TE AWARAUA-O-PORIRUA COLLABORATIVE MODELLING PROJECT: LIFE CYCLE COSTING - THREE WATERS MITIGATION MATRIX

URBAN INTERVENTIONS/ SOLUTIONS

3 Waters Type	Mitigation/ Solution	Description	Mitigation/ Solution Objectives	Water Quality Benefits (High, Med, Low for each Contaminant)	Water Quantity Benefits (High, Med, Low)	Land-use Applicability	Scale of Implementation	Recommended Catchment Area	Soil Constraints	Slope Constraints	Other Limitations	Potential Additional Benefits	Public vs Private Implementation	Cost Considerations	Cost Information - Sources (TAC, MC, LCC)	Mitigation currently used in Wellington Region
Stormwater	Dry detention basins	A permanent depression of pond area that temporarily stores stormwater runoff to reduce flooding and the peak rate of stormwater runoff. They are normally dry between rain events.	Provides water quantity control (attenuation of peak flows and reduction of flooding)	Sediments - Medium	Peak flow attenuation - High; Flood attenuation - High; Stream channel protection - Med.	Urban (all landuse types); urban-rural; rural	Catchment-scale attenuation	>6ha	None	The steeper the slope the more difficult it becomes to meet the minimum water surface area or storage requirements.	Space constraints may preclude the use of a dry detention basin.	Dry basins can also be used as recreational/ amenity areas during the inter-event dry period.	Public implementation (built by developers, vested with council and operated by council/ CCOs)	Land consumption for dry pond.	COSTnz, SDSS Economic Module - modelled LCC costs available ($/ha)	Unknown.
	Ponds	An open body of water which provides treatment through the process of sedimentation and attenuation via live storage.	Provides water quality and water quantity control (attenuation of peak flows from small and large storms, flooding)	Sediments - High; Metals - Low; PAHs - Low; TPHs - Very low.	Peak flow attenuation - High; Flood attenuation - High; Stream channel protection - Med.	Urban (all landuse types); urban-rural; rural	Catchment-scale attenuation and treatment	>4ha	Needs to be in clay soils to maintain a permanent pool. Clay or impermeable liner otherwise required.	The steeper the slope the more difficult it becomes to meet the minimum water surface area or storage requirements.	Space constraints may preclude the use of a pond. Difficult and expensive to use in areas of bedrock. Ponds can cause thermal downstream effects when discharging directly to streams.	Ponds can be used as water storage reservoirs (e.g. Water for fire fighting, stock watering, etc). Ponds can enhance those property values for those properties which abut the pond. Ponds can be aesthetically pleasing and provide amenity value to surrounding communities.	Public implementation (built by developers, vested with council and operated by council/ CCOs)	Land consumption for pond. Cost of desludging and disposing sediment.	COSTnz, SDSS Economic Module - modelled LCC costs available ($/ha)	Yes. Will be used for the Transmission Gully Road.
	Wetlands	Constructed wetlands are designed to mimic natural wetland systems which use processes involving wetland vegetation, soils, microbes and sedimentation to improve water quality. Due to the complex mix of physical, chemical and biogeochemical processes, wetlands are very effective at treating a wide-range of contaminants in stormwater.	Provides water quality and water quantity control (attenuation of peak flows from small and large storms, flooding)	Sediments - High; Metals - High; Nutrients - High; PAHs - High; TPHs - Low.	Peak flow attenuation - High; Flood attenuation - High; Stream channel protection - Medium.	Urban (all landuse types); urban-rural; rural	Catchment-scale attenuation and treatment	>1-2ha	Needs to be in clay soils to maintain a permanent pool. Clay or impermeable liner otherwise required.	The steeper the slope the more difficult it becomes to meet the minimum water surface area or storage requirements.	Space constraints may preclude the use of a pond. Difficult and expensive to use in areas of bedrock.	Wetlands can provide attractive open space areas and add amenity value to surrounding communities. In addition they provide habitat for a variety wildlife and plant communities.	Public implementation (built by developers, vested with council and operated by council/ CCOs)	Land consumption for wetland Regular inspections to ensure vegetation is established in the first 3 years. Cost of desludging and disposing sediment. Replanting costs	COSTnz, SDSS Economic Module - modelled LCC costs available ($/ha)	Yes (Wellington foreshore area). May also be used for the Transmission Gully Road.
	Rain gardens and tree pits	A rain garden is an attractive, landscaped shallow depression that captures, absorbs and treats stormwater runoff from impervious areas such as car parks, roads, driveways and roofs. There are two types of rain gardens. A bioretention rain garden infiltrates stormwater back into the ground (no piped system). A biodetention rain garden detains water and releases it into a piped system. A tree pit is a small rain garden that captures rain water from sidewalk pavements or roadways	Provides water quality treatment and stream channel protection/ volume reduction (in bioretention rain gardens)	Sediments - High; Metals - High; Nutrients - High (designed); TPHs - High.	Stream channel protection - Med - High.	Urban (all landuse types); urban-rural; rural	Catchment scale and site scale treatment	0 - 3 ha	Tree pits and rain gardens use an introduced filter media. Existing soil types are generally not a limitation. For tree pits: esnure sufficient quantity of soil to support tree growth and avoid saturation of roots.	N/A	Most limitations can be overcome through careful design. Plants chosen need to be able to survive both wet and dry conditions.	Rain gardens and tree pits assist with "bringing nature back into an urban environment". They can provide refuge areas for birds, lizards and insects, assist with disconnecting impervious areas and reducing the temperature of urban stormwater.	Public and private implementation. Public implementation generally related to roading infrastructure and private implementation related to house and driveway treatment.	Concrete encased rain gardens can be expensive. Regular inspections to ensure vegetation is established in the first 3 years. Replacement of filter media and replanting costs.	COSTnz, SDSS Economic Module - modelled LCC costs available ($/ha), Auckland Unitary Plan modelling	Yes (near GWRC building)
	Swales and filter strips	Swales and filter strips are vegetated tracts of land which have been designed to filter contaminants and increase infiltration. As stormwater flows through the vegetation (often grasses) contaminants are removed by filtration, infiltration, biological uptake and adsorption. Swales tend to have a trapezoidal or "V" shape and can accept concentrated flow, whilst filter strips can only accept sheet or distributed flow.	Provides water quality treatment and volume reduction (if design for infiltration)	Sediments - High; Metals - High; TPHs - Medium;	Stream channel protection and Volume reduction - Medium.	Urban (all landuse types); urban-rural; rural	Catchment scale and site scale treatment	0 - 4ha	None	Slopes should not be steeper than 5% unless check dams are used.	Vegetation needs to be well established and therefore they may need to be protected during the construction of house lots. Most limitations can be overcome through careful design.	Swales and filter strips are particularly effective in treating linear impervious areas such as roads.	Public and private implementation. Public implementation generally related to roading infrastructure and private implementation related to house and driveway treatment.	Ongoing regular mowing required, although this can be reduced if native grasses are used instead of rye grass. Relatively low cost maintenance and construction.	COSTnz, SDSS Economic Module - modelled LCC costs available ($/ha)	Yes (will be used in for the Transmission Gully road)
	Infiltration trenches & permeable paving	Infiltration trenches capture water from impervious areas and discharge it into the underlying soils and groundwater. Permeable paving also infiltrates water through the permeable gaps into either the ground or an underground storage area before being piped into a stormwater system.	Provides for volume reduction and water quality treatment.	Sediments - High; Metals - High; Nutrients - Medium.	Volume reduction - high.	Urban (residential or commercial); urban-rural	Catchment scale and site scale treatment	0 - 4ha	Infiltration trenches cannot be used in clay or silty clay soils. Permeable paving can be used if it incorporates an underground storage and piped system.	Limited to gentle slopes.	Infiltration practices are very prone to clogging and should not be used in areas where a high level of sediments and contaminants may be expected.	The reduction in volume of surface runoff recharges aquifers (a source of drinking water in some areas) and also protects streams from accelerated erosion resulting from increased stormwater volumes and velocities following development.	Public and private implementation. Public implementation generally related to roading infrastructure and private implementation related to house and driveway treatment.	Regular inspections are vital to check if the trench or paving is clogging. Maintenance can be very expensive if pavers or infiltration media needs to be removed and replaced due to clogging from high sediment loads.	COSTnz, SDSS Economic Module - modelled LCC costs available ($/ha), Auckland Unitary Plan modelling	Yes (Johnsonville)
	Sand filters	Sand filters are similar to other biofiltration devices such as rain gardens, except that they use sand (or an organic-sand mix) to provide filtration. Whilst they can be built above ground, they are often built below ground in highly urbanised areas where space is limited. They are effective at removing hydrocarbons and finer sediments and have been used for many years to treat runoff from motorways.	Provides for water quality treatment.	Sediments - High; Metals - High; TPHs - High	None	Urban (all landuse types)	Catchment scale and site scale treatment	0 - 6ha	None	They are highly engineered devices and are therefore generally not constrained by topography or soils. There does, however, need to be enough grade to allow the sand filter to function hydraulically.	As with other filtration solutions, they can be prone to clogging.	None	Public and private implementation. Public implementation generally related to roading infrastructure and private treatment of industrial/ commercial yards.	Regular inspections needed to check if the sand/ peat media is clogging. Scarifying or replacing the top 10cm of sand assists with clogging.	COSTnz, SDSS Economic Module - modelled LCC costs available ($/ha), Auckland Unitary Plan modelling	Unknown.
	Rain tanks	A rain tank collects and stores rainwater from an impervious area and then either facilitates the reuse of that water or discharges into the stormwater system. Rain tanks serve individual properties and are usually used to collect water from roof areas. Underground water tanks can also be used to collect and store water from car parking areas.	Provides for peak flow attenuation and volume reduction.	None	Peak flow attenuation: high Volume reduction - high (when designed for reuse).	Urban (all landuse types); urban-rural; rural	Site scale attenuation and reuse	<1 ha (related directly to roof or parking area)	None	None	None	It encourages the reuse of rain water which reduces potable water demands. Increases resilience of the water supply and stormwater system.	Mainly private.	Large range of rain tanks available makes costing difficult. In general though, underground tanks will be more expensive than above ground tanks. Regular inspections needed, but these can, for the most part, be done by homeowners. Replacement of pumps, screens and filters.	COSTnz (to be updated based on cost information from manufactuers), Auckland Unitary Plan modelling	Yes
	Green roofs	A green or living roof is a roof of a building which is completely or partly covered by vegetation. It includes special lightweight soils to support plant growth, a drainage layer, and a waterproofing layer to protect the building from leaks. Many countries are also now promoting the use of green walls as well as green roofs.	Provides for volume reduction and water quality treatment.	Airborne contaminants - High	Volume reduction - high.	Urban (all landuse types) - cannot be used in areas where rain tanks are needed for potable water supply	Site scale	related directly to roof/ wall area	None	None	Structural loading and water proofng considerations if being retrofitted on an existing building.	They help to reduce pollution entering our waters, reduce local flooding potential, they act as an insulator for a building therefore reducing energy usage, reduce the "urban heat island" effect and beautify our cities and attract native birds and insects to our urban landscapes.	Private (unless the green roof/ wall is covering a publically owned building).	Additional structural reinforcement of building can be costly depending on the depth of filter media of the green roof. Roof access is required. Access is also needed for maintenance. They require regular maintenance, especially in the first few years to ensure the plants grow well and survive. Irrigation may be required during dry periods, and they need to be routinely inspected to check on the plants, integrity of the water proofing and drainage media, and to ensure there are no blockages to drainage.	Data to be collected from manufacturers. Auckland Unitary Plan modelling	Yes (Victoria University has green walls)
	Source control (roofs)	Impervious surfaces themselves can leach contaminants. For example, galvanized metal roofs and copper roofs are significant sources of zinc and copper respectively in urban environments. By using inert roofing materials, these contaminants will not enter the stormwater system (avoidance rather than treatment). Inert roofing materials include clay or concrete tile roofs, colour-bonded roofs, low-lead painted roofs and the like	Avoidance of contaminants	Depends on the type of roofing material - usually eliminates or drastically reduces zinc or copper as a source of contaminants from roofs.	None	Urban (all landuse types); urban-rural; rural	Site scale	related directly to roof/ wall area	None	None	None	Reduces costs of stormwater treatment for roof areas.	Private (unless it is a publically owned building)	Need to follow manufacturers recommendations.	Data to be collected from manufacturers.	Yes
	Riparian buffer strips	A riparian buffer strip is a well vegetated strip of land (usually bush/ forest vegetation) adjacent to a stream which assists in protecting the stream from stormwater impacts. In low density residential areas which abut streams, planted native riparian buffer strips assist in providing treatment for diffuse discharges and helps to reduce the total volume and peak rate of stormwater runoff via evapotranspiration and plant uptake.	Provides water quality and water quantity control (attenuation of peak flows from small and large storms, flooding) and volume reduction from diffuse flows only.	Sediments - Medium; Metals - Medium; Nutrients - Medium (for diffuse flows only)	Peak flow attenuation - High; Flood attenuation - High; Stream channel protection - Medium; Volume reduction - Medium	Urban (low density residential); rural-urban; rural	Site and catchment scale	No limits	None	None	Space availability is the key constraint within the urban environment: approximately 3500m2 of bush revegetation to mitigate 600m2 of impervious area. Narrow riparian strips (<20m) can have problems of weed infestation.	Native bush riparian buffer strips can provide shading of waterways and habitat for a diverse wildlife populations and plant community	Varies - if land is vested with council as green space then it would be publically owned.	Cost of land to retire into bush/ riparian planting. Initial cost of maintenance during the first 3 years of growth with respect to plant establishment, weeding, predator control and watering.	SDSS Economic Module - modelled LCC costs available ($/ha)	Yes (will be used in for the Transmission Gully road)
	Catchpits, manholes and pipes	Catchpits, pipes and manholes provide for the safe collection and underground conveyance of stormwater away from urban areas.	Safety of infrastructure and people - purpose is the safe conveyance of stormwater.	None	None	Urban (all landuse types); urban-rural	Site and catchment scale	None	Geotechnically stable subgrade required.	None	None	None	Generally public, but pipes on private land connecting to the public system are privately owned.	Costs will vary depending on the material and diameter of pipes (very variable). High costs of pipe laying in areas of bedrock. CCTV inspections needed to determine if maintenance/ upgrades are needed. Flushing and cleaning of pipes and catchpits.	Data from network operator asset management plans; suppliers; contractors	Yes
	Water supply dams	Compacted earth or concrete structures that result in water storage, providing treatment through particle settlement.	Allows for water collection as a potable water source, irrigation, etc. water quality and quantity control, reducing flood effects by storing storm run-off.	Sediments - Med (sediment is trapped by the dam but settles out); Metals-Low; PAHs- Low; Hydrocarbons -Low;	Peak flow attenuation - High; Flood attenuation - High; Stream channel protection - Nil	Urban, Urban-Rural, Rural	Catchment-scale attenuation and treatment	N/A	Needs to have an impermeable base so rock or clay will remove the need for a liner. Rock depths and conditions will determine whether an embankment or concrete dam should be used. Soil needs to be geotechnically stable.	A sufficient slope is required to direct the rainfall from the catchment towards the dam and to provide for impoundment of surface water. Slope must be geotechnically stable.	Must be in elevated areas exposed to high rainfall, can have high impacts on surrounding environment and wildlife, can cause downstream erosion due to sediment retention by the dam. Can cause downstream thermal effects when discharging to rivers.	Effective and steady source of water for irrigation. Can provide amenity for visitors.	Public implementation (vested with council and operated by council/ CCOs)	Costs of repairs, and maintenance to ensure safety discharge measures remain functional. Land use, and cost of impact to the surrounding environment. Building and resource consents. Annual inspection is required, five yearly independent dam safety assurance audit required.	watercare (description information), http://www-personal.umich.edu/~murty/Designing-Earth-Dams-Optimally.pdf. Three Waters Asset Management Plan: http://wellington.govt.nz/~/media/your-council/plans-policies-and-bylaws/plans-and-policies/a-to-z/threewaters/files/threewaters.pdf?la=en	No (Dams have been decomissioned and are not actively used for water supply)

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Water Supply	Water treatment plants	Facilities for removing suspended solids, and any damaging chemicals or microbiological organisms so that water is suitable for end use.	Provides water quality control to ensure suitable drinking water is provided through aeration, coagulation and flocculation, followed by chlorination and UV treatment.	Sediments - High; Metals - High; Hydrocarbons - High; Bacterial - High	N/A	Urban, Urban-Rural	Catchment-scale	N/A	Soil must have geotechnical capacity to support the weight of the structure	N/A	Resource consents may be required to take water from natural water supplies (and thus may limit the quantity of water that can be taken).	Can provide a water supply for hydrants for fire-fighting. Lower health-care costs due to removal of water-borne disease. Allow for fluridation of water to increase dental health.	Public implementation (vested with council and operated by council/ CCOs)	Require trained technicians to determine chemical treatment dosage rates, if not fully automated will require operators. Essential to provide effective machinery and adequate chemical dosage to ensure water is probably treated. Require scheduled servicing and desludging.	Hamilton City Council Water Supply, Palmerston North City Council Water Supply, Kapiti Coast District Council	Yes
	Treated water reservoirs	A storage space for treated water, can be above or below ground.	Provide extra water during peak demands, allowing the treatment plant to continue running at it's desired rate.	Water would have already been treated by the treatment plants.	N/A	Urban, Urban-Rural, Rural	Catchment scale	N/A	Ground level, partially buried, underground reservoirs must be placed outside the 100-year flood plain. It is ideal to place the reservoir bottom above the groundwater table. Soil must have geotechnical capacity to support the weight of the reservoir structure and water contained within.	If the site is sloped, it is ideal to 'cut back' into the slope to ensure the reservoir is placed on a flat base. Slope must be geotechnically stable.	Must provide adequate security to prevent access by non-authorised persons. Must have measures in place to prevent surface runoff entering. Water turnover should be encouraged by proper mixing/circulation. Adequate overflow drainage must be provided.	Reduce demands on treatment plants, can provide water for fire fighting, can be used if any water mains break or when distribution pipes are shut for maintenance.	Public implementation (vested with council and operated by council/ CCOs)	Coastal areas may require more reservoirs due to often being a greater distance from treatment areas. Hydraulic controls, cleanliness, security, and structural condition must all be inspected routinely (usually quarterly). Distance from the existing distribution system.	Tauranga City Council, Guidelines for Drinking-water Quality Management for New Zealand (chapter 16). WA DOH Water Reservoir guidelines.	Yes
	Water pump stations	Stations located near the potable water source,designed to supply energy, allowing water to enter the distribution network.	Increase pressure to allow water to be supplied to pipes without the need for a favourable gravitational difference.	N/A	N/A	Urban, Urban-Rural	Catchment scale	N/A	Soil must have geotechnical capacity to support the weight of the structure.	Slope must be geotechnically stable.	Pump water level that the water needs to be pumped will determine the type of pump required. Pump discharge will need to meet minimum requirements. It is essential that clean water supply is not cross contaminated by waste water. Lubrication used in pump systems must not contaminate water supply, so should be listed under the NZ MAF Food Assurance Authority C15.	N/A	Public implementation (vested with council and operated by council/ CCOs)	Energy costs are significant, thus it is vital to ensure the pump is efficient. Regular inspections are required, and pumps, leaks, valves and control system need to be repaired/replaced. Chamber cleaning must take place. Testing of efficiency must be carried out to compare actual pump rate and design rate. Annual inspections of bolts, supports, wire ropes and chains on lifting beams and gantry cranes required. Vibration monitoring, thermography and leak detection testings are required to determine likely failure. Confined space entry access may increase costs of repairs/inspections. Might be best to pay the upfront costs to automate electric monitoring, in order to save on daily checks.	Sustainable sanitation and water management, Guidelines for Drinking-water Quality Management for New Zealand (chapter 16). Watercare Asset Management Plan.	Yes
	Water pipes	Hollow cylinders that convey water along a network to transport it from one location to another.	Allows raw water to be brought to treatment plants for appropriate water quality treatment, and then transports treated water to its required location for end use.	N/A	N/A	Urban, Urban-Rural, Rural	Site scale to catchment scale	N/A	Geotechnically stable subgrade required.	Slope must not be too steep so that it damages the pipe due to high velocities, but if it is not being used in conjunction with pumps, gravity must be sufficient to allow flow. Diameter, slope, and pipe material must all be used in conjunction in order to achieve the necessary flow rate.	Velocities must not be greater than 2.0 m/s to avoid water hammers. There must be adequate cover between the ground surface and the pipes, and manholes placed at appropriate spacing. Care must be taken to select the right diameter, as undersizing will reduce capacity whilst oversizing with increase costs. Daily consumption, peak day demand, peak day demand peaking factor, the number of residents and the daily consumption will determine the required flow.	N/A	Both Public and Private implementation	Pipe performance must be analysed (such as breaks or leaks) to interpret condition. Condition grade assessment must be undertain by the contractor during maintenance. Depth at which the pipe is buried, and the diameter of the pipe will greatly influence the price of installation.	Christchurch City Council design standards	Yes
	Valves and hydrants (includes peet valves, flushing valves, sluice valves,gate valves, fire hydrants)	Fittings which alter passageways to control the flow of water.	Provide water quantity and direction control by regulating flow direction, volume and pressure.	N/A	N/A	Urban (all landuse types); urban-rural; rural	Small, many valves are required for each water system	N/A	N/A	N/A	Many constraints need to be taken into account when selecting valves: flow characteristics, control range, cavitation, flashing, water hammer, valve body size, actuator type, safety rating, control speed, maintenance, water pressure. Adequate steps need to be taken to ensure water cannot be stolen from public hydrants. Care must be taken when opening/closing hydrants and valves as water hammer can damage pipes. Hydrants must prevent back-flow to avoid contamination of water.	Can be used to control water supply for potable and irrigation uses, as well as altering pressures to be used in washing machines/dishwashers etc. Efficient fire hydrants can increase safety of a neighbourhood and save lives.	Both Public and Private implementation	NZ Fire Service Hydrant inspections must be carried out. All valves must be tested/maintained at varying intervals.	Water Care Asset Management Plan, E+C Spot On-Selection of conrtol valves on water optimisation projects	Yes
	Wastewater treatment plants	Facilities to treat wastewater to remove suspended solids, chemicals and micro-organisms in order to safely return this water to the environment	Provides water quality benefits by removing impurities to reduce impacts on the environment when this wastewater is discharged into the sea	Sediments - High; Metals - High; Organic pollutants - High; PAH-Med Bacterial - High	N/A	Urban, Urban-Rural	Catchment scale treatment	Depends on contributing network.	Soil must have geotechnical capacity to support the weight of the structure	Site needs to be a flat aspect preferably low in the catchment to allow for gravitational feed of wastewater.	Treatment plant must be located in proximity to the coast in order to discharge the treated water into the environment, all discharged wastewater must avoid any possible health risk, damage to environment, or impact on recreational activites in the harbour.Must ensure maintenance workers are not exposed to health-hazards from improper containment of wastewater.	Use of waste solids for fertiliser. Harvesting gas from treatment plant for power generation. UV treatment ponds can provide amenity to people and habitat for birds.	Public implementation (built by council and operated by council/ CCOs)	Regular condition inspections by the maintenance team. Water quality tests must be presented to the council monthly. Desludging costs need to be considered.	Watercare. https://www.globalmethane.org/documents/ww_fs_eng.pdf.	Yes
	On-site wastewater treatment systems/Septic tanks and irrigation fields	Connections between septic tanks and a variety of different irrigation measures which allow effluent to be discharged to the soil and subsequently treated through bacterial action in the soil	Provides both a source of irrigation for crops as well as disposing of effluent waste in an efficient and useful manner when connection to the sewer mains is unavailable.	Sediments - High; Organic pollutants - High; Bacterial - High	N/A	Urban-Rural, Rural	Site scale	N/A	The soil permeability needs to be assessed. It is necessary to have adequate effluent drainage so it is necessary to check for bedrock or impermeable clay on the site. There must be a minimum depth of 600mm of soil underneath the area that will experience soakage, thus the water table must be at sufficient depth to provide this	Slope must be under 20 degrees to prevent effluent runoff, otherwise a system must be designed specific to the site. If the system uses gravity soakage trenches, the slope must allow the effluent to pass over the entire field, rather than simply discharging at the beginning of the trench. Pressure-compensating drip irrigation lines can function on slopes. A level base is required for the sceptic/aerated treamtent tank.	Must consider the position of the water table, and the area available for land application. The crops that are irrigated by effluent waste cannot be grazed or used for human consumption. Potential effects on near-by properties or local ecologies must be investigated before installation. Discharge permits are required if it is within a water supply catchment. Influent volumes are limited by the capacity of the irrigation field. Overloading the irrigation field may result in contamination of the stormwater network and associated public health risk.	Save on water consumption required to irrigate crops. Reduce demands on wastewater treatment plants and thus release less waste into oceans. Ideal for areas where access to water supply is limited.	Private implementation	Adequate land must be provided, and tanks/irrigations require regular maintenance to avoid sludge build up. Pumps may be required if there is not favourable slopes for gravity feeds. The type of irrigation method used (ie buried/drip fed/low pressure pipelines) will influence the cost. Minimum flow paths and tank sizes must be provided in accordance with AS/NZS 1546.1:1998. Building consent is required, and a discharge permit might be required. Diversion methods are required to prevent surface runoff entering the soakage treatment area	http://www.level.org.nz/water/wastewater/on-site-wastewater-treatment/land-application-disposal-systems/ http://www.aucklandcouncil.govt.nz/EN/ratesbuildingproperty/consents/buildingstructures/Documents/onsitewastewatermanagementintro.pdf http://www.gw.govt.nz/assets/council-publications/Environment%20Management_20010223_154203.pdf	Yes
	Hydrocarbon Interceptor Units	A trap made up of three units designed to remove hydrocarbons (including petrol) from wastewater	Due to difference in densities between hydrocarbons and water, installing a hydrocarbon interceptor unit allows these contaminants to be skimmed from the surface of wastewater and thus prevents it from entering the pipe network.	Hydrocarbons-High;	N/A	Urban, Urban-Rural	Site scale	Size of the catchment area appropriate for the unit depends on the size of the unit.	As the units are usually buried, the soil needs to be geotechnically stable, and have sufficient strength to support the buried structure.	N/A	An access cover must be provided in order to allow servicing to take place. Interceptor are usually required for carparks greater than 800m2/50 car spaces or that discharge to sensitive environments, vehicle maintenance areas, vehicle refuelling areas and roads.	Reduces the likelihood of blockages, overflow, or oil accumulation in pipes, and allow the wastewater treatment systems to remain efficient.	Private implementation	A tradewaste consent is required to discharge to the sewer, and a building consent to alter the drainage. Must be cleaned out regularly, using cleaning products with a pH of 6-10, and the sludge must be removed by a professional to be taken for treatment.	http://www.marlborough.govt.nz/sitecore/shell/Controls/Rich%20Text%20Editor/~/media/Files/MDC/Home/Services/Utilities/Trade waste_Petrol_Oil_Interceptor.ashx http://hugoplastics.nz/wp-content/uploads/2015/10/Hugo-Plastics-HP-9BG-Petrol-and-Oil-Interceptor.pdf https://www.sepa.org.uk/media/60086/ppg-3-use-and-design-of-oil-separators-in-surface-water-drainage-systems.pdf	Yes

3 Waters Type	Mitigation/ Solution	Description	Mitigation/ Solution Objectives	Water Quality Benefits (High, Med, Low for each Contaminant)	Water Quantity Benefits (High, Med, Low)	Land-use Applicability	Scale of Implementation	Recommended Catchment Area	Soil Constraints	Slope Constraints	Other Limitations	Potential Additional Benefits	Public vs Private Implementation	Cost Considerations	Cost Information - Sources (TAC, MC, LCC)	Mitigation currently used in Wellington Region
Wastewater	Grease Traps	Interceptors that can catch grease and oils before they are able to enter the wastewater network.	Prevents blockages or damage to drains/sceptic tanks by helping to reduce excess buildup of grease.	Sediments/oils - High;	N/A	Urban, Urban-Rural	Site scale	N/A	N/A	There are no slope constraints for the grease trap itself, but the slope (and volume) of the wastewater pipe feeding into will determine the size of the greasetrap required.	Wasterwater with temperatures greater than 60 degrees celsius or from dishwashers cannot be discharged into greasetraps as they emulsify the grease. They must be installed in a location which is possible to access for maintenance/cleaning/inspection. The wastewater pipe must be adequately sloped to direct fats/oil/grease towards the grease trap.	Prevent costly maintenance and repairs to wastewater networks, and the fats/oils/grease trapped on the grease trap can be turned into garden mulch or biodiesel (although this process is still rather difficult). Prevents environmental damage resulting from fat blockage induced dry weather overflows from the wastewater network.	Private implementation	Building consents are required. Regular cleaning and appropriate disposal needs to occur to ensure the trap remains effective. If the grease trap is difficult to access, this could increase maintenance costs. If the trap is buried, a pump truck is required for cleaning.	http://qcode.us/codes/placentia/view.php?topic=16-16_24-16_24_020 http://www.signalwaste.com.au/There-and-Back-Again-Grease-s-Tale-from-Table-to-Table-bgp3077.html http://thermaco.com/blog/grease-trap-to-fuel-tank-makes-sense/	Yes
	Wastewater pump stations	Transport wastewater across pipe networks to the treatment plants.	Increase pressure to allow wastewater to be supplied to pipes without the need for a favourable gravitational difference.	N/A	N/A	Urban, Urban-Rural	Site scale through to catchment scale	Depends on contributing network.	Soil must have geotechnical capacity to support the weight of the structure	N/A	Height to which wastewater needs to be pumped will determine the type of pump required. Pump discharge will need to meet minimum requirements. Must ensure maintenance workers are not exposed to health-hazards from improper containment of wastewater.	Allows for wastewater to be added to the gravitational pipe network thereby reducing the need for additional satalite treatment plants or wastewater discharges to freshwater or marine receiving environments, which have the potential to harm fisheries and tourism.	Public implementation (built by developers, vested with council and operated by council/ CCOs) . Can also in some cases be privately owned in order to connect private household wastewater uphill to the public network.	Regular routine inspections. Wet-well washing to remove fat build up. Testing of efficiency must be carried out to compare actual pump rate and design rate. Annual inspections of bolts, supports, wire ropes and chains on lifting beams and gantry cranes required. Vibration monitoring, thermography and leak detection testings are required to determine likely failure. Confined space entry access may increase costs of repairs/inspections. Pumpstations near schools, daycares or restaurants suffer more wear and need more frequent servicing. Might be best to pay the upfront costs to automate electronic monitoring, in order to save on daily checks.	Watercare Asset Management Plan, Water Projects LTD.	Yes
	Wastewater pipes	Hollow cylinders that convey wastewater along a network to transport it from one location to another.	Allows for removal of unwanted wastewater from locations, provide transportation to appropriate treatment stations.	N/A	N/A	Urban, Urban-Rural, Rural	Site scale through to catchment scale	N/A	N/A	Slope must not be so steep that the pipe is damaged due to high velocities, but if it is not being used in conjunction with pumps, gravity must be sufficient to allow flow. Diameter, slope, and pipe material must all be used in conjunction in order to achieve the necessary flow rate.	Velocities must not be greater than 2.0 m/s to avoid water hammers. There must be adequate cover between the ground surface and the pipes, and manholes placed at appropriate spacing. Care must be taken to select the right diameter, as undersizing will reduce capacity whilst oversizing with increase costs. The number of residents, dry weather flows, dry weather peaking factor and peak wet weather flows will determine the design flow.	N/A	Both Public and Private implementation	Condition grade assessment by contractor when maintenance/repairs are carried out. Specialist pipe bridge inspections are required. CCTV, sonar, laser profiling and walk-through inspections. Pipe performance must be analysed (such as breaks or leaks) to interpret condition. Diameter, material, and depth of pipe need to be carefully selected to maximise efficiency and economic benefits.	Watercare Asset Management Plan	Yes
	Manholes/chambers	An opening to provide access to inspect, repair or adjust buried wastewater services.	Allow inspection, cleaning, joining of wastewater pipes.	N/A	N/A	Urban (all landuse types); urban-rural;	Small scale, must be provided every 90-150 m	N/A	Bearing capacity of the soil must be sufficient for the manhole foundation.	Steep grade pipelines (>7%) should be avoided if possible, otherwise a series of precautions must be taken.	Must be provided at all locations where pipes change direction, gradient and size. Need to be at least 1.0m from structures/boundaries. If located on a road, vehicle wheels must push any hinged manholes closed, rather than open (communication with Auckland Transport required). Measures must be put in place to ensure the safety of contractors accessing the manhole .	Allowing ease of inspection means potential malfunctions can be identified before they occur.	Both Public and Private implementation	Maintenance such as flushing and plastering is required. Additional services/connections may need to be installed into an existing manhole.	Auckland Design Manual, Drainage NZ.	Yes