A COMMERCIAL APPLICATION
OF VIROSOIL™ TECHNOLOGY

CASE STUDY: ACTION SANDS, CHINDERAH, NSW, AUSTRALIA

"Action Sands are now in full-scale commercial production using ViroSoil™ Technology to transform our waste pile into a product we call Action Garden Mix... I would recommend Virotec's ViroSoil™ Technology to any other similar operation looking to adopt sustainable environmental solutions."

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PROBLEM

Action Sands quarrying and processing facility has accumulated 30,000m^3 of unusable dredge spoil material (a by-product of dredging the Tweed River), after many years of production. The spoil by-product is mildly acidic with low nutrient value in its present form. The stored spoil had no financial or environmental value to the company.

Altering the chemical and physical composition of the spoil by-product by applying Virotec's ViroSoil™ Technology, would enable Action Sands to produce a "conditioned" soil mix for sale to residential and commercial traders, whilst also re-establishing previously unavailable land area.

Accumulated dredge spoil material stored on site at Action Sands.

VIROTEC TOTAL SOLUTION

ViroSoil™ Technology was applied by installing tailored plant equipment, in order to combine ViroBind™ reagent with the by-product to successfully remediate dredge spoils into a saleable soil material. The benefits of using ViroSoil™ Technology are summarised below:

- Increased soil moisture retention;
- Creation of a healthy, sustainable soil horizon to allow revegetation by controlling trace element availability in a way that promotes plant growth and soil microbiota;
- Provision of adequate nitrogen (N), phosphorus (P) and potassium (K) for healthy plant growth;
- Provision of adequate organic carbon for healthy plant growth;
- Neutralisation of soil acidity;
- Increased pH buffering capacity;
- Immobilisation of inorganic metal contaminants (such as iron and aluminium) as non-bioavailable, environmentally inert forms;
- Retention of phosphate, ammonium, calcium, magnesium, potassium and other essential macro-and micro-nutrients in plant available forms; and
- Improving the mechanical properties of soil.

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Left: Dredge spoil prior to stockpiling.
Right: The near-barren surface of the dredge spoil stockpile.

ViroSoil™ Technology components included design, engineering, application and ongoing monitoring. The solution is ideal as an economical, continuing treatment for the soil by-product.

BACKGROUND

Action Sands operates a major sand quarrying and processing facility at Chinderah in the north-eastern corner of New South Wales (NSW), Australia, and is responsible for supplying large volumes of sand to the construction industry within northern NSW and the Gold Coast (one of the most rapidly developing regions in the country).

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 or lakes. Acid sulfate soils (ASS) are soils and sediments containing iron sulfides. When exposed to oxygen and water due to any combination of exposure, drainage or disturbance, these sulfidic soils and sediments produce sulfuric acid, leading to low soil pH and conditions that are unsuitable for plant growth.

Action Sands had accumulated 30,000m^3 of unusable dredge spoil material that was mildly acidic and had a low nutrient value in its present form. Action Sands intended to convert this waste material into a saleable soil product. The goal of the process was to produce a "conditioned" soil mix that would enable different species of flora to grow and thrive.

The dredge spoil at Action Sands was characterized by:

- A high sulfide–sulfur content with a corresponding high Total Potential Acidity (TPA);
- High levels of calcium, primarily due to the large quantities of shell grit (calcium carbonate) in the material. This contributed to a low cation exchange capacity (CEC);
- A substantial nutrient deficiency, with low levels of potassium, nitrogen and phosphorus; and,
- A high permeability due to the high sand content.

Visually, the material was dominated by shell grit and black organic matter as shown in the Figures above and overleaf.

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ViroSoil™ Technology installation and ViroBind™ application to dredge spoils.

TREATMENT METHODS

Virotec Global Solutions were contracted by Action Sands to trial an application of ViroSoil™ Technology at its sand quarrying and processing facility located in Chinderah, NSW. The application involved the preparation of a medium scale plot to demonstrate that various plant species could be grown in treated dredge spoil waste material. The trial followed successful laboratory trials performed by Virotec to prove that the ViroSoil™ Technology reagent ViroBind™ was able to provide good chemical, physical and biological properties to enable healthy, sustainable plant growth. A combination of native trees, shrubs, flowers, vegetables and grasses were planted, as seeds or seedlings. The ViroBind™ reagent has the advantage of:

- Permanently neutralising acidity;
- Immobilising heavy metals;
- Enhancing nutrient retention capacity and promoting vigorous plant growth;
- Improving the chemical and physical properties of the soil;
- Being applied to the dredge spoils in situ;
- Being added to the soil profile using dry powdered or slurried forms of the reagent, depending on which form is most convenient and appropriate for each site; and,
- In most cases, creating 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 works by forming strong bonds with various metal ions in the soil. The technology effectively immobilises metals into an insoluble, non-reactive sediment. The ViroBind™ reagent has a high charge-to-mass ratio that increases its ability to bind metals ions from the soil.

The heterogeneous mineral surfaces in ViroBind™ catalyse metal precipitation from solution at a pH lower than that achievable with conventional alkaline treatments such as lime, magnesium oxide

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and sodium hydroxide, by providing nucleating surfaces and acting as substrates for precipitation.

The primary mechanism of acid neutralization in ViroBind™ involves reaction with low solubility hydroxide, carbonate and hydroxy carbonate minerals. Metals are bound by precipitation of new low solubility minerals, co-precipitation, crystal growth of existing minerals, adsorption and solid state diffusion.

The ability of ViroBind™ to trap trace metals increases with time. Most metals bound by ViroBind™ are held as structural components of very low solubility minerals and therefore cannot be easily removed. Most trace metals are initially trapped by adsorption; ViroBind™ is dominated by particles 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 recrystalisation.

> *Phosphate Retention*

When ViroBind™ is applied to a soil or other solid, only a small proportion (typically less than 1%) of any applied phosphate can be leached from the soil by rainfall, compared to about 50% in ordinary superphosphate that is commonly removed by leaching. ViroBind™ addition ensures that users obtain close to the full benefit of phosphate fertiliser. Greater than 95% of the applied phosphate will remain readily available to the end user's crops.

Dredge spoils stockpile.

The above Figure shows part of the stockpile of dredge spoil material which has accumulated over the last few years (approximately 30,000 m^3). The Figure, giving a view of the top of the pile, shows minimal grass growth. It was clear that the existing dredge spoil material was unsuitable as a substrate for any sustainable vegetation growth.

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Left: Virotec's Trial of plant growth in ViroSoil™-remediated soils.
Right: The results after 3 months.

RESULTS

Plant growth in the soils treated with ViroSoil™ Technology proved successful, with the following results:

- Significant growth for grasses, trees, shrubs, flowers and vegetables.
- Significant increase in key nutrient levels including phosphorous, nitrate, ammonia and sulphur (refer to Table 1).
- The acidity was greatly reduced to near-neutral.
- The cation exchange capacity (CEC) was increased to an acceptable level, therefore countering the large quantity of calcium-rich shells in the spoils.
- Extremely good moisture retention in the soil.
- Good, consistent soil texture.

Healthy root growth in ViroSoil™ Technology treated soils.

The figure above shows significant and healthy root growth from several of the shrubs that were extracted for analysis. It was found that root growth was both horizontal and vertical, an indication that the substrate would support a healthy flora.

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Element	Typical Soil Analysis (ViroSoil™ Technology treated)
pH	7.5
Conductivity	2.2
Calcium (mg/kg)	58.5
Potassium (mg/kg)	1.8
Magnesium (mg/kg)	5.1
Sodium (mg/kg)	2.1
Aluminum (mg/kg)	0.0
CEC	67.5
Copper (mg/kg)	0.8
Iron (mg/kg)	115.5
Manganese (mg/kg)	7.0
Zinc (mg/kg)	1.9
Phosphorous (mg/kg)	142.0
Organics %	15.5
Nitrate (mg/kg)	47.8
Ammonia (mg/kg)	150.9
Chloride (mg/kg)	145.0
Sulphur (mg/kg)	4695.0
Moisture %	21.9

Table 1.
Typical Analysis of Action Sands dredge spoils after ViroSoil™ Technology treatment.

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CONCLUSION

The application of ViroSoil™ Technology, using ViroBind™ reagent, proved to be extremely successful in providing the chemical and physical conditions in the soil required for sustainable flora growth.

The benefits, using ViroBind™ to remediate dredge spoils into a saleable soil material, are summarised below;

- Increased soil moisture retention;
- Creation of a healthy, sustainable soil horizon to allow revegetation by controlling trace element availability in a way that promotes sustainable plant growth and soil microbiota;
- Provision of adequate nitrogen (N), phosphorus (P) and potassium (K) for healthy plant growth;
- Provision of adequate organic carbon to sustain the soil microbiota populations needed for healthy plant growth;
- Neutralisation of soil acidity;
- Increased pH buffering capacity;
- Immobilisation of inorganic metal contaminants (such as iron and aluminium) as non-bioavailable environmentally inert forms;
- Retention of phosphate, ammonium, calcium, magnesium, potassium and other essential macro- and micro-nutrients in plant available forms; and
- Improving mechanical properties of soil.

The production facility, creating a high quality garden mix plant, is now in full-scale production.

The end result is a saleable quality garden mix.

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TESTIMONIAL

"Virotec were contracted by Action Sands to implement a solution for an intractable environmental problem. As a result of our sand quarrying and dredging operations we produce a waste product that has been stockpiled for the last five years of operation.

Virotec first performed laboratory test work to determine if ViroSoil™ Technology was applicable for the remediation of the dredge spoil. Action Sand's goal was to create a saleable garden mix from the waste stockpile.

At the completion of laboratory trials Virotec conducted field trials to prove that the remediated waste could sustain a healthy flora over an extended period of time. At the completion of the field trials it was clear to Action Sands that Virotec had a technology capable of transforming our waste pile into a valuable resource.

Action Sands are now in full-scale commercial production using ViroSoil™ Technology to transform our waste pile into a product we call Action Garden Mix. The product has gained commercial success over the last few months and we look forward to working with Virotec on an ongoing basis.

Virotec staff were keen to co-operate with Action Sands at all stages during the project and were diligent in regards to environmental and health and safety procedures. Virotec were integral in the implementation of this waste to resource activity and Action Sands enjoyed a high level of technical support throughout the project.

I would recommend Virotec's ViroSoil™ Technology to any other similar operation looking to adopt sustainable environmental solutions."

MARTIN DOBNEY
Quarry Manager
Action Sands

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