CLONCURRY IMHOFF TANK OPERATION MANUAL

Operational Manual for Cloncurry Wastewater Imhoff Tank

Cloncurry Water and Wastewater

This manual describes how to operate, inspect and maintain the Cecil Plains Wastewater Treatment Plant. This document is to be used as a reference document by operational staff

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Glossary Terms

BOD	Biochemical Oxygen Demand
DEHP	Department of Environment and Heritage Protection
EMS	Environmental Management System
PST	Primary Sedimentation Tank
SS	Suspended Solids
SST	Secondary Sedimentation Tank
WWTP	Wastewater Treatment Plant
RTO	Registered Training Organisation
EPA	Department of Environment and Heritage Protection

NOTE:

This manual is current as of the date listed on the bottom of each page in this manual. All printed copies of this manual are uncontrolled and therefore may not be up to date or be correct in the information that they hold, ALWAYS refer to current digital copy of this manual for up to date information.

All drawing and schematics in this are not drawn to scale. Refer to design specifications and original O&M Manuals for precise drawings and schematics.

This Manual does not replace on the job training nor formal training provided by RTO's. This manual is designed to assist operational staff.

Description of Facilities

Introduction

The township of Cloncurry utilises a Imhoff Tank, Lagoons and Polishing Plant to process the sewage within the township of Cloncurry.

Treatment Plant

Cloncurry uses a Imhoff Tank to process the raw sewage from ?? sewage pumps stations. The treatment plant (Imhoff Tank), uses 7 oxidation ponds. Wastewater from the oxidization ponds is then drawn into a polishing plant and then pumped out onto irrigation fields. Water from the Polishing plant is then used for required DEHP sampling.

Design Principles of Imhoff Tank

The Imhoff tank process was developed by Karl Imhoff to serve the residents of Emscher District of Germany. In 1907 he brought the plant design to the United States where they were widely installed. The plant was widely used for primary treatment preceding trickling filters.

* Alternative in small communities the use of lagoon systems can replace the biological filters, secondary setting tanks and chlorine disinfection.

**Credit for use of the Texas Water Commission Document LP14-01 "Operation & Maintenance Guide for Imhoff Tank and Oxidation Pond Wastewater Treatment Plants", which gives permission to copy the material freely, as is done in this manual.*

Design

The components of the Imhoff tank design are shown in Figure 1. The Imhoff tank incorporates sedimentation and sludge digestion within the same structure without impairing the aerobic effluent quality with anaerobic septic condition, resulting from the organic solids removed.

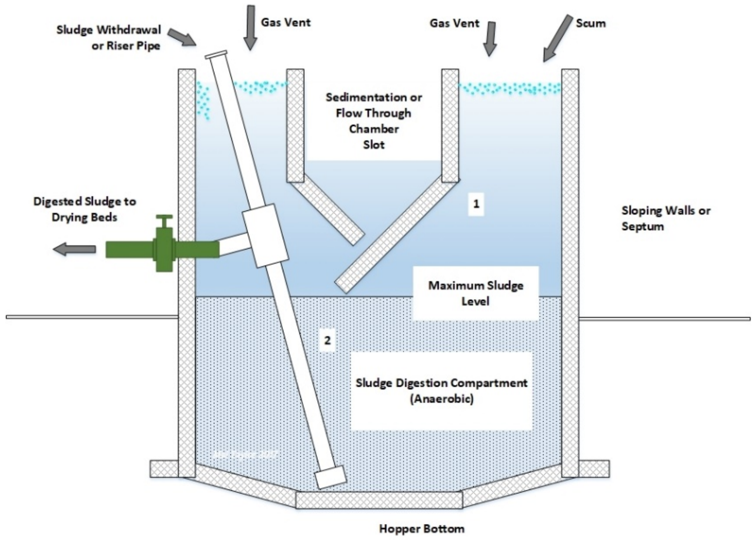
The tank is structured into two levels: (1) sedimentation taking place in the upper level; and (2) sludge digestion taking place in the level below.

The tank may be horizontal rectangular flow or circular radial flow

The rising main discharges into a screening chamber screen and silt trap.

(1). The Upper level or sedimentation chamber has baffles to slow down the flow so solids can settle out.

(2). The digestion compartment is generally divided with cross walls. These cross walls are for even distribution of solids and for structural reasons. These walls have openings in them to provide equalisation and distribution of sludge to the various compartments. These cross walls are located well below the normal sludge level.



Sedimentation (Flow Through Chamber)

After the raw sewage has passed through the grit chamber and bar screens, it enters the tank and flows through the "sedimentation" or flow-through chamber. The chamber has an internal diameter of 6.1m with a capacity of is 87.1 kL. This chamber has inlet and outlet structures and baffles (to prevent short circuiting and to trap floating debris). The sedimentation chamber removes approximately:

- 100% of settleable solids
- 60% of suspended solids
- 30% of Biochemical Oxygen Demand (BOD)

from the influent of the velocity is maintained to 0.15 to 0.3m/s. The sloping (septum) walls give the sedimentation chamber a through-shaped bottom that has a slot which extends the entire length of the sedimentation chamber. The suspended solids separated from the raw sewerage adhere to the vertical or sloping walls or slide into the digestion chamber. The sedimentation chamber is designed to:

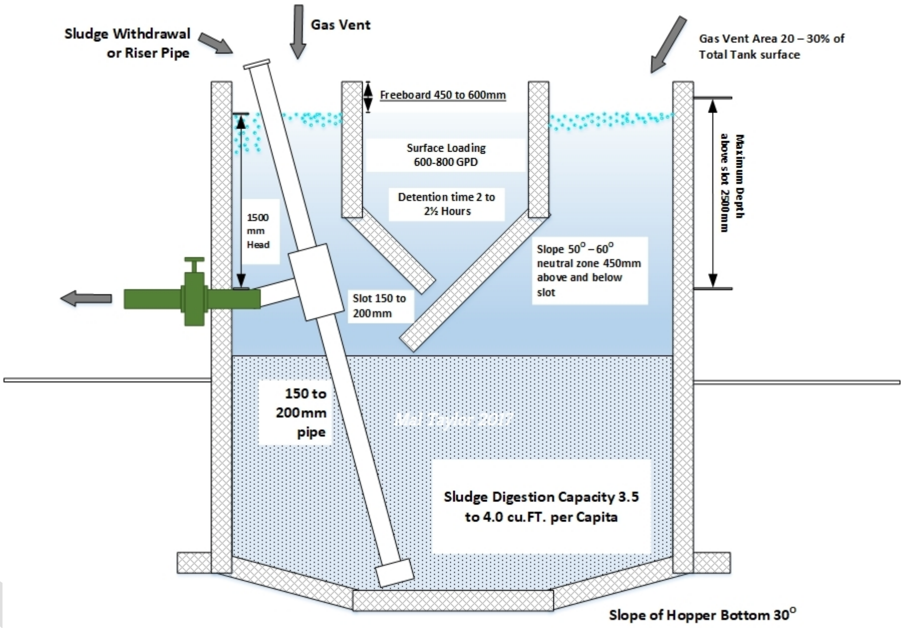
- Have a displacement velocity of less than 0.45m/minute, generally 0.15 to 0.3 m/minute.
- The theoretical detention time ranges from 2.0 to 2.5 hours.
- Surface loading – 3 to 5 kL per square metre of surface area.
- Maximum depth from top of outlet to weir slots is 2.7m.
- Width of the slots is 150mm to 200mm
- Inlet baffles – constructed across the chamber near inlet end. Bottom edge 300mm to 450mm below level of outlet weir and the top, which is bevelled downward toward the inlet, should extend slightly above the anticipated level of the sewerage in the chamber at peak flow (to prevent debris blocking entering the chamber)
- Outlet baffles – constructed across the chamber near the outlet with the top edge level with the top of the tank and the bottom edge 150 to 300mm below the outlet weir level.

- Outlet weir – a metal plate weir, each knife edged or notched, which can be adjusted to make it level, is provided at the outlet end of the chamber.

Outlet channel – provided to collect the effluent from the weir sized to carry the effluent from the weir in such a manner as to prevent their submergence to oxidation ponds

Sludge Digestion Chamber

One of the most important advantages of this type of treatment is that the sedimentation and sludge digestion can take place in the same structure. The sludge undergoing digestion in the Imhoff tank is warmed by sewage flowing above the digestion chamber and the surrounding earth which is mounded around the tank, maintaining an even temperature while ambient temperatures fluctuate. To create minimum diffusion between sludge liquor and sludge blanket, the sewage passing through the sedimentation chamber - a neutral zone of at least 450mm above and below the slot must be maintained. The sludge blanket should never be allowed to reach the slots. If the neutral zone is not practiced, the flowing sewage will become septic and excessive amounts of scum will form



The major bacteria in an Imhoff plant is *Psychrophillic* which in cold temperature conditions (<10ºC – 20ºC) and *Mesophillic* in warmer temperatures (20ºC – 45ºC). Saprophytic bacteria, which are the acid formers, are present. These need a pH of 6.5 to 8.0. The methane formed transforms to the acids or volatiles into methane gas. Other gasses formed are carbon dioxide and hydrogen sulphide. The sludge digestion:

- Capacity should be about 0.1m^3 per capita. The capacity of this plant is 42m^2 based on the volume available 0.45m below the top of the sludge chamber.
- Depth is 2.98m
- Slope of hopper-bottom is 30 to 45 degrees
- Sludge withdrawal or riser pipe is 150mm dia. A horizontal pipe branches from the riser which is fitted with a valve to withdraw sludge to the trying beds when required.
- The two outer openings beside the channel are called gas vents or scum chambers – the function of providing scum that is brought to the surface by adhering to the gasses produced in the digestion process. This allows gasses to escape to the atmosphere. The gas vent area is 25% to 30% of the total tank surface area. The width of the vents is designed to allow entrance to the sludge compartments when the tank is empty for maintenance.

Sludge Drying Beds

The total area of the four sludge drying beds is 21.6m^2, which is adequate for the current population, but can pose a challenge in the winter if wet conditions are prolonged.

Oxidization Ponds

The first wastewater treatment systems known were ponds. The main limitation of ponds is that with larger populations these easily become overloaded.
Advantages of waste treatment ponds:

- Lack of expensive operating equipment
- Doesn't require technical skilled personnel
- Economical to construct
- Adaptable to fluctuating loads
- Most trouble-free process when operated and designed properly

The normal release is from pond ???? weir, which is Licence point????. The discharge is distributed to a series of outlet pipes (manifold arrangement).

Description of the Treatment Process

Background

Wastewater is defined as any water that has been adversely affected in quality by human influence. Wastewater contains a mixture of domestic sewage (i.e. water from household/public toilets, sinks, showers, and washing machines etc.), industrial effluent, occasional run-off of surface water and ground water which has infiltrated into the sewers. 95-99% of wastewater is water with small amounts of dissolved or suspended solids.

The use of untreated wastewater can have a detrimental effect on agriculture and waterways and poses serious health risks to the community. Treated wastewater however can potentially be reused as source water such as for industry (cooling towers), in agriculture, open space irrigation and in the rehabilitation of natural ecosystems. Therefore, the treatment of wastewater is not only desirable, but it is a necessity.

Wastewater Treatment is the process of removing contaminants from wastewater. Wastewater Treatment uses physical, chemical, and biological processes to remove physical, chemical and biological contaminants in wastewater. The aim of the treatment process is to produce environmentally safe liquid waste stream (i.e. treated effluent) and a solid waste (i.e. treated sludge) suitable for disposal or reuse (usually as farm soil conditioner).

Wastewater Treatment chemistry is a complex process and reflected by the complexity of a Wastewater Treatment Plant in comparison to a water treatment plant. The Cloncurry Wastewater Treatment process can be broken down into five phases:

- Preliminary Treatment
- Primary Treatment
- Secondary Treatment
- Tertiary Treatment
- Sludge (biosolid) Treatment

Preliminary Treatment

Preliminary Treatment is initial phase of the treatment process where the raw sewage first enters the plant. Raw sewage contains larger solid inorganic materials such as paper, plastic and rags which are damaging and impeding to the WWTP. Raw sewage also contains grit, silt and other particles which are abrasive to plant equipment. The aim of this phase is to remove this material from the raw sewage water. This is the purpose of the inlet chamber at the Cloncurry WWTP. The inlet chamber use screens and augur screening to remove this material from the raw sewage. The raw sewage enters the Imhoff tank for both primary and secondary treatment.

Primary Treatment

Primary Treatment is the second phase of the Wastewater Treatment process where the raw sewage from the inlet chamber undergoes sedimentation. In this phase solid particles of organic material in the sewage settle to the bottom sludge digestion compartment.

Secondary Treatment

Secondary Treatment is the third phase of the Wastewater Treatment process where the raw sewage is subjected to aerobic digestion and sedimentation. Aerobic Digestion is the process of oxidizing and decomposing the organic part of the sludge by micro-organisms in the presence of oxygen. This process occurs in the stabilisation and oxidation ponds.

Tertiary Treatment

Tertiary Treatment is the fourth phase of the treatment process. In this phase the effluent is dosed with chlorine for disinfection to comply with the licence requirements. Chlorination was reportedly trialled at the Cecil Plains Wastewater Treatment Plant, but not continued. The effect of ultraviolet sunlight is sufficient to produce Class C effluent suitable for discharge and controlled irrigation at the adjacent golf course.

Sludge Treatment

Sludge Treatment is the fifth phase of the Wastewater Treatment process. The settled solids in the Imhoff Sludge Digestion compartment undergoes anaerobic digestion, a series of biological processes in which microorganisms break down biodegradable material in the absence of oxygen. The digested sludge is drawn off at intervals to maximise digestion but also to allow sufficient freeboard to the bottom of the sedimentation tank.

The digested sludge is drained into the drying beds. The drying beds are used to dewater sludge both by draining through the sand and gravel media and by evaporation from the surface exposed to the air. The dried sludge can be used as a natural soil conditioner on farmland or simply be disposed of in landfill. At Cloncurry the dried sludge is disposed of within the Landfill compound.

Operation of Treatment Process and Facilities

Sewage Pumping Stations (SPS)

No 2 Pumping Station is responsible for the total delivery of sewage to the treatment plant. Therefore it must be monitored and maintained very carefully.

It is recommended that the pump-well be hosed and broomed every day. The build-up of fat should be scraped from the walls at least once a week.

Level control for the stations utilises a multitrode which must be cleaned once a week. Start/stop set points can be varied and time delays are built into the controls. The correct operation of the multitrode must be checked daily. The wet well of No 2 Pumping Station is able to take 2-3 hours of average dry weather flows. There is no overflow holding tank at this site. Overflows may occur if the Pumping Station fails (i.e. electrical faults, power failures and pump issues etc.). Cleaning up is documented in the list of work instructions.

Note: Storage capacity is very limited, therefore immediate response to alarms is vital.

Imhoff Tank

A. Clean Daily (Figure 4 and Figure 5)

- screens
- grit chamber
- surfaces

B. Remove and dispose of accumulations in the inlet and outlet channels.

C. "Churn" the scum in gas vents with scum hoe to ensure proper escape of gasses resulting from digestion of sludge and to aid in settling the solids trapped in the scum.

Note: Scum which will not settle must be removed from the scum chamber and be buried at the landfill to prevent odours and fly breeding.

D. Sedimentation chamber (flow through chamber)

- All floating solids should be skimmed from the surface and material removed should be placed in gas vent or buried.
- After removal of floating material, the total submerged interior surfaces of chamber sides, ends and sloping walls should be *squeeged* to remove solids adhering to them.
- To be assured that all solids slide into the digestion compartment and that no obstructions exist along the slots, a *chain* is lowered through the slots, and then proceed from one end to the other end of the tank in a sawing type motion.
- The skimming process should again be repeated to remove new floating materials.

- Remove all organic material which might be splashed above the normal sewage level on the sides and ends of the sedimentation chamber. Also, remove this material as well as any material trapped in the baffles with a stiff *bristled broom or brush.*

E. Digestion Compartment

- At least once a week the elevation of the sludge blanket should be measured. This is done with a sludge sounding block on a chain. The sludge level should be 450mm below the slots of the sedimentation chamber.

- Draw sludge in small amounts at frequent intervals rather than large amounts at longer intervals during the winter months when temperatures are below 10°C. But if temperatures reach 30°C only 30 days.

- Fully digested sludge should be brownish-black in colour and have a pH of 7.0 or greater.

Note:A light spray of water can assist in breaking up floating scum or debris.

Note:Care must be taken when entering the channels for the required cleaning or maintenance purposes. The conditions can be extremely slippery and could result in personal injury. A risk assessment must be completed prior to entering the channels.

Waste Treatment Ponds

Pond Classifications and Uses

There are three types of pond classifications and uses:

1. Stabilisation ponds – No 1 treatment unit, often quite large
2. Oxidation ponds – ponds in a series after 1st treatment pond; these will provide additional clarification, BOD removal and disinfection
3. Polishing ponds – ponds in a series after trickling filter plant

The Cecil Careful Pond No 1 is deeper and slightly larger and acts as a stabilisation pond. The detention time is over 20 days, which characterises a facultative treatment process: the upper portion (supernatant) is aerobic, while the bottom portion is anaerobic. Algae supplies most of the oxygen to the supernatant.

Ponds 2-4 are shallower and smaller than pond no 1 and are classed as oxidation ponds but may still be partly facultative. The average detention time in each pond is around 20 days (based on 50kL/d).

Explanation of Pond Treatment Process

1. Aerobic Pond:
    a. Organic matter plus bacteria release carbon dioxide (CO_2) and Ammonia (NH_3). Then along with sunlight plus water (H_2O) algae populations increase.
    b. Algae combined with the carbon dioxide (CO_2) in the water and with sunlight release oxygen as a by-product (and some CO_2). At night this pressure reverses.
    c. Bacteria + oxygen + organic matter = CO_2 & NH_3.
2. Anaerobic Ponds:
    a. Organic matter acted on by acid producing bacteria to produce CO_2, nitrogen and other organic acids.
    b. Organic acids acted on by methane producing bacteria produces methane gas resulting in alkalinity.
    (Cecil Plains does not have an anaerobic pond, only anaerobic zones)
3. Facultative Pond:
   The above two (2) processes both occur in the facultative pond

Sludge Acumination in the Aerobic Zone

1. Sludge accumulation is the result of:
    a. Lack of Biological Population
    b. Low pH
    c. Presence of inhibiting factors
    d. Low temperature
2. All organic matter on the bottom of the pond is subject to "methane fermentation IF:
    a. Abundance of organic matter is present
    b. pH is between 6.5 and 7.5
    c. Alkalinity is high – i.e. several hundred mg/L
    d. Suitable temperature

Pond Performance

Depending on conditions, typical pond performance is:

1. Ponds provide a BOD5 removal of 50%-90%)
2. Facultative ponds with 50 days detention removes 90-95% coliform bacteria and 70-80% of BOD load.
3. Physical Sedimentation removes 90% of suspended solids in 3 days, and 80% Dissident organic Solids in 10 days. "Bioflocculation" (i.e. clumping) may occur within hours if good population of algae and bacteria are present.

Pond not doing its job when:

1. Creates visual and/or odorous nuisance
2. Leaves high BOD, solids, grease or Coliform Bacteria

Starting or Restarting a Pond

One of the most critical points of pond life is:

1. At least 300mm of water should be in a pond before introducing wastes. *Therefore, do not pump out a lagoon completely for irrigation transfer to the Golf Course.*
2. Start during warm part of the year. The warmer the pond, the better the treatment. The process takes 60 days to develop.

Notes

1. Green colour means Algae Bloom. pH of effluent will increase
2. Bubbles rising near inlet (bacterial action: pH should be kept at 7.5 if possible.

Daily Operation of Ponds

Scum Control

Scum is common in warm weather and may harbour odorous blue-green algae and/or cut of light penetration. Wind activity normally breaks this up. The operator may use:

1. Raking from shore
2. Water Jet streams
3. Removal of trees and shrubs near shores that prevent air flow

to correct the problem.

Note: The use of Copper Sulphate for Blue Green Algae Control is not permitted by the Environmental Regulator.

Note: Waterfowl and other bird life can contaminate the water, and reintroduce faecal coliform, Botulism and Salmonella. Strict hygiene practice is to be observed at all times.

Odour Control

Most odours are caused by overloading and/or poor *housekeeping*. Suggested odour control measures, depending on available resources:

1. Mechanical recirculation of aerobic water.
2. Mechanical Aeration
3. While chlorination can be added as a means to odour control, this is not generally recommended.
4. Sodium Nitrate ($NaNO_3$) is sometimes used to add oxygen to the waters, but this is also not recommended.

Weed Control

If weeds and vegetation are not controlled, it will allow mosquito breeding, allows scum accumulation and will hinder circulation of air and water. Shading of trees will reduce the efficiency of treatment and sunlight disinfection.

Insect Control

Mosquitoes: keep weeds and scum down to a minimum.

Midges: Spray if necessary with Council Approved spray.

Operating Hints

1. Ponds in series may cause the first pond to become overloaded. Ponds in parallel will more evenly distribute the wastewater. Ponds 1 and 2 may be operated in series or in parallel by valve control (boards).

2. Ponds will need cleaning (de-sludging) when solids begin floating and when sludge depths become excessive.

3. Do not apply insecticides or herbicides without first checking with the relevant authorities for long term effects.

Aerators

The Cloncurry Treatment Plant does not at this stage use mechanical aerators or air bubblers.

Troubleshooting

Troubleshooting Treatment Ponds

Problem:	**EXCESSIVE WEEDS**
Indicators	• Excessive weed growth • Mosquito problems in neighbourhoods of ponds • Poor Pond Circulation
Monitoring Analysis and/or Inspection	• Check water depth in selected areas of the pond
Corrective Measures	• Deepen all pond areas shallower than 0.9m • Remove all weed growths as soon as they are visible • For mosquito control, vary liquid level in the pond every 10 days (if practical)

Problem:	**POND ODOURS**
Indicators	• Odours of hydrogen sulphide origin from pond • Other objectionable odours
Monitoring Analysis and/or Inspection	• Check Blue Green Algae Growth in pond • Check for scum accumulation in pond • Analyse for total and dissolved sulphides in pond influent • Check pond pH and influent pH • Check DO content in pond at several locations
Corrective Measures	• If pond effluent is septic, correct situation upstream by aeration or controlled pre-chlorination • If possible aerate the pond with mechanical aerators • Remove or break up all scum accumulations

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Corrective Measures	• If pond effluent is septic, correct situation upstream by aeration or controlled pre-chlorination • If possible aerate the pond with mechanical aerators • Remove or break up all scum accumulations

Problem:	LOW POND DISSOLVED OXYGEN
Indicators	• Low Algae Growth in pond • Trace Hydrogen Sulphide Odours • Grey Colour Pond
Monitoring Analysis and/or Inspection	• Check all areas in pond for adequate DO • Monitor flow into pond and calculate average daily detention in pond • Check pH of pond influent and pond contents • Run total dissolved sulphides in pond influent • Check Pond Loading Rate (kg/ BOD / m^2) • Check for floating aquatic weeds
Corrective Measures	• Increase detention time in the ponds to at least five days by placing ponds in parallel (e.g. ponds 1 and 2) • In the absence of adequate DO in the pond, aerate pond contents or pond influent • Chlorinate pond influent if sulphides are present, subject to environmental regulatory permission • Physically remove floating weeds to increase light penetration

Recycled Water

Recycled Effluent

Effluent is supplied from the discharge point before the cofferdam. The Effluent is then pumped through the Polishing Plant before being used for irrigation at the Cloncurry Cemetery and also within the Cloncurry Wastewater Compound.

Effluent Supply Diagram

Sampling

Sampling and monitoring is conducted to ensure that the treated effluent that is compliant with legislative licence requirements and to ensure there are no adverse effects on the environment. Cloncurry WWTP monthly sampling of E.Coli is required.

Monthly Sampling

The monthly samples are to be collected and sent to ALS Brisbane for analysis. The results are to be

recorded in the WWTP Spreadsheet.. Non-conformances in licence parameters will be identified by the ???? (or delegate) who will report these to the EPA.

Cloncurry WWTP requires monthly licence sampling at ???? Sampling parameters to be sampled for are ?????? The results are to be entered into the WWTP Spreadsheet .

Weekly Sampling

Cloncurry also requires weekly sampling at ???. The only licence parameter is E.Coli. A single sample is taken for E.Coli, and sent to ALS Brisbane for analysis. The results are to be entered into the results from testing are to be entered into WWTP Spreadsheet.. Irrigation must not be used if E.coli results are >1000cfu/100mL.

Daily Sampling

Cloncurry WWTP is required to have daily samples collected. Operational staff are collect and test at the WWTP operator lab the following parameters; Free Chlorine mg/L (from polishing plant discharge point), turbidity, suspended solids, BOD, Dissolved Oxygen,pH, ?????? All results from Daily operating sampling and analysis are to be recorded in WWTP Spreadsheet.

Environmental and near miss sampling

Plant Operation and Maintenance

Cloncurry WWTP and Polishing Plant

Daily Records

- Record flow from flow meter at WWTP
- Record flow from flow meter at Polishing Plant

Daily Tasks

- Check Grit Chamber and Bar Screens for obstructions and remove any obstructions
- Check sedimentation compartment for grease, scum and floating solids, and remove if necessary
- Hose and break up scum in the scum chamber
- Hose Weirs as well as Inlet and Outlet chambers
- Check chlorine levels for chlorine dosing at Polishing Plant and replace/replenish as required.
- Check free chlorine from Polishing Plant sample tap

Weekly Tasks

- Draw off Sludge to fill one drying bed
- Squeegee or scrape the side of the sedimentation compartment to remove build-up of solids
- Hose and break up scum in the scum chamber if required
- Check general housekeeping and tidiness (including holding ponds), for litter, debris and mowing.

Annual Tasks

- Empty the sludge digestion chamber
- Check all Safety Data Sheets are correct and up to date for chemicals being used
- Check all safety signs are still clearly visible around WWTP and Pumping Stations

Township Operations

- Check all Sewage Pumping stations for overflows and blockages
- Record flowmeter readings from all pump stations
- Hose down wet wells at pumps stations and clean pump probes.
- Check operation of pumps in pumping stations.

General Duties

- Mowing, weed eating , weed spraying as necessary or directed at;
    - Cloncurry WWTP
    - Sewage Pumping Stations
    - Organise for removal of grit screens bit at WWTP when required
    - Keep compounds at WWTP and Pump Station clean and tidy.
- Order chemicals and other supplies as necessary

Valving Cloncurry Polishing Plant.

Polishing Plant showing valve locations and sample tap location