abate. Although an odour source may have a high odour emission rate, the corresponding odour intensity (strength) may be low and therefore it is easily diluted. Those sources that express the same odour character as an odour impact should be investigated first for abatement/minimisation before other sources are examined as these sources are the driving force behind the character of the perceived odour.

5. Discussion of results

This section will discuss the results obtained during the desktop study.

5.1. Odour plume dispersal for proposed Cork Harbour Main Drainage Scheme WWTP specimen design with the incorporation of odour mitigation protocols

The plotted odour concentrations of ≤ 1.50 Ou_E m^{-3} for the 98th percentile and ≤ 3.0 Ou_E m^{-3} for the 99.5th percentile for the proposed Cork Harbour Main Drainage Scheme WWTP specimen design operation are illustrated in *Figure 8.1 and Figure 8.2*, respectively. As can be observed for the 98th percentile contour, it is predicted that odour plume spread is small with a radial spread of 80 metres from the boundary of the facility in a northerly direction. In accordance with odour impact criterion in *Section 3.6.4*, and in keeping with currently recommended odour impact criterion in this country, no long-term odour impacts will be generated by receptors in the vicinity of the future proposed WWTP.

In terms of the 99.5th percentile of hourly averages over five years of meteorological data, the overall odour plume spread is similar with a radial spread of 75 metres in a northerly and easterly direction. In accordance with odour impact criterion in *Section 3.6.4*, and in keeping with currently recommended odour impact criterion in this country, no short-term odour impacts will be generated by receptors in the vicinity of the future proposed WWTP.

Figures 8.4 and 8.5 illustrates the odour plume spread for individual grouped odour sources to include odour control units (OCU's) 1 to 5 and tankage odour sources Aeration, Secondary settlement and Storm water tankage. As can be observed, the main contributor of odour to the actual plume spread is the aeration, secondary settlement and storm water tankage. All other offensive odour sources will be covered, sealed and negatively ventilated and odourous air directed to two stages of odour control if biological treatment is chosen as first stage. The maximum predicted ground level concentration for odour control units 1 to 5 will be less than 0.41 Ou_E/m^3 at the 98 percentile of hourly averages over 5 years of meteorological data. This is a result of a guaranteed odour threshold concentration of less than 300 Ou_E/m^3 for OCU's 1, 2, 4, and 5 and less than 500 Ou_E/m^3 for OCU 3. The overall stack heights of each OCU is 12 m high from ground level with an efflux velocity greater than 15 m/s.

5.2. Odour plume dispersal for five Pumping stations with the incorporation of good design and odour management systems

The plotted odour concentrations of ≤ 0.10 Ou_E m^{-3} for the 98th of hourly averages for five years of meteorological data for the proposed Raffeen Pumping station is illustrated in *Figure 8.5.* The maximum ground level concentration of odour in the vicinity of the facility will be 0.19 Ou_E/m^3 for the 98th percentile following the implementation of standard design elements for odour management (e.g. tight fitting covers, etc.). In accordance with odour impact criterion presented in *Section 3.3.4,* no long-term odour impacts will be perceived in the vicinity of the Pumping station. This is up to 87% lower than the odour impact criterion presented in *Section 3.3.4.*

The plotted odour concentrations of ≤ 0.30 Ou_E m^{-3} for the 98th of hourly averages for five years of meteorological data for the proposed West beach Pumping station is illustrated in *Figure 8.6.* The maximum ground level concentration of odour in the vicinity of the facility will be 0.34 Ou_E/m^3 for the 98th percentile following the implementation of standard design elements for odour management (e.g. tight fitting covers, etc.). In accordance with odour impact criterion presented in *Section 3.3.4,* no long-term odour impacts will be perceived in the vicinity of the Pumping station. This is up to 77% lower than the odour impact criterion presented in *Section 3.3.4.*

The plotted odour concentrations of ≤ 0.20 Ou_E m^{-3} for the 98th of hourly averages for five years of meteorological data for the proposed Monkstown Pumping station is illustrated in *Figure 8.7.* The maximum ground level concentration of odour in the vicinity of the facility will be 0.23 Ou_E/m^3 for the 98th percentile following the implementation of standard design elements for odour management (e.g. tight fitting covers, etc.). In accordance with odour impact criterion presented in *Section 3.3.4,* no long-term odour impacts will be perceived in the vicinity of the Pumping station. This is up to 84% lower than the odour impact criterion presented in *Section 3.3.4.*

The plotted odour concentrations of ≤ 0.14 Ou_E m^{-3} for the 98th of hourly averages for five years of meteorological data for the existing Church Road Pumping station is illustrated in *Figure 8.8.* The maximum ground level concentration of odour in the vicinity of the facility will be 0.18 Ou_E/m^3 for the 98th percentile following the implementation of standard design elements for odour management (e.g. tight fitting covers, etc.). In accordance with odour impact criterion presented in *Section 3.3.4,* no long-term odour impacts will be perceived in the vicinity of the Pumping station. This is up to 88% lower than the odour impact criterion presented in *Section 3.3.4.*

The plotted odour concentrations of ≤ 0.10 Ou_E m^{-3} for the 98th of hourly averages for five years of meteorological data for the proposed Carrigaloe Pumping station is illustrated in *Figure 8.9.* The maximum ground level concentration of odour in the vicinity of the facility will be 0.15 Ou_E/m^3 for the 98th percentile following the implementation of standard design elements for odour management (e.g. tight fitting covers, etc.). In accordance with odour impact criterion presented in *Section 3.3.4,* no long-term odour impacts will be perceived in the vicinity of the Pumping station. This is up to 90% lower than the odour impact criterion presented in *Section 3.3.4.*

The implementation of good design and odour management systems (e.g. standard design for odour minimisation, tight fitting covers, etc.) within each pumping station (both minor and major) will minimise the uncontrolled release of fugitive odour emissions and prevent complaints from the public at large.

6. Conclusions

A worst-case odour emission scenario was modelled using the atmospheric dispersion model Aermod Prime with meteorology data representative of the study area. A worst-case odour emission data set was used to predict any potential odour impact in the vicinity of the proposed Cork Harbour Main Drainage Scheme WWTP and five Pumping stations. Odour impact potential was discussed for proposed operations with the implementation of management and mitigation protocols. It was concluded that:

Cork Harbour Main Drainage Scheme WWTP

- In accordance with odour impact criterion in *Table 2.2*, and in keeping with current recommended odour impact criterion in this country, no odour impact will be perceived by sensitive receptors in the vicinity of the proposed Cork Harbour Main Drainage Scheme WWTP following the installation of proposed odour management, minimisation and mitigation protocols assuming specimen design. As can be observed, the overall odour emission rate from the new proposed Cork Harbour Main Drainage Scheme WWTP will be no greater than 6,611 Ou_E/s based on the specimen design.
- All residents/industrial neighbours in the vicinity of the proposed Cork Harbour Main Drainage Scheme WWTP will perceive an odour concentration at or less than 1.50 Ou_E m^{-3} for the 98th percentile and less than 3.0 Ou_E/m^3 for the 99.5th percentile for five years of meteorological data (*see Figures 8.1 and 8.2*). Those odour sources considered most offensive (inlet works, primary treatment and holding tanks, centrate, filtrate, sludge, RAS/WAS pump sumps, flow splitting chambers and all sludge handling processes including tankage will be effectively contained and ventilated to an odour control system and therefore the overall risk of any resident/industrial neighbours detecting odour will be negligible since the major odour sources contributing to the remaining odour plume are considered low risk in term of odour. These sources include the aeration tankage, secondary settlement tankage and storm water tankage (*see Figures 8.3 and 8.4*).
- Those management and mitigation strategies discussed through this document should be considered and implemented in the design of the proposed Cork Harbour Main Drainage Scheme WWTP. Any deviations from the proposed mitigation strategies will require reassessment in order to ensure no odour impact in the vicinity of the proposed facility.

Pumping Stations

- In accordance with odour impact criterion in *Section 3.3.4*, and in keeping with current recommended odour impact criterion in this country, no odour impact will be perceived by sensitive receptors in the vicinity of the major Pumping stations Raffeen, West Beach, Monkstown, Church Road and Carrigaloe Pumping Stations following the implementation of good design in terms of odour management (e.g. tight fitting covers, etc.).
- All residents/industrial neighbours in the vicinity of the proposed pumping stations will perceive an odour concentration at or less than 1.50 Ou_E m^{-3} for the 98th percentile for five years of meteorological data (*see Figures 8.5 to 8.9*). All pumping station (both minor and major) will incorporate the use of an odour management system (e.g. good design in terms of odour minimisation, tight fitting covers etc.) to ensure no fugitive release of odours from each pumping station. In addition, each pumping station will be regularly visited so as to ensure efficient operation of the odour management system.
- It is acknowledged that many of the pumping stations are located in populous areas. For this reason the design of the collection system will include best practice and adequate odour management systems to prevent odour complaint and impact.
- The pumping stations will be covered/sealed to allow for containment of odours. The implementation of odour management systems within each pumping station (both minor and major) will minimise the uncontrolled release of fugitive odour emissions.

- Pumping stations will be subject to Part 8 Planning at detailed design. It will be the responsibility of the designer and contractor to review the PS location and the odour management systems proposed to prevent odour complaints and impact.

7. Recommendations

The following recommendations were developed during the study:

1. Odour management, minimisation and mitigation procedures as discussed within this document in general will be implemented at the proposed Cork Harbour Main Drainage Scheme wastewater treatment plant and each Pumping Station in order to prevent any odour impact in the surrounding vicinity.
2. The maximum allowable odour emission rate from the overall proposed WWTP should not be greater than 6,611Ou_E s^{-1} (*see Table 4.1*) inclusive of the odour emission contribution from the abatement systems installed on the primary treatment, pumping and sludge handling processes. The maximum overall odour emission rate from the odour control units shall be no greater than 2,314 Ou_E s^{-1} (exhaust stack concentration of less than 300 Ou_E/m^3 for OCU 1, 2, 4 and 5 and less than 500 Ou_E/m^3 for OCU 3, respectively). The hedonic tone of this odour should not be considered unpleasant (Scale greater than –2) as assessed in accordance with VDI 3882:1997, part 2; ('Determination of Hedonic) for all emission points. The specimen design suggests the use of three OCU's. As long as the total odour emission rate for the WWTP (i.e. 6,611Ou_E s^{-1}) is achieved along with the total minimum odour treatment volume (i.e. 6.20 m^3/s) and a total odour emission rate from the OCU's of less than or equal to 2,314 Ou_E s^{-1} is similar, then the number of OCU's utilised onsite is not important.
3. The odour management systems to be installed upon Raffeen, Carrigaloe, West Beach, Monkstown and Church road should be sufficient to prevent any uncontrolled fugitive odours escaping from the system. In addition any odour management system incorporated into the design and upgrade of the pumping station should be capable of achieving less than 1.50 Ou_E/m^3 at the 98th percentile and less than 3.0 Ou_E/m^3 at the 99.5th percentile of hourly averages.
4. Maintain good housekeeping practices (i.e. keep yard area clean, etc.), closed-door management strategy (i.e. to eliminate puff odour emissions from sludge dewatering building), maintain sludge storage within sealed airtight containers and to implement an odour management plan for the operators of the WWTP and all Pumping station. All odourous processes such as inlet works, primary treatment, and thickening will be carried out indoors/enclosed tankage.
5. Avoid accumulation of floating debris and persistent sediments in channels and holding tanks by design (i.e. flow splitters and secondary sedimentation tanks, etc.). Techniques to eliminate such circumstances shall be employed.
6. Enclose and seal all primary treatment, wet wells and sludge handling processes.
7. Operate the proposed WWTP within specifications to eliminate overloading and under loading, which may increase septic conditions within the processes.
8. Odour scrubbing technologies employing will be implemented within the proposed Cork Harbour Main Drainage Scheme WWTP. An odour management system will be implemented upon each pumping station (both minor and major). All other odour management, minimisation and mitigation strategies contained within this document where necessary will be implemented within the overall design.
9. When operational, it is recommended that the contractor should provide evidence through the use of dispersion modelling (Aermod Prime) and olfactometry measurement (in accordance with EN13725:2003), that the as built WWTP and Pumping stations are achieving the overall mass emission rate of odour and emission limit values for the installed odour management systems.

8. Appendix I-Odour dispersion modelling contour results for Cork Harbour Main Drainage Scheme

8.1 Predicted odour emission contribution of proposed overall Cork Harbour Main Drainage Scheme WWTP operation with odour abatement protocols implemented (ref Scenario 1) (see Table 4.1), to odour plume dispersal at the 98th percentile for an odour concentration of ≤ 1.50 Ou_E m^3 for five years of meteorological data.

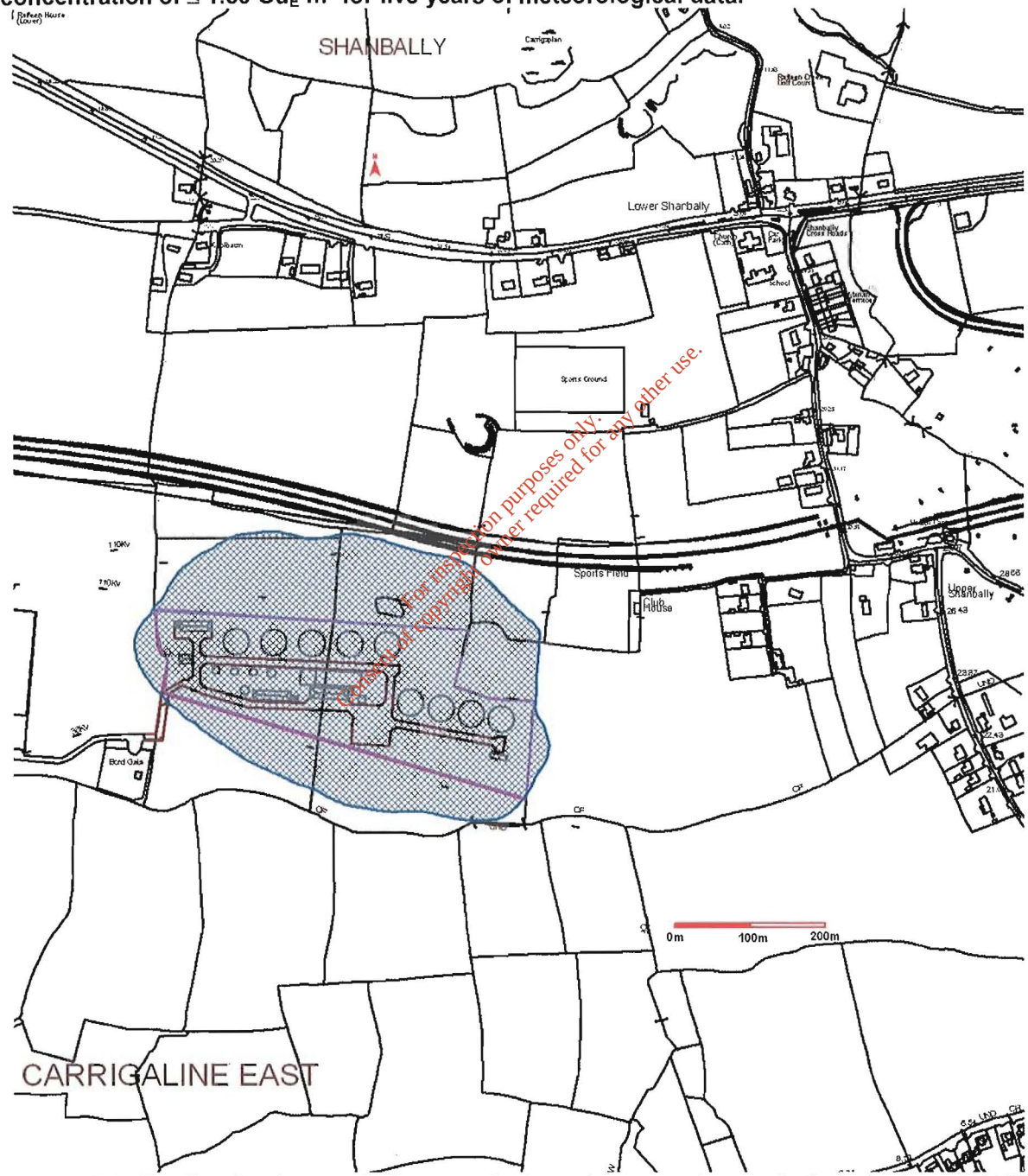

Figure 8.1. Predicted odour emission contribution of proposed overall Cork harbour WWTP operation with odour abatement protocols implemented to odour plume dispersal for Scenario 1 at the 98th percentile for odour concentrations ≤ 1.5 Ou_E m^{-3} (▬) for five years of meteorological data.

8.2 Predicted odour emission contribution of proposed overall Cork Harbour Main Drainage Scheme WWTP operation with odour abatement protocols implemented (ref Scenario 1) (see Table 4.1), to odour plume dispersal at the 99.5th percentile for an odour concentration of ≤ 3.0 Ou_E m^3 for 5 years of meteorological data.

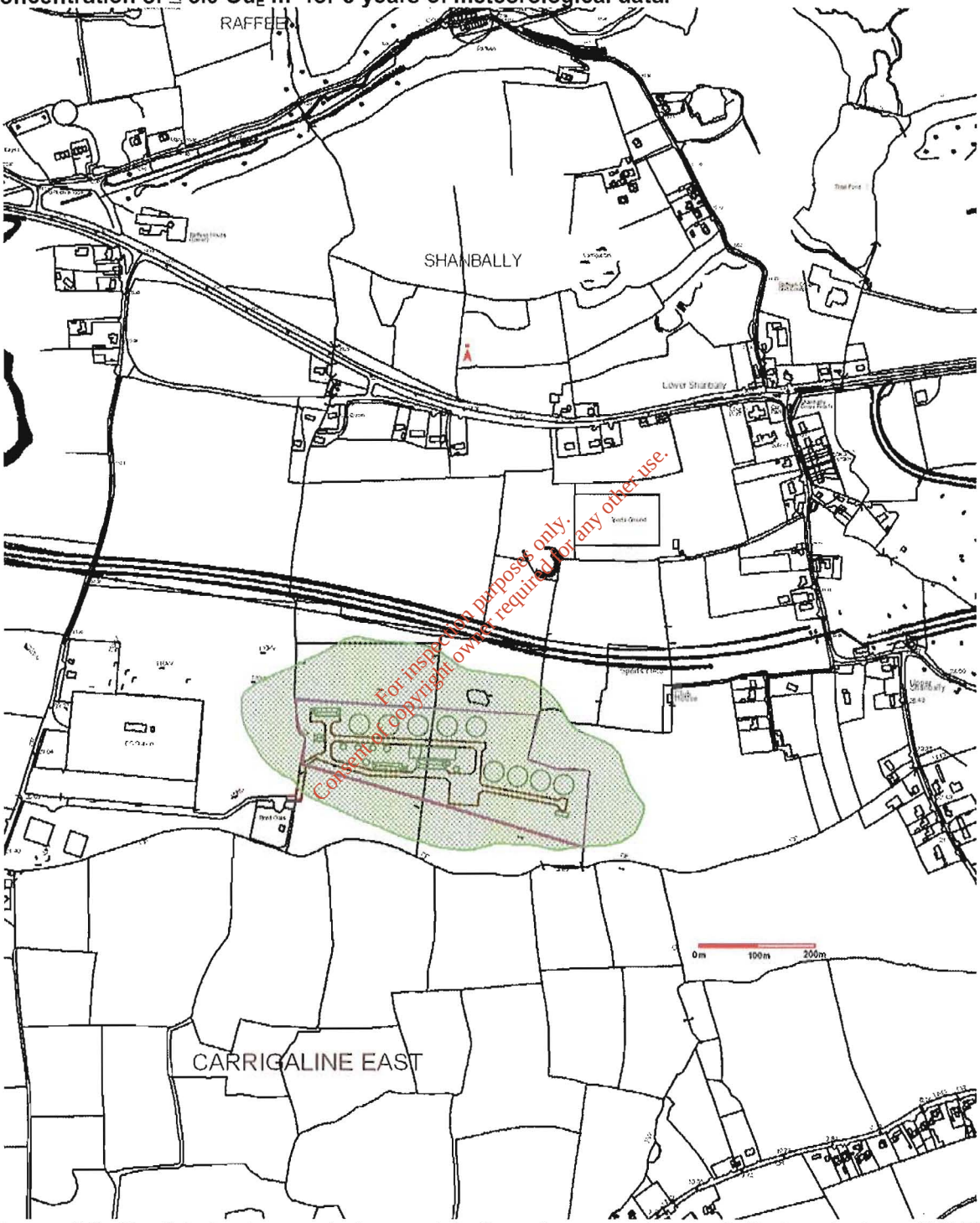

Figure 8.2. Predicted odour emission contribution of proposed overall Cork harbour WWTP operation with odour abatement protocols implemented to odour plume dispersal for Scenario 1 at the 99.5th percentile for odour concentrations ≤ 3.0 Ou_E m^{-3} (▬) for 5 years of meteorological data.

8.3 Predicted odour emission contribution of individual grouped odour control unit sources for proposed overall Cork Harbour Main Drainage Scheme WWTP operation (ref Scenario 1) (see Table *4.1*), to odour plume dispersal at the 98th percentile for an odour concentration of ≤ 0.30 Ou_E m^3 for five years of meteorological data.

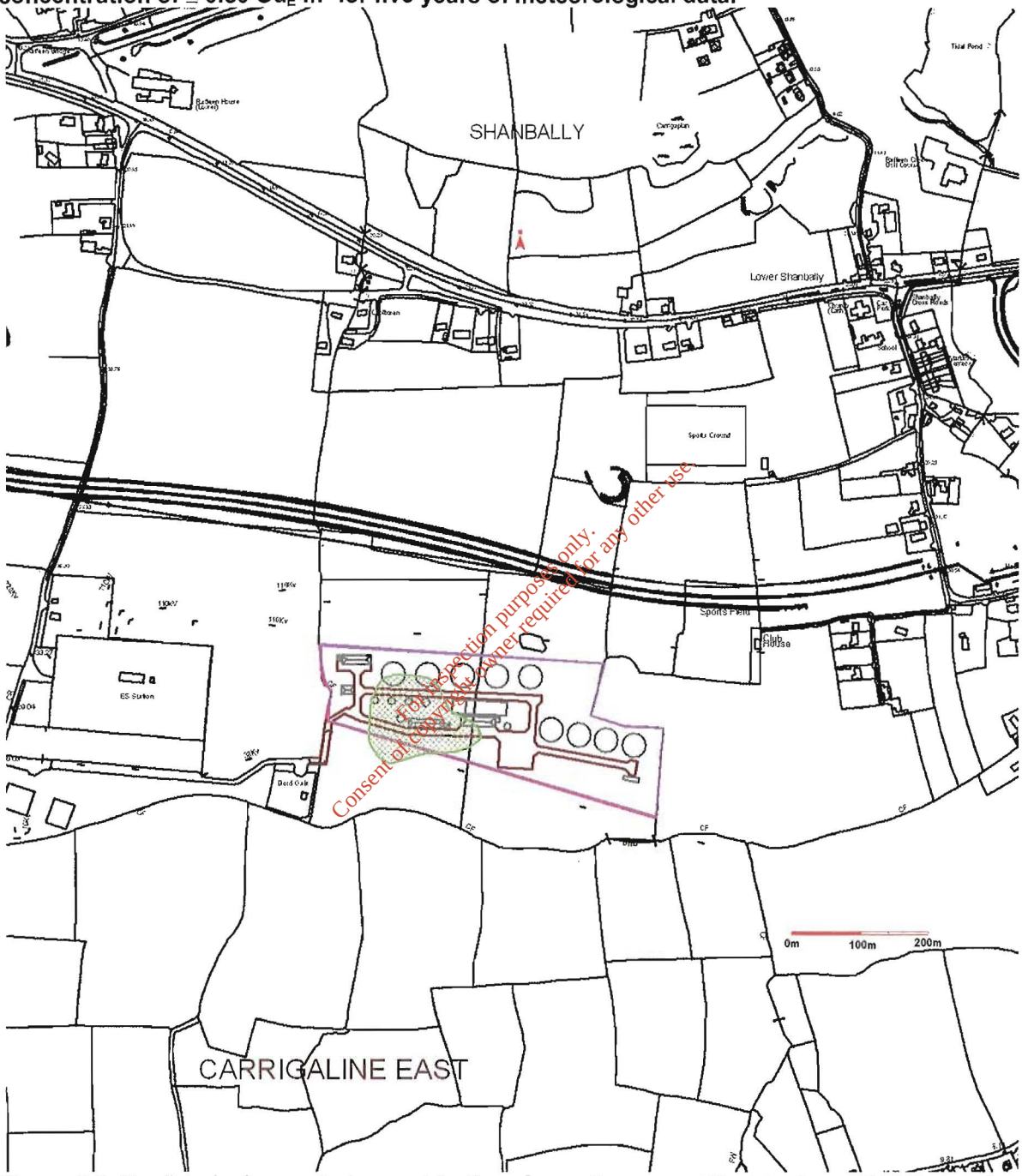

Figure 8.3. Predicted odour emission contribution of overall proposed Cork harbour WWTP to odour plume dispersal for grouped sources Odour control units 1, 2, 3, 4 and 5 for an odour concentration of less than or equal to 0.30 Ou_E m^{-3} (——)at the 98th percentile of hourly averages for 5 years of meteorological data.

8.4 Predicted odour emission contribution of individual grouped aeration tankage, secondary settlement tankage and storm water tankage sources for proposed overall Cork Harbour Main Drainage Scheme WWTP operation (ref Scenario 1) (see Table *4.1*), to odour plume dispersal at the 98th percentile for an odour concentration of ≤ 1.50 Ou_E m^3 for five years of meteorological data.

Figure 8.4. Predicted odour emission contribution of overall proposed WWTP to odour plume dispersal for grouped odour sources aeration tankage, Secondary settlement tankage and Storm water tankage for an odour concentration of less than or equal to 1.50 Ou_E m^{-3} ( )at the 98th percentile of hourly averages for 5 years of meteorological data.

8.5 Predicted odour emission contribution of proposed Raffeen Pumping station operation with odour abatement protocols implemented (ref Scenario 2) (see Table 4.2), to odour plume dispersal at the 98th percentile for an odour concentration of ≤ 0.10 Ou_E m^3 for five years of meteorological data.

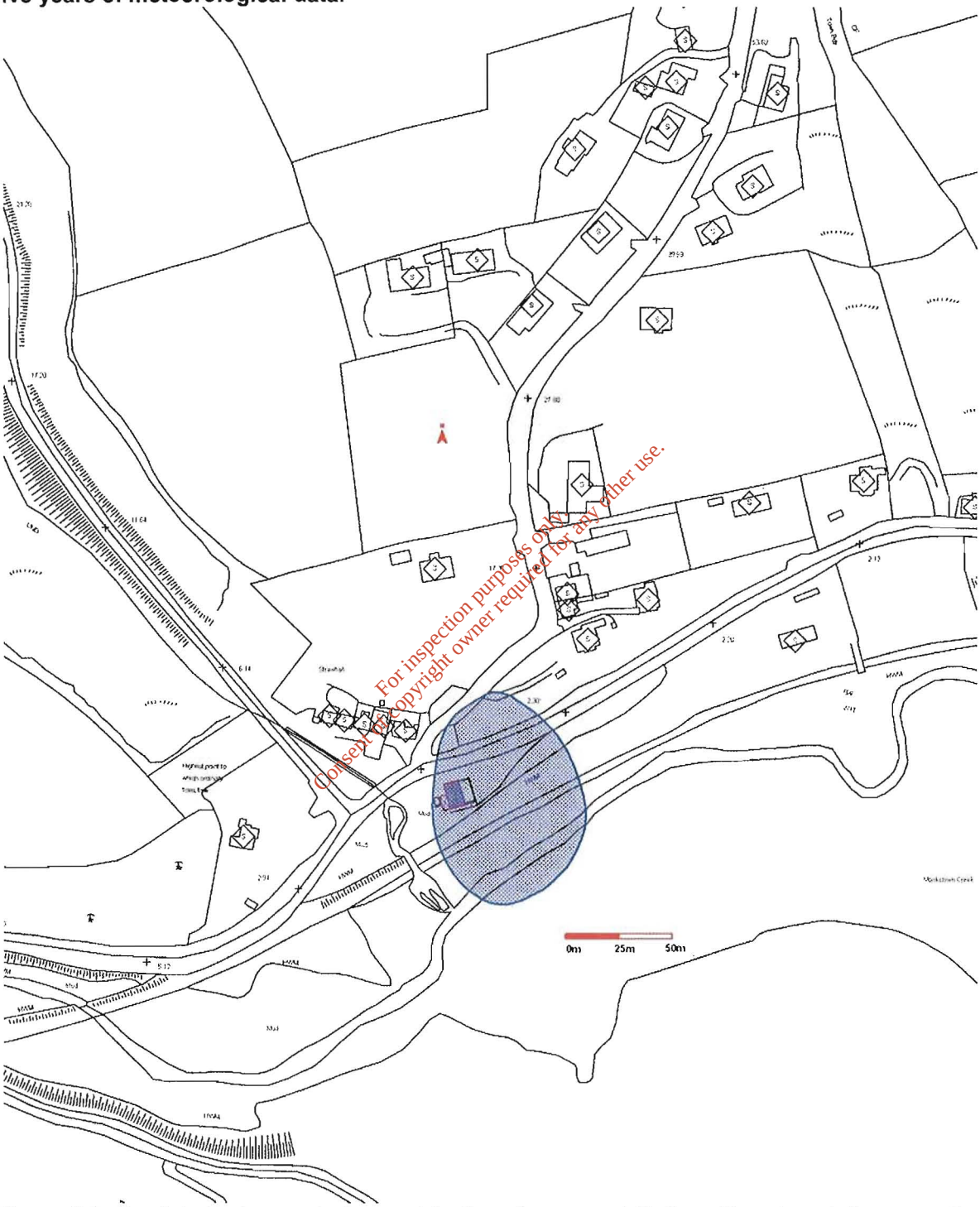

Figure 8.5. Predicted odour emission contribution of proposed Raffeen Pumping station operation with odour management protocols implemented to odour plume dispersal for Scenario 2 at the 98th percentile for odour concentrations ≤ 0.10 Ou_E m^{-3} (▬) for five years of meteorological data.

8.6 Predicted odour emission contribution of proposed West beach Pumping station operation with odour abatement protocols implemented (ref Scenario 2) (see Table 4.2), to odour plume dispersal at the 98th percentile for an odour concentration of ≤ 0.30 Ou_E m^3 for five years of meteorological data.

Figure 8.6. Predicted odour emission contribution of proposed West beach Pumping station operation with odour management protocols implemented to odour plume dispersal for Scenario 2 at the 98th percentile for odour concentrations ≤ 0.30 Ou_E m^{-3} (▬) for five years of meteorological data.

8.7 Predicted odour emission contribution of proposed Monkstown Pumping station operation with odour abatement protocols implemented (ref Scenario 2) (see Table 4.2), to odour plume dispersal at the 98th percentile for an odour concentration of ≤ 0.20 Ou_E m^3 for five years of meteorological data.

Figure 8.7. Predicted odour emission contribution of proposed Monkstown Pumping station operation with odour management protocols implemented to odour plume dispersal for Scenario 2 at the 98th percentile for odour concentrations ≤ 0.20 Ou_E m^{-3} (▬) for five years of meteorological data.

8.8 Predicted odour emission contribution of proposed Church Road Pumping station operation with odour abatement protocols implemented (ref Scenario 2) (see Table 4.2), to odour plume dispersal at the 98th percentile for an odour concentration of ≤ 0.14 Ou_E m^3 for five years of meteorological data.

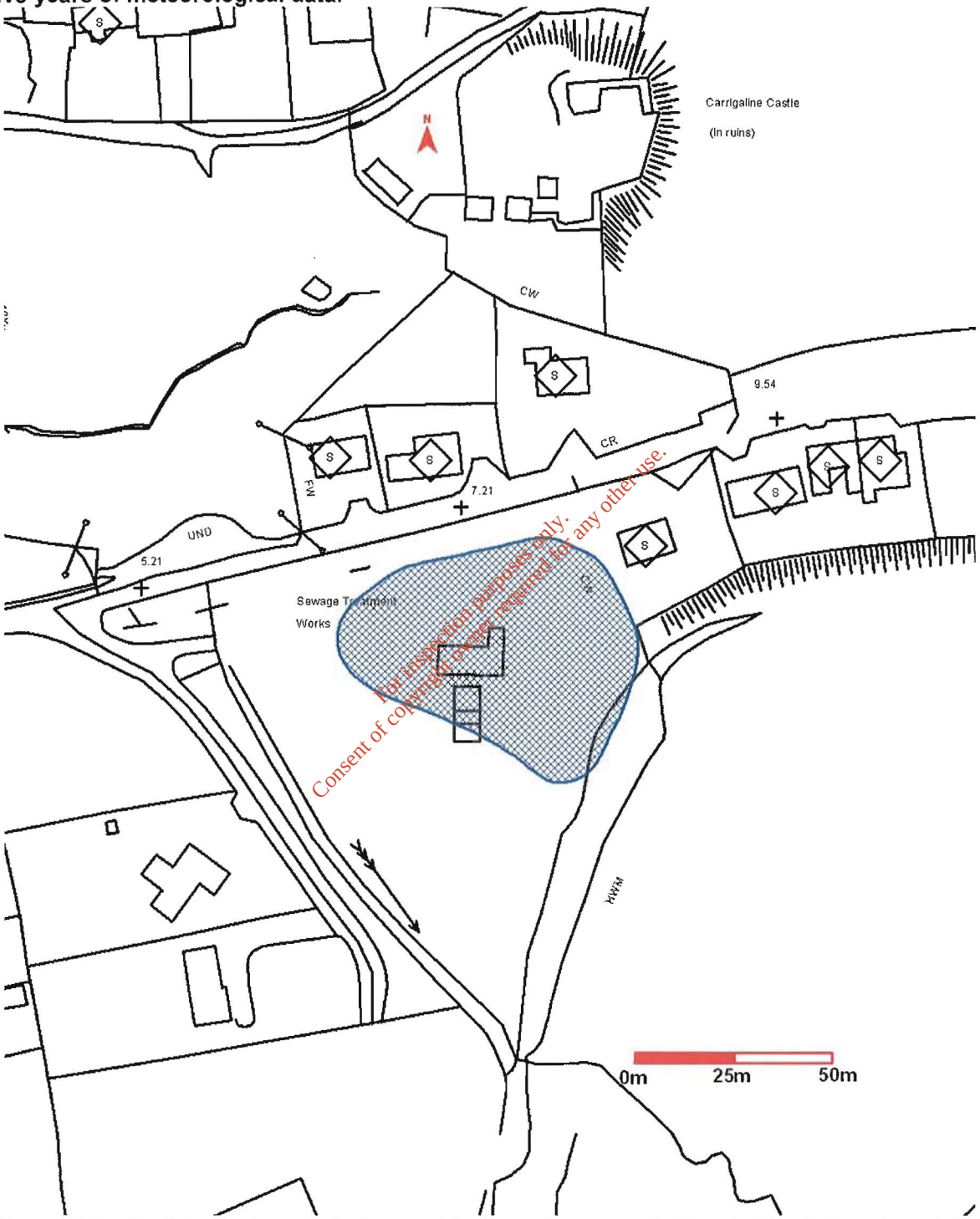

Figure 8.8. Predicted odour emission contribution of proposed Church Road Pumping station operation with odour management protocols implemented to odour plume dispersal for Scenario 2 at the 98th percentile for odour concentrations ≤ 0.14 Ou_E m^{-3} (▬) for five years of meteorological data.

8.9 Predicted odour emission contribution of proposed Carraigaloe Pumping station operation with odour abatement protocols implemented (ref Scenario 2) (see Table 4.2), to odour plume dispersal at the 98th percentile for an odour concentration of ≤ 0.10 Ou_E m^3 for five years of meteorological data.

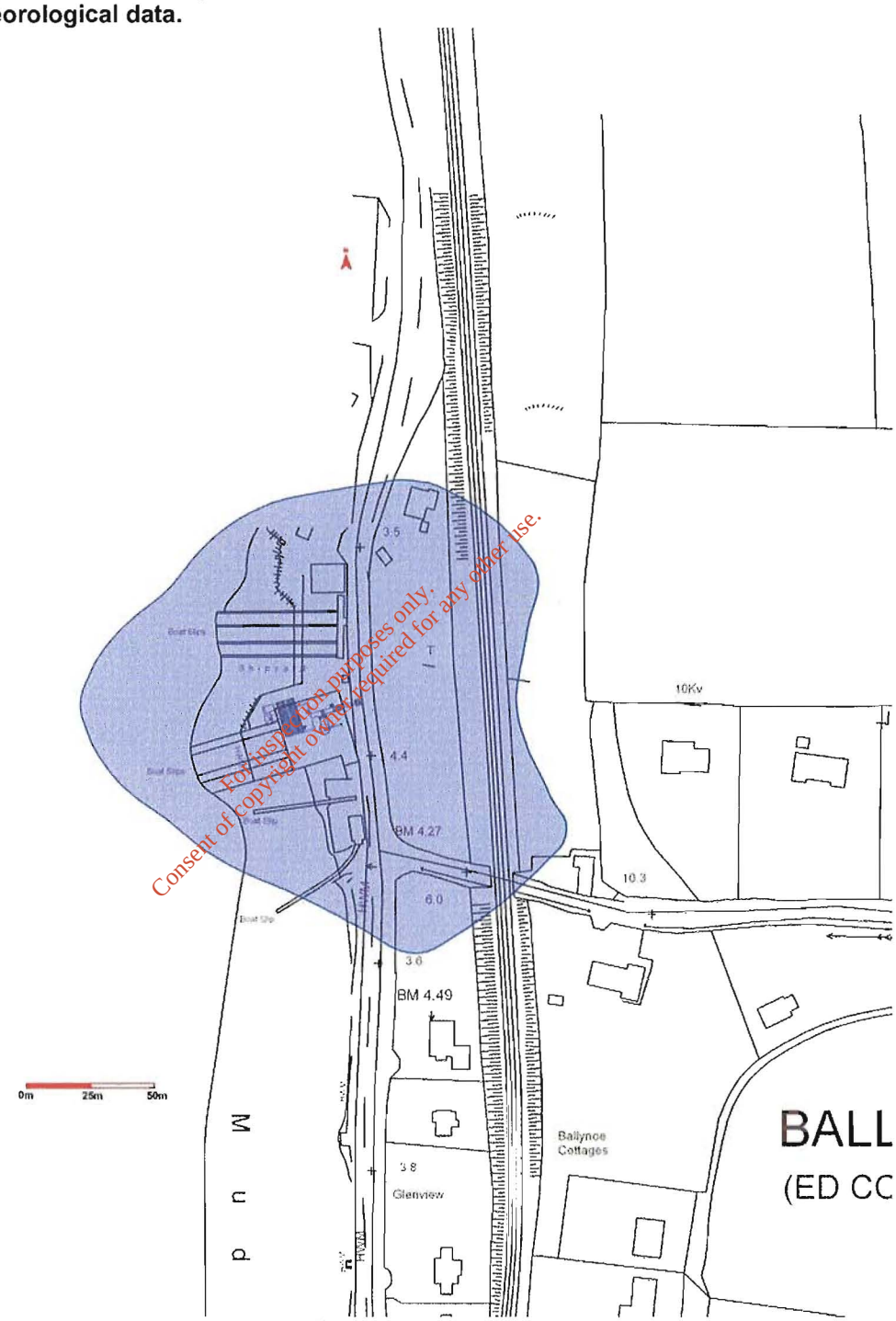

Figure 8.9. Predicted odour emission contribution of proposed Carraigaloe Pumping station operation with odour management protocols implemented to odour plume dispersal for Scenario 2 at the 98th percentile for odour concentrations ≤ 0.10 Ou_E m^{-3} (▬) for five years of meteorological data.