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THE APPLICATION OF VIROSOIL™ TECHNOLOGY  
USING VIROBIND™ REAGENT IN ENVIRONMENTAL REMEDIATION

VIROSOIL™ TECHNOLOGY TECHNICAL DATA SHEET

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**INTRODUCTION**

The contamination of soils by acidity or inorganic contaminants, or both, is common in natural acid sulfate soils, at sites where sediment is dredged from harbours, estuaries lakes or dams and then stored in subaerial conditions, in agricultural soils through the addition of biosolids and some fertilisers, in soils contaminated by fallout from smelters and refineries, and at mine sites as a result of sulfide mineral oxidisation.

Acid sulfate soils (ASS) are soils and sediments containing iron sulfides. When exposed to oxygen and H<sub>2</sub>O due to any combination of exposure, drainage or disturbance, these sulfidic soils and sediments produce sulfuric acid, leading to low water pH (4.0 and below). During ASS formation, sulfate in seawater is microbially reduced to sulfide, primarily as hydrogen sulfide, but other organo-sulfides are also produced. Furthermore, ASS releases toxic quantities of iron (Fe), aluminium (Al) and other heavy metals into water sources, which in turn bind phosphates and other nutrients needed for the growth of natural food.

The acidic, nutrient-depleted water, iron, and aluminium can cause significant damage to the environment and to the health of prawns, fish, birds, animals and even humans. It is generally accepted that warmer temperatures provide more favourable conditions for bacteria to propagate, and hence the greater the potential for iron sulfides and ASS to form. ASS in tropical areas such as Queensland, Australia typically contains higher levels of iron sulfides than ASS formed in the cooler conditions of southern Australian states.

ViroSoil™ Technology, provided by Virotec International plc, has the remarkable ability to neutralise acid and remove heavy metals from soil across a wide range of applications.

This remarkable technology can be applied to economically treat acid sulfate soils and marine clays to:

- > Permanently neutralise acid.
- > Trap trace metals and prevent leaching.
- > Enhance nutrient retention capacity and promote vigorous plant growth.

ViroSoil™ Technology is a total and highly effective solution. Indeed, ViroSoil™ Technology “may be the only acceptable and sustainable solution from an economic point of view to solve acid rock drainage and acid sulphate soils,” according to Professor Olaf Schuiling from the International Institute of Environmental Engineering in Delft, The Netherlands.

ViroSoil™ Technology ensures selection of the best application and monitoring strategy. Management of the treatment process is based on Virotec’s:

- > Extensive research database.
- > Practical experience with commercial scale applications.
- > Results of laboratory analysis and trials for each soil to be treated.

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**VIROSOIL™ TECHNOLOGY APPLICATIONS**

Virotec has developed its ViroBind™ reagent to treat Acid Sulfate Soils (ASS) and marine clays, enhance nutrient retention capacity, and promote grass, plant and tree growth. The methods used to achieve this allow in situ remediation and the reagent can be added to the soil profile using dry powdered, water soluble or slurried forms of the reagent depending on which form is most convenient and appropriate for each site.

In most cases after application of ViroBind™ reagent treated soils and wastes can be used to create a rich substrate for plant growth safe in the knowledge that immobilised metals cannot be translocated into adjoining non-polluted environments or taken up by plants.

ViroSoil™ Technology can be customised to suit any individual application. It can be easily added to existing treatment facilities and requires minimal capital works, depending on the application.

The remediated soil formed when using ViroBind™ reagent has potential re-use options. The remediated soil holds the bound metals sufficiently tightly that they can neither be taken up by the plants, nor released in leachate. This property combined with the high organic content of the sludge has potential for use as a soil conditioner.

***The major advantages of using ViroSoil™ Technology can be summarised below:***

- > Create or maintain a healthy, sustainable soil horizon to allow revegetation by controlling trace element availability in a way that promotes sustainable plant growth and soil microbiota;
- > Neutralise soil acidity in the application zone;
- > Neutralise soil acidity below the application zone;
- > Immobilise inorganic metal contaminants as non-bioavailable environmentally inert forms;
- > Retain phosphate, ammonium, calcium, magnesium, potassium and other essential macro- and micro-nutrients in plant available forms; and
- > Increase soil moisture retention.



***Photos showing tree growth in ASS on a sugar cane farm in northern NSW without (left), and with (right), the use of ViroSoil™ Technology.***

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**CHEMISTRY OF VIROSOIL™ TECHNOLOGY**

ViroSoil™ Technology works by forming strong ionic bonds with various metal ions in the soil. The technology effectively immobilises metals into an insoluble, non-reactive sediment.

Specifically, ViroBind™ reagent has a high charge-to-mass ratio that increases its ability to strip metals ions from the soil.

The heterogeneous mineral surfaces in ViroBind™ reagent catalyse metal precipitation from solution at a pH lower than that achievable with conventional alkaline treatments such as lime, magnesium oxide and sodium hydroxide, by providing nucleating surfaces and acting as substrates for precipitation.

The primary mechanism of acid neutralization and metal uptake in ViroBind™ reagent is the dissolution of readily soluble alkaline minerals which supply hydroxides, carbonate ions for the precipitation of insoluble metal hydroxides, and carbonates and hydroxy-carbonate compounds on the product's surfaces.

The ability of ViroBind™ reagent to strip trace metals increases with time. Most metals bound by ViroBind™ reagent are held as structural components of the mineral and therefore cannot be easily removed.

Most trace metals are initially trapped by adsorption. ViroBind™ reagent is dominated by particles



*Mixing ViroBind™ reagent into ASS at a sugar cane farm in northern NSW (left) and watering the treating area (right).*

with a high surface area-to-volume ratio and high charge-to-mass ratio. During aging, elements are redistributed to become structural components of new minerals during recrystallisation.

**ENVIRONMENT AND SAFETY**

The use of ViroSoil™ Technology to treat ASS and marine clays is both environmentally sustainable and economically viable. ViroBind™ reagent is environmentally safe and the exhausted material may be disposed as a non-leachable solid residue.

Used ViroBind™ reagent is not a hazardous or prescribed waste material. Even after use in many applications, it can be usefully reused in other applications. Exhausted ViroBind™ reagent can also be used in selected downstream applications depending on individual site conditions.

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The leaching of used ViroBind™ reagent cannot result in the release of any trace elements at potentially environmentally hazardous concentrations.

ViroBind™ reagent is classified as a non-hazardous, inert or solid substance for transportation and is safe for unskilled workers to handle.

ViroBind™ reagent consists of minerals that are not known to pose any environmental hazard.

Virotec International plc recommends checking with local environmental regulations before final disposal.

### > CASE STUDY – GLADSTONE PORT AUTHORITY

#### PROBLEM

Gladstone Port Authority in Queensland, Australia, was experiencing problems with sulfidic marine clays (acid sulfate soils) resulting from its past dredging and land reclamation operations. Due to a planned change in a railway siding and loop line approximately 30,000 cubic metres of this sulfidic marine sediment was excavated and stockpiled. This stockpiled material oxidized and became acidic, resulting in an ecological scald where no vegetation would grow.

#### VIROTEC SOLUTION

The Virotec solution was successful in neutralising the acid generating capacity of the stockpile whilst at the same time preventing heavy metal leachate escaping into the nearby harbour. ViroSoil™ Technology utilising the ViroBind™ reagent was able to enhance nutrient retention,



*Photos showing application of ViroBind™ reagent at Gladstone.*

Parameter	Before	1 Month After	2 Years After
Soil pH	4	6.5 - 7.5	6.5 - 7.5
Net Acid Generating Potential	High	0.02 moles/kg	0.02 moles/kg
Re-vegetation Potential	Extremely Low	High	High

*This table summarises the Treatment Results.*