

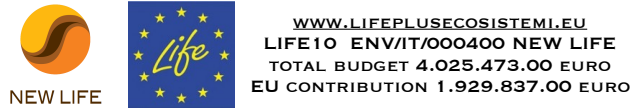
ENVIRONMENTAL RESTORATION ASSESSMENT BY MEANS OF LCC AND FCC

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RECONSTITUTION IS A PEDOTECHNIQUE PRODUCING ENVIRONMENTAL PROPER AND FERTILE TECHNOSOLS APPLYING CHEMICAL-MECHANICAL TREATMENT TO ALLUVIAL SEDIMENTS, DEGRADED SOILS AND PEDOMATERIALS INCLUDED WASTE BY DIFFERENT PRODUCTIVE PROCESSES.

BY THE MEANS OF RECONSTITUTION THE ENVIRONMENTAL RESTORATION OF COVERING DEGRADED SOIL OF A CLOSED LANDFILL NEAR PIACENZA IS MADE.



LCC IS USED TO CLASSIFY LANDS; THE LIMITATION MADE UP BY LOW PRODUCTIVITY, DUE TO SOIL CHEMICAL FERTILITY (PH, C.E.C., ORGANIC MATTER, SALINITY, DEGREE OF SATURATION) IS RELATED TO MORPHOLOGY, CLIMATE AND VEGETATION OF THE AREA WHERE SOIL IS.

FCC IS USED TO EVALUATE SOIL FERTILITY, NOT IN RELATION TO MORPHOLOGY OR EVOLUTION, BUT ON THE BASES OF PHYSICO-CHEMICAL PROPERTIES OF THE 0-20 CM SOIL LAYER. ON THE BASIS OF PH, ORGANIC MATTER, TOTAL CaCO₃, EXCHANGEABLE K₂O, P₂O₅ A MODIFICATION OF FCC IS USED TO CALCULATE AN INDICATOR OF GLOBAL SOIL FERTILITY.

| INTRINSEC FERTILITY | |
|---------------------|-------|
| N | CLASS |
| < 2 | C |
| 2 - 4 | B |
| > 4 | A |

INTRINSEC FERTILITY DECREASES FROM A TO C.
N = YEARS FOR C MINERALIZATION
N = ORG. C / K₂
K₂ = 1200 X (1 / (CLAY + 20)) X (1 / (CACO₃ + 20))

| | | CHEMICAL FERTILITY | | | | | | | | | | | | | | | |
|---------|--|---|------------------------------|------------------|------------------|--------------------|------------------|------------------|--------------------|------------------|------------------|--------------------|------------------|------------------|--------------------|------------------|------------------|
| | | K ₂ O MG KG ⁻¹ | <80 | | | 80-100 | | | 101-120 | | | 121-160 | | | >160 | | |
| | | pH | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| TEXTURE | P ₂ O ₅ MG KG ⁻¹ | <5 0 >8.5 | 5.0-6.5 7.9-8.5 | 6.6-7.8 | <5 0 >8.5 | 5.0-6.5 7.9-8.5 | 6.6-7.8 | <5 0 >8.5 | 5.0-6.5 7.9-8.5 | 6.6-7.8 | <5 0 >8.5 | 5.0-6.5 7.9-8.5 | 6.6-7.8 | <5 0 >8.5 | 5.0-6.5 7.9-8.5 | 6.6-7.8 | |
| | SAND>60 % | <23 23-30 31-34 >34 | 5 4 3 3 | 5 4 3 3 | 4 4 3 3 | 5 4 3 2 | 4 3 3 2 | 4 3 3 2 | 4 3 3 2 | 3 2 2 2 | 4 3 2 2 | 3 2 2 2 | 3 2 1 2 | 4 3 2 2 | 4 3 2 2 | 3 2 2 2 | |
| | LOAM | <30 30-39 40-48 >48 | 5 4 4 4 | 5 4 3 3 | 5 4 3 3 | 5 4 3 3 | 5 4 3 3 | 5 4 3 3 | 5 4 3 3 | 5 4 3 3 | 4 3 2 2 | 4 3 2 2 | 4 3 2 2 | 4 3 2 1 | 4 3 3 3 | 4 3 3 2 | 4 3 3 2 |
| | | CLAY>35 % | <34 34-44 45-55 >55 | 5 5 4 4 | 5 4 3 3 | 5 4 3 3 | 5 4 3 3 | 5 4 3 3 | 5 4 3 3 | 5 4 3 3 | 5 4 3 3 | 4 3 3 2 | 4 3 3 2 | 4 3 3 2 | 4 3 3 2 | 4 3 3 1 | 4 3 3 2 |

CHEMICAL FERTILITY DECREASES FROM 1 TO 5

CHEMICAL FERTILITY DECREASES FROM 1 TO 5

| | | FERTILITY | | |
|---|--|--------------------|---------------------|-----|
| | | CHEMICAL FERTILITY | INTRINSEC FERTILITY | |
| | | A | B | C |
| | | I | I | II |
| | | II | II | III |
| | | III | III | III |
| | | IV | IV | V |
| 1 | | I | I | II |
| 2 | | II | II | III |
| 3 | | II | III | III |
| 4 | | IV | IV | V |
| 5 | | IV | V | V |

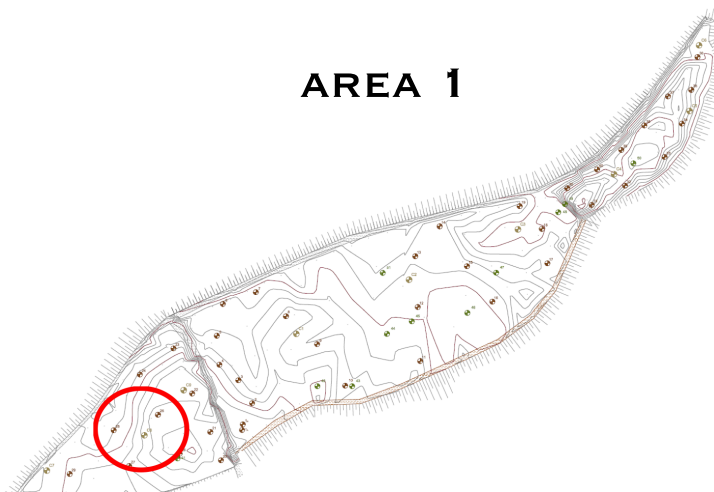
FERTILITY DECREASES FROM I TO V

LCC CLASSES

| | |
|------|--|
| I | SOILS HAVE SLIGHT LIMITATIONS THAT RESTRICT THEIR USE |
| II | SOILS HAVE MODERATE LIMITATIONS THAT RESTRICT THE CHOICE OF PLANTS OR THAT REQUIRE MODERATE CONSERVATION PRACTICES |
| III | SOILS HAVE SEVERE LIMITATIONS THAT REDUCE THE CHOICE OF PLANTS OR REQUIRE SPECIAL CONSERVATION PRACTICES, OR BOTH |
| IV | SOILS HAVE VERY SEVERE LIMITATIONS THAT RESTRICT THE CHOICE OF PLANTS OR REQUIRE VERY CAREFUL MANAGEMENT, OR BOTH |
| V | SOILS HAVE LITTLE OR NO HAZARD OF EROSION BUT HAVE OTHER LIMITATIONS, IMPRACTICAL TO REMOVE, THAT LIMIT THEIR USE MAINLY TO PASTURE, RANGE, FORESTLAND, OR WILDLIFE FOOD AND COVER |
| VI | SOILS HAVE SEVERE LIMITATIONS THAT MAKE THEM GENERALLY UNSUITED TO CULTIVATION AND THAT LIMIT THEIR USE MAINLY TO PASTURE, RANGE, FORESTLAND, OR WILDLIFE FOOD AND COVER |
| VII | SOILS HAVE VERY SEVERE LIMITATIONS THAT MAKE THEM UNSUITED TO CULTIVATION AND THAT RESTRICT THEIR USE MAINLY TO GRAZING, FORESTLAND, OR WILDLIFE |
| VIII | SOILS AND MISCELLANEOUS AREAS HAVE LIMITATIONS THAT PRECLUDE THEIR USE FOR COMMERCIAL PLANT PRODUCTION AND LIMIT THEIR USE TO RECREATION, WILDLIFE, OR WATER SUPPLY OR FOR ESTHETIC PURPOSES |

FOR EACH SOIL LCC CLASS AGREES TO THE MOST SEVERE CLASS ASSIGNED TO A PARAMETER.

COMPARISONS OF 5 SOIL SAMPLES BEFORE AND AFTER RECONSTITUTION SHOW HOW RECONSTITUTION IMPROVES LCC AND FCC CLASSES



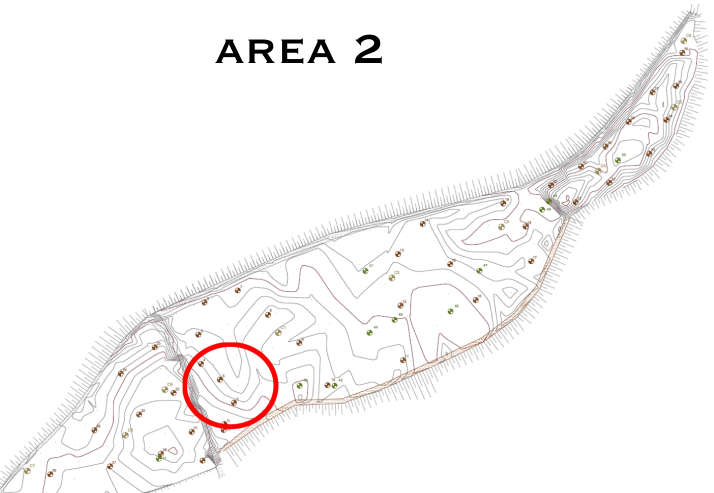
| | AREA 1 (2011) | | AREA 1 (2016) | |
|-----------------------------|---------------|----|---------------|----|
| | LCC | | LCC | |
| ROOT RESTRICTING LAYER CM | 35 | IV | >150 | I |
| TEXTURE | SL | II | SL | II |
| PARENT MATERIAL % | 12 | II | <5 | I |
| GRAVEL % | 6.5 | IV | <0.3 | I |
| STONINESS | NO | I | NO | I |
| CHEMICAL FERTILITY | - | I | - | I |
| SALINITY DS M ⁻¹ | 0.2 | I | 0.8 | I |
| SLOPE % | <0.2 | I | <0.2 | I |
| EROSION RISK | NO | I | NO | I |
| CLIMATIC LIMITATION | NO | I | NO | I |

| CHEMICAL FERTILITY | | | | | | |
|---|---------------|------------|-----|---------------|------------|-----|
| | AREA 1 (2011) | | | AREA 1 (2016) | | |
| | | EVALUATION | LCC | | EVALUATION | LCC |
| PH | 7.9 | GOOD | I | 7.8 | GOOD | I |
| SALINITY DS M ⁻¹ | 0.2 | GOOD | I | 0.8 | GOOD | I |
| C.E.C. MEQ/100G | 19.7 | GOOD | I | 31.2 | GOOD | I |
| CaCO ₃ TOT G KG ⁻¹ | 38 | GOOD | I | 124 | GOOD | I |

| | AREA 1 (2011) | AREA 1 (2016) |
|---|---------------|---------------|
| | | |
| CLAY % | 15 | 11 |
| CACO ₃ TOT G KG ⁻¹ | 38 | 124 |
| 1 YEAR MINERALIZED O.M. % | 1.5 | 1.0 |
| ORG. C % | 1.7 | 4.7 |
| YEARS FOR C MINERALIZATION N | 1.1 | 4.5 |
| PH | 7.9 | 7.8 |
| P ₂ O ₅ MG KG ⁻¹ | 99 | 104 |
| K ₂ O MG KG ⁻¹ | 82 | 199 |
| INTRINSEC FERTILITY | C | A |
| CHEMICAL FERTILITY | 3 | 2 |
| FERTILITY | III | I |

AREA 1 IMPROVES FROM CLASS IV SOIL WITH VERY SEVERE LIMITATIONS THAT RESTRICT THE CHOICE OF PLANTS AND/OR REQUIRE VERY CAREFUL MANAGEMENT TO CLASS II SOILS HAVE MODERATE LIMITATIONS THAT RESTRICT THE CHOICE OF PLANTS OR THAT REQUIRE MODERATE CONSERVATION PRACTICES; FERTILITY IMPROVES FROM CLASS III TO I.

| LCC | AREA 1 | | | | | | | | | |
|------|----------------|--------|---------|------------------|-----------|---------|----------|-----------|----------------|------|
| | NATURAL ENVIR. | FOREST | LIMITED | PASTURE MODERATE | INTENSIVE | LIMITED | MODERATE | INTENSIVE | VERY INTENSIVE | |
| I | | | | | | | | | | |
| II | | | | | | | | | | 2016 |
| III | | | | | | | | | | |
| IV | | | | | | | | | | 2011 |
| V | | | | | | | | | | |
| VI | | | | | | | | | | |
| VII | | | | | | | | | | |
| VIII | | | | | | | | | | |



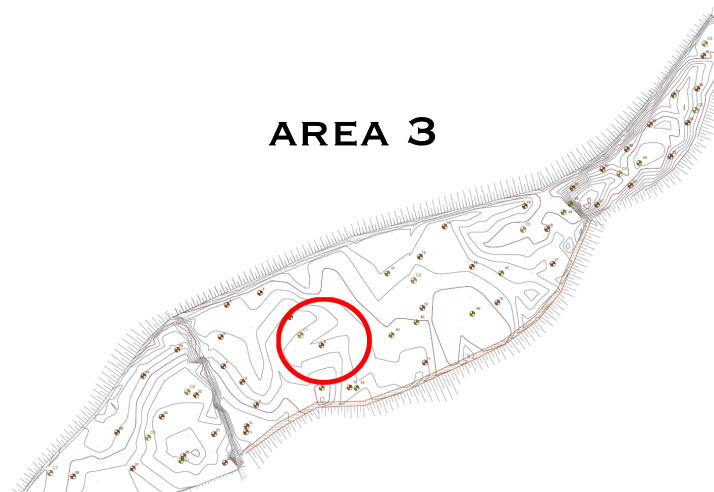
| | AREA 2 (2011) | | AREA 2 (2016) | |
|-----------------------------|---------------|-----|---------------|--------|
| | | LCC | LCC | |
| ROOT RESTRICTING LAYER CM | 26 | IV | >150 | I |
| TEXTURE | SL | II | L - SL | I - II |
| PARENT MATERIAL % | 18 | III | <5 | I |
| GRAVEL % | 5 | IV | <0.3 | I |
| STONINESS | NO | I | NO | I |
| CHEMICAL FERTILITY | - | I | - | I |
| SALINITY DS M ⁻¹ | 0.3 | I | 2.8 | II |
| SLOPE % | <0.2 | I | <0.2 | I |
| EROSION RISK | NO | I | NO | I |
| CLIMATIC LIMITATION | NO | I | NO | I |

| CHEMICAL FERTILITY | | | | | | |
|---|---------------|------------|-----|---------------|------------|-----|
| | AREA 2 (2011) | | | AREA 2 (2016) | | |
| | | EVALUATION | LCC | | EVALUATION | LCC |
| PH | 7.5 | GOOD | I | 7.8 | GOOD | I |
| SALINITY DS M ⁻¹ | 0.3 | GOOD | I | 2.8 | GOOD | II |
| C.E.C. MEQ/100G | 12.1 | GOOD | I | 34.5 | GOOD | I |
| CaCO ₃ TOT G KG ⁻¹ | 55 | GOOD | I | 243 | GOOD | I |

| | AREA 2 (2011) | AREA 2 (2016) |
|---|---------------|---------------|
| | | |
| CLAY % | 12 | 10 |
| CACO ₃ TOT G KG ⁻¹ | 55 | 243 |
| 1 YEAR MINERALIZED O.M. % | 1.5 | 0.9 |
| ORG. C % | 2.7 | 6.6 |
| YEARS FOR C MINERALIZATION N | 1.8 | 7.3 |
| PH | 7.5 | 7.7 |
| P ₂ O ₅ MG KG ⁻¹ | 48 | 95 |
| K ₂ O MG KG ⁻¹ | 95 | 211 |
| INTRINSEC FERTILITY | C | A |
| CHEMICAL FERTILITY | 3 | 2 |
| FERTILITY | III | I |

AREA 2 IMPROVES FROM CLASS VI SOILS HAVE SEVERE LIMITATIONS THAT MAKE THEM GENERALLY UNSUITABLE FOR CULTIVATION AND THAT RESTRICT THEIR USE MAINLY TO PASTURE, RANGELAND, FORESTLAND, OR WILDLIFE HABITAT TO CLASS II SOILS HAVE MODERATE LIMITATIONS THAT RESTRICT THE CHOICE OF PLANTS OR THAT REQUIRE MODERATE CONSERVATION PRACTICES; FERTILITY IMPROVES FROM CLASS III TO I.

| LCC | AREA 2 | | | | | | | | | |
|------|----------------|--------|---------|------------------|-----------|---------|----------|-----------|----------------|------|
| | NATURAL ENVIR. | FOREST | LIMITED | PASTURE MODERATE | INTENSIVE | LIMITED | MODERATE | INTENSIVE | VERY INTENSIVE | |
| I | | | | | | | | | | |
| II | | | | | | | | | | 2016 |
| III | | | | | | | | | | |
| IV | | | | | | | | | | |
| V | | | | | | | | | | |
| VI | | | | | | | | | | 2011 |
| VII | | | | | | | | | | |
| VIII | | | | | | | | | | |



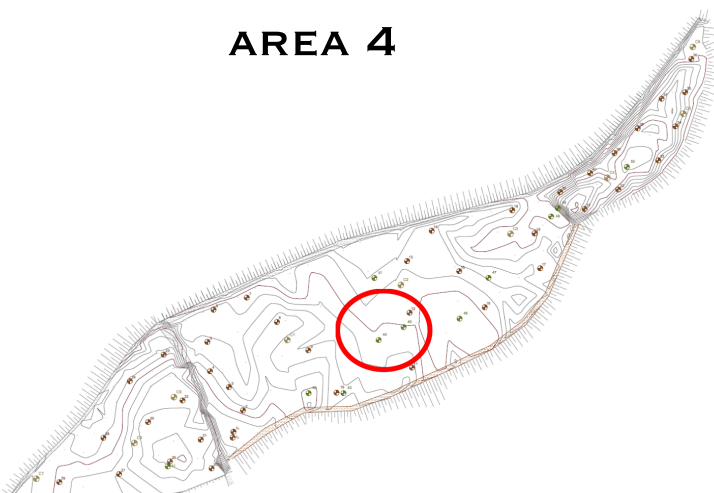
| | AREA 3 (2011) | AREA 3 (2016) | | |
|--------------------------------|---------------|---------------|------|----|
| | | LCC | LCC | |
| ROOT RESTRICTING LAYER CM | 24 | VII | >150 | I |
| TEXTURE | SL | II | SL | II |
| PARENT MATERIAL % | 37 | IV | <5 | I |
| GRAVEL % | 28 | VII | <0.3 | I |
| STONINESS | NO | I | NO | I |
| CHEMICAL FERTILITY | - | I | - | I |
| SALINITY DS M ⁻¹ | 2.0 | I | 2.4 | II |
| SLOPE % | <0.2 | I | <0.2 | I |
| EROSION RISK | NO | I | NO | I |
| CLIMATIC LIMITATION | NO | I | NO | I |

| CHEMICAL FERTILITY | | | | | | |
|---|---------------|------------|-----|---------------|-------------------|-----|
| | AREA 3 (2011) | | | AREA 3 (2016) | | |
| | | EVALUATION | LCC | | EVALUATION | LCC |
| PH | 7.9 | GOOD | I | 7.7 | GOOD | I |
| SALINITY DS M ⁻¹ | 2.0 | GOOD | I | 2.4 | PARTIALLY GOOD | II |
| C.E.C. MEQ/100G | 8.5 | GOOD | I | 33 | GOOD | I |
| CACO ₃ TOT G KG ⁻¹ | 130 | GOOD | I | 173 | GOOD | I |

| | AREA 3 (2011) | AREA 3 (2016) |
|---|---------------|---------------|
| | | |
| CLAY % | 12 | 11 |
| CACO ₃ TOT G KG ⁻¹ | 130 | 173 |
| 1 YEAR MINERALIZED O.M. % | 1.1 | 0.9 |
| ORG. C % | 1.9 | 5.1 |
| YEARS FOR C MINERALIZATION N | 1.7 | 3.1 |
| PH | 7.9 | 7.7 |
| P ₂ O ₅ MG KG ⁻¹ | 18 | 85 |
| K ₂ O MG KG ⁻¹ | 98 | 284 |
| INTRINSEC FERTILITY | C | A |
| CHEMICAL FERTILITY | 5 | 2 |
| FERTILITY | V | I |

AREA 3 IMPROVES FROM CLASS VII SOILS HAVE VERY SEVERE LIMITATIONS THAT MAKE THEM UNSUITABLE FOR CULTIVATION AND THAT RESTRICT THEIR USE MAINLY TO GRAZING, FORESTLAND, OR WILDLIFE HABITAT TO CLASS II SOILS HAVE MODERATE LIMITATIONS THAT RESTRICT THE CHOICE OF PLANTS OR THAT REQUIRE MODERATE CONSERVATION PRACTICES; FERTILITY IMPROVES FROM CLASS V TO I.

| LCC | AREA 3 | | | | | | | | | |
|------|----------------|--------|---------|------------------|-----------|---------|----------|-----------|----------------|------|
| | NATURAL ENVIR. | FOREST | LIMITED | PASTURE MODERATE | INTENSIVE | LIMITED | MODERATE | INTENSIVE | VERY INTENSIVE | |
| I | | | | | | | | | | |
| II | | | | | | | | | | 2016 |
| III | | | | | | | | | | |
| IV | | | | | | | | | | |
| V | | | | | | | | | | |
| VI | | | | | | | | | | |
| VII | | | | | | | | | | 2011 |
| VIII | | | | | | | | | | |



| | AREA 4 (2011) | | AREA 4 (2016) | |
|--------------------------------|---------------|----|---------------|----|
| | LCC | | LCC | |
| ROOT RESTRICTING LAYER CM | 35 | IV | >150 | I |
| TEXTURE | SL | II | SL | II |
| PARENT MATERIAL % | 12 | IV | <5 | I |
| GRAVEL % | 6.2 | IV | <0.3 | I |
| STONINESS | NO | I | NO | I |
| CHEMICAL FERTILITY | - | I | - | I |
| SALINITY DS M ⁻¹ | 0.2 | I | 1.4 | II |
| SLOPE % | <0.2 | I | <0.2 | I |
| EROSION RISK | NO | I | NO | I |
| CLIMATIC LIMITATION | NO | I | NO | I |

| CHEMICAL FERTILITY | | | | | | |
|---|---------------|------------|-----|---------------|------------|-----|
| | AREA 4 (2011) | | | AREA 4 (2016) | | |
| | | EVALUATION | LCC | | EVALUATION | LCC |
| PH | 8.1 | GOOD | I | 7.6 | GOOD | I |
| SALINITY DS M ⁻¹ | 0.2 | GOOD | I | 1.4 | GOOD | II |
| C.E.C. MEQ/100G | 32.2 | GOOD | I | 41 | GOOD | I |
| CaCO ₃ TOT G KG ⁻¹ | 138 | GOOD | I | 199 | GOOD | I |

| | AREA 4 (2011) | AREA 4 (2016) |
|--|---------------|---------------|
| CLAY | 12 | 13 |
| CACO ₃ TOT G KG ⁻¹ | 138 | 199 |
| 1 YEAR MINERALIZED O.M. % | 1.1 | 0.9 |
| ORG. C % | 2.3 | 7.5 |
| YEARS FOR C MINERALIZATION N | 2.1 | 8.3 |
| PH | 8.1 | 7.6 |
| P ₂ O ₅ MG KG ⁻¹ | 139 | 121 |
| K ₂ O MG KG ⁻¹ | 99 | 183 |
| INTRINSEC FERTILITY | B | A |
| CHEMICAL FERTILITY | 3 | 2 |
| FERTILITY | III | I |