



Application Instructions





RegenOx Quick Reference Table

The following table is a quick reference guidance providing only the most relevant information. Please review the entire document carefully, plus the product Safety Data Sheet prior to any application. Please contact REGENESIS Technical Support if you need any further assistance.

Components	<p>RegenOx is a 2 component product:</p> <ul style="list-style-type: none"> • RegenOx Part A (oxidizer; white soluble powder) • RegenOx Part B (catalyst; green/brown liquid gel) <p>Proportion frequently is 1 kg Part B for 1 kg Part A, but can vary (proportion to be discussed with REGENESIS)</p>
Viable application methods	Direct push, In wells, In excavation
Number of injection campaigns	Typically, multiple campaigns are required. Typical distance between campaigns: 1 to 2 months. Campaign structure to be discussed with REGENESIS
Typical dilution factor & mixing activities – Direct push and excavation	<p>Typical dilution factor:</p> <ul style="list-style-type: none"> • Part A and Part B can be mixed together • 5% on Part A weight (exact dilution to be discussed with REGENESIS) • 1 kg of Part A in 20 litres of water <p>Mixing:</p> <ul style="list-style-type: none"> • Add Part A to tank <u>already</u> filled with water. Mix carefully to dissolve completely • Add some water to Part B bucket and mix, to make the gel more liquid • Add Part B only after Part A is completely dissolved • Maintain mixing throughout injection process
Typical dilution factor & mixing activities – In well	<p>Typical dilution factor:</p> <ul style="list-style-type: none"> • Part A and Part B to be applied separately • 5% for both Part A and Part B (exact dilution to be discussed with REGENESIS) • 1 kg of Part A in 20 litres of water • 1 kg of Part B in 20 litres of water <p>Mixing (repeat separately for each component, first Part B and then Part A):</p> <ul style="list-style-type: none"> • Add component to tank <u>already</u> filled with water • Mix carefully to dissolve completely • Maintain mixing throughout injection process
Recommended injection pump	Diaphragm pump
Recommended injection pressure	Low to average pressure injection. Typically 1-5 bar. Adjust pressure using pressure regulator. Take note of pressure and flow rate for each step
Direct push injection	Retractable screen tip recommended; pressure activated tip as an alternative. Typical injection steps every 30 cm. More info on direct push injection.
In well application	Apply first Part B; flush with clean water; then apply Part A. Pressure injection; DO NOT gravity feed. Use single or double packer. Flush well with clean water after application. Reduction in well efficiency to be expected, due to residual solids
Excavation application	Mix with water before application. Place at the bottom of excavation. Mix carefully with soil at the bottom using excavator to enhance contact. More info on excavation application.
Other recommendations	Always wash and flush equipment with clean water. Seal injection direct push points after injection. Do not operate P&T or other activities likely to disturb groundwater in surrounding area during and after injection
Recommended monitoring	Typically, monthly monitoring after last injection campaign. Monitoring period typically 3 to 6 months. Monitoring between injection campaigns recommended (higher frequency, also depending if pumping of desorbed contaminant is performed). Parameters: contaminants of concern. Supporting evidence: O ₂ , redox, pH, electrical conductivity, eventual daughter products



Subsurface application of RegenOx® via low pressure injection is commonly performed using either direct push technology (DPT) or via injection wells. RegenOx is a two-part product comprising Part A: the sodium percarbonate-based solid alkaline oxidant, and Part B: the sodium silicate-based activator complex. RegenOx Part A is a dry white powder that ships as a 5.1 Class Oxidizer in 18.1kg bags. Part B is a non-hazardous thick green/brown liquid gel shipped in 18.1kg buckets.

Unlike many chemical oxidisers, RegenOx does not pose a risk to underground services, making it suitable for use on operational sites with an extensive network of underground services. RegenOx application will typically be completed over several separate injection events, or 'campaigns'. These separate campaigns help to address contaminant rebound; when contaminants are removed from the soil-bound phase into the dissolved phase and free phase. The recommended number of campaigns will be specified by REGENESIS during the design phase.

Safety Data Sheets (SDS) for Part A and Part B are provided with each shipment, which should be studied carefully by the user to ensure the RegenOx is handled and stored appropriately. It is assumed that the user is appropriately trained and competent and will have completed a comprehensive site-specific health, safety & environmental risk assessment for the works they intend to carry out.

Pre-Application Process

Prior to RegenOx application, REGENESIS recommends completing a pre-application test injection using clean water. This procedure is useful to determine the quantity of liquid the target zone is able to accept and will provide valuable flow rate and pressure information. REGENESIS recommends the injection test volume of water is in the range of **15-20% greater** than the single-point design volume e.g. if the design specifies a RegenOx volume of 1,000L per point then the water test injection should aim for 1,150 – 1,200L. A pump capable of delivering of up to 30-50 litres/minute up to approximately **6-8 bar pressure** is generally considered suitable.

RegenOx Part A is a powder that will readily dissolve in water, provided that the user dilutes with the appropriate volume of water. The RegenOx Part B gel activator complex can be difficult to handle due to its thickness, particularly in colder temperatures. Product handling can be improved by adding a small quantity of water to fill the Part B bucket to near the brim and mixing using a battery-powered drill with a mixing attachment or a hand-held paddle, making sure to reach any settled product at the bottom of the bucket.

Mixing and Application via Direct Push

When injecting RegenOx via direct push, RegenOx Part A and Part B can be mixed with water in the same mixing tank and co-injected. Typically, a RegenOx Part A concentration of between **4% and 6%** is optimal. Table 2 demonstrates how these concentrations can be achieved. Please note the quantity of RegenOx Part A and B may vary between RegenOx campaigns. If applicable, this will be highlighted by REGENESIS during the remediation design phase.

Solution to be prepared (%)	Amount of RegenOx Part A (kg)	Amount of RegenOx Part B (kg)	Amount of mix water (L)	Approximate final volume (L)
4	18.1	18.1	430	470*
5	18.1	18.1	340	380*
6	18.1	18.1	280	320*

Table 2: RegenOx mixing quantities for direct push injection

* Total volume increases as a result of the added RegenOx

RegenOx mixes readily into water when batched at the recommended solution ranges. REGENESIS recommends slow addition of RegenOx Part A powder to the requisite amount of water and mixing using appropriately sized equipment, to ensure thorough mixing throughout the vessel. The RegenOx solution should be mixed in appropriately sized tanks that match the project's requirements. Ideally the tank should be conical or flat bottomed to ensure thorough mixing and no settlement of undissolved solids. REGENESIS would not recommend reliance on recirculation to mix RegenOx, although this method can aid the mixing process.

Once the Part A has dissolved in the water, RegenOx Part B can then be poured directly from the bucket into the tank, and mixed thoroughly. Any residue remaining in the Part B bucket should be removed using clean water and a battery powered drill with a mixing attachment and added to the mixing tank.

When Part A and Part B are mixed in the same vessel, a small degree of flocculation and foaming can occur therefore we would recommend that the RegenOx is continually mixed throughout the injection process. Once a mixing tank has been emptied it is recommended to use clean water to flush/clean out the tank to ensure there is no build-up of undissolved solids over time. This will also help to flush out the pump, hoses and injection rods. REGENESIS would also advise that all equipment is flushed through with clean water at the end of each working day and on completion of the injection works. Mixed RegenOx should not be left for long periods e.g. overnight in the mixing tank. REGENESIS would recommend use

of retractable screened tips instead of pressure activated tips to facilitate ease of injection. The injection rods should be advanced to the target depth and the RegenOx injected, while note is taken of the flow rate and pressure. Once the requisite volume has been applied evenly over the target horizon, clean water should be used to flush through the pump, hoses and injection tip to ensure all RegenOx has been displaced into the target formation. Once the point has been completed the injection hole should be sealed with bentonite or cement. The purpose of this effort is to seal off any potential pathways to the surface which may allow “daylighting” (upflow) of injected RegenOx and/or groundwater. If the RegenOx application is based on a grid design, the application should be performed by systematically working from the outside to the centre of the injection array to minimise local pressurisation of the groundwater. Where possible, a suitable distance should be maintained between consecutive injection locations to avoid overloading the formation with injected product.

Mixing and Application via Injection Wells

REGENESIS recommends that injection wells should generally be constructed using **≥50mm diameter HDPE, with 1mm slot width**. Where possible, the well seal should consist of a maximum of 300mm of bentonite pellets, above which a sand & cement mix should be applied to seal to the surface. Prior to injection of any remedial reagent, REGENESIS recommends that the injection wells are purged of fine-grained particles present in the well bore, to the extent practicable. Co-mixing and injecting RegenOx Part A and B is not recommended for application into injection wells due to the risk of blocking the well screen with flocculent that can be created when the two parts mix and react together. Instead, REGENESIS recommends applying Part B first in all wells, flushing with 2-3 times the well volume with clean water, then following up with application of Part A and flush water within the same injection campaign. Typically, a RegenOx Part A concentration of between 4% and 6% is optimal. Table 3 demonstrates how these concentrations can be achieved.

Solution to be prepared (%)	Amount of RegenOx Part B (kg)	Amount of RegenOx Part A (kg)	Volume of mix water (L)	Total volume per injection campaign (L)
4	18.1		430	900*
4		18.1	430	
5	18.1		340	720*
5		18.1	340	
6	18.1		280	600*
6		18.1	280	

Table 3: RegenOx mixing quantities for injection wells

* Total volume increases as a result of the added RegenOx



RegenOx Part B should be added slowly to the requisite amount of water in the mixing vessel and agitated using appropriately sized equipment to ensure thorough mixing throughout the vessel. The RegenOx solution should be mixed in appropriately sized tanks that match the project's requirements. Ideally the tank should be conical or flat bottomed to ensure thorough mixing and no settlement of undissolved solids. REGENESIS would not recommend reliance on recirculation to mix RegenOx, although this method can aid the mixing process. Any residue remaining in the Part B bucket should be removed using clean water and a battery powered drill with a mixing attachment and added to the mixing tank. RegenOx Part B has a green/brown appearance once dissolved in water.

RegenOx Part A mixes readily into water when batched at the recommended solution ranges. REGENESIS recommends slow addition of RegenOx Part A powder to the mixing tank water followed by thorough mixing. RegenOx Part A has a milky white appearance once dissolved in water.

After each RegenOx injection event, each injection well should be flushed with clean water. The volume of the clean flush should be equivalent to at least 2-3 borehole volumes. When wells are used for RegenOx injection, the injection wells and nearby groundwater monitoring wells should be either tightly capped or alternatively, equipped with a pressure gauge and relief valve. This will reduce potential for short circuiting to the surface.

Daylighting Events

If excessive daylighting of RegenOx and/or groundwater is observed, please contact REGENESIS for advice. The following actions/checks could be taken:

- For direct push
 - What type of injection tip is being used?
 - Is the RegenOx being applied evenly over the target vertical distance?
- For well applications
 - Was Part A & B injected separately?
 - Was sufficient flush water used between application of Parts A & B and between injection campaigns?
 - What was the construction method for the wells? Was a sufficient seal installed?
- Check that the geology onsite matches what was expected e.g. is the formation as permeable as expected?
- Ensure that consecutive injections are not taking place in adjacent points
- Reduce the injection flow rate and pressure
- Increase the dilution (to form a less reactive solution)

Excavation Application

For excavation applications, RegenOx Part A and Part B can be mixed with water in the same mixing tank and co-applied. Typically, a RegenOx Part A concentration around **5%** is optimal. However, for this scenario a more concentrated solution could be considered, if there is concern over the amount of liquid being added to the excavation. In this instance, please contact REGENESIS for advice. For preparation of the solution, please refer to the mixing instructions under the paragraph 'Mixing and Application via Direct Push'.

Depending on the size of the excavation, the application could be performed by pouring directly into the excavation, using a pump and hose, or using an excavator bucket or forward-tipping dumper. In general, it is recommended to proceed as follows:

- Ideally divide the surface into equal sections, into which a known quantity of product is applied;
- Use a toothed excavator bucket to 'rake' the product into the base of the excavation;
- Proceed with filling the excavation immediately after application to the bottom of the excavation.