

**Vetiver System for the Prevention and  
Treatment of Contaminated Water and Land**  
(Special Reference to Domestic and Municipal  
Wastewater Treatment in Australia)



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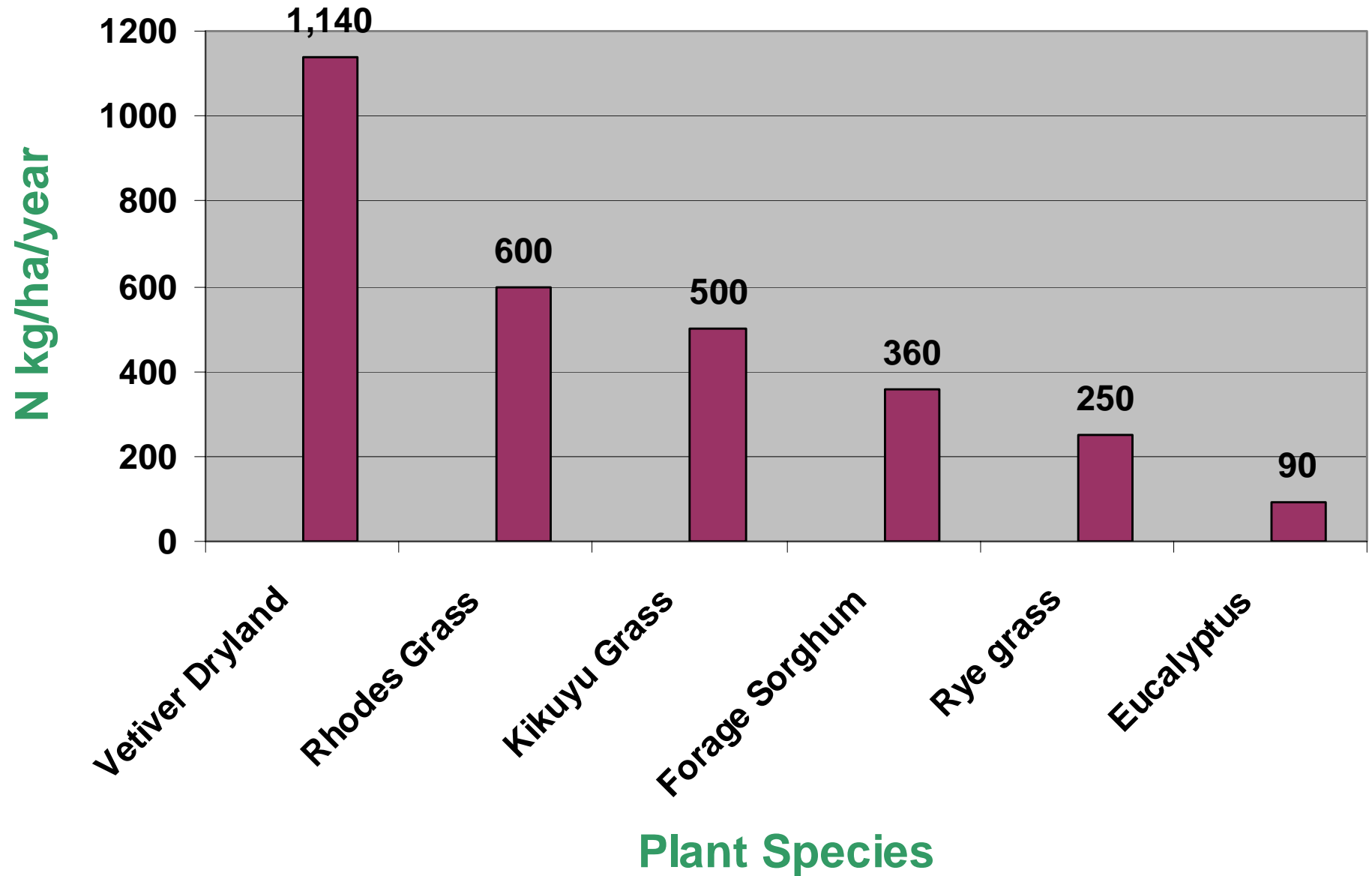
# INTRODUCTION

- The Vetiver System (VS) is was first developed by the World Bank for soil and water conservation and now being used in over 100 countries for various applications.
- R&D conducted in several countries showed that vetiver grass is tolerant to the most adverse conditions: high in acidity, alkalinity, salinity and sodicity; heavy metal toxicities and also capable of take up large amount of nutrients in soil and water.
- Due to the above features VS has been used successfully for soil and water conservation in agricultural lands, infrastructure and environmental protection in Australia, Africa, Asia, Latin America and southern Europe.

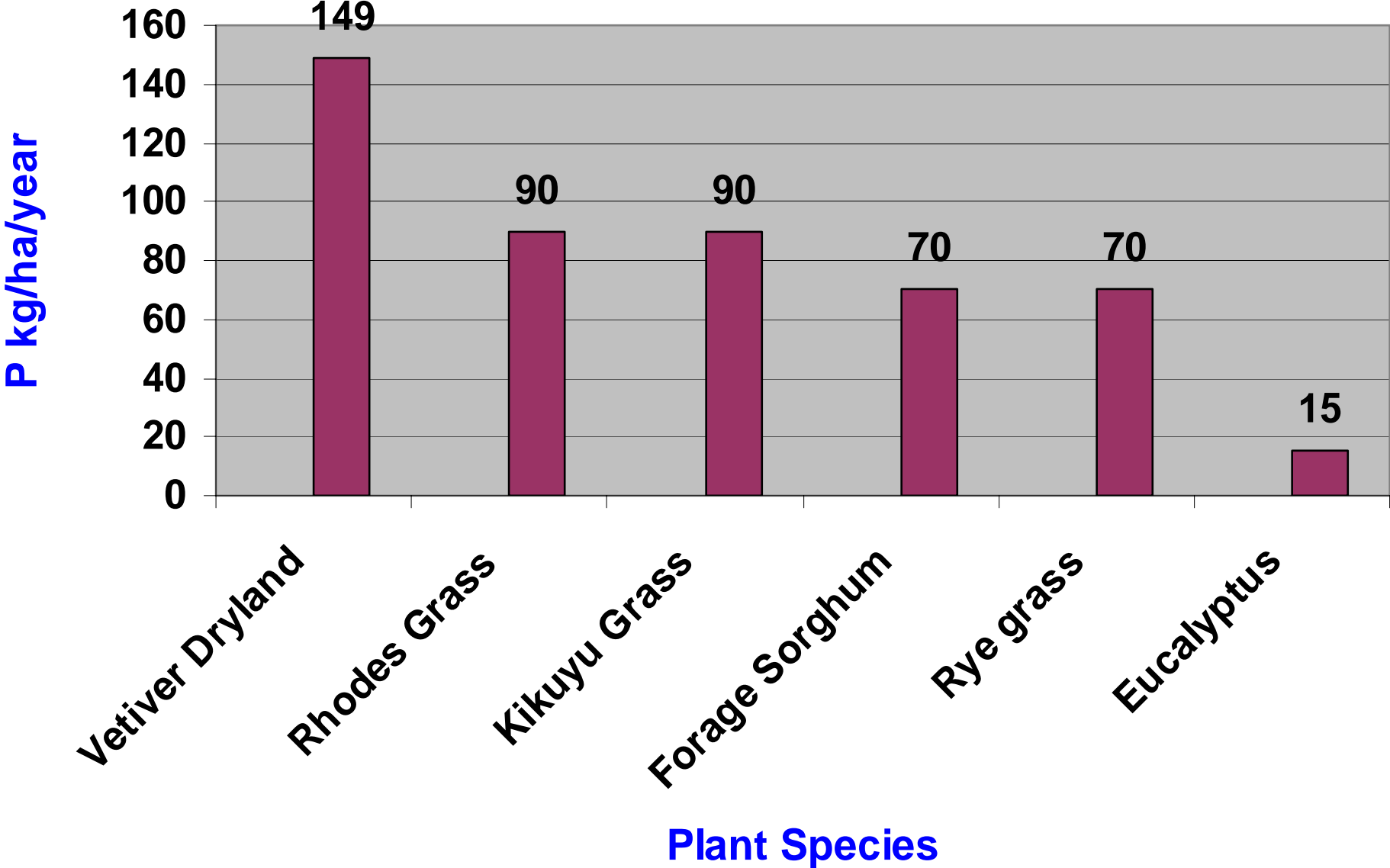
# **SPECIAL CHARACTERISTICS SUITABLE FOR WASTEWATER TREATMENT**

- **Very high capacity for N and P uptake under Dry land, Wetland or Hydroponics conditions**
- **Very fast growth with very high water consumption under wet conditions**
- **Biomass up to 132t/ha**
- **Tolerant high levels of herbicides and pesticides**
- **Highly tolerant to heavy metal toxicities**

# NITROGEN UPTAKE



# PHOSPHORUS UPTAKE



***High N and P removal:*** With high capacity of removing N and P in polluted water, vetiver cleaned up blue green algae in 4 days

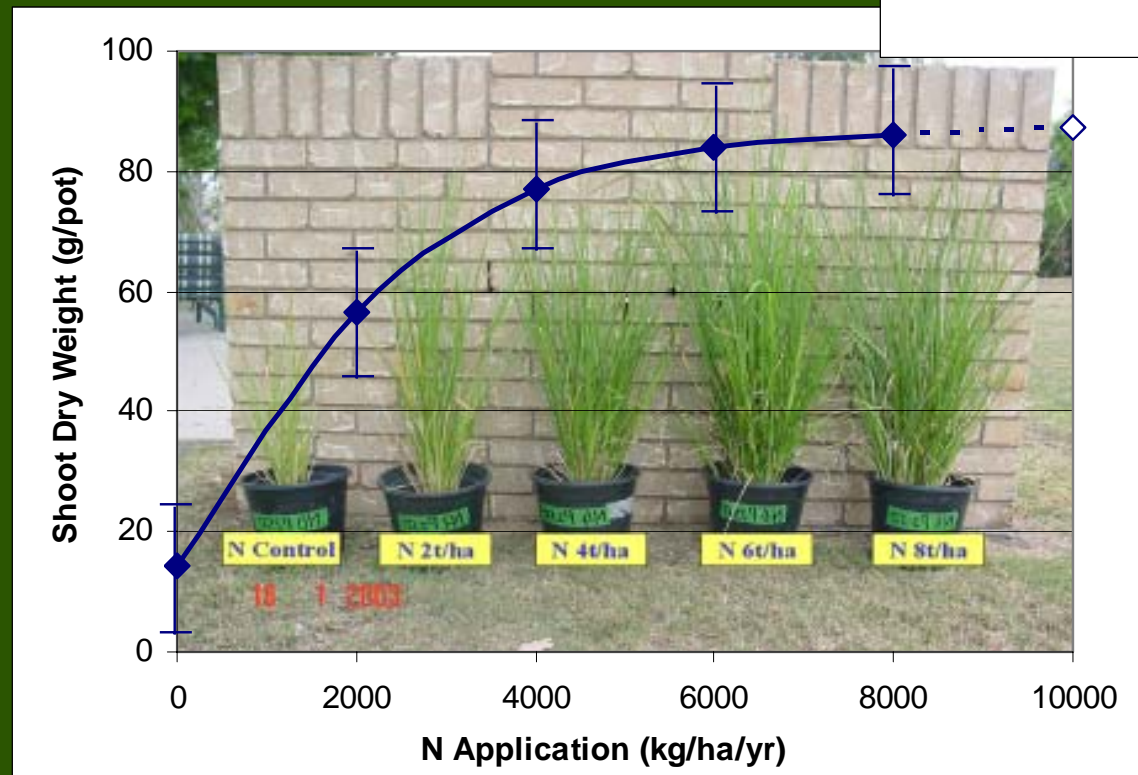
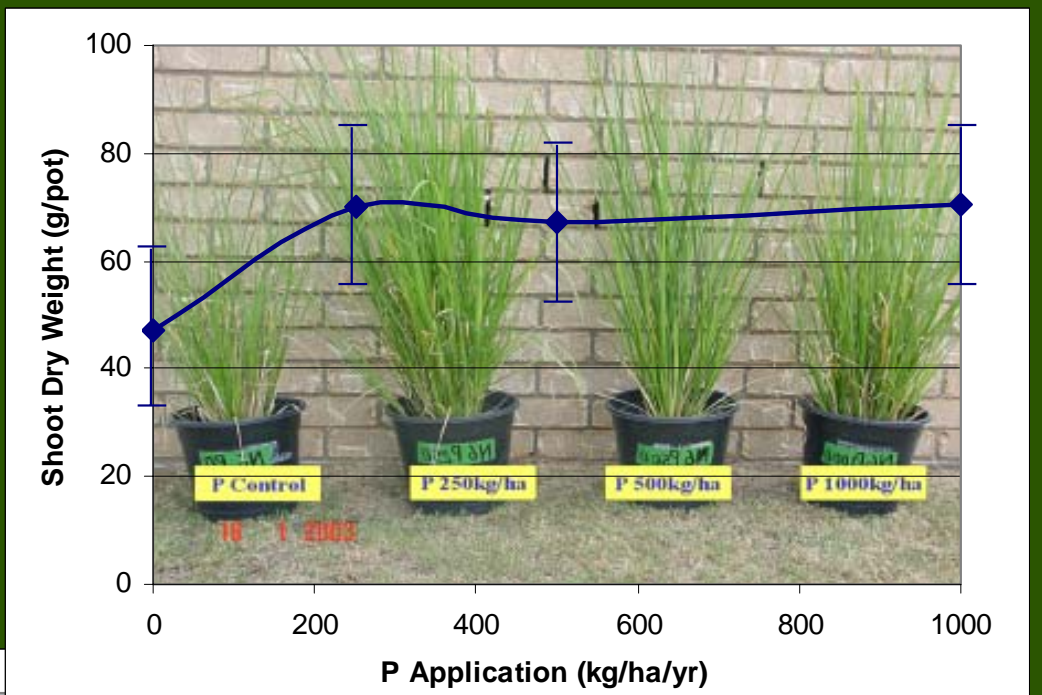
**Sewage effluent infested with Blue-Green algae due to high Nitrate (100mg/L) and high Phosphate (10mg/L)**

**Same effluent after 4 days after treating with vetiver, reducing N level to 6mg/L (94%) and P to 1mg/L (90%)**



08/12/00

# Tolerance to extremely high levels of nutrients



# APPLICATION OF VETIVER SYSTEM FOR EFFLUENT TREATMENT

- *Domestic effluent*
- *Municipal sewage effluent*



***Domestic effluent* : Vetiver was the most effective plant in absorbing effluent discharge from a toilet block on a Community Center**



**This stand of vetiver absorbed all the effluent discharge from the toilet block, note the luxuriant growth, 5 months after planting**

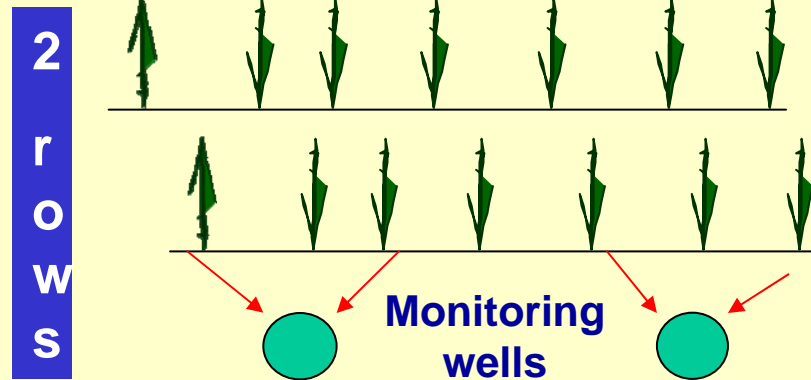


**Six months after planting this stand of 100 plants absorbs all the discharge from the toilet block**



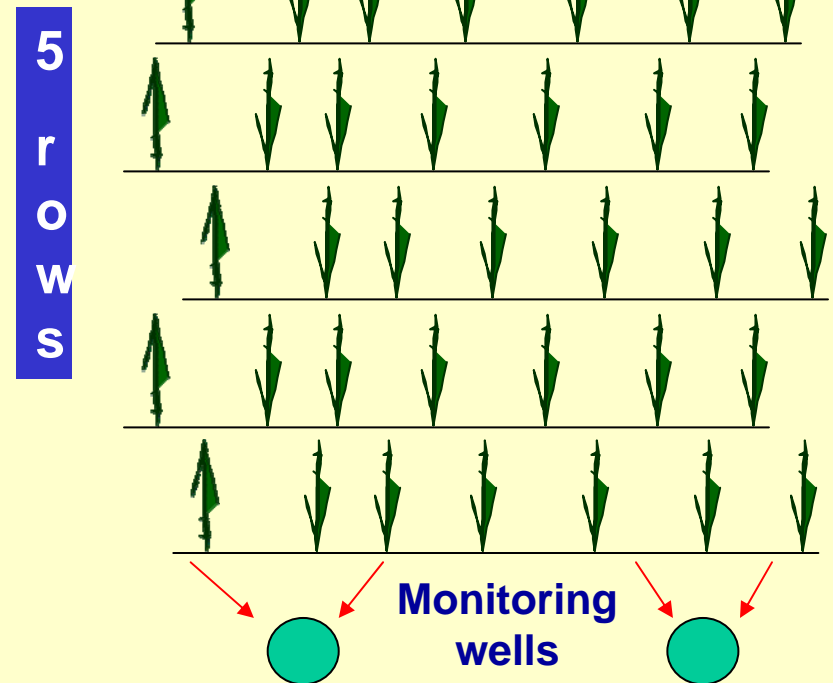
# Effectiveness of vetiver in reducing N level in domestic blackwater

**Entry: Total N level at 95.2mg/L**



**Exit: Total N level at 16mg/L**  
or a reduction of **83%**

**Entry: Total N level at 95.2mg/L**

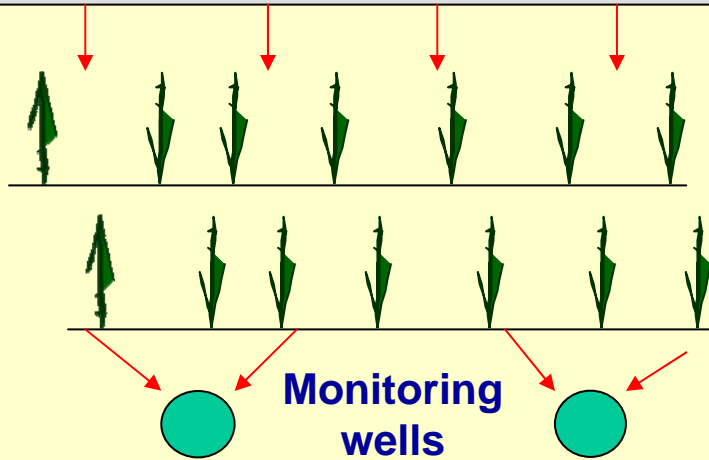


**Exit: Total N level at 1.2mg/L**  
or a reduction of **99%**

# High capacity for P absorption in domestic sewage in Australia

**Entry:** Total P level at 1.3mg/L

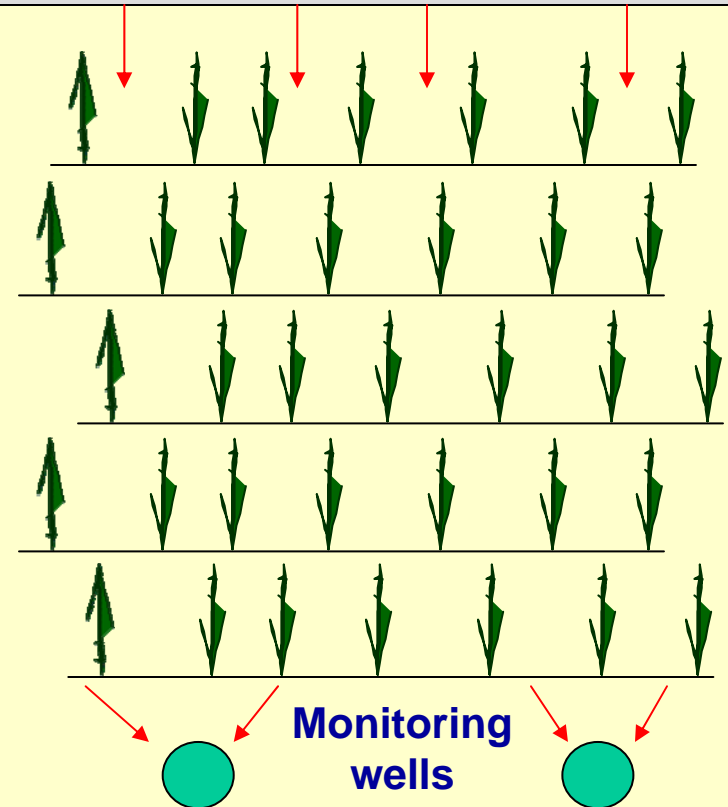
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**Exit:** Total P level at 0.24mg/L  
or a reduction of **82%**

**Entry:** Total P level at 1.3mg/L

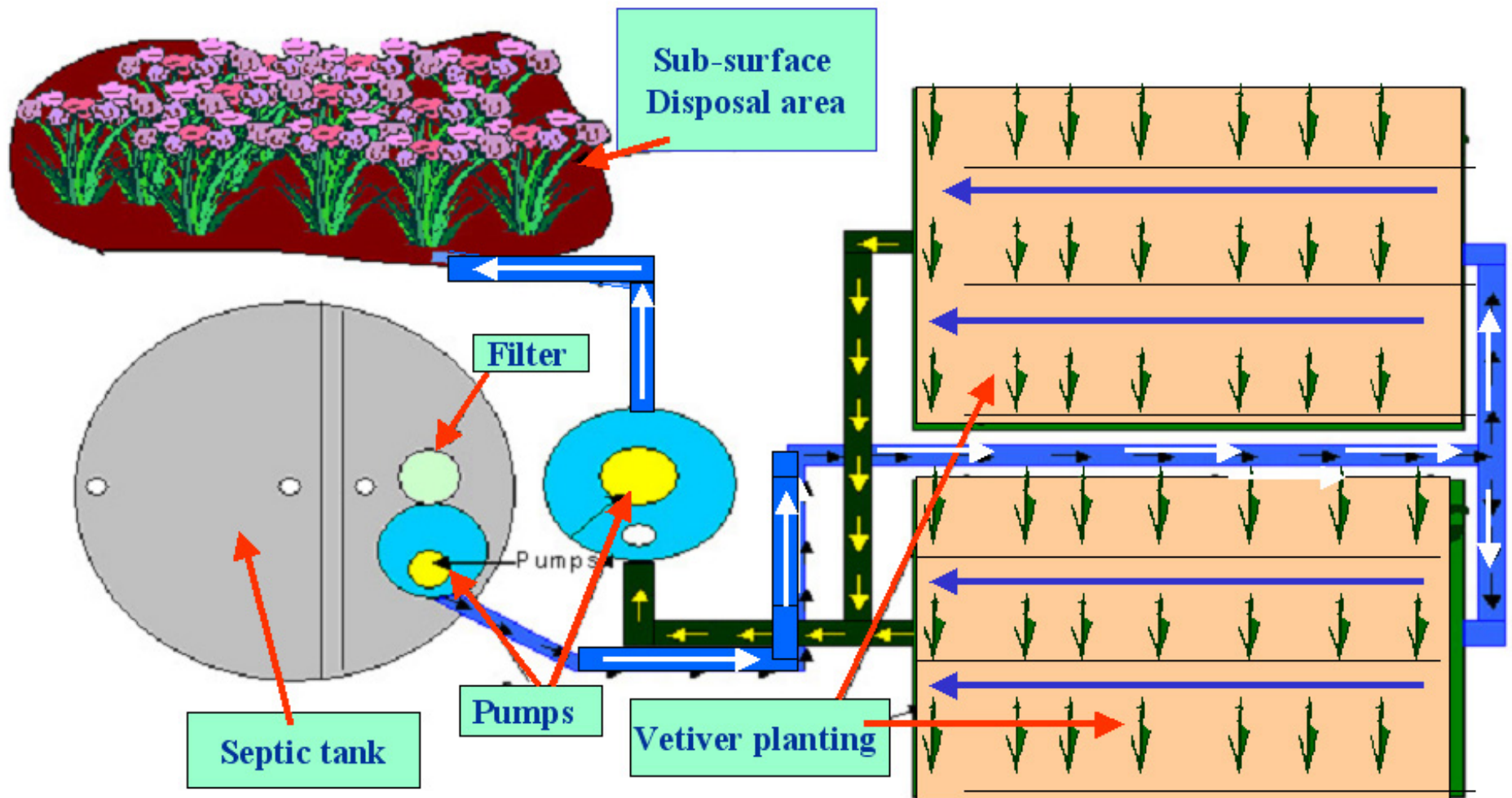
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**Exit:** Total P level at 0.20mg/L  
or a reduction of **85%**

# Domestic Effluent Recycling Plant

## Diagrammatic layout of a domestic disposal system

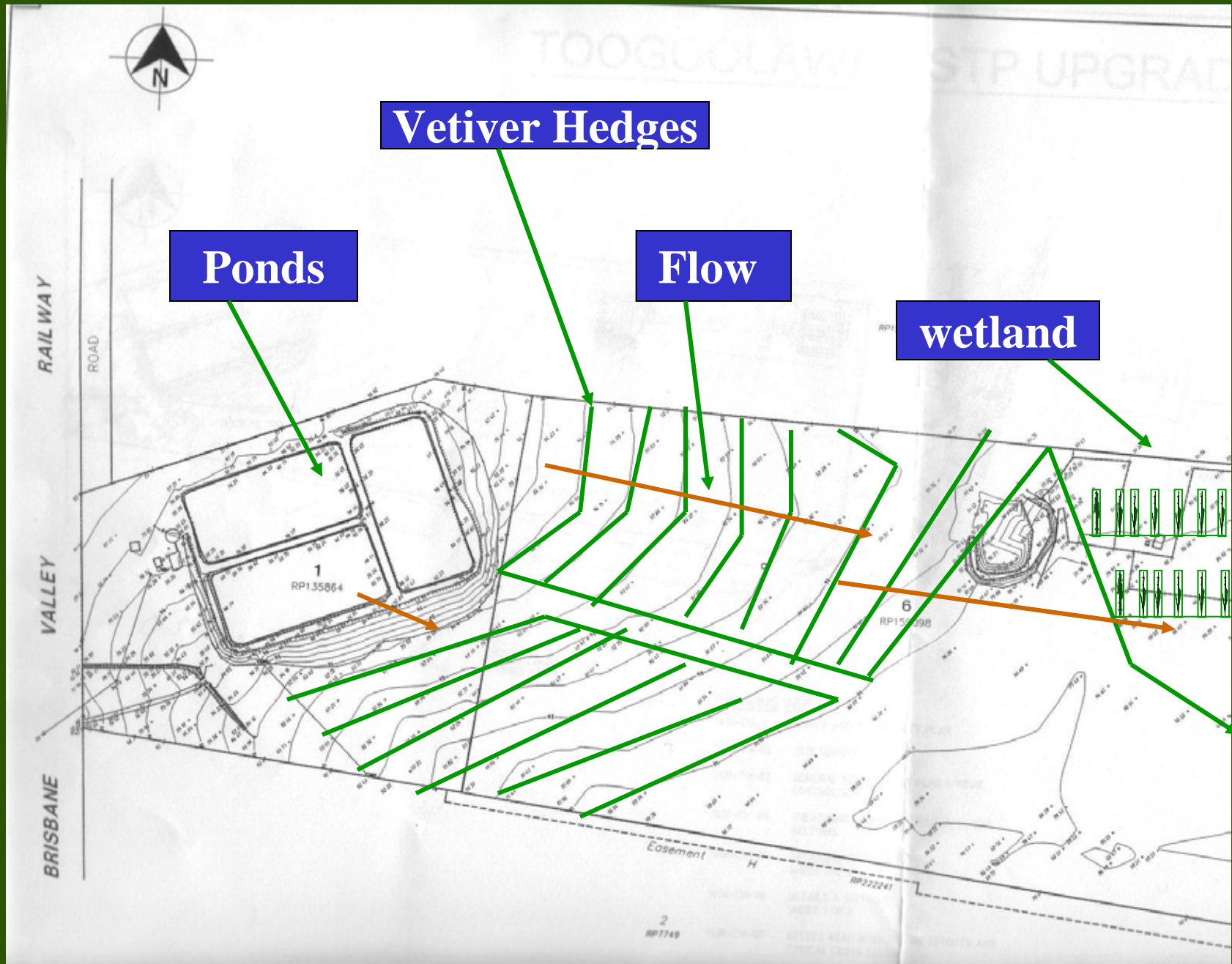


# Treatment Strategy

## Treatment in two phases:

- Pre treating effluent in storage pond with vetiver pontoons and pond edges
- Ephemeral Wetlands to treat the main body of effluent to ANZECC recommended level of 10mg/L for N and 1mg/L for P.

# Diagrammatic layout of contour lines Vetiver planting





# Municipal Effluent Treatment in Australia

First step:  
Hydroponics treatment of  
effluent in ponds



## Second step: Ephemeral Wetland treatment of municipal sewage effluent in Australia



# Ten months after planting



# TEST RESULTS OF SEWERAGE EFFLUENT

*(License Requirements in Brackets)*

Tests	Plant Influent	2002/03 Results (9 month old)	2003/04 Results (18 month old)
PH (6.5 to 8.5)	7.3 to 8.0	9.0 to 10.0	7.6 to 9.2
D. Oxygen (2.0 minimum)	0 to 2 mg/L	12.5 to 20 mg/L	8.1 to 9.2 mg/L
5 Day BOD (20 - 40 mg/l max)	130 to 300 mg/L	29 to 70 mg/L	7 to 11 mg/L
Suspended Solids (30 - 60 mg/l max)	200 to 500 mg/L	45 to 140 mg/l	11 to 16 mg/l
Total Nitrogen (6.0 mg/l max)	30 to 80 mg/L	13 to 20 mg/L	4.1 to 5.7 mg/L
Total Phosphorous (3.0 mg/l max)	10 to 20 mg/L	4.6 to 8.8 mg/L	1.4 to 3.3 mg/L

**Hydroponics  
treatment of  
intensive animal  
farm effluent**



**China**

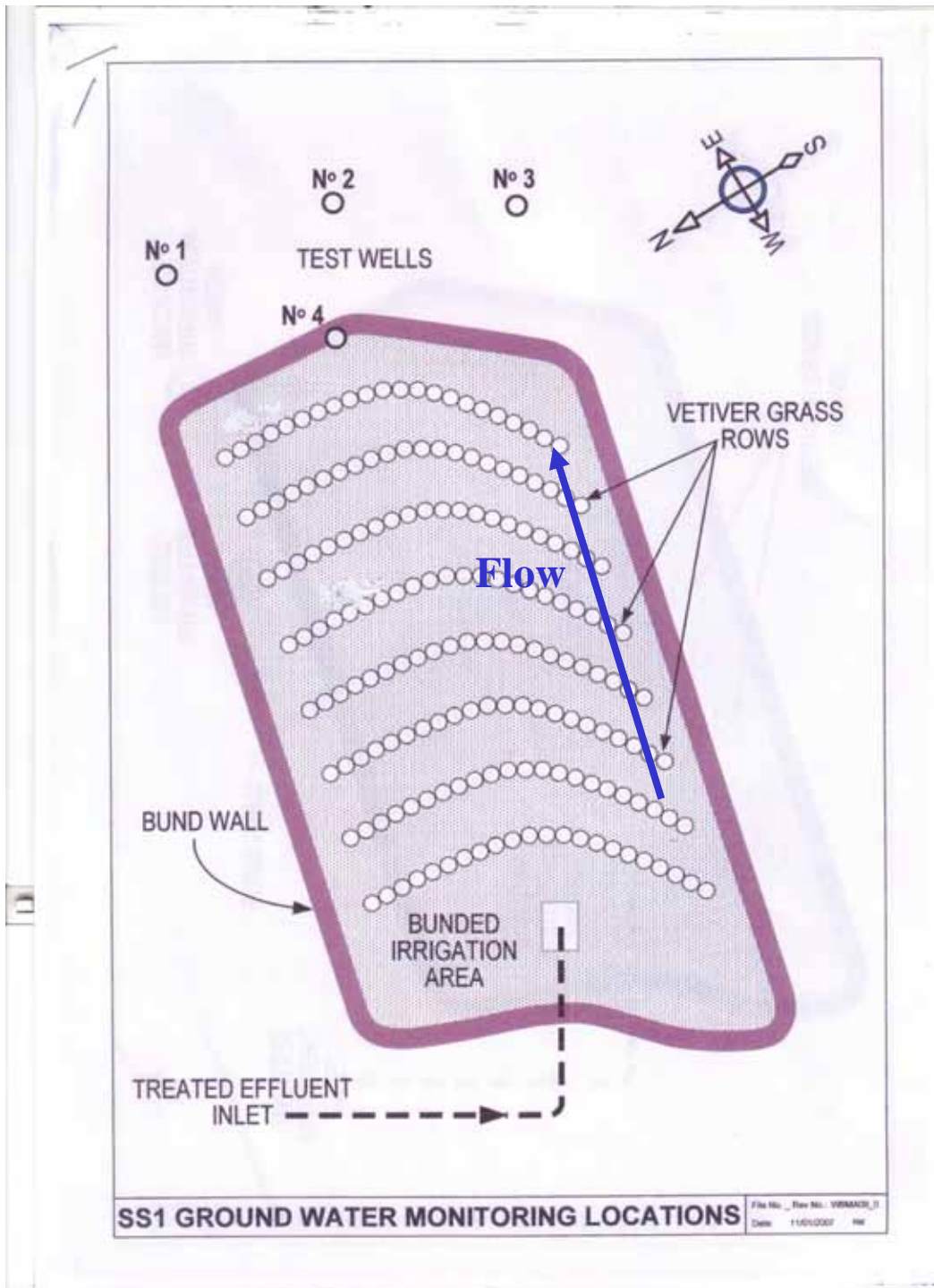


**Vietnam**

18 16:16

# APPLICATION OF THE VETIVER SYSTEM FOR SEWAGE EFFLUENT TREATMENT

*Vetiver was planted to dispose sewage effluent from a small recreational airfield in Queensland, Australia*



## Planting Design

- 8 rows of vetiver
- 10m long each
- Inter-row spacing 1m
- Plant spacing 5/m
- Total plants 400
- Gravel trench 60cm deep
- Land area 100 sqm
- Bund wall W54 X H30cm

**First year:** The first few rows have excellent growth, but the last 3 rows are very poor due to lack of effluent



**Good growth**

**Poor growth**

**Bund**

8 6 2005

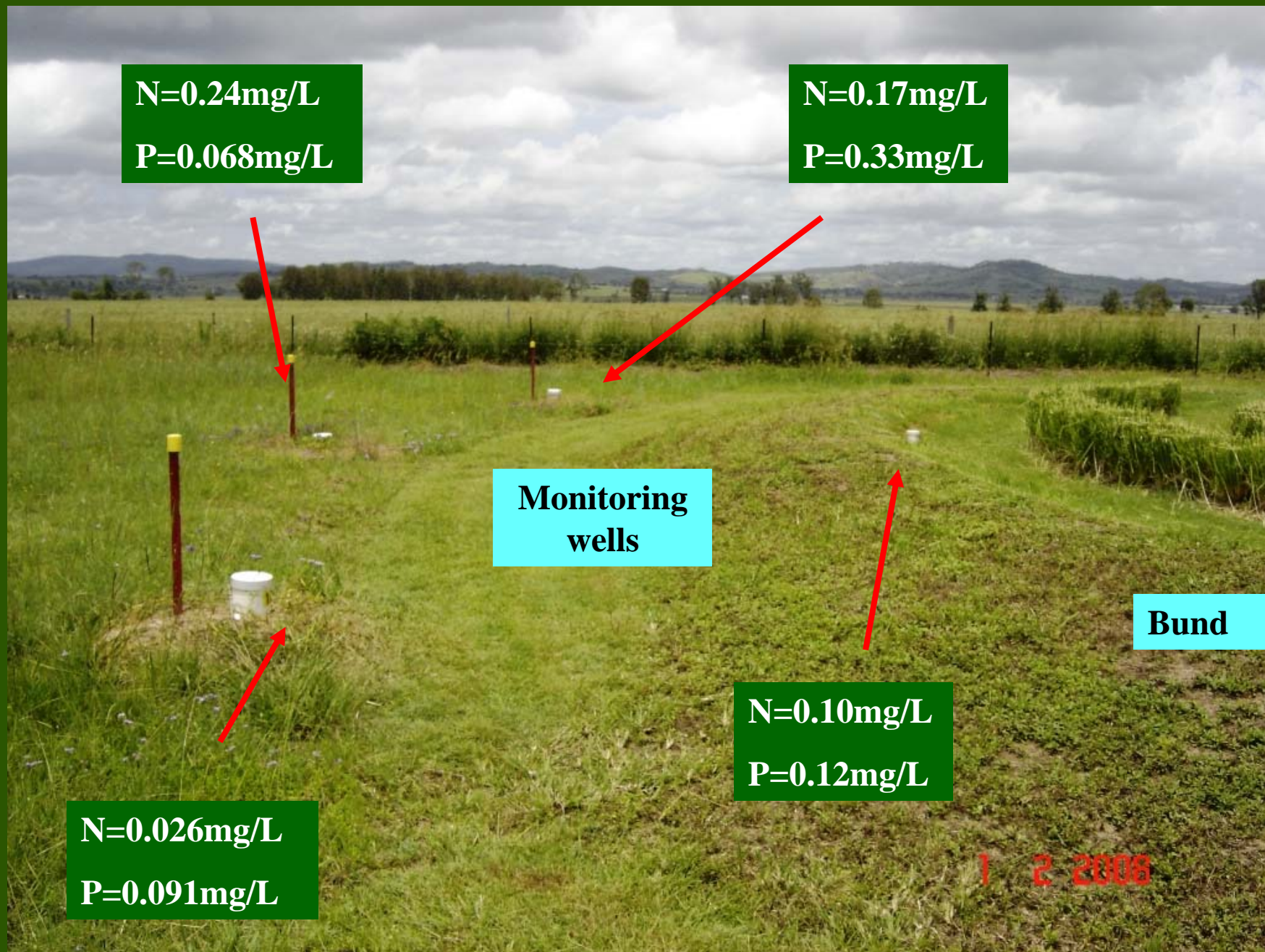


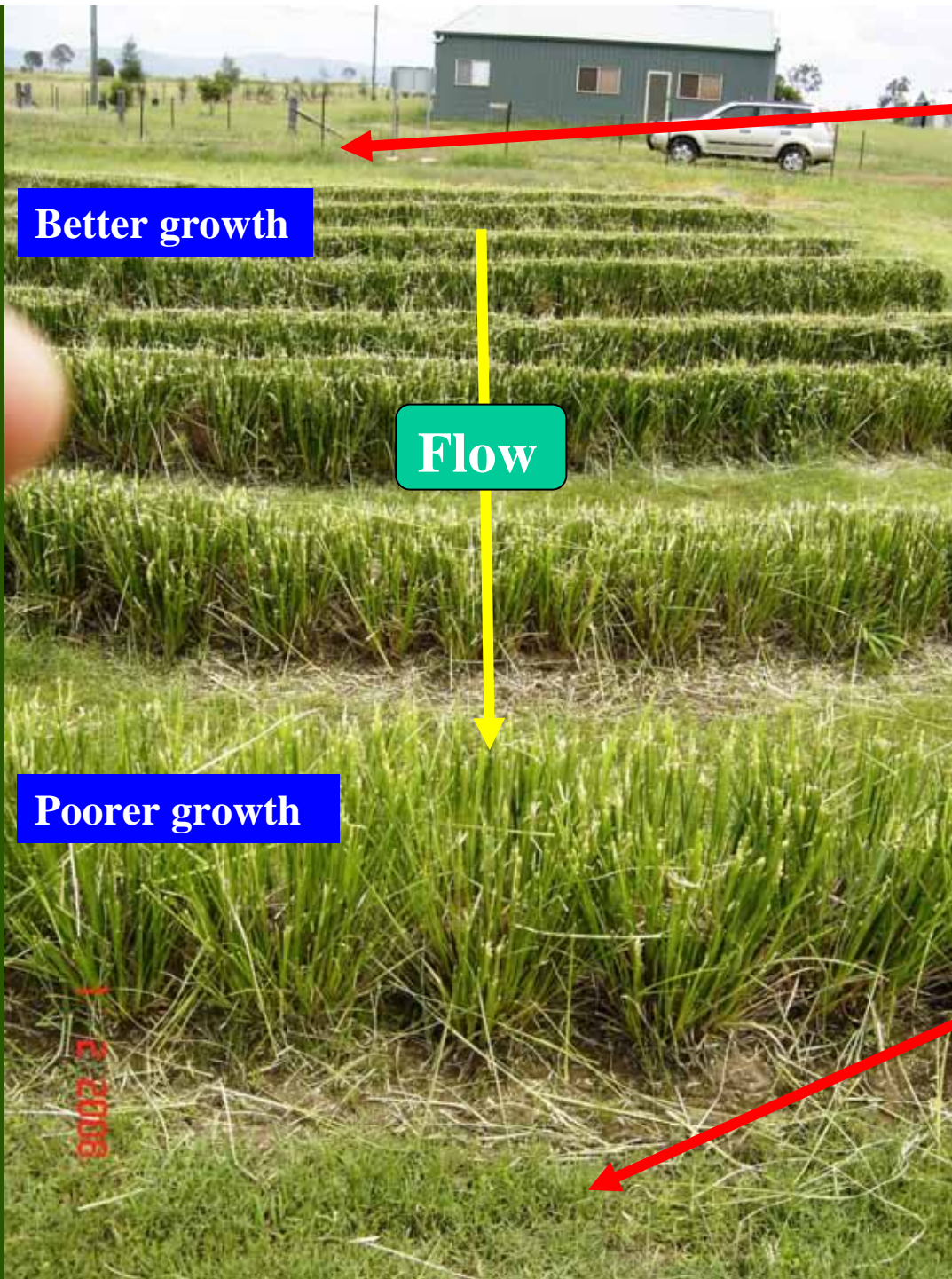


**Third year:  
Excellent growth,  
exceeding 2m.**



# Monitoring wells and nutrient levels (May 2008)





Better growth

Flow

Poorer growth

12/2008

## IN FLOW

Average daily flow: 1 670L

Average total N: 68mg/L

Average total P: 10.6mg/L

Average Faecal Coliform: >8 000

## SUMMARY

## OUT FLOW

Average daily flow: Almost Nil\*

Average total N: 0.13mg/L

Average total P: 0.152mg/L

Average Faecal Coliform: <10

\* Only flow after heavy rain



## Domestic Sewage Disposal

Aceh, Indonesia

American Red Cross  
built 2 000 units and  
will built another  
1500 in 2 009

PC: Vant Hoff



**Sewage Disposal**  
**High School, Aceh, Indonesia**

**Sewage Disposal**

**Oberoi Resort  
Bali, Indonesia**

**PC: Vant Hoff**



# **APPLICATION OF THE VETIVER SYSTEM FOR LANDFILL LEACHATE TREATMENT**

**Leachate Seepage Control**

## Landfill Leachate Seepage Control



**This leachate runoff is highly contaminated with Chromium, Cadmium, Copper, Lead and Zinc. It will eventually run into a nearby creek**

## Landfill Leachate Seepage

**Leachate after rain on the side slope of an 30 year old landfill**



## **Landfill Leachate Seepage**

**A thick stand of  
vetiver was planted  
at the outlet  
of the leachate  
seepage**



**Three months after  
planting**





## **Landfill Leachate Seepage**

**Twelve months after planting, excellent growth, unaffected by heavy metals contamination in the leachate.**

**Within a year vetiver has completely stopped the leachate seepage**



**Kikuyu grass is not effective for landfill seepage control.**

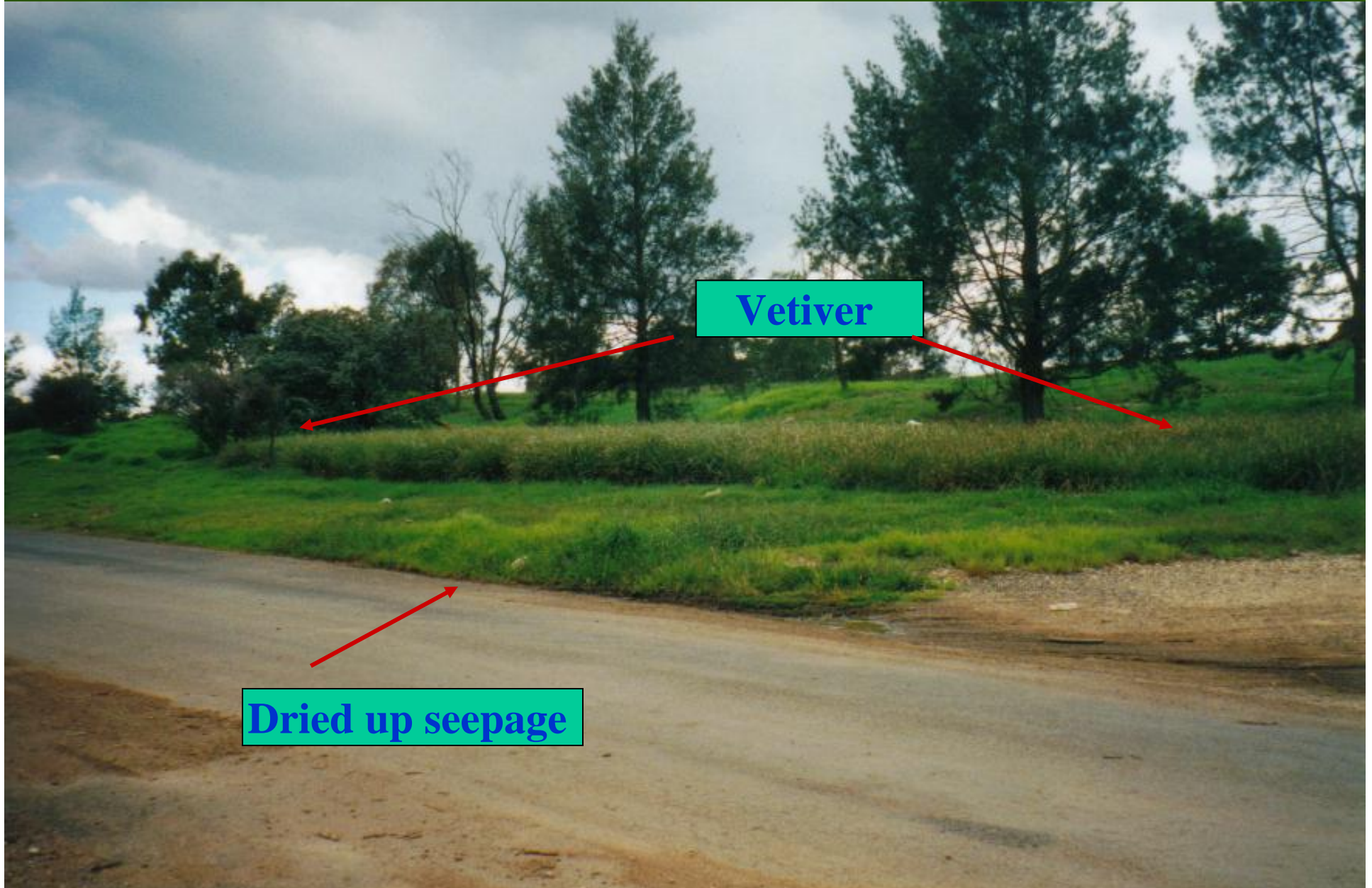


**Kikuyu grass**

**Seeping leachate**

**After the second summer vetiver planting  
eliminated the seepage problem**

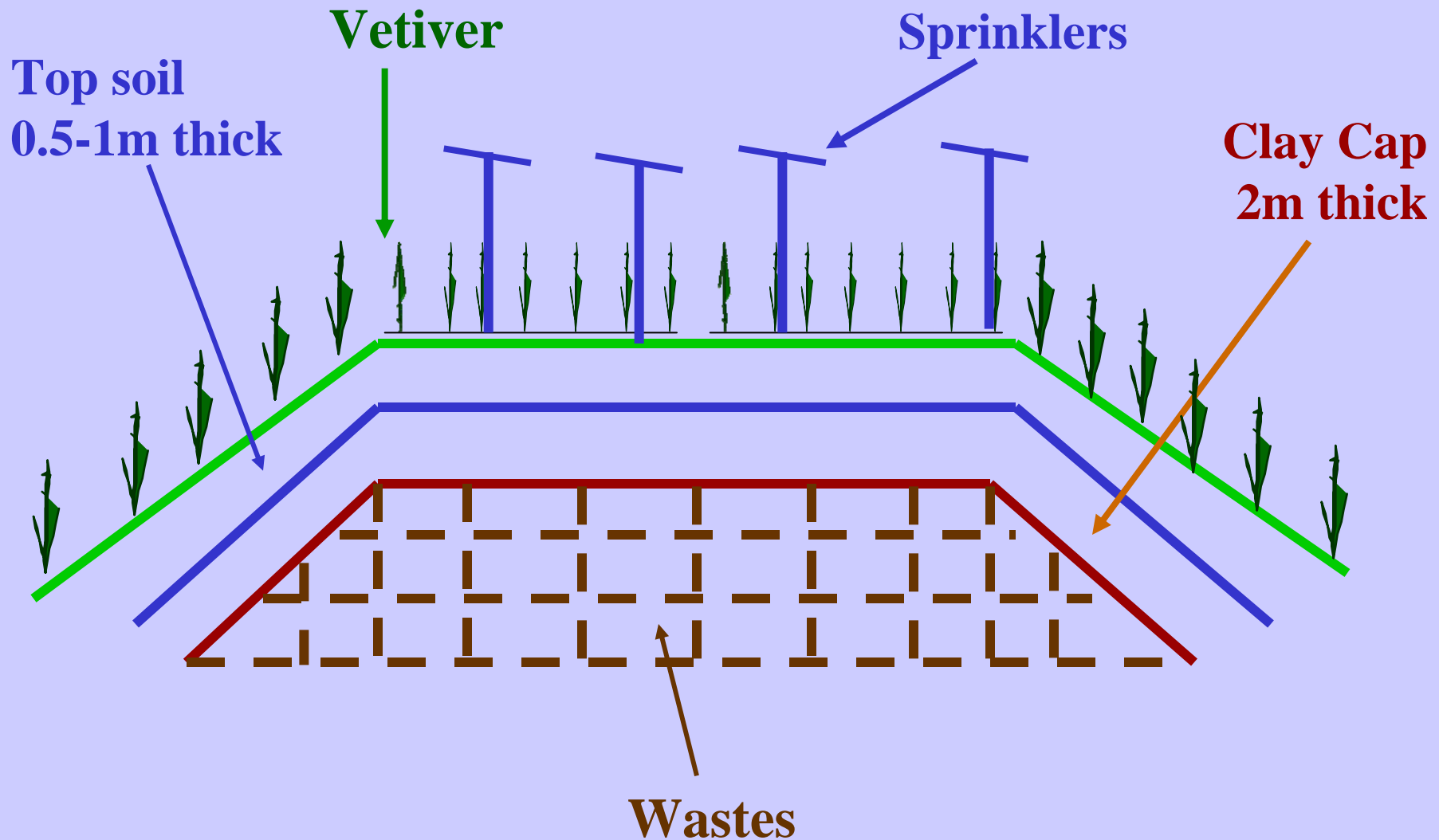
**Landfill Leachate Seepage**



# **APPLICATION OF THE VETIVER SYSTEM FOR LANDFILL LEACHATE TREATMENT**

**Leachate disposal**

# Landfill Leachate Disposal



**Diagrammatic cross section of the mound at Stotts Creek Landfill, Muwillumbah**

**Vetiver planted on the top of the mound**

**Landfill Leachate Disposal**



## Landfill Leachate Disposal

Irrigated  
with leachate  
after planting  
each day



Three months after planting:  
good growth and  
establishment



## Landfill Leachate Disposal

Ten months after  
planting



Fifteen months after  
planting and full flower  
in autumn





**Vetiver growth was over 3m in  
the second summer**



**Growing in highly saline and  
polluted leachate pool**



# **Phytoremediation of Contaminated Land**

- Explosive factory**
  - Fertiliser factory**
    - Paper factory**

## Contaminated Land: Explosive factory, Australia

This site is highly contaminated  
with Nitrate and NH<sub>3</sub>:

- Soil total N up to 5 400mg/kg
- Soil total NH<sub>3</sub> up to 1 220mg/kg
- Water total N up to 18 300mg/kg
- Water total NH<sub>3</sub> up to 12 300mg/kg



**Contaminated Lands**

**Two months  
after planting**



**One year  
after  
planting**



## **Contaminated Land: Explosive factory, Australia**

**This site is highly contaminated  
with Nitrate, NH<sub>3</sub> and heavy  
metals**



**Two months  
after planting**



## Contaminated Lands



**Ten months  
after planting**



**Contaminated Land:**  
**Paper factory Vietnam**



**Contaminated  
Land:  
Fertiliser factory  
Vietnam**



# VETIVER

**This grass is being used as a low impact alternative to managing effluent.**

**The increased uptake rate of Vetiver reduces odours, leakages and contamination of the subsoil and water table.**

*Thank You*