• Increases yields of crops, vegetables and fruits
• Produces superior turf and deep roots
• Enhances uptake of fertilizers
• Replenishes depleted soils
• Promotes ecological balance
ARCTECH CORPORATE PROFILE

- Established in 1988 as a spin-off company from Atlantic Research Corp., a large U.S. Aerospace Company
- Headquarter and Technical Center – Chantilly, Virginia
- Manufacturing Plant – South Boston, Virginia
- Market Profile: Develops Innovative Solutions from Concept to Implementation for Energy, Environment, and Agriculture markets
- Commercial Products Applications in U.S.A., Egypt, Gulf Countries, and S.Korea
- Creating Biotechnology Solutions since Mid 1970’s.
- Selected as one of the six top bioprocessing firms in the United States (Arthur Young, 1989)
HUMIC ACID

- Carbon-rich highly functionalized organic molecule comprising of carboxlic, phenolic, carbohydrates and enolic groups
- Colloidal organic matter, water soluble at pH above 2 and insoluble at pH below 2
- Brownish black color
ESSENTIAL ELEMENTS FOR PLANTS

- C  carbon
- H  hydrogen
- O  oxygen

MACRO:
- N  nitrogen
- P  phosphorus
- K  potassium
- Ca calcium
- Mg magnesium
- S  sulphur

MICRO:
- B  boron
- Cu copper
- Fe  Iron
- Mn Manganese
- Mo molybdenum
- Zn  zinc
- Cl  chloride
- Co cobalt
THE actosol® HUMIC ACID ADVANTAGE

- Enhances yield and quality of crops, vegetables, and fruits
- Produces healthy and deeper root mass for superior turf
- Creates vegetation in saline and poor soils
HOW DOES actosol® HUMIC ACID CREATE BENEFITS?

- By enhancing soil structure and fertility through the addition of vital organic matter in the soil;

- By efficient transfer of fertilizer nutrients and micronutrients because of the high chelation and cation exchange proportion of the active humic acid component of actosol®;

- By increasing moisture holding capacity of soil;

- By increasing microbial activity in the soil; and

- By enhancing plant cell biomass.
APPLICATIONS OF actosol® HUMIC ACID

- Agriculture
- Horticulture
- Floriculture
- Turf Management/Maintenance
- Mine/Landfill Reclamation
- Dune Stabilization
- Road/Highway Erosion Control
- Hydroseeding
- Pasture Land, Conservation of Natural Resources
ARCTECH’S RECENT CLIENTS

UNITED STATES
- Landscaping
- Erosion Control
- Landfill Closure
- Golf Courses
- Sod Farms
- Nurseries-Tomatoes
- Sand Dunes
- Floriculture

GULF COUNTRIES
- Rhodes Grass
- Water Melon
- Cucumber
- Alfalfa
- Orange Groves
- Grapes
- Onion
- Date Trees

MAURITIUS
- Sugar Cane
- Horticulture

S. KOREA
- Golf Courses
- Greenhouses

actosol® HUMIC ACID BEING APPLIED SUCCESSFULLY IN VARIOUS APPLICATIONS
IMPORTANCE OF HUMUS, A KEY COMPONENT IN actosol® DISCOVERED DURING ALASKAN CRUISE

Sitka, Alaska
ACTION OF HUMIC SUBSTANCES ON PLANT GROWTH

Physical

• Increases water holding capacity
• Increases aeration of soils
• Improves soil workability
• Helps resist drought
• Improves seed bed
• Makes soil more friable or crumbly
• Reduces soil erosion.

Chemical

• Chelates nutrients for uptake by plants
• Possesses high ion-exchange capacity.
• Increases buffering properties of soils
• Increases percentage of total Nitrogen in soils.

Biological

• Accelerates plant cell division and promotes growth
• Increases germination of seeds and viability
• Increases root respiration and formation
• Stimulates growth & proliferation of soil microorganisms.
• Aids in photosynthesis.
Primary and micronutrients bound to actosol® humic acid

Microbial counts and humic acid content are higher in actosol® treated soils

actosol® improves soil structure

actosol® humic acid increases water holding capacity
Approval of actosol® Humic Acid

A. USDA National Organic Food Production Program
   October 21, 2002

   Allows use of Humic Acid for Growing Organic Foods

   Additional Info: www.ams.usda.gov/nop

B. US Environmental Protection Agency
   June 13, 2003

   Approves humic acid as environmentally safe and exempts from
   Tolerance requirement when used as an ingredient (adjuvant, UV
   protectant) in pesticide formulations

   Additional Info: www.epa.gov/fedregstr

C. OMRI Listed (Organic Materials Review Institute)
   February 18, 2005

   Additional Info: www.omri.org

Preserving tomorrow’s world... today
### TYPICAL ANALYSIS OF actosol® PRODUCTS (w/v%)

<table>
<thead>
<tr>
<th></th>
<th>HUMIC ACID</th>
<th>MACRO N</th>
<th>P (P₂O₅)</th>
<th>K (K₂O)</th>
<th>SECONDARY Ca</th>
<th>Mg</th>
<th>S</th>
<th>MICRO B</th>
<th>Cl</th>
<th>Cu</th>
<th>Fe</th>
<th>Mn</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turf Booster actosol®</td>
<td>3</td>
<td>20</td>
<td>5</td>
<td>5</td>
<td>0.08</td>
<td>0.07</td>
<td>.10</td>
<td>0.007</td>
<td>0.5</td>
<td>0.01</td>
<td>0.1</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Garden actosol®</td>
<td>3</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>0.08</td>
<td>0.07</td>
<td>.10</td>
<td>0.007</td>
<td>0.5</td>
<td>0.01</td>
<td>0.1</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Calcium actosol®</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2.00</td>
<td>0.07</td>
<td>.10</td>
<td>0.007</td>
<td>0.5</td>
<td>0.01</td>
<td>0.1</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Micronutrient actosol®</td>
<td>3</td>
<td>0.4</td>
<td>0.08</td>
<td>.5</td>
<td>0.08</td>
<td>0.07</td>
<td>.10</td>
<td>0.007</td>
<td>0.5</td>
<td>0.01</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Base actosol®</td>
<td>12</td>
<td>0.4</td>
<td>0.08</td>
<td>1.5</td>
<td>0.08</td>
<td>0.07</td>
<td>.10</td>
<td>0.007</td>
<td>0.5</td>
<td>0.01</td>
<td>0.5</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Bio-Activated- granular actosol®</td>
<td>70</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.08</td>
<td>0.07</td>
<td>.10</td>
<td>0.007</td>
<td>0.5</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
</tbody>
</table>

### Notes:

1. All actosol® products are water soluble liquid except granular actosol®

2. Analysis of Humic components in liquid actosol® products is based on acid precipitation method as specified by the Soil Science Society of America and California Dept. of Food and Agriculture other methods such as BaCl₂ precipitation and absorption result into analysis well over 3% to as high as 20%. Acid precipitation gives scientifically sound and uniform humic component analysis.

3. All the actosol® products contain humic and fulvic components, however no quantification because of lack of any acceptable analytical method.

4. All actosol® liquid products formulated with NPK contain slow release bound 35% N, 50% P₂O₅ and 50% K₂O.

5. Granular solid actosol® 70% as extractable insoluble humic component.
Turf

**actosol®** CREATES VEGETATION IN SAND DUNES

**HYDROSEED MIX PLUS actosol®**

Ocean City, MD

6 weeks growth, Virginia Tech., Testing
actosol® Hydroteeeding Effective for Reclamation Site in Northern Alabama

before treatment

actosol®
treated

control

after treatment

Preserving tomorrow's world... today
Vigorous growth of bitter panicum (*Panicum amarum*) when a fertilization regime was coupled with a Humic Acid application of 100 ml per m². Note extensive amount of vegetative spread (tillering) and flowering within only 5 months after planting (photo taken September 2004).

The effect of humic acid (applied as Actosol 3% humic acid solution) on biomass production by two widespread dune grass species (sea oats and bitter panicum) and salt marsh species (black mangrove and smooth cordgrass). *Spartina alterniflora* (smooth cordgrass) biomass production was substantially increased by addition of humic acid, especially the 400 ml m² level. Mangrove and Bitter Panicum both demonstrated greater biomass production at the 100 ml m² humic acid level. It is anticipated that Sea Oats will demonstrate elevated productivity at some more moderate level of humic acid (<25 ml m²).
REGIONAL EQUIPMENT CENTER
WEST KIMMAR PARKWAY
WANAMIE, PA. 16634
(717) 735-0355 OR 735-0573
FAX (717) 735-9233

August 14, 1995

Mr. Tom Sikand
Arctech, Inc.
14100 Park Meadow Drive
Chantilly, Va. 22021

RE: “ACTOSOL” Results on East Side Landfill Project

Dear Mr. Sikand:

During the closure of the East Side Landfill site in Luzerne County, Pennsylvania, Regional Equipment Center used a topsoil/ cellulose mix for the top six (6) inches of cover over a one hundred ten (110) acre prior landfill.

The contractors used a conventional method of hydroseeding with fertilization. The grass germinated and quickly died.

Regional Equipment Center then contacted the experts at Arctech. Following the recommendations of those experts and applying “ACTOSOL”, Regional Equipment Center was able to provide rich, lush grass. The results were astonishing.

Thanks to the staff and the “ACTOSOL” the final cover on the East Side Landfill site was most successful.

Sincerely,

Joseph Yudzi-Paz
Executive Director
Floriculture

actosol® BRIGHTENS FLOWERS

Horticulture

actosol® MIRACLE ON VEGETABLES

<table>
<thead>
<tr>
<th></th>
<th>Days</th>
<th>Radish</th>
<th>Turnip</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>67</td>
<td>B</td>
<td>B</td>
</tr>
</tbody>
</table>

A - Standard Garden (20-20-20)
B - Garden actosol® (10-10-10)
Agriculture

60% INCREASE IN SOYBEAN YIELD USING actosol®

EFFECT OF actosol® ON CORN PLANTS

King William Co., VA 1997

Bushels per acre

actosol®  no actosol®

Treatment
SUCCESSES OF

actosol® HUMIC ACID FERTILIZER

Amazingly, the growth rate of the alfalfa and wheatgrass was significantly better – thicker, taller and a much darker green color - in the plot where the Actosol-Z™ was added, even though only about 25% of the prescribed 100 ppm concentration of Actosol-Z® was actually applied. This is also evident in the photos below, where the agricultural consultant is shown collecting alfalfa and wheatgrass samples for analysis.
actosol® APPLICATION INCREASED NUMBER OF HARVESTS AND COLOR OF CLOVER IN KAFR EL SHEIK, EGYPT

<table>
<thead>
<tr>
<th></th>
<th>Yield (Tons/fed for total of 5 Fresh Cuts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated</td>
<td>75.7</td>
</tr>
<tr>
<td>Untreated</td>
<td>67.2</td>
</tr>
<tr>
<td>% Yield Increase</td>
<td>12.65</td>
</tr>
</tbody>
</table>
PRESS RELEASE

FOOD AND AGRICULTURAL ORGANIZATION OF THE UNITED NATIONS
VIA DELLE TERME DI CARACALLA - 00100·ROME, ITALY
LIAISON OFFICE FOR THE AMERICAS·1001-22nd ST.NW·WASHINGTON,DC 20437

SOIL LOSS ACCELERATING WORLDWIDE
Hinders Effort to Feed Earth’s Growing Population

- 25 billion tons per year of topsoil lost worldwide
- 6 billion tons per year lost in U.S. alone
- Critical need exists to enhance soil fertility to feed world’s growing population
COMPARISON OF ANALYSIS OF SOIL ORGANIC MATTER OF HALIFAX COUNTY, VIRGINIA FARM SOIL

<table>
<thead>
<tr>
<th>SAMPLE ID</th>
<th>LOCATION</th>
<th>Organic Matter ( % ) *</th>
<th>Organic Matter ( % ) **</th>
<th>Organic Matter ( % ) ***</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Chad Francis Farm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01</td>
<td>Alpha Hay Field</td>
<td>2.2</td>
<td>2.1</td>
<td>0.04</td>
</tr>
<tr>
<td>02</td>
<td>Sweet Corn Field</td>
<td>2.3</td>
<td>1.5</td>
<td>0.39</td>
</tr>
<tr>
<td>03</td>
<td>Fescue Pasture</td>
<td>2.1</td>
<td>1.6</td>
<td>0.12</td>
</tr>
<tr>
<td>B. Rosemary Dairy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Fescue Hay Field</td>
<td>3.2</td>
<td>2.0</td>
<td>0.00</td>
</tr>
<tr>
<td>05</td>
<td>Clover Hay Field</td>
<td>5.4</td>
<td>5.0</td>
<td>0.606</td>
</tr>
<tr>
<td>C. Wayne Kendrick Farm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>Flue Cured Tobacco</td>
<td>2.3</td>
<td>1.7</td>
<td>0.17</td>
</tr>
<tr>
<td>07</td>
<td>Burly Tobacco Field</td>
<td>2.2</td>
<td>1.4</td>
<td>0.39</td>
</tr>
<tr>
<td>08</td>
<td>Soybean Field</td>
<td>2.5</td>
<td>1.8</td>
<td>0.14</td>
</tr>
<tr>
<td>09</td>
<td>Corn Field</td>
<td>4.6</td>
<td>3.1</td>
<td>0.20</td>
</tr>
<tr>
<td>D. Bit By Bit Farm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Soybean Field</td>
<td>2.9</td>
<td>1.7</td>
<td>0.79</td>
</tr>
<tr>
<td>11</td>
<td>Produce Field Tomato/pumpkin</td>
<td>3.2</td>
<td>1.9</td>
<td>0.15</td>
</tr>
<tr>
<td>12</td>
<td>Cornfield</td>
<td>1.1</td>
<td>0.8</td>
<td>0.00</td>
</tr>
</tbody>
</table>

*Loss-On-Ignition (LOI), a gravimetric, dry oxidation method, was used to estimate the percentage Soil Organic Matter by Virginia Tech.
** A modified Walkley-Black method was used, where dichromate solution oxidizes organic C to CO2 in acid medium by Virginia Tech.
*** Humic Matter Analysis Method by Alkali Extraction per American Society of Soil Agronomy by Arctech, Inc.
Optimum Dilution Rates for actosol®

Turf actosol®, Garden actosol®, Calcium actosol®, Micronutrient actosol®
3% humic acid

- <800 ppm: 1:40 Dilution
- <1500 ppm: 1:20 Dilution

Foliar Soil

Base actosol®
12% humic acid

- <800 ppm: 1:150 Dilution
- <1500 ppm: 1:80 Dilution

Foliar Soil
**actosol® Organic Fertilization Program for Turf Management and Plant Health Care**

**Why actosol®?**

Actosol® is an organic nutrient activator which enhances soil fertility and stimulates the growth and development of plants. It is formulated with natural humic and fulvic acids, the active components of rich soil humus. Today soils have become highly depleted in organic humus and even with high nutrient inputs, the yields are suffering. The American Society of Agronomy publication, Humic Substances in Soil and Crop Sciences (1990) states that by additions of organic humic the health and growth of plants can be significantly increased.

**Benefits of actosol®**

**Physical Benefits**
- Increases water holding capacity
- Increases aeration of soils
- Improves soil workability
- Helps resist drought
- Improves seed bed
- Makes soil more friable or crumbly
- Reduces soil erosion.

**Chemical Benefits**
- Chelates nutrients for uptake by plants
- Possesses high ion-exchange capacity.
- Increases buffering properties of soils
- Increases percentage of total Nitrogen in soils.

**Biological Benefits**
- Accelerates plant cell division and promotes growth
- Increases germination of seeds and viability
- Increases root respiration and formation
- Stimulates growth & proliferation of soil microorganisms.
- Aids in photosynthesis.

![With ORGANIC MIRACLE for Sustained Greening](image)

<table>
<thead>
<tr>
<th>Time</th>
<th>Application</th>
<th>actosol® Product in 200 gallon tank*</th>
<th>Lbs per 90,000 sq. ft Application</th>
<th>Humic/ Fulvic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>P</td>
<td>K</td>
</tr>
<tr>
<td>Late Feb-</td>
<td>Pre-Emergent – Restart</td>
<td>12</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Early March</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late May</td>
<td>Emergent – Lush greening</td>
<td>10</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early to</td>
<td>Pre-Summer – Maintenance</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Mid June</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late July to</td>
<td>Summer – Stress free Green</td>
<td>16</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>August</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sept. – Oct.</td>
<td>Fall – Sustained Beauty</td>
<td>1.2</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Nov. – Dec.</td>
<td>Winterizer – Prepare</td>
<td>8</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>55.60</td>
<td>21.5</td>
<td>2.5</td>
</tr>
</tbody>
</table>

*If needed mix fungicide in the tank. However perform jar test for compatibility. May reduce fungicide use by as much as 50%.

Contains non-plant food ingredients, 2.9% Humic/Fulvic Acid derived from Lignite. Quick and sustained release with 30% Nitrogen, 50% P₂O₅ and 50% K₂O bound to humic/fulvic components

USDA ALLOWED/EPA APPROVED

![Preserving tomorrow’s world... today](image)
COMPARISON OF ACTOSOL® HUMIC ACIDS WITH SOIL HUMIC ACIDS

$^{13}$C Nuclear Magnetic Resonance

actosol® Humic Acids

soil Humic Acids
## AVERAGE ELEMENT COMPOSITION OF SOIL HUMIC SUBSTANCE

<table>
<thead>
<tr>
<th>Element</th>
<th>Humic Acid %</th>
<th>Fulvic Acid %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>53.8-58.7</td>
<td>40.7-50.6</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>3.2-6.2</td>
<td>3.8-7.0</td>
</tr>
<tr>
<td>Oxygen</td>
<td>32.8</td>
<td>39.7-49.8</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0.8-4.3</td>
<td>0.9-3.3</td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.1-1.5</td>
<td>0.1-3.6</td>
</tr>
</tbody>
</table>
COMPONENTS OF FERTILE SOIL

- Mineral Matter: 40%
- Air: 15%
- Water: 25%
- Organic Matter: 19.9%
- Living Organisms: 0.1%

MOST ACTIVE:
- Humic Acid (Soluble at high pH)
- Fulvic Acid (Soluble at all pH)
- Humic (Insoluble)

Preserving tomorrow’s world... today
### COMPONENT PARTS OF SOIL TEXTURAL CLASS

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sand:</strong></td>
<td>Soil that contains 85% or more of sand; % silt + 1.5 times % clay shall not exceed 15</td>
</tr>
<tr>
<td><strong>Loam:</strong></td>
<td>Soil contains 7-27% clay; 28-50% silt &amp; 52% sand</td>
</tr>
<tr>
<td><strong>Clay:</strong></td>
<td>Soil that contains 40% or more clay; 45% sand and 40% silt</td>
</tr>
</tbody>
</table>
SOIL TEXTURE CLASSES

- Sand
- Loamy sand
- Sandy loam
- Loam
- Silt loam
- Silt
- Sandy clay loam
- Clay loam
- Silty clay loam
- Sandy clay
- Silty clay
- Clay
MODELS OF HUMIC ACID MOLECULE

A. Stevenson, 1972

B. TNB, 1998 (Temple, Northeastern and Birmingham)

Empirical Formula: $C_{36}H_{30}O_{15}N_x \cdot xH_2O$

$x=0$-$15$