Developing a certification program for installers for Onsite Sewage Systems for Tippecanoe County Health Department & investigation of installers practices of installing Domestic Wastewater Treatment Systems in Ireland

By

Damian O'Sullivan

Submitted in Partial Fulfilment of B.Sc. (Hons) Environmental Health

School of Food Science and Environmental Health,

Technological University Dublin,

Cathal Brugha Street,

Dublin 1

March 2020

Abstract

Wastewater requires treatment of harmful bacteria before being released into the environment to prevent contamination of groundwater and risk to human health. Where wastewater treatments are not connected to a public treatment system an individual treatment system is required by households. Domestic Wastewater Treatment Systems (DWWTSs) provide single households with treatment of household's wastewater. This wastewater once treated is percolated into the soil for further treatment. Unfortunately, failure of a DWWTS occurs due to several reasons. Failure of DWWTSs can lead to contamination of the environment and may pose a risk to human health (EPA,2020).

Tippecanoe County Health Department (TCHD) situated in Tippecanoe County in the State of Indiana proposed regulation for certification of installers in the Tippecanoe Health Department Annual Report (2017). The governance of a certification program for certified installers is practiced in neighbouring counties of Tippecanoe in Indiana State. Developing a certification program was carried out during private professional placement in Tippecanoe County Health Department. A certification program was designed through this research along with requirements for obtaining certification. It was concluded that the certification program was ready for implementation in the TCHD and for installers of DWWTS to sit the certification program to become certified.

Along with developing a certification program for Tippecanoe County Health Department further investigation was carried out of how installers in Ireland carry out practices based on the EPA Code of Practice for Wastewater Treatment Systems for Single houses. A short survey was carried out to see how installers are operating in line with the EPA Code of practice. The survey showed that most installers in Ireland are knowledgeable with the EPA Codes of Practice and will contact a competent authority if unsure of any site assessment results on a proposed site. The survey also showed that installers were in favour of a certification program in Ireland based on the EPA Code of Practice (2009), similar with the certification program that was developed for TCHD.

TABLE OF CONTENTS

CHAPTER 2

List of Tables

List of Figures

Acknowledgements

- I would like to thank my supervisor Sara Boyd for her guidance and patience in helping me complete this project.

- To Craig, Ron and Nick in Tippecanoe County Health Department for their guidance and advice in helping me with completing this project.

- I would like to thank Elaine, Olivia, Eleanor and Angela for the continued support throughout this project and the last 4 years and a special thank you to Elaine for proofreading this project.

- A special thank you to my family especially Mom and Dad. The support over the last 4 years has been amazing and nothing was ever too much.

- To my friends and classmates that I have shared this college experience with, it was a pleasure to share this experience with you and I have made friends for life.

- Finally, again a special thank you to Sara Boyd and Aoife Donnelly. 4 years ago, I was interviewed to gain a place in the Environmental Health course as a mature student. Thank you for giving me the chance to do this course. It has changed my life and exceeded my expectations and I am very grateful for this opportunity.

Author’s Declaration

I hereby certify that this material, which I now submit in part fulfilment of the requirement for the award of B.Sc. (Environmental Health) is entirely my own work and has not been taken from the work of others save and to the extent such work has been cited and acknowledged within the text of my own work.

Signed Damian O'Sullivan

Candidate

Date 18/03/2020

Chapter 1 – Literature Review

This Literature Review will examine different types of DWWTSs and how studies have developed newer techniques in benefitting performance of systems. The literature will look at how Ireland and Indiana differ in policies of installation of DWWTSs. In addition to this, it will look at how the environment has been affected by poor wastewater disposal and other areas of environmental health.

1.1 The effects of DWWTSs on the Environment

Water is vital for all types of organisms to survive and exist. Fresh water levels are decreasing as environments are constantly under pressure to deal with the wastewater discharge (WHO, 2019). Domestic wastewater includes sewage from toilets, sinks and household appliances for example, washing machines. Domestic wastewater can contain harmful pathogenic bacteria including other contaminants for example, nitrogen and ammonia (Richards, 2016).

Wastewater from commercial Industries and domestic homes must be treated for the protection of the environment (USEPA, 2018). Where public wastewater systems are not available, domestic homes and other properties must depend on a DWWTS to treat the wastewater being emitted. It is usually common in rural areas that DWWTSs are needed as being connected to the public wastewater system is not feasible (Missouri DHSS, n.d.).

Poor wastewater treatment systems can lead to environments becoming contaminated and unable to treat the wastewater resulting in threats to public health such as communicable diseases like *E. coli* 0157:H7 from faecal sludge and antimicrobial resistance being the World Health Organisations (2019) biggest public health challenge at present (CDC, 2018). It is reported by the EPA (2020) that one litre of domestic wastewater contains approximately one million *E. coli* bacteria.

Failing DWWTSs have been in connection with food poisoning outbreaks. In 1997, Australia experienced a food poisoning outbreak of Hepatitis A from consumption of oysters. The outbreak was linked to a failing septic system. The septic system from Dunalley hotel leaked effluent into the nearby bay where the oysters were being farmed. As a result of this system failure, 444 food poisoning cases were confirmed (Environment and Health International Magazine, 2015).

Poorly installed and maintained DWWTSs can be a risk to human health especially if a DWWTS is near a private well which can result in a higher risk of contamination to private well drinking water. Another factor of contamination to groundwater is insufficient treatment due to not enough subsoil. This can result in contamination of groundwater particularly if a private well is nearby sourcing from the same groundwater (EPA, 2018). The EPA (2018) in 2013 reported under the National Inspection Plan, half of inspections of DWWTSs where sited near an operating private well and failed the inspection.

DWWTSs when installed correctly can successfully treat wastewater and percolate into the soil ensuring that public health is protected (Missouri DHSS, n.d.). DWWTSs are considered point sources of pollution especially when the wastewater effluent can escape from being treated in the soil. DWWTSs effluent is known for increase of nutrient loading which can contribute to the water quality of rivers and streams according to Richard *et al*. (2016). The EPA (2018) outlined that 11% of 'At Risk' water bodies are being impacted by contributing pressure factors. The EPA (2018) further reported that 1% of these pressure factors are DWWTSs placing water bodies at risk.

1.2 Legislation in Ireland

In Ireland, The Water Services Act 2007 is the main legislation that regulates how wastewater is discharged. It is adapted to comply with the European Union (EU) Waste Framework Directive (WFD) (75/442/EEC).

The EU WFD state that member states must provide measures on how to deal with waste while protecting the environment and human health. Member states must ensure proper disposal and treatment of waste. This also includes wastewater. The Water Services Act 2007 does not cover the adequate measures to be taken about the treatment of domestic wastewater, i.e. DWWTSs (eISB, n.d.).

In 2009 however, the EU Court of Justice brought Ireland to court whereby it found that Ireland was in breach of the EU WFD. Under Article 4 and Article 8 of the EU WFD, Ireland did not have regulation of DWWTSs under the Water Services Act 2007. Therefore, Ireland was found guilty of this breach. As a result, the Irish government had to enact new legislation to ensure that DWWTSs was covered in the Water Services Act 2007 (European Commission, 2011).

The Water Services (Amendment) Act 2012 was implemented to regulate DWWTSs under Part 4 (a). Part 4 (a) ensures that all DWWTSs must be registered to the competent authority and a register maintained. Furthermore, inspections of DWWTSs by the competent authority are to be carried out under a National Inspection Plan (eISB, n.d.).

A National Inspection Plan was implemented to inspect DWWTSs where they are a risk to human health and the environment. A risk based approached is used to determine the inspection of DWWTSs under the national inspection plan. Local Authorities carry out the inspections in each county (EPA, 2020).

Although the Water Services Act 2007 and 2012 regulates DWWTSs, unlike Indiana State law, it does not require the certification of DWWTS installers. The Code of Practice: Wastewater Treatment Systems for Single Houses by the EPA (2010), outlines installation of a DWWTS in Ireland is that the person shall be competent.

1.3 Indiana Legislation & Tippecanoe County

Figure 1.1 – Map of the United States of America with the State of Indiana highlighted

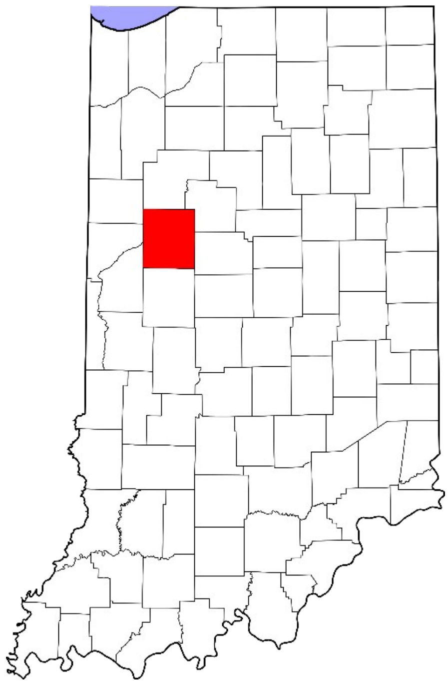

Figure 1.2 – Map of the State of Indiana with Tippecanoe County highlighted in Red

Indiana State in the United States of America has 92 counties. Each county has its own Ordinance (legislation) when dealing with DWWTSs. The Health Department's in each Indiana County are the competent authority for inspection and issue permits for installers to install wastewater treatment systems. Tippecanoe County in Indiana is the seventh largest populated county with a population of 193,048 (Indiana Demographics, 2019).

The Tippecanoe County Health Department consists of two Environmental Health Officers (EHOs) overseeing the Environmental Division. The Environmental Division is responsible for the issuing of permits for anyone who wants to install, replace or repair a DWWTS. Once an application is submitted along with a fee, the EHO will visit the site and inspect the specification of the proposed DWWTS. The EHO will then issue a permit to the installer which will allow them to proceed to carry out installation.

According to the 2017 Tippecanoe County Health Department Report there were a total of 191 permits issued and 224 DWWTSs inspected by EHO's. Most of these permits were in relation to new DWWTS repairs or replacements of systems. In 2017, 10% of complaints were related to sewage according to the 2017 Tippecanoe Health Department annual report (Tippecanoe County Health Department, 2018).

In Tippecanoe County there is no requirement for the certification of installers who install DWWTSs. It was suggested in the Tippecanoe County Health Department Annual Report 2015 and 2016 that research and implementation of an installer's certification program would be proposed. From this research it is hoped that a certification program can be established, reviewed, and in the near future implemented to ensure that all installers of DWWTSs are certified, and other accredited certifications will be recognised through the Tippecanoe County Health Department (Tippecanoe County Health Department, 2017).

An installer under the Allen County Health Department Ordinance is someone who carries out work whether it be installation, repair, replacement or modification on a DWWTS must be certified.

Other County Ordinance's for example, Allen County, Indiana and Howard County, Indiana, have implemented the requirement of a certified installer of an Onsite Sewage System or DWWTS. These Counties have outlined that installers have to pass an exam on correctly installing a DWWTS. When certified it is a requirement that certified installers must re-certify in a certain time frame, for example every two to three years (Allen County Department of Health, 2019).

Likewise, in Howard County, Indiana, a certified installer is necessary to carry out work on a DWWTS. However different requirements need to be met like Allen County. This shows that although a certified installer is mandatory, each County has different standards in regulating a certified installer (Howard County Department of Health, 2006).

1.4 DWWTS in Ireland

In Ireland there are approximately half a million wastewater treatment systems, 90% are a septic tank system while the other 10% make up more modern systems which can treat domestic effluent more effectively (EPA, 2019).

Approximately one-third of Irish homes use a DWWTS, especially in rural areas in Ireland. With a high number of rural areas reliant on DWWTS to treat their wastewater, most of these areas also rely on groundwater sources with the use of a private well for drinking water. According to O'Dwyer *et al.* (2018), approximately 750,000 people source their drinking water from groundwater sources. As a result, rural Ireland particularly has the highest reported occurrences of Verotoxigenic Escherichia coli (VTEC) in the European Union (Devitt *et al*. 2016).

Inspectors for Local Authorities inspect over 1,000 systems each year with 2,371 DWWTS inspected in 2017-2018. Out of these inspections, 1,135 DWWTS did not meet the standard requirements due to failure in construction. Poor maintenance was the most reason for DWWTS in 2017-2018 being over 25%. Figure 1.3 gives a representation of the reasons for failure which included sewage leaks, ponding of sewage on the ground and contributed to pollution discharge of sewage into streams and rainwater systems. It is estimated by the EPA (2019), that 852 systems have still to be rectified by householders since 2013.

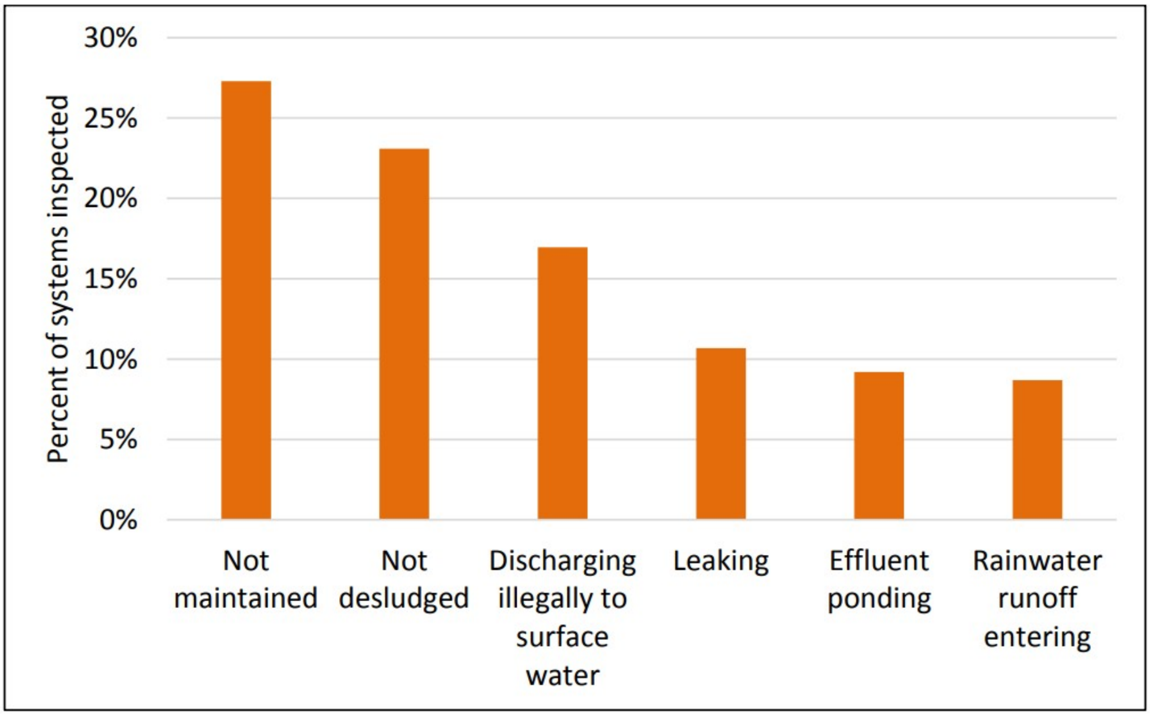

Figure 1.3 - Reasons for failed DWWTS 2017-2018, EPA (2019)

1.5 Types of Domestic Wastewater Treatment Systems

There are many types of DWWTS which can best suit the environment that it needs to function in. A Septic Tank is the common type of tank used to deal with wastewater from domestic homes. The treatment takes place away from a household. A septic tank is buried in the ground and is the first stage of treatment of wastewater. The basic function in the septic tank is that it comprises of mainly two chambers although other makes and models may vary.

Figure 1.4 shows a design of a typical septic tank. The wastewater enters the first chamber and begins to separate. The wastewater separates by sludge settling to the bottom of the tank, and the effluent on top with a layer of dirt or scum which can contain grease rises to the top. The effluent from the first chamber enters the second chamber and more settling occurs like the first chamber and eventually the effluent leaves the septic tank.

The wastewater then goes into a distribution box which disperses the wastewater drains out through a piped percolation system into gravel which has been layered underneath the piped percolation system. The effluent percolates through the stone and eventually the soil underneath where microorganisms treat the effluent contamination before it reaches the groundwater and the environment (USEPA, 2018).

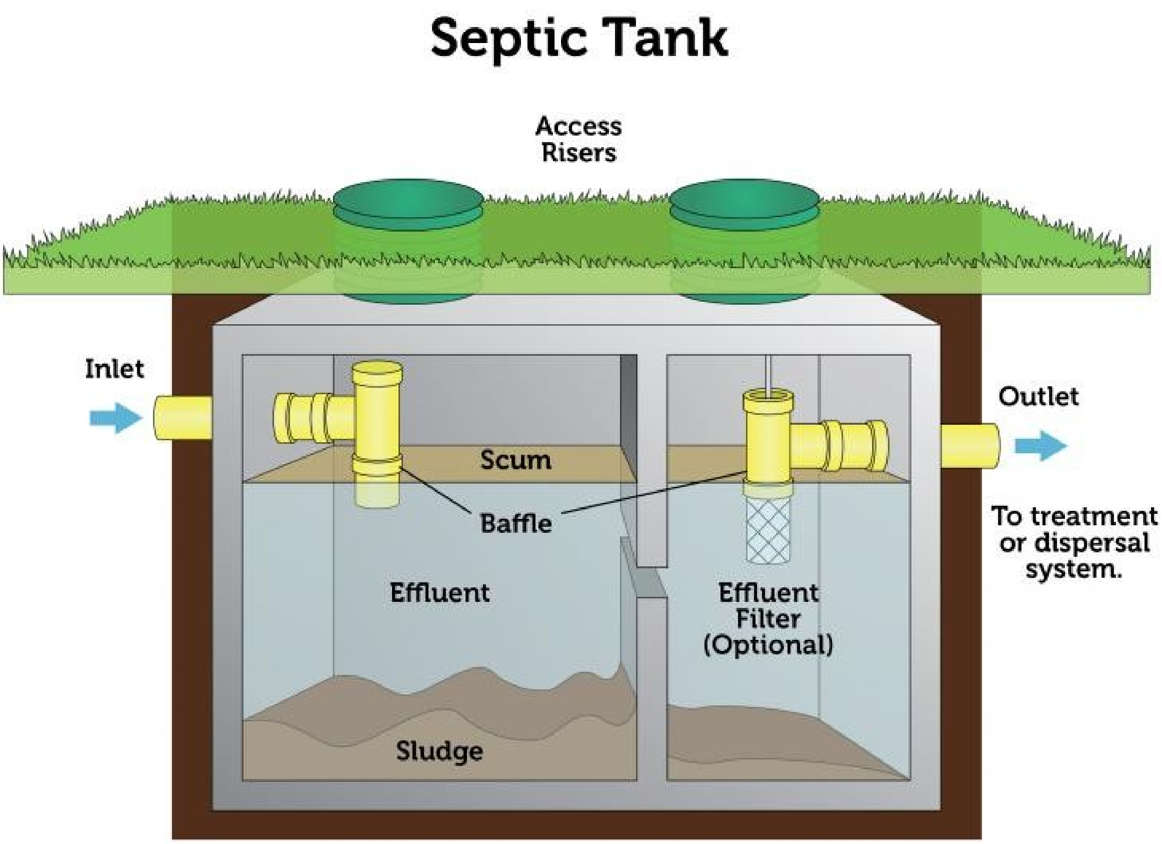

Figure 1.4 - Basic diagram of a Septic Tank (USEPA,2018)

1.5.1 Conventional Septic System

A septic tank and percolation system are commonly known as a conventional septic system. This system is the most common type of DWWTS used. The conventional septic system is an anaerobic system and is economically affordable amongst most households with an easy design and satisfactory operation (Sharma and Kazmi, 2015).

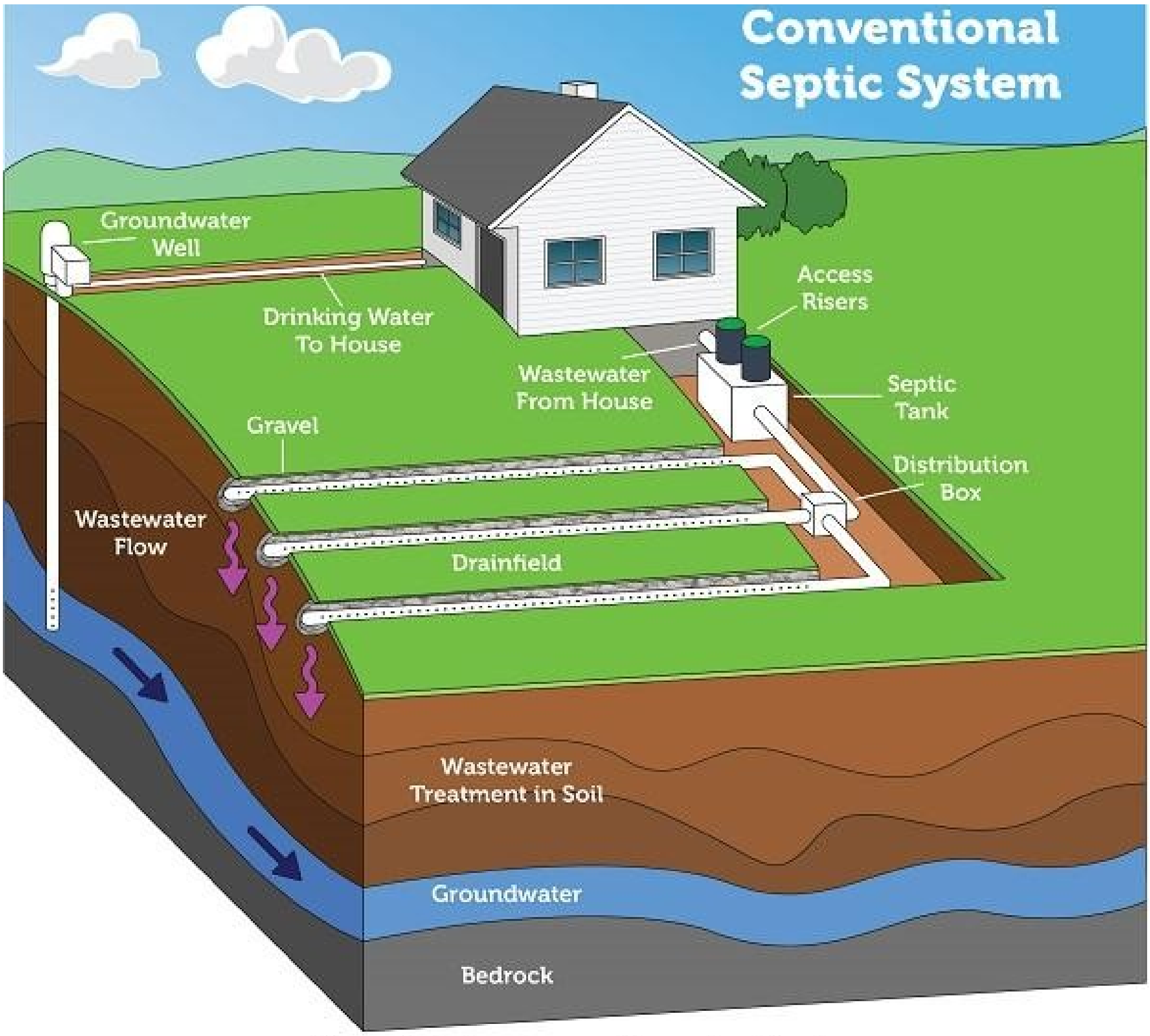

Figure 1.5 - Diagram of a Conventional Septic System (USEPA, 2018)

According to Wang *et al*. (2018) showed using conventional septic systems reduced human associated viruses and even remove viruses by the addition of an ozone treatment. Wang *et al*. (2018) continued to propose that conventional septic systems decrease parasitic protozoa and bacteria.

Other studies by Sharma and Kazmi (2015) propose other alternatives to a conventional septic system. They proposed a potential anaerobic septic system with the use of a filter-based packaged system as another way to treat septic effluent. This system during their study achieved the removal of high levels of Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS) and coliforms. The system did not need as much frequent desludging as a conventional septic system would need Sharma and Kazmi (2015) added.

Other studies have researched into other approaches on how to enhance the widely used conventional septic system by developing alternative methods of treatment or adding extra filtration or process to the traditional conventional septic system.

Anil and Neera (2016) suggested using a modified septic tank system to treat wastewater from domestic settings. They recommended to use a copper modified zeolite device which would act as a filter along with a disinfection method at the end of the septic tank. The modified septic tank contained vertical baffles which acted like a traditional septic tank with two chambers that would carry out anaerobic treatment. Once the effluent entered the second chamber after settlement in the first chamber, the copper modified zeolite acted as an adsorbent along as a filter for the wastewater. The disinfection method would take place in a third chamber where a bleaching powder would be used to treat the wastewater and then analysed for results. The results from this study showed that it was an effective procedure in treating wastewater. It indicated that it was able to remove Total Coliforms, TSS, Ammonia Nitrogen and BOD. 94% of BOD and 3 Colony forming unit per 100ml (CFU/ml) which was reduced from 390 CFU/100ml through the disinfection step and removed pathogenic microorganisms Anil and Neera, (2016).

These studies show that Wang *et al*. (2018) methods of treating wastewater using additional ozonation and Anil and Neera (2016) and Sharma and Kazmi, (2015) using modified methods and filtrations, that both aerobic and anaerobic treatments can be used to treat domestic wastewater. Furthermore, all studies show positive outcomes in the treatment methods and advances in DWWTS.

1.5.2 Constructed Wetland System

Constructed Wetland system is a common natural wastewater treatment system and have been in use since approximately since 1950. They are man-made wetlands which have been constructed to treat organic and excess nutrient contaminants. They have been designed to take on the natural process of natural wetland vegetation, soils, microbes and other media which aid the breakdown of wastewater and improve water quality in a structured surrounding. The use of constructed wetlands has been used for many industries and not just for domestic household treatment. Examples include effluent from abattoirs, landfill leachate and wastewater from brewery and wine production (Vymazal, 2014, Wu *et al*. 2015). It is estimated that more than 50,000 wetlands are constructed in Europe and more than 10,000 in the United States (Wu *et al*. 2015).

In a domestic setting a constructed wetland system contains a waterproof liner, gravel and sand fill along with the suitable wetland plants. These wetland plants need to be in a waterlogged environment to be able to survive. Once the domestic wastewater has gone through the septic tank it then enters the constructed wetlands system for treatment (USEPA, 2018).

Wu *et al*. (2015) assessed the sustainability of constructed wetlands through design and operation and a means of a green technology to treat numerous wastewater effluents. Wu *et al.* (2015) continued to examine the type of plants commonly used in wetland systems which contribute to the water quality in end wastewater. The study found that the plants used could come under environmental pressures when exposed to treat toxic pollutants which may result in plant death. Wu *et al*. (2015) argued that when wetland systems are faced with high levels of wastewater, the systems were not in a sustainable state due to stress of plant survival. Wetland plants could be subject to environmental conditions for example limited plant growth due to eutrophication and high levels of ammonia could prevent plants from absorbing nutrients from the wastewater (Wu *et al* 2015).

The selection of an underlying layer is just as important as the other media used for a constructed wetland system. An underlying layer can determine the growth of plants and the flow of wastewater through the system. It can also remove pollutants from wastewater such as phosphorus (Wu *et al.* 2015).

Wu *et al.* (2015) concluded that selection of both plants and an underlying layer are important for sustainable wastewater treatment especially the selection of plant species for different climates.

Garfí *et al.* (2012), study discussed influencing environmental factors like climate conditions could affect constructed wetland systems. This study examined the quality of wetland systems through the time of year, climate and the quality of the wastewater after treatment in a Mediterranean climate. Garfí *et al*. (2012) indicated that constructed wetlands were suited to warmer climates due to sustained plant growth although constructed wetland systems can be altered for colder climates. The study showed that seasonal conditions were an influencing factor performance of constructed wetland systems. The study revealed that in warmer climate conditions that Total Suspended Solids (TSS) and Biological Oxygen Demand (BOD) as high as 90% were observed than colder months only reaching to 80% or less (Garfí *et al*. 2012).

Resende *et al.* (2019), study can be noted to Wu *et al*. (2015) and Garfí *et al.* (2012) studies on constructed wetland system performance. Resende *et al.* (2019) found that with the addition of an aerated system along with a constructed wetland system it can increase the life cycle cost of treating wastewater in a small-scale treatment system. However, a disadvantage from this addition would be the running cost of the pumps in an aerated system would prove unsustainable (Resende *et al.* 2019).

Both Garfí *et al.* (2012) and Wu *et al.* (2015) studies would show strong links that both environmental and climate conditions can have influencing factors for performance of constructed wetland systems with Resende (2019) study of adding an aeration system to the constructed wetland system can help improve the life cycle cost of treating wastewater.

1.5.3 Soil Mound Systems

Where an area has a high-water table, poor soil and depth, a soil mound system can be constructed and act as a means of percolation. It requires low maintenance. A soil mound system is a raised percolation area in a domestic setting where it can treat the effluent from the septic tank. The wastewater effluent goes into a pump chamber after leaving the septic tank and is then pumped to the mound area in fixed quantities for treatment. The wastewater effluent is treated through gravel where the percolation pipes are located and sand and then through the resident soil (USEPA, 2018).

Figure 1.6 - Diagram of a Mound System (USEPA, 2018)

1.5.4 Secondary Treatment System Filters

There are several filters that can be used as a secondary treatment for onsite wastewater treatment. These filters are installed onsite if conditions of a DWWTS are not approved. A filter system can be composed of soil or sand. Like a mound system, the wastewater from a septic tank goes into a pumping chamber where fixed quantities are sent to the filters for treatment sporadically. This filter system is known as an intermittent filter system. A soil filter, peat filter and sand filter systems are several types of intermittent filters (EPA, 2010).

1.5.5 Tertiary Treatment Systems

By placing a tertiary treatment system to a DWWTS offers additional treatment from secondary treatment systems. Polishing filters is an example of a tertiary treatment system. A polishing filter is required in such systems as a constructed wetland. This filter can further reduce the biological load in the effluent in comparison to both the septic tank and secondary treatment stage. This results in a higher quality effluent being released into the environment. Like secondary treatment systems, polishing filters can be comprised from soil or sand polishing filters (EPA, 2010)

As outlined by the Garfi *et al.* (2017) alternative DWWTS wastewater treatment systems like a constructed wetland system have been gaining interest compared to a conventional septic system. Grafi *et al*. (2017) adds that conventional treatment systems can contribute to problems which may harm the environment compared to more natural treatments which have been shown to contribute to low energy consumption, simple operation methods and low maintenance required. The use of filter systems for example soil and sand filters as a secondary treatment system and even polishing filters with a conventional system will help further treat wastewater effluent before discharged into the environment. This is in contrast as outlined by Charles *et al*. (2008) who discusses that the increase of selecting alternative systems has been shown limitations. Charles *et al*. (2008) continues by explaining that the reason for this is due to economic and location restrictions. Furthermore, the development of some alternative treatment systems is giving concern to authorities like the EPA on possible malfunction of these systems. Additional concern is raised that householders with these alternative systems will fail to carry out maintenance (Charles *et al*. 2008).

Although Charles *et al*. (2008) holds acceptable points, alternative treatment systems are a valuable source for sites that may have a high-water table or poor percolation conditions. The addition of a tertiary system allows households to ensure that wastewater is given additional treatment before reaching the groundwater. This would be justified by Harden *et al.* (2008) who reported that the USEPA outlined that alternative treatment systems may be needed in such sites as karst areas.

1.6 EPA Code of Practice: Wastewater Treatment and Disposal Systems Serving Single Houses

Under the Planning and Development Regulations 2006 article 22 (2) (c), it is necessary for information to be shown to the Planning Authority that a DWWTS is suitable in the proposed site. This information can be gathered from a site characterisation assessment which is carried out to determine the suitability of a DWWTS. A full site assessment will better determine the type of DWWTS to select but more so be effective in treating wastewater and protecting the surrounding environment from possible contamination. A site characterisation involves different stages to gather information about the site. These include a desk study, an onsite assessment, assessment of data obtained, determining the suitability of the site, suggested disposal route of wastewater effluent once it leaves the DWWTS and indicate suitable DWWTSs for the required site as outlined in figure 1.7. These assessments should be carried out by a competent person under the Code of Practice (EPA, 2010).

A desk study is information already available to recognise any vulnerable or limitations that could prevent a DWWTS from being installed. A desk study can show locations of groundwater flow and aquifers which may be supplying a private well. It can also identify any Special Areas of Conservation or Special Protected Areas nearby which may be vulnerable to wastewater pollution. Furthermore, a desk study shows the type of subsoil on site which could support good drainage and karst landscapes which can be obtained from Geographic Information System (GIS) (EPA, 2010).

1.6.1 Visual Assessment

A visual assessment looks at the site and the surrounding area to determine suitability for a DWWTS. A visual assessment may look at several different factors.

The slope of the site will impact of the design of the DWWTS and the direction of surface water run off which could potentially gather where a DWWTS could be located on the site. Ponding already on the site could show that low absorbency of the soil due to a high-water table or watercourse. This indicator would indicate that a conventional septic system would not be suitable, and additional treatment system may be required if feasible, for example mound treatment system. Other indicators for suitability of DWWTS would be locations of private wells. It is suggested by the EPA (2010) that a private well need to be situated 30 metres away from a DWWTS to prevent contamination of the private well if it is used as a source of drinking water. A visual inspection of the vegetation already growing on the site is another indicator which can display if a site has good or bad drainage. Certain plants for example, Thistle, Bracken and Ragwort would show that good drainage is available whereas plants such as Iris and Rushes would indicate that poor drainage or a high water. These types of visual indicators are an easy way to determine suitability for a DWWTS (EPA, 2010).

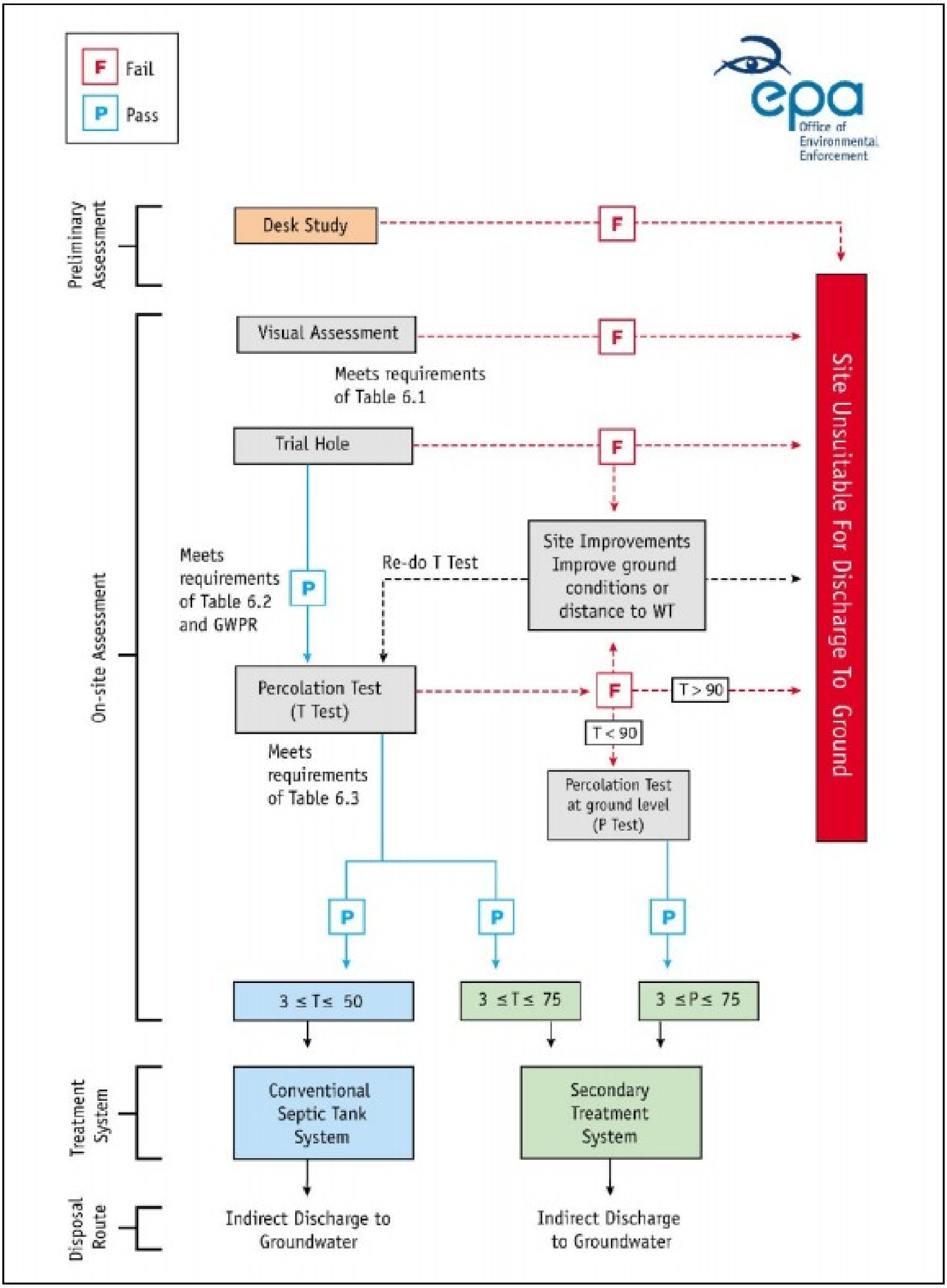

Figure 1.7 – Diagram of the EPA Code of practice (2010). A selection guide of a DWWTS discharging to the ground.

1.6.2 Trial Hole

A trial hole is used to the measure how deep the water table is, the type of soil and subsoil and how deep the bedrock is. A trial hole is a good indication if a DWWTS is suitable or not. A trail hole assessment determines the flow of the wastewater that will be emitted through the subsoil. A trial hole should be excavated next to the potential percolation area site to get a better awareness of the subsoil, water table depth and the depth of the bedrock and a depth of 1.2m of free draining subsoil should be achieved. At least 48 hours should be given to establish if the water table to reappear after excavation.

A trial hole is an initial indication if there is suitable means of percolation. If the trial hole fails, then there would be little point in carrying with a percolation test (Clare County Council, 2009).

1.6.3 Percolation Test

A Percolation test determines the amount of time the soil can absorb water at a certain distance in a percolation hole. The purpose of a percolation test is to see the capability of the soil from carrying wastewater effluent from a septic tank through the soil and into the groundwater. The percolation test shows how long the wastewater effluent will remain in the subsoil while it treats the pollutants in the effluent discharged from the septic tank. It is required that three percolation tests are carried out on all sites (EPA, 2010).

There are two percolation tests that can be carried out to determine permeability of the soil, a T-Test and a P-Test.

A T-Test is used to assess the suitability of subsoil at a depth of 400mm below the invert level of the percolation pipes.

A P-test is tested at ground level on sites with a high-water table, shallow rock or other soakage problems. A P-test is used to determine the percolation quality for the soil being tested if a T-test resulted in poor percolation. By carrying out a P-test it is used for other treatment systems for example, secondary treatment or a mounded system which would percolate effluent at ground level (EPA, 2010).

1.7 Determining a DWWTS

Once the desk study and the onsite assessment information are completed, it is then possible to decide if a DWWTS is practical on a proposed site and to select the appropriate DWWTS suitable for a site. In some instances, different DWWTS may be selected due to the results from the desk study and on-site assessment information. It is important that when selecting a DWWTS from the information gathered that a competent person select the right DWWTS that will effectively treat the wastewater. The type of treatment should be certified to fulfil the National Standards which are I.S. EN 12566-1:2000/A1:2004 for septic tanks or I.S. EN 12566-3:2005 for packaged systems or other systems which would come under the National Standards.

Other features that should be considered is the:

- construction, installation and commissioning service are supervised,
- Maintenance service that would be available,
- the expected life of the system,
- the cost of the system selected,
- The performance of the system and its capacity of reducing COD, BOD, TSS, Phosphors and Nitrogen, and coliforms.

By achieving these factors when selecting a system, it will enable the DWWTS to give reasonable amount of protection to the environment (EPA, 2010).

1.7.1 Site improvement works

In certain instances where a domestic household is to be built, certain environmental factors may inhibit the favourable of a DWWTS being used. Factors such as a high-water table, landscape of the site where a slope is present or even the type of soil being poor for suitable percolation and treatment of wastewater. Therefore, site improvement works may be carried out to favour conditions so that a DWWTS can operate more effectively. Site improvement works may include placing suitable soil on the site. If this site improvement is carried out, then more percolation tests should also be carried out. Testing of each 300mm layer with a 150 mm square hole should be dug out as the new soil is placed on the site. A pint of water should be poured into the hole and the time (should be between 10 and 120 minutes) for the water to soak into the soil should be recorded (EPA, 2010).

1.8 Conclusion

From researching the different types of treatment systems available, it can be concluded that additional and more developed technologies from the conventional septic system is a more beneficial option. These systems favour better effluent discharge which will protect the environment and human health. However, as discussed by Charles *et al*. (2008) over the concerns of authorities of possible failure of systems would conclude the importance of certified installers to reassure authorities. Therefore, this would show the importance of having certified installers to make competent decisions and carrying out installation or other associated works to DWWTS. Richards *et al*. (2016) continues the discussion that the design of a septic tank and management are key elements in the quality of effluent from a DWWTS and can reduce possible contamination to the environment.

1.9 Aims

From reviewing of the Literature review, the aims of this project are,

- To investigate installers in Irelands practices to see if they are following the EPA Code of Practice: Wastewater Treatment Systems for Single Houses by the EPA (2010)
- To examine installers opinions would a certification program for installers in Ireland based on the EPA Code of Practice be a practical idea which may reduce sub-standard practices.
- To develop a certification program for Tippecanoe County Health Department which will be ready for certification of installers in Tippecanoe County. This will include a multiply choice exam, marking scheme and requirements in order to be certified.

Chapter 2 – Methodology

2.0 Introduction

In order to achieve the aims presented in the Literature Review in Section 1.9.1 the following methodologies were conducted.

2.1 Methodology to investigate installers in Ireland when installing DWWTS – Design of Survey for Installers of Domestic Wastewater Treatment Systems in Ireland

An online survey titled Survey for installers for Domestic Wastewater Systems in Ireland was designed for DWWTS installers in Ireland to see if installers follow the EPA code of Practice when installing DWWTS. The questions for the survey was created using the EPA Code of Practice as a reference guide. The survey contained both qualitative and quantitative methods to gather data.

A total of thirteen questions was generated for the survey. The survey would take approximately 2 minutes to complete by the participant.

The survey compiled of;

- Ten closed ended questions with a tick the answer style questions that was appropriate for the installer,
- Two short questions and,
- One open-ended question at the end of the survey.

The ten closed ended questions were specific to the EPA Code of Practice. The aim of these questions was to get an understanding of Irish installers knowledge. Some questions asked installers if they used the EPA Code of Practice as a reference guide and the use of the online site characterisation site tool that is available free to installers. One question asked if installers worked as a sole trader or in a limited company. This was to get a better perception to see if there was any difference with installers knowledge from either working as a sole trader or in a limited company.

The two short questions in the survey asked the installer how many years they worked as an installer and the second short question asked installers if they carried out any training for installation of DWWTS. The main purpose of this was to show if any training was carried out for installation of DWWTS.

The open question asked installers for their opinion if Ireland should have a type of system or requirement for certifying installers to install DWWTS based on the EPA Code of Practice. This question would see if installers views would be in line with those in Indiana where installers in some counties must be certified to install DWWTS.

The draft survey was reviewed by the researcher's supervisor to ensure the format, layout, grammar and questions were appropriate and specific to the research question.

Once the questions were proofread, it was uploaded online using Google Forms. Google Forms is a free online tool and is convenient and easy to distribute to a target audience. The use of Google forms does not restrict in how many questions can be asked and allows for this data to be extracted and analysed easily.

2.1.1 Survey for Installers of DWWTS in Ireland

Survey for Installers of Domestic Wastewater Treatment Systems in Ireland

My name is Damian O'Sullivan and I am in my final year of Environmental Health at Technological University of Dublin. As part of my degree I am completing a thesis and asking installers of Domestic Wastewater Treatment Systems their knowledge based on the Code of Practice from the Environmental Protection Agency. *The results of this survey will provide me with data required for my research study. The survey is completely anonymous.* *Thank you for taking the time to complete this survey.*

1. **Have you heard of the Environmental Protection Agency Code of Practice for Wastewater treatment systems for Single Houses?**

- Yes
- No
- Don't know

2. **If so, would you use the Code of Practice as a reference guide when installing a Domestic wastewater treatment system in a Single House?**

- Always
- Usually
- Sometimes
- Rarely
- Never

3. **Have you installed a secondary or tertiary domestic wastewater treatment system other than a traditional conventional septic system? If so, what type of system (e.g. sand mound, constructed wetlands)**

- Yes
- No
- Don't know

4. **Would you recommend a suitable septic tank on the quality, cost or on new technologies in treatment systems for the proposed single house? (Please tick the options that apply to you)**

- Quality of the System
- Cost

- New Technologies in treatment systems
- All the above
- No choice

5. **Are you familiar with of separation distances for certain areas, i.e. private drinking wells, surface water soakaway, open drains, dwelling house?**

- Extremely familiar
- Very familiar
- Somewhat familiar
- Not so familiar
- Not at all familiar

6. **Do you perform Visual Assessments of a proposed site before carrying out a Trail hole and Percolation Test?**

- Always
- Usually
- Sometimes
- Rarely
- Never

7. **Are you able to determine if a site is suitable from the results of a Percolation test or Trail hole assessment?**

- Yes
- No
- Don't know

8. **If you are unsure of results from a Percolation Test or Trail hole, do you consult with a competent person/authority?**

- Yes
- No
- Don't know

9. **Do you use the online Site Characterisation form on the Environmental Protection Agency website to help calculate Trial holes, visual assessment and percolation tests?**

- A great deal
- A lot
- A moderate amount
- A little
- Never

10. **Have you undergone any training in installing Domestic wastewater treatment systems, e.g. An onsite wastewater management course? If so, who was the training provider?**

____

11. **How long have you been installing Domestic Water Treatment Systems (Septic Tanks) for?**

____

12. **Are you a Sole Trader or Company installing Domestic Wastewater Treatment Systems?**

- Sole Trader
- Limited Company

13. **Do you think in your own opinion that Ireland should have a type of system for certifying installers to install Domestic wastewater treatment systems based on the code of practice by the EPA?**

____

____

____

End of Survey, Thank you for your participation

2.1.3 Target Audience

Extensive research was completed to compile a list of installers in Ireland. A total of 40 installers were identified from the research. It was noted there is a voluntary association named the Irish Onsite Wastewater Association (IOWA). The survey was emailed to the secretary and asked to circulate the survey to members of the IOWA for the survey to reach a wider audience.

A brief note was attached to each survey before being sent to the 40 installers directly. The note explained the aim of the survey and what the intention of the data collected would be used for. The note also stated that surveys would be anonymous to the researcher.

The respondents of the survey were as follows;

Total installers	40
Total replies from installers	14

2.1.4 Data Analysis

The survey was closed off from replies in February 2020. After, the data was extracted onto Microsoft Excel. Some of the data was formulated into charts and graphs to give an easier visual representation. A table was formed to exhibit some of the opinions installers had of the open question about having a certifying system for installers in Ireland. The rest of the data along with the charts and graphs was transcribed into Microsoft Word and a report was completed to show the findings from the survey.

2.1.5 Limitations

There was a low response rate from the surveys. The survey was emailed between December 2019 and February 2020 which would be a less busy time for installers, intent here was to give companies as much time as possible to fill in the survey.

The DWWTS installers are a small demographic and niche area in Ireland. Most companies emailed were established companies throughout Ireland and it was difficult in finding Sole Traders or Independent contractors. Due to no regulation for installers to be registered, showed limitations in finding professions that installed DWWTS as described under the EPA Code of Practice (2009) states that a competent person should install a DWWTS.

2.2 Methodology for program to regulate DWWTS installers for certification - Design of a program to regulate DWWTS installers of the Multi-Choice Question (MCQ)

The design of a program to regulate DWWTS installers in Tippecanoe County was carried out during private placement in the Environmental Division in TCHD in 2019.

The Environmental Division in TCHD have two EHO's who oversee the issuing of permits to installers in the Tippecanoe County. Several meetings were needed to gather the Administrator (Principal EHO) and EHO's thoughts of how the program should be structured and what areas should be covered.

It was decided that a Multiple-Choice Question (MCQ) approach would be best suited for the program. Research into neighbouring and other counties protocols in the state of Indiana were conducted to get a sense of how those Counties regulate installers of DWWTS. The IOWPA website contained sample questions for installers in the state of Indiana. This was an aid to help structure the design of the MCQ for the program.

The MCQ was designed using the Indiana Code; Residential On-site Sewage Systems Rule 410 IAC 6-8.3 which contained many requirements for DWWTS. This legislation was read, and potential questions were highlighted for the MCQ. Since the vast number of requirements in the legislation not all areas could be covered in the MCQ.

Figure 2.1 shows the table of contents from the Residential On-site Sewage Systems Rule 410 IAC 6-8.3.

<u>Table 2.1 – Table of Contents (page i) - Residential On-site Sewage Systems Rule 410 IAC 6-8.3</u>

Table 2.2 – Table of Contents (page ii) - Residential On-site Sewage Systems Rule 410 IAC 6-8.3

2.2.1 Layout of MCQ exam

The layout of the MCQ was then divided into 5 sections using the table of contents from the Residential On-site Sewage Systems Rule 410 IAC 6-8.3 shown in Table 2.1 and Table 2.2 as follows.

Section 1

- General Sewage Disposal requirements
- Onsite Evaluation
- System Selection
- Separation Distances
- Dispersal area

Section 2

- Septic Tanks: General Requirements
- Septic tanks: Construction details
- Septic tanks and dosing tanks: Installation and maintenance

Section 3

- Subsurface trench on-site sewage system site suitability
- Elevated Sand mound on-site sewage system site suitability
- Table for Onsite sewage system selection
- Subsurface trench gravity on-site sewage systems: design and construction requirements
- Subsurface trench flood dosed on-site sewage systems: design and construction requirements

Section 4

- Elevated Sand Mound System

Section 5

- Drainage
- Dosing Tanks
- Effluent Pumps

Under these headings questions were extracted using the Residential On-site Sewage Systems Rule 410 IAC 6-8.3 and transcribed into Microsoft Word. Questions were restructured or rephrased to suit the MCQ style of questioning. Certain questions quoted the legislation and other questions formed tables with information missing for the installer to answer.

Once questions were selected, answers were formulated. Some MCQ answering involved multiple choice from four potential correct answers, questions A-D. Other questions involved a True or False answer and more questions required a short answer from the question being asked.

The MCQ was compiled by creating a question in one Microsoft Word document and then copy and pasting the question into another Microsoft Word document and then highlighting the answer. This was for the TCHD to have a reference of the correct answers. Once the MCQ exam was designed, both Microsoft Word documents were the same, only one had the correct answers highlighted.

In total, 96 questions were created for the MCQ exam program.

2.2.2 MCQ examination program for OSS installers in Tippecanoe County

TIPPECANOE COUNTY
HEALTH DEPARTMENT

Onsite Sewage System Installer's Examination for Certification for Tippecanoe County Health Department

Compiled by Damian O'Sullivan

BSc Environmental Health Final Year Student

Instructions:

- Please read all questions carefully.
- Questions are divided into 5 sections as described below.
- Circle one correct answer. Some questions may require more than one answer, and this is highlighted in **RED** in the question.
- Some questions are divided up into part (a) and (b).
- All questions carry equal marks.
- Time to complete examination: 3 hours.
- To successfully pass the examination a score of 75% is required.

Section 1 (*Questions 1-16*)

- General Sewage Disposal requirements
- Onsite Evaluation
- System Selection
- Separation Distances
- Dispersal area

Section 2 (*Questions 17-24*)

- Septic Tanks: General Requirements
- Septic tanks: Construction details
- Septic tanks and dosing tanks: Installation and maintenance

Section 3 (*Questions 25-46*)

- Subsurface trench on-site sewage system site suitability
- Elevated Sand mound on-site sewage system site suitability
- Table for Onsite sewage system selection
- Subsurface trench gravity on-site sewage systems: design and construction requirements
- Subsurface trench flood dosed on-site sewage systems: design and construction requirements

Section 4 (*Questions 47-69*)

- Elevated Sand Mound System

Section 5 (*Questions 70-96*)

- Drainage
- Dosing Tanks
- Effluent Pumps

Section 1

General Sewage Disposal requirements

Q. 1 What areas should be complied with under the Indiana Rule 410 IAC 6-8.3?

a) Design, Construction, Installation, Location, Maintenance & Operation.
b) Layout, Permit, Size of Operation, Installer.
c) Design, Observation, Sampling & Testing of Soil

Q.2 A bedroom must have at least _________ square feet.

a. 50 square feet
b. 60 square feet
c. 70 square feet
d. 80 square feet

Q. 3 Which wastewater is unsuitable for Onsite Sewage Systems?

a) Roof Drains
b) Foundation drains
c) Swimming Pool main drains
d) Hot tub drains
e) Area Drains
f) All the above

Q. 4 A jetted bathtub is treated as a bedroom equivalent for system sizing requirements if its capacity is greater than:

a) 75 gallons
b) 100 gallons
c) 110 gallons
d) 125 gallons

Construction Permits

Q. 5 When should you obtain a written construction permit?

____
____
____

Q. 6 What information should be on the application for a construction permit when applying to the local health department?

1a. <u>The name and address of the property owner</u>

1b. ____________________________________

1c. ____________________________________

2. ____________________________________

3. ____________________________________

4. ____________________________________

Q. 7 What is the <u>Permeability Rating</u> for Square Feet Needed in Trench Bottom per Bedroom

Please circle the **TWO** correct answers	Permeability Rating	Square Feet Needed in Trench Bottom per Bedroom
a)	3 in. to 7 in. per hour	350 square feet per bedroom
b)	4 in. to 6 in. per hour	340 square feet per bedroom
c)	2 in. to 6 in. per hour	250 square feet per bedroom
d)	1 in. to 2 in. per hour	330square feet per bedroom
e)	5 in to 3 in. per hour	340 square feet per bedroom

Q. 8 Why should the tank be cleaned when installing a replacement system?

a) For health reasons
b) It should not be pumped
c) To check the baffles, remove solids, and to confirm the tank is watertight
d) The new system starts fresh

Q. 9 While it may improve the operation of a marginal on-site sewage system to divert water from water softeners and laundry to the nearest road ditch, it is not permitted in Indiana?

True or False

Q. 10 What is the definition of residential on-site sewage system failure?

a. The soil surface has ponding of effluent
b. The system will not accept sewage at the designed rate
c. There is effluent contamination of potable water supply, ground water, or surface water
d. All the above

Onsite Evaluation

Q. 11 *The information needed to evaluate a site*

Topographic information including the following:

(A) Slope and slope aspect.

(B) Surface drainage characteristics and patterns including swales, ditches, and streams.

(C) Proposed or existing location of house and well.

(D) Location of other major features or structures.

(E) Location of soil evaluation sites and appropriate soil type boundaries.

(F) Topographic position of the site.

and

Soil characteristics as follows.

(A) Approximate depths of soil horizons.

(B) Soil colour, structure, and texture at each horizon.

(C) Depth to any layer which has a loading rate greater than seventy-five hundredths (0.75) gallons per day per square foot.

(D) Depth to seasonal high ground water as indicated by soil wetness characteristics.

(E) Depth to bedrock.

(F) Soil consistence at each horizon.

(G) Soil effervescence at each horizon.

(H) Presence or absence of roots

(I) The soil effervescence at each horizon.

(J) The percent coarse fragments at each horizon.

(K) The percent clay at each horizon, by field estimation, for any horizon where the percent course

fragments are greater than thirty-five percent (35%) by volume.

(L) The presence or absence of roots.

(M) Frost penetration depth, if applicable.

True or False

System Selection

Q. 12 What is the slope percent needed for a subsurface soil absorption system?

a) 20% or less

b) 15% or less

c) 10% or less

d) 5% or less

Q. 12 The topographic position of the site on which the system is to be built is convex, hill slope, or flat.

True or False

Separation Distances

Q. 14 Sec 57 (a) states that all septic tanks, dosing tanks, lift stations, and soil absorption systems shall be located appropriately.

Please fill in the minimum distance from the following,

	Septic Tank and Other Treatment Units, Dosing tank, Lift Station	Soil Absorption System
Private water supply well		
Commercial water supply well		
Public water supply well, lake, or reservoir		
Storm water detention area		
River, stream, ditch, or drainage tile		

Q. 15 What <u>distance and treatment</u> can a residential on-site sewage system be located within the minimum distances as per part (a) for a public water supply, lake, or reservoir?

____

____

Dispersal area

Q. 16 (a) A dispersal area is required for a soil absorption system when.

The soil loading rate used to determine the size of the soil absorption system is ___ gallons per day per square foot or less

a) 1 gallon
b) 0.5 gallons
c) 0.2 gallons
d) 2 gallons

Q. 16 (b) Or, there is a horizon in the upper ____ inches of the profile description with:

a) 60 inches
b) 50 inches

c) 40 inches
d) 30 inches

Section 2

Septic Tanks: General Requirements

Q. 17 Septic tanks should be.

a) Constructed with any material and protected from corrosion
b) Watertight and constructed of durable material such as concrete, fiberglass, polyethylene, and protected from corrosion
c) Watertight and concrete block made and protected from corrosion

Q. 18 Septic tanks should not be made up of

a) Concrete block, wood or metal,
b) Fibreglass, wood, polyethylene,
c) Concrete, wood or polyethylene
d) Concrete, fibreglass or metal

Q. 19 A septic tank should have a minimum capacity below the water line. Please fill in the capacity of a tank in Gallons for the following number of bedrooms.

Number of Bedrooms in Dwelling	Capacity of Tank in Gallons
2 or less	
3	
4	
5	
5+	

Q. 20 All effluent should discharge into a

a) Mound system
b) A river
c) Soil absorption system
d) No system needed

Septic tanks: Construction details

Q. 21 The minimum water depth in any compartment shall be?

a) 40
b) 60
c) 30
d) 20

Septic tanks and dosing tanks: Installation and maintenance

Q. 22 Septic and dosing tanks should be installed level on:

a) Undisturbed soil, sand, aggregate not larger than 1 ½ inches in diameter or an engineered base
b) Undisturbed soil, aggregate not larger than 1 inch in diameter or an engineered base
c) A mixture of undisturbed soil and sand only
d) None of the above

Q. 23 The top of the septic tank or dosing tank is installed.

a) At ground level with some openings to be watertight and securely fastened covers
b) At or above grade, watertight and unfastened covers
c) At or above grade, all access openings shall be fitted with watertight, securely fastened covers
d) At ground level, all access openings fitted with watertight securely fastened covers

Q. 24 What is the minimum length of non-perforated pipe that must extend away from the distribution box?

a) 10 feet
b) 5 feet
c) 15 feet
d) 3 feet

Section 3

Subsurface trench on-site sewage system site suitability

Q. 25 OSS feasibility location and selection shall be based on the:

a) Site evaluation, information from the onsite soil's evaluation and Design Daily Flow
b) Site evaluation, onsite soils and groundwater evaluation
c) Site evaluation, onsite water evaluation and design daily flow
d) Site evaluation and design daily flow only

Q. 26 Subsurface trench soil absorption systems shall **not** be constructed as:

a) Where surface runoff or subsurface drainage will not have an adverse effect on the OSS, not located in a drainage way, subject to ponding
b) Where surface runoff or subsurface drainage will have an adverse effect on the OSS, Located in a drainage way and not subject to ponding
c) Only subject to ponding and located in a drainage way
d) Where surface runoff or subsurface drainage will have an adverse effect on the OSS, located in a drainage way, subject to ponding
e) Only subject where surface runoff or subsurface drainage will have an adverse effect on the OSS

Elevated Sand mound on-site sewage system site suitability

Q. 27 A site on which the elevated sand mound OSS is to be built has a slope of.

a) 5% or less
b) 10% or less
c) 6% or less
d) 8% or less

Q. 28 Site conditions permit any seasonal high-water table at the site of the proposed elevated sand mound OSS to be lowered to at least.

a) 25 inches below original grade
b) 20 inches below original grade
c) 10 inches below original grade
d) 15 inches below original grade

Q. 29 The topographic position of the site on which the elevated sand mound OSS is to be built.

a) Hill slope
b) Flat
c) Convex
d) Hill slope, convex or flat

Q. 30 If surface and subsurface drainage can be diverted around the site, what type of slope can be utilized?

____

Q. 31 <u>Table for Onsite sewage system selection</u>

Please fill in the appropriate figures for the corresponding on-site system selection as stated in Sec. 73. Of the Rule

Onsite Sewage System Selection based on requirements of 410 IAC 6-8.3						
Site Requirements	Subsurface Trench On-site Sewage System					Elevated Sand Mound On-site Sewage Systems
	Gravity Flow		Flood Dosing or Alternative	Flood Dosing	Pressure Distribution	
Slope	≤ 15%					
Design Daily Flow						
Distance from Trench Bottom (ground surface for mounds) to layer with a soil loading rate <0.25 gpd/ft^2						
Distance from Trench Bottom (ground surface for mounds) to layer with a soil loading rate <1.20 gpd/ft^2						
Distance from Trench Bottom (ground surface for mounds) to Soil Horizon with 20% Clay and >60% Course Fragments by Volume						
Distance from Trench Bottom (ground surface for mounds) to Seasonal High-Water Table						

Subsurface trench on-site sewage systems: general design and construction requirements

Q. 32 The minimum absorption area required for each subsurface trench soil absorption system shall be based on the following:

a) The number of bedrooms only and the appropriate soil loading rate
b) The number of bedroom and bedroom equivalents in the dwelling, the appropriate soil loading rate
c) The number of each room in a dwelling and the appropriate soil loading rate
d) The number of bedroom and bathrooms in the dwelling, the appropriate loading rate

Q. 33 Subsurface trench soil absorption systems shall <u>not</u> be as long and narrow as the site permits while not exceeding maximum trench length?

True or False

Q. 34 Vegetation on the soil absorption field site that would interfere with the soils evaluation, system layout or system construction shall be cut and removed prior to installation without compacted soil material

True or False

Q. 35 Trees located within the construction site for soil absorption trenches:

a) Must be cut off at the ground level and the stumps left in place
b) Must be left standing
c) Stumps and root balls may be removed provided the resulting excavating will not exceed the permit requirements for width or depth of the soil absorption trench
d) Must be excavated and moved

Q. 36 The residential sewer shall be a minimum of:

a) 3 inches
b) 4.5 inches
c) inches
d) inches

Q. 37 The residential sewer shall be installed with a positive slope of:

a) Not less than 4 inches in 25 feet and not more than 36 inches in 25 feet
b) Not less than 5 inches in 25 feet and not more than 35 inches in 25 feet
c) More than 4 inches in 25 feet and more than 25 inches in 35 feet
d) More than 5 inches in 25 feet and not more than 35 inches in 25 feet

Q. 38 Perforated pipe distribution laterals in the absorption trench of a subsurface trench soil absorption system shall have at least ___ inches of aggregate below the pipe

a) 5 inches
b) 4 inches
c) 6 inches
d) 7 inches

Q. 39 The aggregate used in a subsurface trench soil absorption system shall be covered with a

a) No barrier is needed
b) A geotextile fabric barrier
c) A metal barrier
d) A plastic barrier

Q. 40 How many inches of cover should be provided over the aggregate in the trenches and what should any fill be required to provide or promote over the entire soil absorption system

a) 12 inches and provide surface run off
b) 10 inches and provide surface run off
c) 12 inches and provide suitable grass growth
d) 10 inches and provide suitable grass growth

Subsurface trench gravity on-site sewage systems: design and construction requirements

Q. 41 The first ten feet of effluent sewer leaving the distribution box for a gravity feed subsurface absorption system must be unperforated and placed in a gravel backfill

True or False

Q. 42 The invert elevation of the end of each effluent sewer pipe connected to a distribution box shall be:

a) At least 2 inches from the elevation so that each gravity distribution lateral receives an equal volume of effluent
b) At the same elevation so that each gravity distribution lateral receives an equal volume of effluent
c) At least 3 inches from the elevation so that each gravity distribution lateral receives an equal volume of effluent
d) At least 2.5 inches from the elevation so that each gravity distribution lateral receives an equal volume of effluent

Q. 43 All soil absorption system gravity distribution laterals shall have an internal diameter of

a) 3 inches
b) 5 inches
c) 6 inches
d) 4 inches

Q. 44 The distribution box shall be at least ___ feet from the proximal end of each soil absorption field trench

a) 4 feet
b) 5 feet
c) 6 feet
d) 2 feet

Subsurface trench flood dosed on-site sewage systems: design and construction requirements

Q. 45 When a subsurface trench flood dosed soil absorption system is used, the dosing effluent pump shall be sized, and its controls set to deliver the DDF to the soil absorption field in each dose. Effluent pump selection shall be based on manufacturers pump curves for the required discharge rate at the total head imposed on the pump.

What are the required effluent pump discharge rates for the following subsurface trench flood dosed on-site sewage systems if:

Number of Bedrooms	Discharge Rate in Gallons per Minute
1	30-35
2	
3	
4	

Q. 46 The effluent force main shall drain unless it is installed below the frost line, designed so that no effluent remains in any portion of the effluent force main located above the frost line. What is Frost penetration in Tippecanoe County in inches?

a) 50 inches
b) 70 inches
c) 60 inches
d) 40 inches

Section 4

Elevated Sand Mound Systems

Q. 47 The final ground surface of an elevated sand mound must be designed and constructed to maintain a minimum of the following slope on all sides:

a) 1:1
b) 2:1
c) 3:1
d) 4:1

Q. 48 The aggregate and sand of the elevated sand mound shall be covered with a minimum of twelve (12) inches of soil material. An additional six (6) inches of that soil material, for a total of eighteen (18) inches

True or False

Q. 49 The sand in an elevated sand mound is installed at a minimum slope of:

a) 2:1
b) 5:1
c) 3:1
d) 4:1

Q. 50 In an elevated sand mound, the bottom of the aggregate bed shall be installed level along its length and width.

True or False

Q. 51 In an elevated sand mound with a DDF of 750 gpd or less, the manifold must be:

a) 1 inch
b) 2 inches
c) 4 inches
d) 5 inches

Q. 52 When a perimeter drain surrounds an elevated sand mound, the mound's dispersal area:

a) Extends only to the perimeter drain
b) 1/2 the width of the mound
c) Equals the width of the mound
d) Is not needed because the site is flat

Q. 53 In an elevated sand mound, the bed shall be centered in the mound if:

a) The mound is perpendicular to the slope
b) The site has a slope of less than or equal to 0.5%
c) The force main can only be routed through the end of the system
d) The plow layer must be deeper than 14 inches because of plow pan

Q. 54 In an elevated sand mound, laterals shall be placed ______ inches from the sides of the bed

a) Not less than 12 inches and no more than 16
b) Not less than 18 inches and no more than 24
c) Not less than 12 inches and no more than 18
d) Not less than 7 inches and no more than 14

Q. 55 What is the required dispersal area for an elevated sand mound on a site with a 0.5% slope and a design loading rate of 0.25 gal/sq ft per day?

a. Half the width of soil absorption field
b. 30 feet
c. 50 feet
d. 1/4 width of soil absorption field on both the upslope and downslope sides of the elevated sand mound

Q. 56 When tilling the site to receive INDOT Specification 23 for an elevated sand mound system, one should till along the contour

True or False

Q. 57 When using a moldboard plow to prepare the basal area for an elevated sand mound at least:

True or False

Q. 58 What is the required depth of tilling when preparing the basal area of an elevated sand mound system?

a. 3-7 inches
b. 7-14 inches
c. 12 inches
d. 10 inches

Q. 59 What is the amount of aggregate required beneath the pressure distribution laterals in the bed of an elevated sand mound system?

a. 12 inches
b. 10 inches
c. 4 inches
d. 6 inches

Q. 60 What is the minimum allowable inside diameter of the pipe in the pressure distribution laterals in an elevated sand mound system?

a. 1 inch
b. 1.5 inches
c. 2 inches
d. 1.5 to 2 inches

Q. 61 The minimum downslope dispersal area required for an elevated sand mound is:

a. 66 feet
b. 50 feet
c. 30 feet
d. 10 feet

Q. 62 On a sloping site of more than .5%, the basal area of a mound is:

a. The area underneath the aggregate bed and downslope of the aggregate bed
b. The entire mound area downslope of the aggregate bed
c. The entire mound area downslope of the aggregate bed and extending to the perimeter drain
d. Only the sand area underneath the aggregate bed

Q. 63 Elevated sand mounds:

a. Must be constructed so that the longest axis is located along the contour.
b. Should be as long and narrow as possible for the site.
c. Effluent force main must drain between doses or be installed below frost line.
d. All the above.

Q. 64 The sand for an elevated sand mound must be placed on the tilled area:

a. Immediately after tilling the site
b. Any time before a rain event
c. Only after a rain
d. The sand must be placed before plowing

Q. 65 What type of sand must be used in an elevated sand mound:

a. Pit run
b. INDOT Spec 43
c. Clean sand
d. INDOT Spec 23

Q. 66 What is the minimum depth of sand under the aggregate bed in an elevated sand mound?

a. 10 inches
b. 6 inches
c. 12 inches
d. 15 inches

Q. 67 What is the minimum width of the aggregate bed in an elevated sand mound?

a. 2 feet
b. 3 feet
c. 4 feet
d. 6 feet

Q. 68 What is the maximum width of the aggregated bed in an elevated sand mound?

a. 10 feet
b. 12 feet
c. 18 feet
d. 20 feet

Q. 69 Spacing between adjacent pressure distribution laterals in an elevated sand mound must be between:

a. 15 inches and 24 inches
b. 12 inches and 36 inches
c. 24 inches and 36 inches
d. 35 inches and 45 inches

Section 5

Drainage

Q. 70 Perimeter drains that outlet to the surface require:

a) Vents
b) Rodent guards
c) Cleanouts
d) Caps so water discharge is prevented

Q. 71 A surface diversion is required on sites where surface runoff from the adjoining upslope landscape affects the soil absorption field.

True or False

Q. 72 A Subsurface drain can be back-filled to the surface with approved aggregate.

True or False

Q. 73 Pumps or siphons can be used to move the water away from the perimeter drain on new construction

True or False

Q. 74 A subsurface drain, when required, shall be at least _________ below adjacent soil absorption trench bottom or at least __________ into a soil limiting layer.

a. 36 inches and 4 inches
b. 30 inches and 3 inches
c. 25 inches and 4 inches
d. 36 inches and 2 inches

Q. 75 A segment drain is required on sites where the distance between the upper and lower sides of the perimeter drain exceed __________, unless a greater spacing is determined through calculations

a. 70 feet
b. 65 feet
c. 50 feet
d. 40 feet

Q. 76 A surface diversion can be used in combination with a subsurface interceptor or perimeter drain in the same location

True or False

Q. 77 Subsurface drains and/or segment drains can;

a. cross any portion of the soil absorption system
b. not cross any portion of the soil absorption system
c. part of the soil absorption system

Q. 78 Subsurface perimeter drains installed upslope of an absorption system shall be backfilled with aggregate to within ________ of final grade.

a. 5 inches
b. 8 inches
c. 6 inches
d. 10 inches

Q. 79 The perimeter drainpipe must be at least 3 inches in diameter, unless a suitable outlet cannot be found

a. 3 inches
b. 4 inches
c. 5 inches

d. 6 inches

Q. 80 If the seasonal high-water table is perched, the perimeter drain around the absorption field must be constructed ________ into the glacial till or fragipan at the lowest point of the limiting layer

a. 4 inches
b. 5 inches
c. 2 inches
d. 6 inches

Q. 81 Upslope drains shall be backfilled with aggregate to:

a. The surface
b. Within 6 inches of final grade
c. within 18 inches of the surface
d. Enough aggregate to cover the pipe
e. Both a and b

Q. 82 What is the minimum slope for a 4-inch subsurface perimeter drain?

a. 4 inches in 25 feet
b. 1 inch in 100 feet
c. 2 inches in 100 feet
d. 2.4 inches in 100 feet

Q. 83 When the slope of a site exceeds this percentage, a subsurface drain may be constructed only on the upslope side of the on-site system

a. 0.5%
b. 2%
c. 6%
d. 15%

Dosing Tanks

Q. 84 The required liquid holding capacity of the dosing tank shall not be considered as any portion of the required liquid volume of the septic tank

True or False

Q. 85 Dosing tanks may be constructed of which of the following materials:

a) Steel
b) Vitrified clay
c) Concrete
d) Pressure treated lumber

Q. 86 The pump and high-water alarm must be wired on separate circuits

True or False

Q. 87 The high-water alarm is installed in a dosing tank must be

a) Audio
b) Visual
c) Digital
d) Audio/visual

Q. 88 Which of the situations listed below requires that the residential sewage disposal system be pump-assisted.

a) When the system is to be installed in a floodplain
b) When there is no aggregate available
c) When the total lineal footage required for the absorption system trenches exceeds 500 feet
d) When there is no outlet for a perimeter drain

Q. 89 In a dosing tank, what must the effluent pump be fitted with

a) Corrosion resistant rope or chain
b) Quick disconnect unions, breakaway flange or a similar disconnect device
d. Chain & weep hole
e. Weep hole & break away flange
f. Both a & b

Q. 90 What is the maximum distance that the inlet baffle or 90-degree elbow in the distribution box must be above the bottom of the distribution box?

a) 2 inches
b) 1 inch
c) 4 inches
d) 2.5 inches

Q. 91 A subsurface trench gravity system may be constructed if the soil absorption system, including either half of a subsurface trench alternating field OSS, is designed with a total absorption trench length that does not exceed;

a) 300 lineal feet
b) 400 lineal feet
c) 500 lineal feet
d) None of the above

Q.92 The minimum depth from original grade to the bottom of a trench of a subsurface trench soil absorption system shall

a) Not be less than 12 inches
b) Not be less than 10 inches
c) More than 12 inches
d) More than 10 inches

Q.93 The maximum depth from final grade to the bottom of a trench of a subsurface trench soil absorption system shall

a) Not be more than 30 inches
b) More than 30 inches
c) Not be more than 36 inches
d) More than 36 inches

Q.94 No single absorption trench in a subsurface trench soil absorption system shall

a) Exceed 400 feet in length
b) Exceed 100 feet in length
c) Exceed 200 feet in length
d) Exceed 600 feet in length

Q.95 The holes in the pressure distribution laterals in an elevated mound system should be placed facing:

a) Up
b) Down
c) Sideways
d) None of the above

Effluent Pumps

Q. 96 Effluent Pumps must be:

a) Suitable for use in a corrosive atmosphere
b) Sized to deliver the total design flow rate while meeting the total dynamic head requirements
c) Installed in such a manner as to allow for removal without entering or dewatering the dossing tank
d) All the above

<u>END OF PAPER</u>

2.2.3 Rubric Marking scheme

A rubric assessment scheme consists of criteria used to base people's performance, for example in an exam. It shows the expectation needed for a person to demonstrate their knowledge to reach a certain grade (NUI Galway, 2012).

A rubric scheme was designed in line with the MCQ exam for the TCHD to give the appropriate grade when correcting exams. This will help make it clear if an installer has met the necessary criteria to be a certified installer.

Grade	Knowledge & Understanding	Mark and % Grade
A – * Pass with Distinction	Can demonstrate an excellent knowledge and understanding of the material asked	Between 82 – 96 marks 85% – 100%
B – * Pass with Merit	Shows evidence of knowledge asked of the relevant material	Between 72 – 81 marks 75% – 84%
C – ** Pass without reaching the requirement	Shows knowledge of relevant material but not enough to demonstrate competency	Between 63 – 71.5 marks 65% – 74%
D – ** Fail	Does not show an adequate level of understanding of the material asked	62 marks or less 64%
*** Notes that the participant has reached the required grade and is certified to install OSS in accordance with Tippecanoe County Health Department.**		
**** Notes that the participant has not done enough to reach the requirements to be certified to install OSS in Tippecanoe County and must retake the exam.**		

Table 2.3 Rubric marking scheme for Onsite Sewage System Installer's Examination for Certification for Tippecanoe County Health Department

2.2.4 Requirements for the Examination program

The approach to the MCQ exam is a knowledge-based examination. Installers that will be taking the MCQ examination will either know the answer or not.

No negative marking will be instigated on the MCQ exam. Installers taking the exam will have a time of 3 hours to answer all the questions.

A rubric marking scheme was designed to grade installers on their examination. It shows that certain criteria must be achieved to pass the examination program with TCHD.

The certificate is valid for a period of 3 years. After 3 years a renewal of certifying for an installer will be needed to ensure that the installer is still competent to install DWWTS.

A fee will be decided for installers to take the exam by the TCHD. This will also include paying a fee for taking a repeat exam or renewal certification exam.

2.2.5 Completion of the program

Once the MCQ was completed, it was handed over to the Environmental Division. It was outlined to the Environmental Division that the MCQ could be in both hard copy and be created using an online document for installers to answer, so they had a choice of how to deliver the exam. The MCQ exam was ready if needed in the future to implement regulation for installation of DWWTS by TCHD through their County Ordinance and could be amended and reviewed when needed.

Chapter 3 - Results

3.1 Introduction

The following chapter shows the results of the fieldwork and desk based work undertaken as part of this project. The answers to the MCQ examination for installers in Tippecanoe County are displayed with the correct answer highlighted in green. Following the MCQ answers is the results from the survey that was sent to installers in Ireland completed. A comparison to the results based on Codes of Practice in Tippecanoe County/State of Indiana is also shown.

3.2 Results of Survey to installers in Ireland

A total of 14 installer participants completed the survey.

Question 1 showed a 100% (n=14) positive response stating that installers have heard of the EPA Code of Practice.

Question 2 also showed a 100% (n=14) positive response stating that installers use the EPA Code of Practice as a reference guide when installing DWWTS in a single dwelling.

Question 3 again received 100% (n=14) response that installers have installed other forms of DWWTS than a conventional septic system, which included secondary and tertiary systems such as constructed wetland system. It was positive to see that installers are adhering to use the EPA Code of Practice as a reference and shows that they carry out a range of DWWTS systems other than the conventional septic system.

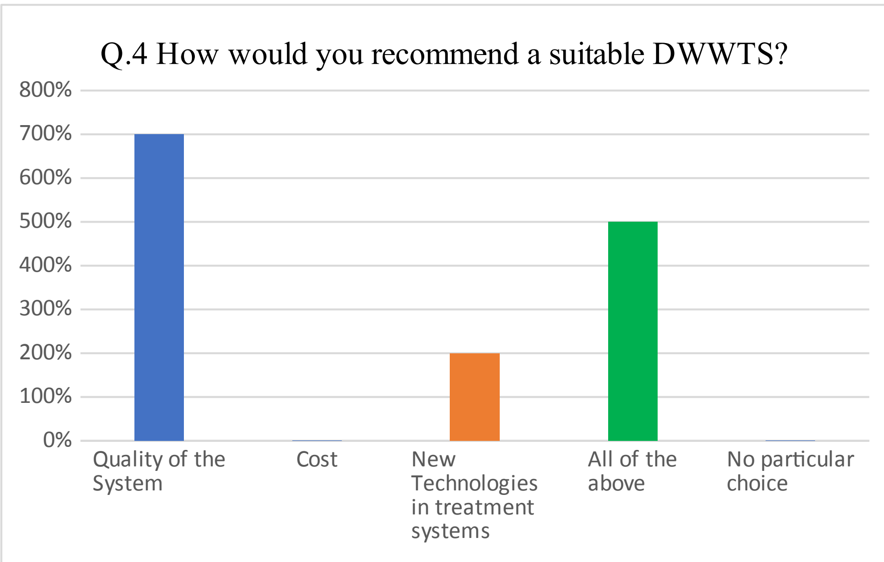

Figure 3.1- *Recommendation of a suitable DWWTS*

As shown in Figure 3.1, Question 4 provided a mixed response on how installers would recommend a suitable DWWTS to a single dwelling. Figure 3.1 shows 50% of installers (n=7) recommended a quality DWWTS over any other recommending factors. 35.7% of installers (n=5) recommended all factors when recommending a DWWTS to a customer while 14.3% (n=2) recommended their decision based on new technologies in DWWTS.

Question 5 in the survey asked installers were they familiar with separation distances regarding the distance from a DWWTS and private wells, surface water soakaway, open drains. 100% (n=14) of installers were extremely familiar with separation distances for certain areas.

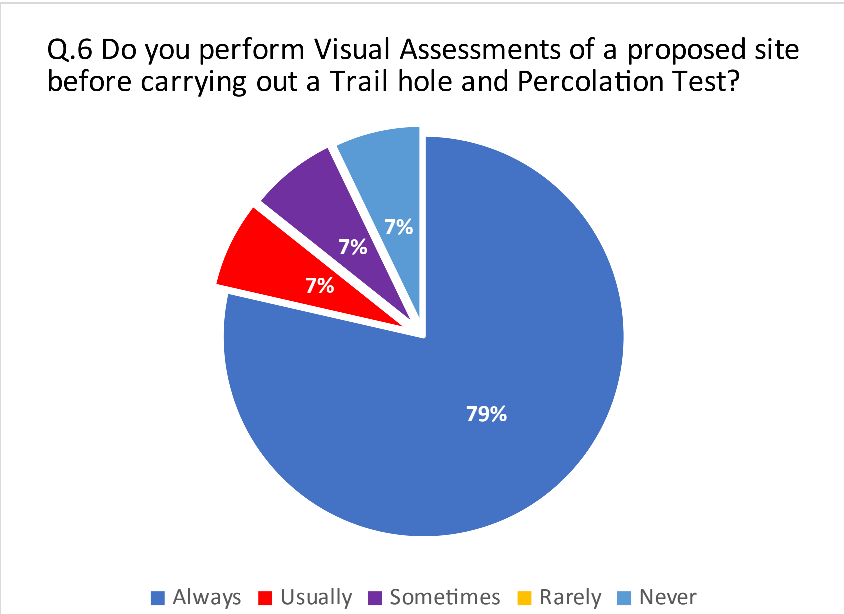

Figure 3.2- *Q.6 Do you perform visual assessments of a proposed site?*

As shown in Figure 3.2, Question 6 provided a varied response when asked about carrying out a visual assessment of a proposed site. 79% of responders (n=11) always carry out a visual assessment before carrying out a trail hole and percolation test. The remaining responders of 14% (n=1, n=1) carry out a visual assessment usually or sometimes. A further 7% (n=1) never carry out a visual assessment on a proposed site as shown in Figure 3.2.

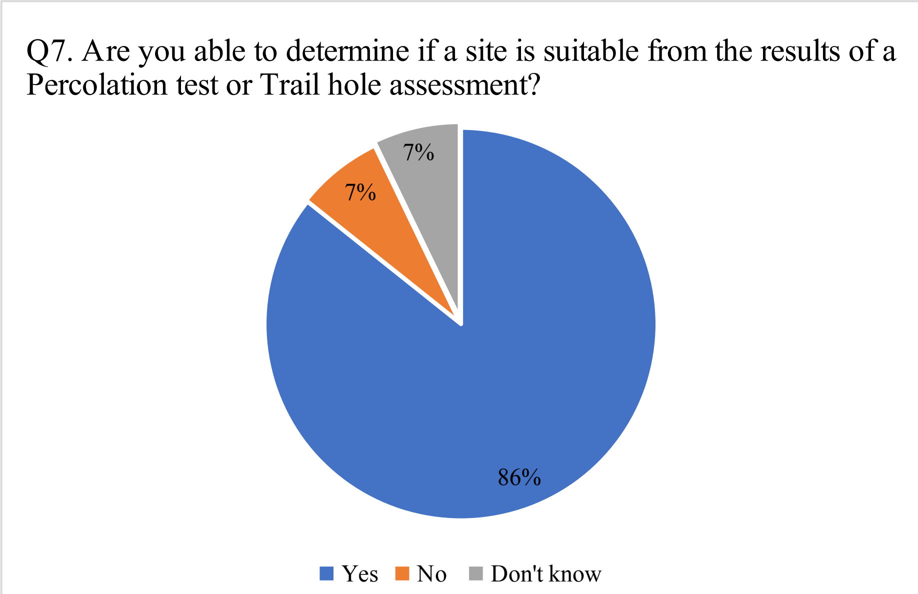

Figure 3.3- *Q.7 Are you able to determine if a site is suitable from the results of a Percolation test or Trial hole assessment?*

From Figure 3.3, 86% of installers (n=12) can determine site suitability from percolation tests and trial hole assessment results. From the survey, 7% of installers (n=1) could not interpret the results and another 7% of installers (n=1) did not know how to understand the results.

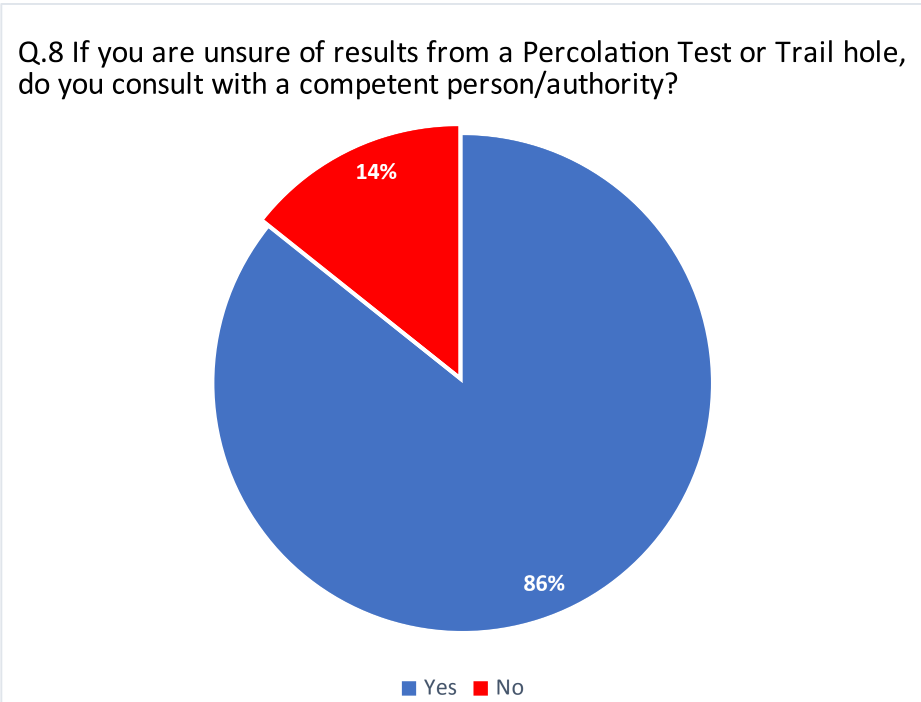

Figure 3.4 – *Q.8 If unsure of results from a percolation test or trial hole, do you consult with a competent person/authority?*

Question 8 from the survey as shown in Figure 3.4, showed that 86% of installers (n=12) will consult with a competent person/authority if they are unsure of the results from a percolation test or trial hole assessment. However, 14% of installers (n=2) showed that they do not consult with a competent person or authority when they are unsure of results.

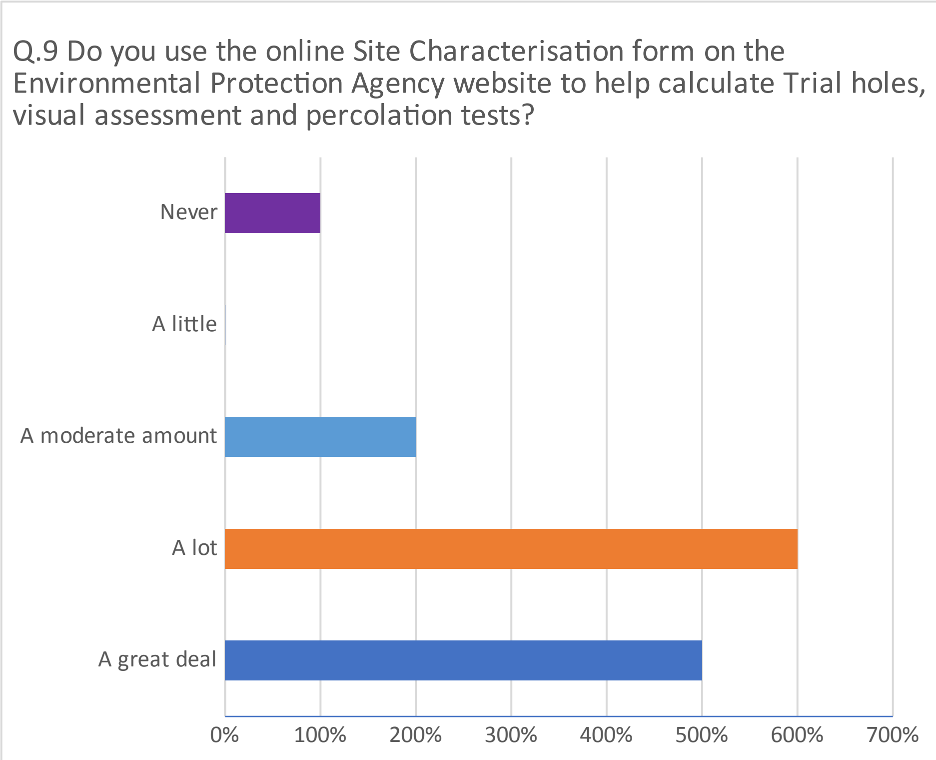

Figure 3.5 – *Q.9 Do you use the online Site Characterisation form on the Environmental Protection Agency website to help calculate Trial holes, visual assessment and percolation tests?*

The most common response from Figure 3.5, 42.9% (n=6) of responders say they use the online site characterisation form provided by the EPA. This was closely followed by 35.7% (n=5) of responders choosing that they would use the online site characterisation form a great deal. Responders would use the online characterisation form a moderate amount of the time. 7% (n=1) of responders never use the online characterisation form.

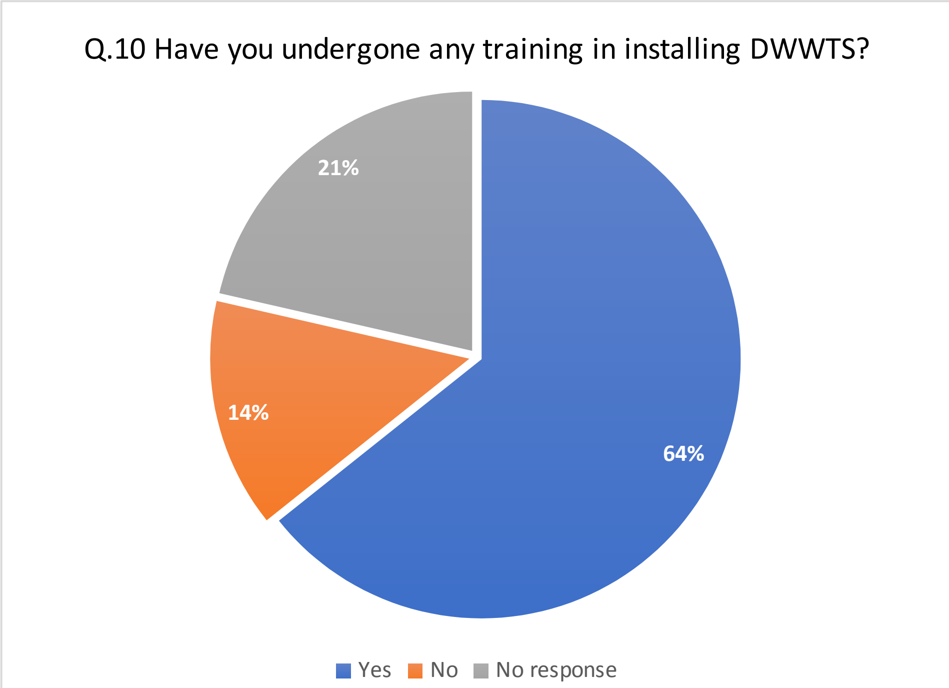

Figure 3.6 – *Q. 10 Have you undergone any training in installing DWWTS?*

As shown in Figure 3.6, Question 10 in the survey asked have installers carried out any form of training in relation to DWWTS in Ireland. 64% (n=9) of responders expressed that they have taken training for DWWTS and could provide the type of training. 14% (n=2) of responders stated that they have not done training. Finally, 22% (n=3) gave no response to the question as shown in Figure 3.6.

Type of training that respondents have undergone
• Onsite Wastewater Management Course
• Wastewater Ireland
• Chevron Training – Donegal County Council
• QQI training
• Manufactures training

Table 3.1 - Types of training that respondents have undergone

Table 3.1 provides the training that respondents have carried out in Ireland. There are a range of courses available in Ireland from Table 3.1 with no respondents having done the same course that has been mentioned in Table 3.1. Table 3.1 also shows that one Local Authority provides its own training in County Donegal.

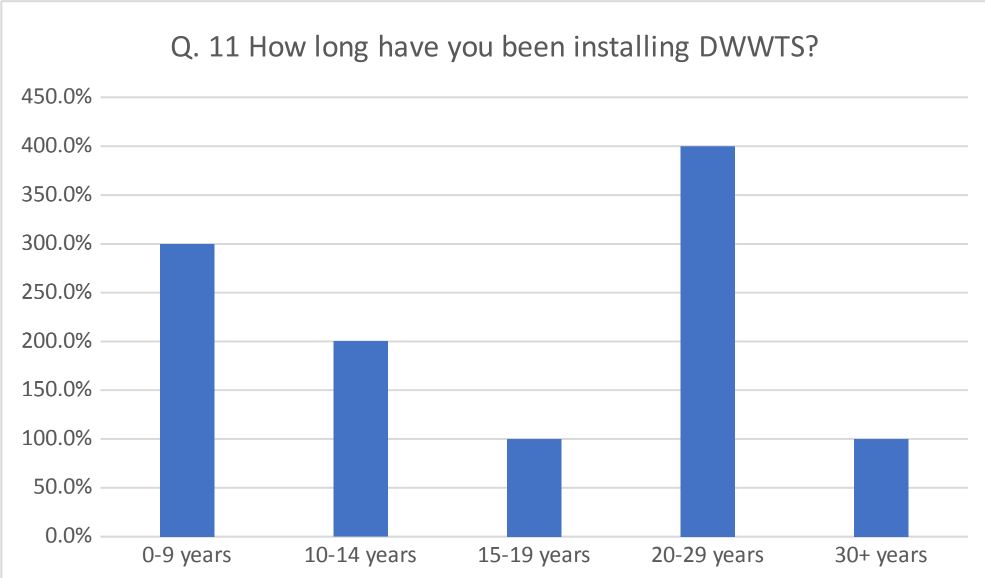

Figure 3.7 – *Q.11 How long have you been installing DWWTS?*

From Figure 3.7, Question 11 in the survey asked how long respondents have been installing DWWTS. More than half of the respondents have been installing DWWTS between 4-19 years (n=6). The remaining respondents 4% (n=4) have been installing DWWTS for more than 20 years with 1% (n=1) respondent installing for more than 30 years.

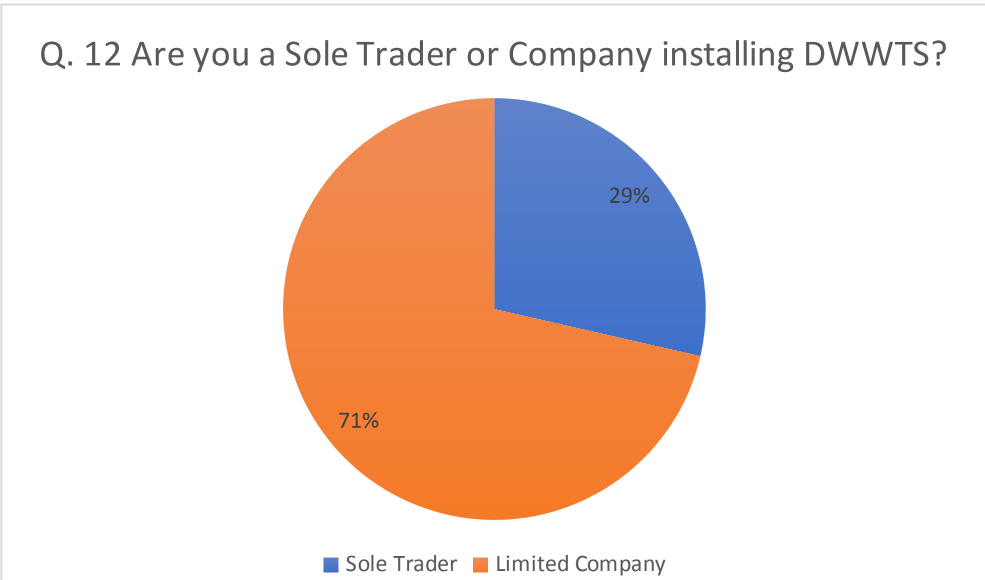

Figure 3.8 – *Q.12 Are you a Sole Trader or Company installing DWWTS?*

It is evident that the majority in Figure 3.8 that 71% (n=10) respondents are working as a limited company in Ireland. The remaining 29% of respondents (n=4) work as a Sole Trader installing DWWTS.

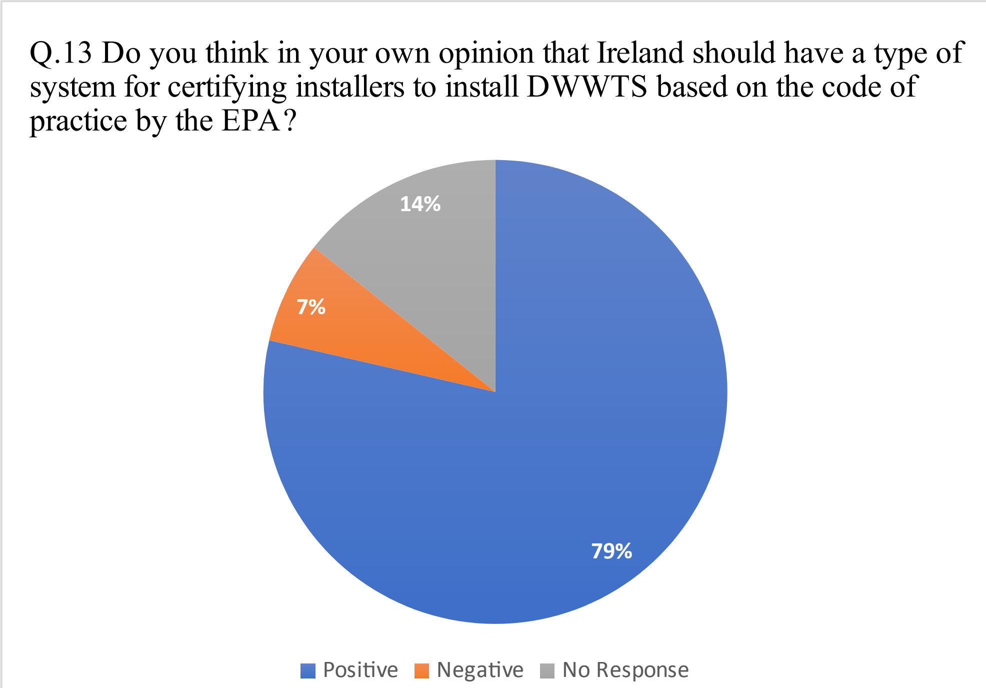

Figure 3.9 - *Q.13 Do you think in your own opinion that Ireland should have a type of system for certifying installers to install DWWTS based on the code of practice by the EPA?*

Figure 3.9 shows the final question in the survey asked for the opinion of respondents if a type of system should be in place to certify installers based on the EPA Code of practice. From the survey 79% (n=11) gave their opinion that there should be some type of certification of installers in Ireland. 7% (n=1) of respondents from the survey felt in their opinion that there should not be a certification of installers system in place. 14 % (n=2) gave no response or no opinion to the question in the survey.

Table 3.2 shows a snapshot of both positive and negative justifying opinions to question 13.

Some opinions of installers to have a certifying system in place in Ireland
• Yes, vitally important to stop current substandard work being carried out.
• Yes, A lot of the problems we find with Percolation areas is caused by poor installation.
• Yes to insure that they are installed properly and if ground conditions change from assessment time changes can be made to the onsite insulation at this time and recorded changes can be agreed, site assessment may have been carried out in dry summer time and installation in winter when ground water could be present

• Personally, I don't think so as the engineer who specifies any system must sign off on the install completion. This to me monitors installs without more red tape. The issue throughout Ireland is quite simply the extortionate prices some companies are charging. The other issue is some installers and suppliers are in the engineer’s pockets and control specification on particular systems for a commission, so this makes it very difficult for companies who want to submit a reasonable price with equipment which meets all requirements.

Table 3.2 – *A list of some respondent’s opinions to Question 13*

3.3 Compare and Contrast of Practices in Tippecanoe County and Ireland

Table 3.3 outlines a comparative and contrast table of practices that are carried out in Tippecanoe County and Ireland. Both areas have similar practices in place and cover the basic requirements in testing soils and areas before an installation can be carried out. The contrasting difference between both areas is the certification requirements in some Counties in the State of Indiana and a National Inspection plan that is carried out in Ireland under the EPA.

Tippecanoe County DWWTS practices	Ireland's DWWTS practices
Application from homeowner/installer to the Local Health Department for issuing of a permit to install DWWTS	Homeowner planning application to seek planning permission to Local Authority to install a DWWTS
Health Department issue a permit to install, replace or repair of a DWWTS	Permission granted or refused based on the planning application.
Tippecanoe County Health Department do not require installers to be certified in installing DWWTS	Planning permission may not be needed if a replacement DWWTS in the same area is needed
Other Counties in the State of Indiana require installers to be certified to install DWWTS	Planning application conditions may require a certification of a competent person to carry out installation of a DWWTS
Registration of a DWWTS with the Health Department	Certificate of compliance is completed when a DWWTS is installed.
	Registration of a DWWTS with the Water Services Authority
No County inspection plan to ensure DWWTS are compliant after installation	National Inspection Plan by the EPA of DWWTS in Ireland to ensure DWWTS are compliant
State of Indiana have legislation on Residential Sewage Disposal Rule 410-IAC-6-8.3 & Tippecanoe County Ordinance for installation requirements	EPA Code of Practice (2009) is used to install DWWTS along with Building Regulation requirements of septic tanks Ireland under the Water Services Acts 2007 and 2012 (Domestic Wastewater Treatment Systems) Regulations 2012 covers the operation and maintenance of a DWWTS for a homeowner

Table 3.3 - *Compare and Contrast of Tippecanoe County and Ireland practices*

3.4 MCQ program

The MCQ listed below covers the correct answers to the questions set as outlined in chapter 2.2.3. The answers are highlighted in green. This document would be for the TCHD in order to correct exams papers.

3.4.1 MCQ examination program for OSS installers in Tippecanoe County - Answers

Onsite Sewage System Installer's Examination for Certification for Tippecanoe County Health Department

ANSWERS

(*All answers are highlighted in GREEN highlight*)

Compiled by Damian O'Sullivan

BSc Environmental Health Final Year Student

Section 1

General Sewage Disposal requirements

Q. 1 What areas should be complied with under the Indiana Rule 410 IAC 6-8.3?

a) Design, Construction, Installation, Location, Maintenance & Operation.
b) Layout, Permit, Size of Operation, Installer.
c) Design, Observation, Sampling & Testing of Soil
d) Construction and Installation only.

Q.2 A bedroom must have at least _________ square feet.

a. 50 square feet
b. 60 square feet
c. 70 square feet
d. 80 square feet

Q. 3 Which wastewater is unsuitable for Onsite Sewage Systems? (Please circle the correct answer)

a) Roof Drains
a) Foundation drains
b) Swimming Pool main drains
c) Hot tub drains
d) Area Drains
e) All the above

Q.4 A jetted bathtub is treated as an extra bedroom equivalent for system sizing requirements if its capacity is greater than:

a. 75 gallons
b. 100 gallons
c. 110 gallons
d. 125 gallons

Construction Permits

Q.5 When should you obtain a written construction permit?

For any dwelling or place of residence that will not be connected to a sanitary sewerage system, the owner or agent of the owner shall obtain a written construction permit.

Q.6 What information should be on the application for a construction permit when applying to the local health department?

1a. The name and address of the property owner

1b. The location of the property

1c. The number of bedrooms and bedroom equivalents

2. The on-site soils evaluation, as outlined in section 56 of this rule, for the site where the residential soil absorption system is to be constructed.

3. Written plans of sufficient clarity that it can be verified that the design of the residential on-site sewage system shall comply with the provisions of this rule

4. Any other information deemed necessary by the health officer.

Q.7 What is the Permeability Rating for Square Feet Needed in Trench Bottom per Bedroom?

Please circle the **TWO** correct answers	Permeability Rating	Square Feet Needed in Trench Bottom per Bedroom
a)	3 in. to 7 in. per hour	350 square feet per bedroom
b)	4 in. to 6 in. per hour	340 square feet per bedroom
c)	2 in. to 6 in. per hour	250 square feet per bedroom
d)	1 in. to 2 in. per hour	330 square feet per bedroom
e)	5 in to 3 in. per hour	340 square feet per bedroom

Q.8 Why should the tank be cleaned when installing a replacement system?

a) For health reasons
b) It should not be pumped
c) To check the baffles, remove solids, and to confirm the tank is watertight
d) The new system starts fresh

Q. 9 While it may improve the operation of a marginal on-site sewage system to divert water from water softeners and laundry to the nearest road ditch, it is not permitted in Indiana?

True or False

Q. 10 What is the definition of residential on-site sewage system failure?

a. The soil surface has ponding of effluent.
b. The system will not accept sewage at the designed rate.
c. There is effluent contamination of potable water supply, ground water, or surface water.
d. All the above.

Onsite Evaluation

Q. 11 *Information needed to evaluate a site*

Topographic information including the following:

(A) Slope and slope aspect.

(B) Surface drainage characteristics and patterns including swales, ditches,

and streams.

(C) Proposed or existing location of house and well.

(D) Location of other major features or structures.

(E) Location of soil evaluation sites and appropriate soil type boundaries.

(F) Topographic position of the site.

and

Soil characteristics as follows;

(A) Parent material.

(B) The approximate depths of soil horizons.

(C) The soil colour, structure, and texture at each horizon.

(D) The horizon designation for each horizon.

(E) The depth to any layer that has a soil loading rate greater than seventy-five hundredths (0.75)

gallons per day per square foot or less than twenty-five hundredths (0.25) gallons per day per square

foot.

(F) The depth to seasonal high ground water as indicated by soil wetness characteristics.

(G) The depth to bedrock.

(H) The soil consistence at each horizon.

(I) The soil effervescence at each horizon.

(J) The percent coarse fragments at each horizon.

(K) The percent clay at each horizon, by field estimation, for any horizon where the percent coarse

fragments are greater than thirty-five percent (35%) by volume.

(L) The presence or absence of roots.

(M) Frost penetration depth, if applicable.

True or **False**

System Selection

Q. 12 What is the slope percent needed for a Sand Mound System:

a) 20% or less

b) 15% or less

c) 10% or less

d) 5% or less

Q. 13 The topographic position of the site on which the system is to be built is convex, hill slope, or flat.

True or False

Separation Distances

Q. 14 Sec 57 (a) states that all septic tanks, dosing tanks, lift stations, and soil absorption systems shall be located appropriately.

Please fill in the minimum distance from the following,

	Septic Tank and Other Treatment Units, Dosing tank, Lift Station	Soil Absorption System
Private water supply well	50	50
Commercial water supply well	100	100
Public water supply well, lake, or reservoir	200	200
Storm water detention area	25	25
River, stream, ditch, or drainage tile	25	25

Q. 15 What distance and treatment can a residential on-site sewage system be located within the minimum distances as per part (a) for a public water supply, lake, or reservoir?

A residential OSS shall not be located within 200 feet of a public water supply lake or reservoir. However, any residential OSS that includes secondary treatment and meets the following requirements may be less than 200 feet, but not less than 50 feet, from the normal or ordinary high-water mark of the lake or reservoir.

Dispersal area

Q. 16 (a) A dispersal area is required for a soil absorption system when;

The soil loading rate used to determine the size of the soil absorption system is ______ gallons per day per square foot or less or,

e) 1 gallon
f) 0.5 gallons
g) 0.2 gallons
h) 2 gallons

Q. 16 (b) Or, there is a horizon in the upper ____ inches of the profile description with:

e) 60 inches
f) 50 inches
g) 40 inches
h) 30 inches

Section 2

Septic Tanks: General Requirements

Q. 17 Septic tanks should be;

d) Constructed with any material and protected from corrosion
e) Watertight and constructed of durable material such as concrete, fiberglass, polyethylene, and protected from corrosion
f) Watertight and concrete block made and protected from corrosion

Q. 18 Septic tanks should not be made up of

e) Concrete block, wood or metal,
f) Fibreglass, wood, polyethylene,
g) Concrete, wood or polyethylene
h) Concrete, fibreglass or metal

Q. 19 A septic tank should have a minimum capacity below the water line. Please fill in the capacity of a tank in Gallons for the following number of bedrooms;

Number of Bedrooms in Dwelling	Capacity of Tank in Gallons
2 or less	750
3	1,000
4	1,250
5	1,500
5+	1,500 + 300 * the number of bedrooms over 5

Q. 20 All effluent should discharge into a

e) Mound system

f) A river
g) Soil absorption system
h) No system needed

Septic tanks: Construction details

Q. 21 The minimum water depth in any compartment shall be?

e) 40
f) 60
g) 30
h) 20

Septic tanks and dosing tanks: Installation and maintenance

Q. 22 Septic and dosing tanks should be installed level on:

e) Undisturbed soil, sand, aggregate not larger than 1 ½ inches in diameter or an engineered base
f) Undisturbed soil, aggregate not larger than 1 inch in diameter or an engineered base
g) A mixture of undisturbed soil and sand only
h) None of the above

Q. 23 The top of the septic tank or dosing tank is installed;

e) At ground level with some openings to be watertight and securely fastened covers
f) At or above grade, watertight and unfastened covers
g) At or above grade, all access openings shall be fitted with watertight, securely fastened covers
h) At ground level, all access openings fitted with watertight securely fastened covers

Q. 24 What is the minimum length of non-perforated pipe that must extend away from the distribution box?

e) 10 feet
f) 5 feet
g) 15 feet
h) 3 feet

Section 3

Subsurface trench on-site sewage system site suitability

Q. 25 OSS feasibility location and selection shall be based on the:

e) Site evaluation, information from the onsite soils and groundwater evaluation
f) Site evaluation, information from the onsite soils evaluation and Design Daily Flow
g) Site evaluation, information from the onsite water evaluation and Design Daily Flow
h) Site evaluation and design daily flow only

Q. 26 Subsurface trench soil absorption systems shall **not** be constructed as:

f) Where surface runoff or subsurface drainage will have an adverse effect on the OSS, located in a drainage way, subject to ponding
g) Where surface runoff or subsurface drainage will not have an adverse effect on the OSS, not located in a drainage way, subject to ponding
h) Where surface runoff or subsurface drainage will have an adverse effect on the OSS, Located in a drainage way and not subject to ponding
i) Only subject to ponding and located in a drainage way
j) Only subject where surface runoff or subsurface drainage will have an adverse effect on the OSS

Elevated Sand mound on-site sewage system site suitability

Q. 27 A site on which the elevated sand mound OSS is to be built has a slope of;

e) 5% or less
f) 10% or less
g) 6% or less
h) 8% or less

Q. 28 Site conditions permit any seasonal high-water table at the site of the proposed elevated sand mound OSS to be lowered to at least;

e) 25 inches below original grade
f) 20 inches below original grade
g) 10 inches below original grade
h) 15 inches below original grade

Q. 29 The topographic position of the site on which the elevated sand mound OSS is to be built;

e) Hill slope
f) Flat
g) Convex
h) Hill slope, convex or flat

Q. 30 If surface and subsurface drainage can be diverted around the site, what type of slope can be utilized?

A toe slope.

Q. 31 Table for Onsite sewage system selection

Please fill in the appropriate figures for the corresponding on-site system selection as stated in Sec. 73. Of the Rule

Onsite Sewage System Selection based on requirements of 410 IAC 6-8.3						
Site Requirements	Subsurface Trench On-site Sewage System					Elevated Sand Mound On-site Sewage Systems
	Gravity Flow		Flood Dosing or Alternative	Flood Dosing	Pressure Distribution	
Slope	≤ 15%		≤15%	≤ 15%	≤ 15%	≤ 6%
Design Daily Flow	≥ 450	<450	Any	Any	Any	Any
Distance from Trench Bottom (ground surface for mounds) to layer with a soil loading rate <0.25 gpd/ft^2	≥30	≥24	≥24	≥24	≥24	≥20
Distance from Trench Bottom (ground surface for mounds) to layer with a soil loading rate <1.20 gpd/ft^2	≥24	≥24	≥24	≥24	≥24	≥20
Distance from Trench Bottom (ground surface for mounds) to Soil Horizon with 20% Clay and >60% Course Fragments by Volume	≥30	≥24	≥24	≥24	≥24	≥20
Distance from Trench Bottom (ground surface for mounds) to Seasonal High-Water Table	≥24	≥24	≥24	≥24	≥24	≥20

Subsurface trench on-site sewage systems: general design and construction requirements

Q. 32 The minimum absorption area required for each subsurface trench soil absorption system shall be based on the following

e) The number of bedrooms only and the appropriate soil loading rate
f) The number of bedroom and bedroom equivalents in the dwelling, the appropriate soil loading rate
g) The number of each room in a dwelling and the appropriate soil loading rate
h) The number of bedroom and bathrooms in the dwelling, the appropriate loading rate

Q. 33 Subsurface trench soil absorption systems shall not be as long and narrow as the site permits while not exceeding maximum trench length?

True or False

Q. 34 Vegetation on the soil absorption field site that would interfere with the soils evaluation, system layout or system construction shall be cut and removed prior to installation without compacted soil material

True or False

Q. 35 Trees located within the construction site for soil absorption trenches:

e) Must be cut off at the ground level and the stumps left in place
f) Must be left standing
g) Stumps and root balls may be removed provided the resulting excavating will not exceed the permit requirements for width or depth of the soil absorption trench
h) Must be excavated and moved

Q. 36 The residential sewer shall be a minimum of:

e) 3 inches
f) 4.5 inches
g) 4 inches
h) 5 inches

Q. 37 The residential sewer shall be installed with a positive slope of:

e) Not less than 4 inches in 25 feet and not more than 36 inches in 25 feet
f) Not less than 5 inches in 25 feet and not more than 35 inches in 25 feet
g) More than 4 inches in 25 feet and more than 25 inches in 35 feet
h) More than 5 inches in 25 feet and not more than 35 inches in 25 feet

Q. 38 Perforated pipe distribution laterals in the absorption trench of a subsurface trench soil absorption system shall have at least ___ inches of aggregate below the pipe

e) 5 inches
f) 4 inches
g) 6 inches
h) 7 inches

Q. 39 The aggregate used in a subsurface trench soil absorption system shall be covered with a

e) No barrier is needed
f) A geotextile fabric barrier
g) A metal barrier

h) A plastic barrier

Q. 40 How many inches of cover should be provided over the aggregate in the trenches and what should any fill be required to provide or promote over the entire soil absorption system

e) 12 inches and provide surface run off
f) 10 inches and provide surface run off
g) 12 inches and provide suitable grass growth
h) 10 inches and provide suitable grass growth

Subsurface trench gravity on-site sewage systems: design and construction requirements

Q. 41 The first ten feet of effluent sewer leaving the distribution box for a gravity feed subsurface absorption system must be unperforated and placed in a gravel backfill

True or False

Q. 42 The invert elevation of the end of each effluent sewer pipe connected to a distribution box shall be:

e) At least 2 inches from the elevation so that each gravity distribution lateral receives an equal volume of effluent
f) At the same elevation so that each gravity distribution lateral receives an equal volume of effluent
g) At least 3 inches from the elevation so that each gravity distribution lateral receives an equal volume of effluent
h) At least 2.5 inches from the elevation so that each gravity distribution lateral receives an equal volume of effluent

Q. 43 All soil absorption system gravity distribution laterals shall have an internal diameter of

e) 3 inches
f) 5 inches
g) 6 inches
h) 4 inches

Q. 44 The distribution box shall be at least ___ feet from the proximal end of each soil absorption field trench

e) 4 feet
f) 5 feet
g) 6 feet
h) 2 feet

Subsurface trench flood dosed on-site sewage systems: design and construction requirements

Q.45 When a subsurface trench flood dosed soil absorption system is used, the dosing effluent pump shall be sized, and its controls set to deliver the DDF to the soil absorption field in each dose. Effluent pump selection shall be based on manufacturers pump curves for the required discharge rate at the total head imposed on the pump.

What are the required effluent pump discharge rates for the following subsurface trench flood dosed on-site sewage systems if:

Number of Bedrooms	Discharge Rate in Gallons per Minute
1	30-35
2	30-35
3	30-45
4	30-60

Q. 46 The effluent force main shall drain unless it is installed below the frost line, designed so that no effluent remains in any portion of the effluent force main located above the frost line. What is Frost penetration in Tippecanoe County in inches:

e) 50 inches
f) 70 inches
g) 60 inches
h) 40 inches

Section 4

Elevated Sand Mound Systems

Q. 47 The final ground surface of an elevated sand mound must be designed and constructed to maintain a minimum of the following slope on all sides:

a) 1:1
b) 2:1
c) 3:1
d) 4:1

Q. 48 The aggregate and sand of the elevated sand mound shall be covered with a minimum of twelve (12) inches of soil material. An additional six (6) inches of that soil material, for a total of eighteen (18) inches

True or False

Q. 49 The sand in an elevated sand mound is installed at a minimum slope of:

a) 2:1
b) 5:1
c) 3:1
d) 4:1

Q. 50 In an elevated sand mound, the bottom of the aggregate bed shall be installed level along its length and width.

True or False

Q. 51 In an elevated sand mound with a DDF of 750 gpd or less, the manifold must be:

a) 1 inch
b) 2 inches
c) 4 inches
d) 5 inches

Q. 52 When a perimeter drain surrounds an elevated sand mound, the mound's dispersal area:

a) Extends only to the perimeter drain
b) 1/2 the width of the mound
c) Equals the width of the mound
d) Is not needed because the site is flat

Q. 53 In an elevated sand mound, the bed shall be centered in the mound if:

a) The mound is perpendicular to the slope
b) The site has a slope of less than or equal to 0.5%
c) The force main can only be routed through the end of the system
d) The plow layer must be deeper than 14 inches because of plow pan

Q. 54 In an elevated sand mound, laterals shall be placed _______ inches from the sides of the bed

a) Not less than 12 inches and no more than 16
b) Not less than 18 inches and no more than 24
c) Not less than 12 inches and no more than 18
d) Not less than 7 inches and no more than 14

Q. 55 What is the required dispersal area for an elevated sand mound on a site with a 0.5% slope and a design loading rate of 0.25 gal/sq ft per day?

a. Half the width of soil absorption field
b. 30 feet
c. 50 feet
d. 1/4 width of soil absorption field on both the upslope and downslope sides of the elevated sand mound

Q. 56 When tilling the site to receive INDOT Specification 23 for an elevated sand mound system, one should till along the contour

True or False

Q. 57 When using a moldboard plow to prepare the basal area for an elevated sand mound at least:

True or False

Q. 58 What is the required depth of tilling when preparing the basal area of an elevated sand mound system?

a. 3-7 inches
b. 7-14 inches
c. 12 inches
d. 10 inches

Q. 59 What is the amount of aggregate required beneath the pressure distribution laterals in the bed of an elevated sand mound system?

a. 12 inches
b. 10 inches
c. 4 inches
d. 6 inches

Q. 60 What is the minimum allowable inside diameter of the pipe in the pressure distribution laterals in an elevated sand mound system?

a. 1 inch
b. 1.5 inches
c. 2 inches
d. 1.5 to 2 inches

Q. 61 The minimum downslope dispersal area required for an elevated sand mound is:

a. 66 feet
b. 50 feet
c. 30 feet
d. 10 feet

Q. 62 On a sloping site of more than .5%, the basal area of a mound is:

a. The area underneath the aggregate bed and downslope of the aggregate bed
b. The entire mound area downslope of the aggregate bed
c. The entire mound area downslope of the aggregate bed and extending to the perimeter drain
d. Only the sand area underneath the aggregate bed

Q. 63 Elevated sand mounds:

a. Must be constructed so that the longest axis is located along the contour.
b. Should be as long and narrow as possible for the site.
c. Effluent force main must drain between doses or be installed below frost line.
d. All the above.

Q. 64 The sand for an elevated sand mound must be placed on the tilled area:

a. Immediately after tilling the site
b. Any time before a rain event
c. Only after a rain
d. The sand must be placed before plowing

Q. 65 What type of sand must be used in an elevated sand mound:

a. Pit run
b. INDOT Spec 43
c. Clean sand
d. INDOT Spec 23

Q. 66 What is the minimum depth of sand under the aggregate bed in an elevated sand mound?

a. 10 inches
b. 6 inches
c. 12 inches
d. 15 inches

Q. 67 What is the minimum width of the aggregate bed in an elevated sand mound?

a. 2 feet
b. 3 feet
c. 4 feet
d. 6 feet

Q. 68 What is the maximum width of the aggregated bed in an elevated sand mound?

a. 10 feet
b. 12 feet
c. 18 feet
d. 20 feet

Q. 69 Spacing between adjacent pressure distribution laterals in an elevated sand mound must be between:

a. 15 inches and 24 inches
b. 12 inches and 36 inches
c. 24 inches and 36 inches
d. 35 inches and 45 inches

Section 5

Drainage

Q. 70 Perimeter drains that outlet to the surface require:

a) Vents
b) Rodent guards
c) Cleanouts
d) Caps so water discharge is prevented

Q. 71 A surface diversion is required on sites where surface runoff from the adjoining upslope landscape affects the soil absorption field.

True or False

Q. 72 A Subsurface drain can be backfilled to the surface with approved aggregate.

True or False

Q. 73 Pumps or siphons can be used to move the water away from the perimeter drain on new construction

True or False

Q. 74 A subsurface drain, when required, shall be at least _________ below adjacent soil absorption trench bottom or at least __________ into a soil limiting layer.

a. 36 inches and 4 inches
b. 30 inches and 3 inches
c. 25 inches and 4 inches
d. 36 inches and 2 inches

Q. 75 A segment drain is required on sites where the distance between the upper and lower sides of the perimeter drain exceed __________, unless a greater spacing is determined through calculations

a. 70 feet
b. 65 feet
c. 50 feet
d. 40 feet

Q. 76 A surface diversion can be used in combination with a subsurface interceptor or perimeter drain in the same location

True or False

Q. 77 Subsurface drains and/or segment drains can;

a. cross any portion of the soil absorption system
b. not cross any portion of the soil absorption system
c. part of the soil absorption system

Q. 78 Subsurface perimeter drains installed upslope of an absorption system shall be backfilled with aggregate to within ________ of final grade.

a. 5 inches
b. 8 inches
c. 6 inches
d. 10 inches

Q. 79 The perimeter drainpipe must be at least 3 inches in diameter, unless a suitable outlet cannot be found

a. 3 inches
b. 4 inches
c. 5 inches
d. 6 inches

Q. 80 If the seasonal high-water table is perched, the perimeter drain around the absorption field must be constructed ________ into the glacial till or fragipan at the lowest point of the limiting layer

a. 4 inches

b. 5 inches
c. 2 inches
d. 6 inches

Q. 81 Upslope drains shall be backfilled with aggregate to:

a. The surface
b. Within 6 inches of final grade
c. within 18 inches of the surface
d. Enough aggregate to cover the pipe
e. Both a and b

Q. 82 What is the minimum slope for a 4-inch subsurface perimeter drain?

a. 4 inches in 25 feet
b. 1 inches in 100 feet
c. 2 inches in 100 feet
d. 2.4 inches in 100 feet

Q. 83 When the slope of a site exceeds this percentage, a subsurface drain may be constructed only on the upslope side of the on-site system

a. 0.5%
b. 2%
c. 6%
d. 15%

Dosing Tanks

Q. 84 The required liquid holding capacity of the dosing tank shall not be considered as any portion of the required liquid volume of the septic tank

True or False

Q. 85 Dosing tanks may be constructed of which of the following materials:

a) Steel
b) Vitrified clay
c) Concrete
d) Pressure treated lumber

Q. 86 The pump and high-water alarm must be wired on separate circuits

True or False

Q. 87 The high-water alarm is installed in a dosing tank must be

a) Audio
b) Visual
c) Digital

d) Audio/visual

Q. 88 Which of the situations listed below requires that the residential sewage disposal system be pump-assisted.

a) When the system is to be installed in a floodplain
b) When there is no aggregate available
c) When the total lineal footage required for the absorption system trenches exceeds 500 feet
d) When there is no outlet for a perimeter drain

Q. 89 In a dosing tank, what must the effluent pump be fitted with

a) Corrosion resistant rope or chain
b) Quick disconnect unions, breakaway flange or a similar disconnect device
d. Chain & weep hole
e. Weep hole & break away flange
f. Both a & b

Q. 90 What is the maximum distance that the inlet baffle or 90-degree elbow in the distribution box must be above the bottom of the distribution box?

a) 2 inches
b) 1 inch
c) 4 inches
d) 2.5 inches

Q. 91 A subsurface trench gravity system may be constructed if the soil absorption system, including either half of a subsurface trench alternating field OSS, is designed with a total absorption trench length that does not exceed;

a) 300 lineal feet
b) 400 lineal feet
c) 500 lineal feet
d) None of the above

Q. 92 The minimum depth from original grade to the bottom of a trench of a subsurface trench soil absorption system shall

a) Not be less than 12 inches
b) Not be less than 10 inches
c) More than 12 inches
d) More than 10 inches

Q. 93 The maximum depth from final grade to the bottom of a trench of a subsurface trench soil absorption system shall

a) Not be more than 30 inches
b) More than 30 inches

c) Not be more than 36 inches
d) More than 36 inches

Q. 94 No single absorption trench in a subsurface trench soil absorption system shall

a) Exceed 400 feet in length
b) Exceed 100 feet in length
c) Exceed 200 feet in length
d) Exceed 600 feet in length

Q. 95 The holes in the pressure distribution laterals in an elevated mound system should be placed facing:

a) Up
b) Down
c) Sideways
d) None of the above

Effluent Pumps

Q. 96 Effluent Pumps must be:

a) Suitable for use in a corrosive atmosphere
b) Sized to deliver the total design flow rate while meeting the total dynamic head requirements
c) Installed in such a manner as to allow for removal without entering or dewatering the dossing tank
d) All the above

END OF PAPER

Chapter 4 – Discussion

4.1 Discussion of Survey for installers for Domestic Wastewater Systems in Ireland

Recommending a DWWTS showed different respondent's preferences. It was reassuring to see that cost was not a major factor in recommending a DWWTS to householders. New treatment systems may also be suitable along with site improvement works to be installed where a proposed site is not favourable. Choosing new technologies on treatment systems also demonstrates that installers are more aware and can move away from the conventional septic system as outlined in the Literature review as conventional septic systems are only anaerobic systems and can only provide primary treatment. New technologies in DWWTSs and alternative DWWTSs can remove much higher levels of bacteria and other microorganisms as outlined by Sharma and Kazmi, (2015) in an alternative system. The use of secondary and tertiary systems which all installers said to have installed show that some of these recent technologies such as a polishing filter improve the quality of effluent and lower the risk of contamination of groundwater. These contributing factors are encouraging to see as these secondary and tertiary systems help improve the quality of percolation of domestic wastewater effluent (EPA, 2009).

Visual Assessments form part of a site suitability assessment for a DWWTS on a proposed site. From the survey it showed that at least 79% of installers always perform a visual assessment on a site. However, the remaining respondents of the survey showed that they either carried out a visual assessment usually, sometimes or never. There could be several contributing factors as to why these installers do not always carry out a visual assessment. This may be due to proposed sites such as agricultural land shows good drainage and installers accept a visual assessment is not needed. Other reasons may be due to installers carrying out a trail hole and percolation test first and therefore avoiding a visual assessment. Another reason might be that installers that never carry out a visual assessment may not know how to carry out an assessment or may not need to carry out one due to holding years of experience of installing DWWTSs. From the survey the respondent that never performed a visual assessment was working as a sole trader. Although this may seem like a contributing factor and association that only sole traders do not perform visual assessments, however, it may not be a causation as the survey showed that other sole traders always carry out a visual assessment. Though this is a small group of survey respondents a trend may show if a larger group were surveyed. Furthermore, the installer surveyed showed that they received training in DWWTSs and has over ten years of experience.

The reason for not carrying out a visual assessment could be further suggested from the survey question of the use of the online site characterisation form available from the EPA website. This online tool assists in determining site suitability for a proposed site (EPA, 2019). Following on from the installers that do not always carry out visual assessments, the same installers also do not avail of the online site characterisation form. This site characterisation form is free and available online and allows the installer to input results on carried out percolation tests and trail hole assessments and make note of visual assessments. There may be several contributing factors for this which may include, that it is time consuming for installers to input information onto the site characterisation form or simply they are unaware this online form is available. However, from the results of the survey, most respondents have heard of online site characterisation form and additionally use the form often in carry out a site suitability assessment. The online site characterisation form also provides the relevant information needed for the planning authority when submitting a planning application for a new dwelling (EPA, 2010)

Most Counties in the State of Indiana regulate installers to ensure they are certified to install DWWTS. This regulation could suggest preventative measures for DWWTS failing and prevent incompetent installers installing DWWTS. Looking towards Ireland's attitudes to installation, the EPA under the EPA Code of Practice (2010) suggest that installers should be competent and suitably qualified. Looking towards at survey respondents, 64% of respondents said that they have carried out training. Furthermore 14% of respondents stated that they have not carried out training and 22% had no response when asked about training. It may be suggested that the no response did not carry out training. Since Ireland has no specific legislation for installers, this could be a contributing factor for failing DWWTS as seen in the EPA (2019) report which has reported the failure of 1,135 systems due to construction defects as one of the reasons for failure. Although some failures would be expected during the lifetime of a DWWTS, legislation for installers to be certified in installing a DWWTS may contribute to reduction of failure of DWWTSs if construction defects was one factor which was a contributing factor for the failure of treatment systems (EPA, 2019). This would also reduce the burden on householders with failing DWWTS in paying out costs that may not have been their fault. When respondents of the survey described the training received, it showed that different courses are available throughout Ireland. The different type of training available may be a contributing factor as more information may be included than other available courses, leading to installers with different standards and competencies in carrying out installations. Courses available in Ireland could be standardised to cover important areas in installation of DWWTSs and related areas to ensure all types of training received allows all installers to be suitably qualified.

From the results it is suggested that at least 14% of respondents are not able to determine if a site is suitable from the results of a percolation test and trail hole assessment. Furthermore, a further 14% of respondents do not consult with a competent person or authority when they are unsure of results on a proposed site. Although the percentage of respondents is low, it still highlights that a low number of installers are unaware of how to interpret fundamental assessments for a DWWTS. It also shows that installers are not consulting with a competent person or authority like the EPA to get guidance on results of proposed sites that they receive. This may suggest that a DWWTS are not being appropriately selected based on results of a site assessment and are not properly in line with the EPA Code of Practice. From the survey 7% of respondents did carry out training and has ten years of experience in installing DWWTSs while another 7% of respondents did not carry out training and only has 4 years of experience and both are unaware to determine results. However, these installers will consult with the competent authority or person which is reassuring that they will seek further guidance to ensure their work is in line with the EPA. From these results it could suggest that training courses that are available in Ireland may need to be reviewed. Additional training could be an important resource for installers to be able to determine such assessments. However, these installers may have experience in installing DWWTS, but due to these results systems could end up not performing properly due to the site location and design of the DWWTS and as a result can lead to contamination of groundwater sources and aquatic systems including a risk to human health (Devitt *et al.* 2016).

The responsibility of maintaining a DWWTS once it is installed is on the householder under the Water Services (Amendment) Act 2012. A study by Devitt *et al.* (2016) showed that most householders in Ireland were not able to demonstrate awareness of their DWWTS including the different types available and the maintenance required. Devitt *et al.* (2016) continues to report that householders find it difficult to gain both physical and visual access to their DWWTS including the sections of the DWWTS for inspection. Although it is guided that DWWTS have the required separation distances from the household, during the installation of the treatment system thoughtful means of allowing the householder gain physical access to the system would be necessary particularly since the onus is on the householder. This ability to gain access to a DWWTS may not always be feasible in all cases but should be considered when installing.

The opinion of installers that Ireland should have a type of program for certifying installers like Tippecanoe county was met with a strong opinion of positivity. From the opinions of respondents, respondents felt that a certification program would stop substandard work being carried out. Respondents seem to find problems with percolation areas are due to poor installation of DWWTS. Furthermore, respondents address that site assessments are carried out during the summer months when conditions are more favourable and not taking winter months into account. Although a type of certification program would help address these issues that installers expressed through the survey, a respondent addressed their view of why a type of certification system would not be suitable in Ireland. The installer opinion addressed that although a competent person will sign off a certification of completion on an installation of DWWTS, it would monitor installation by adding more legislation. The installer continues to address that links with suppliers of DWWTSs and engineers work together in supplying certain types of treatment systems. This opinion may contribute to only certain treatment systems being selected and limit the recommendation of other treatment systems to householders which may be more suitable.

4.2 Discussion of Certification program for installers in Tippecanoe County

The certification program for installers if regulated will need to be clearly outlined with the requirements for the program to installers. Howard County onsite sewage Ordinance (2006) clearly identifies the requirements outlined for installers to be certified. Furthermore, Allen County Onsite Sewage Ordinance gives a more detailed requirement in order to become certified.

The approach to the MCQ certification program is a knowledge-based examination. Installers that will be taking the MCQ examination will either know the answer or not.

No negative marking will be applied on the MCQ exam. Installers taking the exam will have a time of 3 hours to answer all the questions and a fee will be applied to sit the examination including renewal and repeat examination.

A rubric marking scheme outlined in chapter 2 under 2.2.4 was designed to grade installers based on the results of their examination. This marking scheme will help identify if installers have reached the threshold in successfully passing and becoming certified. In order to pass the certification program a score of at least 75% or above is required. Installers that score 74% or below will not reach the required score to become certified. This high pass rate distinguishes installers needs for competencies in order to carry out their work effectively and places trust in the TCHD that contamination of the environment and human health are not at risk. This pass rate score is in line with other counties in Indiana. For example, in Allen County a pass rate of 80% is required whereas in Howard County a pass rate of 70% or higher is needed. Repeat examinations that will be carried out should be taken within a month of taking the first examination.

Installers once certified should always hold their certification and be required to show EHO's when onsite issuing permits for treatment systems. Installers should comply with the legislation that they have been examined on including the Tippecanoe County Sewage Ordinance 1999. The certification will be valid for 3 years and will require installers to re-take the exam for renewal. Training days could be carried out for installers by EHO's based on the Indiana Residential Sewage Disposal Rule 410-IAC-6-8.3.

It is important that once the certification program is implemented, the TCHD reviews the program annually to ensure that the program is still up to date in the case of amendments to legislation or standards.

It is clear from the TCHD annual report (2017), 80 repair or replacement systems were carried out compared to nearly 100 installation of new treatment systems. These results from the annual report in 2017, it may be suggested that from these figures from the 2017 annual report that there is a clear need for certification of installers in Tippecanoe. Furthermore, the TCHD should examine the reasons for failure of treatment systems to determine reasons for so many replacement or repair of systems each year. The regulation of a program to certify installers may attribute to addressing the high number of replacement and repair of systems each year. Furthermore, it may be suggested that

TCHD could adopt a similar inspection plan as Ireland to inspect if DWWTS are working efficiently once installed and operational. From these figures it is also evident that there is a gap for the need of certification of installers in Tippecanoe.

Chapter 5 – Conclusion

Following the completion of this study, the following points were concluded.

5.1 Ireland

- It was noted that not all installers have carried out appropriate training in Ireland to be suitably qualified to carry out a site assessment on a proposed site.

- Consultation with a competent person or competent authority is not always being carried out if installers are unsure of site suitability results.

- Clear suggestion from installers through the research survey show that a form of regulation for installers in Ireland to be certified to install DWWTS was favourable to limit substandard of installation.

- Different types of training for installers in Ireland are available but may not be suitably designed to cover all areas of DWWTS installation and may need to be reviewed.

- Lack of awareness of maintaining a DWWTS by householders is not being addressed.

5.2 Tippecanoe

- The need for the certification program to certify installers is available and ready for implementation for the TCHD.

- The certification program covers a wide range of topic covered in the Indiana Residential Sewage Disposal Rule 410-IAC-6-8.3 and will test installers on most areas of this legislation.

- The certification program is a technical exam and therefore installers taking part in the certification exam will either know the answer or not.

- There are nearly as many replacement or repair of DWWTS in Tippecanoe according to the TCHD annual report 2017. The need for a certification program is needed in the Health Department to help tackle this issue.

- The certification program will need to be review by the Health Department and installers consulted of the potential certification program being implemented.

- A fee along with requirements for passing the certification program will be outlined to installers prior to taking the certification exam.

- When an installer is certified, their certification will be valid for 3 years and a renewal exam will be taken after expiration of their certification.

Chapter 6 – Recommendations

6.1 Recommendations

On completion of this research project, the following recommendations are proposed:

- It would be recommended that installers give follow up inspections to ensure Domestic Wastewater Treatment Systems are working after a year or 2 years and sign off ‘review of inspection after installation’ due to the level of failure of systems in Ireland.

- Installers should recommend advice and guidance to householders on maintaining and de-sludging DWWTS to ensure that the environment is protected from any contamination.

- A national training course should be established to ensure consistency with installation of DWWTSs including new technologies of treatment systems which help eliminate possible contamination to groundwater and the surrounding environment. Training courses that are already established should be reviewed.

- An International approach towards consistency in training and certification of installers should be viewed to help with ongoing failure of systems which would include research carried out with new technologies of treatment systems that can help and improve treatment of domestic wastewater.

- Training should also highlight the risk of when DWWTS fail and the harmful effects that can be at risk to human health and the environment.

- Training should ensure that installers are made aware of the Online site characterisation site form available from the EPA website and teach installers how to use the online tool.

- Local and National training days could be provided for installers in both Tippecanoe and Ireland. The TCHD or the Irish EPA could highlight the problems of current problems both authorities are facing but also highlight current research reports that may help both locations and keep installers informed of current trends.

- New technologies in treatment systems should be recommended to householders along with recommendation of quality treatment systems in both in Ireland and Tippecanoe. These new technologies in treatment systems offer better treatment of domestic wastewater which conventional septic system cannot and will help protect risk to human health and the environment better.

- Local Authorities should compile a list of installers that have completed training and recommend potential householders of these installers when submitting planning permission applications. This would show trust from the Local Authorities that these installers are competent in installing DWWTS.

- Recommendation that Local Authorities set up a register for installers to be registered under each authority.

- It would be recommended that Local Authorities in Ireland could issue permits to installers once they have carried out their inspection of a site suitability assessment.

- More research could be carried out among a larger group of installers to get a wider study and to see if trends would be like the small group of respondents that took part in this research.

- Recommendations that location of installation of DWWTS are considered for householders to allow for access for inspection and maintenance after installation.

6.2 Recommendations for Tippecanoe County Health Department

- It would be recommended that TCHD hold a meeting with established installers in Tippecanoe County and discuss the certification program that has been created in this research project. An outline of how installers will go and take the exam and be certified should be outlined. It would also be recommended that installer's feedback of the certification program will be heard and noted so that the TCHD can amend and change aspects of the program that installers might want to include or not include.

- Recommendations that TCHD review the certification program after discussing with installers and carry out a practice phase to see how the program is received.

- The TCHD should review the certification program once implemented on an annual basis to ensure it is still up to date and relevant if there is an amendment to legislation.

- Training days could be established so that Environmental Health Officers could carry out training before the certification exam is taken by installers.

- The TCHD could create a practice exam for installers to take so that installers can have an idea of how questions are phrased, worded and how questions must be answered. The TCHD could give areas of focus for installers to study before taking the exam.

References

1. Allen County Department of Health (2019), "*Allen County Code Title 10 Department of Health, Article 4.5 Allen County Private Sewage Disposal*", [Online], available: https://www.allencountyhealth.com/wp-content/uploads/2019/01/Allen-County-Private-Sewage-Disposal-Ordinance-Effective-02-04-19.pdf [accessed 12/09/19]

2. Anil, R. and Neera, A.L., (2016), "*Modified septic tank treatment system*", [Online], available: https://reader.elsevier.com/reader/sd/pii/S2212017316301165?token=59AE6DCA9E07623332930D4471CC4E4F390420797CDD02F89DF8A7BC8444C3DD1B6F09C2F5C10E6770B84AADFC311D90 *Procedia Technology*, *24*, pp.240-247. [accessed 08/09/19]

3. Centers for Disease Control and Prevention (CDC) (2018), "*Antibiotic/Antimicrobial Resistance (AR/AMR)*", [Online], available: https://www.cdc.gov/drugresistance/index.html [accessed 11/08/19]

4. Charles, K.J., Souter, F.C., Baker, D.L., Davies, C.M., Schijven, J.F., Roser, D.J., Deere, D.A., Priscott, P.K. and Ashbolt, N.J., (2008), "*Fate and transport of viruses during sewage treatment in a mound system*", *Water research*, 42(12), pp.3047-3056, [Online], available: https://www.sciencedirect.com/science/article/pii/S0043135408001103 [accessed 15/09/19]

5. Devitt, C., O'Neill, E. and Waldron, R., 2016. "*Drivers and barriers among householders to managing domestic wastewater treatment systems in the Republic of Ireland; implications for risk prevention behaviour*". *Journal of Hydrology*, *535*, pp.534-546.

6. electronic Irish Statute Book (eISB) (n.d.) "*S.I. No. 685/2006 - Planning and Development Regulations 2006*", [Online], http://www.irishstatutebook.ie/eli/2006/si/685/made/en/print accessed 10/09/19]

7. electronic Irish Statute Book (eISB) (n.d.) "*Water Services (Amendment) Act 2012*", [Online], available: http://www.irishstatutebook.ie/eli/2012/act/2/enacted/en/print#sec4 [accessed 12/09/19]

8. electronic Irish Statute Book (eISB) (n.d.) "*Water Services Act 2007*", [Online], available: https://data.oireachtas.ie/ie/oireachtas/act/2007/30/eng/enacted/a3007.pdf [accessed 12/09/19]

9. Environment and Health International Magazine (2015), "*Food Poisoning from oysters contaminated by sewage in South East Australia*" by Wood, J.M., Robertson, G., [Online], available: https://www.ifeh.org/magazine/IFEH-magazine-2015_v17-2.pdf page 76 [accessed 08/09/19]

10. Environmental Protection Agency (EPA) (2010), "*Code of Practice: Wastewater Treatment Systems for Single Houses*" [Online], available: http://www.epa.ie/pubs/advice/water/wastewater/code%20of%20practice%20for%20single%20houses/Code%20of%20Practice%20Part%201%202010.pdf [accessed 10/09/19]

11. Environmental Protection Agency (EPA) (2018), "*National Inspection Plan 2018-2021, Domestic Waste Water Treatment Systems*", [Online], available: http://www.epa.ie/pubs/reports/water/wastewater/NIP%202018%20to%202021_web.pdf [accessed 28/02/2020]

12. Environmental Protection Agency (EPA) (2019), "*National Inspection Plan, Domestic Waste Water Treatment Systems 2017-2018*", [Online], available: https://www.epa.ie/pubs/reports/water/wastewater/2017%20&%202018%20NIP%20Report%20Final.pdf [accessed 08/09/19]

13. Environmental Protection Agency (EPA) (2020), "*National Inspection Plan*", [Online], available: https://www.epa.ie/water/wastewater/nip/ [accessed 28/02/2020]

14. Environmental Protection Agency (EPA) (2020), "*Protecting your private well*", [Online], available: https://www.epa.ie/water/dw/hhinfo/protprivwell/ [accessed 28/02/2020]

15. European Commission (2011), "*Environment: Commission takes Ireland back to court over septic tanks and asks for a fine*", [Online], available: https://europa.eu/rapid/press-release_IP-11-592_en.htm?locale=en [accessed 12/09/19]

16. Garfí, M., Pedescoll, A., Bécares, E., Hijosa-Valsero, M., Sidrach-Cardona, R. and García, J., (2012), "*Effect of climatic conditions, season and wastewater quality on contaminant removal efficiency of two experimental constructed wetlands in different regions of Spain*", [Online], available: https://reader.elsevier.com/reader/sd/pii/S0048969712010406?token=6DB9BC3B16444F6C73E29E954E3FE39C73948BEEF4D50E1B9EAE1E5825E7A789C5049BA32394CAC37FD5621C8ECD3F56 [accessed 15/09/19]

17. Harden, H.S., Roeder, E., Hooks, M. and Chanton, J.P., (2008), "Evaluation of onsite sewage treatment and disposal systems in shallow karst terrain", *Water research*, *42*(10-11), pp.2585-2597, [Online], available: https://www.sciencedirect.com/science/article/pii/S0043135408000158#bib14 [accessed 16/09/19]
https://reader.elsevier.com/reader/sd/pii/S1438463917307307?token=313F7971DFACDE2D1508720DAF81ECE05B3FB3E85883B7B1F719AC5A29E3F35958C269EA5B6D9D669CBAB3674CD13920 [accessed 08/09/19]
https://www.sciencedirect.com/science/article/pii/S0022169416300403#b0125
https://www.sciencedirect.com/science/article/pii/S0269749117325320
[accessed 10/02/20]

18. Indiana Demographics by Cubit, (2019), "Tippecanoe County Population", [Online], available: https://www.indiana-demographics.com/tippecanoe-county-demographics [accessed 02/09/19]

19. Missouri Department of Health & Senior Services (Missouri DHSS), (n.d.), "*Onsite Wastewater Treatment Systems*", [Online], available: https://health.mo.gov/living/environment/onsite/systems.php/pdf/SystemOwnersManual.pdf [11/08/19]

20. National University of Ireland Galway (NUI Galway), (2012), "*Assessment Rubrics*", [Online], available: https://www.nuigalway.ie/media/celt/files/coursedesign/Rubrics.pdf [accessed 14/02/2020]

21. O'Dwyer, J., Hynds, P.D., Byrne, K.A., Ryan, M.P. and Adley, C.C., (2018) "*Development of a hierarchical model for predicting microbiological contamination of private groundwater supplies in a geologically heterogeneous region*", *Environmental Pollution*, *237*, pp.329-338. [Online], available:

22. Official Journal of the European Communities (1975), "*Council Directive of 15 July 1975 on Waste (75/442/EEC)*", [Online], available: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31975L0442&from=EN [accessed 12/09/19]

23. Resende, J.D., Nolasco, M.A. and Pacca, S.A., (2019) "*Life cycle assessment and costing of wastewater treatment systems coupled to constructed wetlands*", [Online], available: https://www.sciencedirect.com/science/article/pii/S0921344919302046 [accessed 15/09/19]

24. Richards, S., Paterson, E., Withers, P.J. and Stutter, M., (2016), "*Septic tank discharges as multi-pollutant hotspots in catchments*". *Science of the Total Environment*, *542*, pp.854-863. [Online], /available: https://www.sciencedirect.com/science/article/pii/S0048969715309761 [accessed 17/09/19]

25. Sharma, M.K. and Kazmi, A.A., 2015. Anaerobic onsite treatment of black water using filter-based packaged system as an alternative of conventional septic tank. *Ecological engineering*, *75*, pp.457-461. https://reader.elsevier.com/reader/sd/pii/S0925857414006739?token=B8261974477B47217123016E7A265D87A0A78F43FB62EE116CA98C2B538843B131E1E524F2520E15301FE24AF3FC8AB3 accessed 08/09/19]

26. Tippecanoe County Health Department (2017), "Annual Report 2016", [Online], available: https://www.tippecanoe.in.gov/DocumentCenter/View/13085/2016-TCHD-Annual-Report [accessed 02/09/19]

27. Tippecanoe County Health Department (2018), "Annual Report 2017", [Online], available: https://www.tippecanoe.in.gov/DocumentCenter/View/16790/2017-TCHD-Annual-Report [accessed 02/09/19]

28. United States Environmental Protection Agency (USEPA) (2018), "*Municipal Wastewater*", [Online], available: https://www.epa.gov/npdes/municipal-wastewater [accessed 11/08/19]

29. United States Environmental Protection Agency (USEPA) (2018), "*Types of Septic Systems*", [Online], available: https://www.epa.gov/septic/types-septic-systems [accessed 06/09/19]

30. Vymazal, J., 2014. "*Constructed wetlands for treatment of industrial wastewaters: a review*", *Ecological Engineering*, *73*, pp.724-751, [Online], available: https://www.sciencedirect.com/science/article/pii/S0925857414004455 [accessed 09/09/19]

31. Wang, H., Sikora, P., Rutgersson, C., Lindh, M., Brodin, T., Björlenius, B., Larsson, D.J. and Norder, H., (2018), "*Differential removal of human pathogenic viruses from sewage by conventional and ozone treatments*", *International journal of hygiene and environmental health*, *221*(3), pp.479-488. [Online], available:

32. World Health Organisation (2019) "*Wastewater*" [Online], available: https://www.who.int/water_sanitation_health/sanitation-waste/wastewater/en/ [accessed 11/08/19]

33. World Health Organisation (2019), "*Water*" [Online], available: https://www.who.int/topics/water/en/ [accessed 11/08/19]

34. Wu, H., Zhang, J., Ngo, H.H., Guo, W., Hu, Z., Liang, S., Fan, J. and Liu, H., (2015), "*A review on the sustainability of constructed wetlands for wastewater treatment: design and operation*", *Bioresource technology*, *175*, pp.594-601, [Online], available: https://www.sciencedirect.com/science/article/pii/S0960852414014904 [accessed 09/09/19]