VETIVER SYSTEM

PREVENTION AND TREATMENT OF POLLUTED WATER & CONTAMINATED LAND

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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.

VETIVER GRASS

SPECIAL MORPHOLOGICAL CHARACTERISTICS

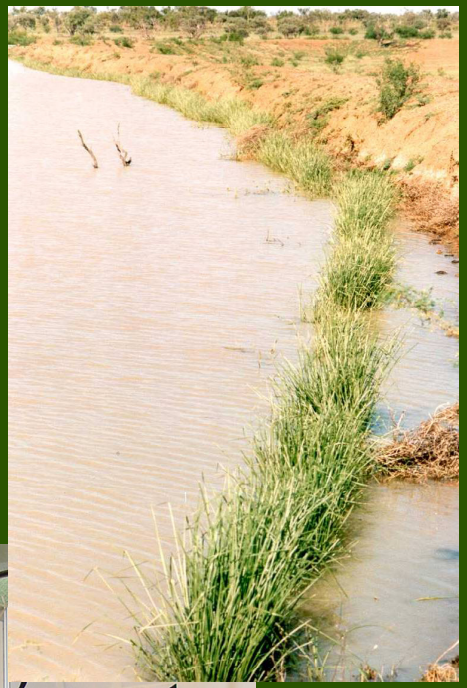
- Stiff and erect stems
- Deep and extensive root system
- It has no above or underground stems

SPECIAL PHYSIOLOGICAL CHARACTERISTICS

- Tolerant to drought, water logging, acidic, alkaline, sodic and saline conditions
- Tolerant to highly polluted environment such as heavy metal and nutrient contamination
- Tolerant high level of herbicides and pesticide in the soil
- Growing on all soil types: heavy clay to sand dune

SPECIAL GENETIC CHARACTERISTICS

- It is sterile, it flowers but sets no seeds
- Therefore it is non invasive and no weed potential
- It can be eliminated easily by Glyphosate spray or uprooting

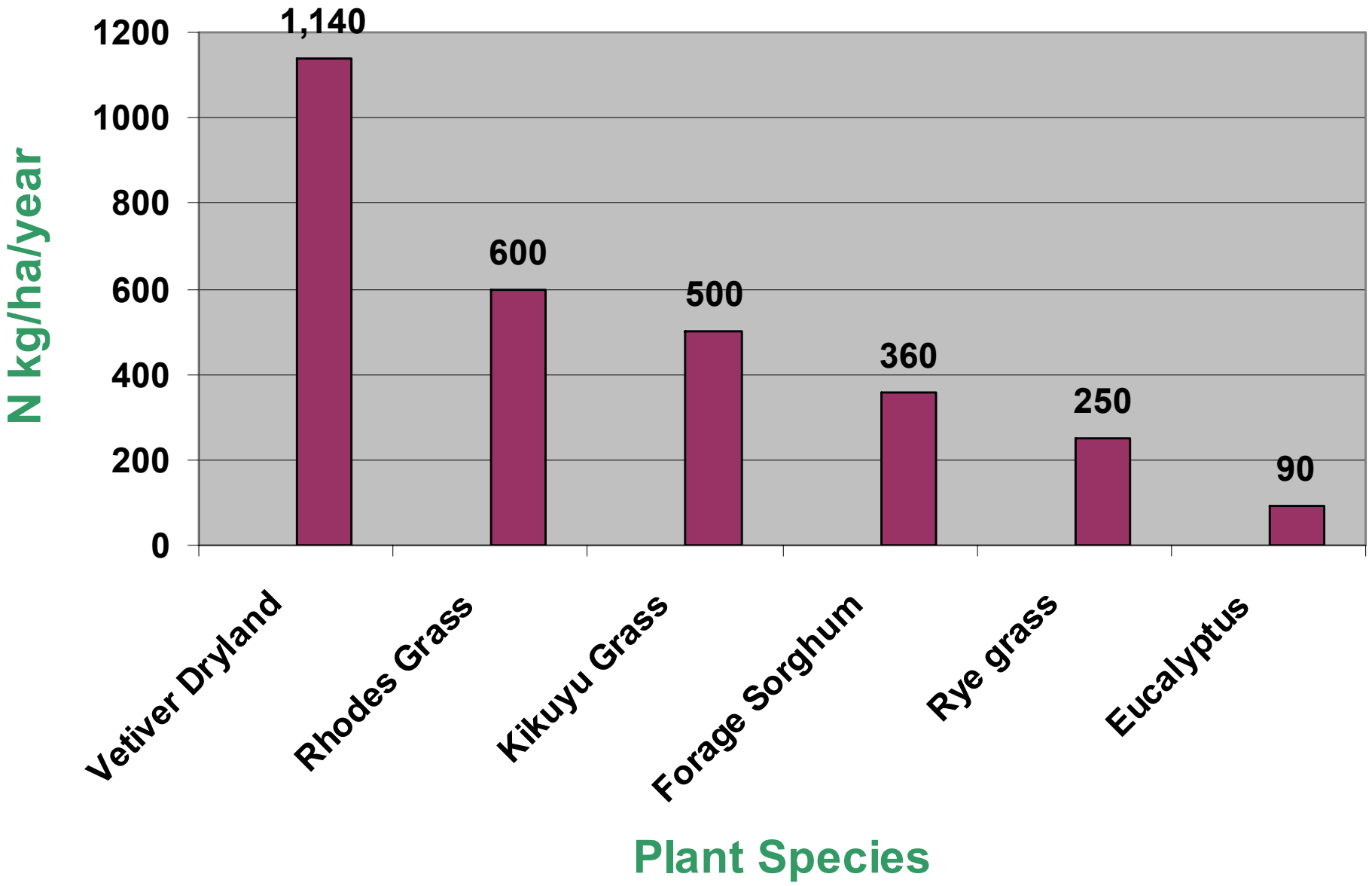


Stiff and erect stems, forming thick hedges, deep and extensive roots, tolerant to extreme adverse conditions such as drought and water logging etc.

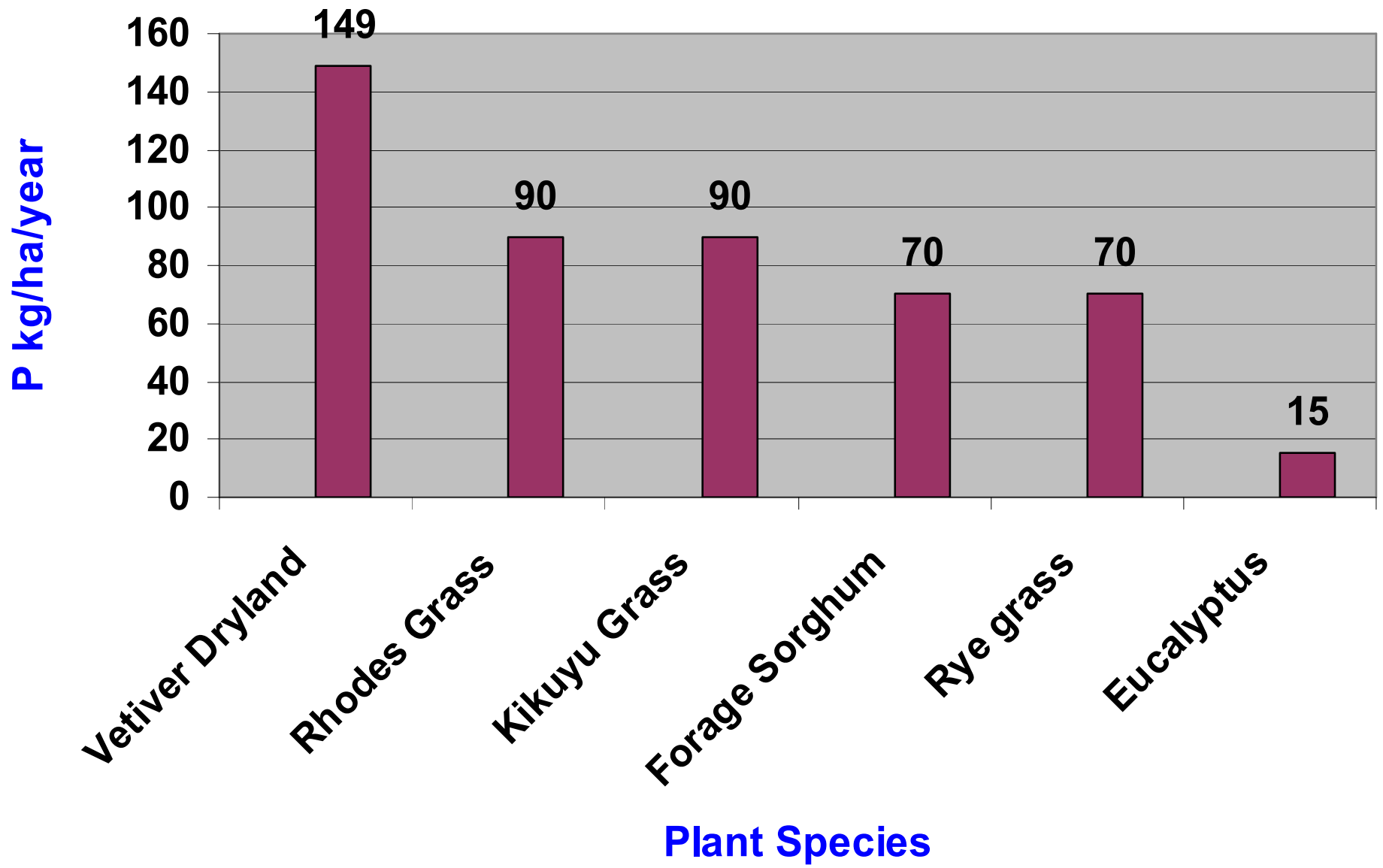
SPECIAL CHARACTERISTICS SUITABLE FOR WASTEWATER TREATMENT

- **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



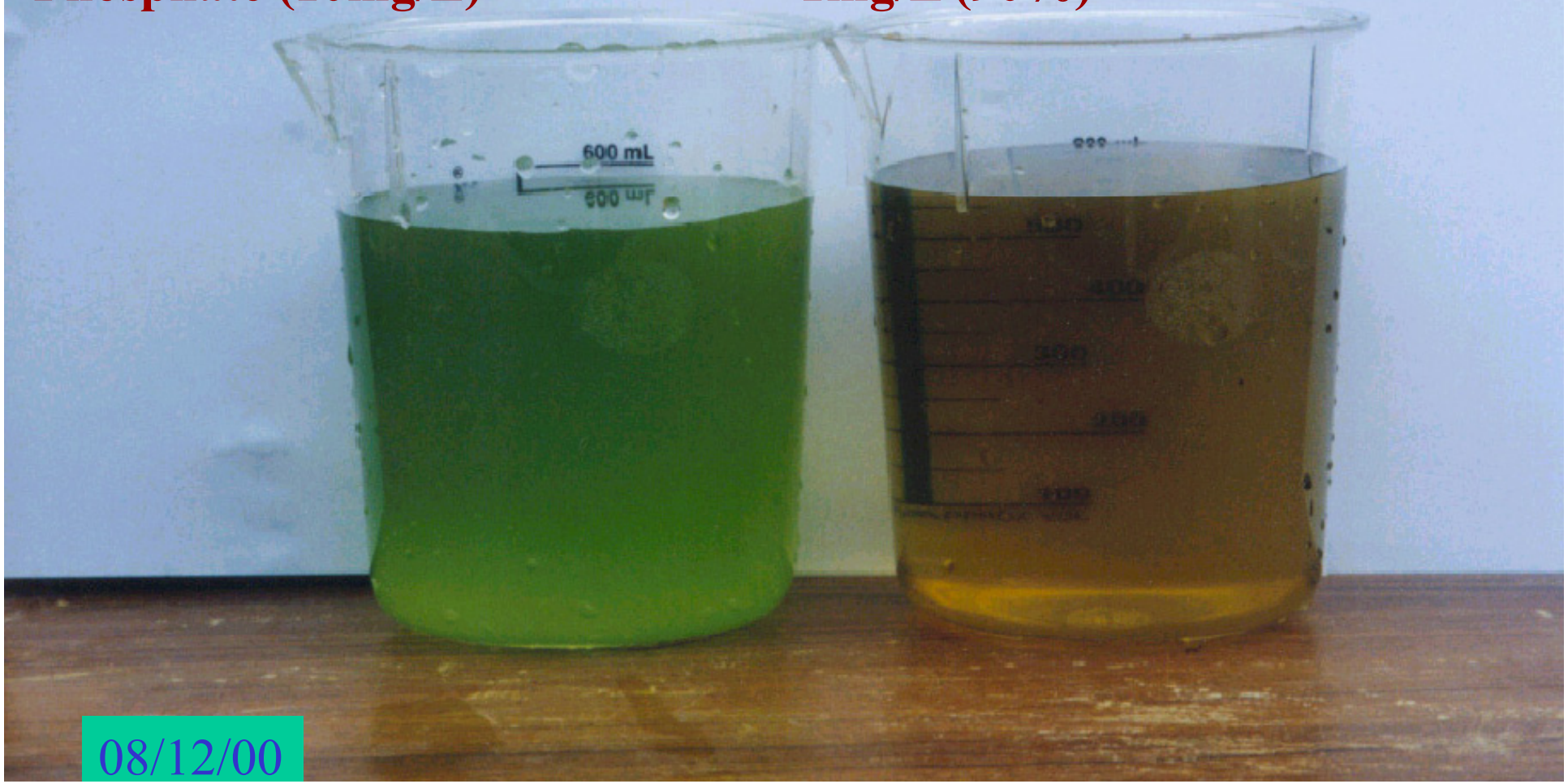
PHOSPHORUS UPTAKE



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%)



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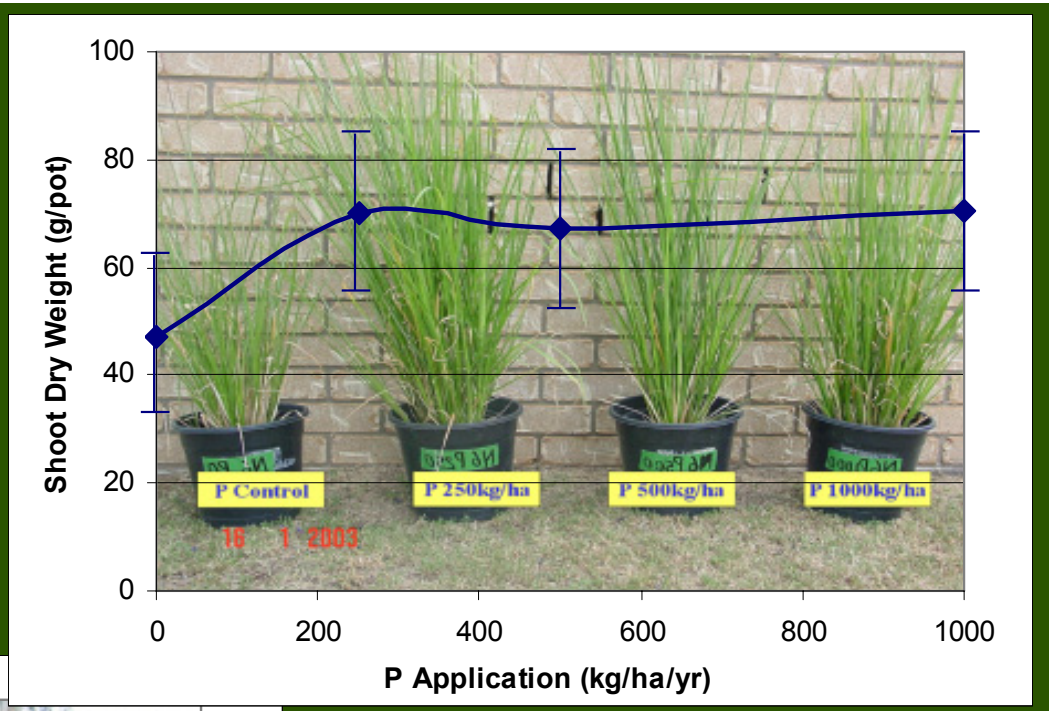
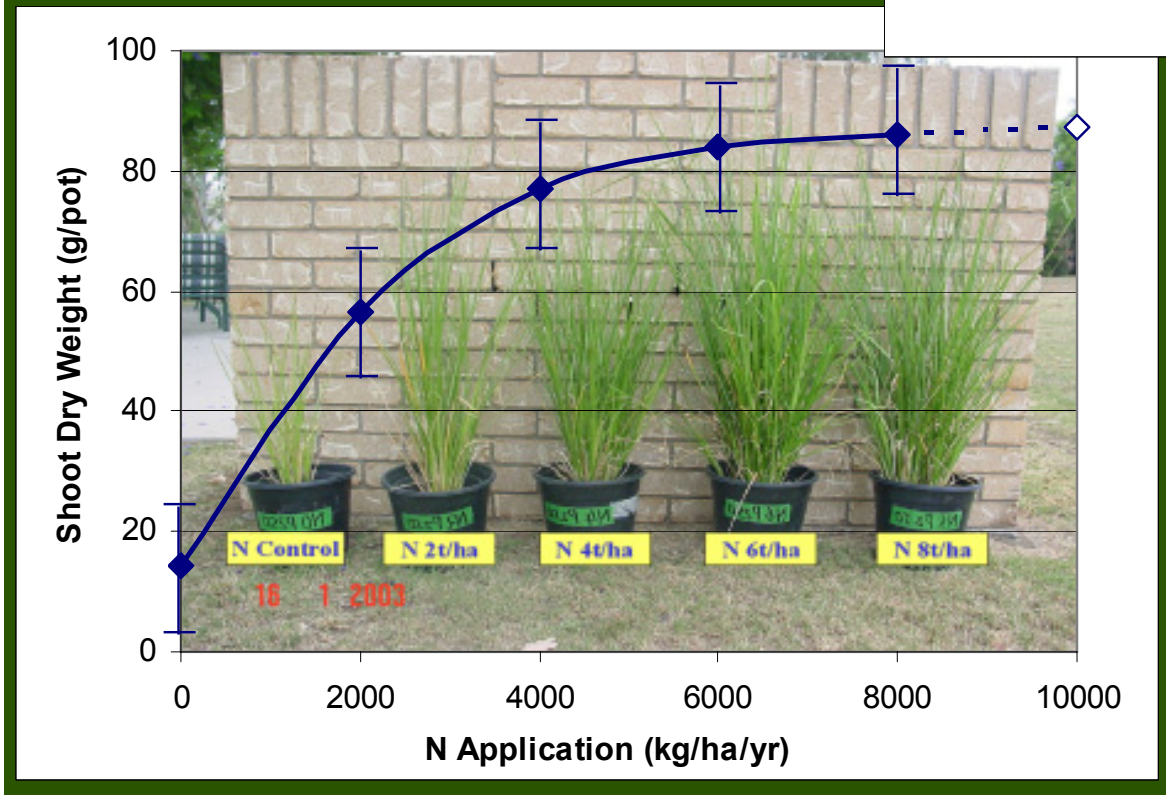
Tolerance to extremely high levels of nutrients





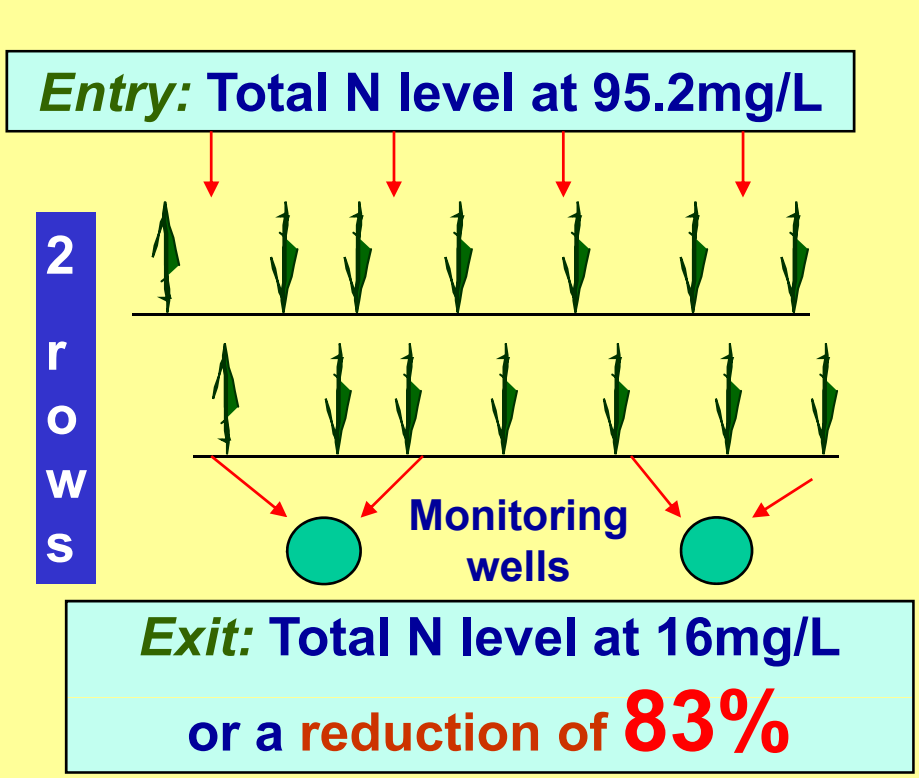
SOME EXAMPLES OF VS FOR WASTEWATER DISPOSAL AND TREATMENT

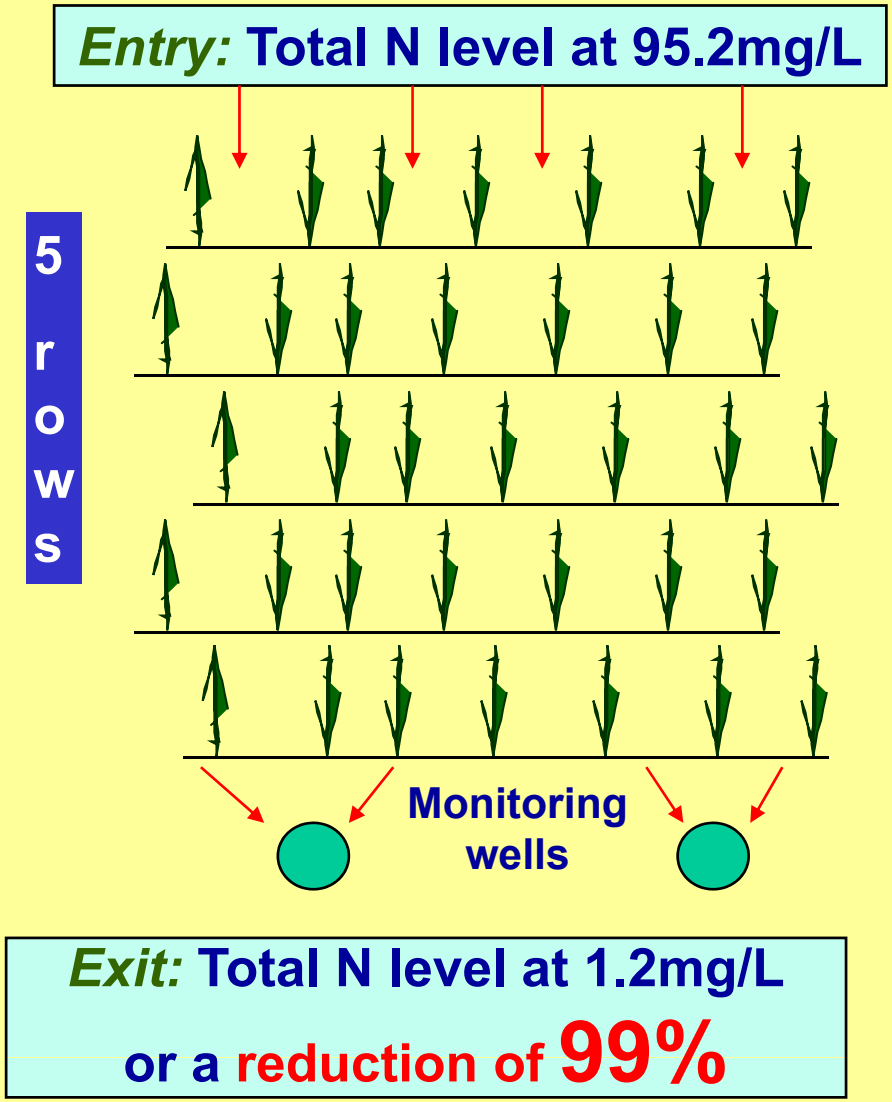
- Domestic sewage disposal
- Municipal sewage treatment
- Landfill leachate disposal
- Industrial waster disposal and treatment

Domestic Effluent: Vetiver was most effective in absorbing effluent discharge from a toilet block in Brisbane, Australia.

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

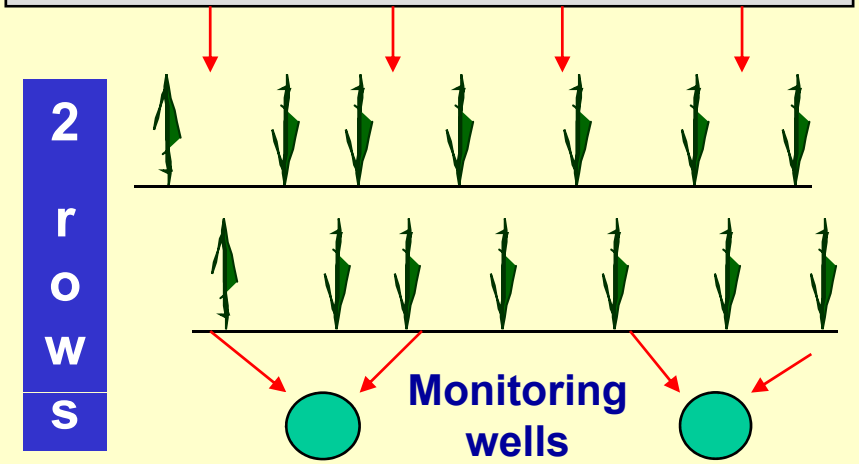
Effectiveness of vetiver in reducing N level in domestic blackwater





High capacity for P absorption in domestic sewage in Australia

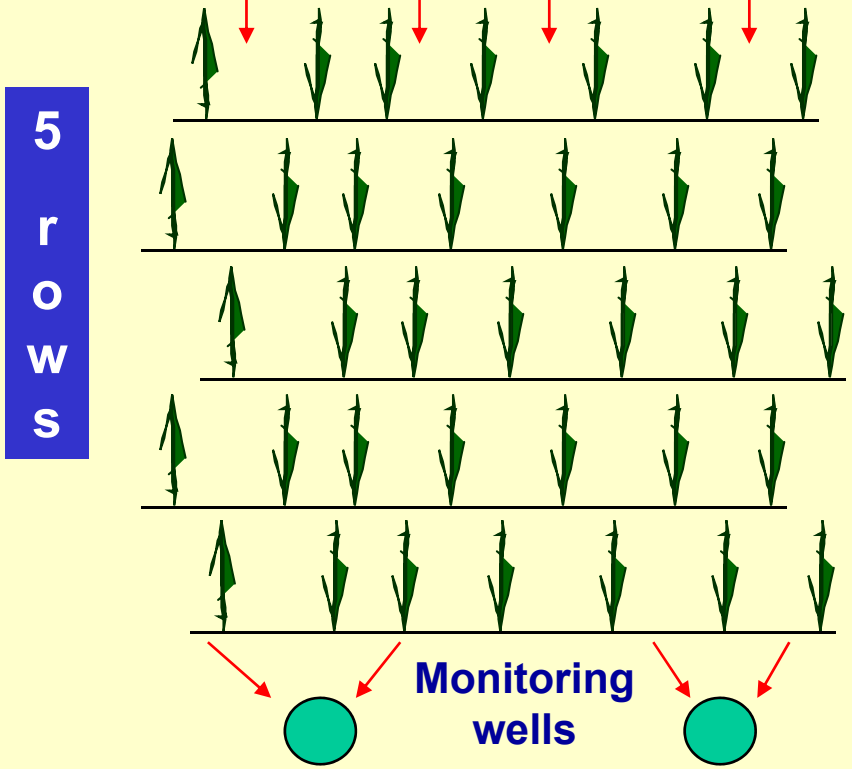
Entry: Total P level at 1.3mg/L



Exit: Total P level at 0.24mg/L

or a reduction of **82%**

Entry: Total P level at 1.3mg/L

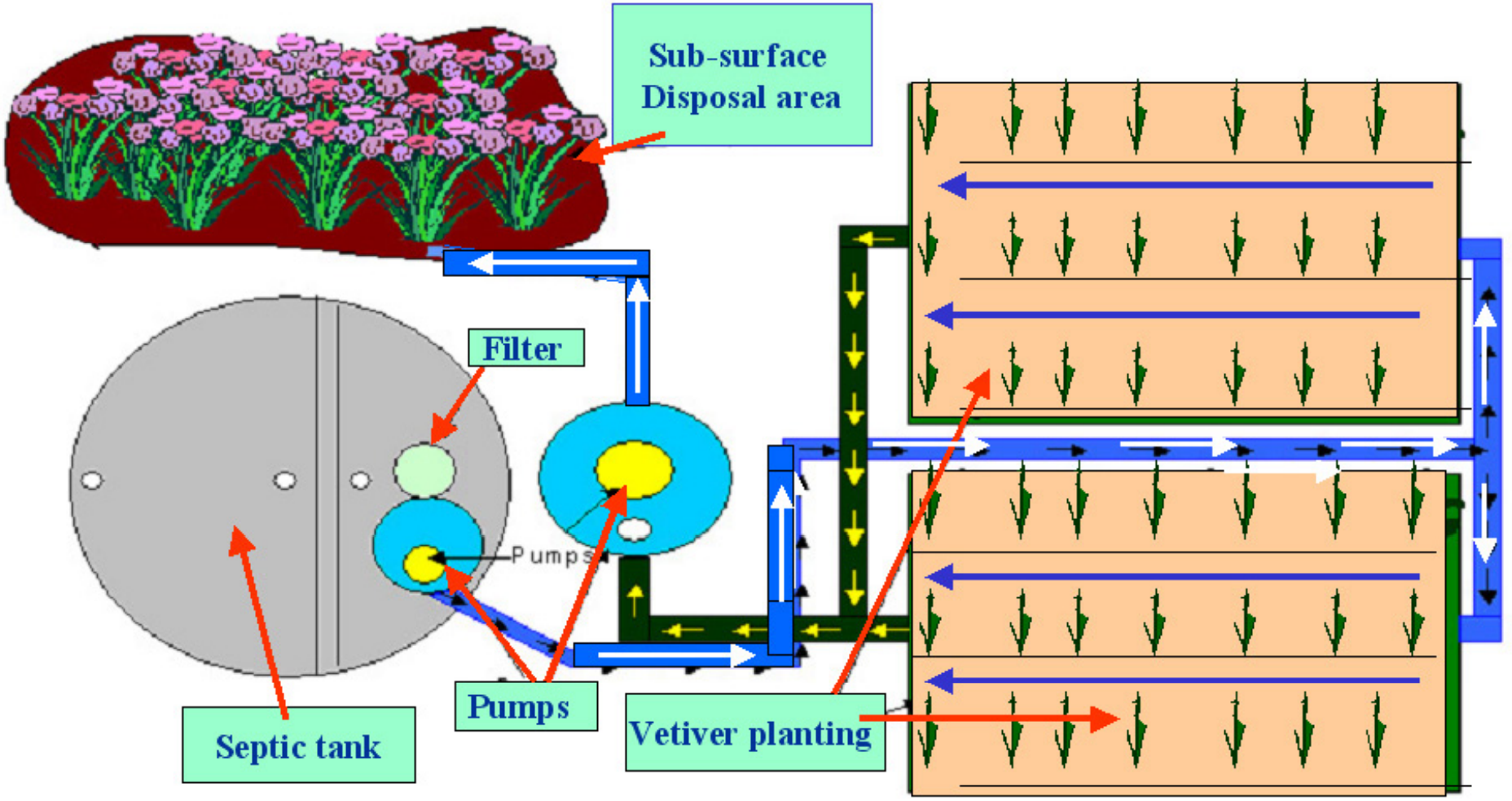


Exit: Total P level at 0.20mg/L

or a reduction of **85%**

Domestic Effluent Recycling Plant

Diagrammatic layout of a domestic disposal system



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

Landfill leachate disposal in Australia

Vetiver growth was over 3m in the second summer

Growing in highly saline and polluted leachate pool

Industrial Wastewater Disposal:

Food factory effluent disposal by land irrigation in Australia

Six months after planting

Growth after 12 months

Producing fodder for livestock from effluent
Grazed readily by cattle

Industrial Effluent from an abattoir in Australia

Effectiveness of vetiver planting on quality of effluent seepage

Analytes	Nutrient levels		
	Inlet	Mean levels in monitoring bores	
		20m down slope from inlet	50m down slope from inlet
pH	8.0	6.5	6.3
EC (uS/cm)	2200	1500	1600
Total Kjel. N (mg/L)	170	11.0	10.0
Total N (mg/L)	170	17.5	10.6
Total P (mg/L)	32	3.4	1.5

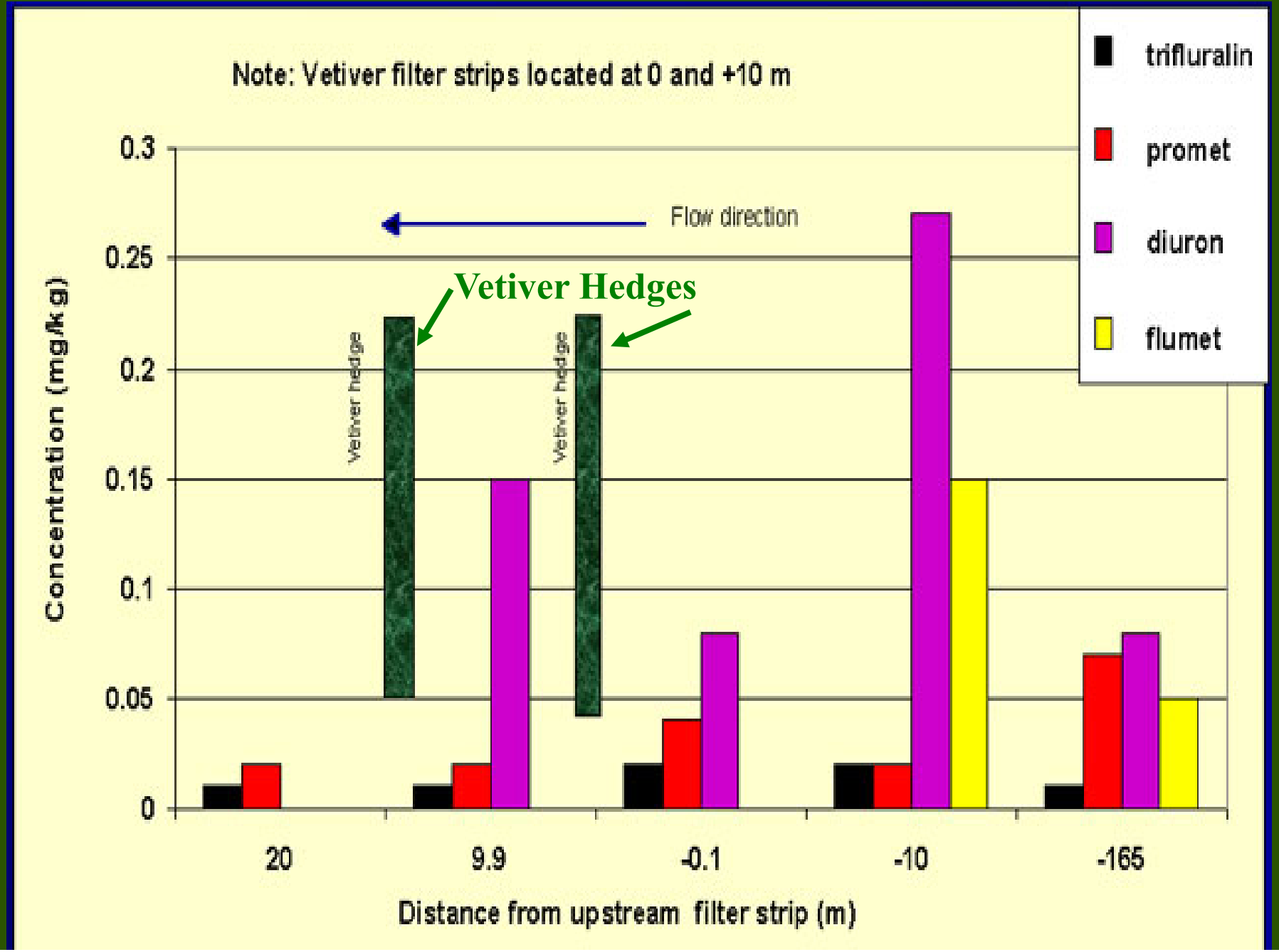
Vetiver strip uses in Australia for water quality improvement

Vetiver strip trapped sediment

BIO-FILTER: For sediment control in waterways in cotton farms

Trapping coarse and fine sediment in cotton farms in Queensland

Trapping herbicides on cotton farms in central Queensland



PHYTOREMEDIATION AND REHABILITATION OF CONTAMINATED LANDS

Vetiver grass is particularly suited for mine rehabilitation and phytoremediation due to its:

- ***Tolerance to High Acidity, Aluminium and Manganese toxicities***
- ***Tolerance to High Soil Salinity, Alkalinity and Sodicity***
- ***Tolerance to Heavy Metal toxicities***

HIGHLY TOLERANT TO HEAVY METALS

Threshold levels of heavy metals to vetiver growth as compared with other species

Heavy Metals	Threshold levels in soil ($mgKg^{-1}$)		Threshold levels in plant ($mgKg^{-1}$)	
	Vetiver	Other plants	Vetiver	Other plants
Arsenic	100-250	2.0	21-72	1-10
Cadmium	20-60	1.5	45-48	5-20
Copper	50-10	Not available	13-15	15
Chromium	200-600	Not available	5-18	0.02-0.20
Lead	>1 500	Not available	>78	Not available
Mercury	> 6	Not available	>0.12	Not available
Nickel	100	7-10	347	10-30
Selenium	>74	2-14	>11	Not available
Zinc	>750	Not available	880	Not available

This coal mine waste rock dump remains bare after 50 years

One year after planting

This Bentonite waste site is barren with an extremely erodible surface which has low water infiltration and high runoff rates.

With Exchangeable Sodium between 35 % and 48 %

Fourteen months after planting, note the growth of other species

Old gold tailings: Eighteen months after planting to control erosion, brown color due to winter frost

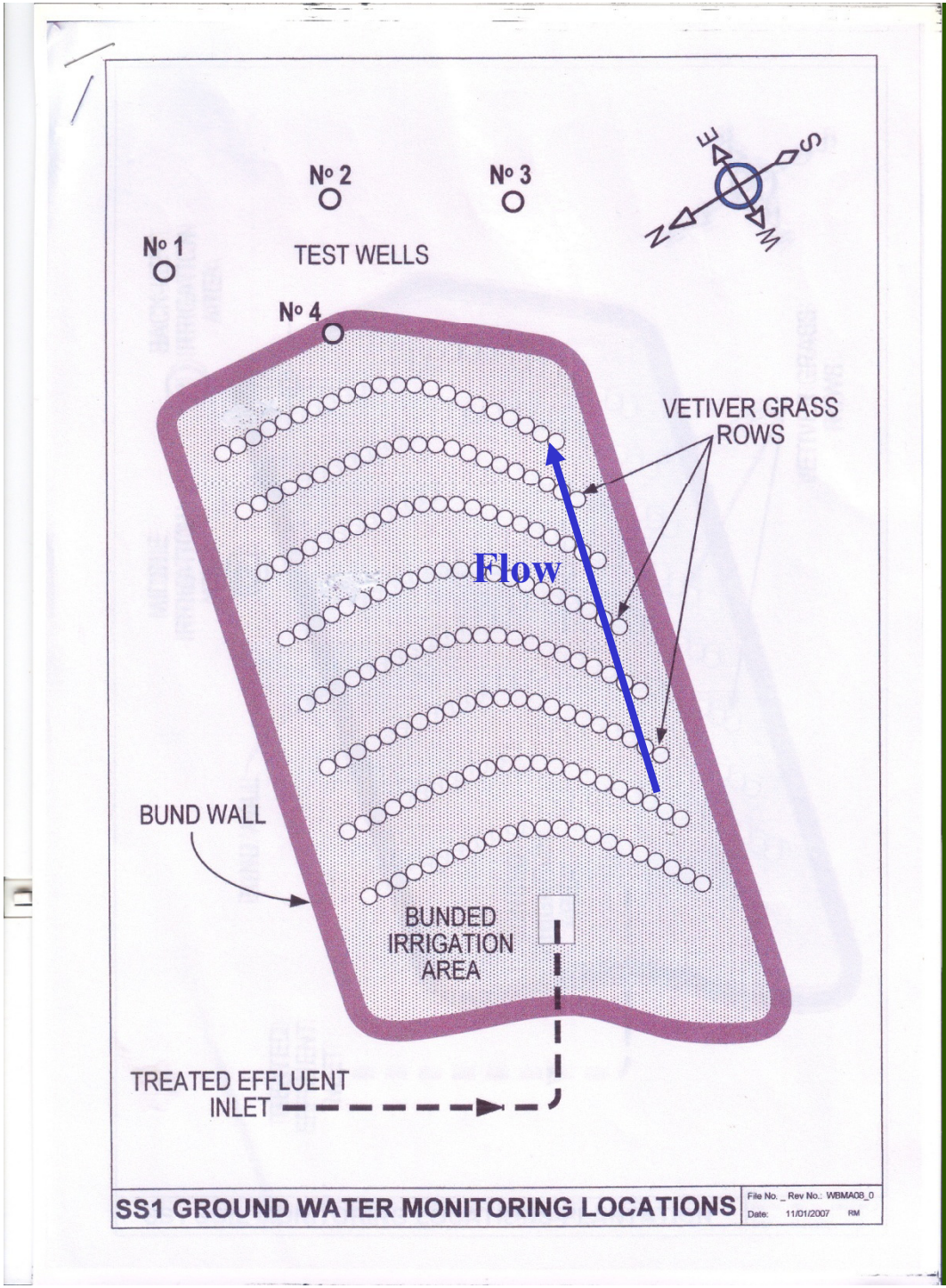
New gold tailings: The dust is highly contaminated with heavy metals such as Arsenic, Copper etc

Vetiver hedges provided a low cost and permanent wind barrier unaffected by strong winds, provided excellent protection for crop establishment

Permanent wind barrier unaffected by strong winds

SUMMARY

Effectiveness of the Vetiver System in Treating Sewage Effluent is Clearly Demonstrated at this Site in Queensland, Australia

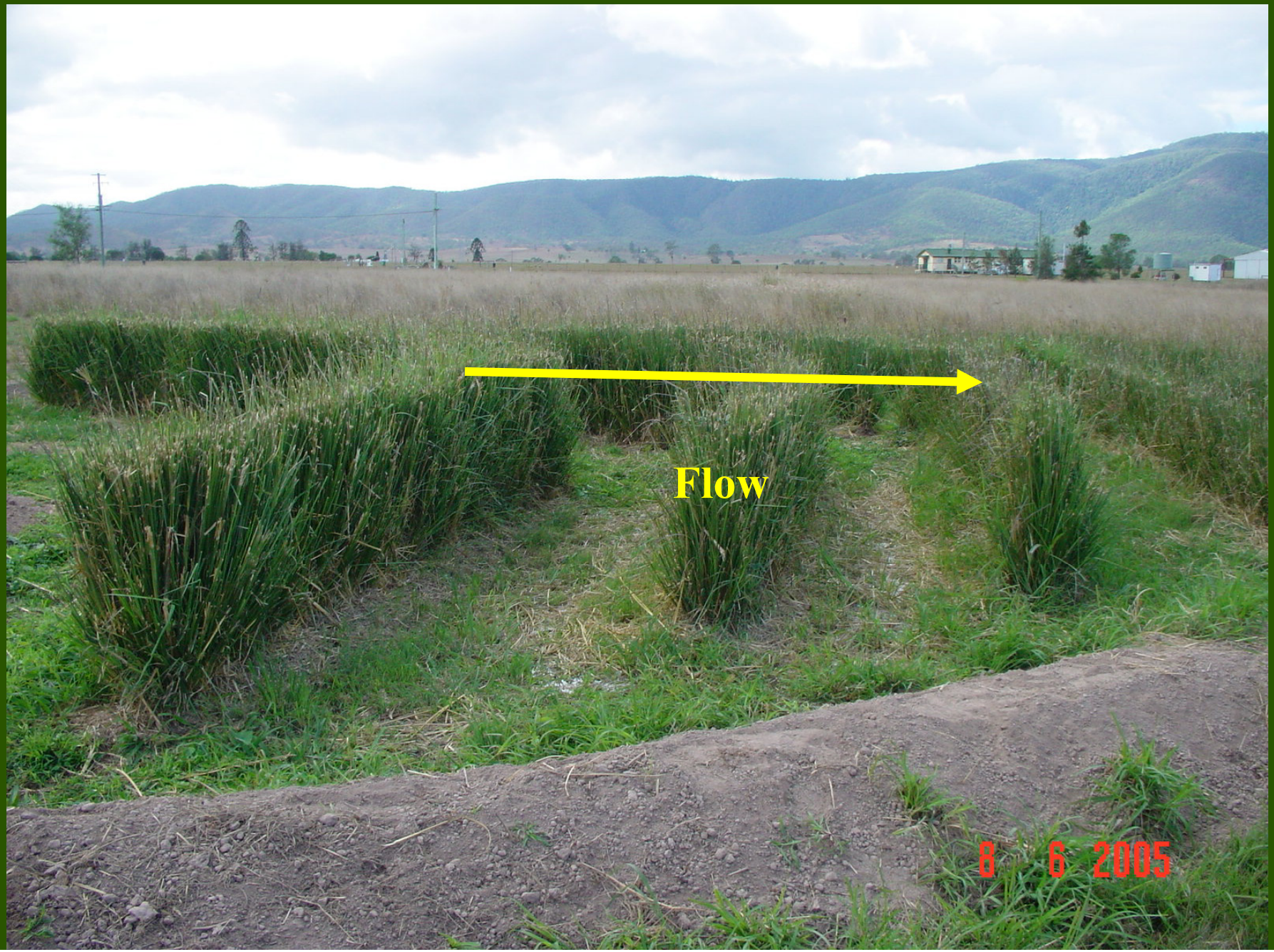


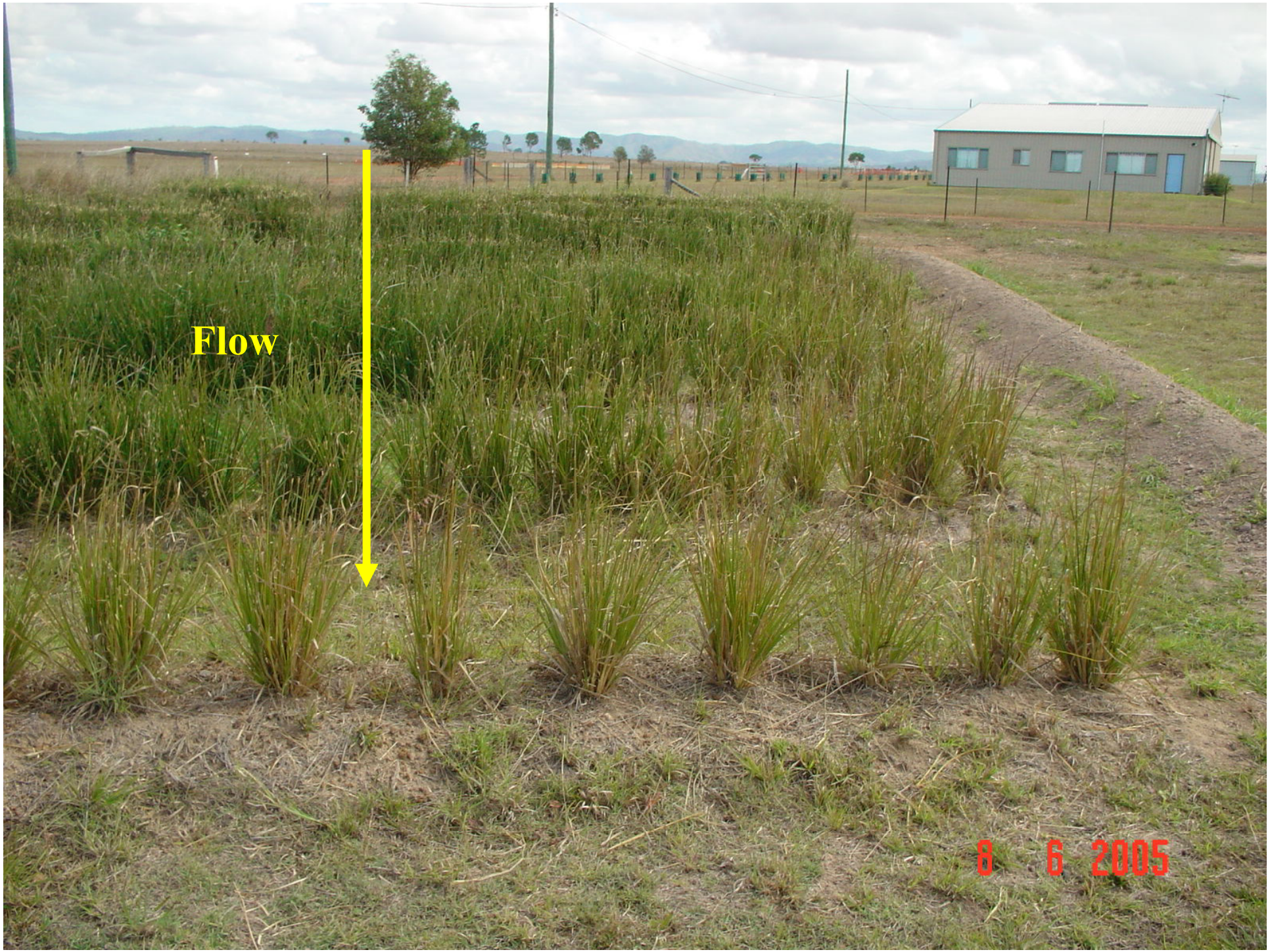
Planting Design

- 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 2 rows are very poor due to lack of effluent

The first few rows have excellent growth




Flow
8 6 2005

Third year: Excellent growth, exceeding 2m.

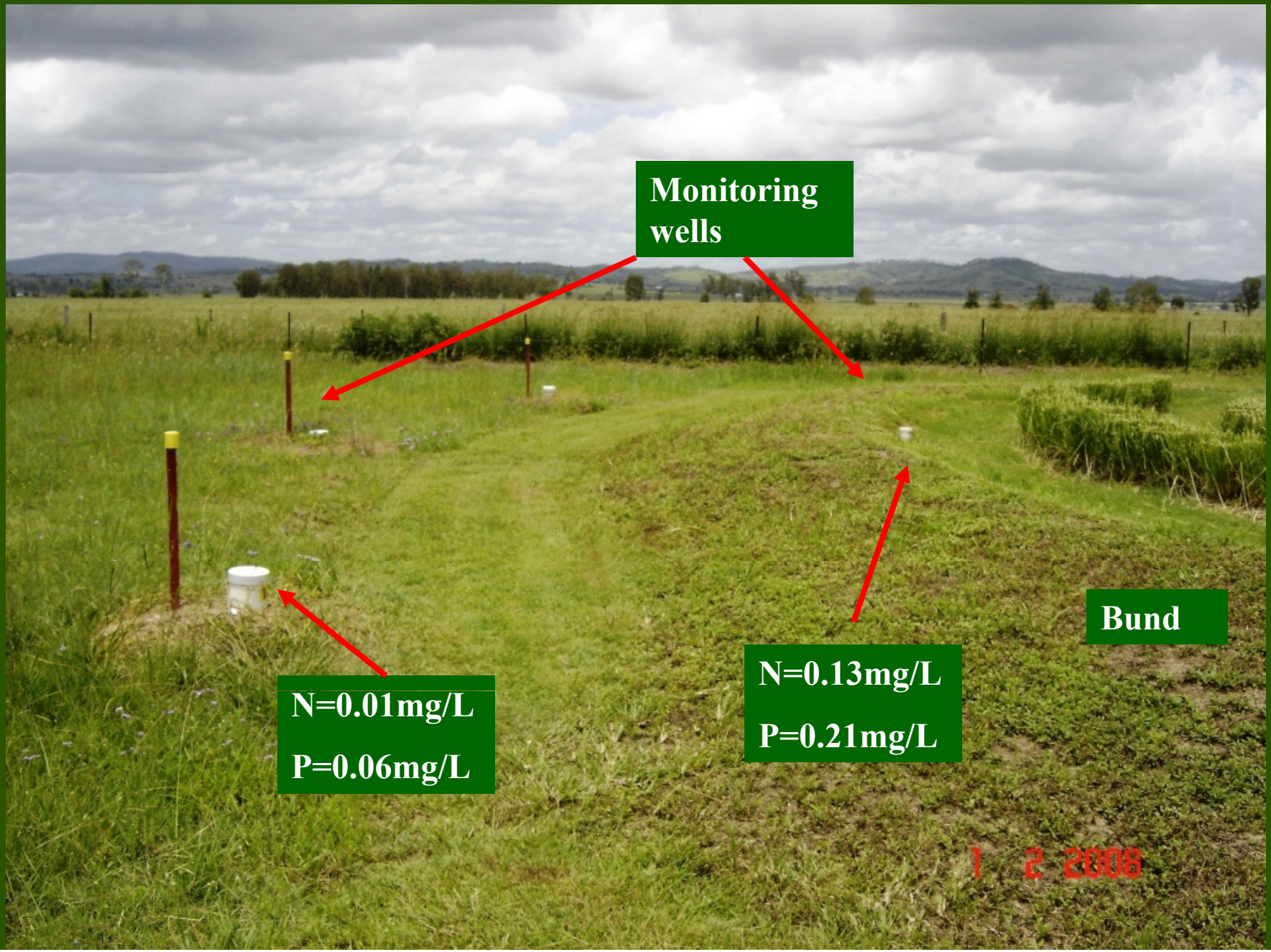
Cutting down to 50cm every 3 months


Effluent inlet
1 2 2008

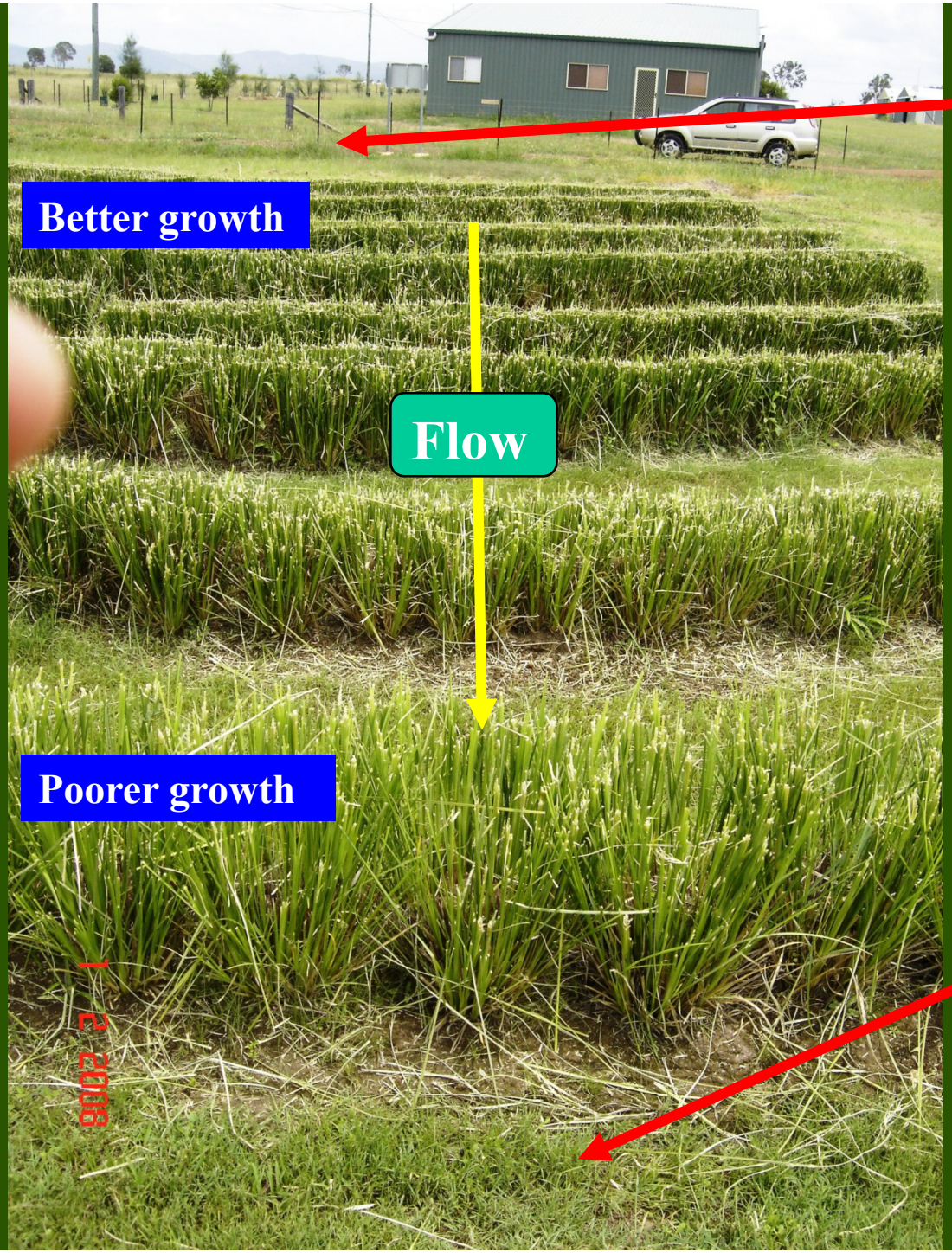

1 2 2008

Properly maintained, note no weed in or between hedges

Monitoring wells and nutrient levels



Hay for mulch or fodder



INPUT

Average daily flow: 1 670L

Average total N: 68mg/L

Average total P: 10.6mg/L

Average Faecal Coliform:>8 000

SUMMARY

OUTPUT

Average daily flow: Almost Nil

Average total N: 3.5mg/L

Average total P: 0.21mg/L

Average Faecal Coliform:<10

PROPOSED VETIVER TREATMENT AT LUDHIANA, PUNJAB

DAIRY SECTION

Effluent discharged directly to the creek

Effluent discharged directly to the creek

Effluent discharged to the creek causing severe pollution

PROPOSED VETIVER PLANTING

Irrigated with effluent discharge from dairy for pollution and erosion control


16 2 2008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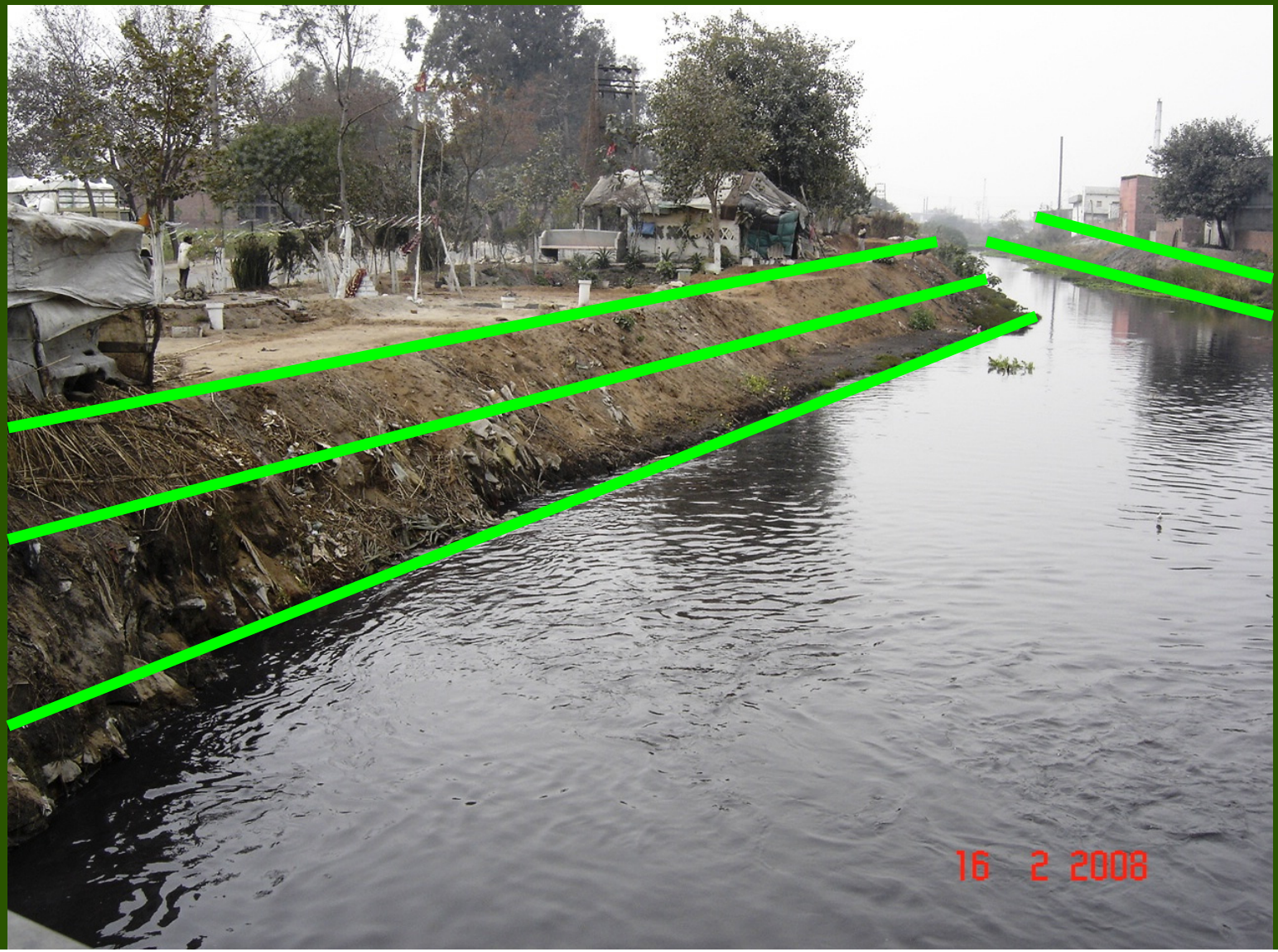
TEXTILE SECTION

Dye effluent discharged directly to the creek

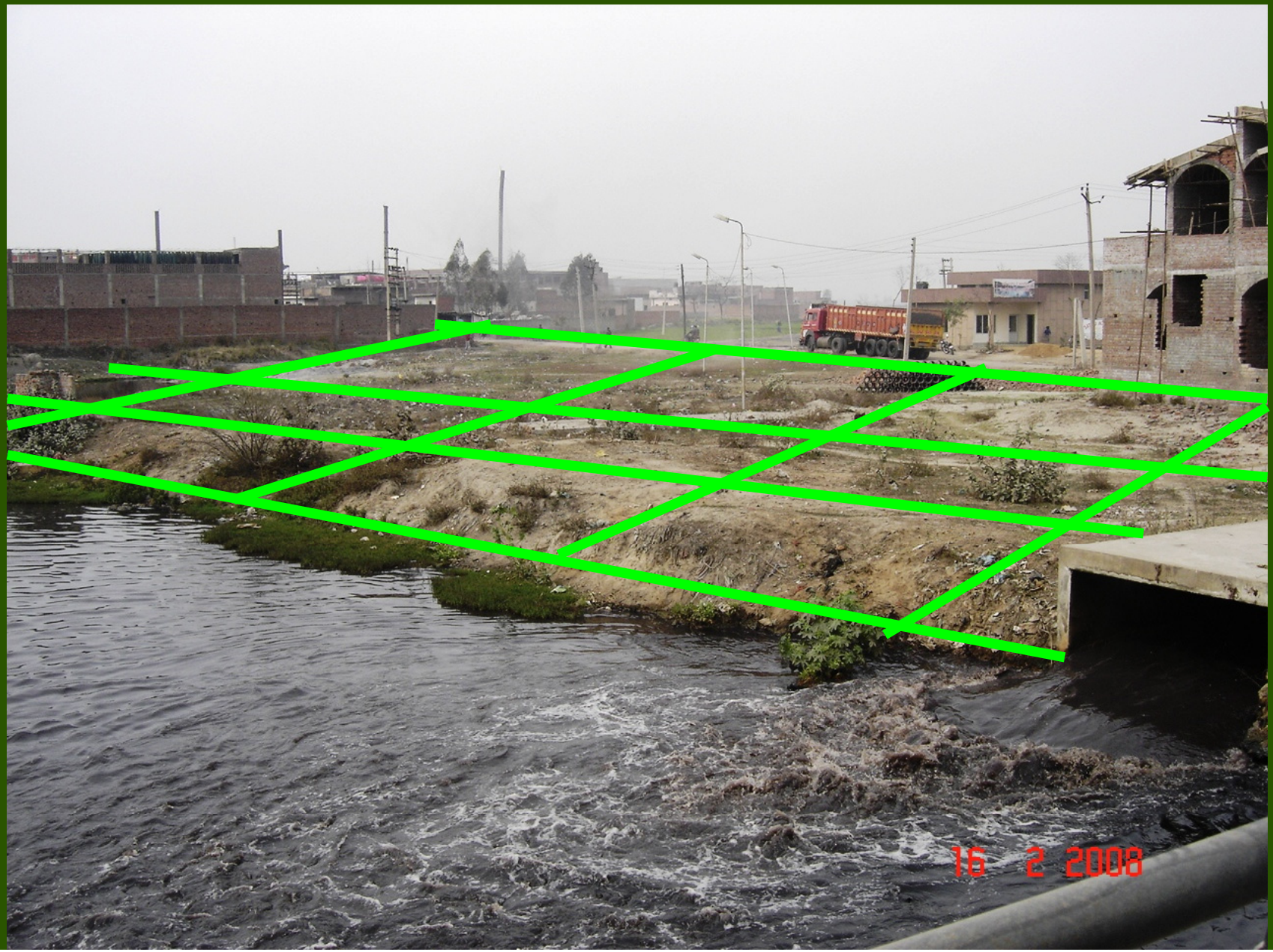
Discharge dyes from textile factory

PROPOSED VETIVER PLANTING

Irrigated with effluent discharge from textile factories for pollution and erosion control



On vacant land Irrigated with effluent to reduce pollution to the creek




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