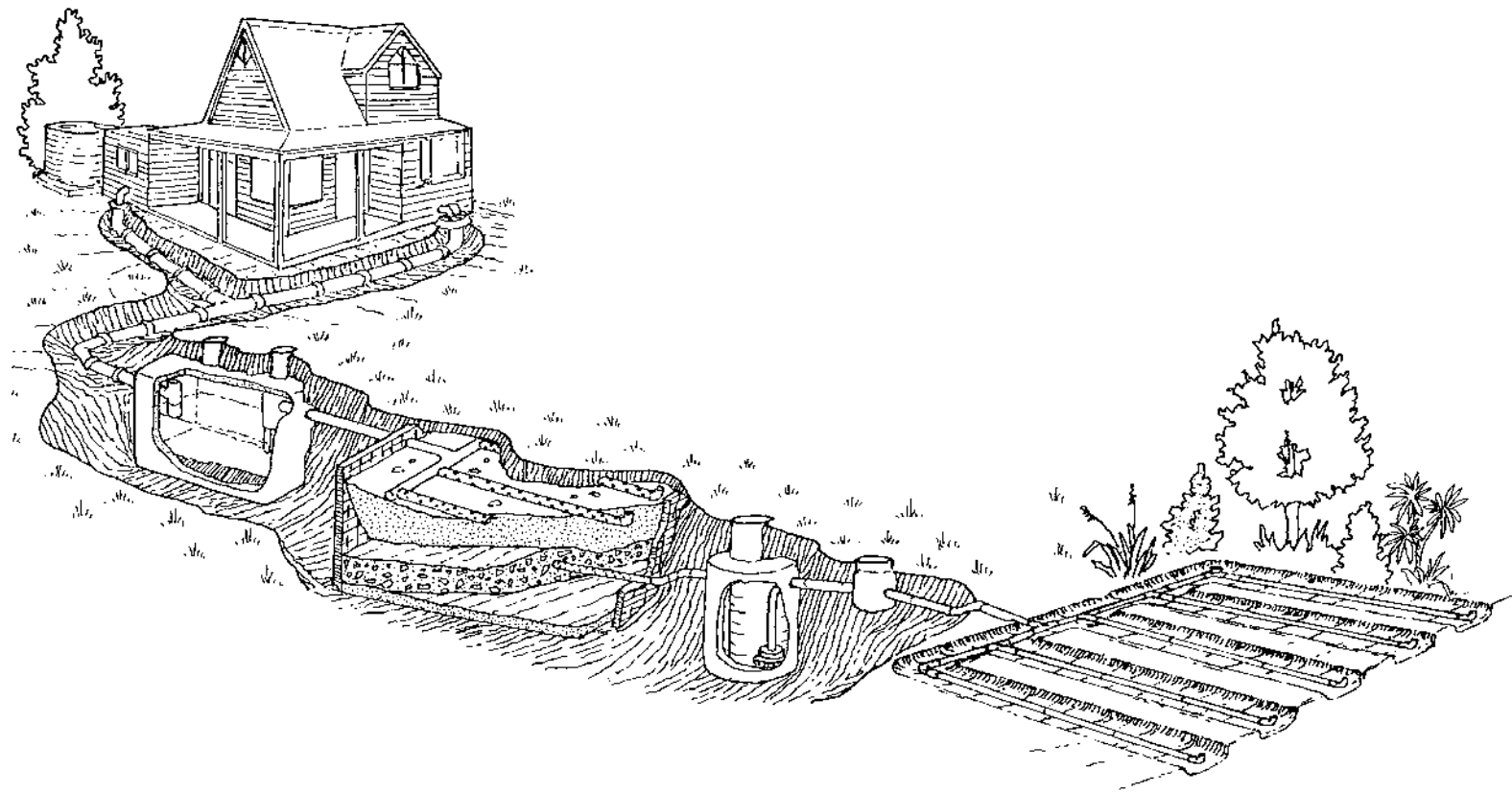


8 > Dosing & Distribution Methods



8. DOSING & DISTRIBUTION METHODS AND FIXTURES FOR SUBSURFACE LAND DISPOSAL SYSTEMS

8.1 SELECTION OF DOSING AND DISTRIBUTION METHOD

Following treatment, the treated wastewater is discharged to surface and subsurface land disposal systems either by a pressurised (controlled) distribution method in doses or by a gravity (uncontrolled) distribution method. The distribution options available include:

Dosing Methods & Devices

- i. **Controlled Dose Loading Devices**
 - Pump.
 - Siphon.
- ii. **Controlled Dose Loading Methods**
 - On demand.
 - Timer control.
- iii. **Uncontrolled Gravity Loading**
 - Trickle Gravity Flow, on demand.
- iv. **Distribution Methods To The Land Disposal System**
 - Automatic sequencing valve.
 - Distribution manifold.
 - Distribution box.
 - Manual Diversion Valves
 - Drop box loading.
 - Serial loading (superseded by drop box loading).
- v. **Distribution Pipe Work In The Land Disposal System**
 - Pressure Compensating Dripper Irrigation.
 - Low Pressure Pipe Distribution (LPP).
 - Low Pressure Effluent Distribution (LPED Nested Dual Pipe System).
 - Drain coil.
 - Perforated PVC Pipe.
- vi. **Distribution Aggregate**
 - Granular distribution media within the trench.
- vii. **Graveless Systems**
 - Vaulted trench distribution.
 - Graveless PVC vault distribution.

The selection of the most appropriate method for discharging wastewater from the treatment system to the land disposal system can be determined from the following Sections 8.2 to 8.9.

8.2 CONTROLLED DOSE LOADING DEVICES

Discharging a controlled dose volume, by pump or siphon, allows for the wastewater to be distributed along the entire length of distribution line and hence across the entire infiltrative area with each dose. This allows for more effective treatment within the land disposal system by utilising the entire infiltrative surface and not overloading a small area of the infiltrative surface potentially resulting in creeping failure. In addition, the greater the number of doses and more evenly they are spread over a 24 hour period, the more the evapotranspiration and renovation of the wastewater by the receiving soils will be enhanced. In free draining soils, dosed loading can limit the potential for development of creeping failure commonly associated with gravity trickle loading. Dosing may have less value in a poorly draining system where waterlogged conditions prevail irrespective of effluent doses. The advantages of dosed systems outweigh the perceived disadvantages of additional mechanical devices [Ref 3].

8.2.1 Pump controlled loading

Pumped dose loading is preferable to siphon dosed loading as the volume and timing of the dose can be readily controlled to best suit the distribution and land disposal system.

8.2.2 Siphon Controlled Loading

Siphon loading is suitable where there is sufficient height difference between the tank outlet and downslope land disposal system for the siphon to operate. Siphon dose loading provides for a set volume of pretreated wastewater to be discharged to the land disposal system. However pretreated wastewater can only be dosed on demand and can still result in overloading of the land disposal system infiltrative surface. Where sufficient head is available to operate a sequencing valve the impacts from demand dose loading can be reduced by sequentially loading a series of beds or trenches.

8.2.3 Controlled Flood loading by Pump or Siphon

Controlled flood loading comprises dosing by siphon or pump discharge to a distribution box, for gravity flood flow to all or to selected sections of the land disposal area.

To be effective, the siphon chamber or pump sump should be sized to break the daily design maximum flow into a minimum of at least 5 to 6 doses per day. The distribution box should be designed to handle flow volumes delivered with each dose, and ensure effective loading of the whole or selected sections of land disposal system.

The length of the subsurface distribution lines should be limited to ensure even distribution and to prevent potential for the dose cycle to overload the front sections of the land disposal system and under loading of the end sections. Maximum suggested distribution line lengths are 12 to 15m for effective loading and should provide reasonable distribution where 100mm perforated distribution lines are used. Hydraulic characteristics for both siphons and pumps will be available from the manufacturers to assist with equipment selection and system design.

8.3 CONTROLLED DOSE LOADING METHODS

Methods for operation of a pump dosing device are either on-demand or timer control of which timer control is the most effective and preferred method.

8.3.1 On-Demand Dose Loading

On-demand dosing systems are siphon or pump operated by float switch. In both cases wastewater doses to the land disposal system are concentrated around the time of wastewater production when the wastewater level has built up in the tank. On-demand dose loading potentially results in saturated conditions and inferior treatment.

8.3.2 Timer Controlled Dose Loading

Timer dose loading allows the discharge of an equal volume and at preset time intervals over 24 hours. Wastewater produced at peak production times during the day are buffered and discharged evenly over the day. The advantages are significant in that this allows more effective control of unsaturated conditions of the infiltrative surface and underlying soil thus reducing the rate of infiltrative surface clogging and improving in ground treatment [Ref 3].

8.4 UNCONTROLLED TRICKLE LOADING

Uncontrolled trickle flow by gravity was the conventional loading method and should now only be used where there is no alternative. The disadvantage of gravity trickle loading is that wastewater may not be distributed across the entire application area and in well drained soils can result in creeping failure.

8.5 DISTRIBUTION METHODS TO LOAD THE LAND DISPOSAL SYSTEM

8.5.1 General

Where alternating loading of effluent is proposed into either individual sections of a land disposal system, or into duplicate systems on a load and rest cycle, then proprietary automatic or hand operated units are available to switch flow between sectors in accordance with the management plan for the system.

8.5.2 Alternation of Loading and Resting

The use of distribution boxes or diversion valves in either gravity or pressurised application systems enables sections of the land disposal system to be rested as required by diverting flow to portions of the system on an alternating basis. This will temporarily overload the loaded section of the land disposal area resulting in an elevated daily loading rate, unless the system has been designed with excess capacity to allow for alternating loading without a daily exceedence of the design application rate.

The resting of a section of a subsoil soakage land disposal system (such as trenches and beds) will only benefit the system's longterm acceptance rate (LTAR), if the rested section fully drains and dries out during each rest period. The rest period in a free draining system will enable rejuvenation of the infiltrative surfaces by aerobic action and drying. On resumption of loading the system will then operate at higher infiltration rates than before resting. These infiltration rates will then progressively, but slowly, decrease over the next operational period as clogging slimes build up again on the infiltrative surfaces.

Resting has no value in non free draining soils that remain waterlogged or only slowly drain during the rest period. Not only is resting not applicable in such situations, but the type of land disposal system or/and loading rate should be reconsidered. Systems using soakage and evapotranspiration rather than purely subsurface soakage application systems being more appropriate in such conditions.

Subsoil soakage systems which are designed to operate without periodic resting and rejuvenation do so at a LTAR (longterm acceptance rate) associated with continuously flooded conditions. In slowly draining soils, such systems could benefit from having duplicated land disposal areas (each designed for 100% of design flows) where resting may take place on 6 month or 12 month cycles.

8.5.3 Automatic Sequencing Valves

Where sufficient head from pump or siphon dosing is available, automatic sequencing valves can be utilised, reducing dependence on the manual operation of hand operated valve units. Sequencing valves, with two, four, or six outlets, switch automatically at pump start up, or under build up of siphon discharge flow pressure. This allows each distribution line or sector to be dose loaded separately and in sequence, with a predetermined dose volume. Division of controlled doses to each sector allows for better control over dose volumes allowing for smaller doses to a number of sectors instead of one large sector and therefore the use of smaller pumps as the volume per dose is reduced.

Head requirements to trigger sequencing valve rotation will need to be confirmed with the manufacturer/supplier. Depending on the sequencing valve spring pressure a head of 4 to 6m is likely to be required in addition to the distribution system pump head required. In any case, during construction and installation a full scale operational trial should be undertaken with clean water to confirm sequencing performance of the unit. For siphons, an important design requirement is that the feed line from the siphon outlet to the sequencing valve has a capacity at least equal to the dose volume. If not, flow may back up the discharge line and interrupt siphon action before the dose cycle is completed, prompting the siphon to cease dosing operation and trickle continuously.

8.5.4 Distribution Manifolds

Proprietary distribution manifolds are available for loading controlled distribution systems and also allow diversion of flow if resting of a sector is required.

8.5.5 Distribution Boxes

A range of layouts for gravity loading (trickle or flood) are possible. For gravity trickle distribution, or pump dosed distribution various proprietary fittings are available to enable the adjustment of outlet levels to ensure even distribution to each line.

8.5.6 Drop box Loading

The method only works on sloping sites as it operates on the basis of incremental loading via gravity flow to a series of trenches or beds. It is generally less favoured here due to the preferential loading of the uppermost trench potentially leading to creeping failure of the system. In all cases pressurised distribution by pump to ensure even distribution over the maximum area is now considered more appropriate.

Drop boxes require sloping sites when they operate on the basis of incremental loading of a series of parallel trenches via gravity flow downslope. The top drop box can be either gravity fed direct from the pretreatment unit, or pump loaded where the land disposal area is located upslope of the treatment unit. Controlled dose loading is the preferred method to feed treated wastewater to the drop box.

Each section of the land disposal system (either trench or bed) at LTAR, is kept flooded at a predetermined level. In relatively free draining soils with higher LTAR values this means the top section of the land disposal area can be maintained under continuous load for long periods. Other sections downhill do not come into operation until overflow takes place from the uphill section. The system can respond to seasonal variations in subsoil soakage rates and evapotranspiration rates by automatically increasing the number of downslope sections of the land disposal area brought into operation during the winter wet periods, and automatically reduces the proportion of the area used during summer drying conditions. The drop box configuration allows shutdown of any section of the land disposal area (e.g. trench or bed) for resting, and it is thus practical to rest the upper section during summer while bypassing flows to the lower portions, which are least frequently in operation.

Reserve area should be provided downslope of the land disposal area to enable extension of the drop boxes and land disposal area as required, and then resting the original upslope system.

8.5.7 Serial loading

This method has been superseded by drop box loading.

8.6 DISTRIBUTION PIPE WORK WITHIN THE LAND DISPOSAL SYSTEM

The pipework in a surface or subsurface distribution system will generally comprise sealed feed lines leading from the distribution system to connect to the perforated distribution lines within the land disposal system area. Careful design and installation of the whole system is critical to ensure that the design area is uniformly loaded, and no effort should be spared in both design and supervision of construction to ensure this objective is met.

It is important that sealed feed lines are not constructed through trenches or beds, since this provides a potential channel for short circuiting of effluent from upslope areas to downslope sections of the system and lower end of the main distribution pipe trench. All distribution pipes should be end fed as shown in Figure 8.2.

The performance of a trench or bed land disposal system is controlled by the effectiveness of the distribution system.

8.6.1 Pressure Compensating Drip Emitter Distribution

Proprietary drip emitter systems are a favoured method for both surface and subsoil irrigation distribution. These systems are discussed in Section 9.2.

8.6.2 Perforated PVC Drain Lines

Perforated rigid PVC pipe is used as an alternative to drain coil, and for many authorities is the preferred distribution method for gravity trickle/flood loading. Perforations may be either drilled holes or saw cuts. Figure 8.1 gives details of sizes to meet the 2% surface area criteria.

8.6.3 Low Pressure Pipe Loading (LPP & LPED)

In situations where flood loading is neither practical nor suitable (for example Category 1-3 soils) a perforated pressure line system loaded by pump or siphon is an alternative for spreading effluent evenly over the full design area. This method is suitable for both free draining and slowly draining soils. LPP (low pressure pipe) and LPED (low pressure effluent distribution) are essentially the same. The difference between the two is that an LPED pressure line is inserted (nested) within drain coil distribution line and a LPP line is not. Where LPED is used for free draining soils it is considered a distribution method to ensure applied wastewater is distributed onto the entire design basal application area in which case design is based on the land disposal method and not LPED areal loading design procedure. Where used in moderate to slowly draining soils LPED is used to distribute the wastewater within a shallow trench and design loading determined on an areal basis.

Design of the Distribution Lines

The pressure lines should be laid within the distribution aggregate along the full length of the land disposal system element (such as a trench length). To achieve effective distribution, the discharge rate from each perforation in the system must be approximately equal, requiring careful balancing of the head loss and flow rate in each distribution line along with selection of appropriate line diameter, hole size and spacing. In addition, the bottom of the system must be accurately levelled in order to avoid low spots, as the dosed flow will tend to overload such spots. Some designers advocate clay or concrete dams at intervals along the system length in order to counteract any inaccuracies in construction and installation. In any case a clay or concrete dam is required at the start of each line to prevent short circuiting via the transport line trench.

Sizing the Dose Volume

The size, number and spacing of discharge orifices in each distribution lateral cannot be designed by a rule of thumb if the laterals are to be evenly loaded.

Where the land disposal system is on sloping ground with each line laid to a different contour, then in addition to a control valve from the manifold to each line, a check (nonreturn) valve must be provided after each control plate to prevent back flow into the main header line and overloading the lower most trench. However, the system will only load evenly when it is fully pressurised resulting in overloading of the lowest lateral during pressurising and draining parts of the cycle.

Determining the pressure within each lateral, outlet orifice spacing and outlet orifice diameter is critical for the correct operation of an LPP or LPED system.

Where it is proposed to dose load the LPP or LPED system by siphon the main transport line from the siphon should be sized to ensure open channel flow and maintained as straight as possible. This minimises the potential of an airlock in the transport line and overloading a section of the application system. The main transport line is also to have sufficient volume to prevent backing up of discharge water to the siphon. If discharge water backs up to the siphon while discharging it can trip such that trickle discharge occurs and wastewater is concentrated into the distribution trench at the lowest point in the irrigation system resulting in overloading and wastewater breakout.

In situations where the system is dose loaded by pump and given the duty rating of the pump to be used, the elevation of pump relative to distribution lines, the difference in elevation of each line, the

size and friction factors of the feed lines, manifold, and distribution lines, then the operating pressure within each distribution line can be determined using standard hydraulic calculation procedures.

The diameter of distribution laterals is based on the requirement that there be no more than 10% variation in flow between one end and the other. The spacing of squirt holes and the longest lateral length must be determined before selecting the lateral diameter.

Some designers have adopted 5.0mm, 4.0mm or 3.0mm diameter perforations. It is important that a squirt height of 1.5m is achieved at each outlet orifice to maximise self scouring. The hydraulic calculations should be undertaken by design specialists. Commercial computer software programmes are available for such calculations. Each lateral can either be loaded individually via a sequencing valve so long as sufficient head is available to trigger rotation or alternatively the entire lateral network can be loaded with each dose. Where the entire lateral network is dose loaded it is important that each lateral is loaded equally and discharge not concentrated into the lowest trenches and can be achieved by placing a flow control plate at the start of each lateral. The control plate orifice size can only be calculated when the height of each lateral, length and number of outlet orifices are known and ensures even loading although individual trenches may be of variable length and elevation. A nonreturn valve at the start of each line ensures the higher elevation laterals do not drain to the lowest laterals between doses and overload the lower lines.

Once the lines are installed and *before* they are covered, the **system must be fully tested with clean water** so that the effectiveness of the dosing system, orifice outlet spacing and lateral lengths can be determined. Any variation in distribution can then be field adjusted by altering hole diameter or spacing, or by adjusting the manifold valves. This is particularly important on sloping sites with several distribution lines at different elevations.

All distribution lines *must* be capped or screw plugged with removable end pieces to enable maintenance in case of line blockage. Any growth which could clog perforations can be dislodged by scoured using high velocity flow to discharge through the uncapped end, disposing of the spent cleaning mixture via a temporary soakhole. The use of oxidising agents such as bleach has a detrimental effect on the soil bacteria and should only be used as a last resort. Checking for blockage of the perforations can be undertaken by checking the pump pressure at the end of each line. This should be undertaken regularly during the life of the system particularly in response to problems involving uneven loading.

8.6.4 LPED (Low Pressure Effluent Distribution)

LPED systems were originally developed for use in free draining coarse soils situations (Soil Categories 1 and 2) where neither gravity trickle, nor flood dose, nor pressure pipe loading provide even distribution along the length of the application system. In these soils, traditional loading tends to overload the porous subsoil at the front sections of the system, while pressure pipe distribution overloads the subsoil in the vicinity of each perforation. This results in progressive reduction of the soil infiltration capacity and can ultimately lead to system failure.

LPED systems consist of a small diameter perforated pressure line inserted (nested) within a draincoil distribution line, thus allowing the jetted flow from the perforations to spread via ponding along the inside length of the draincoil line, and thereby enabling more uniform infiltration loading throughout the system. Hydraulic design is identical to that for pressure pipe loading.

LPED systems are also used as an alternative distribution technique to LPP (low pressure pipe) land disposals systems based on shallow trenches in deep topsoil with "areal" loading of the design area.

Design of the distribution system, hole spacing and number of holes is the same as for LPP.

8.6.5 Draincoil

PVC draincoil is manufactured for land drainage purposes. Its use for effluent distribution via circumference drainage slots is the exact reverse of its intended use. It does however offer a large number of perforations per unit of surface area, enabling effective distribution of effluent throughout its length. Where sediment blocks any slots there are ample additional openings to cope, and it has been used successfully as an alternative to field tiles since 1976. Proprietary brands of draincoil meet the 2% area requirement for perforations as previously recommended by NZS 4610:1982. Some agencies are not satisfied that draincoil is an appropriate distribution method; in such cases use of perforated PVC rigid pipe would be the preferred distribution method.

8.6.6 Perforated PVC Pipe

Perforated PVC rigid pipe is used as an alternative to draincoil. Perforations may be either drilled holes or saw cuts. Figure 8.1 gives details of sizes to meet the 2% surface area criteria.

Figure 8.1: Perforation Details for Distribution Lines in Rigid PVC

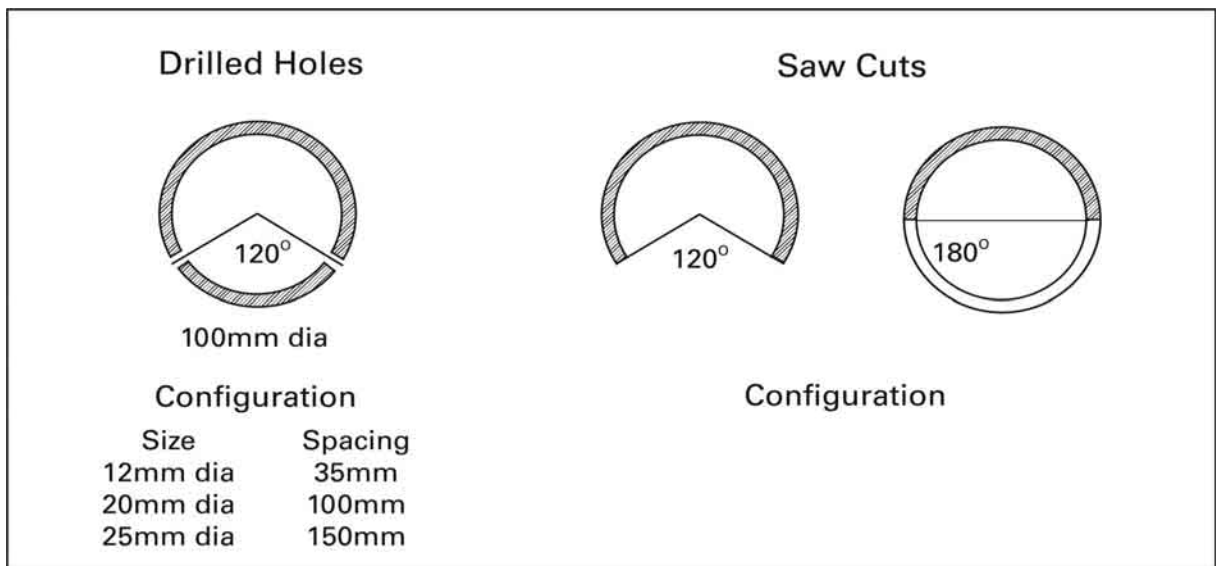
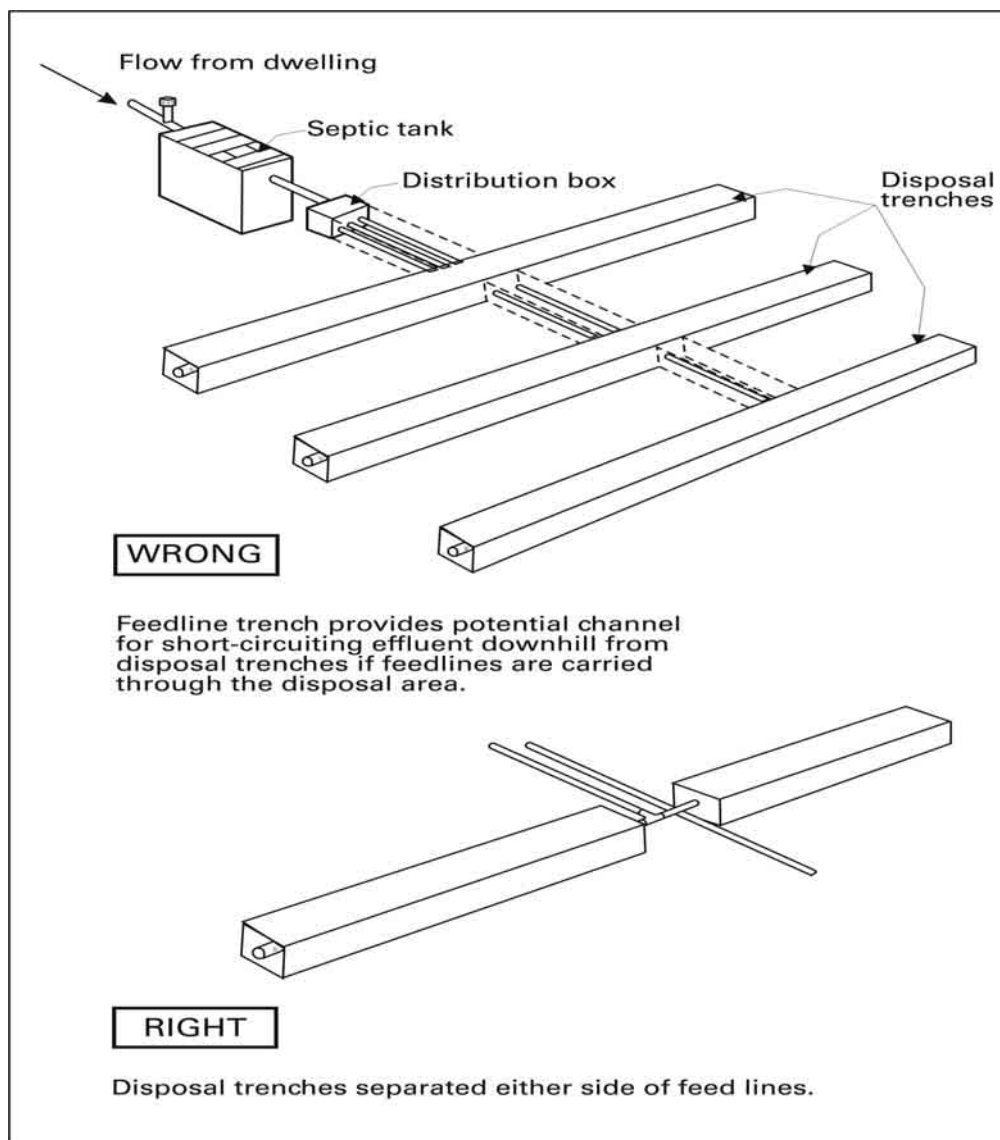


Figure 8.2: Effluent Distribution



8.7 TRENCH AND BED DISTRIBUTION AGGREGATE

8.7.1 Distribution Aggregate (Granular Media)

Graded aggregate (granular media) of durable material is required to support the distribution lines, and enable spread of the applied treated effluent over the design surface area within the land disposal system. The size of aggregate was set at 50mm to 70mm by the earlier Standard NZS 4610:1982. The new joint Standard AS/NZS 1547:2000 [Ref 1] recommends 20mm to 40mm size. The design loading rates recognise that the aggregate itself creates a shadow effect on both bottom area and sidewalls where individual aggregate elements rest against the soil, and that only exposed portions of the soil enable direct infiltration.

If the aggregate is sized too small, the biofilm (bacterial slime) generated by soil bacteria interaction with the organic matter in the effluent can clog at depth into the media. Distribution aggregate must

be totally free of fines or dust that can coat the base of the design area and reduce the soil infiltration capacity. It preferably should be washed before placement. The use of quarry rejects as a means of economising on aggregate installation is in fact false economy, and likely to be a contributing factor to system early failure, with need for costly system replacement.

8.8 GRAVELLESS TRENCH SYSTEMS

8.8.1 Vaulted Trench Distribution

Proprietary polyethylene vault systems, which provide airspace over the horizontal infiltrative surface, can avoid the need for distribution media. Systems either have slotted sidewalls that shelter the effluent distribution slots from surrounding soil or have a surrounding aggregate backfill to protect against potential soil blocking of the openings.

Inspection ports enable access to determine development of clogging mats on the horizontal infiltration surface, and with careful design, sections can be removed to allow access for raking the infiltrative surface. Gravity trickle loading into vault systems can lead to progressive failure in free draining soils, hence controlled loading via LPP or LPED line should be installed within the vault. In other soils loading by pump or siphon can ensure that incoming flows are routinely distributed fully over the infiltrative area. The cost of the vaults has limited their use in New Zealand.

8.8.2 PVC Vaults

An alternative to vaulted trench distribution is to substitute a large rigid PVC pipe cut in half lengthwise placed in the trench and covered over with soil. Treated wastewater is distributed along the trench within the PVC vault by the LPP method.

8.9 PUMP CHAMBERS

8.9.1 General

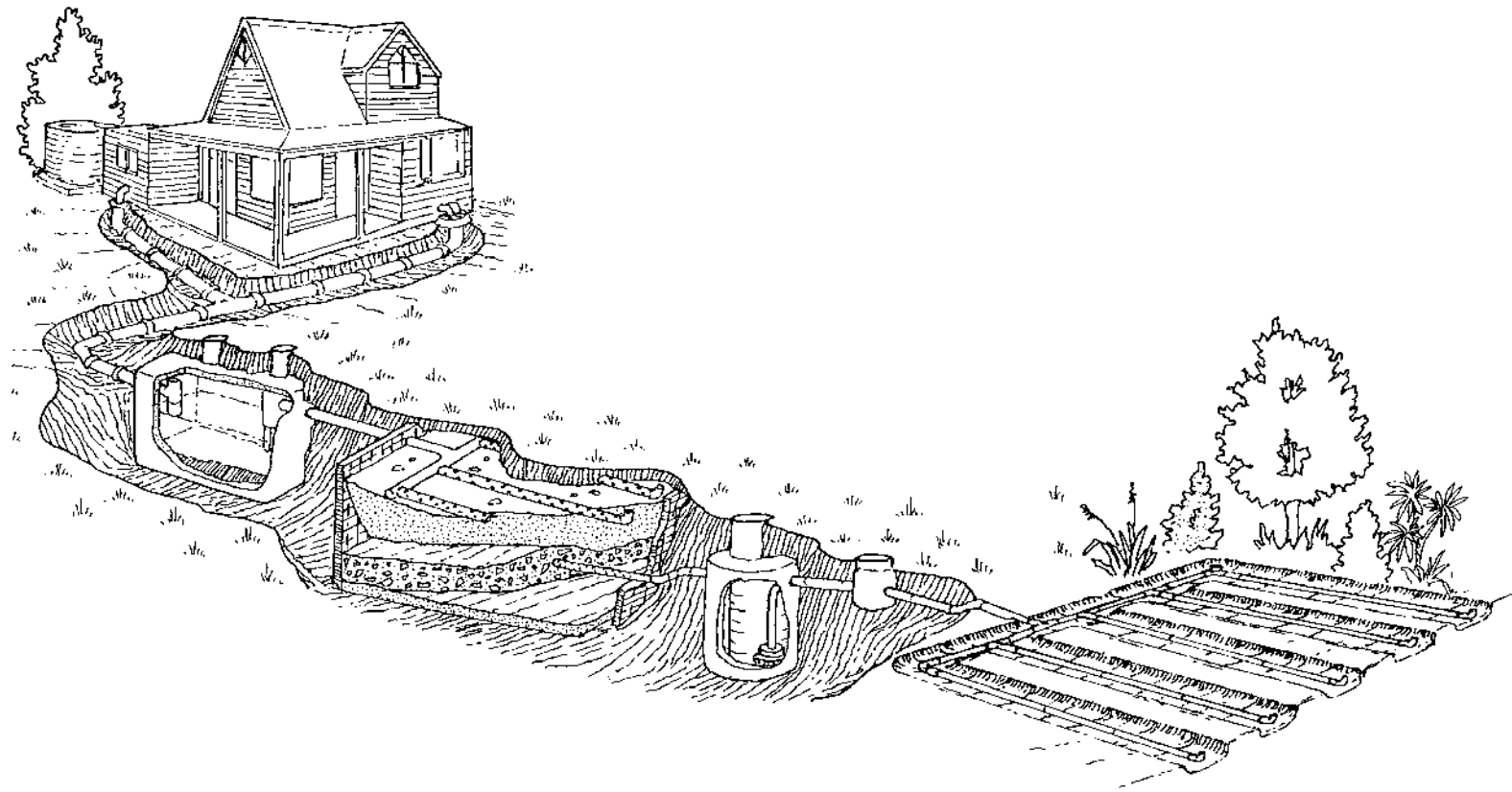
Any pump chamber associated with a septic tank, aerated treatment plant, sand filter dosing chamber, recirculation tank or treated wastewater holding tank, should include 24 hours emergency storage above the high water level alarm. Emergency storage is required to provide sufficient time to rectify a problem in the event of any mechanical or electrical failure. Failure to provide sufficient emergency storage can result in unauthorised overflow of wastewater.

An acceptable substitute to emergency storage in an individual pump chamber is provision of gravity overflow to another chamber, which contains additional emergency storage capacity.

8.9.2 Pump Chamber Alarm Systems

All pump chambers should include a high water level alarm, which activates in the event of the water level rising above the design working volume in the pump chamber. There are a number of float switches or probe systems available to activate alarms. The alarms may be audible or visual. Audible alarms have the advantage that they are noticed and acted upon at an early stage whereas visual alarms can be easily missed resulting in concentrated discharge from the chamber. The disadvantage of audible alarms is that they must comply with New Zealand alarm and security standards.

9 > Land Disposal - Shallow Irrigation Systems



9. LAND DISPOSAL – SHALLOW IRRIGATION SYSTEMS

9.1 SUBSOIL SOAKAGE – GENERAL

The objective of the land disposal system is to provide further treatment of effluent via assimilation through the soil matrix for eventual plant uptake of soil moisture via transpiration, or for evaporation or for percolation through the soil matrix for eventual assimilation with groundwater. Land disposal systems, also known as land application systems, must be designed for a loading rate close to the estimated LTAR (long term acceptance rate) for the soil conditions. LTAR represents the steady state infiltration rate over time following full development of the biological clogging mat that builds up on infiltrative surfaces under continuous use with the application of primary treated effluent. This may take several weeks or months to develop for a new system. Design loading rates are set below the estimated LTAR so that when clogging regimes develop on and into the subsoil infiltrative surfaces, infiltration capacity is maintained, and ponding within the land disposal area will not result in effluent breakout.

Actual acceptance rates will be affected by the capacity of the subsoil to accept effluent through the biomat layer generated by microbial growths feeding on the organic matter in the treated effluent. With shallow soakage systems, effluent organic matter is taken up by aerobic microorganisms within the well aerated upper soil layers at a faster rate than the anaerobic microorganisms which predominate under saturated conditions at depth. Hence application of the “KISS” (keep infiltration systems shallow) principle enables the aerobic upper subsoil and topsoil mantle to be utilised to provide for assimilation of effluent organic matter, uptake of nutrients into vegetation biomass, and transpiration thereby minimising effects on groundwater.

In all design situations, the requirements for separation distances to surface and groundwater as set out in Table 5.2 should be maintained.

Following are the irrigation methods covered in this section below:

- Pressure Compensating Dripper Irrigation (PCDI).
- Low Pressure Pipe Subsurface Irrigation (LPP).
- Low Pressure Effluent Distribution Irrigation System (LPED).
- LPED Subsurface Trickle Irrigation.
- LPED Surface Trickle Irrigation.

9.2 PRESSURE COMPENSATING DRIPPER IRRIGATION SYSTEMS

9.2.1 General

Such systems are utilised for distribution of secondary quality effluent or better via pressure dosing into (subsurface drip) or onto (covered surface drip) land disposal areas. Secondary treatment is usually provided via Aerated Treatment Plants (Figure 7.4) or Intermittent Sand Filter and Recirculating Sand Filter, Recirculating Textile Filter, Recirculating Trickling Textile Filter and Recirculating Foam systems (Figures 7.5, 7.6, 7.7 & 7.8). Commercial companies who market specific types of dripper irrigation lines generally provide guidance on system design, layout and operation. Figure 9.1 is a schematic diagram of a pressure compensating drip irrigation system.

9.2.2 Function and application

Two types of pressurised drip irrigation emitter are available, *pressure compensating* and *nonpressure compensating* comprising small diameter pressure pipe with inline effluent discharge emitters built into the pipe typically at spacings of 0.6 to 1.0m.

Pressure compensation allows equal wastewater flow from each emitter although the lines do not need to be level. Dripper irrigation lines are typically installed in parallel lines on the contour and buried at depths in the order of 50 to 200mm within the topsoil zone. Irrigation lines can be placed on and pinned to the ground surface within areas densely established in trees and covered over with leaf fall or mulch or left exposed. Where irrigation lines are on the ground surface in areas where there is potential for human access, the irrigation area should be fenced. It is recommended that irrigation lines be buried wherever possible.

The advantages of pressure compensating drip irrigation (PCDI) over trench, bed and mound land disposal methods are:

- Subsurface slow rate irrigation allows wastewater to be discharged into a specific soil zone and the ability to provide slow rate land treatment using the topsoil as a biofilter.
- That the lines need not be installed level while still maintaining even distribution of wastewater between individual emitters and over the area of the land disposal system.
- Allows more flexible use of a site than traditional systems.
- Distribution within the irrigation area can be targeted to a specific soil horizon.
- Timer dose loading optimises land treatment within the biologically active topsoil.
- Wastewater can become a valuable resource for reuse to subirrigate lawns and gardens minimising potable water requirements.
- Lines can be placed on the ground surface within densely vegetated (bush covered) areas without the requirement for trenching and damage to root systems.
- Lines can be installed where trench or bed land disposal is impractical such as heavily vegetated areas without the requirement for excavation of trenches.
- PCDI allows widespread low application distribution minimising wetting of the ground surface while utilising evapotranspiration assistance of vegetation.
- Allows ongoing access to lawn areas, which would be out of bounds where bed or mound systems are installed. Extreme care is required where subirrigation of lawns is proposed particularly under high traffic areas. The most conservative design areal loading rate is recommended. The use of PCDI under lawns is discouraged where alternative irrigation areas are available on the site.

The Auckland Regional Council strongly discourages placement of pressure compensating dripper irrigation lines on the ground surface in situations where they could be buried. There are increased risks associated with wastewater irrigation onto the ground surface such as:

- Increased risk of human contact and therefore health risks.
- Increased risk of runoff to surface water or stormwater drains.
- Increased risk of damage to irrigation lines during vegetation maintenance.
- Increased risk from vandalism if located adjacent to areas of public access.

The most recent development in pressure compensating dripper irrigation technology is irrigation line that does not drain following cessation of each dose volume charge. This has the advantages of preventing draw back of solids into the line via the emitters in response to suction forces developed when lines drain back to the lowest topographical point and allowing for rapid pressurisation at the beginning of the dosing cycle. The disadvantage is that a higher head capacity pump is required for some brands of emitter than for would be necessary for standard pressure compensating dripper irrigation.

Nonpressure compensating irrigation lines must be installed level along the contour to achieve even distribution of wastewater from each emitter. Typically pressure compensating dripper irrigation lines are installed in preference to nonpressure compensating lines as they provide more certainty with regard to even distribution throughout a land disposal area.

9.2.3 Areal loading rates for pressure compensating drip irrigation

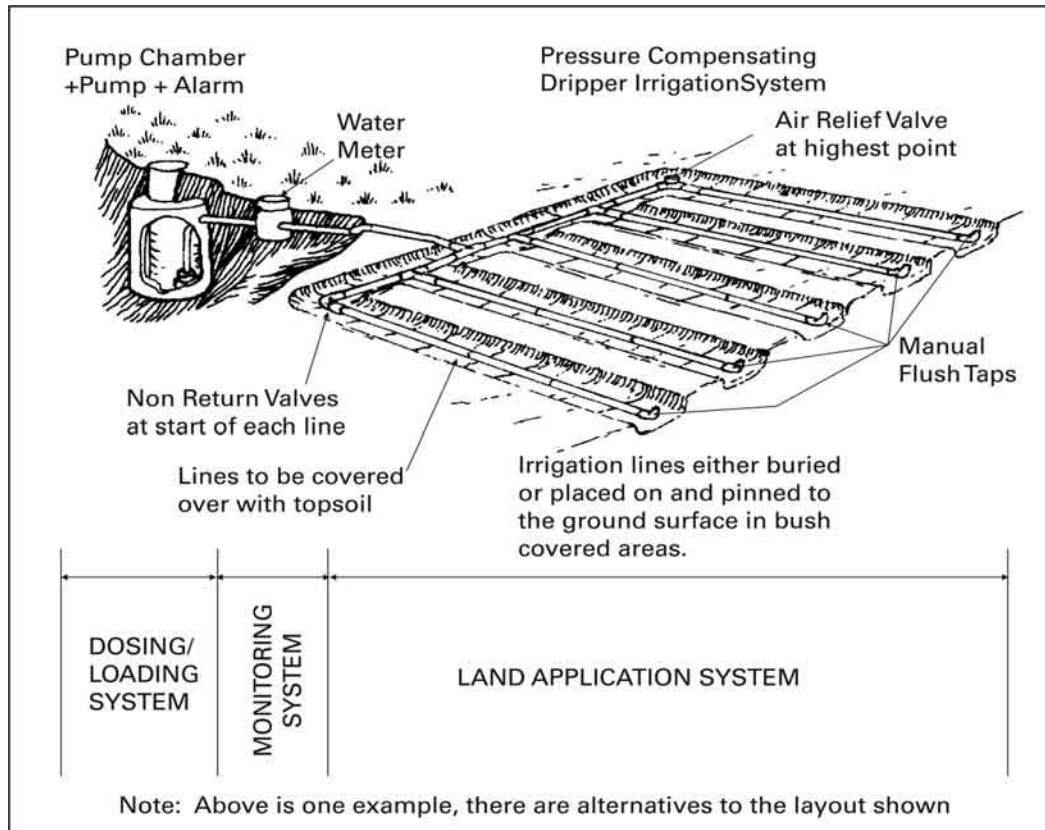
The areal loading rate is determined according to soil characteristics and environmental constraints with lower rates adopted for sites having environmental limitations. Typically the maximum areal loading rate for Category 4 soils is 5mm/day with lower rates of 2 to 3mm/day being employed for Category 5, 6 and 7 soils. Higher loading rates (25 to 50mm/day) may be appropriate for Category 1 and 2 soils depending on the environmental constraints (including groundwater depth and any potential health risks). In the case of Category 1 soils the designer is reminded that PCDI becomes a distribution method for loading a discharge control trench (Category 1 soils) and must following the design guidelines for discharge control trenches using basal loading rates.

The determination of an appropriate areal loading rate is also dependent upon the land use of the proposed land disposal area. Lawn areas can be used for subsurface dripper irrigation enabling sustainable reuse of treated wastewater, which can provide significant benefits.

However, soil pugging can result from subirrigation of lawns, particularly within high use areas. This risk can be reduced by using a conservative areal loading rate coupled with a reduction of irrigation line and emitter spacing (0.3m by 0.3m). The areal loading rate should take into account the influences of rainfall, site aspect, exposure to sun and wind, as well as the Soil Category and its infiltrative capacity.

Although not always practical, subsurface pressure compensating dripper land disposal systems are best installed within gardens, bush areas and low traffic lawn areas.

Figure 9.1: Schematic Diagram of a Pressure Compensating Drip Irrigation System



Note that there are alternative layouts and, with Figure 9.1 an example of one layout. The flush taps should be placed in a 'valve box' to allow easy location at the time of maintenance or the lines can be taken to a single discharge point.

9.2.4 Dose loading

Irrigation lines must be dose loaded by pumping or in some instances by siphon to achieve pressurisation and the flow rate required for operation of emitters. For dose loading to be effective and uniform an irrigation line charging and flushing volume must be allowed for as well as the discharge volume. There are two methods of dose loading:

- Dose loading on demand.
- Timer dose loading.

Dose loading on demand results in discharge of wastewater when it is produced and results in irrigation doses being concentrated into a relatively short time typically following breakfast, lunch and dinner.

Timer dosed loading offers further advantages over demand dose loading enabling discharge as numerous small doses over the entire day rather than unequal on demand loading as wastewater is produced. Timer dose loading optimises land treatment while minimising potential for soil wetting through controlled volume and load/rest cycles.

It is very important that all pressure head losses are taken into account when determining the pump head capacity required. Failure to install a pump capable of achieving the pressure head will result in premature pump failure and uneven distribution of wastewater through the irrigation network.

Table 9.1 is an example for determining the approximate of head loss pump performance requirements.

Table 9.1: Head Loss Calculation Example

EXAMPLE OF HEAD LOSS TABLE		
Component	Head Loss (m)	Comments
Emitter	12.0	Minimum pressure required.
Lateral	0.0	Head loss insignificant for short run.
Submain	1.0	Using Netafim Raam 17 as a submain.
Main	0.6 [Note 1]	Using 25mm LDPE x say 17m.
Filter	3.0 to 5.0	For a semi blocked (3m) to blocked (5m) filter.
Tank Depth	2.0 or actual depth [Note 2]	
Water meter	0.5 – 1.5 [Note 3]	
Elevation: Upslope or Downslope	metres +0.0m	Height difference to uppermost point of irrigation area Downslope [Note 4].
Total	20.1m + 10% = 22.1m [Note 5]	
Note:		
1. Depends on distance from treatment plant to irrigation system.		
2. Actual depth of pump to be used if more than 2.0m.		
3. Depends on type of water meter used.		
4. Include antisiphoning measures at pump station when pumping downhill.		
5. Calculation based on Irrigation Technology Services "Drip Irrigation Effluent Disposal Fields Design Manual" for standard pressure compensation irrigation lines. ITS 2001 and Netafim design guidelines. For the use of alternative pressure compensating irrigation systems the design/installer is to confirm the manufacturers recommended head loss guideline values.		

Where the land disposal application system is located downslope of the pump it is important to ensure the system does not empty the tank by uncontrolled siphoning. Where the system is uphill of the pump the difference in elevation between the top of the pump and the highest point of elevation is to be added to the head loss calculation.

9.2.5 Dripper line installation & Wastewater Quality

Dripper irrigation lines must be installed according to the manufacturer's specifications including wastewater quality requirements. Manufacturers often require installation of fine filtration (120micron such as a disc filter) post treatment plant and prior to the irrigation field to minimise solids carry over and premature line blockage. Filtration following aerated wastewater treatment plants can reduce the maintenance requirements of irrigation lines but there will be a requirement for regular maintenance of the filter. Fine filtration is not required for all sand filter wastewater treatment systems as approved by the irrigation line suppliers. Screen filtration is not an acceptable alternative as pump pressurisation forces solids through the screen resulting in ineffective filtration unless the screen has constant flushing to maintain a clean surface.

The maximum Biochemical Oxygen Demand and Total Suspended Solids content of wastewater recommended by manufacturers' for discharge to pressure compensating irrigation lines is 20gm/m³ and 30gm/m³ (BOD₅:SS). Biochemical oxygen demand exceeding the manufacturers guidelines can lead to premature clogging of the irrigation lines in response to internal bioslime build up.

Lines are generally installed parallel at 0.3, 0.5 to 1m centres, however this can be varied according to the site conditions. Closer line spacing is appropriate where wastewater is reused to subirrigate lawns and within slowly draining Category 4, 5 & 6 soils whereas wider spacing is appropriate on steeper slopes. Installation and loading rate details are summarised in Table 9.2.

The designer must be aware that when the irrigation line spacing is reduced to less than 1.0m the effective land disposal area must be maintained the same as for a 1.0m line spacing to maintain the areal loading rate as expressed in litres per square metre per day. In the event that irrigation lines are placed at more than 1.0m centres the designer must increase the land disposal area by the equivalent amount to accommodate the linear length of lines that would be required for irrigation lines at 1.0m centres.

9.2.6 Maintenance

Dripper irrigation systems require regular 3 to 6 month maintenance including:

- At least manual flushing of individual lines either to a soakage pit or back into the wastewater treatment system as flushing liquid can be a threat to surface water.
- Flushing of the inline fine filter into the soakage pit or wastewater treatment plant.
- Checking for emitter blockage (excessively dry areas and excessively wet areas).
- Maintenance frequency is dependent on the wastewater quality discharge from the treatment plant being higher for aerated wastewater treatment plants without a disc filter than sand and textile filters.
- The use of chlorine or other chemical cleaning agents for removal of slimes and algae is potentially damaging to the soil.
- Root intrusion can be a problem with some vegetation types and result in clogging of emitters and laterals. Root intrusion can be controlled by installing PCDI lines impregnated with herbicide, or installing an in line herbicide dispenser to inhibit roots from entering the emitter.

9.2.7 Discussion

In many areas there is insufficient natural soil depth or separation distance between the subsurface dripper irrigation lines and groundwater. In such case the ground level should be built up with topsoil or mulch. Topsoil is more appropriate as it provides the best medium for treatment and assimilation of the irrigated wastewater. Experience with bark indicates it is not well suited as a wastewater irrigation media, as it tends to hold the water rather than promoting evapotranspiration and seepage.

In addition to taking soil type, Soil Category and environmental constraints into consideration the designer must also consider the proposed other uses of the land disposal area. The use of an appropriate areal loading rate is critical for the optimum longterm performance of a land disposal system and the viability of the land disposal area for additional uses. Where the land disposal area is located beneath lawns, the designer should consider the use of the most conservative areal loading rate. The designer is strongly encouraged to use decreased irrigation line and emitter spacing (0.3m x 0.3m) to promote improved dispersion and to minimise the potential for pugging of the ground surface particularly in heavily trafficked lawn areas. In open areas potentially accessed by the public it is also recommended that signage be erected to advise that the lawn or garden area is used for

wastewater irrigation and that extreme care is required when digging so as to avoid cutting the lines. Garden areas provide the most appropriate area for subsurface irrigation, as the vegetation provides enhanced evapotranspiration and the soil structure is more open promoting improved assimilation.

The homeowner will require care when cultivating soil so as not to break the irrigation lines and cause concentrated wastewater discharge. It is critical with all shallow land disposal systems and particularly so with garden subirrigation that human contact is restricted and only undertaken with suitable safety precautions, such as gloves.

Table 9.2: Drip Irrigation Design Criteria Summary

Line Spacing	Variable (Typically 0.3m, 0.5m or 1.0 metre).
Emitter Spacing	Variable (Typically 0.3m, 0.6m or 1.0metre).
Emitter Rates	Typical rates 1.2 l/hr, 1.6 l/hr, 2.0 l/hr, 2.3 l/hr, 3.5 l/hr, 4.0 l/hr.
Design Areal Loading Rates	
<u>Soil Category</u>	
1	35mm/d to 50mm/day [Note 1]
2	25mm/d [Note 2]
3	15mm/day to 20mm/day [Note 2 & 3] [Dependent on environmental constraints]
4	5mm/day
5	3 mm/day to 4 mm/day [Notes 3 and 4]
6	2 mm/day to 3 mm/day
7	2 mm/day or less
Depth of Lines	50mm to 200mm or pinned to ground surface and covered with mulch or bark.
Notes:	
1. <i>Category 1 soil requires special design, such as installation of drainage control trenches under the irrigation lines. In this instance the PCDI becomes a distribution method.</i>	
2. <i>PCDI is a distribution method when used in Category 1, 2 & 3 soils.</i>	
3. <i>The higher loading rates are only applicable where there is at least 50% reserve area.</i>	
4. <i>Loading rates of up to 5mm/day may be appropriate in Category 5 soils where the depth of topsoil is 250mm or more.</i>	
<i>Effective distribution in lawns is best achieved using closely spaced lines and emitters (0.3m x 0.3m) and use very conservative loading rates of less than 3mm.</i>	
<i>The land disposal area and/or linear length of irrigation lines are to be adjusted when the line spacing is varied from 1.0m [Ref 17].</i>	

9.3 LOW PRESSURE PIPE SUBSURFACE IRRIGATION SYSTEMS

9.3.1 General

Irrigation systems involve the ultimate in the “KISS” approach to land application of treated effluent. Distribution into (and in some cases onto) the soil over a broad design area is undertaken on the basis of “areal” loading. Irrigation distribution methods include:

- Pressure compensating drip emitter irrigation surface or subsurface irrigation;
- LPP (low pressure pipe) subsurface irrigation;
- LPED (low pressure effluent distribution) subsurface or surface trickle irrigation; and
- Spray irrigation.

Irrigation systems are best suited to Category 4 to 5 soils, where clay type soils underlying topsoil have insufficient soakage capacity to result to provide satisfactory subsurface assimilation rates. They can be used in Category 6 soils providing there is adequate overlying topsoil depth. They are in general more economical to construct than ETS beds as used in Category 5 to 6 soils (refer Section 10.3.3.7), but they also maximise the ET assist potential of the natural soil and vegetation within the larger "areal" design area compared to an ETS system. In the Auckland region pressure compensating dripper irrigation of secondary treated wastewater is the preferred irrigation method for Category 5 and 6 soils.

It is essential that a minimum depth of 250mm of topsoil is available for all LPP and LPED systems to operate effectively. In situations where the topsoil depth is less than 250mm it may be necessary to import additional topsoil. These systems will not operate effectively where located directly onto or into Category 5 and 6 soils without adequate topsoil cover for assimilation of the applied wastewater. Further details on the construction and installation of LPP and LPED systems are provided in Section 9.4. Where LPP and LPED are used in Category 1, 2 or 3 soils it becomes a distribution method and design should be in accordance with Sections 10.1.2 to 10.1.4.

9.3.2 LPP Function and Application

The LPP system was developed in the US for use in either high percolation rate soils with high water tables, or shallow soils over rock, or for poorly permeable soils (such as clays) with a reasonable topsoil layer. It comprises of a series of shallow and narrow (200 to 300mm deep, 150 to 200mm wide) media filled trenches laid within the topsoil and shallow subsoil layer and pressure dosed by small diameter (25 to 30 mm) perforated plastic pipe laterals (Figure 9.2). LPP should only be used on slopes of less than 15°. With trench spacing at around 1500mm the concept is to wet the topsoil between trenches and maximise ET assist from grass growth on an "areal" basis. Pumped dosing is essential to ensure uniform spread of effluent into the design area, and during construction, test dosing with clean water should be undertaken prior to backfilling the pressure distribution lines to ensure that the system will perform as designed. It is essential that LPP and LPED systems are dose loaded either by siphon or pump to ensure even distribution along the entire length of each line and utilisation of the entire infiltration surface.

9.3.3 Advantages and Disadvantages

The USEPA National Small Flows Clearinghouse (NSFC) fact sheet on LPP systems [Ref 38] outlines the following advantages and disadvantages of this technique for land disposal:

Advantages:

- Shallow trench system enhances aerobic bacterial action in the topsoil, and facilitates evapotranspiration assist;
- Shallow, narrow trenches reduce site disturbance during construction and thus provide more protection against soil compaction and loss of permeability;
- Periodic cycles of dose and rest encourage maintenance of aerobic conditions in the land disposal area; and
- Pumped dose loading ensures uniform distribution of applied effluent throughout the design area.

Disadvantages:

- Not suitable for many sites due to insufficient topsoil, soil type, slope, and space availability;
- There is a potential for distribution perforations on the pumped laterals to be blocked by solids or in some situations roots;

- There is limited storage in the trench aggregate because of the much smaller trench size;
- Effective soakage beyond the immediate locality of pipe work is difficult to predict at design stage; wastewater is not evenly distributed throughout the entire disposal field design evapotranspiration area, with areas between LPED lines frequently ineffective, providing;
- Less even distribution than that provided by properly installed drip irrigation systems or LPED systems;
- Regular monitoring and maintenance of the system is required as a lack of maintenance is a sure precursor to failure; and
- Will not operate effectively in Category 5 and 6 soils without adequate topsoil cover.

9.3.4 Design and Operation

Recommended "areal" loading rates for design sizing of LPP are as follows:

- Primary treated effluent on flat to moderate slopes with a minimum of 250mm of good topsoil: 3 mm/day
- Or secondary treated effluent on flat to moderate slopes with a minimum of 250mm of good topsoil: 3 – 5 mm/day

System layout has been based on 1500mm spacing between trench centrelines, with the "areal" loading rate applied to either the total area enclosing the trench system (that is, total trench length times 1.5m) or more conservatively 1.0m of the area between trenches. As noted in the disadvantages section above the effectiveness of the area between LPED lines for ET assist can be limited by the ability of the applied wastewater to utilise the entire area between lines. On the basis that the effective soakage area is more likely to be within 1.0m or less of the distribution line/trench it is recommended that the design areal loading rate is based on a maximum area of 1m per linear metre of line.

Design of the distribution system is discussed in Section 8.6. The use of automatic sequencing valve distribution to each lateral offers particular benefits in ensuring uniform distribution to each trench on a load rest cycle, thus maximising several of the advantages of this system. The dose volume should be controlled to ensure that the applied effluent in a trench on each loading cycle does not flood the aggregate to a depth of more than 50 to 75mm. To ensure even distribution of the applied load is achieved, a full scale clean water pump test should be undertaken during construction and installation. This should be carried out following the laying the lateral pipework, and before covering with the final layer of distribution aggregate, filter cloth, and final topsoil.

The need for protection of the LPP land disposal area from rainfall runoff and groundwater intrusion from upslope catchments should be assessed during both design and installation. Where appropriate, provision of cutoff trenches and diversion drains should be undertaken.

9.4 LPED SUBSURFACE IRRIGATION SYSTEMS

9.4.1 Function and Application

LPED as a distribution method for trench land disposal is discussed in detail in Section 8.6 above. Again LPED lines comprise a perforated dose line installed within agricultural drainage coil. The system involves low pressure pump dosing of predominantly improved septic tank effluent (large septic tank with outlet filter). LPED graveless trenches are an alternative distribution technique to LPP. They work by flooding inverted nested laterals within a draincoil line from widely spaced perforations in the dose line, avoiding the spot loading effect of LPP, and allow for more effective lineal

distribution of effluent along the length of the trench during each dosing operation. It has application for subsurface "areal" loading irrigation in the following circumstances:

- As an alternative to LPP distribution for all the applications as set out in Section 9.3 above or;
- For wastewater distribution in a land disposal system within Category 1 & 2 and 3 soils;

While LPED is superior to LPP distribution, its longterm popularity will depend on how competitive the distribution methodology remains with secondary treatment and associated drip irrigation technology.

9.4.2 Design and Operation for General Purposes

Automatic sequencing valves enable a single dose per day to be flood loaded and allowed to drain with 24 hours of in soil treatment prior to the next dose. This is only effective if there is even loading across the full design surface and sufficient topsoil depth. The design and operational requirements for LPP trench systems as set out in Section 9.3; apply also to LPED irrigation within the same soil and site conditions and the same dosing arrangements.

9.4.3 Advantages and Disadvantages

LPED systems have the following advantages and disadvantages over LPP for land disposal of wastewater:

Advantages:

- Reliance on passive in soil treatment (dependent upon sufficient even topsoil depth);
- Less power and pump dependent than a secondary treatment system;
- The nested pipe allows for improved distribution over a larger soil surface area than LPP systems;
- Shallow trench system enhances aerobic bacterial action in the soil, and facilitates evapotranspiration assist;
- Shallow, narrow trenches reduce site disturbance during construction and thus provide more protection against soil compaction and loss of permeability;
- Periodic cycles of dose and rest encourage maintenance of aerobic conditions in the land disposal area;
- Pumped dose loading ensures uniform distribution of applied effluent throughout the design pipework area;
- Pumped system increases flexibility in siting the system on the lot;
- System can be constructed on sloping sites unsuited to gravity fed systems;
- Lower materials costs (less distribution aggregate required);
- The longitudinal distribution of dosed effluent is more effective in achieving low levels of effluent to soil contact than LPP or conventional gravity trickle distribution methods; and
- Overall costs comparable (or lower) than alternative systems.

Disadvantages:

- Not suitable for many sites due to insufficient topsoil depth (unless sufficient topsoil depth is added), steeper slopes, and area availability for land disposal;

- There is a potential for distribution perforations on the pumped laterals to be blocked by solids or in some situations roots;
- There is limited storage in the trench aggregate because of the much small trench size;
- Effective soakage beyond immediate locality of pipe work difficult to predict at design stage; Wastewater is not evenly distributed throughout the entire disposal field, with areas between LPED lines frequently ineffective, providing;
- Less even distribution than that provided by a properly installed drip irrigation system;
- Regular monitoring and maintenance of the system is required as a lack of maintenance, including checks for even distribution throughout the field can be a sure precursor to failure.

9.4.4 Design and Operation for Free Draining Soils

In sandy and gravel soil conditions (Category 1, 2 & 3), which usually occur on flat land associated with beach, lakeside and river side localities with a predominance of Category 1 to 3 soils, LPED facilitates enhanced distribution and can be used for effective loading a discharge control trench, or conventional trench or bed. The loading rate in such situations is based on the land disposal method and not LPED loading rates or methods.

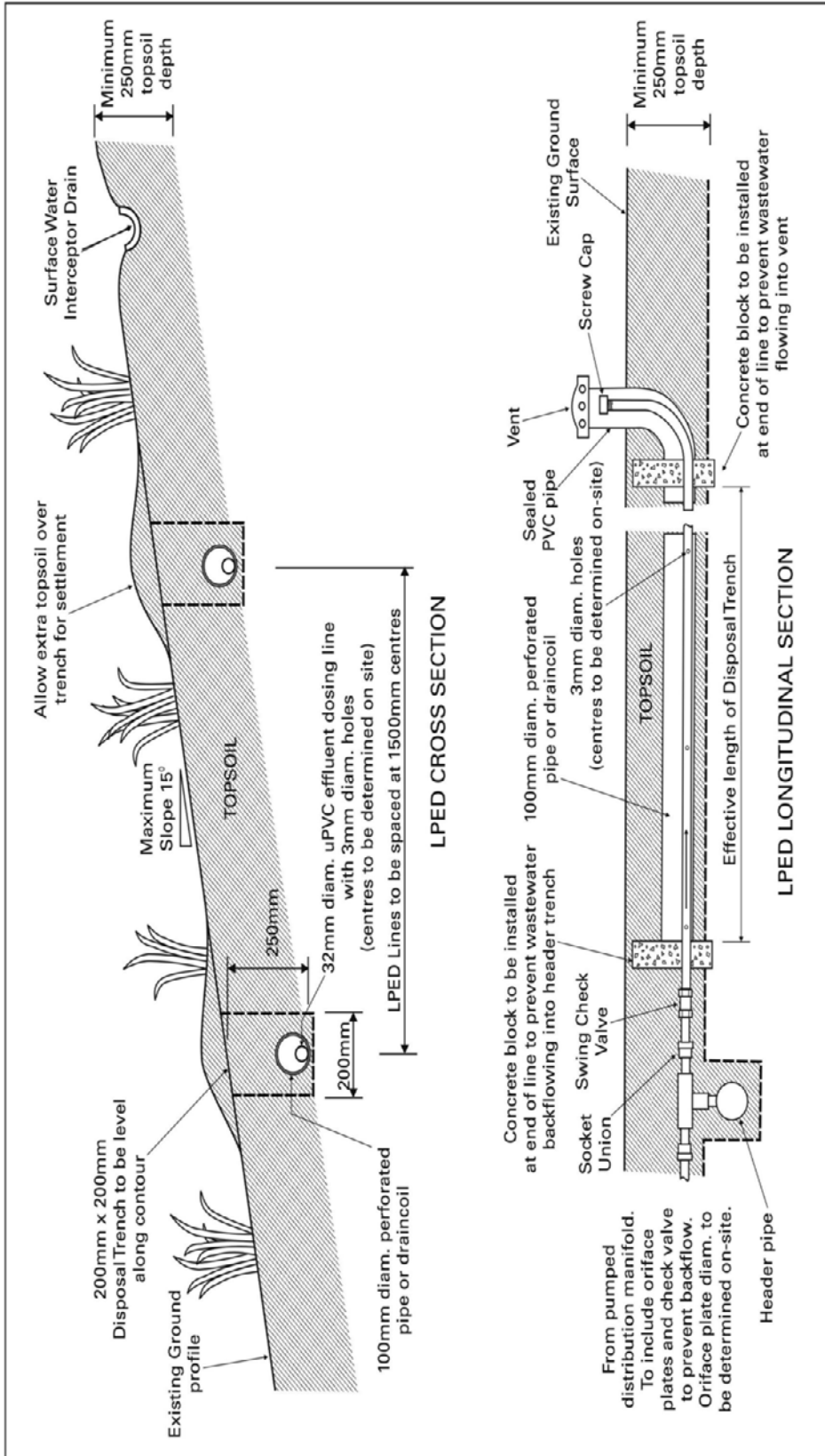
9.4.5 LPED Design and Operation for Slowly Draining Soils

Shallow and narrow LPED trenches are suitable for sites with a good topsoil layer having suitable texture and structure and at least 250mm deep and overlying Category 5 to 6 soils. LPED comprises a series of shallow and narrow (200mm deep, 200mm wide) trenches excavated within the topsoil and shallow subsoil layer with pressure dosed small diameter (25 to 30mm) perforated plastic pressure pipe laterals nested within a 100mm to 150mm drain coil or slotted pressure pipe (Figure 9.2). The LPED trench base and leading edge must be laser levelled and excavated level along the contour to ensure there is no breakout from low points. Trenches are backfilled with topsoil, which should be mounded over the trench to allow for settlement. Concrete blocks located at each end of the perforated distribution pipe prevent wastewater flowing from the shallow trench into the main header trench and at the up stand end of the distribution line. The up stand end of the distribution line is to include a screw cap to allow flushing of the line for maintenance. A non return valve needs to be included at the start of each distribution lateral to prevent lines draining back to the main header pipe and overloading of the lower most trench and an orifice plate sized to ensure equal wastewater loading to each lateral. Squirt hole spacing, number and diameter are to be determined to ensure that there is no more than a 10% difference in flow between the first and last squirt hole in each line. Site requirements are:

- Minimum topsoil depth 250mm;
- Maximum ground slope of 15°.

LPED systems are not appropriate for sites underlain by Category 5 to 6 soils without adequate topsoil (minimum of 250mm). In the case of Category 3 & 4 soils the drainage properties should be sufficient to accept the applied wastewater and therefore additional topsoil is unlikely to be required. Subsurface LPED is more successful on less steep sites (less than 15°) where there is less risk of wastewater breakout over low points on the leading edge of the trench. Pressure compensating dripper irrigation is more appropriate for sites having slopes greater than 15°. It is also absolutely critical that trenches are excavated level along the contour to avoid applied wastewater ponding at the low end of the trench which will result in wastewater breakout.

Figure 9.2: Typical Subsurface LPED Land Disposal System



Recommended “areal” loading rates for design sizing of LPED are as follows:

- Primary or secondary treated effluent on flat to moderate slopes with a minimum of 250mm of good topsoil: 3mm to 5mm/day.
- Effective infiltration area for areal loading is 1m.

The higher rates should only be applied to less steep sites and where there is a good depth of topsoil with suitable texture and Soil Category.

With trench spacing at around 1500mm the concept is to wet the topsoil between trenches and maximise ET assist from grass growth on an “areal” basis. It has been general practice to design for areal loading over the entire 1500mm separation between trenches. This relies on the assumption that infiltrated wastewater will move laterally through the topsoil over the entire width whilst maximising evapotranspiration from plantings. This may operate well in situations with a good topsoil and good depth. In situations where topsoil is not of good quality or where it is only 250mm depth the areal loading rate should only be applied to a maximum distance of 1.0m from the trench. LPED trenches are an acceptable land disposal method in suitable soil and slope conditions. Pumped or siphon dosing is essential to ensure uniform spread of effluent along the trench length, and during construction, test dosing with clean water should be undertaken prior to backfilling over the pressure distribution lines to ensure that the system will perform as designed.

9.5 LPED SURFACE TRICKLE IRRIGATION

9.5.1 Function and Application

This system has application within areas of natural vegetation such as bushed lots on flat and slopes less than 15° (Figure 9.3). Where root systems are close to the surface and it would be imprudent to cut even shallow trenches, the LPED lines may be laid on the ground surface – the disposal area must then be fenced or otherwise appropriately controlled to prevent casual access. Once the lines are laid and carefully pinned and supported in place to ensure they are totally level, then a full clean water pump test should be undertaken to confirm distribution effectiveness, with the lines being adjusted as appropriate to ensure this result. Following successful completion of testing, the covering material (bush litter, bark or compost) can be placed over the lines. This cover material should be held in place by durable plastic net pinned securely to the ground up and downslope. This is important in keeping foraging birds or animals from disturbing the cover material. On steeper slopes it also prevents erosion of the cover material.

Installation and maintenance of level surface located LPED lines within natural vegetation and bush areas is extremely difficult unless the vegetation is very open. Pressure compensating dripper irrigation using secondary quality wastewater is far more effective for surface disposal of wastewater within areas established in bush. PCDI lines do not require levelling.

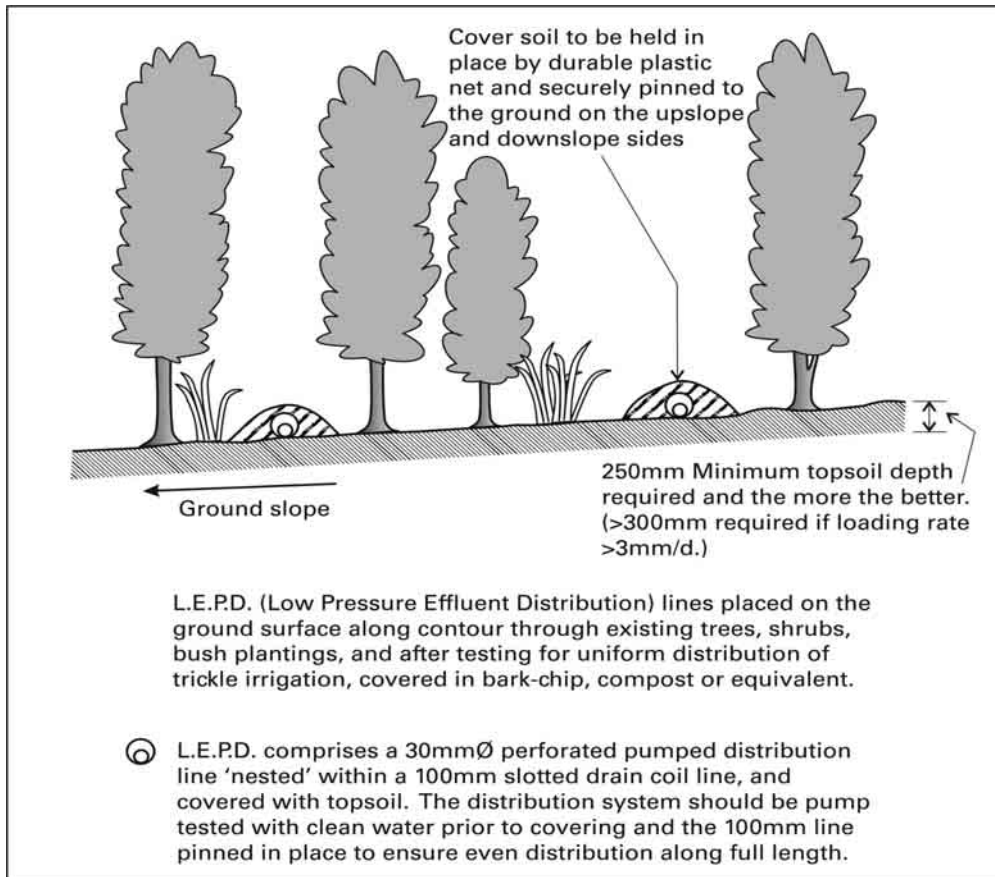
9.5.2 Design and Operation

Recommended “areal” loading rates for design sizing of LPED are as follows:

- Primary or secondary treated effluent on slopes less than 15°;
- With a minimum of 250mm of good topsoil: 3mm to 5mm/day (The higher rates should only be applied for sites having good topsoil and low slope angle).

Regular and frequent operation and maintenance inspections are necessary during the initial months of operation to ensure that distribution effectiveness is being maintained. Once the system has settled down, the routine monitoring and inspection programme can be implemented.

Figure 9.3: Typical Surface LPED Land Disposal System

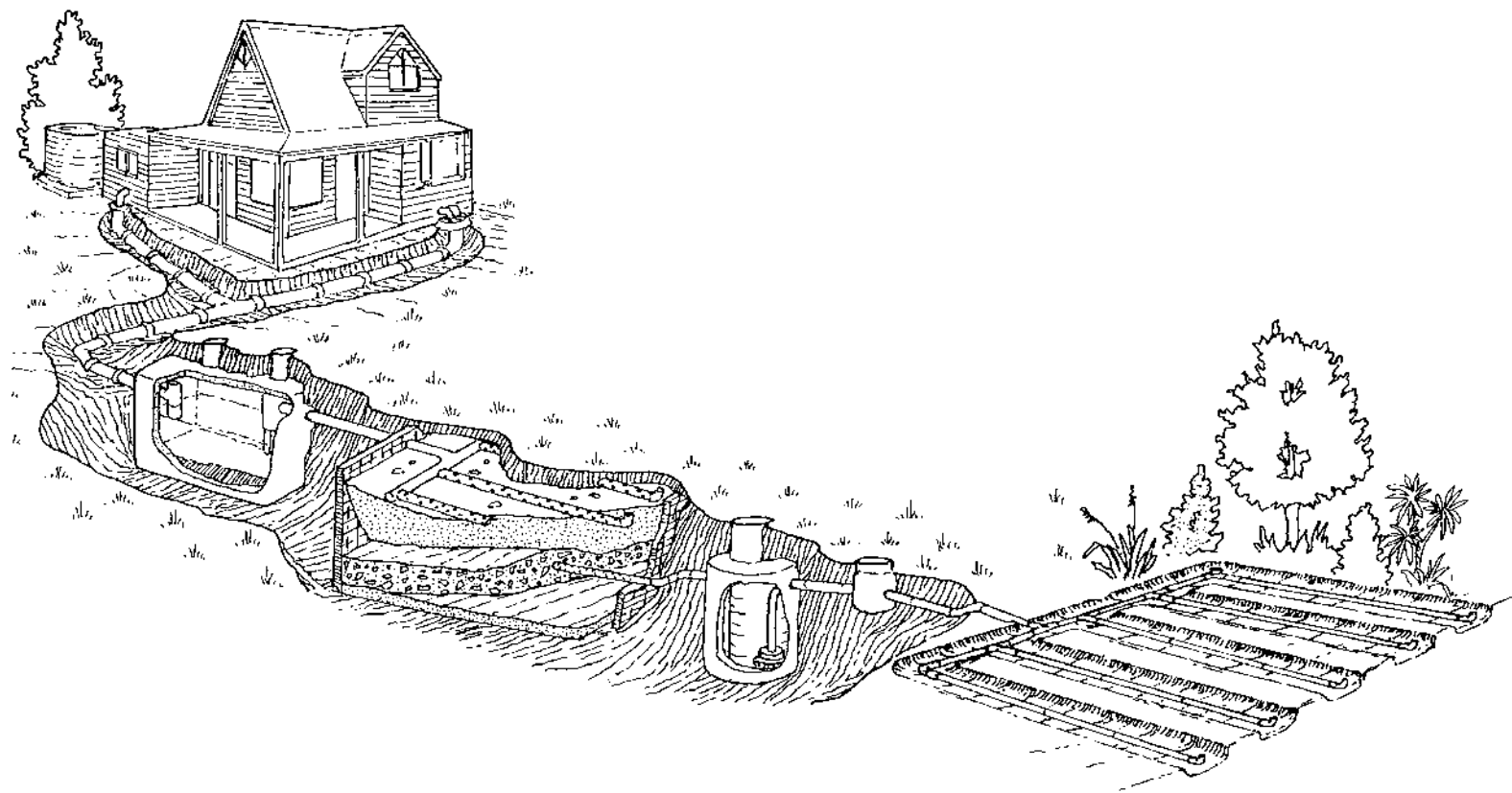


9.6 SPRAY IRRIGATION LAND DISPOSAL

Spray irrigation systems for on-site use are not a permitted activity within any Regional Council rules in New Zealand, and hence will be subject to specific design and consent procedures. The inclusion of spray irrigation systems within AS/NZS 1547:2000 [Ref 1] is based on the historical situation related to the use of ATP and spray irrigation land disposal systems in Australia, where in some states thousands of these units are in use. Stringent bacterial effluent quality standards now relate to effluent, which is to be spray irrigated. Drip irrigation is by far the preferred irrigation method in those site and design circumstances where spray irrigation land disposal might have been considered.

Where spray irrigation is proposed extreme care is required by the designer when determining the areal loading rate and to locate the irrigation area so as to ensure runoff to surface water does not occur. Other considerations are; aerosol formation and drift, separation distance from property boundaries and public access to the irrigation area including with holding times.

10 > Land Disposal - Conventional Systems



10. LAND DISPOSAL - CONVENTIONAL SYSTEMS

Conventional disposal systems predominantly involve trench disposal and bore soakage systems. Then over the past twenty years there were variations into beds, and ETS beds, which optimise evapotranspiration. Other alternatives that have evolved include mound disposal systems and bottomless sand filters. While ETS beds and mound systems are an advanced option compared to conventional beds, their popularity is decreasing as they are more expensive in capital costs than secondary effluent plants discharging to land drip irrigation land disposal systems (as are general bed and trench systems although to a lesser extent), while still occupying a similar footprint.

In all design situations, the requirements for separation distances to surface and groundwater as set out in Table 5.2 should be maintained. Following are the disposal methods covered in this section in the order below:

- Conventional Trenches;
- Shallow and Narrow Trench Systems;
- Discharge Control Trench Systems;
- Deep Trench Systems;
- Infiltration Systems;
- Deep Bores;
- Conventional Beds;
- Evapotranspiration Seepage Beds;
- Mound Land Disposal Systems; and
- Bottomless Sand Filters.

10.1 TRENCHES

Loading Rates for disposal trenches should be set in accordance with conservatively predicted longterm acceptance rates. Actual acceptance rates will be affected by the capacity of the subsoil to accept effluent through the biomat layer generated by microbial growths feeding on the organic matter in the treated effluent. With shallow soakage systems, effluent organic matter is taken up by aerobic microorganisms within the well aerated upper soil layers at a faster rate than the anaerobic microorganisms which predominate under saturated conditions at depth. Hence application of the "KISS" (keep infiltration systems shallow) principle enables the aerobic upper subsoil and topsoil mantle to be utilised to provide for assimilation of effluent organic matter, uptake of nutrients into vegetation biomass, and transpiration thereby minimising effects on groundwater.

Venting shallow land disposal areas (as in the ETS systems of Section 10.3.3.7) also helps in maintaining LTAR values, and is critical in all subsurface distribution systems unless aerobic conditions are maintained in the lines (as in pressure compensating drip irrigation and shallow LPED systems) where effluent is pumped. The literature suggests that improving effluent quality to secondary standards further assists in achieving higher LTAR values than is achieved when disposing of conventional septic tank effluent. The higher loading rates set out in AS/NZS 1547:2000 for soakage systems to which secondary effluent is applied are discussed in Section 10.2.1. Increased secondary loading rates are not covered here in TP58 and are not a permitted activity in the Auckland region. The increased loading rates provided in AS/NZS 1547:2000 can only be considered through a discretionary consent application, where conditions can be put in place to ensure the system is appropriately monitored over time.

10.1.1 “Least Conservative” versus “Most Conservative” Loading Rates

Implementation of on-site wastewater design is not an exact science, and hence the provision of a broad band of design loading rates against given soil conditions provides opportunity for the designer to select values appropriate to the specific circumstances related to the site conditions. The range of loading rates between “least conservative” and “most conservative” in Tables 10.2 and 10.3 represent a band within which many values from overseas design rules fit. They are believed to be lower than the LTAR conditions that will develop for the given soil categories. Where potential future wastewater loading or soil conditions or any other site factor introduces a level of uncertainty to the design process, then the designer should adopt a more conservative Soil Category for design, and thereby use a lower design loading rate.

“Most conservative” design loading rates should be used when:

- Soil and site condition investigations indicate that the soil is unable to support adoption of increased loading rates.
- Site and soil limitations indicate a conservative approach to design is required.
- Soil structure is likely to restrict drainage away from the land disposal system.
- The designer’s experience indicates that for this particular locality a conservative design approach is warranted.
- The lower loading rate is warranted as a factor of safety measure for design purposes.

“Least conservative” design loading rates may be adopted when:

- Site and soil conditions are highly favourable (such as absence of potential surface water influences, good quality and depth of topsoil, site well exposed to wind and sun, availability of evapotranspiration assist from nearby plantings).
- Secondary treated black and greywater or primary treated greywater is to be applied to the trench system.
- Shallow trenches of 300mm width and 300mm depth or less are adopted.
- Timer or sequential dose loading of individual trenches/beds is utilised for soils in Categories 2 to 3.

Loading rate evaluation may result in values between “most conservative” and “least conservative” being selected. This is the designer’s prerogative, and the design report should set out the rationale for the adoption of the particular design value. The selected design loading rate may be a value interpolated between those assigned to adjacent Soil Categories (where favourable conditions exist the interpolation may be made with the upper category; where constraints require an increased factor of safety, the interpolation may be made with the lower category).

10.1.2 Conventional Trenches

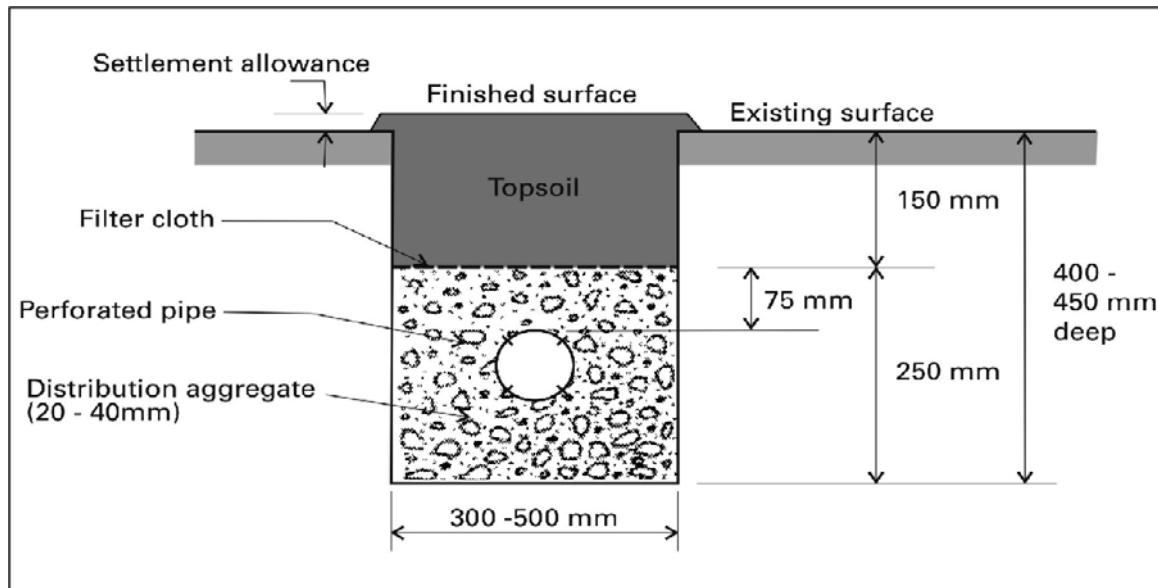
Conventional trenches must be carefully excavated and prepared and provide for shallow soakage via bottom and sidewalls. In the case of shallow trenches only the basal area is considered the effective disposal area and the effective infiltrative surface area required is based on this area only. Figure 10.1 shows a typical conventional trench cross section.

Design loading rates are set out in Table 10.2. These apply to sizing of the **bottom** area of the trench. When effluent ponds within the trench sidewall soakage occurs. Sidewall infiltration is not included in the design calculation, but provides a factor of safety against sealing of the trench bottom area.

In rapidly draining soils (Category 1, 2 & 3) trickle loading via gravity flow is not appropriate, as effluent drains preferentially at the entry point to the trench, eventually leading to creeping failure. Wherever possible effluent should be pump dosed to provide for even distribution along the trench via low pressure pipe or LPED for any soil type. Where pumping is not possible and the trenches are located at a lower elevation than the septic tank it is preferable to dose load by siphon.

Where the bottom width of a trench exceeds the combined effective sidewall depth by more than 30%, the system can be classed as a conventional bed for design purposes (refer Section 10.3.1).

Figure 10.1: Conventional Trench



10.1.3 Shallow and Narrow Trench Systems

In order to implement the "KISS" principle shallow trench systems should be used instead of the conventional 450mm deep trench system (Figure 10.1). Depths of 200 to 300mm provide greater opportunity for sidewall contact. This sidewall contact is enhanced by decreased widths (200 to 300mm), thus enabling design loading at "least conservative" higher rates where secondary effluent is applied (refer Section 10.2). The resulting increase in loading rate above the "most conservative" values when applied to narrow trenches will compensate to some extent for the overall increase in trench lengths resulting from the decreased width. However the designer must use extreme care when determining an appropriate loading rate and should only use the least conservative rates where a deep topsoil (more than 250mm) is present. Trenches are typically installed at 2.0m centres to allow sufficient space for construction of replacement trenches in the event of installed trenches failing.

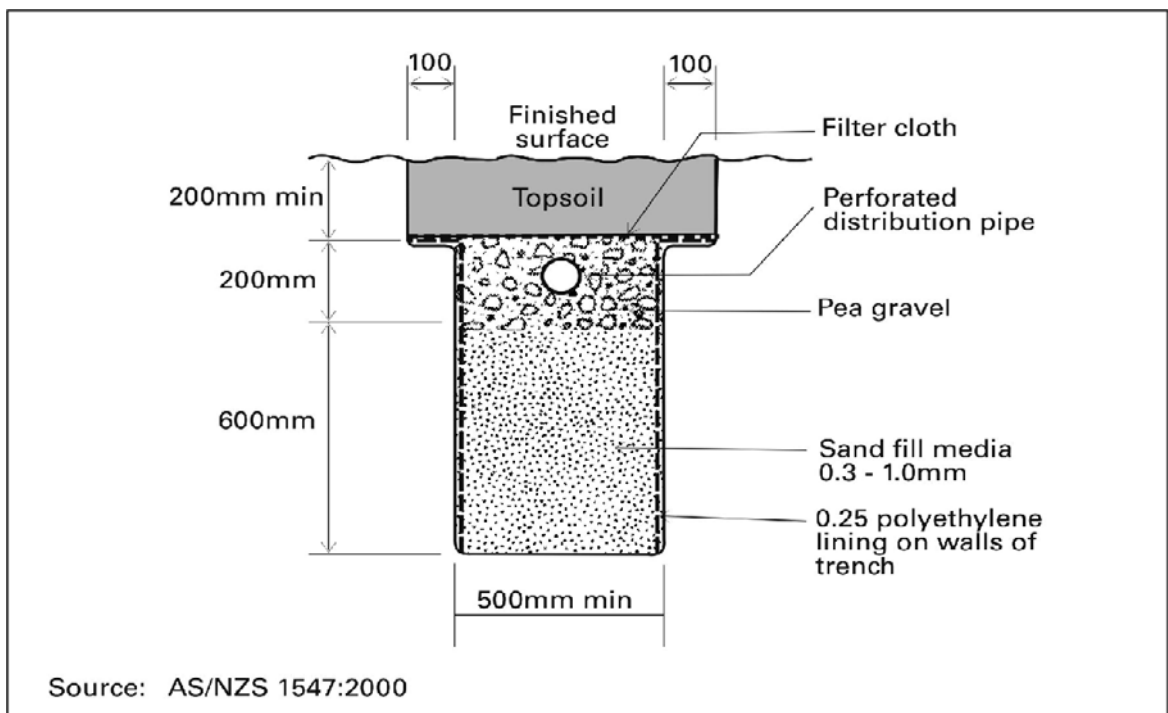
10.1.4 Discharge Control Trench System

General

Rapidly draining Category 1 gravels and coarse sands provide little if any in ground treatment of infiltrating wastewater resulting in a high risk of groundwater contamination by pathogens and nutrients. In order to provide additional treatment before the wastewater passes from the trench into the Category 1 soil a discharge control trench [Ref 1] may be required. Essentially a discharge control trench is an in trench intermittent sand filter designed to provide additional treatment by reducing BOD_5 , suspended solids and faecal coliforms. There is however little if any reduction in nutrients. The use of a discharge control trench is of particular importance where primary treated wastewater is discharged into Category 1 soils and there are groundwater protection concerns. Secondary treatment systems, such as AWTS, recirculating sand filters and recirculating textile filters, have variable faecal coliform reduction potential unless effluent is tertiary disinfected. A discharge control trench will be required where there are concerns that the secondary treatment effluent quality will not provide groundwater quality protection from BOD_5 , TSS and faecal coliforms.

Discharge control trenches are therefore required for primary and secondary treated wastewater where groundwater quality protection is required from faecal coliforms. Category 1 soils have limited nutrient reduction capacity and if nutrients are of concern it will be necessary to use additional nutrient reduction measures in the wastewater treatment process and possibly a different land disposal method. Figure 10.2 shows a typical discharge control trench.

Figure 10.2: Schematic of a Typical Discharge Control Trench



Minimum Wastewater Treatment Level

The minimum wastewater treatment level is to comprise a septic tank including an effluent outlet filter. Secondary treated wastewater is to have a minimum standard of 20:30mg/L (BOD₅:SS). Where nutrients are of concern additional tertiary treatment to reduce nutrient levels prior to discharge into the ground may be required.

Wastewater Distribution

Wastewater is to be dose loaded to the LPED distribution system located in the top of the discharge control trench.

Design Loading Rate

Design loading rates for a Discharge Control Trench and Discharge Control Beds are provided in Tables 10.1, 10.2 and 10.3. The designer must be aware that the design loading rates are for the sand media backfill and not the rapidly draining gravel and sand. Trenches are designed for basal area loading. Primary treated wastewater is to be loaded at the most conservative loading rate of 35mm/day and secondary wastewater loaded at up to a maximum of 50mm/day.

Table 10.1: Discharge Control Trench Loading Rates

Wastewater Treatment Standard	Effluent Quality BOD ₅ : SS (mgO/L:mg/L)	Maximum Basal Loading Rate mm/day	
		Most Conservative	Least Conservative
Primary	>70 - >50	20	35
Secondary	Better than 20:30	35	50

Construction

A discharge control trench has maximum dimensions of 1.0m depth and a width of 500mm. The depth of the trench will be controlled by site specific environmental constraints such as the depth to the groundwater table and ensuring a minimum clearance of 1,500mm for wastewater that has only had primary septic tank treatment and 1,200mm for wastewater that has been secondary treated (Table 5.2). Construction details are shown in Figure 10.2.

10.1.5 Deep Trench Systems

Narrow deep trenches may be appropriate for use in Category 2 and 3 soils where there is at least 1200mm groundwater clearance from the base of the trench and no environmental constraints exist. The minimum treated wastewater quality for discharge to a deep trench is secondary. It may be appropriate to reduce the groundwater separation distance where wastewater is treated to advanced secondary levels or better (Table 5.2). Deep trenches are narrow (150–300mm) and deep (1000–1200mm) utilising sidewall soakage only. As the sidewalls are unevenly loaded from top to bottom during draining, the most conservative design loading rate is to be used. The design infiltrative surface comprises the total sidewall area of both sides of the trench below the topsoil cover. The basal area is excluded from the design area calculation. Construction details are provided in Figure 10.3 and a worked design example provided in Technical Sheet 3.

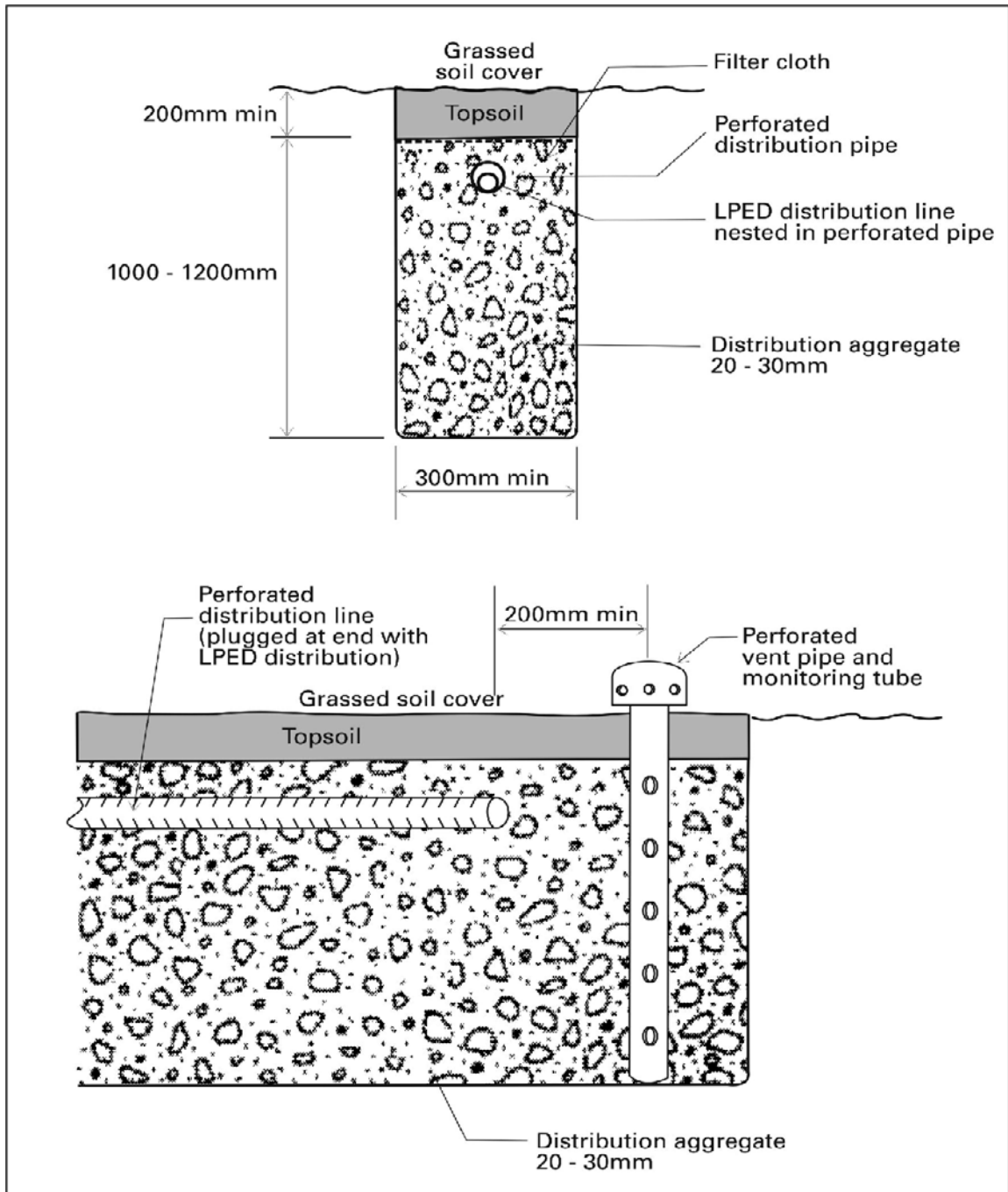
Minimum Wastewater Treatment Level

The minimum level of wastewater treatment for discharge to deep trenches in Category 2 & 3 sands is secondary quality 20:30mg/L (BOD₅:SS).

Wastewater Distribution

Wastewater is to be dose loaded to an LPED distribution system to ensure even loading of the entire trench length.

Figure 10.3: Typical Deep Trench



10.2 SELECTION OF DESIGN LOADING RATES FOR TRENCHES

10.2.1 Effluent Quality and Design Loading Rate

Tables 10.2 and 10.3 show a range of design wastewater loading rates from *most conservative* to *least conservative* for primary effluent, and a separate set of loading rates for secondary effluent quality. Primary effluent is defined as outflow from blackwater, greywater or all flows septic tanks. Secondary effluent is defined as equal to or better than 20g/m³ BOD₅ and 30g/m³ TSS.

AS:NZS:1547 2000 includes an allowance for increased loading rates within Category 2 to 6 soils where secondary effluent is applied to standard and shallow trenches. Wastewater loading rates have previously been based on domestic septic tank primary treated effluent.

There are conflicting arguments both for and against using increased loading rates for secondary treated effluent based on research in the United States. The concept is that secondary effluent is low in organic content and has a relatively low oxygen demand. This allows the preservation of aerobic conditions at the infiltrative surface and within the underlying soil. Where anaerobic conditions develop the anaerobic microorganisms are not able to breakdown the waste materials [Ref 3]. Secondary treated wastewater is highly treated in terms of TSS, BOD and ammonia with reduced levels of faecal coliforms.

The USEPA [Ref 3 and others Refs 18, 19, 20] recommend caution when considering high secondary loading rates as the high loading rates may allow deep penetration of pathogens. In addition the designer is cautioned that well tested organic loading rates for different soils and land disposal systems have not been developed and are poorly understood. Van Cuyk & Siegrist [Ref 21] caution the use of higher secondary effluent loading rates in that based on hydraulics the practice may be sound but purification of contaminants and nutrients is less likely and remains of concern, especially as the fate of pathogenic bacteria and virus has not been proven.

The ARC considers the concept of increased loading rates to be a retrogressive notion that secondary treated wastewater is a waste to get rid of in contrast to a valuable resource that may be reused. There are concerns that proposed high secondary treated wastewater loading rates may appear to be effective over months having low rainfall and when soils have a greater capacity to accept applied water whereas there may be wastewater breakout during months with higher rainfall with resultant runoff from the site to stormwater and surface water.

Soils are heterogeneous and as such soil properties are highly variable both laterally and vertically. Standard loading rates provide an allowance and degree of conservatism thus providing some compensation for soil property variability. The wastewater production rate, wastewater production management, variable nature of site soils and wastewater quality all impact on a wastewater land disposal system performance. Removal of the factors of safety from the system design (reduced design wastewater production rate and reduced land disposal area) potentially increases the risk of system failure by hydraulically overloading the site soils. Designers are also cautioned against the use of high loading rates for moderately to strongly structured (fractured/cracked soils) in the Auckland region, as there is a high risk of short circuiting via soil desiccation fractures during summer months.

During wet months when soils may swell infiltration is reduced increasing the risk of wastewater surface breakout. There are therefore concerns that the potential environmental risks resulting from applying high secondary effluent loading rates for the Auckland region's poorly draining soils outweigh the perceived advantages. The cumulative environmental effects are potentially the same as that from poorly performing primary septic tank discharge to soakage trenches particularly if increased subdivision or multiple dwellings are developed to take advantage of the decreased disposal area requirements.

Designers are discouraged from applying elevated loading rates for secondary treated effluent. The application of higher secondary loading rates are not a permitted activity in the Auckland region and will be evaluated on a case by case basis as part of discharge consent application process.

Table 10.2: Recommended Design Loading Rates for Conventional Trenches

Soil Category [Note 1]	Soil Type	Primary Effluent mm/day [Note 2]		NOT PERMITTED ACTIVITY IN AUCKLAND REGION mm/day
		Most Conservative	Least Conservative	AS/NZ5 [Note 3]
1 [Note 4]	Gravel, coarse sand – rapid draining [Note 4]	35 [Note 5]	50 [Note 5]	50
2 [Note 4]	Coarse to medium sand – free draining [Note 7]	25 [Note 5]	35 [Note 5]	50
3	Medium fine and loamy sand – good drainage	20	30	30 to 50
4	Sandy loam, loam, and silt loam – moderate drainage	15	20	30
5 [Note 8]	Sandy clay/loam, clay loam and silty clay loam – moderate to slow drainage	5	10	10 to 30
6	Sandy clay, non swelling clay and silty clay – slowly draining	Trenches not suitable [Note 9]	Trenches not suitable [Note 9]	8 to 12
7	Swelling clay, grey clay, hard pan – poorly or non draining	Trenches not suitable [Note 9]	Trenches not suitable [Note 9]	

Notes:

1. The Soil Categories in this design manual differ from those in AS/NZS 1547:2000. Categories 1 to 4 above span Categories 1 to 3 of AS/NZS1547:2000; Categories 5 to 7 above span Categories 4 to 6 of AS/NZS1547:2000 (refer Table 6.1).
2. Design loading rates in mm/day equate to litres/m²/day.
3. This column represents alternative the trench loading rates based on AS/NZS 1547:2000 rates using soils categories of weakly structured to massive soils correlated to TP58 soil categories. The ARC does not endorse these, as they are not considered appropriate in the Auckland region.
4. For Category 1 and 2 soils, LPED OR PCDI methods are required to ensure even loading of the design area.
5. Special design considerations are required for Category 1 and 2 soils; refer Section 10.1.4 Discharge Control Trenches. The least conservative loading rates only apply to secondary treated wastewater.
6. The maximum loading rate for any effluent quality into Category 1 and 2 soils is recommended at 50 mm/day.
7. Wind blown sands are likely to exhibit slowly draining characteristics similar to Categories 5 and 6. Caution should be applied in selecting design values for such sands.
8. Trenches should only be considered in Category 5 soils where more appropriate shallow disposal options such as drip irrigation or LPED cannot be used.
9. For Category 6 and 7 soils conventional trench systems are not appropriate. Alternative designs based on evaptranspiration or drip irrigation are recommended.

Designers are cautioned against applying high secondary wastewater loading rates for mod to strongly structured (fractured/cracked soils) in the Auckland region as there is a high risk of short circuiting during summer months. During wet months when soils may swell infiltration is reduced increasing the risk of wastewater breakout.

10.3 BED LAND DISPOSAL SYSTEMS

10.3.1 Conventional Beds

Conventional bed systems are a second best alternative to trenches and applicable where topography and site area is too restrictive for trench installation. Because beds have limited sidewall area compared to that provided by trench construction, their design loading rates are reduced since the low ratio of sidewall to bottom areas reduces their operational factor of safety. They should never be installed where room exists for trenches, and should only be applied in relatively good draining Category 1 to 4 soils. Table 10.3 sets out bed loading rates for sizing the bed bottom area and Tables TS5-1 and TS5-2. Where the bottom width of a trench exceeds the combined effective sidewall depth by more than 30%, the system can be classed as a conventional bed for design purposes. The design should be modified for discharge of wastewater into Category 1 soils to a discharge control bed.

10.3.2 Construction Details

- It is recommended that beds be maintained at least 1.5m edge to edge.
- The maximum bed width 1.0m to 4.0m.
- Multiple distribution lines will be required for beds more than of 1.5m width.
- Minimum separation width 1.0m.

Refer also to 10.3.4 for design requirements.

BED DESIGN EXAMPLE

1. Calculate peak daily wastewater production based on maximum occupancy and per capita design flow.
2. Determine Soil Category and the appropriate basal loading rate.

EXAMPLE

$$\begin{aligned} \text{Bed Basal Area} &= \frac{\text{Peak Daily Wastewater Production (litres/day)}}{\text{Basal Loading Rate (mm/day)}} \\ \text{Peak Daily Flow} &= 560 \text{ litres} \\ \text{Soil Category} &= 4 \\ \text{Basal Loading Rate} &= 10 \text{ mm/day} \\ &= \frac{\text{Peak Daily Wastewater Production } 560 \text{ litres/day}}{\text{Basal Loading Rate } 10 \text{ mm/day}} \end{aligned}$$

$$\text{DESIGN BASAL AREA} = 56 \text{ m}^2$$

Table 10.3: Recommended Design Loading Rates for Conventional Beds

Soil	Soil Type	Primary Effluent		NOT PERMITTED ACTIVITY IN AUCKLAND REGION Secondary Effluent
		MM/DAY		
		[NOTE 2]		
Category [Note 1]		Most Conservative	Least Conservative	mm/day [Note 2]
1 [Note 3]	Gravel, coarse sand – rapid draining	30 [Note 4]	40 [Note 4]	50
2 [Note 3]	Coarse to medium sand – free draining [Note 6]	20 [Note 4]	30 [Note 4]	50
3 [Note 5]	Medium fine and loamy sand – good drainage	15	20	40
4	Sandy loam, loam, and silt loam – moderate drainage	10	15	30
5	Sandy clay/loam, clay loam and silty clay loam – moderate to slow drainage	Beds not suitable [Note 6]	Beds not suitable [Note 6]	15
6	Sandy clay, non swelling clay and silty clay – slowly draining	Beds not suitable [Note 6]	Beds not suitable [Note 6]	Beds not suitable [Note 6]
7	Swelling clay, grey clay, hard pan – poorly or non draining	Beds not suitable [Note 6]	Beds not suitable [Note 6]	Beds not suitable [Note 6]

Notes:

- The Soil Categories in this design manual differ from those in AS/NZS 1547:2000. Categories 1 to 4 above span Categories 1 to 3 of AS/NZS1547:2000; Categories 5 to 7 above span Categories 4 to 6 of AS/NZS1547:2000 (refer Table 6.1).
- Design loading rates in mm/day equate to litres/m²/day.
- For Category 1 and 2 soils, LPED methods are required to ensure even loading of the design area. Where groundwater protection from bacterial contamination is important, then a bottomless sand filter may be used (refer Section 10.7 above). The maximum loading rate for any effluent quality into Category 1 and 2 soils is recommended at 40 mm/day.
- Special design considerations are required for Category 1 and 2 soils; refer Section 10.1.4 Discharge Control Trenches and Discharge Control Beds. The least conservative loading rates only apply to secondary treated wastewater.
- Wind blown sands are likely to exhibit slowly draining characteristic similar to Categories 5 and 6. Caution should be applied in selecting design values for such sands.
- For Category 5, 6 and 7 soils conventional bed systems are not appropriate. Alternative designs based on evapotranspiration or drip irrigation are recommended.

Table 10.4: Summary of Land Disposal System and Recommended Loading Rates vs. Soil Category

Land Disposal Method	Soil Category						
	1 Gravel Coarse Sand Rapid draining	2 Coarse to Medium Sand Free Draining	3 Medium Fine and Loamy Sand Good Drainage	4 Sandy Loam and Silt Loam Moderate Drainage	5 Sandy Clay Loam Mod to Slow Drainage	6 Non-swelling Clay and Silty Clay Slowly Draining	7 Swelling Clay Poorly or Non draining
Pressure Compensating Drip Irrigation	Note 1						Note 2
LPP/LPED Shallow Trenches	Note 3	Note 3	Note 3				
Discharge Control Trench							
Narrow Deep Trenches			Note 4				
Conventional Trenches							
Conventional Beds	Note 5						
ASB/ETS Beds							
Mounds							
Bottomless Sand Filter							
Infiltration Systems	Note 6	Note 6					

Notes:

1. PCDI becomes distribution method within a discharge control trench.
2. Specific design required within Category 7 soils.
3. LPED becomes a distribution method within Category 1 to 3 soils.
4. Assumes there are no environmental or site constraints.
5. Conventional beds design to be modified to a discharge control bed in Category 1 soils.
6. Assumes there are no environmental or site constraints.

10.3.3 ETS (Evapotranspiration Seepage) Beds

The concept of evapotranspiration seepage (ETS) systems was originally introduced into New Zealand in the 1970's, in response to research undertaken in Canada by Bernhart [Ref 6 & 22], on the use of ET assist in advanced bed systems. They became increasingly popular on sites with poor soakage as an alternative to trench land disposal throughout the 1980's. However, more recently, many of these advantages have been replicated and superseded by pressure compensating dripper irrigation [Ref 6].

Evapotranspiration seepage (ETS) systems utilise both subsoil soakage and assistance from plant evapotranspiration (ET) to achieve disposal [Ref 23]. The applied wastewater infiltrates through the natural soil (via seepage) at a rate determined by the soil type and condition. The sand layer overlying the distribution media draws liquid via upward capillary action to feed both water and nutrients to stimulate plant growth and ET. During periods of wet weather when soils adjacent to the beds become saturated the beds fill with seepage water that can displace effluent and result in surface breakout.

In the past, conventional beds were designed for basal seepage only. The benefits of maximising evapotranspiration are now recognised in all bed systems by designing to provide for evapotranspiration and seepage rather than only soakage in conventional beds. Good planting of ETS beds and maintenance of vegetation is critical to achieve the hydraulic absorption required, particularly in Category 5 and 6 soils, where bed disposal methods are otherwise unsuitable.

10.3.4 Function and Water Balance

Research with ETS found that plantings could boost pan evaporation values some 2 to 3 times that of bare soil rates. In windy locations the "clothes line" effect accentuates this evapotranspiration mechanism significantly. The ETS loading rate of 5mm to 12mm incorporates an allowance for subsoil seepage together with the effects of pan evaporation plus a multiplier to allow for seasonal transpiration from selected vegetation (Table 10.5).

The ETS bed will fill with applied effluent during winter while sidewall seepage into the topsoil on the downslope side of the ETS system distributes flow into the space between individual beds. This expands the area available for ET assist under the lower winter ET rates.

10.3.5 Design Notes and Specifications

In the New Zealand situation the detailed Bernhart water balance approach [Ref 22] has been set aside in favour of simplified design rules. These are based upon experience since 1976 with local ETS construction and performance. The following items are important components in the design and installation of ETS (Figure 10.4):

- i. The ETS system enables beds to be used in Category 5 to 6 soils for on-site disposal.
- ii. Reasonable topsoil depths are required on site (a minimum of 150mm) to handle controlled sidewall seepage under winter conditions.
- iii. Pretreatment should be a minimum of 4500litre septic tank system (for a standard household) and effluent outlet filter.
- iv. Effluent should be dose loaded (by pump or siphon) to ensure even loading of the design basal area at all times.
- v. The maximum bed length should be 20m to ensure even distribution over the entire infiltration surface.

- vi. The minimum media depth should be 200mm of sand overlying 200mm of gravel or scoria; (whereas Bernhart recommended a minimum sand depth of 450mm [Ref 22]).
- vii. Surface water cutoff drains to be provided to intercept and divert away from the disposal area.
- viii. Groundwater cutoff drains to be installed where a high seasonal groundwater table affects the disposal area.
- ix. A minimum of two disposal beds or contour trenches to be installed (each half the design area).
- x. Distribution lines to be vented at each end.
- xi. A 100% reserve area for future extensions to be available (to meet the situation where performance of the initial system does not, due to unforeseen circumstances, match design expectations).
- xii. Bed to be mounded to shed rainwater and planted with grass.
- xiii. Selected ET plantings (such as those listed in Appendix G) can be utilised on the downslope edge of beds or trenches to control seepage, or alternatively can be planted on the beds.

It is also recommended that where bed width is 1500mm or more, two parallel distribution pipes should be used to ensure even loading across the width of each bed.

10.3.6 Design Sizing

Design area to be sized on the basis of soil type and basal area as follows:

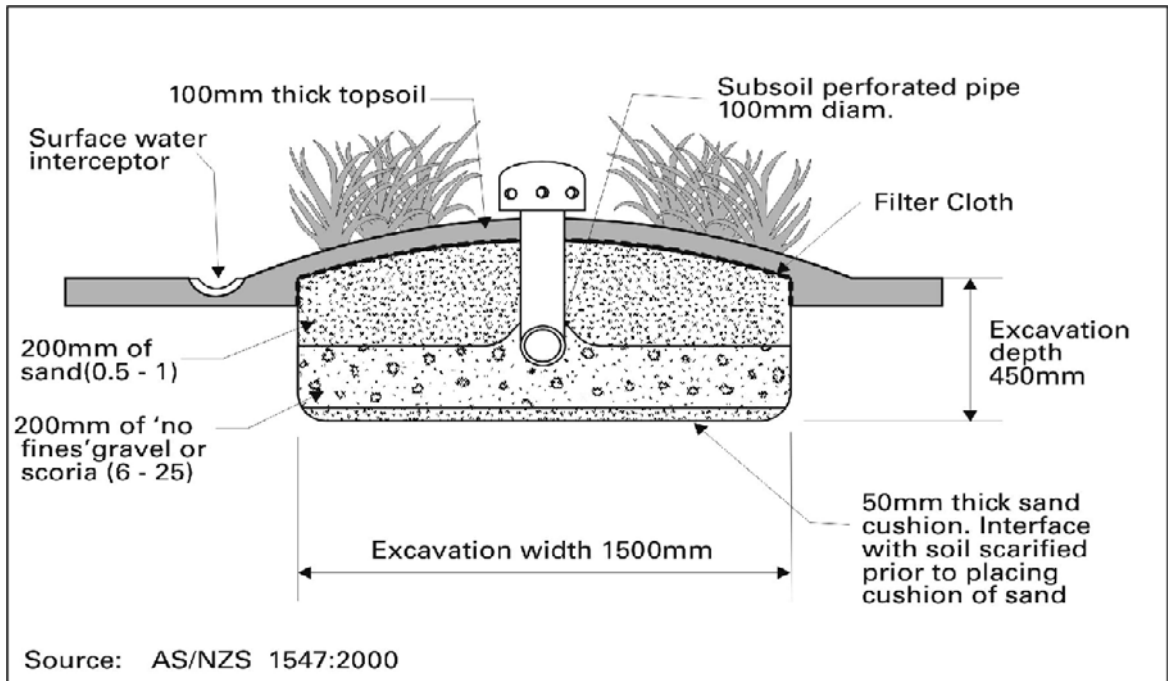
Table 10.5: ETS/ASB Design Loading Rates

Soil Category	ETS Beds Loading Rate (mm/day)
1	[Note 1]
2	[Notes 1 & 2]
3	[Notes 1 & 2]
4	15
5	8 to 10
6	5
7	[Note 1]
Notes:	
1. ETS/ASB systems are not normally used in Category 1 to 3 and are never appropriate in Category 7 soils.	
2. Should ETS beds be used in Category 2 or 3 soils, the loading rates for conventional beds apply (Table 10.3). This is because there will be minimal additional evapotranspiration in ETS compared to that in conventional beds in soils with high soakage characteristics.	

The "areal" loading rate (being design area plus the natural soil space between adjacent disposal beds) should be up to 3mm per day for primary effluent and up to 5mm/day for secondary effluent.

The concept of "areal" loading is important in the New Zealand context. This refers to the total load on the design area plus the natural soil space between adjacent disposal beds or trenches. For ETS on Category 6 tight clay soils under winter conditions, high effluent watertable in the disposal area can seep into the downslope topsoil thus increasing the total area available for ET assist, and thereby compensating for the lower winter ET rates.

Figure 10.4: Evapotranspiration Bed/Aerobic Soakage Bed

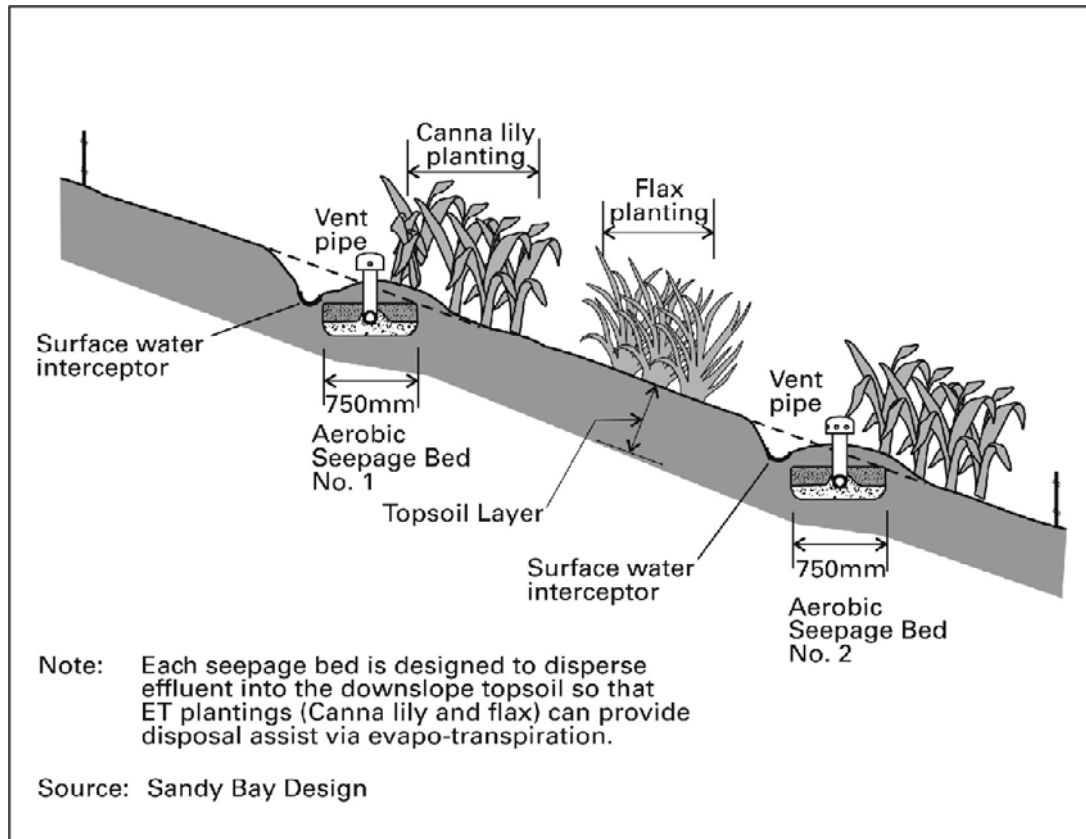


10.3.7 Bed Construction Details

The standard width for ETS beds is recommended at 1500mm, but 1800mm up to 3000mm maximum can be utilised provided crowning to shed rainfall is increased accordingly. Contour ETS beds of 450mm to 750mm width can be used on sloping sites (Figure 10.5). However pressure compensating dripper irrigation is a superior land disposal technique for all sites. It is recommended that beds are maintained to at least 2.0m centres edge to edge, although 1.5m centres are also common.

Sand size for ETS beds of 0.5 to 1.0mm is recommended. It is important that sand is not too fine so as to encourage evapotranspiration. For the Auckland area a sand known as "Mercer No. 3" has been utilised in successfully operating bed systems.

Figure 10.5: ETS (EvapoTranspiration Seepage) Contour Beds



10.4 MOUND LAND DISPOSAL SYSTEMS

10.4.1 General

The application of the Wisconsin Mound in the past has been for those soil and site conditions where conventional disposal trenches are unsuited due to shallow soils overlying a hardpan or rock, or where water quality protection is required for a high water table in permeable soils. The mound provides for distribution of effluent onto a layer of sand of at least 600mm depth to ensure satisfactory renovation before entering the natural soil and then diffusing into the surrounding soil above the hardpan or water table. The sand fill media provides for additional treatment of the primary treated wastewater in a similar manner to an intermittent sand filter. Effluent must be dose loaded via pumping into the mound distribution system to ensure even distribution across the entire infiltration surface and maximise wastewater renovation potential within the sand media rather than plug flow through a section of the media and ineffectual treatment. Treatment should be via a minimum 4,500litre septic tank with an effluent outlet filter or better.

10.4.2 Wisconsin Mound Systems

The Wisconsin Mound on-site land disposal system (Figure 10.6) is utilised on relatively flat slopes of less than 11°, which have 450mm to 600mm of unsaturated undisturbed topsoil and subsoil overlying a limiting layer or elevated groundwater. The mound is constructed directly onto the natural ground surface that is ploughed or cultivated prior to mound construction. Wastewater renovation takes place within the sand fill of the mound, enabling the unit to be placed on rapidly draining or moderately draining subsoils. They can also be utilised on filled areas.

Location of mounds on steeper slopes increases the risk of wastewater breakout from the downslope edge requiring design of a toe or toe extension to assist with assimilation of applied wastewater. Level sites allow wastewater to spread over the infiltration surface under the entire mound area but can result in wastewater mounding in Category 4 soils. Mounds should always be located on the upper portion of slopes, not at the slope base.

On sloping or level sites, the mounds should be designed and constructed as long and narrow as possible and extend along the contour to ensure that toe loading limits are reduced and allow applied effluent to move away from the toe area within the natural soil without breaking out of the toe. The effective basal area taken for disposal in the sloped system is increased over that for flat land (Figure 10.7). When determining the mound basal area required the design is to take into account the sand fill loading rate, the underlying natural soil loading rate and for sloping sites the linear loading rate along the downslope edge of the toe.

Media Requirements

All aggregate used for construction of the sand fill and distribution bed is to be free of clay and silt. The sand fill media acts as a sand filter, which renovates primary or secondary treated wastewater. In the case of primary treated wastewater a media that is too fine could potentially clog resulting in failure of the mound and wastewater breakout from the sides. The sand fill grain size and infiltration capacity will determine the bed basal area. Use of local sand will reduce the cost against importation of sand. The use of highly permeable materials for sand fill is not recommended as their treatment capacity is less and there is a risk of seepage from the mound edge when located on slowly draining soils.

Table 10.6: Comparison of Recommended Media Loading Rates (in the Literature)*

Wisconsin Mound Distribution Media and Sand Fill Media Loading Rates		
Design Source		Loading Rate* (l/m ² /d)
Sand Fill		
AS/NZS/1547:2000 [Ref 1]	0.3 – 1.0mm UC = 4	Max 50
USEPA 1980 & Crites [Ref 24 & Ref 2]	Medium Sand >25% 0.25 – 2.0mm <30 – 35% 0.05 – 0.25mm <5 – 10% 0.002 – 0.05mm	Max 50
Converse [pers.com]	D ₁₀ 0.3 – 0.5mm UC 1 – 4 (Intermittent Sand Filter Grading)	30 to 40
Distribution Aggregate		
AS/NZS/1547:2000 [Ref 1]	20 – 60mm non crushed	50
USEPA (1980) [Ref 2]	18 – 64mm	
Notes:		
* Loading Rates recommended by TP58 are presented in Table 10.7.		

There is some variation in the literature regarding suitable grain size distribution for use as sand fill media in mounds. AS/NZS1547:2000 requires 0.3 to 1.0mm however the relatively fine size increases the risk of a clogging mat developing at the interface between the distribution aggregate and sand fill particularly where effluent is only primary treated. Clogging of the infiltrative surface will cause effluent breakout from the mound edge. The use of sand fill that is very coarse will allow rapid movement of applied wastewater through to the natural soil infiltration surface and minimise the risk of clogging but only provides limited wastewater treatment. USEPA (1980) [Ref 24] and Crites [Ref 2] recommend a maximum sand fill loading rate of 50mm/day for a sand having more than 25% of the grain size being 0.25 – 2.0mm.

James Converse recommends sand fill grain size grading such as that used for intermittent sand filters is appropriate and having a D_{10} of 0.3 to 0.5mm [Ref 25] (refer Table 10.7). Converse also recommends a conservative sand fill wastewater loading rate to minimise the potential for development of a clogging layer. In the event that the sand infiltration surface develops a clogging layer over time, Converse recommends aerating wastewater prior to discharge into the mound [Ref 25].

Recommended media grains size and design sizing is based on the following table:

Table 10.7: Mound Design Sizing Criteria

Parameter	Design Specifications
Distribution Bed Coarse Media (20 – 60mm diameter)	Loading rate based on sand fill media and not to exceed 50mm/day [Note 1]
Sand Media Loading Rate D_{10} 0.3 – 0.5 UC = 1 – 4 [Notes 2 & 3]	30mm/d for Primary Effluent [Note 4] 50mm/d for Secondary Effluent
Basal Soil Loading Rate Soil Category 1 – 2 Soil Category 3 – 4	35mm/d 12mm/d
Mound Toe Maximum Linear Loading Rate	Max 50mm/linear metre/day
Notes:	
<ol style="list-style-type: none"> 1. Distribution media loading rate is determined by sand fill media sizing, distribution media is to provide for even distribution of applied wastewater across the sand fill infiltrative surface. 2. D_{10} refers to the effective grain size that is the 10% size by weight for a wet sieve analysis. 3. UC is uniformity coefficient defined by the D_{60}/D_{10}. 4. The application of primary treated effluent into the gravel distribution bed can result in clogging by bioslimes/clogging mat of the sand fill infiltration surface if the loading rate is too high. Finer fill will require lower application rates. 	

Mounds are appropriate for Category 1 to 4 soils but are not recommended For Category 5 to 7 soils. For Category 1 to 4 soils secondary treatment and drip irrigation systems may be far better suited to shallow topsoil and high water table conditions for which mounds would have been previously used. However it may be necessary to import topsoil to raise ground level and provide the required groundwater separations.

Design Procedure

The mound must be designed for the sand fill loading rate, basal soil loading rate and where the site is sloping for the linear loading rate of the toe area. The basal area sizing is calculated on the area beneath and downslope from the distribution bed. Wastewater is to be dose loaded into the distribution bed and distributed within the bed by LPED or similar to ensure even loading at a loading rate not exceeding 30mm/day for primary treated effluent.

Figure 10.6 and 10.7 show the design layouts for a Wisconsin Mounds on a flat site, and sloping site respectively. The designer should size the basal area to ensure there sufficient area to absorb all the applied wastewater before it reaches the edge of the mound or breakout will result. This will require determining the Soil Category and assigning the basal loading rate. In the case of level sites the entire basal area [basal length (L) x basal width (W)] is used to calculate the mound basal area in which case I and J will be equal. In all cases the maximum side slope is 1 in 3 from the base of the distribution bed. This will set the actual areal footprint of the mound. The design does not include the area between the distribution bed and edge of the mound (K) in the basal area loading rate calculation. On sloping sites only the mound area downslope of the distribution bed is used to calculate the design infiltration area [B x (A + J)]. Where experience shows the basal area loading rate is inadequate to prevent seepage occurring from time to time, then a toe extension should be installed. The toe width I is determined by ground slope and the requirement for a maximum mound face angle of 1:3, (refer Appendix D, TS D-2). The designer should always include a work sheet when submitting designs for a Wisconsin Mound to enable a simple check of the design for correctness.

The advantages of Wisconsin Mounds are:

- They increase the separation distance between the disposal system and water table or hard pan;
- They provide additional wastewater treatment; and
- They provide wastewater treatment and slow effluent flow over Category 1 soils.

The disadvantages of Wisconsin Mounds are:

- They can be expensive to construct;
- They require a relatively large land area dedicated to wastewater application only although the entire area is less than that which may be required for PCDI ; and
- They are only suitable for gently sloping sites of less than 11°.

When located upslope from buildings and on slowly draining soils a 10m separation distance is required.

Figure 10.6: Wisconsin Mound Details for a Flat Site

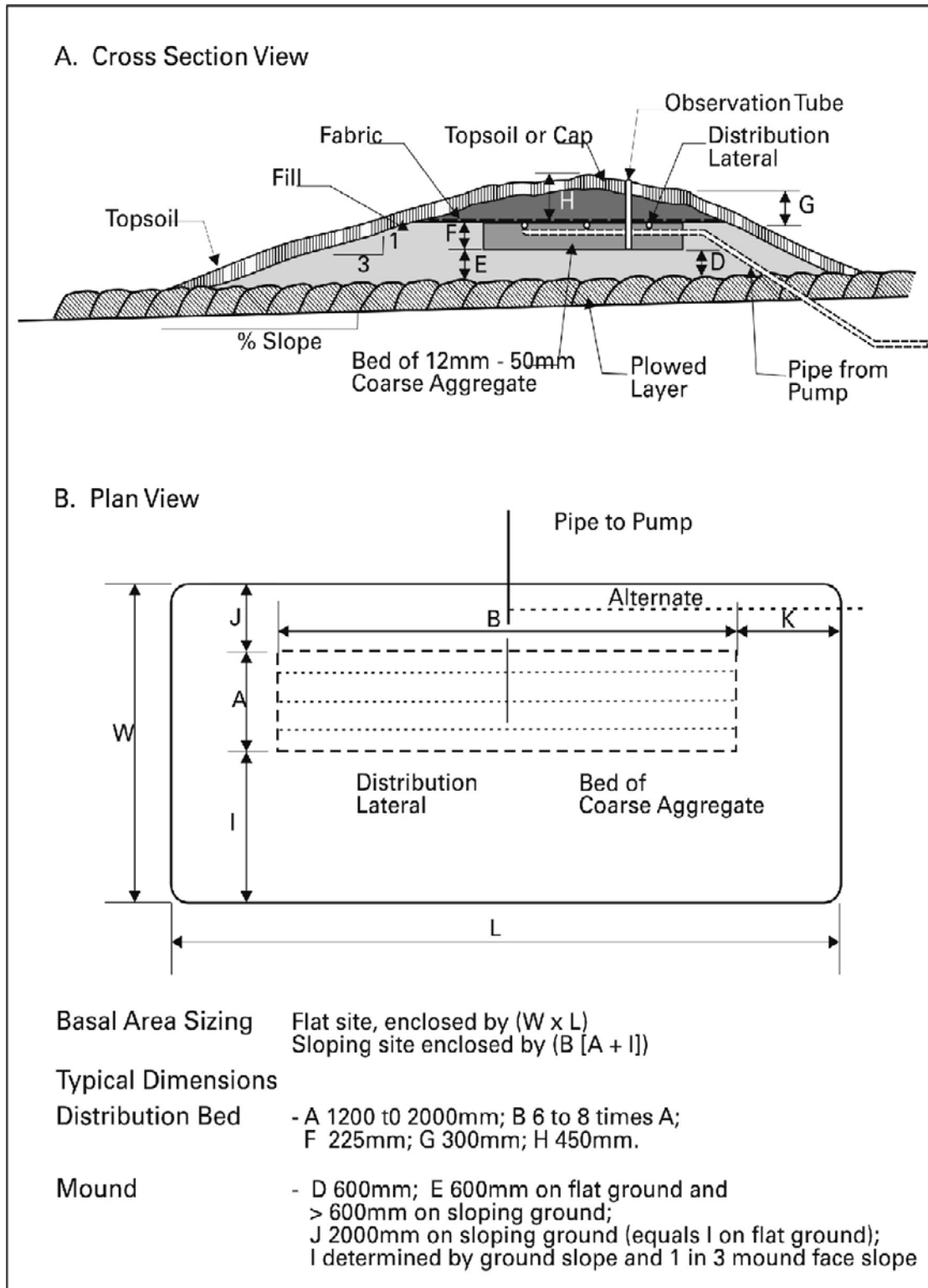
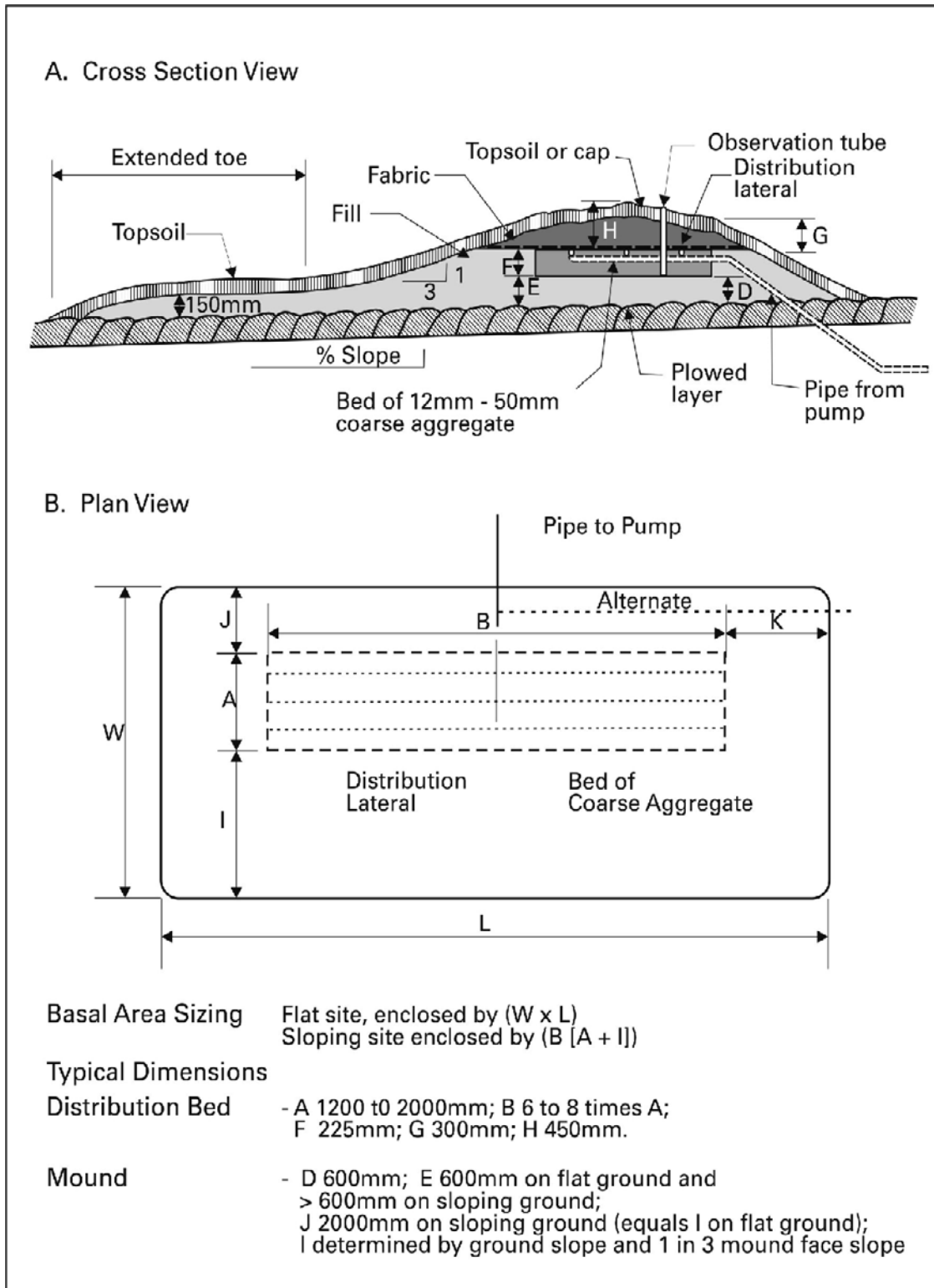


Figure 10.7: Wisconsin Mound Details for a Sloping Site



10.4.3 At-Grade (Fill) System

Where there is some 900mm clearance to a limiting layer from ground surface the sand fill normally present in a Wisconsin Mound can be deleted and the distribution media bed laid directly on the topsoil. All other details are as for the mound design – ploughed topsoil, pressure distribution into perforated pipe. A minimum of 300mm of soil fill is placed over the distribution media bed, and tapered some 1500mm beyond the edge of the bed. Grass is planted as ground cover [Ref 26 & Ref 27].

Design sizing is based on length times the width of the media bed (i.e. the effective width) at the following loading rates:

- a. Category 1 and 2 soils 30mm/day
- b. Category 3 and 4 soils 10mm/day

For Category 5 to 7 soils, the at-grade system is not recommended. For these soils secondary treatment and drip irrigation systems are far better suited.

10.4.4 Mound Construction

The natural ground surface onto which the mound fill is to be laid should be cultivated carefully to a depth of 180 to 200mm by plough or tined cultivator (not rotary hoe). Sand fill of 0.3 to 1.0mm size (uniformity coefficient 4) should be carefully spread over the design surface and built up to full 600 to 700mm depth with manual or light machine compaction. The preferred distribution aggregate (granular media) size is 20 to 60mm, with the initial layer of 150mm laid before the pressure distribution laterals are placed. The distribution system should then be pump tested with clean water to confirm distribution effectiveness, following which the aggregate is completed to the full 225mm depth before covering with fabric, plus additional sand/loam fill and topsoil cover shaped to divert rainfall.

10.5 BOTTOMLESS SAND FILTER

The bottomless sand filter is the same design as an intermittent sand filter but without a basal lining and collection system for discharge of treated wastewater to a pump chamber and separate land disposal system. The base of the bottomless sand filter is open to the underlying sand and doubles as the land disposal system. Bottomless sand filters are only to be used following pretreatment comprising a septic tank and outlet solids control filter. Wastewater is timer dose loaded onto the filter via a pipe distribution network to ensure even coverage of the entire distribution area. Flood loading the sand filter surface is unacceptable, as this method does not achieve even distribution across the entire bed surface and results in localised overloading, impaired treatment and potentially failure of the system. Bottomless sand filters are only to be used in Category 1 – 2 gravel and sand soils.

The bottomless sand filter can be built either above ground within a walled containment unit comprising timber or earth mounded sides or can be inset into the ground where there is adequate groundwater clearance measured from the base of the sand filter (refer Table 5.2). The walls shall be plastic lined to ensure that a vertical flow of applied primary effluent is achieved.

Sizing of the filter horizontal surface area is recommended as follows:

- a. Category 1 soils 50 to 70mm/day (900mm sand filter depth)
- b. Category 2 soils 35 to 50mm/day (min 600mm sand filter depth)

These loading rates and treatment sand depth recognise that the natural soil provides a variable degree of in soil treatment. The choice of a design loading rate should also take the wastewater source (domestic or public toilets or restaurant) and therefore strength in terms of BOD₅ into account. For Category 1 soils the 900mm of sand filter depth maximises the treatment level prior to draining rapidly through the natural coarse sand and gravel below the system and directly into the water table with minimal additional in ground treatment. The 50mm/day loading rate is suitable for these conditions. For Category 2 soils the shallower 600mm sand filter depth is compensated for by the lower application rate, which is more suited to the underlying soil conditions. Bottomless sand filter loading rates are higher than those for discharge control trenches in Category 1 soils as bottomless sand filters are a specifically engineered treatment and land disposal system, involving timer dose loading and with specifically graded sand, whereas discharge control trenches are not. Such systems should only be designed and installed by experienced professionals.

It is recommend that a 50mm thick gravel layer is located at base between the natural sand and sand filter as a capillary break and a distribution/spread layer.

The designer should also determine the potential for and quantify the amount of groundwater mounding beneath the bottomless sand filter where the groundwater table is shallow. If groundwater mounding is problematic it may be necessary to utilize a more widespread distribution system or an alternative land disposal area.

10.6 INFILTRATION SYSTEMS

Rapid infiltration systems may be practical in rapid to free draining soils (Category 1 and 2 gravels and coarse to medium sands) *provided no environmental constraints exist* such as groundwater which is to be at more than 3m in depth and where the construction/installation enables access to the infiltrative surfaces for maintenance purposes (Figure 10.8).

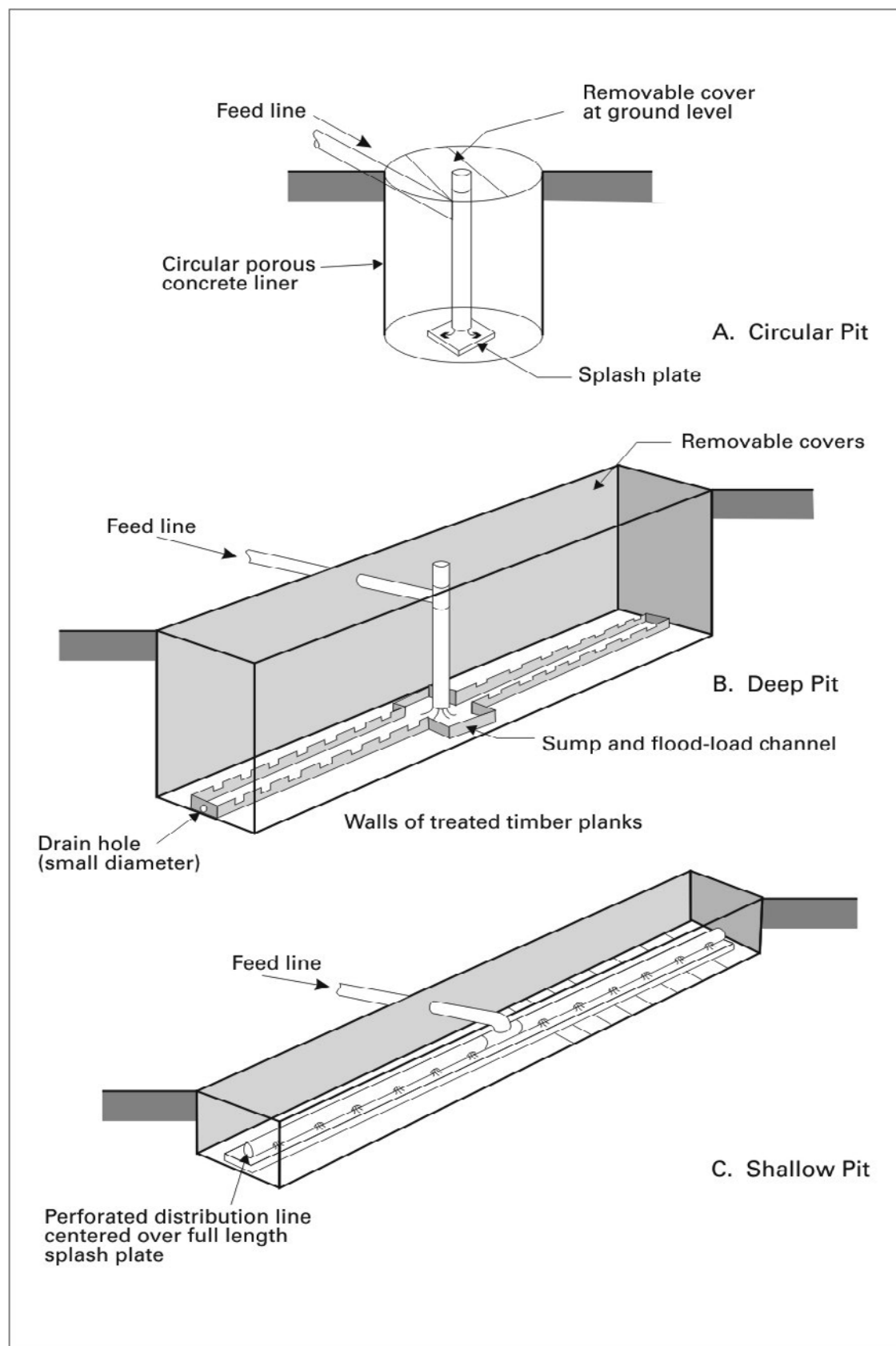
In gravels and coarse sands loading rates up to 200mm/day for secondary effluent can be used for individual household systems. These loading rates are applied to the bottom area of the infiltration system, and take into account the effect of sidewall soakage. For larger applications (10 persons and greater) and in Category 2 – 3 medium sands, careful site evaluation should be carried out to confirm the infiltration capacity of the subsoil and the influence of potential groundwater mounding due to the proximity of the water table. At least secondary quality wastewater treatment is recommended where rapid infiltration is proposed. Loading rates should be dropped to between 100 to 200mm/day for such sands. Covers should be lifted regularly and the horizontal infiltration surface inspected and raked as required. Frequency of this maintenance procedure will be determined from operating experience with each individual system. The distribution of flow into the system should be arranged to avoid scouring of the infiltrative surface (Figure 10.8).

The disadvantages of rapid infiltration systems are:

- That minimal nutrient reduction is achieved within granular soils;
- There is potential for high impacts on the receiving groundwater;
- The fate of wastewater discharge is unknown;
- There may not be any additional treatment of nutrients or viruses, bacteria or pathogens; and
- There is a risk of surface water inflow during or following rain.

The use of infiltration systems is not a permitted activity in the Auckland region and will be evaluated on a case by case basis as part of a discharge consent application process.

Figure 10.8: Typical Infiltration Pit Systems



10.7 DEEP BORES

10.7.1 General

Deep bores are a form of deep infiltration system used on sites where there are restrictive soils near the surface, such as poorly draining clays, overlying more permeable subsoil layers at depth. They are typically no deeper than 6m. Deep bores are considered to be a high risk method for land disposal of wastewater primarily as it is difficult to determine the fate of the wastewater and the high potential impacts on groundwater or surface waters.

Essentially deep bores are a disposal mechanism only; they do not provide for consideration of sustainable management of resources as is now required under the Resource Management Act 1991 (refer Section 2). Sustainable management is promoted by keeping treated wastewater within the shallow soils layer where it can be easily absorbed by plants via transpiration and into the atmosphere by evaporation. At the deep infiltrative surfaces, there is unlikely to be any significant further treatment of the wastewater as can be expected to occur with shallow land disposal systems. The retention within the aerobic soils enables significant biodegradation by soils microorganisms that is only possible at a much slower rate by the anaerobic bacteria at depth and there is little to no nutrient reduction

Deep bores may have hydraulic applicability where permeable subsoil layers or fractured rock exists at depth under poorly draining clayey upper soil layers but are not environmentally sustainable. However, a specialist soils/geological consultant must be engaged to advise on the design, the likely environmental constraints, the ultimate destination of effluent, and the need for secondary treatment. Such wastewater disposal systems are generally inappropriate for sites close to surface water, areas where there is a permanently or seasonally elevated groundwater table, where soils are highly permeable, steeply sloping sites and sites close to edges of cliffs and embankments.

10.7.2 Deep Bores in the Auckland Region

Deep bore wastewater disposal has been seriously misused in the past as bores have been applied to sites with slow and poorly draining soil, which has often resulted in severe system failures, involving direct contamination of ground or surface water and corresponding health effects. Deep bores are directly contrary to the modern concept of sustainable on-site land application of wastewater, predominantly involving the shallow and even distribution of wastewater in the topsoil layers of the soil in a manner that maximises evapotranspiration. In the case of sites with highly permeable soils there may be a lower potential for failure due to poor of soakage, however, there is still a significant risk of unacceptable impacts on ground and surface waters. For all these reasons, they are considered an inappropriate option for any new system in the Auckland region.

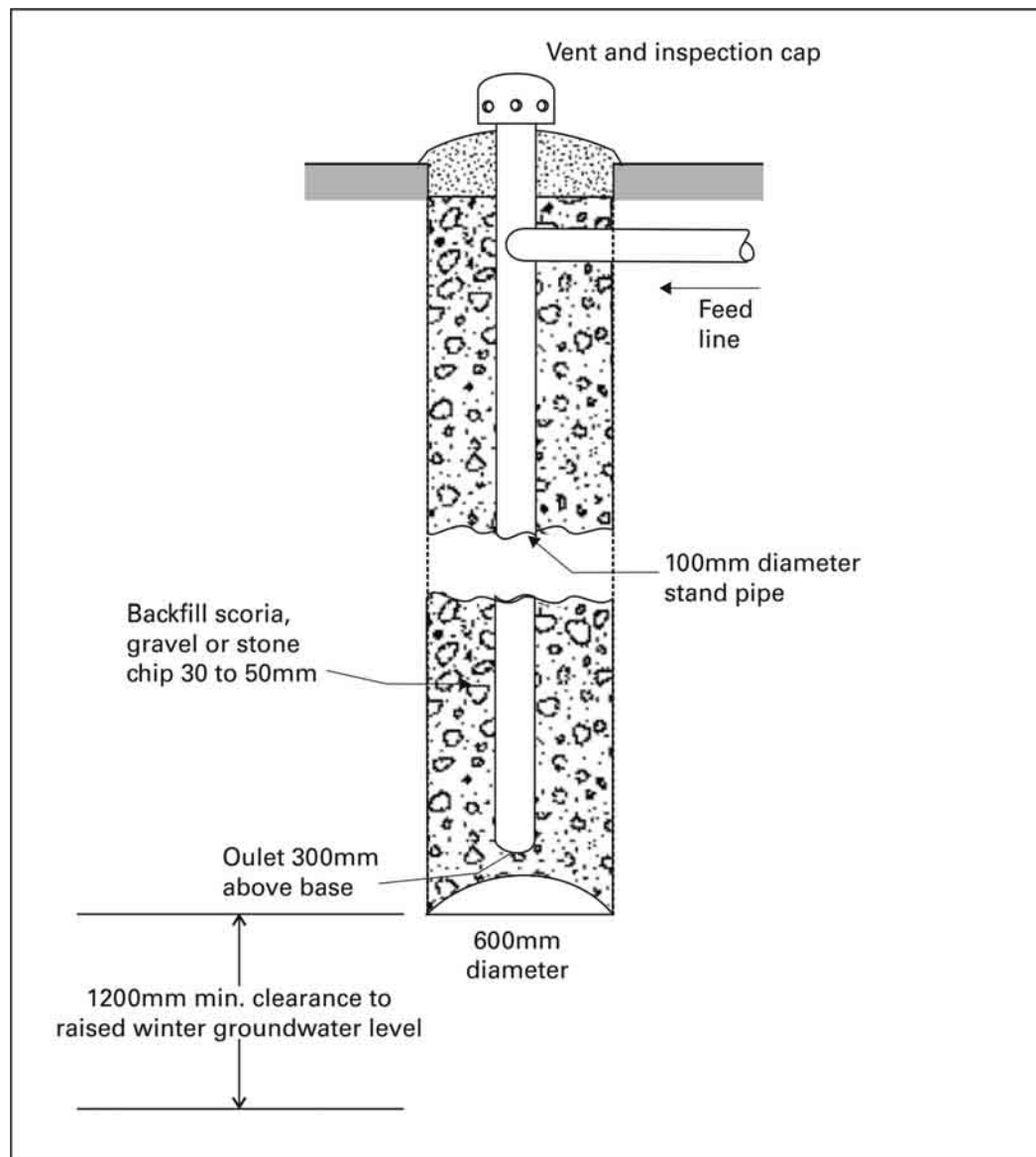
AUCKLAND REGIONAL COUNCIL AREA

In all cases, deep bores may only be considered in the Auckland region in an upgrade of an existing wastewater system, where no viable alternative exists and also only providing effluent is to be treated to at least secondary quality. Replacement deep bores will be evaluated on a case by case basis as part of a discharge consent application process.

Deep bores should only be installed in soil structures at depth that can maintain free draining characteristics. Recommended minimum environmental clearances are:

- 1200mm from bottom of bore to highest seasonal groundwater level;
- 20m to surface water;
- In fractured rock there is unlikely to be any additional treatment within the rock and is therefore considered unsuitable;
- Fractured soil/clay.

Figure 10.9: Schematic Diagram of a Deep Bore



10.7.3 Site evaluation, soakage testing, and design sizing

Soil investigation and preinstallation site testing by a specialist are important steps in sizing the system. The following procedure is recommended.

Step 1: Carry out a soil profile study via 50mm auger holes to identify suitable permeable soil layers at depth; this study will indicate the potential of the site for deep bore disposal, but design must be based upon a full scale test procedure.

Step 2: Prepare two full scale 600mm diameter test holes (machine dug) to a depth not usually exceeding 6m or to within 1500mm of groundwater level.

Step 3: Test load each hole with clean water over a 4 hour period and measure the head loss at 15 minute intervals.

Step 4: From a plot of soakage rate versus time, take the minimum soakage rate from the curve for design purposes in terms of the tangent at the 4 hour.

Step 5: From the rate of fall in the fourth hour calculate the volume rate of soakage per hour, halve the figure obtained, then calculate the number of 600mm diameter deep bores to soak away the daily design flow volume over an 8 hour period at this rate. This then becomes the requirement for the installed system.

It can be seen that the design sizing for infiltration of primary effluent (such as septic tank outflow) is based upon a soakage rate per deep bore of one sixth ($1/6^{\text{th}}$) that indicated by the clean water 4 hour test result.

The disadvantages of deep bore disposal are:

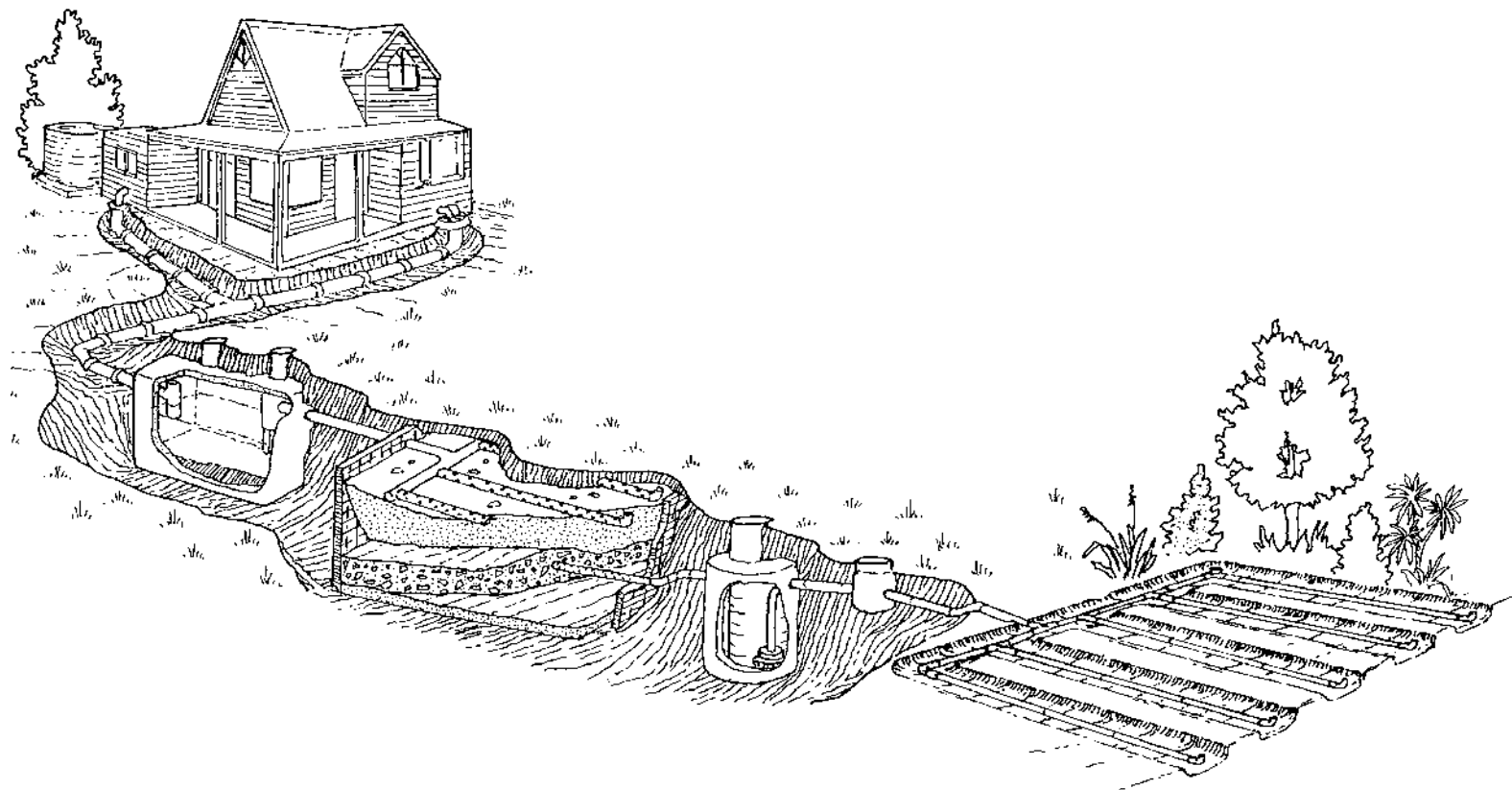
- The fate of wastewater discharge is unknown;
- There may be potential impacts on surface and groundwater;
- If discharge is into fractured rock there will not be any additional treatment of nutrients or viruses, bacteria or pathogens;
- There is a risk of surface water inflow during or following rain; and
- Discharge is at depth and below the zone of aerobic bacteria activity required for the breakdown of organic matter.

10.7.4 Installation and Operation

The design process, based as it is on the results of a clean water soakage test, recognises that eventually deep soakage systems taking septic tank effluent will clog, and have to be duplicated. Two sets of deep bores can be installed from the outset, and operated under weekly or monthly alternation of load and rest. Providing high quality treatment can also extend the life of the system, and this then becomes a design consideration, particularly for systems serving larger than household size populations.

A check should be made where shallow bores (i.e. 2m depth or less) are used in Category 1 soils that a minimum of 24 hours storage capacity within the voids of the backfill media over the operating depth is available in the duty set. Groundwater bore installation details are provided in Figure 10.9.

11 > Environmental Effects From On-site Wastewater Disposal



11. ENVIRONMENTAL EFFECTS FROM ON-SITE WASTEWATER DISPOSAL

11.1 CONSIDERATION OF ENVIRONMENTAL EFFECTS

11.1 Introduction

The discharge of contaminants in wastewater into the environment has an adverse effect on receiving soils, groundwater, and nearby surface water. Even in the case of a conservatively designed, well installed and well maintained system, it is likely that there will still be a gradual change in the condition of the receiving soils over the long term. The goal of a conservative approach to on-site wastewater system design is to achieve a system that will be sustainable in the long term with any effects remaining negligible. It is critical that potential future effects of an on-site system are considered at the design stage and are minimised in the long term by good system management.

Adverse effects become increasingly evident where there is an increased density of on-site systems within a catchment. A number of wastewater land application systems within a catchment, particularly where the sites are small due to the intensification of residential/commercial development, can lead to significant cumulative effects in the wider receiving environment. These effects can manifest as effects on surface and groundwaters. This can occur even if adverse effects are not apparent on the individual sites. Where potential for cumulative adverse effects exists from the collective application of nutrients or microbiological loads on a number of sites in close proximity, conservative designs and appropriate mitigation measures become increasingly necessary.

An impact assessment is a critical part of the design stage and should address such effects on the receiving environment. Effects should not only be considered within the next 10 year period but also for the maximum foreseeable life of the system and beyond. With improved technology and the corresponding increased long term success of on-site systems, there are decreasing expectations that systems only need serve as only a temporary option until an area is reticulated. It is worth noting that in the United States, 25% of households, and a similar level of households in Australia and New Zealand, are reliant on some form of on-site system, mostly as a permanent option.

An impact assessment should include the potential removal capacity of site soils, groundwater depth, impact of groundwater discharge to the eventual receiving waters and sensitivity of that environment to nutrients and other contaminants. Environmental effects need to be addressed in terms of both hydraulic and organic loading rates, the adoption of treatment and disposal technologies and the corresponding effects on the receiving environment. An Assessment of Environmental Effects (an AEE) should detail all potential effects from the system and mitigation measures included to minimise any effects.

11.1.2 Assessment of Environmental Effects and Mitigation Measures

All applications to discharge treated wastewater should have regard to the effect on public health and on environmental effects, The key environmental effects that should be considered are:

- Impact on *Surface Water*;
- Impact on *Groundwater*;
- Impact on *Soils*; and
- Impact on *Amenity Values*.

Regard for effects should include details of mitigation measures to minimise effects potential environmental effects (and thereby also health effects). These need to be covered in the AEE provided with a system design in an on-site wastewater discharge application. All on-site wastewater discharge applications should therefore also describe the mitigation measures included in the design. These measures may include:

- a. A conservative approach to determining the **System Design Discharge Volume** (e.g. based on peak predicted flows for peak occupancy).
- b. A **Robust Treatment System Design** (e.g. that will achieve consistent high quality effluent under a range of likely conditions).
- c. A high level of wastewater treatment and **Treated Wastewater Discharge Quality**.
- d. Mitigation **Measures within the Treatment Systems to Protect Against System Failure**, (such as dual pumps, emergency storage, both audible and visible alarms etc.).
- e. **Conservative Hydraulic Loading Rates** for the treatment and land disposal systems (and where known, organic loading rates).
- f. Measures to ensure **Even Distribution and Even Loading** of the land application area.
- g. **Protection** of the Land application area from **Hydraulic Overloading** by the provision of surface storm water diversion drains or/and subsurface groundwater cutoff drains.
- h. A description of **Soil Types** and **Soil Category** that will enhance further wastewater rejuvenation (including topsoil depth and thickness and of other soil horizons).
- i. A description of the land application area **Aspect, Slope** and **Vegetation** cover.
- j. Separation Distances of the land disposal area **from Surface Water**.
- k. Separation Distances of the land disposal area from **Groundwater**.
- l. Separation distances of the land disposal area from **Water Supply Bores**.
- m. Determination of the potential **Flood Risk** and location of the wastewater treatment and land disposal systems to mitigate and minimise this risk.
- n. Provision of sufficient **Reserve Allocation**.
- o. Provisions to **Discourage Access** to the treatment and or land disposal area, such as signage, fencing or planting.

Measures to protect public health include any further measures that **prevent human contact with treated wastewater**, including prevention of contact with the treatment system. Mitigation measures can also be specified that address the following further effects:

- p. **Odour** effects.
- q. **Noise** effects.

Measures to ensure the correct ongoing operation and performance of the wastewater treatment and land disposal systems should also be mentioned at the application stage and these should include:

- r. A **System Management Plan**.
- s. A **System Maintenance Contract**.
- t. **Education of System Users** of key Do's and Don'ts for discharges, and the critical system maintenance and management requirements.

11.2 INTRODUCTION TO CONTAMINANTS IN RECEIVING SOILS

There is likely to be an increased regard for the application of nutrient salts to soils over time, as on-site wastewater land application systems are increasingly seen as a permanent disposal option. The importance of nutrient (particularly nitrogen) reduction and disinfection in treatment systems becomes more significant through the adoption of biological denitrification stages and UV or chemical disinfection processes within the total treatment process.

Bacterial application can be less of a concern in soils in many situations, providing precautions are in place to prevent wastewater surfacing on land or seeping into surface water or to rapidly into groundwater. Precautions include a good level of treatment and even and low hydraulic loading rates. Bacterial levels can reduce significantly by die-off at depth in the receiving soils, unless there is a high groundwater table or fissures in hard soils to coarse soils that enable short circuiting of wastewater and rapid contact with groundwater. Where a significant risk exists of bacteria from treated wastewater impacting on ground and surface water, further precautions should include disinfection to reduce bacterial levels.

The effects of the application of nutrients and other contaminants to receiving environments are discussed throughout this section. Potential inorganic contaminants from on-site wastewater systems include nitrogen, phosphorus, metals and salts. This section addresses the subsurface movement and fate of these contaminants and the need for consideration to be given to options for minimising and assessing the impacts of contaminants on the receiving environment during the system design stage. It also touches on the need for consideration of the long term usage of and discharges of chemicals and other wastes into the wastewater system.

The design of on-site wastewater systems should not only be based on the hydraulic and the organic capacity of the soils, but to ensure a long term performance, should have regard to the potential chemical loadings on the soils and the nutrient immobilisation and buffering capacity of the receiving soils. Soil has limited ability to absorb nutrients and therefore cannot be continuously loaded without eventual leaching of nutrients through the soils in various solute and salt forms as the receiving soils approach saturation [Ref 28]. The extent of this capacity varies significantly depending on soil type, contaminant concentration and the wastewater land application rate, in addition to a large number of other factors.

Options for minimising the impact of contaminants on the receiving environment can include improved treatment systems, improved land application methodologies as well as comprehensive maintenance and monitoring programs. Just as importantly, are the needs for reduction of mass load of contaminants in wastewater and/or for reduction in chemical discharges from domestic facilities and the corresponding chemical loadings into the receiving soils. (The latter is discussed in more detail in Section 12.2.2.2 and in Technical Sheets 1-5 and I-6 in Appendix I.)

11.3 INTRODUCTION TO EFFECTS OF NUTRIENTS ON THE ENVIRONMENT

Nutrients, in particular nitrate and phosphorus, in wastewater discharged to land disposal systems have the potential to create adverse environmental effects. The extent of the environmental effects is often dependent upon the concentration applied, the soil type and the life of the system.

The release of nitrates direct to surface or groundwater can raise concentrations to levels with a potential to exceed drinking water standards. The Ministry of Health drinking water standard for nitrate in water is 50g/m³ nitrate [Ref 45], (with "nitrate" meaning "total nitrogen" (being organic and inorganic) in this context). This is equivalent to 10g/m³ nitrate nitrogen (NO₃-N) when only referring to the nitrate form [Ref 29]. Ammonia, which is highly soluble and easily leached into groundwater, is toxic to aquatic life. Both nitrates and phosphates in soil or groundwater can reach water bodies

such as streams, ponds and lakes. These nutrients can stimulate increased plant and algae growth and when present in natural water are significant factors in eutrophication. The die off of additional vegetation or algal growth in the water; a result of the increased nutrient load, is then decomposed by bacteria that absorb oxygen in the water. This in turn has a significant impact on the degradation of water quality, and alters sensitive aquatic ecosystems.

To reduce cumulative adverse effects, wherever practicable and especially where nutrients may impact on natural ground or surface waters, nutrients and in particular nitrogen components should be reduced in wastewater via the treatment process. In addition, the wastewater land distribution and application system methodologies should be designed to optimise further reduction in the soils prior to contact with water.

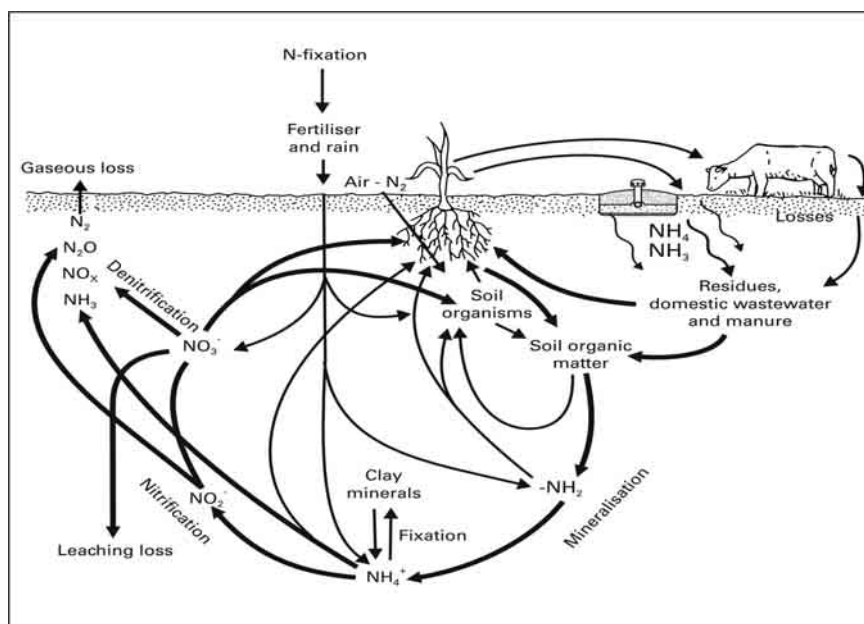
11.4 NITROGEN REMOVAL

11.4.1 Nitrogen Cycle

Total nitrogen comprises of organic nitrogen, ammonia, nitrite and nitrate. Nitrogen in human wastes is mainly in the form of organic nitrogen (Org-N) and ammonia nitrogen ($\text{NH}_3\text{-N}$). (Total Kjeldahl Nitrogen (TKN), is the sum of the total of organic nitrogen component plus ammonia.) In anaerobic conditions, organic nitrogen is converted to the ammonium form by anaerobic bacteria.

In the presence of oxygen and specialist bacteria, ammonium nitrogen is nitrified to nitrite (NO_2) and then nitrate (NO_3) (*nitrification*) and this must occur before *denitrification* can occur. *Denitrification* is the conversion of nitrogen oxides (NO_3 and NO_2) to nitrogen gases (NO , N_2O and N_2). The nitrogen gases are then released to the atmosphere [Ref 20]. Denitrification requires the presence of anaerobic/anoxic conditions (low to nil oxygen availability) and a carbon or sulphur source for conversion to nitrogen gases. The conversion of organic nitrogen to inorganic nitrogen (ammonium and nitrate) is termed *mineralisation*. This conversion can occur in soils in the presence of soil microorganisms. Plant uptake of inorganic nitrogen (ammonium and nitrate) only provides a removal mechanism for nitrogen from the immediate environment once the vegetative crop is removed from the site [Ref 18].

Figure 11.1: Schematic Diagram of the Nitrogen Cycle



11.4.2 Concentrations and Fate of Nitrogen Forms in Wastewater Treatment

11.4.2.1 Total Nitrogen in Raw Wastewater

Total nitrogen levels in raw wastewater can be in the order of 30 to 80mg/l. Crites [Ref 2] indicates that the per capita production of TKN nitrogen (ammonia and organic nitrogen) is in the order of 13g/p/d. A number of United States, Australian and New Zealand sources suggest that total nitrogen in raw wastewater (equating to TKN) can range from 8 to 13 g/p/d. Gunn [Ref 29] refers to 12 g/p/d as being a conservative estimate of the total nitrogen per person contribution in the absence of representative data for New Zealand [Ref 29]. In the New Zealand context, assuming a typical water usage of 180 l/p/d, this equates to a TKN concentration of 66g/m³ (and 72g/m³ if a contribution of 13 g/p/d is used) [Ref 29]. The designer should be aware that the TKN concentration in wastewater from facilities with a high proportion of toilet wastewater, can be significantly higher due to the limited dilution compared to that provided by the greywater contribution in normal domestic wastewater.

11.4.2.2 Nitrogen Reduction by Primary Septic Tank Treatment

Approximately one third to a half of the total nitrogen in raw wastewater entering a septic tank is in the ammonium ion form (NH₄⁺), while the rest is in the organic-nitrogen form. It is generally accepted that all nitrogen entering a septic tank is discharged in the effluent [Ref 29]. While the organic nitrogen initially settles with the solids in which it is bound, once it is converted to ammonia, it dissolves and is then discharged with the primary treated wastewater [Ref 29]. Crites [Ref 2] has shown no difference in nitrogen reduction via primary treatment between that occurring in conventional septic tanks and that in modern tanks with an effluent outlet filter, with a nominal reduction in the order of 3.5%. Gunn [Ref 29] refers to other United States researchers that suggest reductions of up to 33% in a septic tank, but recommends a conservative approach would be to assume there is no significant reduction via septic tank treatment.

11.4.2.3 Nitrogen Reduction by Secondary Treatment

As raised above, secondary treatment involves biological treatment of primary treated wastewater in aerobic conditions. The nitrogen in the final secondary effluent is dependent upon the type of secondary treatment process used and its ability to remove nitrogen. The total nitrogen figure for standard secondary treated effluent, based on aerated wastewater treatment plants (package plants), is typically in the order of 35 to 40gN/m³. In improved secondary and advanced secondary treatment processes this can decrease to be in the order of 25gN/m³ and 15 gN/m³ respectively [Ref 29].

Reported nitrogen removal capabilities for a range of secondary treatment systems are provided in Table 11.1.

Table 11.1: Typical Nitrogen Removal Ranges for well Managed Systems

Process	% Total Nitrogen (TN) removal	% Total Nitrogen (TN) removal
	<i>Source: USEPA 2002, TFS9 [Ref 3]</i>	<i>Source: Gunn 2003 [Ref 29]*</i>
Intermittent Sand Filter.		42
Intermittent Sand Filter with Anaerobic Upflow Filter.	55 - 75	65
Recirculating Sand Filter.	40 - 50	44 - 45
Recirculating Sand Filter, with Anoxic Zone.		85
Recirculating Sand Filter, with recycle to Septic Tank or Anaerobic Upflow Filter.	70 - 80	75
Septic Tank Fixed Film System, with recycle to Septic Tank or Anaerobic Upflow Filter (equivalent to TF-AWTS**).	65 - 75	70, 75 and 78
Sequencing Batch Reactor.	50 - 80	65
Source Separation and Removal.	60 - 80	
Source Separation with treatment applied to both systems and then recombined.	40 - 60	
Foam Media Biological Filter with recycle to septic tank.		77 [Ref 31]
Textile Filter.		Percent removal data not available but final Tot-N reported in the order of 10gN/m ³ [Ref 30]
<p>Notes: * Mostly based on material from Crites (1998)[Ref 2] and USEPA (2002) [Ref 3]. ** TF-AWTS stands for Trickling Filter – Aerated Wastewater Treatment System and is covered in Section 7.3.5.</p>		

There have been a number of studies into the performance of various treatment systems and their ability to remove nitrogen. Investigations into nitrogen removal for secondary treatment processes should compare levels in primary treated effluent (secondary influent) with levels in secondary treated effluent, with data presented in terms of levels of actual total nitrogen, ammonia, TKN and nitrates and in terms of percent removal of total nitrogen. The results will be affected by a number of factors including in some cases the level reduction, if any, via the primary treatment process. The actual nitrogen concentrations are also affected by water usage quantities in the raw wastewater. It is possible that nitrogen data from the United States may show lower nitrogen concentrations than equivalent New Zealand data due to the higher per capita water usage and therefore greater wastewater dilution in some United States examples.

Nitrogen Removal Capacity According to Treatment Level

Approximate total nitrogen concentrations in secondary, improved secondary and advanced secondary effluents are provided above. However, actual concentrations will be system and situation specific. When a supplier claims a system's potential nitrogen removal capabilities, it is appropriate that robust actual field data are provided, as well as associated comment on actual flow volumes versus design flows, and the level of maintenance and household precautions in place.

Nitrogen Levels for a Range of Treatment Systems

Converse [Ref 46] provides some interesting statistics of effluent quality from a range of different types of aeration units in current use in the United States. The purpose of the study was to determine how well aeration systems were performing in the field, although with no attempt made to determine whether individual systems were well managed. Nine types of aeration treatment units (ATUs) were studied, consisting of three suspended growth ATUs, attached growth ATUs, and single pass and recirculating sand filters. The effluent quality data from a total of 139 systems showed mean total nitrogen ranging from 34 to 47mgN/L, with mean TKN ranging from 5 to 36mgN/L, mean ammonia ranging from 3 to 28mgN/l and nitrate from 3 to 32mgN/L. In comparison, septic tank effluent had a total nitrogen mean of 62mgN/L, ammonia mean of 48mgN/L and nitrate mean of 2mgN/L.

The conclusion on the investigation included concern that some systems designed for denitrification did not perform any better than other units, based on mean total nitrogen levels, but also that systems were not necessarily properly maintained, and that this and the respective home owner activities, would have affected the overall performance data [Ref 46]. (Further data and comments are provided for other parameters and system types, with the point made of difficulties with direct comparisons of system types due to differences, and in some cases limitations, in the number of systems of each type.)

Other Methods

Wetland and peat bed systems, as for vegetated land disposal systems, may also provide variable quantitative performance in reducing nutrient levels. Such nutrient treatment units are beyond the scope of TP58 and need to be designed, manufactured, installed and maintained on a case by case basis by specialist companies, and will need on going monitoring to verify actual nitrogen removal capacity.

11.4.3 Fate of Nitrogen in the Receiving Environment

Contamination by nitrogen of the groundwater below disposal fields has been well documented [Ref 3]. Leaching and potential for effects is dependant on several factors:

- The type of nitrogen in the wastewater discharged;
- The concentration of nitrogen in the wastewater discharged;
- The type of soil in the land disposal area (clay, silt, sand or gravel);
- What removal mechanisms exist (plant uptake/denitrification); and
- The fate of the nitrogen (export/dilution).

11.4.3.1 Details of the Nitrogen Cycle in Soils

The molecular form of the nitrogen is reflective of the treatment stages and its impacts on the environment. The predominant forms of nitrogen in primary treated effluent are as ammonia and as organic nitrogen, bound up in proteins. For the most part, nitrogen in the form of ammonia needs to first be converted to nitrate to be available for removal by *denitrification*. This requires highly aerobic conditions, and therefore is preferentially achieved by secondary treatment of the septic tank effluent before discharge.

In secondary treated effluent, there should be little residual protein and ammonia, as providing there is sufficient aeration and other conditions are appropriate, this should predominantly be oxidised to nitrate (NO_3) by the bacteria and oxygen in the aerobic treatment process.

While ammonia from primary treatment can bind in soils, it is easily mobile and can leach to groundwater when concentrations in the soil exceed the soil's binding capability. Nitrate is completely soluble and is in an anionic form so has the same negative charge and therefore highly mobile [Ref 3]. Mobility through soils is greatest in granular soils (sand and gravel), which have a high permeability and have little or no organic content.

Importantly however, nitrate has the ability to be degraded further by *denitrification* to nitrogen gas, by specialist denitrifying soil bacteria in conditions where there is no dissolved oxygen. This conversion of nitrogen to gas and the consequent escape of gas from the soils into the atmosphere is a key mechanism in reducing nitrogen impacts on groundwater. To strip the oxygen from the nitrate molecule, the denitrifying bacteria require the complete absence of oxygen and the presence of a carbon source, some form of carbohydrate. Only nitrogen in the form of nitrate is useable by these denitrifying bacteria.

The degree of nitrogen leaching increases with higher soil carriage water (rainfall and effluent loading rate). Therefore low effluent loading rates, especially time dosed loading can assist in mitigation of nitrogen leaching through the creation of alternative wetting and drying cycles [Ref 3], where the correct soil conditions exist.

11.4.3.2 Details of Nitrogen Modification in Soils

Estimates of total nitrogen removal in soil suggest in the order of up to 20% to 40% removal can be achieved in fine soils, for high quality secondary and primary treated wastewater respectively (e.g. clay, loam and silt type soils). The lower percent nitrogen removal for secondary effluent is due to the lower nitrogen concentration in that wastewater. The proportions of nitrogen removal also depend significantly on the soil type, with lower proportions in highly permeable soils (e.g. down to only 15% for primary treated wastewater in very porous soil) [Ref 29].

Methodologies of Nitrogen Removal

Land application does not always result in significant nutrient reduction, but can constitute an effective part of the overall treatment and effluent management process. The key method of nitrogen removal from treated wastewater is via its movement through soils. Nitrification and denitrification occur in aerobic soils because the oxygen promotes nitrification and anoxic microsites within the soil enable denitrification [Ref 29]. Adequate carbon must be present in the soil layer from organic matter to assist the denitrification process. Ammonia adsorption also occurs storing NH_3 -N long enough for biological conversion.

Processes within the Soil

Saturated soils at depth may assist in creating low oxygen environments (but may lack carbon). In free draining soils with little organic carbon (sands/gravels), rapid nitrogen leaching with little or no denitrification to sensitive environments (surface and groundwaters) can occur. This is exacerbated in situations where soils have rapid drainage characteristics, a low organic content, a high groundwater level, and where there is also significant horizontal groundwater movement and nearby sensitive receiving environments. Fine grained soils (silts, clays) containing organic matter are more effective at providing denitrification than coarse grained soils [Refs 3], although layered soils of fine over coarse textures also provide very good nitrogen reduction potential [Ref 29].

Conservative approaches from applied septic tank effluent to soil would be to assume up to 25% removal from fine grained soils, and up to 15% removal from coarse grained soils [Ref 29], which is based on data in Crites [Ref 2] and a range of 10 to 30% removal in USEPA [Ref 3].

Enhancing Denitrification Within the Soils

Denitrification within soils can be optimised by placing the land disposal system within the topsoil horizon, rather than deep within the soil profile and by applying wastewater at conservative loading rates using shallow dripper irrigation [Refs 3&29]. Denitrification is significantly assisted by a good depth of topsoil (with a good depth considered to be in the order of 250mm or more), particularly where the topsoil has a high organic content to allow cycles of wetting and drying [Refs 3, 29], and a carbon source.

11.4.3.3 Nitrogen Uptake by Plants

Uptake by plants is another mechanism of nitrogen removal. Root zone irrigation of secondary effluents promotes denitrification, as anaerobic pockets can exist in soils and organic matter (a carbon source) is present. Plants take the nitrogen from the soil and store it in foliage. Plant species vary in their ability and preference to remove nitrogen as either ammonia or nitrate. Pasture prefers an estimated 50:50 ratio, while other plants are more specific in preference. Care should be applied in planting a land disposal area, with consideration necessary of the plant tolerance to nutrient types and loads. A nonexclusive reference guide to species tolerant of conditions exhibited in wastewater disposal systems is provided in Appendix G, although the nutrient tolerance of each plant is plant specific.

Importantly, nitrogen taken up by plants is only removed permanently from the immediate environment if the plant is harvested and exported outside the sensitive zone/catchment [Ref 29]. Lawn clippings harvested and dumped in a pile nearby where nutrients are concentrated and can leach back into the soil may be of little assistance in overall nitrogen removal, although spreading it thinly over another area will increase potential for denitrification, soils adsorption and plant uptake. Grazing is likely to worsen the impacts already occurring from the irrigated treated effluent, due to leaching from urine "hotspots". Grazing of active disposal areas is generally strongly discouraged for health reasons, in addition to the obvious need for the protection of the soil structure and of the distribution lines.

The amount of nitrogen in effluent generally exceeds that which plants can use. It is therefore suggested that the use of water tolerant plant species within the disposal field be incorporated as part of the overall treatment and effluent management process. Removal from of nitrogen from the soil via plant uptake is estimated in the literature to be possibly up to 80 to 100kg/ha/yr depending on the plant species and condition [Ref 29].

11.4.4 Methods for Assessing Nitrogen Load

Based on a large number of assumptions very rough estimates can be made of the nitrogen removal and net nitrogen leaching rate for residential properties dependent on on-site systems. Regard needs to be had for the following factors:

- The total nitrogen output per capita (refer Section 11.4.2.1);
- Removal via primary treatment (assume nil, refer Section 11.4.2.2);
- Removal via secondary treatment providing systems well maintained (refer Section 11.4.2.3);
- In soil nitrogen removal, assuming a shallow land application system (refer Section 11.4.3.2); and
- Further removal from the soil via plant uptake (refer Section 11.4.3.3).

Where lot sizes are determined based on the site's nitrogen removal and adsorption capacity, previous Australian studies have indicated that using a conservative approach to establish land area required for treated wastewater land application for a standard house per lot, 1000m² to 1500m² can be required [Ref 29]. Additional land area is then also required for the dwelling, paved areas and

reserve area. Other Australian studies suggest a total area per lot of 2000m² to 4000m² could be necessary for sustainable nutrient management without significant proportions leaching to groundwater. In all cases, the total lot areas necessary will vary significantly depending on the wastewater quality, soil type, topsoil depth and the organic content of the soil.

In the Auckland region, maximum application rates of nitrogen to land for dairy farms is restricted by the ARC Regional Plan: Farm Dairy Discharges [Ref 32] and in the ARC Proposed Regional Plan: Air Land and Water (Notified Version October 2001) to a limit of 200kgN/ha/year and 50kgN/ha/day on low permeability clay soils of low vulnerability due to poor groundwater quality/yield. Limits of 150kgN/ha/year and 30kgN/ha/day apply for areas underlain by Aeolian sands and volcanic basalt (including the areas in the Auckland region of Awhitu, Kaipara, Pakiri Omaha Flats, Pukekohe, Puni, Bombay, Waiuku and Mangere). The Dairy Plan outlines that ARC took what it considered to be a precautionary approach when setting these limits, using nitrogen application rates it considered posed a minimum risk to groundwater quality and taking note that the risks included a wide range of factors both environmental and physical which influence nitrogen uptake and mobility.

11.4.5 Options for Reducing Nitrogen Impacts

The primary mechanism for reducing nitrogen discharges into the receiving environment is reduction of the organic load from the household or other premises into the treatment process itself. In the case of households, the total nitrogen load can be reduced by the elimination of garbage grinders and the reduction in use of nitrogen based cleaning chemicals.

Tools for prudent wastewater system design to avoid cumulative effects on the environment would at least be the inclusion of improved or advanced secondary treatment. This should then be followed by land application of the treated wastewater to the shallow topsoils at very low loading rates, ideally with pressure compensating drip irrigation to surface or shallow subsurface topsoils. Modifying soil conditions, by adding organic matter such as compost or extra topsoil, and evenly dose loading the wastewater into the soils, can significantly enhance further removal. To assist with permanent reduction of nitrogen levels in a land application area, in extreme cases regard can also be had to harvesting and regular removal of the excess vegetation.

Where emerging receiving environment nutrient concerns exist, nitrogen reduction technology should be applied to the treatment process. Such technologies include for example intermittent and recirculating sand filters with recycle steps for nitrogen reduction, sequencing batch reactors and additions of anoxic upflow chambers. These systems generally provide for specific denitrification steps, or the delivery of nitrate rich secondary treated effluent back into anaerobic parts of the system where a carbon source is also present (such as into the primary treatment chamber).

The following is a summary of measures available for reducing nitrogen impacts from existing individual on-site systems:

- a. Reduction at source by decreasing use of all nitrogen (and phosphorus) based cleaning chemicals, and avoiding other unnecessary nitrogen loads into the treatment system.
- b. Intensive treatment system design, including comprehensive maintenance and monitoring to optimise performance and nitrogen removal.
- c. Land application area design and maintenance to achieve shallow and even wastewater distribution.
- d. Harvesting of vegetation in the land application area and disposal in a controlled manner via a low and even application onto land elsewhere on the site or off-site disposal.
- e. Optimising separation distances by locating the wastewater system as far away from surface or groundwater as practicable.

- f. Intensive planting of any buffer areas between a land application area and natural water.
- g. Soil modification to enhance nitrogen reduction, such as applying a carbon source through the regular application of organic matter (i.e. compost) to the land application area.

11.5 PHOSPHORUS REMOVAL

11.5.1 Phosphorus in Domestic Wastewater

Total phosphorus (TP) in untreated domestic wastewater is approximately one third in the inorganic soluble form, namely dissolved reactive phosphorus (DRP), with the rest is in the insoluble organic form. Most of the insoluble organic phosphorus converts to the soluble inorganic form after the anaerobic digestion process in a septic tank and following further treatment. DRP is typically in the order of 75 to 90% of the total phosphorus in an effective secondary treatment system.

11.5.2 Phosphorus Removal in On-site Systems

There is minimal reduction in total phosphorus concentrations in standard wastewater treatment systems. Any removal is via the binding of phosphorus to solids in the wastewater and the corresponding removal of those solids by separation/settling in the septic tank and secondary treatment process. This has only a very limited success at reducing total phosphorus levels. Concentrations in final treated effluent can vary significantly, and predominantly depends on the levels in the influent.

Phosphorus removal is seldom required for discharge to on-site land application systems in New Zealand, unless there is a likelihood of discharge or seepage into natural water sources. This is because soil sorption is considered the most effective method of removal phosphorus removal from wastewater. In the soil, phosphate ions bind with iron and aluminium minerals in soils with natural acidic to neutral conditions. These in turn bind with calcium minerals in neutral to alkaline conditions. The capacity for soil sorption is however finite, and continued concentrated loading may eventually result in leaching of phosphorus to groundwater. However, it is noted that measurements of phosphorus in groundwater underlying well managed septic tank systems have generally indicated that minimal concentrations of insoluble phosphate mineral compounds are introduced to groundwater [Ref 33].

For on-site land application systems, specific site investigations are required on a case by case basis to determine the soils phosphorus sorption potential and the corresponding land area requirement. It is also critical that a precautionary approach is taken to conservatively base the design on the maximum possible long term life of the system and to also allocate sufficient replacement land as reserve.

11.5.3 Effects of Phosphorus in the Receiving Environment

The potential effects of phosphorus from treated wastewater on groundwater quality depends on the concentrations in the wastewater, the application rate into the land, the separation distance between the level in the soil that the wastewater is applied, the sorption in the soil, the groundwater level, and on the dilution potential within the groundwater body.

For phosphate sensitive areas (such as some parts of New Zealand where phosphorus leaching can affect eutrophication of aquatic waterbodies/streams/lakes and in some parts of Australia where it is less easily absorbed by the soils, (as it is by some New Zealand soils), disposal field design sizing is calculated on the phosphorus binding ability of the soil over the expected life of the system. This requires a land disposal area many times greater than the size likely to be required for hydraulic

disposal alone. Peat beds have had limited success at absorbing phosphorus unless iron or limestone sources are present and so have constructed filters and constructed wetlands [Ref 2]. However, this success is normally finite with the phosphorus only being absorbed by the respective media and plants until they reach saturation [Ref 34].

11.5.4 Specialised Options for Phosphorus Removal

Specialised options for phosphorus removal are available for septic tank systems. However, these are more commonly applied to municipal wastewater treatment systems, as these are more likely to discharge into sensitive aquatic waters. These options usually involve the lowering of phosphorus concentrations through the input of chemical additions.

Aluminium sulphate (alum), lime and, ferric chloride are used commonly in land based municipal treatment plants, and can also be effective in lowering BOD and suspended solids levels. The aluminium and ferric ions are effective by binding with the phosphate ion and then the salt, which is precipitated out of the solution within the treatment process. Alum has the additional benefit of removing coliform organisms [Ref 33].

The problem with these options is the high concentrations of minerals required: an alum:phosphorus and ferric:phosphorus ratios in the order of 2 to 3 and 0.5 to 2 respectively are required to be effective (depending on the phosphorus level in the wastewater and the level required in the final effluent). For a ratio of 2, 22g alum would be required to precipitate 1g of phosphorus [Ref 33]. While less ferric chloride is required by weight compared to alum, it is generally more expensive than alum (by up to 50%). Control of pH is also important for effective removal, and lime or caustic soda can be also required to improve the effectiveness of ferric chloride [Ref 34], further increasing its cost. For chemical dosing to achieve effective phosphorus removal at all, dosing at the appropriate location within the treatment system followed by an effective sludge removal process are both critical. Advanced separation methodologies can also be considered, however, these are outside the scope of this manual.

A further option for phosphorus removal is filtering the effluent through steel mill slag (iron) [Ref 34]. The phosphorus adsorption varies depending on contact time, the initial phosphorus concentration and the chemical make up of the slag. The actual phosphorus saturation level is unproven but is suggested to be in the order of 1.35mg phosphorus per kilogram of slag [Ref 34]. The process generates waste slag once it has become saturated with phosphorus and needs to be replaced. This is under trial at a municipal system in New Zealand with evidently good phosphorus removal results, but again is most unlikely to be considered relevant for an on-site system within the foreseeable future.

11.6 INORGANIC CONTAMINANTS – TRACE METALS

Metals in treated wastewater can lead to contamination of shallow groundwater supply sources and can result in increases in arsenic, copper, iron, lead, mercury and manganese above recommended limits. Elevated levels of copper and lead and cadmium can be due to corrosion of roofs in houses dependant upon roof water supply and/or corrosion of old plumbing. Levels of zinc and cadmium should also be investigated.

Indications of acceptable metal levels in drinking water are available in the “*Drinking Water Standards for New Zealand*” [Ref 45]. Acceptable metal levels in fresh and marine water resources are specified in *Australia and New Zealand Environmental and Conservation Council 2001 (ANZECC Guidelines)*, titled “*Australian Water Quality Guidelines for Fresh and Marine Waters Volume 1, The Guidelines*”. These guidelines provide authoritative guidance for setting water quality targets to sustain environmental values for water resources in Australia and New Zealand.

The four major reactions that determine the transport and fate of heavy metals in soils are:

- Adsorption;
- Ion exchange;
- Chemical precipitation; and
- Formation of complexes with organic substances.

Fixation by any of the reactions is dependant upon a number of factors including soil composition, texture, pH and the oxidation-reduction (redox) potential of the soil and associated ions. Of these, adsorption is the most important for the fixation of heavy metals and is highly affected by soil composition. Clays are extremely important in adsorption reactions because of their high cation exchange capacity and soils high in humus or organic topsoil also provide a good exchange capacity. The chemistry of each metal in the soils is unique and also depends on the presence of competing ions. The influence of anaerobic conditions and associated ions can increase the mobility of metals in the subsurface environment. All these factors affect the possibility of heavy metal contamination of groundwater as a result of the land application of wastewater [Ref 33].

11.7 SALTS

Salts include common table salt (sodium chloride), which dissociates in water to sodium and chloride ions and gaseous ammonia, which dissociates in water to form ammonium ions. A salt is a compound of basic and acidic ions, which when dissociated has a significant impact on the electrical conductivity of the liquid.

11.7.1 Chlorides

Chlorides are natural constituents in surface and groundwater and are also found in typical domestic wastewater and both on-site and municipal treatment systems are ineffective at chloride removal. Chloride concentrations depend on the natural concentrations in the reticulated water supply. Chlorides can be useful as tracer or indicators for domestic wastewater pollution, due to their anionic form (Cl⁻), which prevents them from binding with other soil minerals, and due to their mobility with the water phase.

11.7.2 Effect of Cationic Salts on Soil Structure

The accumulation of sodium in the soils from on-site wastewater systems can lead to significant structural changes of the soil that have the potential to impair the performance of the on-site disposal system [Ref 35].

The potential impact of sodium is dependent on the soil type. Sodium has little impact on granular soils as these soils have limited ability for ion exchange to occur. Sodium can have the most impact on clay soils and particularly clays having a high cation exchange capacity. Significant losses in soil hydraulic conductivity associated with small increases in sodium in wastewater seepage through soils can have a significant implication on the effective life of the disposal area.

Sodium affected soils are less suitable for irrigation and plant growth and therefore are also less efficient in the treatment of wastewater. The ability of soils to accept sodium varies and is represented by a soils particular cation exchange capacity (CEC). Typically, clay soils have a higher capacity to accept sodium and sandy soils a lower capacity. The Sodium Absorption Ratio (SAR) of wastewater provides an indication of the potential of an effluent to result in an increase in sodium in soil. Typical domestic wastewater has a low SAR and poses a low risk to soil. The level of sodium saturation of a soil can be determined by calculating the Exchangeable Sodium Percentage (ESP%) as detailed below.

At levels of Electrical Conductivity (EC) and Sodium Absorption Ratios (SAR) consistent with treated domestic wastewater, sodium can affect the hydraulic conductivity (ability of water to be absorbed into the soils and mobilise through the soils in accordance with osmosis pressures) [Ref 32]. There is conflict in the literature concerning the degree of this effect, but it will ultimately depend on the sodium content and therefore the concentration of chemicals in the discharge.

11.7.3 Importance of a Salt Balance

Imbalances in the loading of solutes and salts can also result in failure of the system by biochemical oxygen demand overload under anaerobic conditions, or in collapse of the soils structure due to sodicity [Ref 32]. While beneficial reuse of irrigated wastewater and nutrients is the objective of on-site wastewater land application, the chemical ratios of nutrients often fail to meet the balance plants require. This will affect soils structure and leads to a gradual decrease in its ability to absorb certain nutrients.

Typically a mixed healthy pasture has a N:P:K:S:Na ratio (nitrogen:phosphorus:potassium:sulphur ratio) in the order of 17:2:14:1:1. Typical wastewater effluent has nitrogen: phosphorus ratio to one part sodium of 3.5:1, significantly short of the nitrogen level required for plant growth to fully absorb all the phosphorus. The potassium:sodium ratio in wastewater effluent is in the order of 1:2 rather than 14:1 in typical pasture, which means that the sodium levels in wastewater are 28 times higher than that required for the salt balance required in healthy pasture.

Many factors combine to influence the characteristics of the receiving soils in a disposal field and the long term ability of those soils to effectively absorb nutrients. Critical factors include:

- Maintenance of soils water and nutrient absorption capacity;
- Maximisation of plant growth and transpiration rates;
- Removal by absorption by plant material; and
- Management of land application soakage rates so that water seepage into groundwater does not raise levels of water tables and loss of organic nutrients and salts in leachate is maintained.

11.7.4 Sodium Absorption Ratio

The main cations present in wastewater effluent are sodium, calcium and magnesium. The relative concentrations of each of these cations is necessary for determining the Sodium Absorption Ratio (SAR). The SAR of the wastewater provides an indication of the potential impacts from wastewater on soil structure and the ability of soil to absorb wastewater. Sodium contained within wastewater displaces calcium and magnesium cations resulting in deflocculation of clays (produces clods separated by shrinkage cracks) and in particular high swelling clays such as montmorillonite, vermiculite and illite. Swelling and dispersion of clay particles blocks the soil pores, breaks down the soil structure, decreases soil porosity, infiltration and ability to absorb applied wastewater and increases the potential for surface runoff of wastewater. The risk from sodium is greater with commercial and industrial wastewater typically containing higher sodium concentrations than domestic wastewater. The potential risk to a soil from sodium can be assessed by determining the sodium absorption ratio (SAR). SAR is the balance between the sodium ion, calcium ion and magnesium ion in the wastewater.

Application of wastewater with a high SAR, (>3) has a potential to increase the soils sodicity over time but this is also dependent on the soil type. Sodium affected (sodic) soils are less suitable for irrigation and good plant growth and therefore are less efficient at the treatment of effluent [Ref 36].

The SAR of wastewater is calculated using the following formula where:

$$\text{SAR} = \frac{[\text{Na}] \text{ mmol}}{\sqrt{([\text{Ca}] + [\text{Mg}] \text{ mmol})}}$$

To convert from mg/l to mmol: $\text{Na mg/L} / 22.99 = \text{Na mmol/L}$
 $\text{Ca mg/L} / 40.08 = \text{Ca mmol/L}$
 $\text{Mg mg/L} / 24.32 = \text{Mg mmol/L}$

The actual critical effluent SAR varies between 4 and 18 depending on soil type, although an SAR of more than 3 has the potential to increase soil sodicity in clay soils [Ref 36]. Soils with little or no clay can tolerate an SAR up to 20. A high SAR does not indicate the effluent is unsuitable for irrigation to land but there may be a limitation on the vegetation tolerance and soil management may be required [Ref 2].

Exchangeable Sodium Percentage (ESP%) provides an indication of the level of sodium saturation of the soil and is a measure of the level of exchangeable cations that are sodium ions within the soil. When assessing the impact of wastewater irrigation the effluent SAR should be determined as well as the ESP% of the soil. As a rule of thumb, ESP of 15% is the critical level at which the soil structure and therefore permeability can be deleteriously affected assuming water having an electrical conductivity of 0.3 to 1dSm/m [Ref 36]. To estimate the extent of sodium saturation the following calculation should be used.

$$\text{ESP}\% = 100 \times \frac{\text{(exchangeable sodium)}}{\text{(sum of all exchangeable cations)}}$$

The exchangeable cations to be summed are calcium, magnesium and potassium.

11.7.5 Mitigation Measures for Sodic Soils

If soils are affected by a high ESP% (sodic conditions) then they are less suitable for irrigation and can prohibit good plant growth. An estimate of a soils ability to accept sodium is given the cation exchange capacity CEC. Soils with low CEC (<12meq/100gm) can accept a much smaller amount of sodium than those with a high CEC (>25meq/100gm) [Ref 37]. Sandy soils typically have a CEC of 1–

10, Silt loam 12–20 and clay and organic soils >20 [Ref 2]. Tables 10.7 and 10.16 in [Ref 2] provide guideline concentrations.

Soil sodicity becomes relevant where soils have been receiving wastewater for an extended period of time and the absorption capacity of the soils is reduced. The time period can be dependent on soils type, wastewater application method, design and age of system, effluent loading rate, and cation concentration. The cation concentration in a wastewater is typically dependent upon detergent usage within the facilities. To extend the life of a land disposal system, care should always be taken to reduce the use of high sodium detergents. Detergents also have an impact of increasing the pH of the soil, which has an alkaline affect on the soil, which affects cation exchange and plant growth. High pH, greater than 6.5, may have the impact of decreasing the nutrient availability to plants, but this effect may be compensated by the effect of nutrients within the effluent. Low pH can be corrected by the application of lime. Ideal soil pH for plant growth is 5.5 to 8.4 although the pH susceptibility depends on the crop type.

To reduce the sodium concentration within a soil and improve soil structure for wastewater irrigation, calcium based soil amendment can be applied to the soil. The calcium cations displace the accumulated sodium by leaching. The most commonly used soil amendment for this is gypsum. Snow [Ref 36] recommends that to displace 1.0tonne of sodium, about 3.7tonnes of gypsum are required. Gypsum is recommended where soil pH is greater than 6. Where soil pH is less than 6, then lime should be used. Although sodicity of a soil can be corrected, it can be difficult to correct the soil structure.

11.8 DESIGN MITIGATION MEASURES

Environmental effects need to be considered in terms of hydraulic and organic loading rates and the adoption of treatment and disposal technologies that can produce treated effluent that can assist achieve low loading rates and consequently avoid related adverse effects. They also need to be considered in terms of nutrient and bacterial application rates.

There is likely to be an increased regard for the application of nutrients and salts to soils in the future, as on-site wastewater land application systems are increasingly seen as a permanent disposal option and public awareness of the need for environmental protection increases. The demand for improved nutrient (particularly nitrogen) reduction and pathogen reduction by disinfection in treatment systems is likely to increase, leading to increased adoption of biological denitrification stages and UV or chemical disinfection processes within the total treatment process.

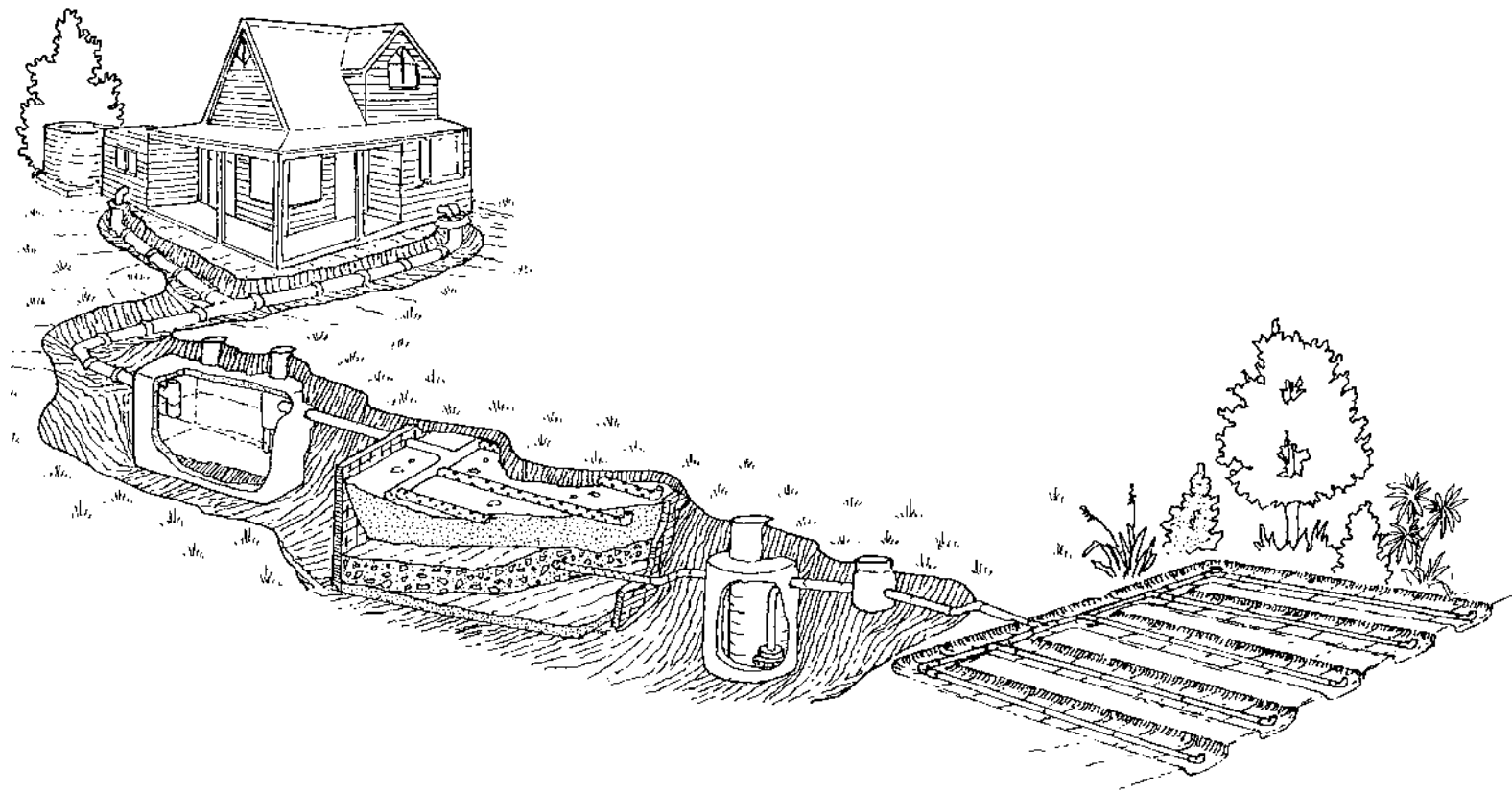
For new intensive developments/subdivisions, a comprehensive assessment of environmental effects (AEE) is an essential part of an application to a consent authority. Where the development is in a sensitive receiving environment and/or there is potential for cumulative effects, specialist consideration may be necessary to determine the extent of potential effects and mitigation options for minimising effects. Mitigation options can include polishing of the wastewater by tertiary treatment to reduce nutrients and/or to disinfection to remove pathogens. Nutrient dynamics and their impacts are highly specialist fields, and in difficult situations, specialist advice should be sought, for example from Crown Research Institutes, the New Zealand Land Treatment Collective or similar specialist consultancies .

In the case of individual on-site system designs, particularly if there is not a significant potential for direct contact with surface or groundwater, providing a general precautionary approach is adopted, there are aspects of design that can be easily optimised to achieve sufficient nutrient mitigation measures without necessarily requiring engineered tertiary treatment. These aspects are listed in Table 11.2 with references provided to where relevant design criteria are covered in TP58.

Table 11.2 Methods in Design that Assist Nutrient Mitigation

Design Aspects	Covered Further in TP58 (Chapter Reference)
Low densities of on-site systems, to reduce potential for cumulative effects (also addressed in relevant District Plans).	Chapter 4 and 11, (Relevant District Plans)
Measures to conserve water and to reduce wastewater discharge volumes and reuse option.	Chapter 6 (Tables 6.2 and 6.3) Chapter 7.8 and Appendix J-1
Measures to reduce organic and chemical loads into the wastewater system and into the receiving soils.	Chapter 7.1 - 7.2 and Appendix I (1 to 6)
Secondary & advanced secondary treated effluent.	Chapter 7
Early comprehensive site assessment to determine the most appropriate location for the wastewater land disposal systems.	Chapter 5 and Appendix E
Surface/subsurface irrigation into the topsoil zone.	Chapters 3 and 9
Low hydraulic loading rates.	Chapters 6, 9 and 10
Pressurised timer dose loading for improved even effluent distribution and other technologies for improved distribution.	Chapters 8, 9 and 10
Allocation of reserve area to provide for the future replacement of the land disposal system.	Chapter 5 (Table 5.3)
Separation distances of wastewater distribution systems from surface and ground water.	Chapter 5 (Table 5.2)
Planting of land application system to optimise evapotranspiration.	Chapter 9 and Appendix G
System maintenance and on going monitoring to enhance long term system performance.	Chapter 12 and Appendices F and H
Operational controls to enhance long term system performance.	Appendix I (1 to 6)

It is also important that systems are designed with consideration of long term effects on the receiving environment. As indicated in the table above, a conservative design approach is applied throughout TP58. The aim of TP58 is to provide a package of prudent mitigation measures that can be applied to differing extents in all on-site system designs to assist minimise potential cumulative effects. Without sufficient protection measures, environmental effects, particularly nutrient effects, could become increasingly evident over the performance life of a system.



12 > System Installation and Maintenance

12. SYSTEM INSTALLATION AND MAINTENANCE

12.1 ON-SITE SYSTEM INSTALLATION

System construction practices are critical to the performance of on-site wastewater disposal systems. Satisfactory system performance depends on the soils within and around a disposal system maintaining porous conditions. To achieve, this it is critical that the soils are evenly loaded and not over loaded. Poor system construction can significantly reduce the soil porosity and eventually this will cause a system to hydraulically fail.

Good construction practices require that careful consideration be given to the site protection requirements before and during the construction phase. Careful consideration of the site preparation needs and the construction equipment selection and use, is also necessary [Ref 3].

12.1.1 Site Protection

Construction of the on-site wastewater system may only be one of many construction activities that occur in the development of a site. If an on-site reticulation, treatment and land application system is not protected against stormwater or groundwater intrusion, the soils in area of the proposed on-site treatment and land application system can be damaged by other unrelated construction activities. Therefore the proposed on-site treatment and land application area should be staked before construction begins to ensure all parties involved in construction of other buildings and infrastructure on the site are aware of the need to protect that area and to keep heavy machinery and materials stockpiles off it.

The construction manager along with the system installer need to anticipate the protection necessary during construction; site access points, traffic areas, stockpile areas and equipment storage need to be specified on the drawings provided to the contractor.

12.1.2 Site Preparation

Site preparation activities include clearing and surface preparation for filling. Before these activities commence, the soil moisture should be assessed. In non-granular soils, compaction will occur if the soil is near its plastic limit. This can be tested by removing a sample of the soil and rolling it in the palms of the hand. If the soil fails to form a "rope", the soil is sufficiently dry to proceed. However, constant care should be taken to avoid soils disturbance as much as possible.

Clearing

Clearing should be limited to moving and raking because disturbance to the surface needs to be minimised. If trees must be removed they should be cut at the base of the trunk and removed without heavy machinery. If it is necessary to remove the stumps, they should be ground out. Grubbing of the site (mechanically removing roots) should be avoided. If areas on the site are to be filled, the surface should be mouldboard or chisel-ploughed parallel to the contour (usually to a depth of 150 to 250mm) when the soils is sufficiently dry to ensure maximum vertical permeability. The organic layer should not be removed, but if it is, it should be replaced. Scarifying the surface with the teeth of an excavator bucket is not appropriate.

Excavation

Excavation activities can cause significant reduction in soils porosity and permeability. Compaction and smearing of the soils infiltrative surface occur from equipment traffic and vibration, scraping actions of the equipment and placement of the land application system medium on the infiltration surface. Only lightweight excavators are appropriate. Front end loaders and blades should not be used because of their scraping action. All efforts should be made to avoid any disturbance to the exposed infiltration surface, including keeping equipment off the infiltration disposal area.

Before any disposal system medium is installed, any smeared areas should be scarified and the surface gently raked. If gravel or drainage aggregate is to be used for the medium, the aggregate should be placed in the trench/bed by using an excavator bucket rather than dumping it directly from the truck. If damage occurs, it might be possible to restore the area, but only by removing the compacted layer. It might be necessary to remove as much as 100mm of soils to regain the natural soil porosity and permeability. Consequences of the removal of this amount of soils over the entire infiltration surface can be significant. It will reduce the separation distance to the restrictive horizon and could place the infiltration surface in an unacceptable soil horizon, and therefore may need to be replaced by ploughing in a layer of organic topsoil.

To avoid potential soil damage during construction, the soil below the proposed infiltration surface elevation must be below its plastic limit. This should be tested before excavation begins. Also, excavation should be undertaken only when the infiltration surface can be covered on the same day to avoid loss of permeability from wind blown silt or raindrop impact. Another solution is to use lightweight gravel less systems, which reduce the damage and speed up the construction process.

Before completion of installation, the area around the site should be graded and any upslope surface and/or subsurface water cut-off drainage installed to divert surface run-off or groundwater away from the disposal area. The backfill over the infiltration surface should be mounded slightly to account for settling and eliminate depressions over the system that result in the ponding of water. Finally, the area should be seeded/planted and mulched.

12.1.3 Summary of Critical Aspects of System Installation

Each of the following criteria should be considered and undertaken by the system installer during the installation of a wastewater treatment and land application system:

12.1.3.1 Site Works

- Systems should be installed so as not to affect any structural elements of buildings.
- All components shall be in compliance with setbacks from boundaries, buildings, surface water and groundwater (refer Table 5.2).

12.1.3.2 Installation Instructions

Manufacturers/designers should provide installation instructions, including:

- Provision concerning excavation for each part of the wastewater system;
- Preparation of the bottom and sides of any excavation;
- Method of safe handling and lifting of components;
- Provision of precautions where tanks could be subject to high groundwater or flotation;
- Fitting of pipework and attachments e.g. inlets, outlets partitions, outlet filters etc;
- Backfilling around tanks, including type of backfill material and method;
- Requirement to fill all tanks with water immediately following installation to prevent flotation;
- Procedure for commissioning; and

- Planting requirements and timeframes.

12.1.3.3 Treatment Systems

Manufacturers/designers should provide installation instructions, including:

- Specifications for installing all system components as per the approved design plans, including separation distances;
- Directives for excavation to be in accordance with safe practice procedures;
- Requirement that all tanks are water tight and constructed to the standards in AS/NZS 1546.1;
- Requirement that all joints (pipe to pipe and pipe to tank) are watertight glued and socketed;
- Requirement that all access lids to tanks include risers with plastered watertight connections and watertight lids;
- Requirement that lids are to be fastened to prevent access by children;
- Provision that there is no vehicle access on to the completed treatment plant, but that access to the plant is provided and maintained available for future maintenance purposes only;
- Provision that all stormwater is diverted from the treatment plant;
- Requirement that all electrical connections are safe and in compliance with current codes (AS/NZS 3000) and operate correctly; and
- Provisions for all pump chambers to have 24 hours emergency storage and high level alarms.

12.1.3.4 Land Disposal Area

Manufacturers/designers should provide installation instructions, including:

- Installation of all system components to be in accordance with the approved design plans, including separation distances;
- Avoidance of the use of heavy machinery; minimise damage to the soils by using lightweight machinery;
- Provisions to ensure excavation is only be undertaken when soils are sufficiently dry to prevent smearing and sealing of infiltrative surfaces;
- Provisions to ensure that no surface water flow can access the land disposal area;
- Provision that the land application area is fenced or planted around the perimeter to prevent vehicle access;
- Planting of the disposal area to maximise evapotranspiration nutrient uptake;
- Specification that the terminal ends of all irrigation lines are marked and ports are flushed.

2.1.3.5 As-Built Plans by the System Installer

Accurate As-built plans need to at least cover the following:

- The location and capacities of all treatment system components;
- The location and capacities of all disposal system components including the primary and reserve land disposal areas;
- The critical components of the land disposal system including flush points, separation distances, air relief valves and non return valves or other critical components;
- The location of all electrical cables installed as part of the system;
- The location of all sewer pipes discharging to the treatment plant;
- The location of all rising mains to land disposal areas;
- The location of alarm controls and alarm panels, recirculating valves, splitter valves, monitoring ports, shutoff valves;

- Identification of all critical separation distances from buildings, property boundaries and surface water.

12.1.3.6 Certification by the System Installer

The certification needs to be provided to the owner of the wastewater system and needs to confirm the following:

- Certification that all system components have been installed as per the approved design plan; and
- Certification that any water conservation devices required as part of the wastewater system design have been installed, and should include specifications of the actual devices in place.

12.1.3.7 Operation and Maintenance Management Plan

An on-site system management plan is best prepared by the system supplier and installer, prior to system commissioning and should be regarded as an evolving document with further information on optimum operation of the system added to it over time as experience improves. Details of the level of information that should be contained in a management plan are detailed in Section 12.2.8.

12.2 SYSTEM MAINTENANCE

12.2.1 Importance of Regular System Maintenance

Routine system maintenance is critical for optimising the performance of wastewater treatment and disposal systems. This will extend their effective life and minimise potential for adverse effects on the receiving environment. Ignoring system maintenance requirements may not only result in system problems and ultimately failure, but can also lead to further significant risks including the following:

- Foul odours, for example from the discharge of hydrogen sulphide gas from anaerobic wastewater;
- Anaerobic and clogged soil conditions resulting in effluent breakout;
- Breakout resulting in overland flow paths towards stormwater drainage channels;
- Sewage contamination of groundwater and surface water.

In addition to environmental reasons for regular system maintenance, there are also a number of public health and amenity benefits as following:

- Decreased levels of pathogens in the treated wastewater;
- Decreased risk of overflow from treatment plant/surfacing of wastewater in the disposal area;
- Decreased risk of human contact with treated/partially treated sewage;
- Decreased risk of adverse health effects;
- Decreased potential for attraction of pests including flies and rodents;
- Decreased impact on amenity values, such as odour nuisances and decreased property values.

Appropriate maintenance of on-site wastewater systems not only reduces the risk of environmental pollution and public health risks, but also reduces potential costs that could be incurred when a damaged system needs to be repaired or replaced.

Systems owners need to be aware of the importance of maintenance not only for the reasons above, but also because under Section 17 of the Resource Management Act 1991, *“Every person has a duty to avoid, remedy or mitigate any adverse effects on the environment arising from an activity ...”*.

In all cases it is important that maintenance is undertaken on a routine basis to avoid problems. In the unfortunate situation where problems do develop, it becomes critical that appropriate actions are taken as soon as practicable to remedy the problem, so as to avoid progressive system failure.

The exact maintenance requirements for a particular wastewater system depend on the actual system components. The following sections provide an overview of some minimum maintenance requirements for the most common system types. The summary is not meant to be exclusive. There are a wide variety of specific factors affecting the maintenance requirements of each particularly system.

12.2.2 Management of Wastewater Generation

Water Usage

Performance of a wastewater treatment and land application system is greatly affected by the owner's water usage management. For example, average washing machine water consumption is 22% of the daily total water allocation used for design purposes. However, daily wastewater production derived from clothes washing can be significantly higher where all the use is on one or two days each week. This can result in significant overloading of the treatment and land application systems on those days, unless there is adequate flow buffering in the system. It is critical that the homeowner understands the implications of concentrated use of high water consumption appliances over a short time period and that such use is moderated.

Waste Production and Discharge

The types of chemical uses in the cleaning and laundry processes can also have a significant impact on the performance of a system. For better longterm performance of a wastewater treatment system and the minimisation of the long-term effects on the receiving soils and the greater environment, care is necessary to minimise the total mass load of contaminants in the wastewater generated. This can be achieved by the; elimination of garbage grinders to reduce the total organic load into the system, and the removal and disposal of excess oils and fat for disposal to refuse or on a commercial scale, for collection by to a separate waste removal contractor. Particular care should be taken in the selection of types and in the volumes of cleaning chemicals used in households discharging into on-site systems. More reference to types of chemicals that should and should not be used is provided in the ARC Technical Sheets I-5 and I-6 in Appendix I.

12.2.3 Primary Treatment System Maintenance

Primary Treatment systems are defined as *"The separation of suspended material from wastewater by settlement and/or floatation in septic tanks, primary settling chambers etc. prior to effluent discharge to either a secondary treatment process or to a land disposal system"*. As primary treatment systems are usually dependant on natural gravity separation processes and only a limited degree of technology is involved, the systems are reasonably robust, but do require maintenance. Key maintenance requirements are:

Regular septic tank pumpouts to prevent sludge and scum build up, which reduce the retention and treatment capacity for the influent wastewater. The frequency of the pumpouts depends on the size of the tank, the influent flow volume and wastewater characteristics. Easy checks can be undertaken by lifting the access lid and poking a stick to the base of the tank and estimating the respective depths of the scum, liquid and sludge layers by the changes in density at the interface of each layer. All tanks need to be pumped out once the sludge and scum levels occupy half the tank volume. At least annual checks are recommended, with up to monthly checks required for systems that have a high proportion of blackwater in the wastewater flow, such as public toilet facilities and/or food premises.

Regular checks of the septic tank outlet filter. Outlet filters are defined as “A removable, cleanable device inserted into the outlet piping of the septic tank designed to trap excessive solids due to tank upsets that would otherwise be transported to the subsurface wastewater infiltration system or other downstream treatment components.” If these are not installed, they should be wherever practicable (refer Section 7.2.6). These should be checked monthly and removed and rinsed (hosed down) whenever the slime build-up starts to block the filter orifices. The wastewater discharge should be drained back into the septic tank or into a sewerage gully trap or onto ground in a densely vegetated area unlikely to be accessed by children or animals and then refitted into the tank.

A summary of key septic tank system maintenance requirements is provided in Appendix I, ARC Technical Sheet I-1.

12.2.4 Secondary Treatment Systems Maintenance

Secondary treatment systems involve a high level of technology in their design and their effective operation can be dependent upon a number of critical factors.

Aerobic wastewater treatment systems (AWTS) are a mechanical on-site treatment unit that provides secondary (biological) wastewater treatment by mixing air (oxygen) and aerobic and facultative microbes with the wastewater, followed by clarification. AWTSs typically use a suspended growth treatment process (similar to activated sludge extended aeration) or a fixed film treatment process (similar to trickling filter). Design details and critical maintenance requirements for these systems are detailed in Section 7.3. In summary, it is important to balance the influent wastewater concentrations in AWTS systems with the aeration level and in the case of some systems, also with the sludge recirculation ratio.

In the case of sand filter systems, the surface of the sand filters needs to be checked regularly for signs of uneven wastewater distribution, which will affect the system performance and the life of the system. The surface needs to be kept free of weed growth and the splitter valves also need to be checked. Textile filter sheets need to be checked and the sheets hosed down once the slime build up on the sheets begins to impact upon their effectiveness. In all cases, the alarm sensors and audible and visual alarms need to be checked.

Trained professionals who are familiar with the system design best address all of the above matters. To ensure on going effective system performance, a maintenance contract must be entered into with an experienced wastewater treatment plant operator specifically trained for the particular system, preferably the system supplier. Ideally, routine maintenance inspections should be undertaken on a quarterly basis. Site owners must also follow the supplier’s instructions on the routine elementary inspections that need to be undertaken and ensure that they contact the supplier whenever anything untoward is identified. Inspections by experienced contractors should be undertaken in accordance with the minimum frequency recommended by the system supplier. This is unless routine sampling shows a treatment system is not consistently achieving the required discharge quality standards (refer Section 7.5), in which case, more frequent inspections should be undertaken until the system stabilises.

A summary of key package treatment system maintenance requirements is provided in Appendix I, ARC Technical Sheet I-3.

12.2.5 Other Treatment System Maintenance

Additional specialised treatment system components such as chlorine or ultraviolet disinfection systems, wastewater re-use treatment systems, composting systems and other land based treatment systems etc. all have specific operational and maintenance requirements that are particular to the type of system concerned. In all cases, maintenance must be undertaken in accordance with the

supplier's recommendations, in addition to the critical minimum maintenance requirements specified with the relevant design information in the respective parts of Sections 7.6 to 7.9.

12.2.6 Disposal System Maintenance

Maintenance contracts should also include a requirement for the contractor to undertake an inspection of the disposal system and undertake any routine maintenance with the distribution lines. This may include flushing the lines, replacing any blocked or ineffective emitters and making recommendations to the system owner to arrange any other maintenance requirements. Ultimately the performance of the wastewater disposal system is the responsibility of the system owner. This requires that the system owner takes responsibility for regular inspections of the wastewater disposal field; walkover inspections every two to four weeks are recommended. These inspections should include:

- Checks for even wastewater distribution within the disposal field and downslope of the field. Zones of soil saturation/wet patches or signs of wastewater/sludge on the ground surface should be investigated immediately and remedial actions taken as soon as practicable;
- Flushing of irrigation lines to avoid solids or slime build-up in the lines, (if required more frequently than the routine maintenance contractor inspections);
- Root intrusion can be a problem and result in clogging of emitters and laterals. Root intrusion can be controlled by installing PCDI lines impregnated with herbicide or installing an in-line herbicide dispenser to inhibit roots entering the emitters.
- Checks for even plant growth across the field. Only highly water absorbent plant species should be planted in the wastewater disposal areas to enhance evapo-transpiration. Vegetation growth should be even and where it is not, further plants should be planted and/or the problem of plant dieoff addressed;
- Grasses should be regularly mowed to ensure that it is maintained in the active growth phase and the clippings removed;
- Access by children should be restricted unless the surface soils are very dry. Wastewater disposal fields in public land should be clearly signposted and preferably fenced to discourage access;
- Access by vehicles and stock should be prohibited as this can disturb the distribution lines and cause uneven compaction of the soils.

Problems with wastewater disposal systems can be due to uneven distribution, and checks for this should be undertaken as part of a routine maintenance inspection procedure. However, problems are just as likely to be from the wastewater flows exceeding the system's original design capacity and/or with problems with the treatment system design/performance. These latter matters are addressed further in this Section 12.2.10 "Remedial Procedures for System Failure".

12.2.7 Maintenance Contracts

Secondary treatment systems are complex systems due to the number of parts involved and the degree of technology often involved in their design and their performance can vary significantly in response to only minor changes in circumstances. Due to their sensitivity and the complexity, it is critical that they are routinely inspected and maintained by professional wastewater system operators.

The frequency that professional maintenance inspections required depends on the following factors:

- The system type and the quality of the associated components;
- Specific details in the design and quality of the installation;
- The plant performance and whether the required discharge quality standards (Section 7.5) are routinely met;
- The number of people using the system, fluctuations in occupancy/usage and their water conservation practices;
- The load into the system in terms of flow volumes, BOD and oils and grease in the raw wastewater compared with the levels assumed at the design stage;
- The system owner/operator's knowledge of the systems and the level of routine maintenance inspections/system maintenance they are able to and actually do undertake; and
- The precautions taken to minimise the BOD and toxic/chemical loads put on the system by the users of the facilities.

To ensure such critical maintenance is undertaken and systems continue to perform as anticipated at the time they were designed and as they were approved at the time of installation, and as is critical for long-term sustainability of the disposal system, all owners of secondary types of treatment systems must enter into a maintenance contract with an appropriate trained professional maintenance contractor. Package treatment plants are too prone to failure without routine maintenance. The maintenance contractor should have a high level of experience with the operation of on-site wastewater treatment systems, such as the system designer and/or the system supplier. Maintenance inspections should ideally be undertaken on a 3 monthly basis, and even more frequently for unstable systems and possible less frequently for systems only used on an infrequent basis. In the Auckland region, *in all cases* ARC requires at least two inspections per year at six monthly intervals by maintenance contractors. This is except for systems only operated for short consecutive periods each year, such as holiday facilities, which are used for a short period each year. In these which cases, less frequent i.e. only annual inspections may be appropriate, at the risk of the system owner.

12.2.8 Management Plans

A key requirement of all newly designed wastewater treatment and disposal systems is that a Management Plan is provided by the system designer/installer/supplier prior to the system commissioning so that the system owner has a clear understanding from day one of the key maintenance requirements.

Key requirements of items to be included in Management Plans are as follows:

- a. *Contact Details* of System Designer, Supplier, Installer and recommended Maintenance Contractor(s), including 24 hour emergency contacts.
- b. *Design Discharge Volume*: Details of the scope of the key facilities/premises covered the system is designed to serve, including the peak occupancy/usage on which the design is based and the corresponding design discharge volume.
- c. The *Process Flow Diagram*: A diagram showing the process components, hydraulic profile, electrical controls and alarm circuitry, any timer settings, mechanical controls, flow splitting, proportioning equipment and finally any special equipment and any configurations that need to be set manually or electronically.
- d. The *Process Description*: Details of the physical and biological processes, flow controls, dosing volumes/cycles and loading rates.

- e. A copy of the *Approved Design Site Plan and/or The 'As-Built' Plans* (all plans should be dated), showing the location of key components of the wastewater treatment system, the disposal system and the location of the allocated reserve area. Details of what should be shown on the As-Built plans is further covered in Section 12.1.3 (e).
- f. The *Wastewater Treatment System Maintenance*: Details of the key components, inspection procedures, key maintenance requirements and maintenance frequencies. The plan should also specify who is responsible for undertaking the maintenance tasks e.g. the site owner and/or system supplier and/or system maintenance contractor. Wherever there is any doubt concerning the long-term maintenance responsibilities of a treatment system, the purchaser should receive data sheets for the system specifying design start up and long-term operating parameters. This should include programmable timer ranges, flow meter range and units, electrical and operating characteristics with specifications for normal system operating conditions, flow head-loss characteristics at all valves, flow meters, flow splitters distributing equipment and manifolds.
- g. The *Wastewater Disposal System Maintenance*: Details of the operation and maintenance requirements and inspection procedures and frequencies. This should include details of the regular maintenance requirements of vegetation within the disposal system. The plan should also specify who is responsible for undertaking the maintenance tasks e.g. the site owner and/or system maintenance contractor.
- h. *Preventative Maintenance Worksheets*: Checklists of key operational and maintenance requirements covered in Part (f) and (g) above.
- i. *Monitoring and Reporting Requirements*: Frequency and procedures for monitoring and reporting records, where within the systems monitoring should be undertaken and where records must be forwarded (i.e. the address of the statutory agency that is to receive flow and discharge quality records).
- j. *A Contingency Plan/Trouble Shooting Guide*: The Plan or Guide should provide a guide to diagnosing problems and potential causes and determining appropriate response actions. A Plan of actions that must be taken should include contact details, in the event of any mechanical or biological system emergencies or key system failures or other problems. It should also specify that a site log is kept to ensure records of all irregular incidents with the system and response actions are kept, to assist determination of recurring problems/trends.
- k. *Educational Material of Routine Precautions*: Details of water producing activities, devices which may affect the successful operation of the system e.g. dishwashers, garbage grinders, the need for water conservation and the need for caution with the discharge of strong chemicals/cleaning agents. Where water saving devices are included as a system design component, these should be clearly specified in the management plan (Further details of key matters a householder should be aware of are covered in Appendix I – ARC Technical Sheets I-1 to I-4 and cleaning agents that should not be used are covered in ARC Technical Sheets I-5 & I-6. The effects of cleaning substances with high nutrient concentrations on the receiving environment are addressed in Chapter 11).
- l. *Copies of relevant Regulatory Documentation*: the *Building Consent* and if available, the *Discharge Consent and/or the Land Use Consent* and details of consent conditions that must be complied with, e.g. criteria of the permitted activity for on-site disposal of domestic wastewater and/or conditions of the controlled or discretionary discharge consent, including any monitoring conditions.

Examples of On-Site Wastewater Treatment and Disposal System Maintenance Summary Checklists are provided in Appendix H.

12.2.9 System Monitoring

Reasons for Requiring Monitoring

Wastewater system monitoring is a most important tool for verifying system performance, for assessing the validity of the original wastewater system design AEE (assessment of environmental effects) and as a means of justifying design assumptions.

In addition to regular contracted monitoring services by a professional operator (as covered in Section 12.2.7), the most important form of monitoring by the system user/owner are the regular inspections of the wastewater treatment and disposal system for any signs of system malfunction. These system checks should be undertaken on a routine basis in accordance with the procedures in the management plan and with regard had for the problem solving guide also included in the plan.

Further formal system monitoring procedures may be required by a condition of consent. The degree of monitoring required is usually in response to the degree of uncertainty in the design and the level risk in the event of system failure. It can also be agreed as a mitigation measure through a consent process as an option for alleviating public concerns with a proposed discharge.

Flow Monitoring

The most common form of wastewater system monitoring is flow monitoring. As covered in Chapter 6, it is recommended that flow meters be installed wherever concern exists about risk of actual flow volumes exceeding design flow volumes. The meter should then be read at times of peak occupancy to provide for the home user/owner to control of actual water usage as required. Most owners of wastewater systems authorised by the ARC consent process (as well as those of systems with conditional approval as a permitted activity where flow volume uncertainty exists at the design and building consent stage), are required to monitor wastewater flows on a continuous or intermittent basis and to report the flow records to the consent authority. This is required where risk of failure is significant (as it can be on poor or small sites and/or on sites with a significant flow volumes) and/or where environmental and health effects from system failure are also considered significant.

Discharge Quality Monitoring

The next most common form of system monitoring is discharge quality monitoring to assess system performance. This is increasingly required as system complexity and potential of malfunction increase. It is likely to be required to verify ongoing optimum system performance and to verify the actual discharge quality against the quality standards claimed in the design stage. Again discharge quality monitoring is more likely to be required in situations where risk of adverse effects in the event of poor system performance is considered significant.

Monitoring of treated and disinfected wastewater prior to reuse is critical and is likely to be required in most cases, to verify system performance and to enable precautions to be taken to reduce risks in the event of actual or potential system failure. The recommended treated wastewater quality monitoring specifications are detailed in Section 7.8. In the case of chlorine and/or UV disinfection, regular (daily or weekly) monitoring of the chlorine residual and possibly turbidity by the system user/owner, is likely to be required. Less frequent (fortnightly, monthly, quarterly or six monthly) professional analyses for biochemical oxygen demand, suspended solids, faecal coliforms, turbidity and pH concentrations are also likely to be required. Again the frequency will depend on the degree of risk, with more regular monitoring required dependant on the magnitude of risk in the event of any failure and/or as a means of verifying adequate system maintenance.

Monitoring of the Receiving Environment

The third form of monitoring is monitoring of the receiving environment. In particular, monitoring of surface or groundwater or stormwater channels may be required where risk of impact on water quality is considered significant, such as in situations where there is inadequate separation distances and/or where monitoring is considered necessary to provide a means of ensuring design mitigation measures are maintained.

Use of Monitoring Data

In many cases, discharge consent conditions will require response actions in the event of any non-complying monitoring result, such as where a result exceeds a trigger level or limit in the consent. Such actions are likely to include mitigation measures and may or may not include reporting to the consent authority and increased monitoring until results verify resolution of the non-compliance event.

In all cases, the necessary monitoring and response procedures must be included in the system management plan, as outlined in items (i) and (l) in Section 12.2.8. It is important that monitoring is undertaken in a consistent manner in accordance with the specified procedures in a management plan, particularly if the data is to be analysed for any trends or comparisons over time.

12.2.10 Remedial Procedures for System Failure

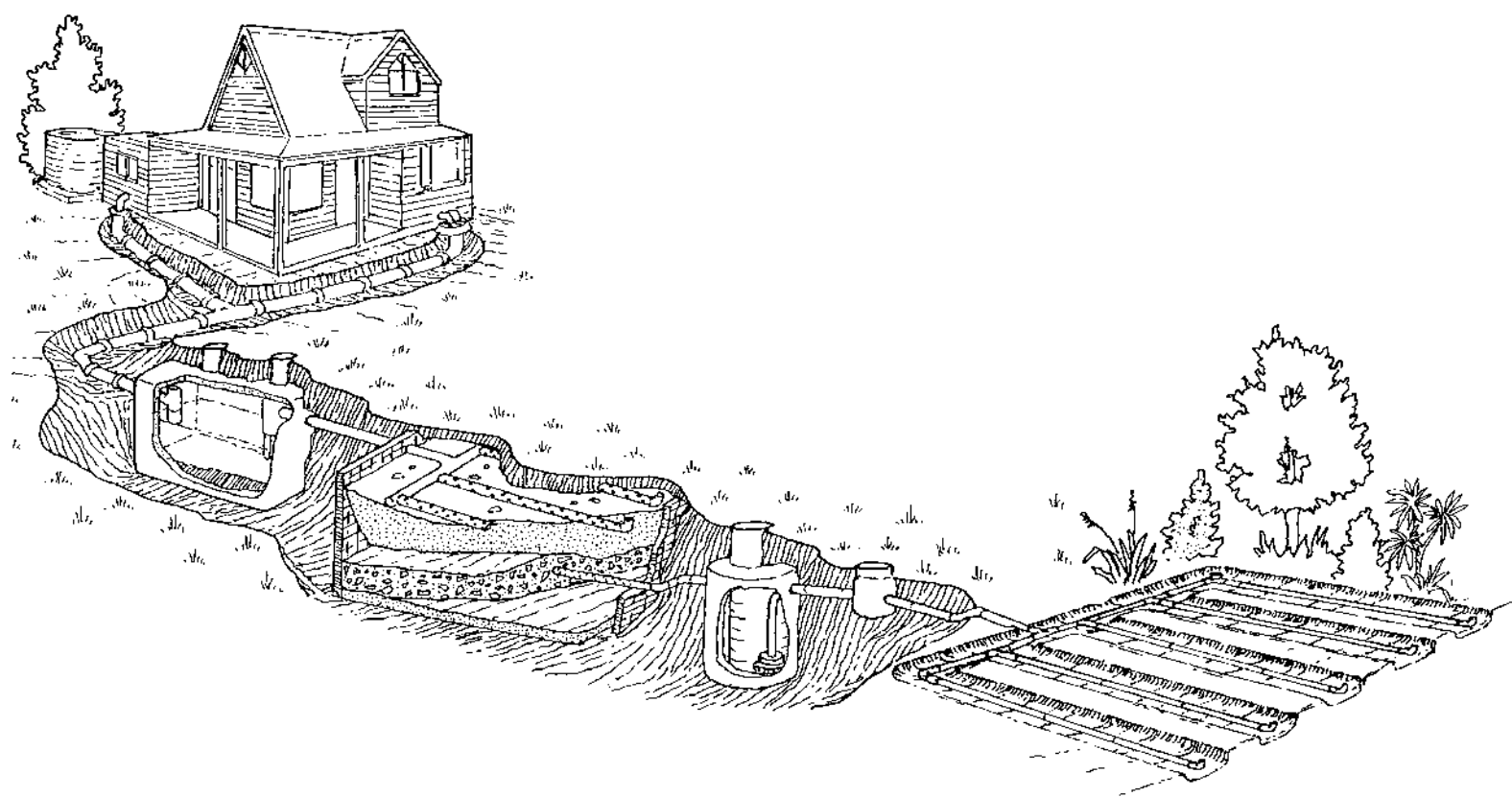
Figure 12.1 outlines a 5 step procedure for responding to system failure. The key steps involved are the identification of the first *indications of possible failure*, the *obtaining of background information* that should be known or can be easily obtained before the investigation proceeds, the *immediate matters to be investigated* to clarify the problem and the cause, the *determination of the cause of the problem* through the investigation of further relevant information and finally *identifying the solution* and undertaking the *corrective actions*.

Further information on solutions for various types of possible on-site wastewater system problems and options for avoiding and addressing such problems is provided in the following ARC Technical Sheets provided in Appendix I:

- Technical Sheet I-1 – How to Avoid Problems with On-site Wastewater Treatment and Disposal Systems – Key Maintenance Requirements.
- Technical Sheet I-2 – On-site Wastewater Septic Tanks: Do's & Don'ts Summary for Householders.
- Technical Sheet I-3 – On-site Wastewater Package Treatment Plants: Key Maintenance Requirements to be undertaken by Maintenance Contractor.
- Technical Sheet I-4 – On-site Wastewater Treatment and Disposal Systems: Problem Solving Guide.
- Technical Sheet I-5 – Household Cleaning Chemicals: Effects on Disposal System Soils.
- Technical Sheet I-6 – On-Site Wastewater Treatment & Disposal Systems: Substitutes For Household Cleaning Chemicals And Other Waste.

TABLE 12.1: STEP PROCEDURE FOR INVESTIGATING AND REMEDIATING ON-SITE WASTEWATER SYSTEMS' FAILURE

<p>IDENTIFY FAILURE</p>	<p>↔</p>	<p>Possible symptoms e.g. foul odours and/or wastewater breakout, rank-poorly growing vegetation; poor drainage off-site land or water contamination; and surface water discolouration/ eutrophication.</p>
<p>↓</p> <p>Collect Important Background Information</p>	<p>↔</p>	<ul style="list-style-type: none"> • Site constraints; soil type; groundwater depth; • Design wastewater flow volume capacity; • Treatment system design; • Disposal system design & limitations; • Reticulation pipework layout; • System age; • System use/occupancy numbers; extent/frequency of occupancy; • Daily flow records/estimates; • Recent changes in circumstances; • System maintenance record.
<p>↓</p> <p>Investigate Problems</p>	<p>↔</p>	<ul style="list-style-type: none"> • Problems identified from on-site inspection; • Problems identified from surrounding environment inspection; • Current disposal area loading rate versus design loading rate; • Treatment system performance & discharge quality; • Flow records of actual water usage/wastewater discharge volumes.
<p>↓</p> <p>Complete Investigation to Determine Cause</p>	<p>↔</p>	<ul style="list-style-type: none"> • System components testing and monitoring; • Potential for stormwater/groundwater infiltration; • Treated wastewater sampling & analysis; • Wastewater breakout/seepage sampling & analysis; • Occupancy records • Soil bore logs within & down slope of disposal area; • Maintenance records; • Changes in wastewater character; • Increases in organic load and/or fat & oil concentrations; • Condition of receiving soils & vegetation • Condition of down slope soils & water quality.
<p>↓</p> <p>Identify Solutions and Initiate Corrective Actions</p>	<p>↔</p>	<p>Get Help</p> <ul style="list-style-type: none"> • Engage experienced wastewater design engineer; • Engage System Supplier/ Maintenance Contractor; • Arrange one-off / ongoing septic tank pumpouts & off-site disposal. <p>Fix System</p> <ul style="list-style-type: none"> • Upgrade /Service wastewater treatment system; • Repair damaged system components; • Install outlet filter to septic tank if not in place; • Increase system capacity; • Extend/replace disposal system; • Improve condition of plantings & maintenance on healthy vegetation; • Commence/Renew Maintenance Contract. <p>Reduce Flows</p> <ul style="list-style-type: none"> • Install flow reduction valves on all water outlets/faucets; • Improve water construction; • Eliminate baths, decrease shower duration; • Decrease washing machine usage; • Eliminate stormwater infiltration; • Install surface/subsurface water cut-off drains; • Reduce organic waste in discharge and avoid toxic discharges.



13 > Glossary of Terms and References

GLOSSARY OF TERMS

Absorption	The process by which one substance is taken into and included within another substance such as the absorption/uptake of water/effluent by soil or of nutrients by plants.
Activated sludge process	A biological wastewater treatment process by which biologically active sludge (concentrated biomass) is agitated and aerated with incoming wastewater. The activated sludge is subsequently separated from the treated wastewater (mixed liquor) by sedimentation, and most of it is returned to the process. The rest is wasted as needed.
Adsorption	The physical or chemical attachment of substances to the surface of soil particles.
Advanced Secondary Treatment	Aerobic biological treatment process, including settling and/or filtering of wastewater. Secondary treated wastewater is expected to be equal to or better than 15g/m ³ 5-day biochemical oxygen demand and 15g/m ³ suspended solids. (This is for the purpose of land disposal. Higher quality, such as 10gO/m ³ and 10g/m ³ respectively or better, may be required where discharge is into water). Systems that can provide advanced secondary treatment are predominantly sand filters, advanced textile filters and packed bed reactors. Some high performing, stabilised and closely monitored aerobic treatment plants (refer AWTS) can also achieve the same discharge quality.
Aerobic	Having molecular oxygen as part of the environment, or growing or occurring only in the presence of molecular oxygen (as in "aerobic organisms").
Aerated wastewater treatment plant/system (AWTP or AWTS)	A mechanical on-site treatment unit that provides secondary (biological) wastewater treatment by mixing air (oxygen) and aerobic and facultative microbes with the wastewater, followed by clarification. AWTSs typically use a suspended growth treatment process (similar to activated sludge extended aeration) but can also involve or a fixed film (air vented fixed media) biological filtration treatment process, similar to trickling filter. These are also referred to as home aeration plants or household package plants.
All-waste	The combined blackwater and greywater flow from a dwelling or premise that is generating domestic waste.
Ammonia (NH₃)	Un-oxidised form of nitrogen; toxic to aquatic life at elevated concentrations.
Anaerobic	Characterised by the absence of molecular oxygen, or growing in the absence of molecular oxygen (as in "anaerobic bacteria").
ARC	Auckland Regional Council.

Biochemical Oxygen Demand (BOD)	A commonly used gross measurement of the concentration of biodegradable organic impurities in wastewater. The amount of oxygen, expressed in milligrams per litre (mg/L), required by bacteria while stabilizing, digesting, or treating organic matter under aerobic conditions is determined by the availability of material in the wastewater to be used as biological food and the amount of oxygen used by the micro-organisms during oxidation.
Biomat	The layer of biological growth and inorganic residue that develops at the wastewater-soil interface and extends up to about 25mm into the soil matrix. The biomat controls the rate at which pre-treated wastewater moves through the infiltrative surface/zone for coarse to medium textured soils. This growth may not control fluxes through fine clay soils, which are more restrictive to wastewater flows than the biomat.
Blackwater	Liquid and solid human body waste and the carriage waters generated through toilet usage.
Best Practicable Option (BPO)	The best option for wastewater servicing and/or treatment and/or disposal that best meets public health, environmental and economic objectives.
Building Consent	A permit issued or authorized by the regulatory authority that allows the installation of wastewater treatment system in accordance with approved plans and application codes.
Centralised Wastewater Treatment System (CWTS)	The collection of wastewater from homes and commercial facilities in an urban area, that consists of collection sewers with a centralised treatment and disposal/reuse facility, usually remote from its source or the community.
Chemical Oxygen Demand (COD)	A measure of oxygen use equivalent to the portion of organic matter that is susceptible to oxidation by a strong chemical oxidizing agent.
Chlorine residual	The total amount of chlorine remaining in water, sewage, or industrial wastes at the end of a specified contact period following disinfection.
Clarifiers	Settling tanks that typically remove settleable solids by gravity.
Clay	A textured class of soils consisting of particles less than 0.002mm in diameter.
Coliform bacteria	A group of bacteria predominantly inhabiting the intestines of humans or other warm blooded animals, but also occasionally found elsewhere. Used as an indicator of human faecal contamination.
Colloids	The solids fraction that is described as the finely divided suspended matter that will not settle by gravity and yet is too large to be considered dissolved matter.
Decentralised Wastewater Treatment System (DWTS)	The collection, treatment, and disposal/reuse of limited volumes of wastewater, generally from a cluster(s) of dwellings and/or accommodation facilities that are usually located relatively close together, with the wastewater system relatively close to the source (also referred to as "community", "neighbourhood" or "cluster" systems).

Deep Bores	Deep bores are a form of deep infiltration system, typically around 6 metres deep, used on sites where low permeability surface soils, such as poorly draining clays, are underlain by more permeable subsoil layers at depth.
Denitrification	The biochemical reduction of nitrate or nitrite to gaseous molecular nitrogen, or to an oxide of nitrogen.
Design irrigation rate (DIR)	The loading rate that applies to the irrigation of a land-application area with effluent of a secondary quality. It is expressed in L/m ² /week or mm/week. If a spray irrigation system is used, the secondary effluent is subject to continuous disinfection.
Desludging	Removal of the accumulated sludge and scum from the septic tank.
Disinfection	The process of destroying pathogenic and other micro-organisms in wastewater, typically through application of chlorine compounds, ultraviolet light, iodine, ozone, and the like.
Disposal method	The type of land disposal system (dripper irrigation, trench, bed, mound) sized to the daily wastewater flow and wastewater loading rate for dispersal of treated wastewater into the ground for final treatment.
Disposal field	Shallow, covered, excavation made in unsaturated soil into which pretreated wastewater is discharge through distribution piping for application into/onto soil infiltration surfaces through porous media or manufactured (gravelless) components placed in the excavation. The soil accepts, further treats, and disperses wastewater as it percolates through the soil, ultimately discharging to groundwater.
Dissolved Oxygen (DO)	The oxygen dissolved in water, wastewater or other liquid, usually expressed in milligrams per litre (mg/L), parts per million (ppm), or percent of saturation.
Dissolved solids	The fraction of solids dissolved in water.
Distribution Method	The pipe system within the land disposal system to distribute treated wastewater onto the design infiltration area.
Domestic Wastewater	Wastewater originating from households or personal activities including water closets, urinals, kitchens, bathrooms and laundries. Includes such wastewater flows from facilities serving staff/employees/residents in institutional, commercial and industrial establishments, but excluding commercial and industrial wastes, large-scale laundry activities and any stormwater flows.

Drainage	<p>An indication of the local soil wetness conditions likely to occur in most years. Soil wetness is further described as very poorly drained, poorly drained, imperfectly drained, moderately well, drained, well drained and rapidly drained.</p> <ul style="list-style-type: none">• Very poorly drained: water is removed from the soil so slowly that the water table remains at or near the surface for most of the year.• Poorly drained: All horizons remain wet for the periods of several months.• Imperfectly drained: Some horizons are wet for periods of several weeks.• Moderately well drained: Some horizons may remain wet for as long as one week after water addition.• Well drained: Some horizons may remain wet for several days after water addition.• Rapidly drained: No horizon is normally wet for more than several hours after water addition.
Dry vault	<p>A chamber that receives and treats human and domestic organic waste using a biological degradation or dehydrating process. The only water used is for cleaning or assisting the biological degradation process.</p>
Effluent	<p>Sewage, water, or other liquid, partially or completely treated or in its natural state, flowing out of a wastewater treatment system or out of a component of a treatment system.</p>
Effluent filter (also called an Outlet filter and an Outlet solids control device)	<p>A removable, cleanable device inserted into the outlet piping of the septic tank designed to trap excessive solids due to tank upsets that would otherwise be transported to the subsurface wastewater infiltration system or other downstream treatment components.</p>
Engineered design	<p>An on-site or cluster system that is designed to meet specific performance requirements for a particular site as certified by a chartered engineer or other qualified person experienced in on-site wastewater treatment and land disposal systems.</p>
Environment	<p>Surroundings, including natural and physical resources, community and neighbourhood relating to health, aesthetic, social, economic and cultural conditions.</p>
Environmental Sensitivity	<p>The relative susceptibility to adverse impacts of a water resource or other environments that may receive wastewater discharges.</p>
Eutrophic	<p>A term applied to water that has a concentration of nutrients optimal or nearly so, for plant or animal growth. In general, nitrogen and phosphorus compounds contribute to eutrophic conditions in coastal and inland fresh waters, respectively.</p>
Evapotranspiration	<p>The combined loss of water from a given area and during a specified period of time by evaporation from the soil or water surface and by transpiration from plants.</p>

Evapotranspiration-seepage bed	A land-application system that embodies the principles of evaporation, transpiration and absorption. Also known in Australia as an <i>Evapotranspiration absorption trench, bed or area</i> .
Fabric	The combination of arrangements of individual soil particles into definable aggregates or peds, which are characterised and classified on the basis of size, shape, and degree of distinctness.
Filter cloth	Any durable, permeable textile material suitable for use with soil, rock or earth.
Fixed-film wastewater treatment system	A biological wastewater treatment process that employs a medium such as rock, plastic, wood, or other natural or synthetic solid material that will support biomass on its surface. Fixed film systems include those in which the medium is held in place and is stationary relative to fluid flow, those in which the medium is in motion relative to the wastewater (e.g. rotating biological disk), and dual process systems that include both fixed and suspended biomass together or in a series.
Greywater	Domestic wastewater drained from sinks, tubs, showers, baths, dishwashers, clothes washers, and other non-toilet sources. (Greywater should not contain waste from garbage grinders.)
Holding tank	A tank used for holding wastewater prior to pumping out.
Hydrologic conductivity	As applied to soils, the ability of the soil to transmit water in liquid form through pores.
Intermittent Packed Bed Reactor	A single pass sealed reactor media bed (refer Packed Bed Reactor).
Infiltration	Passage of water into soil.
Laminar flow	Used to describe flat, sheet like ground water flows that migrate laterally along the upper surface of a confining layer of soil or rock.
Land Disposal system (Also called Application System)	The system used to apply effluent from a wastewater treatment unit into or onto the soils for further in-soil treatment and absorption.
Long term Acceptance Rate	The maximum rate that a land disposal system can treat primary or secondary effluent. It allows for loss to the soil by percolation through the base and sidewalls of the application system and other losses to the atmosphere by evaporation and evapotranspiration.
Mineralisation	The conversion of an element from an organic form to an inorganic state as a result of microbial decomposition.
Mottling	Spots or blotches of different colours or shades of colour interspersed with the dominant soil colour caused in part by exposure to alternating unsaturated and saturated conditions.
Nitrate (NO₃)	The oxidised form of nitrogen, and the form most readily absorbed by plants.

Nitrification	The biochemical oxidation of ammonium to nitrate.
On-site wastewater treatment system (OWTS)	The collection, treatment, and disposal /reuse of wastewater from an individual home or commercial facility on the same property as it is generated.
Organic nitrogen	Nitrogen combined in organic molecules such as proteins and amino acids.
Organic soil	A soil that contains a high percentage of organic matter (more than 15 to 20%) throughout the soil column.
Outlet filter (Also call Effluent filter)	A removable, cleanable device inserted into the outlet piping of the septic tank designed to trap excessive solids due to tank upsets that would otherwise be transported to the subsurface wastewater infiltration system or other downstream treatment components.
Package plant	Term commonly used to describe an aerobic treatment unit (refer also AWTS systems) but can include any custom built secondary or advance secondary treatment system. Can be a standard built plant that is similar design for many sites or custom made specifically designed to serve a particular situation e.g. involving multiple dwellings or accommodation facilities.
Packed Bed Reactor	A sealed reactor media bed (usually layered sand and gravel) with an under drain collection. Screened effluent is applied to the top of the reactor media in small precise timer controlled doses via a piped distribution system to provide for a thin film flow through the bed reactor.
Particle size	The effective diameter of a particle, usually measured by sedimentation or sieving.
Particle size distribution	The amounts of the various soil size fractions in a soil sample, usually expressed as weight percentage.
Pathogenic	Causing disease, commonly applied to micro-organisms that cause infections disease.
Ped	An element of soil structure. Peds are lumps of soil that can be separated from each other by hand. Void spaces between peds control the passage of water through the soil.
Perched water table	The permanent or temporary water table of a discontinuous saturated zone in a soil, into which groundwater drains.
Percolation	The flow or trickling of a liquid downward through a contact of filtering medium.
Permeability	Ability of a porous medium such as soil to transmit fluids or gases.
pH	A term used to describe the hydrogen ion activity of a system.
Plastic soil	A soil capable of being moulded or deformed continuously and permanently by relatively moderate pressure.

Platy structure	Laminated or flaky soils aggregate developed predominantly along the horizontal axes.
Primary treatment system	The separation of suspended material from wastewater by settlement and/or floatation in septic tanks, primary settling chambers etc. prior to effluent discharge to either a secondary treatment process or to a land disposal system.
Population equivalent	The ratio of the total quantity of wastewater produced to that defined as being equivalent to that produced by one person.
Producer statement	A written declaration by a person responsible for an activity/product/process, settling out the performance requirements, how these are to be met and the measures required in a assessment of their effectiveness.
Recycle	The beneficial reuse of tertiary treated wastewater, usually for toilet flushing purposes only.
Recirculating Packed Bed Reactor	A multiple pass sealed reactor media bed (refer Packed Bed Reactor). The recirculating ratio is typically at one to three to one to five.
Regulatory authority (RA)	The level of government that establishes and enforces codes related to the permitting, design, placement, installation, operation, maintenance, monitoring, and performance of on-site wastewater treatment systems.
Reserve area	An area set aside for future use as a land application area to replace or extend the original land disposal system.
Residuals	The solids generated and retained during the treatment of domestic sewage in treatment system components, including sludge, scum, and pumping from grease traps, septic tanks, aerobic treatment units, and other components of an on-site or cluster system.
Reuse	The beneficial reuse of treated wastewater (usually secondary treated) to irrigation lawns and gardens, typically by pressure compensating dripper irrigation.
Sand filter	A packed bed filter of sand or other granular materials used to provide advanced secondary treatment of settled wastewater or septic tank effluent. Sand/media filters consist of a lined (e.g. impervious PVC liner on sand bedding) excavation or structure filled with uniform washed sand that is placed over an underdrain system. The wastewater is dosed onto the surface of the sand through a distribution network and allowed to percolate through the sand to the underdrain system, which collects the filter effluent for further processing or disposal.
Scum	The floating mass of wastewater solids buoyed up by entrained gas, grease or other substances which form and accumulating layer on the liquid surface inside the treatment tank.

Secondary treatment	Aerobic biological treatment process, including settling and/or filtering of wastewater. Secondary treated wastewater is expected to be equal to or better than 20g/m ³ 5-day biochemical oxygen demand and 30g/m ³ suspended solids. Systems that can provide secondary treatment include well designed and operated, stabilised aerated treatment plants (refer AWTS), usually based on extended aeration activated sludge processes) and can also include sand filters, advanced textile filters, packed bed reactors (refer to advanced secondary treatment systems).
Septage	The liquid, solid, and semisolid material that results from wastewater pre-treatment in a septic tank, which is removed from the system by pump-out/desludging operations.
Septic tank	A buried, watertight tank designed to receive and partially treat raw wastewater by allowing solids separation from the liquid phase and the decomposition of the retained organic matter by anaerobic bacteria, forming dissolved fatty acids and gases. Settleable solids settle to the bottom, forming a sludge layer and grease and other light materials float to the top, forming a scum layer. Tanks are normally vented to enable release of the gases generated during liquefaction of the solids.
Sequencing batch reactor	A sequential suspended growth (activated sludge) process in which all major steps occur in the same tank in sequential order. Sequencing batch reactors include intermittent-flow batch reactors and continuous-flow systems.
Setback	The distance that a wastewater system must be situated from any facility boundary, water body or other limiting factor.
Settleable solids	Matter in wastewater that will not stay in suspension during a designated settling period.
Sewerage	The network of collection drains that carry domestic wastewater or effluent away from the properties of origin for off-site treatment.
Silt	A textual class of soil consisting of particles between 0.05 and 0.002 millimetres in diameter.
Site Assessment	An evaluation of site and soil characteristics and the identification of site constraints. Also includes other environmental, public health legal and economic factors to be considered prior to the determination of wastewater treatment and land disposal system options.
Slickenslides	The skin or coating formed on (usually) large units of soil, which will show striations or grooves resulting from the periodic rubbing together of the soil units due to shrinkage and swelling in response to moisture change.
Sludge	The semi-liquid solids settled from wastewater.
Soil absorption zone	The volume of soil that is required to filter, isolate and absorb wastewater micro-organisms, nutrient and particles. For normal soils, the zone path length required is at least 0.6m to 1.2m. For sandy soils greater volumes of soil may be required. For sandy soils greater volumes of soil may be required.

Soil horizon	A layer of soil or soil material approximately parallel to the land surface and different from adjacent layers in physical, chemical, and biological properties or characteristics such as colour, structure, texture, consistence and pH.
Soil map	A map showing the distribution of soil types or other soil mapping units in relation to the prominent physical and cultural features of the earth's surface.
Soil morphology	The physical constitution, particularly the structural properties, of a soil profile as exhibited by the kinds, thickness, and arrangement of the horizons in the profile and by the texture, structure, consistence, and porosity of each horizon.
Soil permeability	A calculated value derived from the rate at which a head of liquid is absorbed into soil, usually measured in m/day as K_{sat} .
Soil survey	The systematic examination, description, classification, and mapping of soils in an area.
Soil texture	The relative proportions for the various soil separates (e.g. silt, clay, sand) in a soil.
Soil water	A general term emphasizing the physical rather than the chemical properties and behaviour of the soil solution.
Subsoil	In general, that part of the soil below the depth of ploughing.
Subsurface wastewater infiltration system (SWIS)	An underground system for dispersing and further treating pre-treated wastewater. The SWIS includes the distribution piping/units, any media installed around or below the distribution components, the biomat at the wastewater-soil interface, and the unsaturated soil below.
Terrain-soil map unit	An individual mapped area (polygon), which contains a definable slope or group of soils, which require individual soils evaluation prior to use as a land disposal area.
Textile Packed Bed Reactor (Also known as Textile Filter)	A sealed reactor media bed (textile) with an under drain collection, in which engineered textile media replaces the sand and gravel layers used in other forms of packed bed reactors. The effluent is uniformly dosed through a surface pressure distribution system using a timer controlled dosing regime.
Topsoil	The layer of soil moved in agricultural cultivation.
Total Kjeldahl Nitrogen (TKN)	The sum of the total organic nitrogen component plus ammonia.
Total Nitrogen (TN)	The sum of the organic nitrogen, ammonia, nitrite and nitrate.
Unsaturated flow	Movement of water in a soil that is not filled to capacity with water.

Wastewater	The contaminated water produced from domestic activities in dwellings, institutions, or commercial or public facilities, consisting of all waste, greywater or blackwater. Also defined as <i>foul water</i> in the New Zealand Building Code.
Water quality-based performance requirement	A specific, measurable, and enforceable standard that establishes limits for pollutant concentrations or mass loads in treated wastewater discharged to ground water or surface waters.
Water table	The level in saturated soil at which the hydraulic pressure is zero.
Watercourse	A stream that: <ol style="list-style-type: none">1. Has visible bed and banks, i.e. an eroded channel of any size, but not a defined non-eroded grassy course or drainage depression.2. Is partially fed with water from some source other than or in addition to surface water run-off.
Wetland	A system that can provide further treatment of effluent and consists of a bed or rock of other durable media, in which wetland plants are grown.

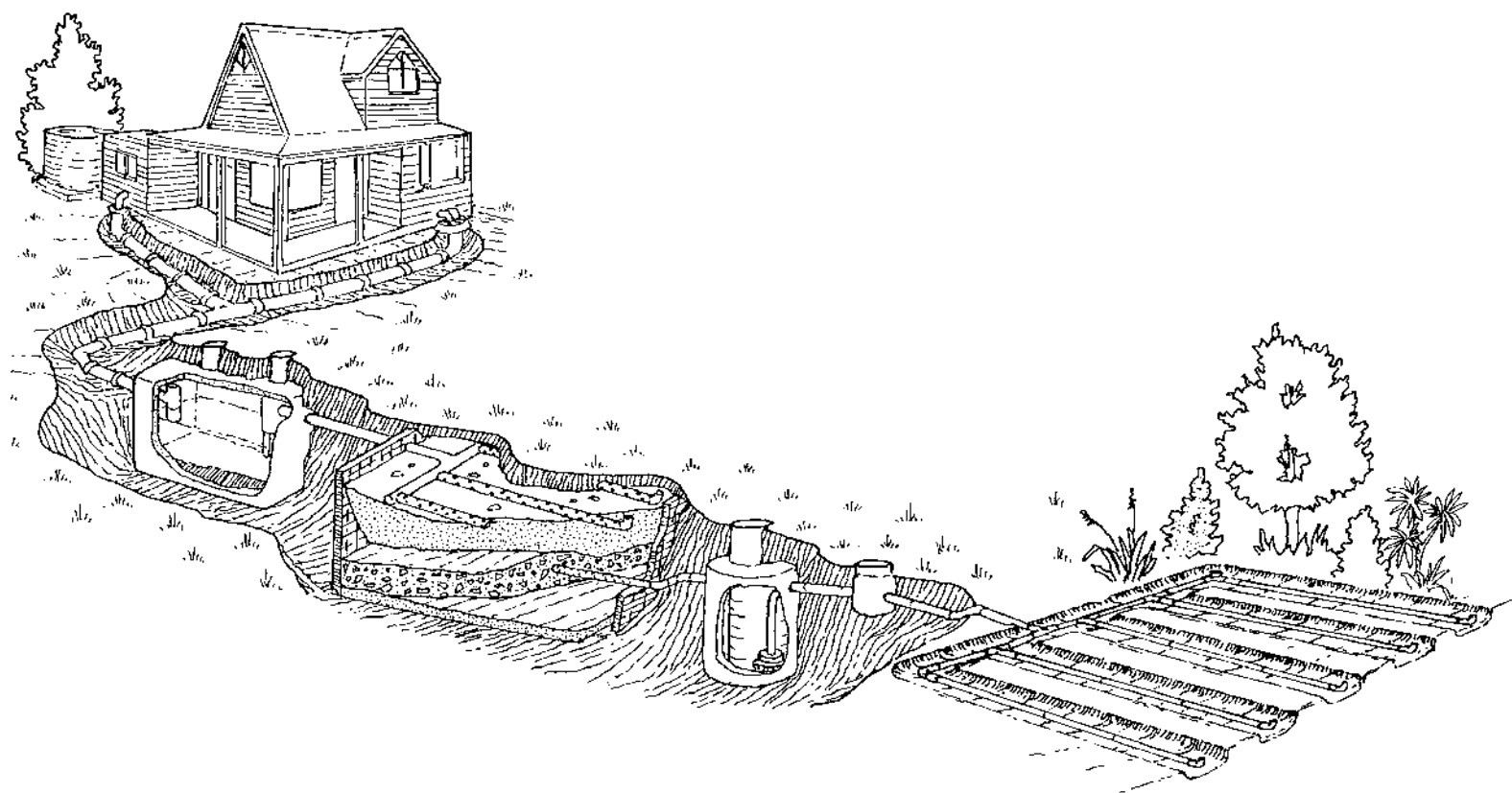
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Appendix A

Data Tables

Auckland Regional Council Technical Sheet A-1 METRIC CONVERSION FACTORS

US Units		Multiply By	SI Units	
Unit	Abbreviation		Unit	Abbreviation
acre	ac	4047	square metre	m ²
acre	ac	0.4047	hectare	ha
cubic foot	ft ³	28.3168	litre	L
cubic foot	ft ³	0.0283	cubic metre	m ³
foot	ft	0.3048	metre	m
square foot	ft ²	0.0929	square metre	m ²
gallon (US)	US gal	3.7854	litre	L
gallon (US)	US gal	0.003785	cubic metre	m ³
gallon (Imperial)	UK gal	4.546	litre	L
gallon (Imperial)	UK gal	0.00455	cubic metre	m ³
gallons/acre/day (US)	gal/ac/d	0.0094	cubic metres/hectare/day	m ³ /ha/d
gallons/square foot/day (US)	gal/ft ² /d	0.0407	cubic metres/square metre/day	m ³ /m ² /d
gallon/square foot/day (US)	gal/ft ² /d	40.7458	litres/square metre/day	L/m ² /d
pound	lb	0.4536	kilogram	kg
pounds/acre	lbs/ac	1.1209	kilograms/hectare	kg/ha
pounds of BOD ₅ /1000 feet ² /day	lbs/10 ³ ft ² /d	0.00455	kilograms of BOD/square metre/day	kg/m ² /d
pounds/1000 feet ³ /day	lbs/10 ³ ft ³ /d	0.0160	kilograms/cubic metre/day	kg/m ³ /d

Auckland Regional Council Technical Sheet A-2 MAXIMUM ACCEPTABLE VALUES FOR CONTAMINANTS and MICROORGANISMS OF HEALTH SIGNIFICANCE IN DRINKING WATER

The following tables outline the maximum acceptable values (MAV) for toxins and microorganisms of significance to health, within drinking water.

The MAV for microorganisms are included as the most common indicators of health risk associated with drinking water is contamination, either directly or indirectly, by human or animal excreta and the micro-organisms contained within faeces [TP58 Ref 45]. The MAV have been taken from the New Zealand's key guideline constituting good quality drinking water, the Ministry for the Environment's 'Drinking Water Standards for New Zealand 2000' [TP58 Ref 46].

It is important to note that different values apply to contaminants in soils. Information regarding background levels of contaminants in Auckland soils are provided in Background levels of inorganic elements in soils for the Auckland Region, ARC Technical Publication 153 [Ref 47], with recommended guideline values for contaminants in soil provided in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000 [TP58 Ref 45].

Contaminant	MAV	Notes
Arsenic	0.01mg/L	Provisional MAV, because of analytical difficulties.
Boron	1.4mg/L	
Cadmium	0.03mg/L	
Chromium	0.05mg/L	Provisional MAV, due to limited information on health effects.
Copper	2mg/L	Concentrations of the substance at or below the guideline value may affect the appearance, taste or colour of the water.
Fluoride	1.5mg/L	
Manganese	0.5mg/L	Concentrations of the substance at or below the guideline value may affect the appearance, taste or colour of the water.
Mercury (total)	0.002mg/L	
Selenium	0.01mg/L	
Nitrate	50mg/L	The sum of the ratio of the concentrations of nitrate and nitrite to each of their MAV's should not exceed 1.
Nitrite	3mg/L	As above for Nitrate.
Zinc	3mg/L	Concentrations of the substance may affect the appearance and taste of water.
Xylenes	0.6mg/L	Concentrations of the substance at or below the guideline value may affect the appearance, taste or colour of the water.
Microorganism	MAV	
<i>Escherichia coli (E.coli)</i>		Less than 1 in 100mL sample.
Pathogenic bacteria		Less than 1 in 100mL sample.
Viruses		Less than 1 enteric virus present in 100mL sample.
Protozoa (pathogenic)		Less than 1(oo)cyst in 100mL sample.
Helminths (pathogenic)		Less than 1 in 100mL sample.
Algae		Less than 1 toxic algae present in a 10mL sample.
Cyanobacteria		Less than 1 potentially toxic cyanobacterium present in a 10mL sample.

Appendix B

ARC Information Sheet ARC Comment on AS/NZS 1547:2000

Auckland Regional Council Information Sheet B-1

ARC COMPARISON OF TECHNICAL PUBLICATION NO. 58

WITH AUSTRALIA STANDARDS/NEW ZEALAND STANDARDS

The Joint Standards Committee produced the Australia Standards/New Zealand Standards (AS/NZS 1547:2000), following a six year period of development in Australia and New Zealand, incorporate national protocols and design standards from both countries. Mr Ian Gunn of the Joint Standards Committee has described the result as being the introduction of a nonprescriptive approach to design by the AS/NZS 1547:2000 umbrella standard for "on-site domestic wastewater management" and publication of related product standards for treatment units in the AS/NZS 1546 series*. Mr Gunn further indicated that the focus [in AS/NZS 1547:2000] is on management of the implementation processes for investigating, designing and installing systems and on setting in place performance management oversight of systems once installed.

This Information Sheet, (IS-B1) addresses differences between TP58 (Third Edition 2004) and AS/NZS1547:2000 (the standards) and it provides a brief summary of ARC's concerns with the adoption of some practices detailed in AS/NZS 1547:2000 in the Auckland region.

The drafting of the revised version of TP58 had commenced prior to the publication of the standards. Its preparation continued once the standards were issued in response to recognition by the ARC that needs remained in the Auckland region for clear design guidance to better assist on-site system design and design assessment by regulators in the Auckland region. TP58 has also been written to complement the revision of the ARC regional rules for on-site wastewater disposal. The regulations require that discharges are only 'permitted' where there is certainty that any effects will be no more than minor. This could not be achieved with reliance on AS/NZS 1547:2000 alone. The core differences in the information covered in the revised TP58 include:

- Clearer direction on site assessment criteria;
- More conservative representative design flow allowances for establishing design flow volumes;
- Details of a range of treatment systems available with design and/or performance specifications for many of the more common treatment options available; and
- Design specifications for wastewater land application distribution and disposal methodologies, with particular regard to soil type and regard to dangers of cumulative effects from intensification of development in the Auckland region.

To many, the approach taken to develop clear design specifications in TP58 is considered too prescriptive. ARC considers that it fills gap left by AS/NZS1547:2000 by providing clear criteria against which good system design can be assessed in the Auckland region and provides more certainty for the assessment of system performance and therefore, potential long term environmental effects, as required by the Resource Management Act 1991. Comments received on the draft version of TP58 (Draft Third Edition August 2003) included claims that TP58 should be more consistent with AS/NZS 1547:2000. Others suggested that design specifications should be more and less stringent than those initially proposed. There were further suggestions that ARC should just use all design standards from AS/NZS 1547:2000, instead of those often more detailed standards recommended in TP58.

Nevertheless, ARC did consider that there was a valid need for some AS/NZS 1547:2000 design standards to be adopted into TP58. Where gaps were identified in the draft TP58, due consideration was given to the alternative material in the standards, and this material has been adopted in TP58 wherever appropriate. However, regard has also been had for the large number of differences in practice between Australia and New Zealand, as covered in both documents. With TP58, ARC has attempted to compensate for what it considered were shortcomings in the AS/NZS design standards, and it has attempted to ensure that TP58 provides improved design criteria that are more specific to the New Zealand situation. This is discussed in more detail below.*

* Gunn, I., (2004) "On-site Wastewater Futures – A New Zealand Perspective", *Proceedings from the First International Conference on Onsite Wastewater Treatment and Recycling, [Conference 11-13 February 2004]*

Following is a brief summary of ARC concerns with the adoption of some practices detailed in AS/NZS 1547:2000 in the Auckland region, written in response to the above claims and concerns:

1. Relevant Legislation

Relevant New Zealand legislation, in particular, the Resource Management Act 1991 and more specifically in the Auckland region, the ARC Regional Policy Statement, require an effects based approach is taken to designing and assessing on-site wastewater systems. For this reason, TP58 has taken a precautionary approach to specifying any design criteria, in order to ensure that systems are sustainable and potential for adverse environmental effects from wastewater discharges are minimised.

The result has been that to some, TP58 may appear particularly prescriptive. There is also concern that this will stop innovation and creative design approach. This is not the intent of TP58 but many design features covered in TP58 are also allowed by default under the new Proposed Auckland Regional Rules: Air Land and Water as permitted activities. The criteria of a permitted activity must provide certainty that any effect from the activities will be no more than minor. Therefore all systems allowed as a permitted activity must be sufficiently well proven, robust and reliable and that there is little scope within relevant design criteria for experimentation. Instead, the consent process provides an avenue for assessment of new design technology. Once sufficient performance data has been accumulated to prove these 'innovative' systems, they would be included where appropriate in an update of TP58, and may then also be allowed as an inclusion as a permitted activity providing other relevant criteria is met.

2. Soakage Testing

AS/NZS 1547:2000 promotes the use of soakage testing for determining a soils capacity to assimilate the applied wastewater. However, this practice has been shown to be highly misleading in New Zealand soils. For example, it can indicate high soakage readings for compact clays, where fissures exist in the locality of the soakage test. This can result in severely under designed land disposal systems. TP58 focuses on the need for a comprehensive site assessment early in the design phase, with soil categorisation from identification of soils types, through the soil profile identified by testpits or boreholes within the proposed wastewater disposal area. This procedure provides more comprehensive information across the soils profile, than soakage testing alone.

3. Per Capita Domestic Flow Allowances

Conservative design flows are essential for minimising risk of system failure in the event of actual flows exceeding design limits. TP58 and AS/NZS1547:2000 provide minimum per capita wastewater design flow allowances for designers. The flow allowance recommended for design purposes in TP58, (Table 6.2) are more conservative than those in AS/NZS1547:2000 ((page 141). TP58 therefore requires a more conservative design flow and therefore a larger wastewater disposal area. Further, the AS/NZS1547:2000 flow allowance reductions with the inclusion of water conservation measures are greater than the more conservative (and believed more realistic) lower reductions recommended in TP58.

4. Soil Types and Design Loading Rates

AS/NZS1547:2000 promotes the use of higher wastewater loading rates (in the order of two to three fold) for secondary treated wastewater discharged into shallow trenches. It also allows elevated loading rates into trenches within soil types into which TP58 does not recommend the use of trenches at all. (Although TP58 does provide conservative guidelines for their use in special cases.)

TP58 discourages the use of trench disposal methods. The elevated loading rates with secondary effluent (a lower BOD load) combined with AS/NZS 1547:2000, along with the less conservative wastewater flow allowances, increases the risk of land disposal system failure. Elevated loading rates make no allowance for Auckland region climatic conditions and increased risk of runoff to surfacewater.

5. Land Disposal Methods.

TP58 promotes the use of pressure compensating dripper irrigation with even wastewater distribution across the infiltration area, in preference to older and less advanced disposal systems. In contrast AS/NZS 1547:2000 favours the use of trenches, and with elevated loading rates, in certain circumstances. Trench disposal methods, which are more suitable to sandy and

sandy loam soils, which also may be more common in some parts of Australia, have proven to be readily prone to failure in clay type soils, typical in the Auckland region.

AS/NZS1547:2000 also more strongly promotes the use of mound and bed disposal systems than TP58. These disposal methods are not favoured in the Auckland region due to the poor soakage characteristics of the underlying (predominantly clay) soil types. These problems have been exacerbated with significant under design of such disposal systems in the past. TP58 specifies conditions where trenches, beds and -alternative systems to drip irrigation may or may not be suitable in the New Zealand context. In particular, TP58 does not allow trenches in Category 6 or 7 soils and does not allow beds in Category 7 soils.

AS/NZS 1547:2000 allows the use of individual on-site spray irrigation of wastewater. Spray irrigation is not allowed under TP58 for individual on-site systems. The reasons TP58 opposes spray irrigation include historic poor homeowner maintenance of the disinfection system and irrigation system, limited evapotranspiration of sprayed wastewater in winter, poor soakage in the Auckland region resulting in effluent ponding, potential surface runoff to stormwater drains, aerosol production and dispersion. For these reasons, spray irrigation is considered likely to provide a greater potential for human contact and a corresponding increased health risk.

6. Separation Distances

The revised Third Edition of TP58 with its effects based ethos, provides guidance for minimising potential adverse environmental effects by including minimum separation distances, which is lacking in previous NZS1460:1982 standards, earlier versions of TP58 and in the current AS/NZS1547 standard. This guidance assists the designer determine an appropriate treatment level and separation distances of land disposal systems from groundwater, surface water or water bores, in different circumstances. AS/NZS1547:2000 does not provide decisive guidance on the protection of ground or surface waters, possibly due to the difficulty of providing such standards for all of New Zealand and Australia. Instead it directs the designer to consult with the relevant regulatory authority concerning separation distances. TP58 represents the environmental standards for the Auckland region.

AS/NZS1547:2000 (page 161) implies discharge of wastewater into the ground is satisfactory with a groundwater separation distance of about 400mm (without specifying the minimum effluent quality required). The minimum allowable separation distance for most soil types in TP58 is 600mm, usually providing effluent is treated to an advanced secondary and/or tertiary standard, with double this required for poorly treated wastewater.

7. Alternative Methods

AS/NZS1547:2000 allows the use of alternative systems, such as composting toilets, but provides less guidance than TP58 for operation and handling of the waste. Such guidance is considered very important for minimising health risk from such systems. Further reasons that ARC considers there is a need for somewhat prescriptive guidelines and limits on innovation is discussed above in item 1.

CONCLUSION

TP58 is more conservative than AS/NZS1547:2000, such that in many situations the application of its design specifications will assist to reduce risk of adverse environmental effects on groundwater. ARC considered that the application of AS/NZS 1547:2000 alone in New Zealand, and in particular in Auckland conditions and with Auckland's new regional rules, would provide less protection for the environment and public health. This is particularly with regard and the environment TP58's recommended per capita flow allowances, treatment system design, land disposal methods and land application rates. However, TP58 also recognises that there is some valuable design information in AS/NZS 1547:2000. In response, wherever practicable, this information has been incorporated within TP58 and where it is omitted from TP58 the user is encouraged to refer to it directly within AS/NZS 1547:2000. Further, AS/NZS 1547:2000 does fit a role beyond the scope of TP58, providing useful guidance to regulators for effective system management procedures, implementation roles education and training and other related information.

Appendix C

ARC Technical Sheets - Wastewater Discharge Consent Requirements and Permitted Activity Requirements

Auckland Regional Council Technical Sheet C-1 ARC WASTEWATER DISCHARGE CONSENT REQUIREMENTS

In the Auckland region, as part of any on-site wastewater treatment and disposal system assessment, the designer must determine whether the proposed discharge it is likely to comply with the criteria for a permitted activity, a controlled activity or a discretionary activity, as specified in the ARC Proposed Regional Plan: Air, Land and Water (PRP:ALW) in the rules relating to Sewage Disposal (Rules No. 5.5.20 to 5.5.28, in the Plan Decision Version, 2004).

While ARC has overarching responsibilities for wastewater discharges within the Auckland region, it has designated responsibilities for approvals of Permitted Activities (PA) to local authorities, occasionally in conjunction with ARC. ARC can require a discharge consent for any activity that may otherwise appear to comply with PA criteria where doubt remains concerning long term compliance with the relevant permitted activity rules or where there is any uncertainty as to whether or not any potential adverse effects of the activity will be minor.

In order for a discharge to be approved as a PA, it must comply with key PA criteria or a discharge consent will be required. There are two preliminary requirements and then a number of key system design criteria, all of which must be complied with.

For the FIRST and proposed THIRD PA rule (Rule No. 5.5.20 - 5.5.22) the two initial tests involve, firstly, that the maximum daily discharge volume must be less than 2000litres and secondly, that the gross lot area to discharge volume ratio must be greater than or equal to 1.5. The other criteria provides specifications for secondary treatment system and for drip irrigation disposal with adequate reserve area; and states that all relevant design specifications must be in accordance with design criteria in TP58. This rule predominantly applies to houses on most small sites of less than 2500 or 3000m².

For proposed FOURTH PA rule (Rule No. 5.5.23) the two initial tests involve, again that the maximum daily discharge volume must be less than 2000litres and secondly, that the gross lot area to discharge volume ratio must be greater than or equal to 3.0. The other criteria involve specifications for the wastewater treatment and disposal systems, with all design specifications required to be in accordance with design criteria in TP58. This rule predominantly applies to houses on sites of 2500 to 3000m² or more.

Determination of Gross Lot Area to Discharge Volume Ratio and Compliance with PA Criteria

A simple check of the Maximum Discharge Volume and then the Ratio of Gross Lot Area to Discharge Volume are necessary within the Auckland region for determining whether a discharge permit is likely to be required (in addition to the local council building permit). This ratio is calculated is using the following procedure:

FIRST, determine the maximum daily wastewater production using the guidelines in TP 58 Tables 6.1 and 6.2:

$$\text{Max Daily Wastewater Discharge} = \text{Max Occupancy} \times \text{Flow Allowance (litres/person/day)}$$

$$\text{IF Flow Greater Than 2000litres} = \text{ARC Consent Required}$$

SECOND, proceed to assess the ratio of lot area to design flow:

$$\text{Gross Lot Area to Discharge Volume Ratio} = \frac{\text{Gross Lot Area (m}^2\text{)}}{\text{Max Daily Flow (litres/day)}}$$

(A:V Ratio)

THIRD, check compliance with the gross lot area to flow volume ratio below with the PA limits.

A:V Ratio < 1.5	= Activity NOT a PA (Application must be made to ARC for a Controlled or Discretionary Activity Consent to Discharge Wastewater)
A:V Ratio ≥ 1.5 AND criteria in FIRST or THIRD PA Rule IS MET	= Activity IS a PA (No ARC Discharge Consent Required)
A:V Ratio < 3.0 AND criteria in FIRST or THIRD PA Rule NOT MET	= Activity NOT a PA (Application must be made to ARC for a Controlled or Discretionary Activity Consent to Discharge Wastewater)
A:V Ratio ≥ 3.0 AND criteria in FOURTH PA Rule MET	= Activity IS a PA (No ARC Discharge Consent Required)
A:V Ratio ≥ 3.0 AND criteria in FOURTH PA Rule NOT MET	= Activity NOT a PA (Application must be made to ARC for a Controlled or Discretionary Activity Consent to Discharge Wastewater)

Table TSB1 – 1 sets out the maximum design flows that can be discharged under the ARC’s Permitted Activity Rule for On-site Domestic Wastewater Disposal (First sewage disposal PA Rule of ARC PRP: ALW Decision Version 2004), for a range of lot size. It also provides approximate disposal area and reserve area requirements for drip irrigation disposal system, assuming an areal application rate onto clay (Category 6) soils of 3mm/day.

Note, there is also another Permitted Activity Rule (Rule No. 5.5.21) for existing on-site wastewater systems, already lawfully in place when the ARC PRP:ALW Decision Version 2004 came into force (i.e. before October 2004).

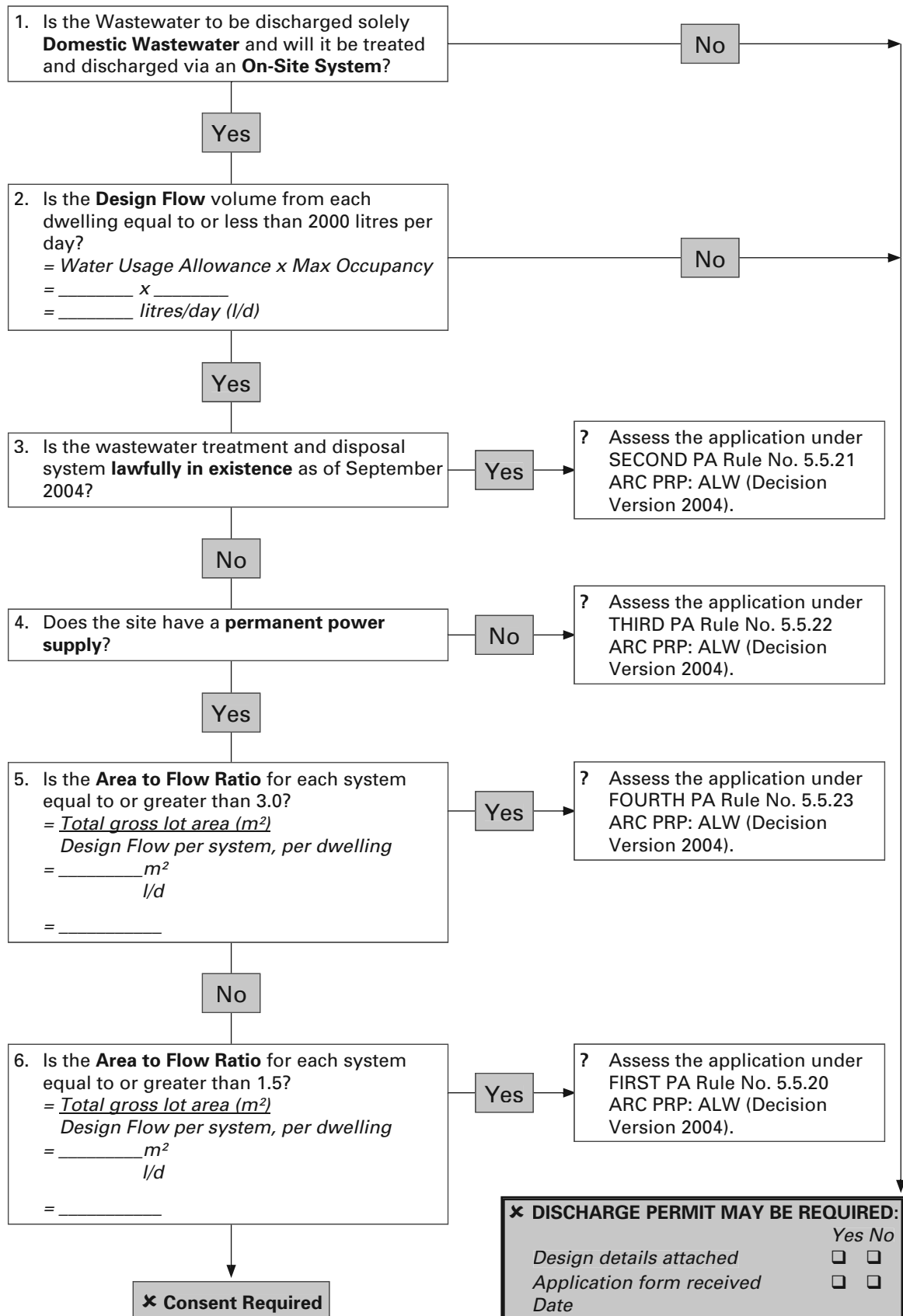
**Table TSB1 – 1: Gross Lot Size versus Maximum Permitted Design Flow Volume
(Under PRP:ALW Plan, FIRST Sewage Disposal PA Rule)**

Gross Lot Area (m ²)	Maximum Design Flow (Not Requiring an ARC Discharge Permit - see notes) (Litres/day)	Minimum Disposal Area required in clay soils (Refer Note Below) Primary Area + Reserve Area (m ²)
500	330	110 + 36
800	530	177 + 58
900	600	200 + 67
1,000	660	220 + 73
1,200	800	267 + 88
1,500	1,000	333 + 110
2,000	1,330	443 + 146
3,000	2,000	667 + 220

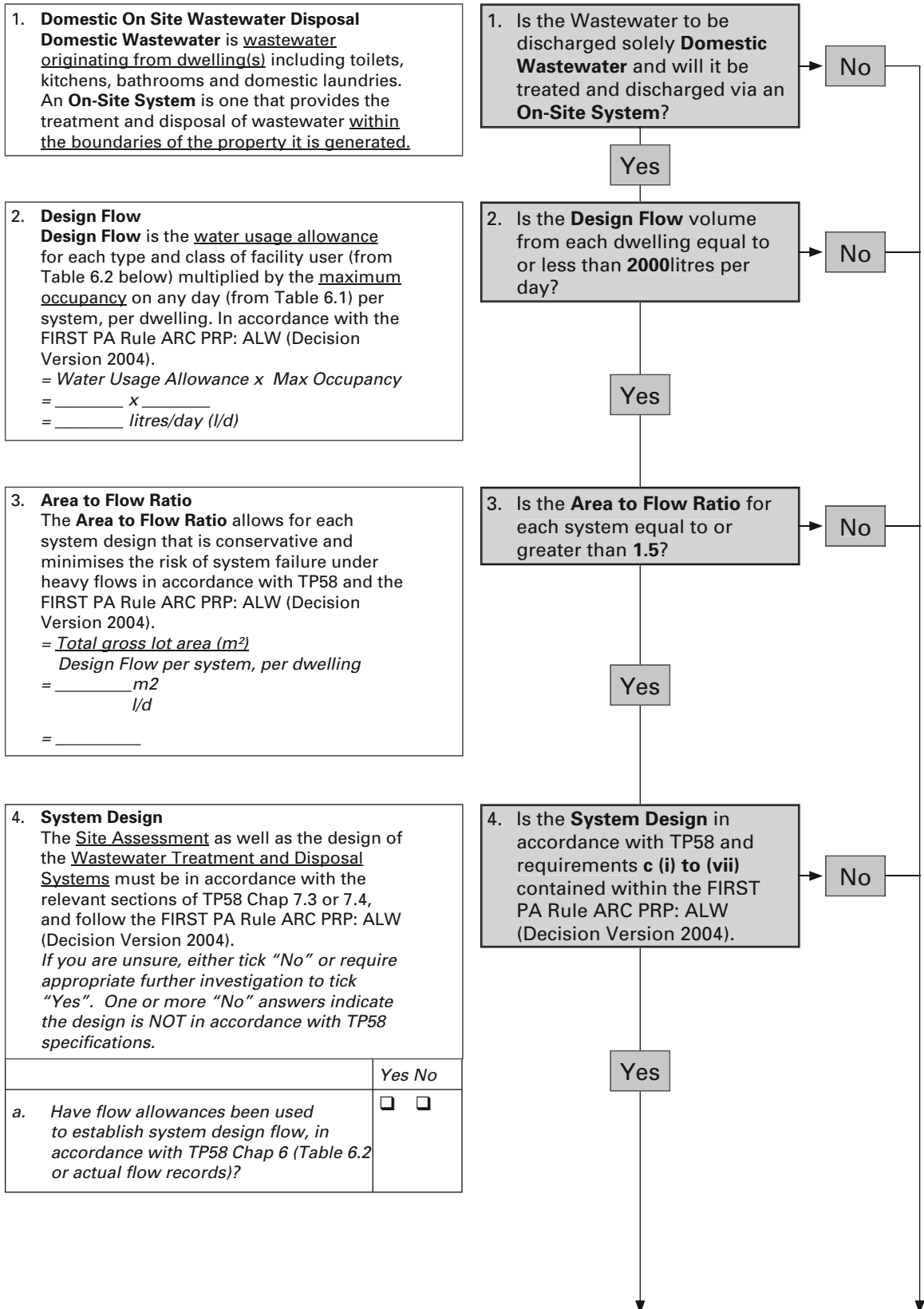
Note:
The FIRST ARC Permitted Activity Rule requires secondary wastewater treatment with pressure compensating drip irrigation. The maximum loading rate allowed in clay soils is no more than 3mm/day, (the predominant soil type in the Auckland region).

Following is a PA Checklist which is an easy check guide for information required by local territorial authorities in the Auckland region for determining compliance with the PA.

Checklist For Determining WHICH ARC PERMITTED ACTIVITY is Required For The On-site Disposal of Domestic Wastewater



Checklist For Determining Compliance With ARC FIRST PERMITTED ACTIVITY For On-site Disposal of Domestic Wastewater (Rule No. 5.5.20 in PRP: ALW, Decision Version 2004 - Sewage Disposal) - NEW SYSTEM & SMALL SITE



On-site Wastewater Systems:
Design and Management Manual (TP 58)

	Yes	No
b. Does the treatment system design include a septic tank and outlet filter (unless the equivalent level of treatment is provided with an aerobic system) in accordance with TP58 (Chap 7.2 and/or 7.3)?	<input type="checkbox"/>	<input type="checkbox"/>
c. Does the disposal system design comprise of drip irrigation in accordance with TP58 (Chap9)?	<input type="checkbox"/>	<input type="checkbox"/>
d. Are discharge quality standards to be achieved per system, in accordance with TP58 (Chap7)?	<input type="checkbox"/>	<input type="checkbox"/>

5. Reserve Area
In accordance with the FIRST PA Rule ARC PRP: ALW Rule (Decision Version 2004) the **Disposal Area** per system must be at least 33% for drip irrigation.
Reserve Area is land maintained available on the site that could be used in future for effluent disposal (Table 5.3).

5. Is the minimum **Reserve Area** allocated as required by Table 5.3 of TP58?

No

Yes

6. Separation Distances
Adequate **Separation Distance** are essential for ensuring that there are no significant adverse effects on the environment, or to human health. *If you are unsure, either tick "No" or require appropriate further investigation to tick "Yes". One or more "No" answers indicate the design is **NOT** in accordance with TP58 specifications and is not environmentally protective.*

6. Do the **Separation Distances** comply with the design specifications and minimum distances specified in TP58?

Consult with the ARC regarding further assessment (Enviroline, ph: 3662000)

Yes

	Yes	No
a. Is the disposal area sufficient separation distance from a surface watercourse?	<input type="checkbox"/>	<input type="checkbox"/>
b. Is the disposal area sufficient separation distance from a water supply bore?	<input type="checkbox"/>	<input type="checkbox"/>
c. Is there sufficient separation distance between the base of disposal bed and ground water?	<input type="checkbox"/>	<input type="checkbox"/>
d. Is there sufficient separation distance between the disposal system and any embankments/retaining walls?	<input type="checkbox"/>	<input type="checkbox"/>

7. Is there a programmed maintenance contract for the system in accordance with supplier's specifications or the requirements of TP58, whichever is the more stringent?

No

Yes

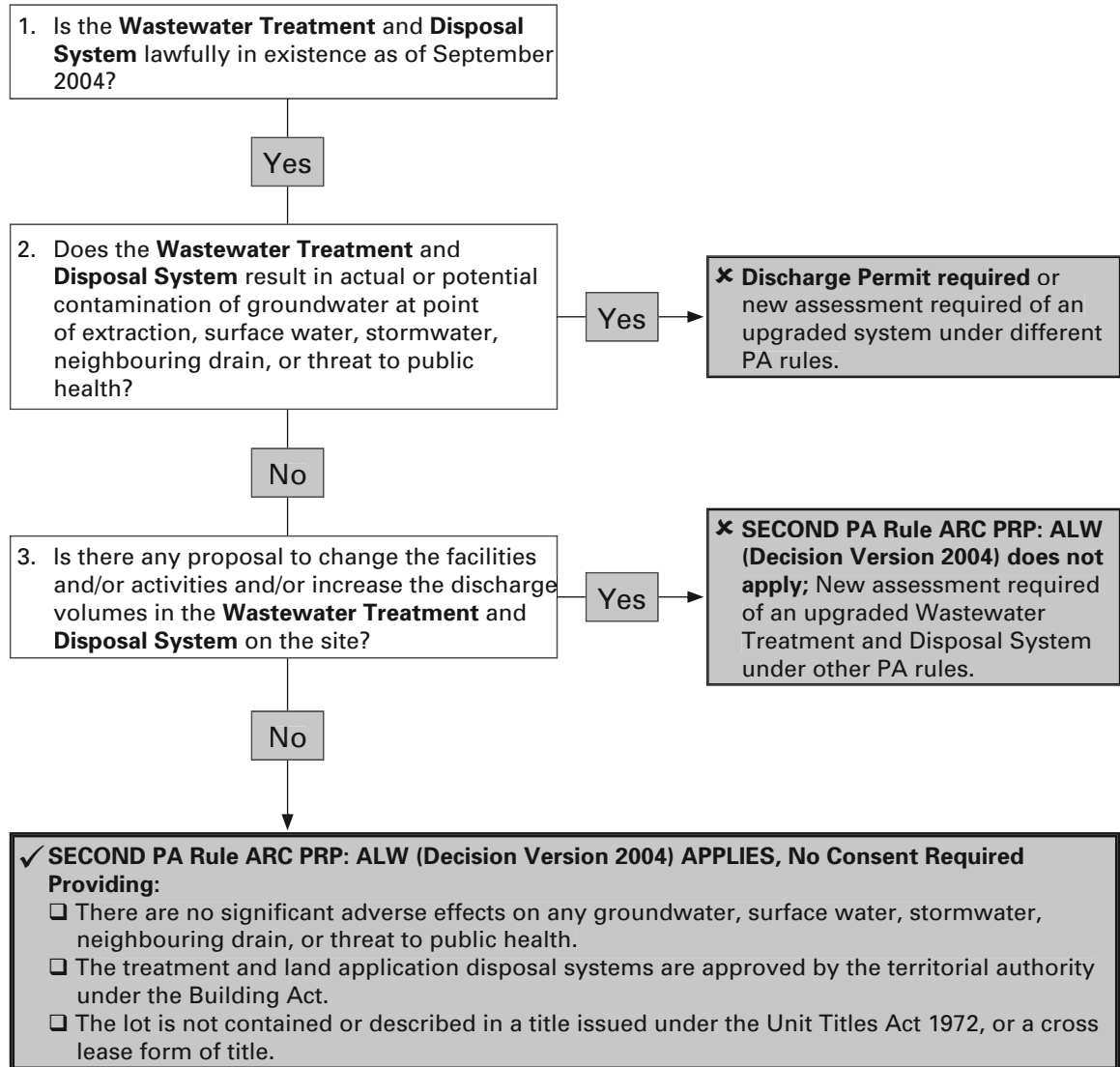
× DISCHARGE PERMIT MAY BE REQUIRED:

	Yes	No
Design details attached	<input type="checkbox"/>	<input type="checkbox"/>
Application form received	<input type="checkbox"/>	<input type="checkbox"/>
Date		

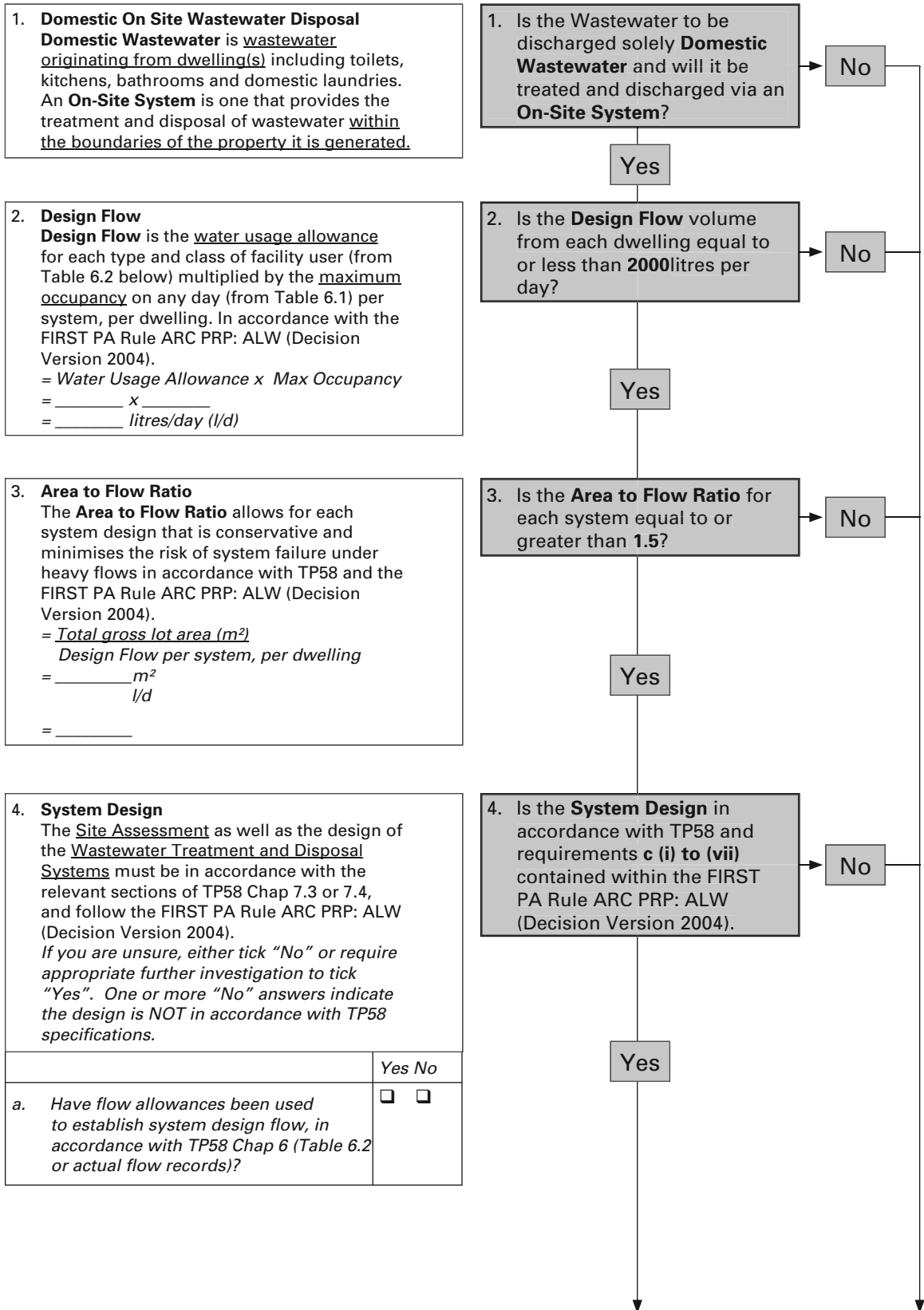
✓ FIRST PA Rule ARC PRP: ALW (Decision Version 2004) APPLIES, No Consent Required Providing:

- There are no significant adverse effects on any groundwater, surface water, stormwater, neighbouring drain, or threat to public health.
- The treatment and land application disposal systems are approved by the territorial authority under the Building Act.
- The lot is not contained or described in a title issued under the Unit Titles Act 1972, or a cross lease form of title.

Checklist For Determining Compliance With ARC SECOND PERMITTED ACTIVITY For On-site Disposal of Domestic Wastewater (Rule No. 5.5.21 in PRP: ALW, Decision Version 2004 - Sewage Disposal) - EXISTING SYSTEM



Checklist For Determining Compliance With ARC THIRD PERMITTED ACTIVITY For On-site Disposal of Domestic Wastewater (Rule No. 5.5.22 in PRP: ALW, Decision Version 2004 - Sewage Disposal) - NO PERMANENT POWER SUPPLY



	Yes	No
b. Does the treatment system design include a septic tank and outlet filter (unless the equivalent level of treatment is provided with an aerobic system) in accordance with TP58 (Chap 7.2 and/or 7.3)?	<input type="checkbox"/>	<input type="checkbox"/>
c. Does the disposal system design comprise of drip irrigation in accordance with TP58 (Chap9)?	<input type="checkbox"/>	<input type="checkbox"/>
d. Are discharge quality standards to be achieved per system, in accordance with TP58 (Chap7)?	<input type="checkbox"/>	<input type="checkbox"/>

5. Reserve Area
In accordance with the FIRST PA Rule ARC PRP:ALW Rule (Decision Version 2004) the **Disposal Area** per system must be 100%. **Reserve Area** is land maintained available on the site that could be used in future for effluent disposal (Table 5.3).

5. Is the minimum **Reserve Area** allocated as required by Table 5.3 of TP58?

No

Yes

6. Separation Distances
Adequate **Separation Distance** are essential for ensuring that there are no significant adverse effects on the environment, or to human health.
If you are unsure, either tick "No" or require appropriate further investigation to tick "Yes". One or more "No" answers indicate the design is NOT in accordance with TP58 specifications and is not environmentally protective.

6. Do the **Separation Distances** comply with the design specifications and minimum distances specified in TP58?

Consult with the ARC regarding further assessment (Enviroline, ph: 3662000)

Yes

	Yes	No
a. Is the disposal area sufficient separation distance from a surface watercourse?	<input type="checkbox"/>	<input type="checkbox"/>
b. Is the disposal area sufficient separation distance from a water supply bore?	<input type="checkbox"/>	<input type="checkbox"/>
c. Is there sufficient separation distance between the base of disposal bed and ground water?	<input type="checkbox"/>	<input type="checkbox"/>
d. Is there sufficient separation distance between the disposal system and any embankments/ retaining walls?	<input type="checkbox"/>	<input type="checkbox"/>

7. Is there a programmed maintenance contract for the system in accordance with supplier's specifications or the requirements of TP58, whichever is the more stringent?

No

Yes

*** DISCHARGE PERMIT MAY BE REQUIRED:**

	Yes	No
Design details attached	<input type="checkbox"/>	<input type="checkbox"/>
Application form received	<input type="checkbox"/>	<input type="checkbox"/>
Date		

✓ THIRD PA Rule ARC PRP: ALW (Decision Version 2004) APPLIES, No Consent Required Providing:

- There are no significant adverse effects on any groundwater, surface water, stormwater, neighbouring drain, or threat to public health.
- The treatment and land application disposal systems are approved by the territorial authority under the Building Act.
- The lot is not contained or described in a title issued under the Unit Titles Act 1972, or a cross lease form of title.

Checklist For Determining Compliance With ARC FOURTH PERMITTED ACTIVITY For On-site Disposal of Domestic Wastewater (Rule No. 5.5.23 in PRP: ALW, Decision Version 2004 - Sewage Disposal) - NEW SYSTEM ON LARGE SITE

1. **Domestic On Site Wastewater Disposal**
Domestic Wastewater is wastewater originating from dwelling(s) including toilets, kitchens, bathrooms and domestic laundries. An **On-Site System** is one that provides the treatment and disposal of wastewater within the boundaries of the property it is generated.

2. **Design Flow**
Design Flow is the water usage allowance for each type and class of facility user (from Table 6.2 below) multiplied by the maximum occupancy on any day (from Table 6.1) per system, per dwelling. In accordance with the FIRST PA Rule ARC PRP: ALW (Decision Version 2004).
= *Water Usage Allowance* x *Max Occupancy*
= _____ x _____
= _____ litres/day (l/d)

3. **Area to Flow Ratio**
The **Area to Flow Ratio** allows for each system design that is conservative and minimises the risk of system failure under heavy flows in accordance with TP58 and the FIRST PA Rule ARC PRP: ALW (Decision Version 2004).
= $\frac{\text{Total gross lot area (m}^2\text{)}}{\text{Design Flow per system, per dwelling}}$
= _____ m² / d
= _____

4. **System Design**
The Site Assessment as well as the design of the Wastewater Treatment and Disposal Systems must be in accordance with the relevant sections of TP58 Chap 7.3 or 7.4, and follow the FIRST PA Rule ARC PRP: ALW (Decision Version 2004).
If you are unsure, either tick "No" or require appropriate further investigation to tick "Yes". One or more "No" answers indicate the design is NOT in accordance with TP58 specifications.

	Yes	No
a. Have flow allowances been used to establish system design flow, in accordance with TP58 Chap 6 (Table 6.2 or actual flow records)?	<input type="checkbox"/>	<input type="checkbox"/>

1. Is the Wastewater to be discharged solely **Domestic Wastewater** and will it be treated and discharged via an **On-Site System**?

Yes

No

2. Is the **Design Flow** volume from each dwelling equal to or less than **2000** litres per day?

Yes

No

3. Is there **Number of Dwellings** within the lot equal to or less than **3**, in accordance with the **FOURTH PA Rule ARC PRP: ALW (Decision Version 2004)**.

Yes

No

4. Is the **Area to Flow Ratio** for each system equal to or greater than **3.0**?

Yes

No

5. Is the **System Design** in accordance with TP58 and requirements **c (i) to (vii)** contained within the **FOURTH PA Rule ARC PRP: ALW (Decision Version 2004)**.

Yes

No

On-site Wastewater Systems:
Design and Management Manual (TP 58)

	Yes	No
b. Does the treatment system design include a septic tank and outlet filter (unless the equivalent level of treatment is provided with an aerobic system) in accordance with TP58 (Chap 7.2 and/or 7.3)?	<input type="checkbox"/>	<input type="checkbox"/>
c. Does the disposal system design comprise of drip irrigation in accordance with TP58 (Chap9)?	<input type="checkbox"/>	<input type="checkbox"/>
d. Are discharge quality standards to be achieved per system, in accordance with TP58 (Chap7)?	<input type="checkbox"/>	<input type="checkbox"/>

5. Reserve Area
In accordance with the FIRST PA Rule ARC PRP: ALW Rule (Decision Version 2004) the **Disposal Area** per system must be 100%. **Reserve Area** is land maintained available on the site that could be used in future for effluent disposal (Table 5.3).

6. Separation Distances
Adequate **Separation Distance** are essential for ensuring that there are no significant adverse effects on the environment, or to human health. *If you are unsure, either tick "No" or require appropriate further investigation to tick "Yes". One or more "No" answers indicate the design is NOT in accordance with TP58 specifications and is not environmentally protective.*

	Yes	No
a. Is the disposal area sufficient separation distance from a surface watercourse?	<input type="checkbox"/>	<input type="checkbox"/>
b. Is the disposal area sufficient separation distance from a water supply bore?	<input type="checkbox"/>	<input type="checkbox"/>
c. Is there sufficient separation distance between the base of disposal bed and ground water?	<input type="checkbox"/>	<input type="checkbox"/>
d. Is there sufficient separation distance between the disposal system and any embankments/retaining walls?	<input type="checkbox"/>	<input type="checkbox"/>

6. Is there 100% Reserve Area per system on the site as required by Table 5.3 of TP58?

No

Yes

7. Do the Separation Distances comply with the design specifications and minimum distances specified in TP58?

Consult with the ARC regarding further assessment (Enviroline, ph: 3662000)

Yes

8. Is there a programmed maintenance contract for the system in accordance with supplier's specifications or the requirements of TP58, whichever is the more stringent?

No

Yes

× DISCHARGE PERMIT MAY BE REQUIRED:

	Yes	No
Design details attached	<input type="checkbox"/>	<input type="checkbox"/>
Application form received	<input type="checkbox"/>	<input type="checkbox"/>
Date	<input type="checkbox"/>	<input type="checkbox"/>

✓ FOURTH PA Rule ARC PRP: ALW (Decision Version 2004) APPLIES, No Consent Required Providing:

- There are no significant adverse effects on any groundwater, surface water, stormwater, neighbouring drain, or threat to public health.
- The disposal area is fenced to prevent heavy vehicle and stock access.
- The treatment and land application disposal systems are approved by the territorial authority under the Building Act.



COMPLIANCE WITH PERMITTED ACTIVITY FOR ON-SITE DISPOSAL OF DOMESTIC WASTEWATER (of ARC Transitional Regional Plan)

'Domestic wastewater' is defined as wastewater generated in domestic dwellings, institutions, commercial and residential facilities, and predominantly originating in bathrooms, kitchens, and laundries.
'On-site wastewater disposal' is the disposal of domestic wastewater to land within the property boundaries of its place of origin.

A. APPLICANT DETAILS

Full Name(s) or Company

Name of the Applicant: _____

Postal Address: _____

Site Address: _____

Telephone: _____

B. PERMITTED ACTIVITY CRITERIA

1. Size of facilities: _____ ; Maximum number of occupants: _____

2. Maximum daily wastewater discharge volume:

No. persons x Water usage allowances/person/day*
_____ x _____ = _____ litres/day

**Use peak flows and maximum number of people ever likely to use facility on any one day.*

Is daily wastewater discharge volume less than 2000 litres per day? YES NO

3. Area to Discharge Volume ratio = $\frac{\text{area of disposal site (m}^2\text{)}}{\text{discharge volume}}$
= $\frac{\text{m}^2}{\text{L/d}}$ = _____

Is the Area to Discharge Volume ratio greater than 1.5? YES NO

4. Type of wastewater treatment system proposed (details): _____

5. Type of wastewater disposal/land application system proposed (details): _____

6. Reserve area allocated for disposal system to increase in size by at least: _____ %*

**Refer to consent officer if < 33% for drip irrigation (Nb. 50% required for some loading rates)*

**Refer to consent officer if < 100% for trenches*

7. Wastewater pre-treatment and disposal system is in accordance with Technical Publication. 58, "On-Site Wastewater Systems Design and Management Manual." (TP58) YES NO

8. Distance from edge of disposal system to nearby surface water: _____ meters*

**Refer to consent officer if < 20 meters*

9. Depth from base of disposal system to winter groundwater table: _____ meters*

**Refer to consent officer if groundwater depth < 1m for primary treated effluent and 0.6m for secondary treated effluent.*

10. Is there any risk of pollution to any natural waters? YES NO

11. Does the proposal comply with Permitted Activity criteria? YES NO

12. Are the Site Assessment Details provided? YES NO

13. Are the Design Plans and Design Report provided? YES NO

ARC/TA Officer Name: _____

Signature: _____ Date: _____

**C. ADDITIONAL ARC DESIGN REQUIREMENTS TO BE A PERMITTED ACTIVITY
(TO BE CONFIRMED BY ARC OFFICER)**

- Stormwater drains upslope
- Water reduction fixtures on all water outlets
- Water meter to be installed to monitor actual water usage
- Alarm System to be installed to activate in event of pump failure
- 24 hour emergency storage available within system in event of pump failure
- Increased topsoil depth
- Disposal method has been approved by the _____ Council and necessary permits have been issued in accordance with the Drainage and Plumbing Regulation 1978.
- Other _____

ARC/TA Officer Name:

Signature: _____ **Date:** _____

Appendix D

ARC Technical Sheets - Soil Assessment and Land Disposal System Designs

Auckland Regional Council Technical Sheet D-1

ASSESSMENT OF SOIL CHARACTERISTICS

FORMATION OF SOILS

Soils are formed as a result of weathering of the parent material from which they are derived. Five key factors determine the nature of the soil profile at any location:

The type of parent material (which determines soil physical and chemical properties).

Climate, particularly rainfall and seasonal temperature fluctuations, as these affect the rate and extent of weathering, and also the accumulation and breakdown of organic matter in the soil.

Living matter such as vegetation and micro-organisms which have significant influence on the weathering process and contribute to the organic content of soil.

Topography influences the effects of climate; elevated sloping areas drain better than low lying flat locations; slopes with a northern aspect have higher soil temperatures than those with a southern aspect; steepness affects erosion and deposition of soil layers.

Soil age effects soil profile; older soils have well developed profiles compared to younger soils (the soil forming process evolves over thousands of years of geological time, it being estimated that approximately one hundred years of weathering is required to accumulate 25mm of soil from a parent material).

SOIL TYPE AND PROFILE

The two main types of soils are “mineral” and “organic”. Mineral soils, are mainly weathered parent material with a small proportion of decayed plant and animal matter. For example, a silt loam soil suitable for plant growth would consist of 45% mineral particles, 5% organic matter 25% air and 25% water (by volume). Organic soils are those consisting of mainly decayed plant material such as occurs in swamps, bogs, marshland or peat lands.

The soil profile consists of the mainly unconsolidated material at the land surface which is utilized for growing crops and supporting structures, and which assimilates and transmits rainfall and constituents of wastes from animal and human activity. Three significant layers make up the soil profile.

The A Horizon; comprises the uppermost layer of most weathered material in which the bulk of the physical, chemical and biological activity in the soil takes place.

The B Horizon; is a transitional layer to which the very fine particles resulting from weathering will migrate and accumulate (e.g. clays).

The C Horizon; is the unweathered layer which most resembles the original parent material from which the soil has been formed, and as such is the zone of least activity in the soil.

In any soil situation the actual soil profile may be made up of a range of horizons as affected by the time history of soil formation and the combination and dominance of the five soil forming factors outlined above.

SOIL TEXTURE

Texture is determined by the proportions of the three principal mineral size fractions in soil – these fractions are clay, silt, and sand. The United States Department of Agriculture (USDA) classification of size fractions are the most commonly utilised in on-site wastewater practice. The USDA textural classification (Figure D1) is based upon the following particle size ranges:

Fraction Particle Diameter mm

Clay	less than 0.002
Silt	0.002 to 0.05
Very fine sand	0.05 to 0.10
Fine sand	0.10 to 0.25
Medium sand	0.25 to 0.50
Coarse sand	0.50 to 1.00
Very coarse sand	1.00 to 2.00
Fine gravel	> 2.00

Either laboratory sieve analysis or a field method based upon “feel” of the soil can be used to determine texture. The following explanation of the “feel method” is taken from guidelines prepared by the University of Minnesota Agricultural Extension Service.

First, a large marble-sized portion of soil is moistened and then kneaded by hand until it has the consistency of putty. Then, the ball of soil is squeezed between thumb and forefinger so that by pushing the thumb forward over the forefinger a ribbon of soil is formed. The nature of any ribbon that forms (or does not form) indicates the soil textural class. Six general textural classes can be readily distinguishable by this technique –

Clay: Fine-textured soil that usually forms hard lumps or clods when dry and is quite plastic when wet. It can be very sticky when wet. When moist it can be squeezed into a long flexible ribbon. A clay soil leaves a “slick” surface when rubbed with a long stroke and firm pressure. Clay also tends to hold thumb and forefinger together due to its stickiness.

Clay Loam: Fine textured soil which usually breaks into clods or lumps that are hard when dry. When moist soil is squeezed, it will form a thin ribbon which will break readily, barely sustaining its own weight. The moist soil is plastic and will form a cast which will bear more handling. When hand kneaded it does not crumble readily, but tends to become a heavy, compact mass.

Silt Loam: When dry, may appear quite freely cloddy, but lumps are readily broken; when squeezed, it feels soft and floury. When wet, the soil readily runs together. Either dry or moist, it will form casts which can be handled freely without breaking, and when moistened and squeezed, it will not ribbon, but will have a broken effect.

Loam: Has a relatively even mixture of sands, silt and clay. A loam feels somewhat gritty, yet fairly smooth and highly plastic. Squeezed when moist, it will form a cast which can be handled quite freely without breaking, and it will not form a ribbon.

Sandy Loam: Contains much sand, but has enough silt and clay to make it somewhat sticky. Individual sand grains can be seen readily and felt. Squeezed when dry, it will form a cast which will fall apart. Squeezed when moist it will form a cast which will bear careful handling without falling apart.

Sandy: Loose and single grained. The individual grains can be readily seen or felt. Squeezed in the hand when dry, it will fall apart when the pressure is released and will not form a ribbon. Squeezed when moist, it will form a cast, but will crumble when the pressure is released.

Soil texture influences its permeability, aeration potential, and capacity to store water and nutrient salts, all of which affect the soils’ ability to assimilate and rejuvenate wastewater components. Soil texture thus has a significant influence on determining design loading rates for on-site systems.

SOIL STRUCTURE

The hydrologic conductivity of a soil is significantly affected by the structure of a soil. By structure is meant the aggregation of soil mass into lumps known as "peds" which can be separated from each other by hand. The surfaces of "peds" will be planar in nature and void spaces between "peds" influence the passage of water through the soil, particularly in clayey soils. Common soil structural elements are "prismatic", "columnar", "blocky", "platy", and "granular". Structure may have a more significant effect on water movement in the soil than texture. For example "platy" structures are resistant to vertical water movement, but facilitate horizontal movement. "Blocky" structure in clay soils during dry weather shrinkage can provide high vertical transmission rates, but when wetted and swelled, will resist passage of water. Granular soils tend to be structureless and water movement is solely a function of texture. Aeration of subsoil is also affected by structure as is natural drainage through the subsoil.

WATER TABLE DETERMINATION

Soil colour and colour patterns are a good indication of the drainage characteristics of a soil and the seasonal variation in water table. Colour is influenced by the primary soil nature, the level of iron and manganese oxides present, and any organic content. Well drained soils above the water table are generally uniformly red, yellow, or brown in colour. Soils permanently (or nearly permanently) saturated are usually grey or blue in colour. Soils subjected to seasonal saturation can be speckled with different colours, known as mottles. Mottles indicate zones of saturated soil under winter conditions when complex biochemical reactions leach solubilised iron and manganese oxides from the soil, turning it grey in patches. Hence mottled soil under unsaturated conditions indicates periodic saturation. It should be noted, however, that not all soils show mottles under saturation, and landscape position and other soil characteristics may be needed to properly interpret the local situation.

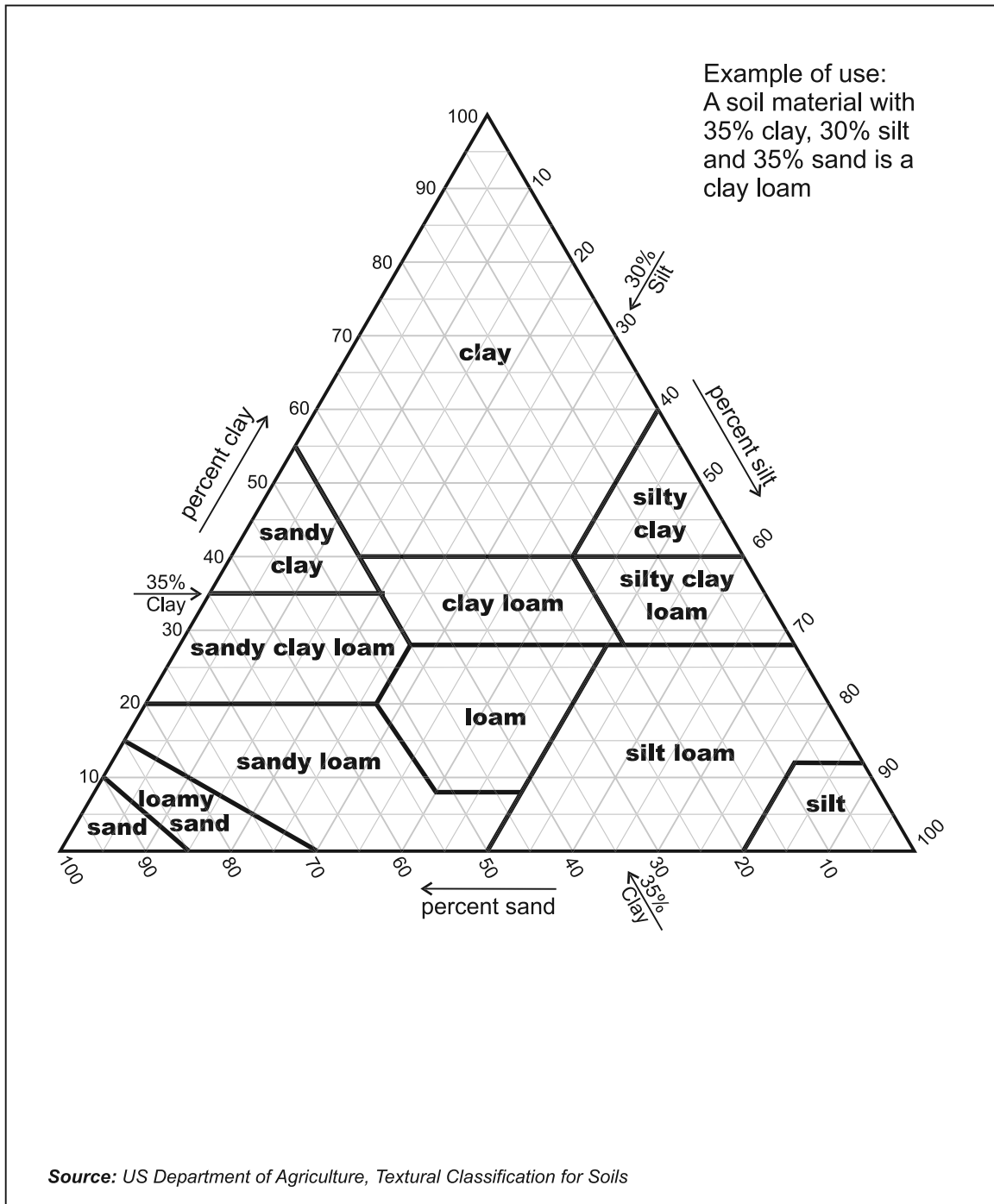
Hence, although the water table depth may be fixed by borehole investigation, that result must then be interpreted relative to the season of the year, the degree of soil mottling from the soil profile, and landscape position.

SELECTION OF SOIL CATEGORY

The estimation of soil category for design purposes (Section 5.4 of TP 58 & Section 4.3 of Appendix E) should be made on the basis of textural and structural assessment of the soil profile along with all other relevant site information. Traditional on-site practice has been to identify a suitable permeable layer of subsoil at depth below the A Horizon and to construct media filled trench (or bed) systems to load ponded effluent through the base of the trench (or bed) system.

It is now recognised that the biologically active A Horizon provides better opportunity for assimilation of effluent organic matter and nutrient salts while at the same time taking advantage of the infiltration and percolation capacity of the underlying subsoil, and the evapo-transpiration potential of planted vegetation. Design techniques which utilise the KISS (keep infiltration systems shallow) approach can take advantage of the disposal capacity of the upper soil/topsoil layer and match the selection of soil category for proposed disposal purposes with the design approach.

Figure D1: US Department of Agriculture Textural Classification for Soils



Auckland Regional Council Technical Sheet D-2 DETERMINING DESIGN INFILTRATION AREAS

Calculating Design Infiltration Areas

The design loading area requirements for the various land disposal systems depend on the soil type, the system best suited to the site and environmental constraints identified by the site investigation. There are three design area loading options, areal loading, basal loading and sidewall loading as detailed in the following sections.

1. AREAL LOADING

The areal loading concept comprises the entire irrigation area including that between the distribution lines and within the topsoil for maximisation of evapotranspiration and seepage. The intention is to distribute treated wastewater over the entire area available for assimilation by the soil. Areal loading is used to calculate land disposal area requirements for Pressure Compensating Dripper irrigation systems and Low Pressure Pipe (LPP & LPED) irrigation systems. The designer must adjust area and/or linear length of irrigation lines where the line spacing where the irrigation line separation distance is not equal to 1.0m as detailed below.

The land disposal area and linear length of lines can be calculated using the following method:

Areal Application Area Calculation	
Design Land Disposal Area (m ²) =	$\frac{\text{Maximum Daily Wastewater Flow (litres/day)}}{\text{Design Land Disposal Rate (litres/m}^2\text{/d)}}$
DESIGN EXAMPLES	
Design Land Disposal Area of 140m ² =	$\frac{700 \text{ l/d}}{5 \text{ litres/m}^2\text{/d}}$
Linear Length of Lines Required for 140 square metres Land Disposal Area (depends on line)	
<i>Lines at 1.0 metre centres (within a 140 square metres disposal area)</i> 140 linear metres =	$140\text{m}^2 \times 1.0\text{m} = 140\text{m}$
<i>Lines at 0.5 metre centres (within a 140 square metres disposal area)</i> 280 linear metres = This is twice the linear length to achieve the 5 litres/m ² /day areal loading rate	$\frac{140 \text{ m}^2}{0.5 \text{ m}} = 280\text{m}$
<i>Lines at 1.5 metre centres (requires a 210 square metres disposal area to achieve the minimum of 140 linear metres of line)</i> 140 linear metres requires an area of 210 square metres	Effective irrigation area = $140\text{m}^2 \times 1.5 = 210 \text{ m}^2$

The designer must be aware that when the irrigation line spacing is reduced to less than 1.0m the effective land disposal area must be maintained the same as if the line spacing were at 1.0m. Reducing the irrigation line spacing results in a reduction in land disposal area and therefore increases the effective areal loading rate and requires an increase in overall irrigation line length to maintain the design areal loading rate as expressed in litres per square metre per day. In the event that irrigation lines are placed at more than 1.5m centres the designer must increase the land disposal area by an equivalent amount to accommodate the linear length of lines that would be require for a system at 1.0m centres.

2. BASAL LOADING

The design land disposal area only comprises the basal area of the trench, bed or mound excluding the area between the trenches/mounds/beds. The design loading rate used for calculating the basal area requirements is determined by the designer based on the soil type and site constraints (Tables 10.2, 10.3 and 10.7 for trenches, beds and mounds respectively).

The land disposal area required is calculated by the following method:

Basal Application Area Calculation	
Basal Application Area (m ²) =	$\frac{\text{Maximum Daily Wastewater Flow (litres/day)}}{\text{Design Land Disposal Rate (litres/m}^2\text{/d)}}$
DESIGN EXAMPLE	
Basal Application Area 70m ²	$\frac{700 \text{ l/d}}{10 \text{ litres/m}^2\text{/d}}$

3. SIDEWALL LOADING

Sidewall loading is only used for design of narrow and deep trenches within free draining Category 2 and 3 soils where there is a winter groundwater separation of at least 600mm below the base of the trench. The design soakage area includes both sides of the trench. The base of the trench is ignored in the calculation.

Deep Trench Sidewall Loading Design	
Sidewall Area Required (m ²) =	$\frac{\text{Maximum Daily Wastewater Flow (litres/day)}}{\text{Design Land Disposal Rate (litres/m}^2\text{/d)}}$
Total Trench Length Required =	$\frac{\text{Sidewall Area (m}^2\text{)}}{\text{Available Sidewall Depth (m) x 2}}$
DESIGN EXAMPLE	
Sidewall Area Required 35m ² =	$\frac{700 \text{ l/d}}{20 \text{ l/m}^2\text{/d}}$
Total Trench Length Required 17.5 linear metres =	$\frac{35 \text{ m}^2}{1 \text{m x 2}}$
Note: <i>The trench depth is multiplied by 2 to allow for both sides of the trench providing an infiltrative surface and therefore halving the total length of trench required.</i>	

The distribution bed area and basal infiltration area for flat and sloping sites are calculated using the following procedure. The mound should be more rectangular in shape for Category 3 & 4 soils and can be square for Category 1 & 2 soils.

4. MOUND BASAL LOADING DESIGN

MOUND DESIGN SIZING CRITERIA	
Distribution Bed Coarse Media (20 – 60mm diameter)	Loading rate based on sand fill media. [Note 1]
Sand Media Loading Rate D10 0.3 – 0.5 UC = 1 – 4 [Notes 2 & 3]	30mm/d for Primary Effluent[Note 4] 50mm/d for Secondary Effluent
Basal Soil Loading Rate Soil Category 1 – 2 Soil Category 3 – 4	35mm/d 12mm/d
Mound Toe Maximum Linear Loading Rate	Max 50mm/linear metre/day
Notes: 1. Distribution media loading rate is determined by sand fill media sizing, distribution media is to provide for even distribution of applied wastewater across the sand fill infiltrative surface. 2. D10 refers to the effective grain size that is 10% size by weight for a wet sieve analysis 3. UC is uniformity coefficient defined by the D_{60}/D_{10} . 4. The application of primary treated effluent into the gravel distribution bed can result in clogging by biomat/clogging mat of the sand fill infiltration surface if the loading rate is too high. Finer fill will require lower application rates	

MOUND DIMENSIONS: FLAT SITES	
Distribution Bed	Typically 1200 to 2000mm wide
Basal infiltration area	Width x Length (W x L) Side slopes max 1 in 3 gradient End slopes max 1 in 3 gradient
MOUND DIMENSIONS: SLOPING SITES	
Distribution Bed	Typically 1200 to 2000mm wide
Basal Infiltration Area including mound toe	$[(B) \times (J + A)]$ Only includes the area below and downslope of the distribution bed. J minimum is 2000mm
Notes: See Figures 10.6 and 10.7 for mound dimensions	

5. DESIGN EXAMPLE FOR A FLAT SITE

Following is a worked example taken from the USEPA Design Manual 1980 for calculating mound dimensions with minor modifications. See Figures 10.6 and 10.7 for definition of bed dimensions.

Wisconsin Mound Design Example

Soil Type	Category 4
Site slope	6%
Wastewater Flow	1,700 l/d

STEP 1

Select a suitable site for locating the mound and pick the best site.

STEP 2

Select the fill media material. If finer size sand is used than the recommended size the loading rate must be reduced.

STEP 3

Estimate the design wastewater flow volume (refer TP58 Section 6).

Step 4 Calculate The Distribution Bed Dimensions				
	Size The Distribution Bed	<u>Daily Wastewater Flow</u> Distribution Bed Loading Rate	<u>1,700 l/d</u> 50 l/m ² /d	Distribution Bed Area = 34m²
	Calculate The Distribution Bed Dimensions	Bed Width (A) = <u>Distribution bed area</u> Assume (B) 20m length	<u>34m</u> 20m	A = 1.7m B = 20.0m
Step 5 Calculate The Mound Dimensions				
	a) Mound Height	i). Fill Depth (D) ii) Fill Depth (E) E = D + [(slope) x (A)] iii) Bed Depth (F) iv) Cap at edge of bed (G) v) Cap at centre of bed (H)	D = Figure 10.6 E = 0.600 + [0.06 x 1.7] F = Figure 10.6 G = Figure 10.6 H = Figure 10.6	D = 600mm min E = 700mm (min 600mm) F = 225mm G = 300mm H = 450mm
	b) Mound Perimeter	(I) is the area below and downslope of the distribution bed on sloping site must be sufficiently large to absorb the wastewater. Select soil infiltration rate (see table above).	Soil Loading Rate Category 4 soil	Soil Loading Rate = 12mm/day
	i) Downslope setback (I)			
	ii) Upslope Setback (J)	(J) Height at upslope end J = [(D) + (F) + (G)] x (3)	$[(0.60) + (0.225) + (0.30)] x (3)$	J = 3.4m
	iii) Side Slope Setback (K)	(K) = (Mound Height at centre of bed) x (3:1 slope) $\frac{[(D) + (E) + (F) + (H)] x 3}{2}$	$\frac{[(0.6) + (0.7) + (0.225) + (0.45)] x 3}{2}$	K = 4.0m
	iv) Basal Area Required	Basal Area = (B) x [(I) + (A)]	<u>1700 litres</u> 12mm/d	Basal Area = 142m²
	Basal Area Required		(I) + (A) = $\frac{142}{(B)}$ (I) = $\frac{142 - A}{B}$ = $\frac{142}{20} - 1.7$	= I = 5.4m
		Check that the downslope setback (I) is sufficient so as not to exceed a 3:1 slope $[(E) + (F) + (G)] x 3$	$[0.70) + (0.225) + (0.300)] x 3$	= 3.7m OK
		As the distance to maintain a 3:1 slope is less than the distance needed to provide sufficient basal area, (I) = 5.8m Mound Length (L) = (B) + 2 (K)	(20) + 2(4.0)	Mound Length (L) = 28m
		Mound Width (W) = (J) + (A) + (I)	3.4 + 1.7 + 5.8	Mound Width (W) = 11m

Summary

The methods for determining the area requirements for commonly installed land disposal systems are listed in the table below.

Table D2 – Method for Calculating Design Area for Types of Land Disposal Systems

Land Disposal System	Design Area Calculation Method
Pressure Compensating Dripper Irrigation	Areal Loading
LPP and LPED	Areal Loading
Beds (ASB and ETS)	Basal Loading
Mounds	Basal Loading
Shallow Trenches	Basal Loading
Discharge Control Trenches	Basal Loading
Narrow Deep Trenches	Sidewall Loading
<p>Note:</p> <ol style="list-style-type: none"> 1. Mound design loading to include separate distribution area and on sloping sites toe design loading in addition to basal loading. 2. Discharge control trenches to be used for Category 1 soils. 3. Deep trenches only suitable for Category 2 & 3 soils 4. Standard trenches not suitable for Category 6 & 7 soils. 	

Auckland Regional Council Technical Sheet D-3 PRACTICALITIES OF CONSTRUCTING LAND DISPOSAL SYSTEMS

The following criteria are common issues to all land disposal system installations.

DRAINAGE CONTROLS

It is most important that groundwater and surface water flows should be diverted away from on-site land application areas. Groundwater cut off drains (TP 58 Figure 4.1) should be of adequate depth to control groundwater movement and if necessary lower the watertable to an appropriate depth underneath the land-application area. Care is required to ensure subsurface short-circuiting of wastewater into the groundwater cut-off drain is avoided. Surface water collectors should be either grassed swales or half tiles which capture overland flow and divert it away. However limitations imposed by a perched water table or poorly drained soils may not be solved through the installation of subsoil groundwater cut off drainage.

CONSTRUCTION REQUIREMENTS

Where a new type of on-site wastewater land-application system that is unfamiliar to the installer or drainage contractor is to be constructed, it is most important that sufficient construction guidance and supervision is provided to the parties charged with installing the system to ensure that the finished construction is compatible with design objectives. The installer should understand the design and proposed functions of the systems they are constructing as all the refinements of design can be compromised by inadequate construction techniques, which will then condemn a new design approach to early failure. The installation/construction specifications for installing any type of on-site system should include (inter alia) coverage of following matters:

- i. Never carry out excavation when the subsoil is wet and likely to smear during use of construction equipment. In plastic soils the moisture content must be below the plastic limit. If soil at the design depth forms "ribbons" when rolled in the hand, it is too wet. If it crumbles construction may proceed.
- ii. Any smeared infiltrative surfaces that do occur, should be dug over by hand to prepare the surface.
- iii. Avoid moving heavy machinery over both the land-application system and the spaces between the beds, trenches, etc. Any heavy equipment used should be carefully deployed to minimise ground contact pressures.
- iv. Cover excavations during rainfall to protect open infiltrative surfaces from smearing.
- v. Backfilling with sand and media should be carried out with care to retain the integrity of infiltrative surfaces.
- vi. All land-application area bases should be excavated level over their full length to prevent effluent ponding locally within the system. Distribution lines should also be laid level, or at a slight slope (1 in 200) if the system is longer than 15m. This is not a requirement for pressure compensating dripper irrigation systems.
- vii. Topsoil cover over land-application areas should be mounded over narrow trenches or spread uniformly over mounded fill in bed or wide trench systems, then carefully compacted by hand and sown immediately with grass.
- viii. Where ET plantings are to be a feature of the design, grass should be sown immediately and then followed by the planting programme. The ETS or ET land-application system should then be commissioned forthwith to provide both nutrient and liquid to assist rapid establishment of the supportive ground cover.
- ix. Pressure distribution systems should be laid in place within the excavated land-application area, and pump tested with clean water to ensure that the design process has achieved even distribution. Minor adjustments to hole spacing and valve settings can be then made and tested again before the system is backfilled.
- x. Dripper lines need to be marked if planting is to occur at a later date.

Auckland Regional Council Technical Sheet D-4

LAND DISPOSAL SYSTEM SUITABILITY VS SOIL CATEGORY

There are a range of land disposal methods available for the designer to implement and the use of which will be determined firstly by soil category and then by site specific constraints. The site evaluator must first determine if the site is suitable for onsite land disposal of wastewater following the procedure specified in TP 58 Section 5 and identify Soil Category, site constraints (e.g. slope, aspect) and environmental constraints (e.g. groundwater, surface water) before determining the most appropriate land disposal method. Having determined on-site land disposal of wastewater is appropriate and identified the environmental constraints the designer must identify the wastewater land disposal system that is most appropriate for the site constraints. Table TS 5-1 below correlates the soil categories with the applicable land disposal systems but not take into account wastewater quality or environmental constraints. Table TS5-2 correlates Soil Category with land application system suitability and wastewater loading rates.

Table TS 5-1: Soil Category and Applicable Land Disposal Method

Land Disposal Method	Soil Category						
	1 Gravel Coarse Sand Rapid draining	2 Coarse to Medium Sand Free Draining	3 Medium Fine and Loamy Sand Good Drainage	4 Sandy Loam and Silt Loam Moderate Drainage	5 Sandy Clay Loam Mod to Slow Drainage	6 Non-swelling Clay and Silty Clay Slowly Draining	7 Swelling Clay Poorly or Non draining
Pressure Compensating Drip Irrigation	Note 1						Note 2
LPP/LPED Shallow Trenches	Note 3	Note 3	Note 3				
Discharge Control Trench							
Narrow Deep Trenches		Note 4	Note 4				
Conventional Trenches							
Conventional Beds	Note 5						
ASB/ETS Beds							
Mounds							
Bottomless Sand Filter							
Infiltration Systems	Note 6	Note 6					

Notes:

1. PCDI becomes distribution method within a discharge control trench.
2. Specific design required within Category 7 soils.
3. LPED becomes a distribution method within Category 1 to 3 soils.
4. Assumes there are no environmental or site constraints.
5. Conventional beds design to be modified to a discharge control bed in Category 1 soils.
6. Assumes there are no environmental or site constraints.

Table TS5 – 2: Summary of Land Disposal Methods and Recommended Loading Rates vs Soil Category

Soil Category	Land Disposal Method										
	PCDI Drip Irrigat'n	Conventional Trench		LPP/ LPED	Discharge Control Trench	Deep Trench	Conventional Bed		ASB / ETS Bed	Wisconsin Mound	Bottomless Sand Filter
	Areal Loading Rate (mm/day)	Most Conservative Basal Loading Rate (mm/day)	Least Conservative Basal Loading Rate (mm/day)	Areal Loading Rate (mm/day)	Basal Loading Rate (mm/day)	Sidewall Loading Rate (mm/day)	Most Conservative Basal Loading Rate (mm/day)	Least Conservative Basal Loading Rate (mm/day)	Basal Loading Rate (mm/day)	See Design Method (mm/day)	Basal Loading Rate (mm/day)
1	35 – 50 Note 1	35 Note 3	50 Note 3	Note 5	20- 25	Note 8	30 Note 10	40 Note 10	Note 12	32	50 – 70
2	25 Note 2	25	35	Note 5	Note 7	35	20	30	Note 12	32	35 – 50
3	1 – 20 Note 2	20	30	Note 5	Note 7	20	15	20	Note 12	12	Note 14
4	5	15	20	5	Note 7	Note 9	10	15	15	12	Note 14
5	3 – 4	5	10	3	Note 7	Note 9	Note 11	Note 11	8 to 10	Note 13	Note 14
6	2 – 3	Note 4 No	Note	Note 6	Note 7	Note 9	Note 11	Note 11	5	Note 13	Note 14
7	2 or less	Note 4	Note 4	Note 6	Note 7	Note 9	Note 11	Note 11	Note 12	Note 13	Note 14

Notes:

1. Pressure Compensating Dripper Irrigation a distribution method in Category 1 soils in conjunction with a discharge control trench or similar.
2. PCDI used as a distribution method.
3. Discharge control trench to be used in place of conventional trench in Category 6 & 7 soils.
4. Conventional trenches not suitable in Category 1, 2 & 3 soils.
5. PP/LPED a distribution method in Category 1, 2 & 3 soils.
6. LPP/LPED shallow trenches not suitable for Category 6 & 7 soils
7. Discharge control trench not suitable in Category 2, 3, 4, 5, 6, 7 soils
8. Deep trenches not suitable for Category 1 soils.
9. Deep trenches not suitable for Category 4, 5, 6, 7 soils.
10. Conventional Bed to be modified to a Discharge Control Bed in Category 1 soil.
11. Conventional Beds not suitable for Category 5, 6 & 7 soils
12. ASB/ETS not suitable for Category 1, 2, 3 or 7 soils.
13. Wisconsin mounds not suitable for Category 5, 6 & 7 soils.
14. Bottomless Sand Filter not suitable for Category 3, 4, 5, 6 & 7 soils.
15. Shaded boxes indicate specific limitations.

Appendix E

On-site Wastewater Disposal Site Evaluation Investigation Checklist

On-site Wastewater Disposal Site Evaluation Investigation Checklist

PART A: Contact Details

1. Applicant Details:

Applicant Name	Please click here and type your name		
Company Name			
	First Name(s)	Surname	
Property Owner Name(s)			
Nature of Applicant*			

(* i.e. Owner, Lessee, Prospective Purchaser, Developer)

2. Consultant/Site Evaluator Details:

Consultant/Agent Name				
Site Evaluator Name				
Postal Address				
Phone Number	Business		Private	
	Mobile		Fax	
Name of Contact Person				
E-mail Address				

3. Are there any previous existing discharge consents relating to this proposal or other waste discharge/disposal on the site?

Yes No

If yes, give Reference Number(s) and Description

--

4. List any other consents in relation to this proposal site and indicate whether or not they have been applied for or granted.

If so, specify Application Details and Consent No.):

(e.g. Land Use, Water Take, Subdivision, Earthworks Stormwater Consents)

--

PART B: Property Details

1. Property for which this application relates:

Physical Address of Property	
Territorial Local Authority	
Regional Council	
Legal Status of Activity	Permitted: <input type="checkbox"/> Controlled: <input type="checkbox"/> Discretionary: <input type="checkbox"/>
Relevant Regional Rule(s) [Note 1]	
Total Property Area (m ²)	
Map Grid Reference of Property [Note 2]	
Notes: 1. In the Auckland Region, the relevant Permitted Activity criteria is as specified in the ARC Proposed Regional Plan: Air Land and Water (ARC: ALWP) Decision Version October 2004 Rule 5.5 20-23 (refer Appendix C and in particular C5, in TP58). 2. NZMS 260 series, scale 1:50,000	

2. Legal description of land (as shown on Certificate of Title):

Lot No.		DP No.		CT No.	
Other (specify)					

Please ensure copy of Certificate of Title is attached.

PART C: Site Assessment – Surface Evaluation

(Refer TP58 – Sn 5.1 General Purpose of site Evaluation and Sn 5.2.2(a) Site Surface Evaluation)
Note: Underlined terms defined in Table 1, attached

1. Has a Desk Study been undertaken for this property

Yes No (Please tick one)

If yes, please specify the findings of the Desk Study, and if not please specify why this was not considered necessary.

--

2. Has a Slope Stability Assessment been carried out on the property?

Yes No (Please tick one)

If No, why not?

--

If Yes, please give details of report (and if possible, please attach report):

Author:	
Company/Agency	
Date of Report	
Brief Description of Report Findings	

3. Site Characteristics (See Table 1 attached):

Provide descriptive details below:

Performance of Adjacent Systems:
Estimated <u>Rainfall</u> and Seasonal Variation:
Vegetation Cover:
Slope Shape:
Slope Angle:
Surface Water Drainage Characteristics:
Flooding Potential: YES/NO
If yes, specify relevant flood levels on appended site plan, i.e. one in 5 year and/or 20 year and/or 100 year return period flood level, relative to disposal area.
Surface Water Separation:
Site Clearances (Provide general description and specific dimensions in Part 6 below and in Site Plan :
Site Characteristics:

4. Site Geology of the subject property

--

Geological Map Reference Number	
---------------------------------	--

5. What Aspect(s) does the proposed disposal system face (please tick)?

North	<input type="checkbox"/>
North-West	<input type="checkbox"/>
North-East	<input type="checkbox"/>
East	<input type="checkbox"/>

West	<input type="checkbox"/>
South-West	<input type="checkbox"/>
South-East	<input type="checkbox"/>
South	<input type="checkbox"/>

6. Site clearances, which should also be shown on the site plan:

Separation Distance from	Treatment Separation Distance (m)	Disposal Field Separation Distance (m)
Boundaries		
Surface water		
Groundwater		
Stands of Trees/Shrubs		
Wells, water bores		
Embankments/retaining walls		
Buildings		
Other (specify):		

PART D: Site Assessment – Subsoil Investigation

(Refer TP58 – Sn 5.1 General Purpose of Site Evaluation, Sn 5.2.2(b) Site Surface Evaluation and Sn 5.3 Subsurface Investigations)

Note: *Underlined terms defined in Table 2, attached*

1. Please identify the soil profile determination method:

Test Pit		(Depth____m)		No. of Test Pits	
Bore Hole		(Depth____m)		No. of Bore Holes	
Other (specify)					
Soil Report Attached?	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	(Please Tick)

2. Was fill material intercepted during the subsoil investigation?

Yes No (Please tick)

If yes, please specify the effect of the fill on wastewater disposal

--

3. Has percolation testing been carried out?

Yes No (Please tick)

If yes, please specify the method

Test Report Attached? (Please tick) Yes No

4. Are surface water interception/diversion drains required?

Yes No (Please tick)

If Yes, please show on site plan

5. Please state the depth of the seasonal water table:

Winter	<input type="text"/>	(m)
Summer	<input type="text"/>	(m)

Please indicate whether measured or estimated (please tick)

6. Are there any potential short circuit paths?

Yes No (Please tick)

If the answer is yes, please explain how these have been addressed

7. Based on results of subsoil investigation above please indicate the disposal field soil category (Refer TP58 Table 5.1):

Is Topsoil Present? If so, Topsoil Depth? (m)

Soil Category	Description	Drainage	Tick One
1	Gravel, coarse sand	Rapid draining	<input type="checkbox"/>
2	Coarse to medium sand	Free draining	<input type="checkbox"/>
3	Medium-fine & loamy sand	Good drainage	<input type="checkbox"/>
4	Sandy loam, loam & silt loam	Moderate drainage	<input type="checkbox"/>
5	Sandy clay-loam, clay loam & silty clay-loam	Moderate to slow drainage	<input type="checkbox"/>
6	Sandy clay, non-swelling clay & silty clay	Slow draining	<input type="checkbox"/>
7	Swelling clay, grey clay, hardpan	Poorly or non-draining	<input type="checkbox"/>

Reasons for placing in stated category

PART E: Discharge Details

1. Water supply source for the property (please tick):

Rainwater (roof collection)	<input type="checkbox"/>
Bore/well	<input type="checkbox"/>
Public supply	<input type="checkbox"/>

2. Calculate the maximum daily volume of wastewater to be discharged, unless accurate water meter readings are available (Refer TP58 Table 6.1 and 6.2):

Number of Bedrooms	<input type="text"/>	
Design Occupancy	<input type="text"/>	(Number of people)
Per capita Wastewater Production	<input type="text"/>	(Litres per person per day)
Other - Specify	<input type="text"/>	
	<input type="text"/>	
Total Daily Wastewater Production	<input type="text"/>	(Litres per day)

3. Do you propose to install:

a) Full Water Conservation Devices?	Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	(Please tick)
b) Water Recycling – what %?	%	<input type="text"/>	No	<input type="checkbox"/>	(Please tick)

If you have answered Yes, please provide additional information including the estimated reduction in water usage:

4. Is Daily Wastewater Discharge Volume more than 2000 litres:

Yes	<input type="checkbox"/>	(Please tick)
No	<input type="checkbox"/>	(Please tick)

Note if the answer to the above is yes an ARC wastewater discharge permit will be required

5. Gross Lot Area to Discharge Ratio:

Gross Lot Area	<input type="text"/>	m ²
Total Daily Wastewater Production	<input type="text"/>	(Litres per day) (from above)
Lot Area to Discharge Ratio	<input type="text"/>	

6. Does this proposal comply with the Auckland Regional Council Gross Lot Area to Discharge Ratio of greater than 1.5)

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	(Please tick)
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7. Does this proposal comply with the Auckland Regional Council Gross Lot Area to Discharge Ratio of greater than 3

Yes No (Please tick)

8. Is an Auckland Regional Council Discharge Consent Required?

Yes No (Please tick)

PART F: Primary Treatment (Refer TP58 Section 7.2)

1. Please indicate below the no. and capacity (litres) of all septic tanks including type (single/dual chamber grease traps) to be installed or currently existing:

Number of Tanks	Type of Tank	Capacity of Tank (Litres)
	Total Capacity	

2. Is a Septic Tank Outlet Filter to be installed?

Yes No (Please tick)

If Yes, please state the type

PART G: Secondary and Tertiary Treatment

(Refer TP58 Section 7.3, 7.4, 7.5 and 7.6)

1. Please indicate the type of additional treatment, if any, proposed to be installed in the system (please tick):

Secondary Treatment	<input type="checkbox"/>
Home aeration plant	<input type="checkbox"/>
Commercial aeration plant	<input type="checkbox"/>
Intermittent sand filter	<input type="checkbox"/>
Recirculating sand filter	<input type="checkbox"/>
Recirculating textile filter	<input type="checkbox"/>
Clarification tank	<input type="checkbox"/>
Tertiary Treatment	<input type="checkbox"/>
Ultraviolet disinfection	<input type="checkbox"/>
Chlorination	<input type="checkbox"/>
Other	<input type="checkbox"/>

Specify

PART H: Land Disposal Method (Refer TP58 Section 8)

1. Please indicate the proposed loading method (please tick):

Gravity	<input type="checkbox"/>
Dosing Siphon	<input type="checkbox"/>
Pump	<input type="checkbox"/>

2. Is a high water level alarm being installed in pump chambers?

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	(Please tick)
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3. If a pump is being used, please provide the following information:

Total Design Head	<input type="text"/>	(m)
Pump Chamber Volume	<input type="text"/>	(Litres)
Emergency storage volume	<input type="text"/>	(Litres)

4. Please identify the type(s) of land disposal method proposed for this site (please tick) (Refer TP58 Sections 9 and 10):

Surface Dripper Irrigation	<input type="checkbox"/>
Sub-surface Dripper Irrigation	<input type="checkbox"/>
Standard Trench	<input type="checkbox"/>
Deep Trench	<input type="checkbox"/>
Mound	<input type="checkbox"/>
Evapo-transpiration Beds	<input type="checkbox"/>
Other (Please Specify)	<input type="text"/>

5. Please identify the loading rate you propose for the option selected in Part H, Section 4 above stating the reasons for selecting this loading rate:

Loading rate	<input type="text"/>	<input type="text"/>	(Litres/m ² /day)
Disposal Area	Basal	<input type="text"/>	(m ²)
	Areal	<input type="text"/>	(m ²)

Explanation (Refer TP58 Sections 9 and 10)

6. What is the available reserve wastewater disposal area (Refer TP58 Table 5.3)

Reserve Disposal Area (m ²)	<input type="text"/>
Percentage of Primary Disposal Area (%)	<input type="text"/>

7. Please provide a detailed description of the design and dimensions of the disposal field and attach a detailed plan of the field relative to the property site:

Description and Dimensions of Disposal Field:

--

Plan Attached ? Yes No (Please tick)

If not explain why not

--

PART I: Maintenance & Management (Refer TP58 Section 12.2)

1. Has a maintenance agreement been made with the treatment and disposal system suppliers?

Yes No (Please tick)

PART J: Assessment of Environmental Effects

1. Is an assessment of environmental effects (AEE) included with application?

(Refer TP58 section 4 (particularly 4.4.2), section 5, and section 11 (parts 11.1 & 11.8). Ensure all issues concerning potential effects addressed)

Yes No (Please tick)

2. Are there any specific environmental constraints?

Yes No (Please tick)

If Yes, please explain

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PART K: Is Your Application Complete?

1. In order to provide a complete application you have remembered to:

(Refer to TP58 section 3.5 for summary list of information to be covered):

Fully Complete this Assessment Form	<input type="checkbox"/>
Include a <i>Location Plan and Site Plan</i> (with Scale Bars)	<input type="checkbox"/>
Include a Property Title (Certificate of Title)	<input type="checkbox"/>
Attach an Assessment of Environmental Effects (AEE)	<input type="checkbox"/>

2. Declaration

I hereby certify that, to the best of my knowledge and belief, the information given in this application is true and complete.

Name		Signature	
Position		Date	

Table 1: Definition of Terms for Site Assessment

SURFACE EVALUATION	
TERM	DEFINITION
DESK STUDY	Review of existing site/area specific information held on council files.
SLOPE STABILITY	Identify any areas of previous or existing slope instability, these areas require specific geotechnical investigation to assess the potential impact of land application of wastewater and may be unsuitable for wastewater irrigation.
PERFORMANCE OF OTHER SYSTEMS	No on-site systems should be proposed in any locality without full knowledge of the performance of adjacent systems, and the reason for any failures occurring, be it soil type, loading rates or poor construction or changes in the type of development and increased per capita water consumption. If there are any doubts about the proposed land application system performance the best available wastewater treatment and land application technology should be used.
RAINFALL	Precipitation intensities and duration will influence the choice and siting of disposal systems relative to subsoil saturation effects.
VEGETATION COVER	Natural vegetation, trees, bush can be retained and incorporated into both land disposal and buffer areas or garden and lawn areas can be sub-irrigated.
SLOPE SHAPE	Identify slope shape and location of depressions/zones of potential surface water ponding. Depressions in which water could pond should be avoided.
SLOPE ANGLE	Past slope limits have been set to accommodate machine digging of conventional trenches; Slopes that are much steeper than 15% can be utilised in good soils by employing either narrow and shallow trenching machines, by hand digging or pinning dripper irrigation lines to the ground surface (see Chapters 9 & 10, TP58).
SURFACE WATER DRAINAGE	Identify surface water flow paths onto and off the site including concentrated or broad flow and areas of potential surface water ponding.
FLOODING POTENTIAL	Where there is a risk of flooding, the 1% and 20% flood levels need to be determined.
SURFACE WATER SEPARATION	Identify any surface water such as permanent and ephemeral streams, lakes, ponds and wetlands and specify separation distances from system/site.
SITE CLEARANCES	Identify separation distances from proposed and existing buildings, site boundaries, paved areas and topographical discontinuities e.g. embankments either supported or unsupported, water bores, paved areas. Table 5.1 (TP 58) specifies recommended minimum separation distances for determining suitable clearances based on the wastewater treatment quality.
SITE CHARACTERISTICS	Note characteristics of surface soil such as soil cracking, evidence for annual soil saturation, seepages, rock exposure etc.

GEOLOGY	Review of geological maps for preliminary soils/constraints assessment.
WATER SUPPLY SOURCE	On-site supply via rainwater roof collection or groundwater bore, or reticulated public supply.
SLOPE ASPECT	Note direction the slope faces for maximising evapotranspiration potential through exposure to sun and wind.
GROSS LOT AREA	Lot area to discharge volume for initial determination of Auckland Regional Council discharge consent requirements.
NET LOT AREA	Area available for primary and reserve land disposal areas excluding land area taken up by right of ways, impermeable areas, setback requirements from surface water etc.

SUBSURFACE EVALUATION	
TERM	DEFINITION
BOREHOLE/ TESTPIT	All site assessments are to include a detailed assessment of soils underlying the proposed land disposal area. The assessment shall be by test pit or where this is impractical by hand auger borehole. The subsurface assessment is likely to be to a depth of at least 1.0 to 2.0metres depth or the minimum recommended groundwater separation distance between the base of the land disposal system and any groundwater table (see Table 5.2). A detailed description of soils encountered, depth to groundwater and relevant soil structure and soil textural features shall be recorded and the depth to each horizon and soil description within the soil profile submitted with the site assessment report.
IN SITU SOIL	Determine if the soils are natural and determine soil suitability for land disposal of wastewater.
FILL MATERIAL	Fill may be unsuitable or poorly suited for land disposal of wastewater, depending on the composition and level of compaction in which case the proposed land disposal area should be relocated, the fill removed or the land disposal system specifically designed to accommodate the soil constraints. In the case of filled sloping sites the designer should take into account the potential for short-circuiting along the fill / natural ground interface.
SOILS	Determine soil type, clay, silt, sand, gravel and provide a detailed description of the soil structure and texture. The USEPA On-site Wastewater Treatment Systems Manual 2002 Sections 4.4.5, 5.5.7 and ANZS 1547:2000 Section 4.1D provides soil description procedures.
SOIL CATEGORY	The soils description above allows determination of the soil category.
SHORT CIRCUITING PATHS	Assess potential for wastewater to short circuit through clay or highly permeable soil into surface or ground water. The soil type, permeability and level of wastewater renovation required within the soil also influence the clearance distance required from the groundwater table and separation from surface water. Extreme care is required in soils prone to summer desiccation in which development of shrinkage cracks can provide short circuiting paths directly to groundwater or surface water. If necessary the "clearance" can be artificially increased by using a "mounded" land-application system and / or the level of wastewater treatment can be increased to include at least secondary treatment prior to distribution to the system. A mound may be constructed from clean topsoil to provide clearance between the base of the disposal system and the seasonally highest level of groundwater.

<p>GROUNDWATER DEPTH VARIATION</p>	<p>It is important to determine the capacity of the site to accept renovated wastewater and an appropriate disposal method which maximises on-site renovation of effluent and minimises groundwater impacts; a “clearance” will be required between the base of the disposal area and the critical groundwater level to satisfy one of two situations (refer Table 5.2).</p> <ol style="list-style-type: none"> 1). Where no public health or environmental constraints exist then the clearance must be adequate to ensure that hydraulic conductivity requirements are met (and no adverse groundwater mounding occurs; 2). Where such constraints are present (e.g. due to the use of groundwater for individual or community water supply) then the clearance must be such that when combined with quality control provided by the pre-treatment and disposal system, the further renovation of effluent during its percolation through the unsaturated soil layer between the land disposal area and groundwater surface is adequate to meet environmental and public health criteria.
<p>GROUNDWATER FLOW</p>	<p>Groundwater flow direction must be identified in the more permeable soils (such as sand & gravel) when in close proximity to lakes, rivers or beaches and the location of groundwater extraction bores identified. The travel time for applied wastewater to reach the groundwater table and to travel with groundwater to the zone of emergence or extraction should be assessed and pathogen die off predicted to determine if environmental and public health requirements are met.</p>
<p>SUM OF SITE CONSTRAINTS</p>	<p>All aspects determined from the site assessment, both positive and negative, are combined with the site development plan to determine the location and area available for land disposal of wastewater.</p>
<p>LAND APPLICATION SYSTEM DESIGN PARAMETERS</p>	<p>Environmental constraints and soil types are combined to identify the wastewater treatment quality required, the most appropriate land disposal method and soil loading rate determined.</p>
<p>DESIGN FOR OPERATION AND MAINTENANCE</p>	<p>In siting the pre-treatment and land-application system, account must be taken of the need for access for operation and maintenance purposes. Treatment units, which require desludging via pumpout, must be located so as to enable ready access for maintenance. Land-application systems must be located away from areas of vehicular or pedestrian traffic so their operation is not compromised by activities on the ground surface such as high use lawn areas.</p>

Appendix F

Secondary Treatment System Design Criteria

Auckland Regional Council Technical Sheet F-1

KEY DESIGN CRITERIA FOR WASTEWATER SECONDARY & ADVANCED SECONDARY TREATMENT SYSTEMS

The objective of any wastewater treatment system is to provide an effluent quality that is compatible with satisfactory long term operation of the land application system and to achieve an effluent quality that is sufficient to minimise effects on the receiving environment. Secondary wastewater treatment systems treating domestic wastewater are designed to achieve this by providing a primary treatment stage (either within or prior to the package plant system) to remove settleable solids and floatable oil and grease, and then by providing a secondary treatment stage, in which biodegradation of remaining organic contaminants occurs in aerobic conditions.

Maximum biodegradation by secondary treatment of the contaminants in the wastewater requires the provision of optimum conditions for biological activity. This includes the provision of favourable conditions for biological growth, a balance between the "feed" (organic load in the influent flow) and the microbial growth in the treatment system and appropriate aeration rate proportionate to the feed concentration and microbiological populations. Any suspended biomass generated in the secondary treatment process must be removed from the final effluent by settling or filtration prior to irrigation. This latter stage is important to reduce any potential for blockages and slime build up in the irrigation lines, enabling even distribution throughout the irrigation field and improving the effective life of the irrigation system.

Following are key design performance requirements for AWTS and Packed Bed Reactor systems. Design criteria are provided to ensure that the plants can adequately achieve the required performance objectives. However, to achieve a satisfactory level of performance, it is important to note that the actual plant performance is also dependent upon appropriate plant operation and management processes in response to the influent flows and concentrations, and on regular monitoring and maintenance. This needs to be verified on a case by case basis in accordance with the system installation, start-up inspection and sampling methodology and installation certification specified below.

Refer to the relevant sections within Chapters 7 and 12 of TP58 for more information. The key criteria are as follows:

PRIMARY CHAMBER

Primary storage capacity can be provided either within the whole treatment plant prior to the secondary stage, or in a tank prior to the package treatment system.

Primary Treatment Design Criteria:

- A. *Minimum combined total retention capacity prior to secondary treatment of at least 3 to 5 days average flow volume, unless the supplier has verified to ARC satisfaction that sufficient final effluent quality is achieved in the secondary treatment process, to achieve the required secondary discharge standards specified in 4A below and that less than 3 days primary treatment is sufficient. (The higher end of this scale becomes more important where there is a significant requirement to consistently achieve a high final effluent quality.)*
- B. *No potential for overflow or cross contamination from primary chamber to any secondary chamber, caused by any surging of blockages in outlet, e.g. where the primary chamber is within the whole treatment plant unit, the walls of the primary chamber must be of full height and sealed.*
- C. *An effective Effluent Outlet Filter must be installed at the outlet of primary chamber to retain any solids with a particle size of 3mm or greater and to prevent such solids entering the aeration chamber. (Ideally this should achieve a primary effluent suspended solids concentration in the order of 30mg/l or less.)*

Secondary Treatment Design Criteria:

Properly sized, operated and maintained AWTS plants can usually provide satisfactory treatment for household wastewater flows. Their performance is however affected by shock loads, large variance in the organic load and flow, insufficient flows, significant temperature variations. To perform well, the following aspects of the design need to be well tuned for the circumstances peculiar to each system and site: sludge return rates, control of the mixed liquor suspended solids concentrations, anti-foaming measures, aeration rate control, provision for scum and grease removal from the final clarifier and a means for the continuous removal of accumulated sludge from final effluent chamber. Adequate retention time in the final clarifying chamber and an appropriate sludge return rate are critical for good performance. Exact design criteria for each of these above aspects depend on the combined design of all features within the system, so generic design criteria cannot be specified here.

- D.1. *The quality of the final effluent from a AWTS system shall be better than or equal to a Biochemical Oxygen (BOD5) and Suspended Solids (SS) concentrations of 20gO/m³ and 30g/m³ respectively. However, where ten or more samples have been taken with 90% of samples complying with these limits, the system shall be considered satisfactory. (As specified in point 13 below, a minimum of two consecutive complying samples are necessary for commissioning purposes to verify a system complies with these standards.)*

Where treatment systems cannot meet this criteria, the supplier must specify what criteria they can realistically achieve. In the Auckland region, ARC or a similar appointed consultative expert forum will then classify the plant and the type of on-site design situations where the plant may still be suitable, such as types of disposal systems and receiving environments where less than secondary discharge quality and elevated suspended solids levels may not be of concern. (BOD5 levels of up to 30gO/m³ may be acceptable in some systems discharging to land where there is no potential for impact on natural waters, but SS levels must be less than or equal to 30g/m³ for sustainable long term performance of most drip irrigation systems.)

It is critical that the different forms of filtration secondary treatment systems, also known as packed bed reactors, are appropriately sized for the maximum influent flows and that the systems are dosed to optimise the conditions within the reactor system and thus the health of the micro-organism population and the performance of the system. Key design criteria for these systems, including details of dosing regime and loading rates, are provided in Section 7.4 of TP58.

- D.2. *The quality of the final effluent from an advanced secondary filtration treatment system shall be better than or equal to a Biochemical Oxygen (BOD) and Suspended Solids (SS) concentrations of 15gO/m³ and 15g/m³ respectively. However, where ten or more samples have been taken with 90% of samples complying with these limits, the system shall be considered satisfactory. (As specified in point 13 below a minimum of two consecutive complying samples are considered necessary for commissioning purposes to verify a system complies with these standards.)*

Where treatment systems cannot meet this criteria, the supplier must specify what criteria they can realistically achieve. In the Auckland region, ARC or a similar appointed consultative expert forum will then classify the plant and the type of on-site design situations where the plant may still be suitable, such as types of disposal systems and receiving environments where less than advanced secondary discharge quality may not be of concern.

Final Treated Effluent Filter Criteria:

- E. *Effective effluent disc (or a screen or a mesh filter with constant backflush), fitted in the discharge pipe, between the discharge point from the treatment process and the irrigation lines, to retain all solids greater 120-130microns within the system, OR verification that the treatment system itself will consistently achieve better than the treated wastewater quality parameters specified by the irrigation system suppliers:*

Alarm System Criteria:

- F. *A malfunction alarm system must be installed to activate in the event of failure of the aeration blower system an/or the in the event of a high water level in any of chamber within the system and/or pump chamber.*
- G. *An audible alarm unit, as well as a visual alarm unit, must be located in a prominent place within the dwelling or office facilities.*

Safety Components Criteria:

- H. *There must be a leak proof and durable lid on the top or side of the whole system, that ensures surface water run-off and is secured to prevent access by unauthorised personnel and yet is readily accessible for maintenance or replacement. All risers must also be sealed.*

Emergency Storage Criteria:

- I. *A minimum emergency storage volume of at least 24 hours capacity above the alarm trigger level is required in the pump chamber. Otherwise a combination of the equivalent emergency storage must be provided within the whole system, providing excess wastewater it will not have access to the clarifier chamber or other lead to cross contamination of other sections.*

Electrical Equipment Criteria:

- J. *All electrical connections and componentry in the system must be in accordance with New Zealand standards (i.e. in accordance with the criteria in AS/NZS 3000).*

Additional Key Criteria – Applicable To Whole AWTS System:

- K. *Systems must be manufactured to the Standards in A/NZS 1546:3 “On-site Domestic Wastewater Treatment Units, Part 3: Aerated Wastewater Treatment Systems”, particularly in terms of the Design Requirements specified in Section 2.5, and must also in accordance with the other relevant design criteria specified in this list above and in Sections 7.3 and 7.5 of TP58, whichever is the more stringent.*

A/NZS 1546:3 provides provisions for the design of tanks and fittings, tank construction, design loads, emergency storage capacity, materials selection, mechanical equipment, electrical equipment, effluent pumps, alarm systems, and disinfection criteria.

System Installation Requirements:

- L. *All secondary treatment systems should be installed by registered drain layers or by a suitably trained and experienced installer. Installation should be undertaken in accordance with the practices covered in Chapter 12 of TP58.*

System Start-up Inspection and Sample Analysis:

- M. *Within three months of commissioning of the system, the system supplier and/or installer shall inspect the system to verify that it has been properly installed and shall collect a sample of the final effluent in a sterilised sample vessel (minimum 1 litre). The sample shall be taken to a registered laboratory for analysis of Biochemical Oxygen Demand and Suspended Solids concentrations, to verify the plant’s performance.*

If the first sample is not within the limits specified in TP58 (criteria D1 and D2 above and in Sections 7.3 or 7.4) for the type of system installed then sampling should continue and recent modifications made to system operation tuned until the average sample results verify that the system performance is in accordance with the above discharge standard for the system type or, in the Auckland region, until an exemption to this standard for that treatment system, is approved by the ARC. The tests should be continued until the discharge quality analyses are within the manufacturer’s system design specifications for at least two consecutive samples.

System Installation Certification (or equivalent Producer Statement):

- N. *The Sample Analytical Data and the Installation Certification (or equivalent Producer Statement) shall be forwarded to the approving authority within 6 months of system commissioning (or at a later date by arrangement).*

Maintenance Contract Requirements:

- O. *The system supplier or equivalent qualified wastewater treatment system operator shall provide the purchaser with the option of a Maintenance Contract for regular 3 monthly maintenance of the system (6 monthly maintenance contracts may be appropriate in special cases where stable system performance is proven), at the time of installation and by the time the purchase is complete (refer Section 12.2.7. of TP58).*
- P. *The site owner or the owners representative shall enter into and maintain in force a signed maintenance contract for the on going maintenance and operation of the wastewater treatment system.*

General System Maintenance – Owner Responsibility:

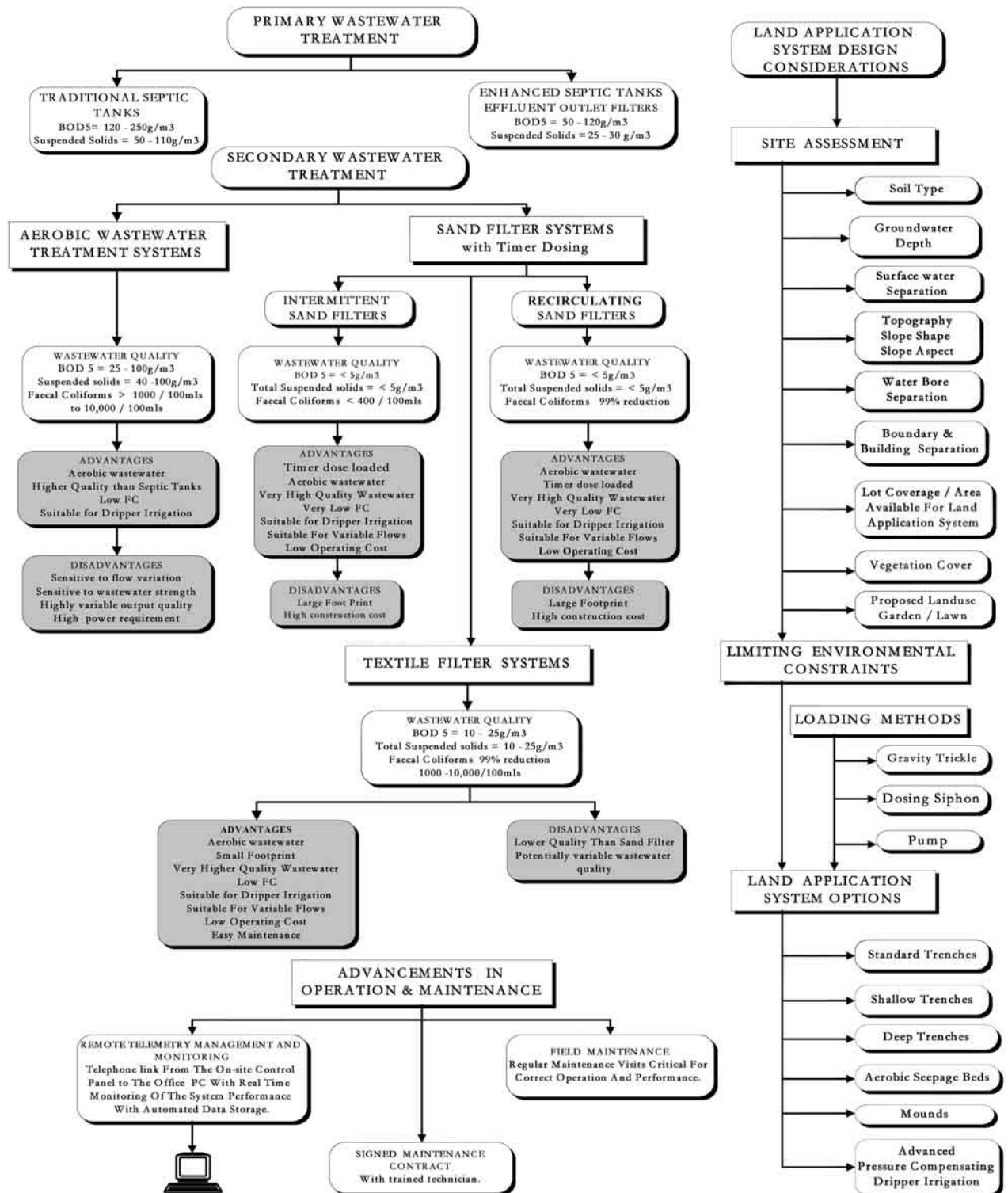
- Q. *In addition to contracted system maintenance, the owner of an on-site wastewater system has their own responsibility to undertake system maintenance to minimise adverse effects of the discharge on the receiving environment. The maintenance should be undertaken in accordance with the Management Plant provided by the system installer (refer Section 12.2.8 of TP58) and regard should also be had for the Remedial Procedures for System Failure (refer Section 12.2.10 of TP58), and in the Information Sheets (refer Appendix I of TP58). The duty of every person to avoid, remedy or mitigate adverse effects on the environment is stated in Section 17 of the Resource Management Act 1991.*

Irrigation System Criteria:

- R. *Flushing valves (taps) must be installed at the end of each irrigation line to enable manual flushing at each service period (automated valves still permitted but are potentially more prone to blockages and line failure).*
- S. *Back flow preventers or non return valves) should be installed on all irrigation lines to prevent all water from the irrigation lines draining from the highest line to the lowest line when the pump stops.*
- T. *Total Head Loss shall be established based on head loss from the following factors:*
- *Depth of pump in the pump chamber;*
 - *Total length and diameter in rising main or header pipe;*
 - *Total length and diameter of all combined irrigation lines;*
 - *Elevation difference between pump outlet and the highest irrigation line;*
 - *Combined loss in emitters;*
 - *Loss in a partially blocked filter; and*
 - *Extra allowances for other factors not already covered with the items above, such as loss in non-return valves, water meter and disc filters.*

Auckland Regional Council Technical Sheet F-2 SCHEMATIC DIAGRAM OF SECONDARY TREATMENT AND DISPOSAL SYSTEM OPTIONS - Advantages and Disadvantages

OVERVIEW OF WASTEWATER TREATMENT & LAND DISPOSAL SYSTEMS



Auckland Regional Council Information Sheet F-3 MONITORING DATA TO INDICATE SYSTEM PERFORMANCE

Table F.3.1 below shows a snapshot of monitoring data for random examples of on-site and decentralised/centralised wastewater systems in the Auckland region. The intent is to provide a general snapshot of what is achieved by a variety of real systems, only so as to assist give a perspective to the discharge quality parameters specified throughout TP58. It also does not a comprehensive review of all the data available for the periods specified, and therefore further details of the respective systems, consent numbers and receiving environments cannot be provided. It doesn't include all one-off extremes, as these can be misleading without an indication of frequency or reason.

While the discharge quality limits are mentioned in some cases, it is important to note that all limits vary significantly between systems for a number of reasons, including information provided at the time of the application, the treatment system type, the type and sensitivity of the receiving environment, any public health risks or concerns and other factors in the individual consent and public consultation processes. Discharge quality limits are generally less stringent where the robustness of the treatment system is proven, there will be no contact with water and any environmental and health risks are considered minor.

Table F.3.1: Examples of Typical Monitoring Data for On-site and Decentralised/Centralised Wastewater Systems

Wastewater	BOD (mgO/l)	TKN (mgN/l)	NH ₃ NH ₄ (mg/l N)	NO ₃ (mg/l N)	Total P (mg/l P)	DRP (mg/l P)
STP ^A Influent	210 – 680	36.3 – 76.9	29 – 40.4	-	-	4.3 – 7.0
STP ^A Effluent	2.0 – 8.4 (Monthly Mean 15)	1.3 – 5.5 (Monthly Mean 15)	0.4 – 3.7 (Max 15 winter & Max 6 sum'r)	2.2 – 6.6	2.0 – 6.7	2.2 – 4.6 (Mean <9)
STP ^B Effluent	< 2 – <6 (< 10)	0.6 – 1.3 (< 10)	0.01 – 0.4 (< 2)	8 – 24 (< 30)	3.4 – 7.7 (< 7)	3.7 – 7.6
STP ^C Influent	290 – 400	54.1 – 73.1	-	0.02 – 0.9	-	8.3 – 10.5
STP ^C Effluent	2.0 – 14 (< 15)	1.3 – 32.2	1.0 – 15	1.9 – 16.6	5.1 – 14.0	4.1 – 13.0
STP ^D Effluent	0.4 – 3.7 (< 30)	-	< 0.4 – 6.3	< 1.0 – 8.9	-	-
STP ^E Effluent	2.3 – 18 (< 45)	<0.2 – 31.3	-	0.3 – 8.4	-	-
STP ^F Effluent	2.0 – 41	45 – 65 ¹	-	-	-	-
STP ^G Effluent	<2 – <7	0.9 – 2.1	< 0.4	4.1 – 16.3	3.4 – 7.6	-
STP ^H Effluent	<2 – <5	1.6 – < 2	0.02 – 0.6	0.05 – 12.6	-	-

NOTE¹: Total N not TKN.

STP^A: Primary Settling, Biological Nutrient Removal, Sandfilter, UV treatment – 12 months' data.

STP^B: Sewage Treatment Plant: Primary Settling, Sandfilter, UV Treatment, Wetland, – Less than one year's data reviewed.

STP^C: Sewage Treatment Plant: Step Screen, Aerated Pond system, Wetland, UV Treatment – Two years' data reviewed.

STP^D: Sewage Treatment Plant: Aerated Lagoon System, Sandfilter, UV Treatment – Two years' data reviewed.

STP^E: Secondary Treatment – Aerated Treatment System discharging to dripper irrigation – Three years' data reviewed.

STP^F: Secondary Treatment: Primary Settling, Recirculating Packed bed Reactor discharging to dripper irrigation – Four months' data reviewed.

STP^G: Secondary Treatment: Primary Settling, Extended Aeration, Sandfilter, UV Disinfection discharging to evapotranspiration beds – Four months' data reviewed.

STP^H: Secondary Treatment: Primary Settling, Trickling Filter, Intermittent Sandfilter, – Two years' data reviewed (old decentralised system with significant stormwater infiltration problems).

Appendix G

Plants For On-Site Wastewater Disposal Systems

Auckland Regional Council Technical Sheet G-1

LIST OF WATER TOLERANT PLANTS SUITABLE FOR ON-SITE WASTEWATER DISPOSAL SYSTEMS

GENERAL MATTERS TO CONSIDER WHEN PLANTING A LAND DISPOSAL AREA:

Plants that are suitable for planting in moist conditions, such as those associated with wastewater land disposal fields need to be selected on the basis of both their tolerance for such moist conditions and for their potential for high level of growth/high transpiration of moisture in such conditions.

Standard lawn grass is a proven effective high transpiration plant species in such conditions, as are a large number of other plant species seen in typical domestic gardens.

Consideration needs to be given to effects of roots from plants and from trees in particular on wastewater distribution pipe networks/emitter lines in land application systems. Potential for root intrusion/disruption to the pipe system must be considered prior to selection and planting of a plant or tree species.

Advice on such matters for particular plant species can be obtained from garden centre specialists and landscaping consultants.

NATIVE PLANTS SUITABLE FOR MOIST CONDITIONS IN THE AUCKLAND REGION:

The following list covers native plant species are considered to be suitable for planting in moist conditions, such as those associated with wastewater disposal fields in Auckland situations. They are all tolerant or fond of moist conditions and all are native to the Auckland region. Much of this information has been adapted from one of the ARC Botanic Gardens advisory leaflets; "14 – New Zealand plants for wet places" and the list edited and reviewed by Dr. Rhys Gardner Consulting Botanist, Auckland War Memorial Museum (August 2004).

Grasses, ground covers, and other plants

***Astelia grandis* (swamp astelia)**

Large clump forming plant with bright green, flax-like foliage. Female plants produce upright panicles of orange berries in the centre of the plant. This endemic species will not tolerate eutrophic conditions and prefers peat soils.

***Blechnum novaezealandiae* (kiokio)**

Large, robust fern growing to 1 or even 2m, Hardy species that tolerates most conditions, but does best in well drained, shady areas.

Carex

There are many members of this genus which grow naturally in damp to wet areas. They all have quite fine drooping foliage and are vigorous in moist conditions. Most prefer very light shade. The following species have been identified for their suitability:

Carex dissita

Endemic species with dull green to reddish tufts often 0.5m tall (although this can vary). Tolerates a range of swampy habitats, but is also noted to grow on drier soils under forest cover.

Carex flagellifera

Endemic species with dense spreading reddish-brown tufts to 0.5m tall. Prefers damp soil and full sun, but is noted to thrive in a variety of habitats including boggy pasture.

Carex geminata

Robust and vigorous endemic species that grows to 1.5m tall. Thrives in a range of wet habitats. Suitable for a larger area.

Carex lessoniana

Robust and vigorous endemic species that grows to 1.5m tall. Similar to *C.geminata* in that the species is spreading and suitable for a larger wet area.

***Carex secta* (purei, makura)**

Endemic species that exhibits tall spreading tussocks. Has been noted to grow to 3m tall, widespread in swampy areas. Useful in the creation of bird habitat.

Carex virgata

Endemic species that forms dense, light green tussocks up to 1m tall. Thrives in a variety of habitats including swamps, drain margins, seepages and wet pastures. Useful in the creation of bird habitat.

***Cortaderia fulvida* (toetoe)**

Branching from the base and forming a clump to 4m high. Long strap-shaped leaves with red-orange coloured veins, flower heads cream yellow. New shoots exhibit pale waxy cover on lower parts (unlike pampas grass) Prefers good drainage and semi-shade. Will struggle to compete if dried out in summer.

***Cyperus ustulatus* (toetoe upoko-tangata, giant umbrella sedge)**

Vigorous leafy sedge growing to 1m in open damp places. Tolerates immersion in standing water within a range of habitats from seepages to wetlands.

***Dicksonia squarrosa* (wheki, tree fern)**

Tree fern up to 7m tall that exhibits tolerance of wet open ground, and floods. Found to shelter and accumulate with other native plants. The base of the fern attracts biodiversity. Useful application to streambank and seepage habitats.

***Elatostema rugosum* (parataniwha)**

Herbaceous plant up to 0.5m tall that spreads by rhizomes. Bronze coloured foliage with serrated edge. Grows on moist sites in light to heavy shade. Intolerant of dry habitats.

Hypolepis dicksonioides

Large fern that prefers fertile moist, but well-drained ground, grows vigorously and spores into planted areas with abundance. Does however, die back during winter.

***Phormium tenax* (harakeke, flax)**

Fast growing clump-forming flax with large stiff leaves, to 3m. Full exposure and sun. Moist to wet conditions. Does not have deep or wide roots. Easily propagated from split fans or grown from seed. Attracts birds, especially Tui.

Trees and shrubs

Consideration needs to be given to the effects of roots land application on wastewater distribution pipe networks. This problem can be more significant for large tree species.

***Carpodetus serratus* (putaputaweta, marbleleaf)**

Lowland forest tree up to 7m tall. Large bunches of cream coloured flowers appear in spring followed by black berries.

Coprosma areolata

Species that grows to 4m tall. Low tolerance to drought, with medium to high fertility.

***Coprosma robusta* (karamu, shining karamu)**

Shrubs or small trees growing to 3m+, with glossy green leaves. Masses of orange-red fruit in autumn are attractive to birds. Hardy plant.

***Coprosma tenuicaulis* (swamp coprosma)**

Endemic species that grows to 3m tall. Leaves pale green with slender branches. Will tolerate a range of swampy to boggy habitats including standing water.

***Cordyline australis* (ti kouka, cabbage tree)**

Palm-like in appearance with large heads of linear leaves and panicles of scented flowers. Sun to semi-shade. Prefers damp to moist soil. Grows eventually to 12m+ height.

***Dacrycarpus dacrydioides* (kahikatea, white pine)**

Tree that grows to 40m. Moderately growing species, which prefers wetland and boggy environments. Application of this species must consider the possible impact of its root systems on the wastewater disposal field.

***Geniostoma rupestre* (hangehange)**

Common forest shrub with pale green glossy foliage, growing to 2-3m. Tiny flowers give off strong scent in spring. Looks best in sunny position where it retains a bushy habit, and prefers well-drained soil.

***Hebe stricta* (koromiko)**

Shrub or small tree growing to 2-5m in height. Natural forms have white to bluish flowers. Plant in full sun. Tolerates exposure. (NB Many cultivars and hybrids are available commercially, but these are all unsuitable for use near existing natural vegetation.)

***Laurelia novae-zelandiae* (pukatea)**

Large upright tree (to 30m) with attractive bright green foliage and distinctive whitish bark. Fast growing and able to handle a wide variety of soils. It will tolerate periodic flooding, breathing roots develop in water logged soils. Can be grown from seed. Tolerant of some sun and frost. Not tolerant of wind.

***Leptospermum scoparium* (manuka)**

Shrub or small tree growing to 4m+ in height. Ubiquitous shrub varying in form throughout New Zealand. Ideal to provide shelter for other plants as it is quick growing and hardy. Requires full sun and. Hardy and tolerant of difficult conditions, including waterlogging and drought.

***Melictyus ramiflorus* (mahoe)**

A fast growing yet long lived tree to 7m height. Prefers well drained fertile soils. Tolerates some frost, wind and sun Birds are attracted to the blue berries.

***Pennantia corymbosa* (kaikomako)**

Slow growing species that will reach 12m in moist, fertile sites. Useful species application in bank stabilisation or wetland habitats.

***Plagianthus betulinus* (ribbonwood)**

Fast growing species to 15m. Similar application to that of *Pennantia corymbosa*.

***Rhopalostylis sapida* (nikau)**

New Zealand's only native palm, with red berries attractive to birds. Requires light shade, plenty of moisture and protection from wind when young. Grows well in areas of permanent dampness.

***Syzygium maire* (maire tawake)**

Attractive and moderately growing wetland tree to 15m with bronze foliage, large bunches of reddish fruit and distinctive whitish bark. Requires a sheltered sunny position. Tolerates some frost.

***Vitex lucens* (puriri)**

Fast growing to 20m in fertile, open but sheltered conditions. Will struggle with poor drainage during adolescence.

Appendix H

On-site Wastewater Systems Management Summary Checklist

Auckland Regional Council Technical Sheet H-1

ON-SITE WASTEWATER SYSTEMS MANAGEMENT SUMMARY CHECKLIST

(Purpose is list of information that must be included in the "Maintenance" section of an On-site Systems Management Plan)

Property Owner

Property Owner:	Date:
Property Address:	

System Design

System Designer

Company:	Phone Number:
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Installation

Supplier/Installers

Supplier/Installer:	Phone Number:
Drainlayer:	Phone Number:
Electrician:	Phone Number:
City/District Council:	
Building Consent Number:	
Date Approved:	
Date Installed:	
Regional Council:	
Discharge Consent Number:	
Date Approved:	
Expiry Date:	
Maximum Discharge Volume:	
Other:	

System Design Parameters and Maintenance Frequencies

Discharge Volume

Water Supply

<input type="checkbox"/> Reticulated	<input type="checkbox"/> Waterbore	<input type="checkbox"/> Roof Water
--------------------------------------	------------------------------------	-------------------------------------

Design Occupancy

Number of Bedrooms:	
Other People/Guests (eg. restaurant etc.):	
Number of People:	
Design Maximum Wastewater Discharge Volume:	Litres/day

Wastewater Treatment

Wastewater Treatment System:
System Installer:

1. Grease Trap

Number:					
Volume: m³					
Maintenance Requirements	Hourly	Daily	Weekly	Monthly	Yearly
Pump Out Frequency					
Specific Maintenance Requirements:					

2. Septic Tanks

Number:					
Volume:		m ³			
Outlet Filter Type:					
Pump:					
Siphon:					
Gravity:					
Sludge Depth:		m			
Maintenance Requirements	Hourly	Daily	Weekly	Monthly	Yearly
Pump Out Frequency					
Outlet Filter					
Alarm Check					
Specific Maintenance Requirements:					

3. Aerobic Wastewater Treatment Plant

System Type/Brand:					
Number of Tanks:					
Maintenance Requirements	Hourly	Daily	Weekly	Monthly	Yearly
Aerator					
Filter					
Pump					
Alarms					
Specific Maintenance Requirements:					

4. Sand Filter Systems

<i>Intermittent / Recirculating</i>					
Loading Rate:		L/m ² /d			
Sand Filter Area:		m ²			
Maintenance Requirements	Hourly	Daily	Weekly	Monthly	Yearly
Weed Control					
Gravel Cover					
Flush Lines					
Recirculation Assembly					
Specific Maintenance Requirements:					

5. Textile Filters

System Type:					
Recirculation Tank Volume:		m ³			
Loading Rate:		L/m ² /d			
<i>Treated Wastewater Holding Tank</i>					
Volume:		m ³			
Emergency Storage Volume:		m ³			
Maintenance Requirements	Hourly	Daily	Weekly	Monthly	Yearly
High Water Level Alarm					
Pump					
Flushing Distribution Lines					
Filter Sheets					
Timers/Control Panel					
Specific Maintenance Requirements:					

6. Disk Filter

Type/Model:					
Maintenance Requirements	Hourly	Daily	Weekly	Monthly	Yearly
Cleaning Frequency					
Specific Maintenance Requirements:					

7. Water Meter

Maintenance Requirements	Hourly	Daily	Weekly	Monthly	Yearly
Reading Frequency					
Specific Maintenance Requirements:					

Land Disposal System

1. Pressure Compensating Dripper Irrigation

Irrigation Area:	m ²				
<input type="checkbox"/> Surface	<input type="checkbox"/> Subsurface				
Depth:	m				
Number of lines:					
Line spacing:	m				
Emitter spacing:	m				
Emitter flow rate:	L/hr				
Soil Category:					
Areal loading rate:	mm/day				
Maintenance Requirements	Hourly	Daily	Weekly	Monthly	Yearly
Vegetation Maintenance					
Clear Surface Water Drains					
Check Line Pressure Flags					
Flush Lines					
Check Irrigation Area for Wet Ground					
Specific Maintenance Requirements:					

2. Trench Systems

Number of Trenches:					
Total Length:	m				
Depth:	m				
Width:	m				
Soil Category:					
Shallow Trenches (basal loading) -Total basal area:					m ³
Deep Trenches (sidewall loading) -Total sidewall area:					m ²
Loading Rate: mm/day					
Maintenance Requirements	Hourly	Daily	Weekly	Monthly	Yearly
Vegetation Maintenance					
Check Irrigation Area for Wet Ground					
Specific Maintenance Requirements:					

3. Beds/Mounds

Number of Beds:					
Length:	m				
Width:	m				
Total Basal Area:	m ²				
Loading Rate: mm/day					
Soil Category:					
Maintenance Requirements	Hourly	Daily	Weekly	Monthly	Yearly
Vegetation					
Surface Water Diversion Drains					
Groundwater Diversion Drains					
Vents					
Specific Maintenance Requirements:					

4. Low Pressure Pipe Irrigation

Soil Category:					
Surface/Subsurface Irrigation:					
Number of Lines:					
Trench/Line Spacing:	m				
Total Line Length:	m				
Trench Depth:	m				
Trench Width:	m				
Total Areas:	m ²				
Areal Loading Rate:	mm/day				
Maintenance Requirements	Hourly	Daily	Weekly	Monthly	Yearly
Vegetation Control					
Irrigation Area Soggy Ground					
Surface Water Drains					
Groundwater Drains					
Line Flushing					
Sequencing Valves					
Specific Maintenance Requirements:					

Discharge Consent Conditions

Maintenance Requirements	Hourly	Daily	Weekly	Monthly	Yearly
Monitoring Requirements					
Sampling Requirements					
Reporting Requirements					
Other:					

Greywater Recycling

System Type:					
Number of Tanks:					
Tank Volumes:					
Disinfection Method: <input type="checkbox"/> UV <input type="checkbox"/> Chlorine <input type="checkbox"/> Other _____					
Maintenance Requirements	Hourly	Daily	Weekly	Monthly	Yearly
Pumps					
Chlorine Dispenser					
UV Lamps					
UV Tube Cleaning					
Water Level Alarm					
Chlorine Level Alarm					
Chlorine Residual					
Filters					
Recycle Water Clarity					
Recycle Water Odour					
Recycle Water Quality					
Specific Maintenance Requirements:					

Alternative Wastewater Treatment Systems

Compost Handling:					
Maintenance Requirements	Hourly	Daily	Weekly	Monthly	Yearly
Specific Maintenance Requirements:					

Appendix I

Wastewater Systems Maintenance Guidelines

Auckland Regional Council Technical Sheet I-1

HOW TO AVOID PROBLEMS WITH ON-SITE WASTEWATER TREATMENT AND DISPOSAL SYSTEMS – Key Maintenance Requirements

Domestic wastewater is wastewater generated in domestic dwellings, institutions, commercial and residential facilities, which predominantly originates from bathrooms, kitchens, and laundries. On-site disposal and is the discharge of wastewater to land within the property boundaries of its place of origin. The traditional on-site treatment system consists of a septic tank and a soil absorption field. A septic tank system includes all tanks, beds, drains, pipes, fittings, appliances and land used on the site in connection with the system. The septic tank through which effluent/domestic wastewater is passed, is the primary stage in any treatment process. It allows solid:liquid separation and retention of the settled solids and floating scum and the settled solids that then undergo anaerobic bacterial digestion.

To be effective septic systems must be adequately sized to accommodate the wastewater flows from the buildings being served and have been properly installed and maintained. The longer the resident time within the septic tank the better for providing optimum adequate separation and to reduce resuspension of solids when there are new plug flows into the tank. Tanks of 4 to 5 days peak flow volume are ideal.

Many conventional septic tank systems fail due to a variety of causes. A key reason is that they are undersized for wastewater flow volumes from modern facilities, connection of garbage grinders, and lack of maintenance. Lack of maintenance can lead to build up of sludge and scum in septic tanks, which can result in lack of separation in the tank, solids carryover, increased odours of raw sewage, clogged absorption fields. Problems with the land disposal area can also be a result of hydraulic overloading caused by increased occupancy and/or greater water use.

Malfunctioning on-site wastewater treatment and disposal systems can contribute to environmental pollution and can become potential health risks. Ignoring system maintenance requirements will lead to signs of system failures which can then lead to further significant problems such as health risks from pathogens, odours, contamination of groundwater and surface water, attraction of flies and rodents, and decreased property value. Proper maintenance of septic systems not only lessens environmental pollution and aesthetic value of a property, but also lessens potential costs that could be incurred when a damaged system needs to be repaired or replaced.

MAINTENANCE AND ENHANCEMENT OF EXISTING ON-SITE SEPTIC SYSTEMS:

All Septic Tank owners are strongly encouraged to:

- **PUMP-OUT SEPTIC TANK**
 - Check the respective depths of sludge, liquid wastewater and scum in the septic tank at least once per year.
 - Pump out the tank once the combined depth of sludge and scum occupies 50% of the tank depth. For a standard household, this should be in the order of once every 3 to 5 years. (This may be required more frequently where houses are fully occupied and/or there is no outlet filter and for tanks serving public toilets, and less frequently, up to once every 5 years or longer, where occupancy is low or intermittent, and/or where an effective outlet filter has been maintained).
- **INSTALL AND MAINTAIN AN OUTLET FILTER**
 - In the Auckland region, these are required to be installed on all new septic tank systems and are **STRONGLY** recommended to be retrofitted to old septic tanks. They are often the most effective and cheapest option for improving the performance and life of a wastewater system. They ensure all solids of 3mm diameter or greater are retained and biodegraded within the septic tank, and do not access or clog the soakage lines. Supplier details can be obtained from your local council).
 - Check the biomat build up on the filter regularly, at least once per month, and clean it as required to avoid excessive build up affecting filter performance.
 - To clean the filter, remove it from the septic tank and hose down, discharging the rinse water back into the septic tank, or elsewhere into dense vegetation where it will not cause any nuisance, and reinstate the filter into the septic tank.

- **AVOID USE OF TOXIC SUBSTANCES**
 - Non-biodegradable chemicals, e.g. don't use drain cleaners or disinfectants.
 - Sanitary napkins, other hygienic products, dental floss, kitty litter, etc.
 - Oil and fat flushed into the system.
 - Detergents (toxic detergents and other household cleaners should be avoided as they kill the bacteria in the septic tank).
 - Do not use or minimise use of garbage disposal units.
 - Compost food scraps or put them in the rubbish.

- **MINIMISE WATER USAGE / IMPROVE WATER CONSERVATION**
 - Particularly important on sites where area available for wastewater disposal and the system's capacity constrained, where any seepage or run off could access natural water and affecting water quality or where disposal areas may be accessed by children.
 - Install water reduction fixtures on water outlets and/or low flush toilets (This is particularly important on small sites and/or where there is high occupancy in the dwelling where the system disposal system capacity is threatened).
 - Do not leave taps running for long periods.
 - Install push button taps on public facilities.
 - Fix water leaks.
 - Do not connect rain gutters or stormwater drains to septic tanks.

- **ENHANCE EVAPOTRANSPIRATION AND DISCOURAGE ACCESS TO DISPOSAL AREAS**
 - Densely plant the disposal area, maintain plantings and check regularly for even wastewater distribution and even plant growth.
 - Where the disposal area is grassed, it should be regularly mowed to optimise growth and prevent the grass from becoming rank.
 - Do not pave the disposal area.
 - Use planting, low chain, signage and/or a small fence to discourage access in public areas.
 - Use signs, low fences and plantings to prevent any vehicle or stock access.

Records should be kept of all maintenance undertaken on the wastewater systems, particularly when contractors are involved. This includes tank pump outs, tank inspections, and access openings. **Do not** add or alter any part of your system without Council approval.

Auckland Regional Council Technical Sheet I-2

ON-SITE WASTEWATER SEPTIC TANKS.

KEY DOS & DON'TS FOR THE HOUSEHOLDER

All wastewater (toilets, shower, sinks, laundry) produced on the site is discharged to an on-site wastewater treatment and land disposal system. The wastewater treatment system is a fragile biological process and therefore requires care by all residents.

You can help maintain an effective wastewater system on your site, by ensuring no toxic chemicals are put down the sinks or toilets and use only environmentally friendly cleaning products. Toxic chemicals, drugs (e.g. antibiotics) kill the bacteria in the treatment system. These organisms are required to treat wastewater and if healthy populations are not maintained, the system will fail resulting in poorly treated wastewater discharging into the soil, odours, increased maintenance requirements and eventually the expense of upgrading the system. You should also minimise your water use as much as possible to protect the system from overloading.

Below is a list of hints for caring for your wastewater system.

DO

- **Minimise your water use.**
- **Minimise the length of showers.**
- **Use showers in preference to baths.**
- **Use bio-degradable soaps and cleaners**
- **Check all your cleaning products to see if they are suitable for septic tanks.**
- **Minimise use of strong toilet cleaners.**
- **Scrape all plates and dishes to remove as much fat and grease as possible. Clean with paper towels and place in the rubbish.**
- **Report/fix all leaking taps as soon as possible.**
- **Use phosphate free/low phosphorus based laundry detergents.**

DO NOT

- **Don't pour any toxic/strong chemicals (paint, oil, grease, paint thinners, pesticides down any drains).**
- **Don't flush any products down the toilet, other than standard toilet paper.**
- **Don't discard any drugs down the sink or toilet.**
- **Don't use strong cleaners.**
- **Don't tip chlorine cleaners or disinfectant based products into the system.**
- **Don't use huge amounts of cleaners.**
- **Don't use chemical drain cleaning products.**
- **Don't do all your laundry on one day.**
- **Don't install in-sink garbage grinders. If a grinder exists, don't discharge high volumes of scraps, especially carbohydrates or fats/oils down it.**
- **Don't put coffee grounds down the sink.**

Auckland Regional Council Technical Sheet I-3

ON-SITE WASTEWATER PACKAGE TREATMENT PLANTS.

KEY MAINTENANCE REQUIREMENTS TO BE UNDERTAKEN BY SYSTEM MAINTENANCE CONTRACTOR

Wastewater system owners are strongly encouraged to enter into a maintenance contract with the system supplier or other contractor experienced in wastewater treatment system operation and maintenance.

The minimum system maintenance requirements for the most basic on-site treatment and disposal systems include but are not limited to the following 3 monthly actions:

- **REMOVE AND CLEAN** (hose down) the effluent outlet filters from the outlet of the septic tank and in the outlet from the treatment system or the following rising main. Ensure appropriate protective clothing is worn and the rinse water is discharged to ground, ideally densely vegetated where it will not run-off.
- **MEASURE THE SLUDGE DEPTH.** This can be done by removing septic tank lid/vent and poking a stick into the tank and noting the change in density of material at the liquid:sludge layer interface within the tank. If the layer is more than one third total tank depth (this equates to more than 0.7m from top of a 2m septic tank), the tank needs to be pumped out.
- **CHECK ALL ELECTRICAL PARTS.** In particular check and test that all visual and audible alarms for pump chamber and aerator blower are working.
- **CLEAR THE AERATOR** by lifting the aerator out of the septic tank and checking for any material that would cause drag. Clean the aerator by hosing it.
- **FLUSH ALL THE DISPOSAL LINES** if the system consists of pressure compensating drip irrigation lines, remove the flush valves and flush with fresh water from the hose, then reinstall the valves.
- **WALK OVER THE DISPOSAL AREA AND LOOK CLOSELY FOR ANY SIGNS OF FAILURE.** This can include uneven vegetative growth, uneven effluent distribution, any wet patches and/or signs of effluent ponding, or clogging or channelling of the soils. In the even any such problems are identified, contract the installer and/or a maintenance contractor to remedy the situation. Also consider measures to reduce water usage.

Auckland Regional Council Technical Sheet I-4 ON-SITE WASTEWATER TREATMENT & DISPOSAL SYSTEMS. GENERAL PROBLEM SOLVING GUIDE

The following is a list of suggested actions in the event of actual problems with your system:

Problem	Solution
Odour	<ul style="list-style-type: none"> ● Insert activated carbon filters into the septic tank vents. ● In the case of an aerobic treatment plant, contact supplier and ensure system is sufficiently aerated.
Septic tank bacterial breakdown	<ul style="list-style-type: none"> ● Use soft soap solutions or biodegradable cleaners for cleaning. ● Use only detergents low in alkaline salts, phosphorous, and chlorine levels. ● Avoid heavy use of detergents and the use of disinfectants and other household cleaners as they affect the bacterial action within septic tanks. ● Do not discharge any pharmaceutical medication or disinfectants into the wastewater system ● Minimise discharge of food waste and fats and oils into kitchen sink/ garbage grinders
Septic tank overflow/ odours	<ul style="list-style-type: none"> ● Engage drain layer/contractor to investigate any blockages immediately. ● Pump out the septic tank. ● Decrease water usage until problem is remedied. ● Mitigate by installing high level alarms, 24 hour storage in new tanks and 12 hour storage in existing tanks as a warning system. ● Mitigate initial problems by removing inspection covers annually to check the depth of the scum mat and sludge. The tank should be cleaned out when combined depth of scum and sludge occupy half the tanks volume or at least every 3 years. (Tea leaves & other kitchen wastes should be composted as they are slow to break down, filling your system more rapidly).
Blocked filter	<ul style="list-style-type: none"> ● Cleaning is required. (This often only involves a quick hose down of the filter. It should then be undertaken regularly at a frequency of once every 2 weeks to 3 months depending upon the type of filter in place).
Clogged disposal system	<ul style="list-style-type: none"> ● Pump out the tank and the disposal lines. ● Inspect and/or consider reconstruction of disposal system and/or individual lines. ● Upgrade the system to improve treatment system such as a pressure compensating drip irrigation system.

Problem	Solution
Overflow on disposal field	<ul style="list-style-type: none"> ● Pump out septic tank and reduce water usage in immediate term. ● Increase the disposal field area. ● Re-locate the disposal area further away from the house and trees or on the northern side of the house to increase evaporation (i.e. provide good exposure to sun and wind). ● Ensure the wastewater disposal area is densely planted to increase evapotranspiration. ● Restrict/avoid access to the field.
Excessively high volume wastewater discharge / Unknown usage	<ul style="list-style-type: none"> ● Install a water meter. ● Install water reduction fixtures. ● Decrease water usage. ● Increase the disposal field area.
Rainfall run-off causing water-logging of disposal field	<ul style="list-style-type: none"> ● Check that no roof downpipes discharge to gully traps or on land where it could drain onto the disposal area. ● Install stormwater cut-off drains upslope of disposal area (such drains need to be maintained over time).
Potential impact on groundwater/surface water	<ul style="list-style-type: none"> ● Ensure all wastewater drainage lines, and irrigation pipes are located at least 15m from any watercourse. ● Regular system maintenance. ● Regular pump outs. ● Install outlet filters. ● Clean filter. ● Avoid the use of phosphorous based household detergents.
Continuing Unresolved Problems	<ul style="list-style-type: none"> ● Engage a consultant experienced in wastewater treatment and disposal systems. ● Upgrade the whole system. ● Enter into a maintenance contract with a wastewater systems contractor/drainlayer/system supplier with a high level of experience in wastewater treatment and disposal system maintenance and operation.
ARC Discharge Consent Required	<ul style="list-style-type: none"> ● Contact ARC Enviroline on 09 3662000

WHO TO CONTACT IF YOUR SYSTEM IS FAILING OR YOU OBSERVE A FAILING SYSTEM:

- Engage an environmental or geotechnical consultant experienced in wastewater treatment and disposal systems.
- An Environmental Health Officer at your local council.
- ARC Enviroline on 09 3662000.
- ARC 24 Hour Water Pollution hotline on 09 377 3107 for water pollution (or ARC Wastewater Discharge Compliance Officer on 09 3662000 (working hours).

Auckland Regional Council Technical Sheet I-5

HOUSEHOLD CLEANING CHEMICALS.

EFFECTS ON DISPOSAL SYSTEM RECEIVING SOILS

Use of many cleaning chemicals in facilities served by on-site disposal systems can result in high concentrations of the constituents in those cleaning agents being discharged into the receiving soils. These chemicals and constituents have a massive impact on the quality and condition of the receiving soils over time.

Many of the chemicals can disrupt soil structure and decreased hydraulic conductivity while others can act as bactericides, destroying the essential microorganisms required to achieve the high level of biodegradation in the treatment and disposal systems. This then increases the potential environmental impacts of the contaminants in the receiving environment.

Improved wastewater treatment technologies can only assist so much in reducing the composition and concentration of some cleaning agents, not the strong acids and strong alkaline agents.

The following matters need to be considered when using cleaning agents in a domestic situation:

- Laundry powders are often extremely high in sodium which will destroy the salt balance in the soils. Check the labels.
- Greywater consisting of washing machine wash cycle discharge water can have an alkaline pH of up to 10. Although this will be diluted in a septic tank, it will impact on microorganism populations and also lead to effects on soils structure
- Wastewater flows from dishwashing machines can have an impact on wastewater treatment systems, not only in terms of wastewater flow volumes and additional organic waste, but more importantly in terms of the strong cleaning chemicals.
- Highly corrosive cleaners (such as toilet and drain cleaners) that have precautionary labels warning users to minimise direct contact, are an indication that they can adversely affect the wastewater treatment system. Up to 1 cup of bactericides such as bleach can be sufficient to impact on all the microorganisms/bugs in a septic tank, severely affecting tank performance for some time.
- All cleaning chemicals must be used with care and in all cases, the less that is discharged, the better this will be for the receiving soils in the long term.
- The best solution of optimising the long term effectiveness of the soils within a wastewater disposal field is to minimise the use and discharge of strong cleaning chemicals at source.

Auckland Regional Council Technical Sheet I-6

ON-SITE WASTEWATER TREATMENT & DISPOSAL SYSTEMS: SUBSTITUTES FOR HOUSEHOLD CLEANING CHEMICALS

Use of the following readily biodegradable substitutes for common potentially harmful household cleaning chemicals will reduce the stress on a septic system, significantly enhance the performance of the whole system and increase the life of the disposal field, while reducing the potential effects of the receiving soils.

GENERAL CLEANERS:

Use soft soap cleaners and bio-degradable cleaners and those low in chlorine levels.

AMMONIA-BASED CLEANERS:

Instead sprinkle baking soda on a damp sponge. For windows, use a solution of 2-Tbs white vinegar to 1-litre of water. Place the mixture into a spray bottle.

DISINFECTANTS:

In preference use Borax: ½ cup in 4-litres of water.

DRAIN DECLOGGERS:

Avoid declogging chemicals. Instead use a plunger or metal snake, or remove and clean trap.

SCOURING CLEANERS AND POWDERS:

Instead sprinkle baking soda on a damp sponge or add 4-Tbs baking soda to 1-litre warm water. It's cheaper and won't scratch.

TOILET CLEANERS:

Sprinkle on baking soda, then scrub with toilet brush.

LAUNDRY DETERGENT:

Choose one with a zero phosphate content and low in alkaline salts (in particular, a low sodium level) and no chlorine.

Use of the following alternatives to standard chemicals is less likely to be of any consequence to the performance of the on-site wastewater system, but are included for completeness only:

CARPET/UPHOLSTERY CLEANERS:

Sprinkle dry cornstarch or baking soda or commercial dry cleaning spray, then vacuum. For tougher stains, blot with white vinegar in soapy water.

FURNITURE/FLOOR POLISHES:

To clean, use oil soap and warm water. Dry with soft cloth. Polish with 1 part lemon juice to 2 parts oil (any kind) or use natural products with lemon oil or beeswax in mineral oil.

METAL CLEANERS:

Brass and copper: scrub with a used half of lemon dipped in salt. Stainless steel: scouring pad and soapy water. Silver: rub gently with toothpaste and wet cloth.

OVEN CLEANERS:

Sprinkle salt on drips, then scrub. Use baking soda and scouring pads on older spills.

Appendix J

Supplier Information

Auckland Regional Council Information Sheet J-1

SUPPLIER INFORMATION: FIXED ORIFICE FLOW CONTROL DEVICES

Fixed Orifice Flow Control devices (FOFC) are fixtures installed to water orifices within a dwelling (such as showers, sinks, basins), that aid in the conservation of water both through a reduction in water usage and discharge volumes. This reduction is reported to reach 25-30% for a standard household with normal fixtures.

One of the key benefits of FOFC devices is their ability to control water pressure to ± 1 litre per minute of the designed flow rate, effectively balancing the system. This stability extends to temperature control of $\pm 1^\circ$. Conservation of energy is achieved through this temperature control, as a reduction in hot water usage, results in a reduction of water required to be heated.

FOFC devices are essentially maintenance free systems with no moving parts. They have the ability to be installed to new dwelling fixtures or retrospectively, with many holding guarantees.

These devices are highly recommended in the wastewater treatment systems where water volumes are a major design consideration. However, ARC requires that a certified installation experts must install FOFC devices.

Table J-1.1: Flow Rates of Standard Fixed Orifice Flow Control Devices Required by ARC

Fixture	Maximum Flow Rate (Required of standard FOFC by ARC) (litres/minute)	Recommended Flow Rate (litres/minute)
Shower	9	4-7
Hand Basins	6	5
Sinks	9	7
Sinks (commercial)	14	10
Laundry Tubs	10	8
Washing Machines	11	10
Baths	18	15

The following brands of FOFC devices are currently available to the New Zealand market. Further information should be obtained from the supplier.

1. TRIDENT¹

Trident is a compact FOFC valve, which is inserted throughout the water system to provide control over each orifice. The valves control the pressure in the water system while regulating the flow and stabilising the mixed water temperature through each orifice. The Trident FOFC can be incorporated into the design of new buildings, as well as through retrofitting with an existing system.

2. JEMFLOW²

Jemflow is a flow controller that is designed to improve the stabilisation characteristics of the common orifice plate. Jemflow FOFC are installed into the water inlet port of the hot and cold faucets and act to reduce the flow of water through the use of four waterways. They are drilled at ninety degrees to the water flow direction and upstream of the final flow rate determining orifice. They essentially use the velocity of the water against itself to provide a suppression of the water flow, resulting in the reduction of water used.

1 Referenced from product information booklet – The Trident Fixed Orifice Flow Control (FOFC) System for Water and Energy Conservation, National Distributor: EnviroSystems Limited.

2 Referenced from product information booklet – Jem Flow: Flow Control Systems for the Efficient Usage of Water and Energy.