Case Study

Vetiver System for Industrial Wastewater Disposal and Treatment, and Mining Waste Rehabilitation in Australia.

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EXTENDED ABSTRACT:

Industrial Wastewater Disposal and Treatment,

The disposal of industrial wastewater in Australia is subjected to the strict environmental guidelines enforced by the Environmental Protection Authority, EPA. The most common method of treating industrial wastewater in Queensland, Australia is by land irrigation, which is presently based on tropical and subtropical pasture plants. However with limited land area available for irrigation, these plants are not efficient enough to sustainably dispose of all the effluent produced by the industries. Therefore to comply with the new standards, most industries are now under strong pressure to upgrade their treatment processes.

Current Constraints

- ***The GELITA APA***, a gelatine factory in Queensland, which extracts gelatine from cattle hide using chemical processes involving strong acids, lime and hydroxides. The effluent from the processing plant is highly saline (average 6 dS/m), alkaline and has a high organic matter content. This effluent is further processed in a typical series of anaerobic and aerobic digestive processes to lower the nitrate contents to approximately 300 mg/L of nitrogen and 2 mg/L of phosphorus. GELITA generates approximately 1.3 ML a day of wastewater, which is characteristically high in nitrogen and total dissolved salts.

Due to extreme climatic variations over the seven years of operation the planting of pasture and annual crops has not provided a viable operational methodology as concentrations of salts in soil increase proportionately to diminishing rainfall.

- ***TEYS Bros,*** a beef abattoir in Queensland, which processes in the order of 210 000 cattle per year for both domestic consumption and export. Effluent generated by the plant, with total N of 170mg/L and 32mg/L of total P, is passed through various primary treatment devices and a series of ponds prior to on-site irrigation of 65ha Kikuyu grass pasture. TEYS Bros generates approximately 1.7 ML/a day or 551ML/year, of wastewater.

Current computer modelling predicted that only 204ML/year could be disposed off if Kikuyu pastures were used. This would leave a surplus effluent volume of 347ML/year to be treated by other means.

Current Management Practices

- To comply with EPA licensing conditions, the GELITA factory effluent output is currently distributed by spray irrigation from hard hose traveling irrigators across 121 hectares of grassland dominated by Rhodes grass.
- At Teys Bros a total area of 65ha is available for irrigation, but after allowing for buffer perimeter, currently only 42.3ha are can be used for irrigation. Currently effluent is either spray or surface irrigated onto Kikuyu pasture at various sites around the property. The pasture is not harvested and the application uniformity is quite poor.

Searching for a More Innovative and Natural Solution

- **For GELITA**, alternative solutions such as chemical treatment plant and transportation to sewage treatment plant were considered but both of which are impractical and most importantly very costly to build and to operate. Therefore a more innovative and natural solution was needed. Tree planting was one of the earlier options considered, it has been trialed for several years but has not provided an effective solution to the problems faced by the company.
- **TEYS Bros** abattoir will pipe excess effluent output to the Logan Shire Council for treatment. The cost of treating this effluent is based on both quantity and quality of the effluent. Therefore any means, which can lower the volume and/or the nutrient loading of the effluent, will reduce the costs of treatment to the company.
- **VS a new innovative phytoremedial technology** for wastewater treatment, developed by the Department of Natural Resources and Mines in Queensland, (Truong and Hart, 2001). VS was identified as having the potential to meet all the criteria of both factories.

Over the past 10 years a research conducted at GELITA APA, and TEYS Bros. has identified VS as having the potential to meet all the criteria:

- Vetiver has the potential of producing up to 132t/ha/year of dry matter yield as compared to 23 and 20t/ha/year for Kikuyu grass and Rhodes grass respectively

- With this production vetiver planting has the potential of exporting up to 1920kg/ha/year of N and 198kg/ha/year of P as compared to 687 of N and 77kg/ha/year of P for Kikuyu and 399 of N and 26 of P for Rhodes grass respectively.

- Vetiver growth can respond positively to N supply up to 6 000kg/ha/year and to ensure this extraordinary growth and N uptake, P supply level should be at 250/ha/year.

Computer Modelling Results

- **At GELITA**, based on an assumed maximum annual effluent output of 475 ML/year, and N concentration of 300mg/L and P of 1mg/L, amongst the three grasses, vetiver requires the least land for sustainable irrigation in both N and effluent volume, 72.5, 104 and 153ha with vetiver, Kikuyu *(Pennesitum clandestinum*) and Rhodes grass (*Chloris guyana*), respectively.
- **At TEYS Bros,** based on an assumed maximum annual effluent output of 551 ML/year, and N concentration of 170mg/L and P of 32mg/L, when Vetiver grass was used, approximately ***1.24 ML/day*** of effluent can be sustainably irrigated on the available land and with Kikuyu grass pasture only approximately ***0.8ML/day*** effluent can be sustainably irrigated on the same site. The above results indicate that, vetiver planting would provide ***an improvement of 55% over Kikuyu.***

Mining Waste Rehabilitation

Vetiver grass, due to its unique morphological and physiological characteristics, which has been widely known for its effectiveness in erosion and sediment control, has also been found to be highly tolerant to extreme soil conditions including heavy metal contaminations suitable for mine rehabilitation

Characteristics of Vetiver Suitable for Mining waste Rehabilitation

- Tolerance to highly adverse conditions: sodic, acidic, alkaline and saline soils
- Tolerance to heavy metals: As, Cd, Cr, Cu, Hg, Ni, Pb, Se and Zn.
- Tolerance to high acidity (pH 3.5) and Aluminium and Manganese toxicities
- Vetiver grass is both a xerophyte (deep and extensive root) and a hydrophyte
- Vetiver can withstand burning, slashing and moderate tractor traffic,
- Resistant to infestation from most pests, diseases and nematodes.
- Most of heavy metals absorbed remained in the root; hence it can be used as fodder.
- Most Vetiver genotypes are sterile; it has no above or underground runners, therefore any potential to become a weed.

Phytoremediation of contaminated lands

VS has been successfully used for stabilisation of steep slopes associated with bunds, tailings dams and revegetation of mine tailings.

- ***Mining wastes***: waste rocks and tailings of coal, copper, gold, lead, platinum and zinc have been successfully stabilised and rehabilitated in Australia, Chile, China, India, Thailand and South Africa.
- ***Industrial wastes***: Industrial wastes contain very high levels of both organic and inorganic compound have been successfully stabilised and treated in Australia, China, India, Thailand and Vietnam.

Keywords: Effluent disposal, irrigation, nutrient, fodder, mine tailings and rehabilitation, heavy metals

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Links to well-illustrated websites:

- http://picasaweb.google.com/VetiverClients/VetiverSystemForMineAndQuarryRehabilitation
- http://www.Vetiver.org/TVN_archive.htm" \l "Anchor-LANDFILL-45656

A Brief Introduction to the second author

Cameron Smeal is the Environmental Manager of GELITA APA operations in Australia and TVNI Associate Director, Brisbane, Australia. Managing Director of CDS Group P/L, and has spent last 10 years in practical development of industrial waste disposal techniques for Weston Bioproducts and GELITA. Research project focus over last 5 years has been in sustainable disposal of industrial effluent by land irrigation.