



# OFFER OF SERVICES

## PG. 2

Preliminary **identification of potential clay candidates** to be used as Supplementary Cementitious Material

## PG. 3

Assessment **of reactivity of the clay candidate** chosen for use as Supplementary Cementitious Material

## PG. 5

Realization of an **industrial for calcination and grinding trial** for the production of cement with calcined clay



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Limestone  
Calcined  
Clay  
Cement

**LC<sup>3</sup>**



## PRELIMINARY IDENTIFICATION OF POTENTIAL CLAY CANDIDATES

**Report #1:** Identification of potential candidates to produce calcined clay as Supplementary Cementitious Material.

1. **Chemical composition** of the clay in oxides
2. **Mineralogical composition** expressed in the main crystalline phases in the material, determined using X ray diffraction techniques, XRD.
3. **Thermo-gravimetric studies** of the material.
4. **Geological information available** on the clay deposit, especially the lithology of the spot where samples were collected, and their geo-referenced location.

**Description:** The work will be done with existing information on clay deposits surveyed in the past, or any other studies carried out in the region on the pursuit of other minerals and resources, where chemical and mineralogical information can be obtained, as well as information on the geology of the region. **Such information should come from the client, but Ecosolutions can also access it on the public domain.**

**Implementation:** 4 weeks from the moment the information is received

### Number of candidates covered in this study:

Up to 5 candidates. **NOTE:** if the client wants to incorporate further candidates there is an extra cost associated.

### Expected results:

Individual assessment of each clay candidate (clay deposit) and further criteria on its viability for the production of SCMs, based only on data from chemical and mineralogical composition and the geological history. These results are very preliminary and must be ratified in further phases aided with experimental studies.



## ASSESSMENT OF REACTIVITY OF THE CLAY CANDIDATE

**Report #2:** Reactivity of the clay candidate as Supplementary Cementitious Material

**Description:** it includes sampling the clay deposit of interest, through the collection of individual samples and/or composite samples, that can be used to produce a representative sample of the entire deposit, which can also be evaluated.

**Implementation:**  
Sampling: 4-6 weeks

1. Accompanying the local geology team at sampling during the exploration of the deposit. **A minimum area of 100 ha will be studied**, to guarantee reserves at least in the order of 1 Mt of clay.

A sampling grid with spacing 250m x 250m will be defined. In each intersection of the axis of the grid individual samples shall be taken, either in trenches or as boreholes. For each individual axis a composite sample shall be prepared through blending of individual samples. Sampling depth will be dictated by the geology of the deposit. A typical study in a 100ha area would produce 25 individual samples, 5 composite samples and 1 integral sample, for a total of 31 samples. **The client can change the sampling design for own purposes**, at an extra cost.

**Number of samples covered in this study:** 31.

**NOTE:** further samples can be tested upon request; this implies an extra cost.

**Expected results:**

Full **characterization of the material available** at the clay deposit subject of interest, including **chemical and mineralogical composition**, kaolinite content, potential reactivity as SCM and physic-mechanical properties in LC3-50 systems (50% clinker, 30% calcined clay, 15% limestone, 5% gypsum)



## ASSESSMENT OF REACTIVITY OF THE CLAY CANDIDATE

**Report #2:** Reactivity of the clay candidate as SCM

**Description:** it includes sampling the clay deposit of interest, through the collection of individual samples and/or composite samples, that can be used to produce a representative sample of the entire deposit, which can also be evaluated.

**Implementation:** Sample evaluation: 6-8 weeks from the point of arrival of the samples to the lab.

**2.** For each of the samples collected the following experimental program shall be undertaken:

- a. Chemical and mineralogical composition.
- b. Determining kaolinite content through the combination of thermal analysis and X ray diffraction.
- c. Lab calcination at 800°C, with quality of calcination controlled using TG.
- d. Assessment of reactivity[1] through:
  - ✓ Evaluation of heat of hydration at 72h in an isothermal calorimeter of a cement paste with composition of LC3-50 (53% CEM I 42,5 N, 30% calcined clay, 15% limestone, 2% gypsum)
  - ✓ Strength at 24h, 7d and 28d in standard mortars with composition of LC3-50 (53% CEM I 42,5 N, 30% calcined clay, 15% limestone, 2% gypsum)

**Number of samples covered in this study:** 31.

**NOTE:** further samples can be tested upon request; this implies an extra cost.

### Expected results:

Full characterization of the material available at the clay deposit subject of interest, including chemical and mineralogical composition, kaolinite content, potential reactivity as SCM and physic-mechanical properties in LC3-50 systems (50% clinker, 30% calcined clay, 15% limestone, 5% gypsum)



## REALIZATION OF AN INDUSTRIAL TRIAL FOR CALCINATION AND GRINDING

**Report #3:** Industrial trial of calcination and grinding LC3 cement.

### Description:

Accompanying the client in the realization of an industrial calcination and grinding trial, that will avail bulky amounts of product to be use for purposes such as standardization or marketing with clients.

### Implementation:

(it depends on the activities)  
Characterization of the industrial sample: 4-6 week.

1. Accompanying the geology team at sampling of an industrial sample of the average material at the clay deposit, which should be representative of the entire deposit. Sample size oscillates between 1-1000 t, depending on the client's interest and the industrial facilities available.
2. Characterization of the industrial sample, using a protocol like the one described in section 2
  - a. Chemical and mineralogical composition.
  - b. Determining kaolinite content through the combination of thermal analysis and X ray diffraction.
  - c. Lab calcination at 800°C, with quality of calcination controlled using TG.
  - d. Clay reactivity in cementitious systems of the kind LC3

### Number of samples covered in this study:

1 sample (although there can be replications)

### Expected results:

Simulation of the industrial processing of raw materials subject of study, with the possibility of obtaining real productive parameters and a sample of some of the potential products to produce.



## REALIZATION OF AN INDUSTRIAL TRIAL FOR CALCINATION AND GRINDING

**Report #3:** Industrial trial of calcination and grinding LC3 cement.

### Description:

Accompanying the client in the realization of an industrial calcination and grinding trial, that will avail bulky amounts of product to be use for purposes such as standardization or marketing with clients.

**3.** Realization of an industrial trial in any of the following facilities:

a. Ecosolutions' Pilot Plant at Santa Clara, with calcination capacity of 150 kg/h under strictly controlled conditions, including color control of the resulting product. In this case the sample size oscillates between 400-800 kg, depending on the client's interests.

b. Existing clinker or lime kilns, depending on the clients' possibilities for the calcination of the material under the designated conditions (gas temperature between 800-900°C, minimum residence time 40 min)

c. Other facilities available for the client, where a calcination trial can be carried out. For example, an intermittent brick kiln with temperature control would eventually do.

### Implementation:

Realization of the industrial trial: 4-6 weeks from the point the samples arrive at the Pilot Plant.

### Number of samples covered in this study:

1 sample (although there can be replications)

### Expected results:

Simulation of the industrial processing of raw materials subject of study, with the possibility of obtaining real productive parameters and a sample of some of the potential products to produce.



## REALIZATION OF AN INDUSTRIAL TRIAL FOR CALCINATION AND GRINDING

**Report #3:** Industrial trial of calcination and grinding LC3 cement.

### Description:

Accompanying the client in the realization of an industrial calcination and grinding trial, that will avail bulky amounts of product to be use for purposes such as standardization or marketing with clients.

### Implementation:

Realization of the industrial trial: 4-6 weeks from the point the samples arrive at the Pilot Plant.

3. Evaluation of quality of calcination and reactivity of the calcined material, using the same protocols described in section 2.

- a. Quality of calcination
- b. Reactivity of the calcined clay in LC3 cementitious systems

4. To guarantee conditions for the realization of an industrial grinding trial (ball mills or similar), which enable grinding the material to fineness equivalent to 3% retention at the 90  $\mu\text{m}$  sieve. These could be:

- a. Ecosolutions' Pilot Plant at Santa Clara, with grinding capacity 100 kg/h in an open circuit ball mill with air extraction of the product.
- b. Any other grinding system that guarantees the demanded conditions.

### Number of samples covered in this study:

1 sample (although there can be replications)

### Expected results:

Simulation of the industrial processing of raw materials subject of study, with the possibility of obtaining real productive parameters and a sample of some of the potential products to produce.



## REALIZATION OF AN INDUSTRIAL TRIAL FOR CALCINATION AND GRINDING

**Report #3:** Industrial trial of calcination and grinding LC3 cement.

### Description:

Accompanying the client in the realization of an industrial calcination and grinding trial, that will avail bulky amounts of product to be use for purposes such as standardization or marketing with clients.

### Implementation:

Realization of the industrial trial: 4-6 weeks from the point the samples arrive at the Pilot Plant.

**5.** Realization of an industrial trial in any of the following facilities:

a. Mineral addition "LC2", which consists of 60% calcined clay, 35% limestone and 5% gypsum. LC2 has a long shelf life, and can be blended with CEM I 42,5 or CEM I 52,5 in different proportions to produce diverse LC3 formulations.

b.LC3 cement properly, according to the formulation demanded by the client (clinker content)

c.Both products will be produced in two batches: (i) calcined clay with color control (black), and (ii) calcined clay without color control (red)

**6.** Assessment of quality of grinding and the properties of the ground product using international standards of the interest of the client.

a.Cement fineness, according to the requested standard.

b.Compressive strength in standard mortars, according to EN-197

### Number of samples covered in this study:

1 sample (although there can be replications)

### Expected results:

Simulation of the industrial processing of raw materials subject of study, with the possibility of obtaining real productive parameters and a sample of some of the potential products to produce.