

Donated By: 511
Herbert Rogers Jr. 48
Rogers Engineering Co.

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GROWERS TESTING SERVICES AGRICULTURAL LABORATORY

2424 E. VALLEY OAKS DRIVE • SUITE D • VISALIA, CA 93291 • 209-732-TEST • 732-8378

July 31, 1985

RECEIVED ACCOUNTING DEPT.

AUG 3 1985

Herbert Rogers, Jr.
ROGERS ENGINEERING CO., INC.
467 Hamilton Ave. - Suite 29
Palo Alto, CA 94301

Rogers Engineering Co., Inc. SAN FRANCISCO

Dear Herb:

I apologize for the delay in getting these results to you.

As I explained to you on the phone, the SUL-FE could not be evaluated by most of our conventional soil test because of the highly acidic nature of SUL-FE. A saturated paste of the material you submitted had a pH of 0.6 pH units. The acid content was determined by mixing a known amount of SUL-FE with water and titrating the acid mixture with standard Sodium Hydroxide solution until all available acidity was neutralized. Expressed in terms of 100% Sulfuric Acid, the SUL-FE displayed an acid content of 6.3%. Obviously, addition of SUL-FE will have a direct, immediate effect on an alkakine soil. Also, any elemental sulfur present will have an additional effect as the sulfur is oxidized to eventually form Sulfuric Acid.

Is SUL-FE acidic enough to be of value in Western soils with a Calcium Carbonate content of 1 to 10%? An acre-6" of soil weighs approximately 1000 tons and therefore may contain 10 to 100 tons of "free lime". One ton of SUL-FE would contain 0.063 tons (126 lbs.) of Sulfuric Acid which in turn neutralizes Calcium Carbonate on essentially a one to one basis (49.04 to 50.04). An application of one ton of SUL-FE to an acre of calcareous soil would probably not have much effect on the pH of the soil. There may be some positive effects for shallow-rooted crops. SUL-FE should be an excellent source of Iron. Properly designed and conducted field trials shoud be conducted to establish the value of SUL-FE as a soil amendment.

I hope these comments prove useful to you.

Sincerely yours,

pry 6. Rim

Jerry B. Rivers

Owner/Chemist

SUL-FE

Over the years, SUL-FE has been marketed under several brand names aimed at different market segments.

These names include SUL-FE, MOTHER EARTH SULPHURSOIL, SULPHURSOIL, and ACID IRON PLUS. These various names all refer to the same product, mined in Sulphurdale, Utah, and have identical physical properties and chemical compositions.

DELANO DEVELOPMENT CORPORATION, Sulphurdale, BEAVER, UTAH 84713 CLAIMS:

- 1. Refined sulphur is insoluble in water.
- Pure sulphur when applied to the earth will take many months, even years, to provide benefit to the crops as a nutrient or a ph control product.
- Producers product is soluble in water and results begin as soon as applied and watered.
- 4. Visual results are evident within 3-10 days.
- We will prove our product by on-site tests, side-by-side with pure sulphur in given plots with our product in a side plot.
- 6. Will show that you get much more for your money

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OYERVIEW OF TECHNICAL DATA

A sizable amount of technical information has been accumulated on the effects of agricultural applications of the natural mineral product called Sul-Fe. This technical information supports the field observations of farmers, landscapers and gardeners who have used the product.

Sul-Fe is often evaluated in terms of its sulphur content alone. When compared to elemental sulphur (100% sulphur), the 18 to 21% sulphur content of Sul-Fe seems relatively low. However, as the following technical data indicates, when judged on actual effects, Sul-Fe's complex mixture of minerals has several advantages over elemental sulphur. When judged on the basis of soil acidulation. Sul-Fe has more immediate effects than elemental sulphur. The rapid acidifying effect is due to Sul-Fe's content of crystaline sulphuric acid. Sul-Fe also has long-term effects on soil pH due to its content of sulphur and sulfides and the time required to oxidize these materials. Elemental sulphur contains sulphur in only one chemical form which must be microbially oxidized before it becomes reactive in the soil solution, a reaction that takes quite some time in some soils. Sul-Fe is thus better than elemental sulphur in terms of immediate effects and comparable in terms of long term effects. Applied blends of Sul-Fe supplemented with elemental sulphur may provide for a maximization of both short and long term effects. An additional benefit derived from the use of Sul-Fe is the addition to the soil of a variety of trace nutrients including iron, calcium, zinc, copper, manganese, magnesium, and molybdenum.

DELAND DEVELOPMENT CORPORATION SUL-FE

- * A naturally occurring mined ore, easy to handle, blend and apty.
- * A pH of 1.5-1.9.
- * Solubility greater than standard gypsum or elemental sulphur.
- * Tested in four independent labs and reported to contain:

Sulphw- elemental- 18%	Cobalt- 0.006.8
Sulpheric acid, dry- 1.5%	Phosphorus- 0.05%
Iron as Iron sulphate- 1.5%	Sodium- 0.05%
Iron- 1.52%	Nickle- 0.007%
Copper- 0.031%	Rubidium- 0.003%
Zinc- 0.910%	Strontium- 0.02%
Calcium- 4.2%	Titanium- 0.02%
PloTybdenum- 0.005%	Zirconium- 0.03%
Nangamese- 0.013%	Chromium- 0.002%
Magnesium- 0.019%	Yttrium- 0.005%
Salicic acid, $Si(JH)_{\Delta}$ - 5%	Arsenic- 0.0004%

Effect on Soil:

- * Rapidly reacts in soil solution to reduce pH
- * Increases cation exchange by releasing and replacing sodic
- * Increases supply of available plant nutrients and trace ele addition of nutrients and by creating a more favorable soi nutrient uptake
- Reduces the need for phosphorus fertilization by increasi availability of phosphorus already in soil, but in an form the plant
- * Improves physical properties of the soil
- * Reduces surface crusting of soil
- * Improves soil water uptake thereby increasing irrigation reducing surface water runoff and resulting soil erosion
- * Increases effectiveness of salt leaching from the soil
- * Effective in the reclaimation of alkaline, sodic and salir

Effect on Plant Growth

- * Promotes growth in plants by favorable adjustment of p
- * Improves survival of seedlings with improved soil wett reduction of specific salt toxicity effects
- * Improves sulphur and iron supply to seedlings-- needed growth
- * Useful in correcting lime-induced chlorosis
- * Favors dark green color, chlorophyll synthesis and high photosynthesis
- improves plant's ability to talerate frost, insects, and

Documented Crop Yield Increases after Applications

* Applications over a five year period on alfalfa in Idaho initially increased yields by one-third while increasing protein by an average of 3%. Increases in many legume crops have been reported presumably due to a result of pH reduction which made the soil environment more favorable for nitrogen-fixing organisms, which were then stimulated by the sulphur, iron, molybdenum and cobalt which are contained in Sul-Fe.

* Barley yields as high as 178 bushels per acre have been recorded using banded starter N and P and 500 pounds per acre Sul-Fe preplant, mainly as a result of Sul-Fe's effect on stiffening the straw and reducing lodging which limits harvestable yield. This effect has been correlated with the silicic acid content of Sul-Fe. Silicic acid, an acid form of silica, has been shown to strengthen the cell walls of plants, making them stiffer and harder. Stiff plant tissue resists lodging as well as penetration by insects and disease.

* Increased yields in potatoes and beets as a result of Sul-Fe's beneficial effect on soil structure:

-A "softer" soil enabled sugar beet growers to harvest the whole beet without breaking off the tap root, thereby not leaving part of the crop in the field. Less soil clung to the beets, meaning less soil hauled and more beets.

-Potato growers using Sul-Fe harvested cleaner potatos which were firmer and stored much better than potatos from untreated fields.

* Gardeners have reported earlier ripening of tomatos as well as increased tolerance to frost after Sul-Fe application

* Field tests at rates of 25 to 75 pounds of Sul-Fe per 1000 square feet surface applied to Kentucky bluegrass showed improved coloration within six days which persisted over one year from the date of application. Surface treatment of turf with Sul-Fe also provided pre-emergent control of several weed species, notable Poa annua and goosegrass, probably a result of the acidulation of the soil surface by the product thus controlling the germination of these serious weeds.

Report from Dr. Schmitz, Professor of Soil Science at Cal Poly, and Dr. Lund, Professor of Biology at UCLA December 30, 1978

The soil used was a field soil from Cal Poly which causes the plants to suffer from "Iron Chlorosis" which also has a high Ph. In other words, it is a soil which we have found to respond to additions of additives such as those we used in a test. It is a "tough" soil.

In other words, we took a soil which is typical of the problem soils that we encounter throughout the west. If we had taken a soil which posed no problem for plants we would have gotten greater change in PH correction and iron release, but then it would not have proved anything because the soil presented no problem to start with.

The research conducted by the U.S. Government and the University have established that the ppm of DTPA extractable iron is a reliable measure of the amount of voluble iron in the soil which is available to plants. The work was largely done at Colorado State University and they indicate that critical levels of DTPA iron is around 5-7 ppm. Values less than this would indicate a deficiency of iron in the soil.

Our test soil had values of 2ppm DTPA iron in the soil.

In addition to making iron available in the soil, the lowering of soil ph is important and this information is given in the table.

RESULTS

PH

The control soil had a ph of 7.8 and this should be used as reference for comparison.

Note that ph reduction was greater with the higher s% of products. This chart shows also, that if you use very high rates of product, you can lower the soil ph very low. Bear in mind that this soil has a very high lime content and thus takes considerable acidity to neutralize this lime. Without any lime in the soil, ph reductions are much greater.

The ferrous sulfate (Commercial product bought on the retail market) was no more effective in lowering soil ph than the 19.00% Mother Earth. The soil sulfur was **not** as effective in lowering the soil ph in the one month period as was 19.00% Mother Earth.

iron Chelate is not supposed to have any effect on soil ph and does not show any effect.

IRON

The control soll contains 2ppm iron which is below the critical 5-7 ppm iron. The two lower grades of product, 2.29% and 6.60% brought the iron above the control and just barely into the sufficiency range.

The 10.76% product brought the iron into the adequate range.

The 15.64% and 19.00% product brought the iron well into the adequate range even at the rate of 25 lb/1000 sq. ft. (½T/Acre).

Higher application rates of product of the lower grades produced adequate iron but rates may be uneconomical.

One very important point to note in the speed of the Mother Earth compared to the soil sulfur. The Mother Earth produced Twice as much available iron in 10 days as did the soil sulfur. (99%S). Important in terms of practical applications for contractors of landscape, plantings, etc.

CONCLUSIONS

- 1. All products produce increases in soil available iron and some lowering of soil ph.
- 2. The 19.00% Mother Earth product is just about as effective as commercial ferrous sulfate in providing iron in the soil. Certainly the amount of Iron released is well above the critical level for plant growth.
- 3. 25 lb/1000 sq. ft. (½ T acre) of the three grades le; 10.76%, 15.64%, and 19.00% provided iron to the soil in adequate quantities. The amount of iron provided increased with increasing % S in the product.
- 4. Field trials with the Mother Earth products correlate closely with the laboratory results. The laboratory results give a scientific basis to explain the field results.
- 5. Both ph correction and Iron supplementation can be achieved with product @ the 10.76% and above at economical field rates of 25 lb and 50 lb/1000 square feet.
- 6. Physical improvement of the soil was noted at the higher rates of acid/iron.

RATES OF MOTHER EARTH MINERAL ADDED TO THE SOIL

		0.19	/ 100	SOIL	₹ 0.2g / 100g SOIL					/ 1000	SOIL	20	20.0g / 100g SOIL				
PH CHANGES		1 DAY	10 DAYS	30 DAYS	1 DAY	10 DAYS	30 DAYS		1 DAY	10 DAYS	30 DAYS	1 DA	10 DAYS	30 DAYS			
2.29% MOTHER EARTH	(1) (2)	7:7 7:7	7.7 7.7	7.7 7.7	7.7 7.7	7.6 7.6	7.55 7.6		7.7 7.65	7.7 7.65	7.65 7.6	7.6 7.6	1	7.5 7.5	ر		
6.60% MOTHER EARTH	(1) (2)	7.7 7.65	7.6 7.65	7.6 7.6	7.65 7.60	1	7.6 7.5		7.4 7.4	7.4 7.4	7.35 7.30	7.2 7.1	1	6.9 6.7			
10.76% MOTHER EARTH	(1) (2)	7.6 7.6	7.55 7.5	7.5 7.5	7.6 7.6	7.5 7.5	7.4 7.45		7.4 7.45	7.4 7.4	7.3 7.35	6.3 · 6.2	1	5.8 5.7			
15.64% MOTHER EARTH	(1) (2)	7.5 7.6	7.4 7.5	7.3 7.3	7.6 7.6	7.5 7.5	7.3 7.3		7.45 7.4	7.4 7.3	7.35 7.3	4.8	- 1	4.3 4.2			
19.00% MOTHER EARTH	(1) (2)	7.2 7.7	7.1 7.1	6.9 6.9	7.3 7.4	7.1 7.1	6.7 6.7		7.2 7.25	6.8 6.8	6.6 6.6	5.1 5.2	1	4.9 4.9	X		

(1) 7.8 7.4 8.2 CONTROL (2) 7.8 7.9 8.1 (No Additives in Soil) 7.5 7.4 7.4 (1) **SOIL SULFUR** (2) 7.5 7.4 7.4 (.02g/100g Soil

FERROUS SULFATE (0.2g/100g Soil) IRON . CHELATE (0.1g/100g. Soil) (1) 7.1 7.3 7.4 (2) 7.2 7.3 7.4

(1) 7.5 7.5 7.5 (2) 7.5 7.5 7.5 TABLE OF PH VALUES

	0.1g / 100g SOIL				0.2g / 100g SOIL				2.0g	/100g	SOIL		20.0g/100g SOIL				
AVAILABLE RON	1 DAY	10 DAYS	30 DAYS	. 3	1 DAY	10 DAYS	30 DAYS		1 DAY	10 DAYS	30 DAYS		1 DAY	10 DAYS	30 DAYS		
2.29% MOTHER EARTH	(1) (2)	4	5 5	6	•	5 5	5 5	6 6		4 5	6 6	8	1	5 5	7 8	10 11	
6.60% MOTHER EARTH	(1) (2)	3 4	4 5	6 6		4	5 5	6 6		6 6	7 . 7	8		15 19	16 19	17 20	•
10.76% MOTHER EARTH	(1)	5 5	7	9		6 6	8 8	10 10		15 15	15 16	16 17		96 95	97 95	99 96	
15.64% MOTHER EARTH	(1) (2)	6	7 8	9 10	·	8 7	9	11 10		24 25	27 26	31 28		137 128	149 154	178 165	
19.00% MOTHER EARTH	(1) (2)	5 5	8 7	10 10		6 6	11 11	15 15		18 18	24 22	29 27		165 159	212 230	248 253	ķ

CONTROL (NO (1) 2 2 2 2 Additives (2) 2 2 2 2 In Soil) SOil SULFUR (1) 5 6 8 0 29/1009 .-(2) 3 4 6 SOIU

FERROUS (1)
SULFATE (2)
O.29/1009 SOIL)
IRON (1)
CHELATE (2)
O.19/1009 SOIL)

· (1) 25 39 36 (2) 26 38 40 (1) 46 46 46 46 46 46 (2)

TABLE OF ppm DTPA extractable FE

Pallor in plants, as in man, indicates sickness, but in plants this unhealthy yellow color usually means sickness caused by hidden hunger for important nutritional elements like nitrogen, phosphorus, potash, etc. However, only a few plants can easily express the symptoms of nutritional deficiency, and by the time hunger signs appear the general health of the plant has declined and yield has been reduced.

Starvation symptoms in plants are not always caused by actual lack of essential minerals in the soil. These nutritional elements may be present but unavailable to the plant because the soil is too alkaline or too acidy. When alling plants fall to respond to fertilizer application it usually suggests that this important alkaline-acid relationship — soil pH — is out of balance.

Perhaps the most important aspect of soil reaction is not the critical deficiencies of minor elements which certain pH values bring about, but on solubility or availability of major fertilizer elements which is controlled to a great degree by these same pH values.

Ready solubility of nutritional elements is one of the important advantages of commercial fertilizer over natural organic sources.

SULPHATE

Sulphate of ammonia contains 20 percent actual nitrogen and applied to soil in the pH 6-8 range has a maximum solubility; yet at pH 8.5 little more than half of the nitrogen applied is available to crops or plants. This means that it may cost \$100 to properly fertilize soil with a high pH value, where \$60 would have produced the same benefits if pH were adjusted first.

The first step to insure proper nutrition is to periodically test soil for excessive acidity or alkalinity before damage to plants can occur.

Once soil pH or soil reaction is known, proper soil treatment can begin so that maximum availability of essential minerals is achieved and minerals which are lacking can be added.

Economically there is much more to be gained than plant well-being by correcting soil pH toward the optimum of 5.5 to 7.0. Loss of nitrogen as volatile ammonia can be in excess of 30 percent if the pH is above 8.0, but reduced to 0 at pH of 7. Phosphate can be removed from the plants use by formation of di-calcium phosphate as low as pH 7.3, but can be made available again by adjustment of the pH with sulfur.

The optimum pH for most crops lies between a low of 5 and a high of 7. All plants will die within a very few minutes in pH below 4, or above 9. As these extreme pH's are approached, plant viability and production suffer.

It requires no effort to change the pH upward by using liming materials, and little more to change it downwards with sulfur. The buffering effect of limestone present in soils does not come into play much above pH 6.5, and not at all above 7.0. It is however present to supply soluable calcium needed for good soil tilth.

HERE'S WHAT THE EXPERTS SAY:

"Applications of sulfur are sometimes made to alkaline soils to reduce their alkalinity. As a matter of fact sulfur is probably used much more frequently and in larger quantities for the purpose of changing soil reaction than for the purpose of adding a nutrient."

Basic Horticulture PP144

"Successful reclamation of sodic soils by Gypsum or elemental sulfur has been reported in numerous publications, as recently reviewed by Tidale."

Sulfur Institute Journal 6P2-7

"It is conceivable that acid application to impation waters, or soils will reduce ammonia volatile loss."

Soil Science Society Am. Proc. 28: 751-4

"Sulfuric Acid applied to P-deficient calcarous soils increased the soluble P severalfold."

J. Environ, Qual, Vol. 4 No. 4 1975

"It is probable that greater yields obtained by acid treatment are, in part, related to the reduced pH, and to an increased availability of nutrients which are often less available in sodium-affected calcarous soils."

Article by Miyomoto, Ryan, & Stroehlein in J. Environ. Qual. Vol. 4, No. 4 1975

"It is recognized that sulfur can be used to advantage on both white and black alkali soils."

THE SOURCE STREET, AND ADDRESS OF THE SOURCE STREET, THE SOURCE STREET, THE SOURCE STREET, THE SOURCE STREET,

Nature and Properties of soils PP315

"Sulfur is the most effective and economical single chemical treatment in the elimination of black alkali." Reclamation of Virgin Black Alkali soils Journ. Amer. Soc. Agron XXVI 752-762, 1934

"Flowers of sulfur undergoes vigorous microbial oxidation in the soil, and is four to five times more effective in developing acidity than ferrous sulfate."

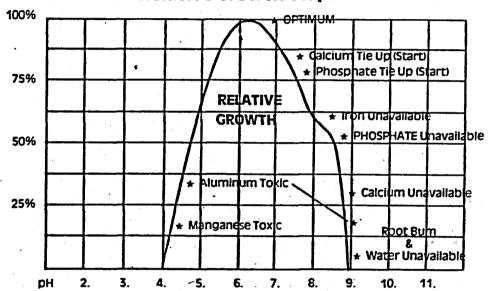
— Water is used in the soil to make nutrients available to the plant. Mother Earth makes the nutrients more mobile, therefore less water is needed.

Add to the Control of the Control of

- Plants trade off water for CO₂ in building tissue. Healthy plants are 2 to 3 times more efficient than plants under stress. Mother Earth relieves stress by several means, including pH adjustment, compaction relief, and sait reduction.
- According to plant experts, production of field and garden crops can progress with 1/3 less water if pH is adjusted from 8.0 to 6.5.
- Irrigation efficiency can be improved by 30 percent to 50 percent in the 1st irrigation after using Mother Earth.
- To use less nitrogen, phosphate, and water, use Mother Earth (and remember one proper application is for permanent correction.)

5 STEPS TO TOP YIELDS OF ALFALFA





Mother Earth is a mined soil amendment that has proven effective to increase production on good farm lands and gardens and reclaim marginal and submarginal land and gardens.

It is finely milled for easy application. It is readily available in small quantities or in economical bulk purchase by the ton.

Mother Earth and is a mixture of the three most commonly used soil amendments, sulphur, gypsum, and sulphuric acid. It is used primarily to increase productivity of marginal and producing soils, but can effectively reclaim soils that are not now making economic productions.

Mother Earth... effectively lowers pH, and reacts with natural limestone in the soil, to act as exchange calcium. This will replace sodium on clay particles, and "open up" soil for water root penetration. Leaching to remove salts can be done more effeciently once penetration is established.

- 1. Plant alfalfa on your best land It can be your most profitable crop.
- 2. Watch soil pH; sulfur when necessary Liming is seldom necessary in the calcareous soils of the mountain west. Alfalfa does best on soil within a range of 6.3 to 7.5 pH. If soil pH is above 7.5 add sulfur.
- 3. Use full-feed fertilizer Reaching for top alfalfa tonnage is no different from going after high yields in other crops; a big fertilizer push is a must. Test your soil, find specifically what and how much fertilization it needs, and then adjust the application rate to desired yield, cropping system, and other management factors.
- 4. Select the right alfalfa(s) Choose an alfalfa to fit the job: high, early yields . . . long stands . . . special resistance to 'nsects and disease . . . excellence in mixtures.
 - 5. Water adequately, in well balanced soil 6 inches of water will produce about 1 ton of hay.

SUMMARY OF CHARACTERISTICS

AND APPLICATIONS OF .

SULFER AND IRON BEARING MINERAL DEPOSITS

Acid Iron Plus is the trade name applied to the material prepared from a hydrothermal mineral deposit located at Sulfurdale, Utah. The mineral deposit is mined crushed, and screened. The degree of fineness is of course controllable but typical preparations pass ½ inch screens with 20% or more passing a 32 mesh screen.

The assembly of minerals in the deposit varies somewhat but the product is characterized for agricultural applications on the basis of its content of elemental sulfur. Sulfur contents in excess of 15% characterizes the material being marketed although material containing lower percentages of elemental sulfur have been demonstrated to be quite effective. In addition to elemental sulfur the mineral body contains ferrous disulfide (FeS₂), iron pyrite and silica (SiO₂) each varying roughly around 10%.

Of particular interest is the presence of about 2% of the mineral ferric acid sulfate hydrate (Fe₂(SO₄)₃·H₂SO₄·2H₂O). Some 55 to 60% of the mineral materials are amorphous., It is thought that the minerals precipitated from hot, highly acidic solutions. In addition to iron and sulfur, already mentioned, Acid Iron Plus contains a number of additional elements in small to trace amounts required for plant growth including calcium, copper, manganese, potassium and zinc.

The utility of the material for agricultural purposes derives from its acidulating nature and its impact on plant nutrition. The latter effect derives from required elements present in the Acid Iron Plus and to changes in availability of minerals in the soil attributed to acidulations of the soil mass in general or at point sources.

Comparison of tissue content of grass from treated plots (green) with untreated plots (iron chlorotic) showed striking increases in the iron content of tissue and modest increases in phosphorus content. Molybdenum content decreased. These trends are consistent with expectations based on soil chemistry considerations.

Regarding beneficial uses, Acid Iron Plus, has been effective in correcting iron chlorosis in numerous plant species for periods of about two years. Longer range studies have not been conducted. It is also effective where beneficial effects from soil acidulation are obtained. As an acidulating agent it is as effective or more so than materials such as elemental sulfur or ferrous sulfate which have long histories of use.

Acidulation is rapid due to the presence of crystaline sulfuric acid in ferric acid sulfate hydrate and is also long lasting due to the time required for microbial oxidation of sulfur and sulfides.

Acid Iron Plus is typically disked in as a preplant treatment to correct iron chlorosis. It may be effectively applied as a top dressing to turf grass or similar situations where disking is not possible. Typical effective application rates are about 1000 pounds per acre. Applications

of 4 tons per acre may cause modest injury to some plants. Applications of two tons per acre or less have not injured plants.

Laboratory studies have shown Acid Iron Plus when applied on a comparable weight basis with elemental sulfur to be equally effective in reducing the soil pH. Additionally, soil extractable iron has been significantly higher than in comparable sulfur treated soils.

8/15/84
Steve Farrar, M.S., Horticulture
Agricultural Crop Consultant and Pest Management Specialist
Hagerman, Idaho

TO WHOM IT MAY CONCERN:

Over the past three growing seasons in my work as a Crop Consultant in southern Idaho, I have had many occasions to not only recommend the application of Sul-Fe to correct specific soil conditions, but to also observe firsthand the beneficial effects of this remarkable product.

Many of the irrigated soils in southern Idaho have pH levels ranging from 7.5 to as high as 8.5. These alkaline conditions are a result of both the parent materials from which these soils are derived, a desert climate and irrigation waters which contain relatively high contents of soluble salts, especially sodium salts. Many undesirable soil conditions are associated with these high pH and salt levels, including poor soil structure, poor water infiltration rates, lack of soil aeration essential for healthy root development, and a tie-up of phosphorus and trace elements.

Based on results of soil tests, I have recommended application rates of 250 to 1500 pounds of Sul-Fe per ocre, depending on the severity of the problem and the value of the crop. My recommedations for the application of Sul-Fe were made as part of a total fertility management program and also included, when needed, the applications of other fertilizers (N, P, K, trace elements) and soil amendments (gypsum, manures, bacterial inoculants, etc). The results have invariably made the applications of Sul-Fe, alone or in combination with other fertilizers, very cost effective. The most dramatic effects have been on legume crops such as alfalfa and beans. On alfalfa, yields and protein levels increased dramatically following fall or spring applications of Sul-Fe. With beans, I noticed increases in the number of pods set, increases in root nodulation (essential for nitrogen fixation) and dramatic decreases in the incidence of root rot. Other crops have benefited from the application of Sul-Fe, including sugar beets, potatos, wheat and corn. In addition to increases in yield and crop quality formers have frequently commented on other beneficial effects of Sul-Fe including: easier harvest of root crops (soil easier to dig, less soil clings to product), less energy required for tillage operations, and reductions in irrigation requirements.

Fertilizer dealers in this area generally recommend heavy applications of phosphorus on an annual basis. Examination of soil test results from this area frequently reveals high pH levels and very low levels of available phosphorus but relatively high levels of total phosphorus. In other words, there was enough phosphorus in the soil, but it was not in a form available for uptake by the plant. Rather than add more phosphorus (which will also

become unavailable and which will also contribute to zinc deficiencies), I generally recommend a correction of the high pH problem. Sul-Fe is much more effective than elemental sulphur and invariably resulted in a decrease in soil pH levels and an increase in available phosphorus levels without the costly addition of fertilizer phosphorus.

In summary, Sul-Fe has been proven in the field to have very beneficial effects on the physical, chemical and biological properties of a wide variety of soil types. The mechanisms by which most of the beneficial effects of Sul-Fe are achieved are relatively straightforward and can be explained by basic soil chemistry and physics. Other benefits which I have observed and heard reports on, such as increased resistance to insects and disease, are more difficult to quantify and explain and will require additional investigation. The effects are none-the-less real.

Signed,

Sulfur Soil:

nature's mineral mix shows promise

Contradable Unzvailable יולבבניה

itrients es the ater is

uliding nore effursoil Hq pai ties t

By R.H. Feust A newly discovered volcanic mineral deposit has been shown to dramatically increase legumes yields and benefit nitrogen fixation by supplying trace minerals essential to nitrogen fixation by both symblotic and free living nitrogen fixing bacteria and algae. This is a rare naturally occurring deposit which is extracted from flanks of an extinct volcano in an area of Intense geothermal activity in southern Utah, A deposit formed at a fissure extends to as deep as 50 miles or more into the earth's crust, which is shallow at that point. The source of this sulfur soil is a geothermal spring which brings dissolved elements to the surface along with various gases including carbon dioxide, hydrogen sulfide, and nitrogen.

It is believed that the gases, minerals and unknown growth factors emited from these volcanic vebts may have been responsible for the lush rich vegetation produced before and during the carboniferous period, when vast forests and swamps provided oil, coal, and humate deposits nearly world wide. This rich vegetation supported a vast bio-mass including glant reptiles and later incredibly diverse mammal populations. When the volcanic periods ended, these minerals including sulfur, cobalt, molybdenum, zinc, copper, sulfur gases, water vapor and nitrogen ceased, causing changes in the vegetation of the world and eventually affecting the weather patterns. Coupled with overgrazing this may be responsible for the unexplained changes that occurred

Sulfur soil was discovered quite by accident when a small amount was added to a house plant and unexpected growth occurred. Since then the material has been used on thousands of acres in Utah and Montana with spectacular results documented time after time.

SULFUR SOIL:

I became interested in sulfur soil when I was looking for a quickly available sulfur source for irrigated alfalfa In Montana. A truckload of this low cost material was obtained and a series of test strips were spread on a large ranch owned by Lloyd Tracht near Kalispell, Montana. The results were evident in five days. Only 250 pounds per acre were used, and a month later the first cutting of alfalfa was taken. The results were spectacular. Increased yields of two tons per acre were produced. The results here were repeated the second year as well. Well over three tons of alfalfa per cutting were produced. This is well over the average for nothern Montana. Plant analyses were performed and it was found that the protein levels were Increased from 16.7% to as high as 22.5% protein. The forage tests performed by Montana Testing Laboratories showed not only Increased protein levels but increased copper, zinc, magnesium, phosphorus, iron and other trace minerals increased dramatically as well.

We knew there was more than a sulfur response involved. The roots were checked and it was found that the nitrogen fixing nodules were vastly increased over the control plots. Tests revealed a significant lowering of the soil pH in a short period of time. Later research revealed that many factors accounted for dramatic yield increases including pH reduction, sulfur and trace minerals, carbon dioxide gases liberated from the reaction of sulfuric acid and time in the soil. Reduction of pH made the soil environment favorable for nitrogen fixing organisms, which were then stimulated by the sulfur-iron molybdenum and cobalt which are contained in the sulfur Joll. Also noted was a soil softening effect partially due to the release of salts, which were held tightly by the clay colloid. Where the sulfur soil pile had been kept, we noted an unexplained increase in the depth of the top soil in a year's time. I had never seen an effect like this. It has since been explained as the stimulation of soil flora and fauna to where soil formation accelerated at an amazing rate due to the buildup of the bodies of micro-organisms and subsequent humification in the reduced pH soll environment. This fits known biological and chamical principals already established.

We have many photos and letters from our test work. The principles are simple; pH reduction alone has dramatic effects on alkaline western solls. Effects of acids are essential to soil formation and release of inorganic nutrients by dissolving parent rock. In dissolving, the lime combines with other nutrients, rendering them unavailable to soll organisms and to higher plants. Dr. William A. Albrecht had many thoughts on the importance of acid and the importance of balance of the soil cations. I will quote from The Albrecht Papers, chapter 13.

SOIL ACIDITY:

"Soil Acidity Is Beneficial, Not Harmfull"

"Only recently have we come to appreciate the services by soll acidity in mobilizing - making available many of the nutrients in the rocks and minerals of the soil. When we learned that soils are less productive in giving us legumes and other protein-rich forage, according as they become more acid either naturally or under our cultivation, we came to the conclusion that soil acidity is the cause of this trouble. We now know that a plant puts acid into the soil in exchange for the nutrients it gets. It is the same acid held on the clay that weathers the rock fragments and serves to pass their nutrients on to the clay, and from there on to the plant.

"The coming into the soll of excessive acidity is merely the reciprocal of the going out of the fertility. Nature's process of feeding the plants, and thereby the animals and us, is one of putting acidity into the soil from the plant roots in order to break out of the rocks what nutrients they contain for nourishment of all the different life forms. Soil acidity always has been the agency in the soil to keep the assembly lines providing the available fertility for crop nutrition, which in turn is nutrition for all higher life.

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"Acidlty is a slow mobilizer of nutrients contained in the minerals. Of course, nature's processes do not demonstrate high speed. It takes six months or more for limestone to stock the clay with enough calcium to feed our legumes. It takes longer for others. Consequently, If phosphate rock is slow in demonstrating its effects on the crop, we need not be alarmed. It certainly will not bevery active in soils that are not acid. In our western soils that have considerable free lime rock mixed throughout. them, the plants suffer from phosphate deliciencies. Rock phosphate may not be so efficient there. Dr. Hutton of South Dakota pointed out that phosphorus delivery to the crop was the major problem on these highly calcareous, or these distinctly neutral soils. It is on soils of that reaction that cattle have been bonechewers. Apparently they are going to that extreme = behavior in order to get their phosphorous, which the forages as feeds on the soils there fail to provide. So when the soils are not acid we may expect shortages of some fertility elements like phosphorus, for example, in the plants and even in the animals. It is on the acid soils where most of our population has always fed Itself. suggesting that it is on those acid soils where there is much more speed in making the fertility active and avallable from out of the reserve minerals.

"Phosphorus deficiencies in the soil suggest possible health troubles. That human health may be related to that deficiency in the soil has come to be more than mere speculation when animal troubles are localizing themselves more and more according to soil fertility deficiencies. If one looks at the map of poliomyelitis in 1946, for example, it is significant that this health trouble was more severe in those states where the less acid soils give deficiencies in phosphorus for the plants and animals. It is all the more significant when weremind ourselves of the fact that the brain and nerve tissues - most seriously affected by "polio" - represent high concentrations of phosphorus. Whether there is any casual connection between this human affiction and these non-acid soils because phosphorus availability there is low is a question that remains for research to answer.

"There are also other nutrients in addition to phosphorus that are not mobilized effectively unless the soils are acid. These include iron, manganese and boron. Perhaps these or some others not yet appreciated are casually connected with this baffling disease, other diseases may be in a similar category. When we see the inroads by brucellosis on our herds of cattle and hogs, and when undulant fever passed seemingly from these is becoming more common, there is decided encouragement to theorize and do some research on the belief that we need acid soils and need to gear more mineral fertility through acid assembly lines of our soils.

"Understanding soll acidity means appreciating the deficiency of soil fertility. We have used lime rock, phosphate rock, and green sand as potassium rock, in both the experimental work in the laboratory and in the field trials, to convince ourselves that the plant nutrients within these are made available to plants by the acidity of the solls. Possibly as we come to appreciate the benefits of soll acidity we shall no longer fight it with carbonates, but shall guard it and use it to treat our time rock as calcium fertilizer, our phosphate rock as phosphorus rock or phosphorus fertilizer, and possibly. many other rocks whose fertilizer values we sill do not appreciate. In the future more of these mineral or rock types of soll builders will very probably go into the soll to build up a reserve of minerals there. This will occur when it becomes more common knowledge that soil acidity is beneficial and not detrimental.

THE pH FACTOR:

It is obvious from research in the past and present that for western soils to become productive and supply all the nutrients needed by both soil micro-organisms, plants and animals, pH must be reduced and acids used to help mobilize the unavailable nutrients in these calcarious soils. Sulfur soil had shown to be the answer to the reduction of pH by instilling a natural, mild form of acid to mobilize plant nutrients.

Stimulation of soil micro-organisms is very important as bacterial action, is largely responsible for most nutrient cycles in the soil. All soils start as rock material and are slowly or rapidly-converted to soil by bacterial action as the organic matter builds and buffers the soil it sets the stage for biological nitrogen fixation which can.

Then support vegetation of sufficient quality to sustain animal population.

In addition to the nitrogen fixation, the organic matter addition - which increases the soil's organic matter - can then be converted by micro-organism populations into humus.

In a high pH calcarious soil we frequently see raw organic matter preserved in tact in the soil with little If any breakdown or oxidized back into the air. In an improved soil pH environment, humification can occur which benefits the soil in many ways.

LEGUMES:

Legumes are protein producers and are needed to feed the protein hungry world population. Legume protein makes more protein per acre than any other crop, and alfalfa is foremost as protein producer far exceeding soybeans and grain. Legumes used in rotation would be of higher quality, complete enzymes systems, amino acid balance due to regulation of soil pH addition sulfur and trace minerals. Sulfur soil contains levels of cobalt and molybdenum which are shown to be essential in nitrogen fixation. In short, sulfur soil may be a major impact on conserving dwindling reserves of oil and Increasing the yield nad quality of our foods at the same time. Sulfur is a building block of many amino acids and without sulfur in the soil there are many deficiencies in the essential amino acids, causing plant and animal health problems.

R.H. Faust is an agronomist, soil specialist and ecological agriculture consultant,

Faust Blo-Agricultural Services, Inc. P.O.Box 1150-Twn Palls Maho 83301-2081 3264868

Reprinted from January, 1978

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P.O. Box 9547, Raytown, Mo. 64133

THESULPHURSTORY

by Robert E. Faust

Back in 1978 I wrote an article about a product exiled sulphursoil. Since then we have learned more about the product. It is now sold under three names in the west. The main reason I am writing an updated story about this material is that after six years of work, I feel that sulphursoil is the most underrated product in agriculture and the most effective and reasonably priced I have ever encountered. Since the original article was published, this product has heen used in eight states and western Canada. It has been used by farmers, orchardists and gardeners. Its use by the turf industry has grown and much interest has centered around this industry. It has beaten nationally known NPK turf formulations in greening up gulf courses and parks in Las Vegas and Los Angeles. It is sold for that purpose under the name Sul-Fe. The product has been tested and proved effective as far away as Saudi Arabia.

In conventional field agriculture, sulphursoil has been especially effective on legume emps. It has been used for five years sunning on alfaifa in southern Idaho as the only fertilizer, and initially incressed yields by one-third while increasing the protein by an average of 3%. It has also been quite successful on grain crops, especially barley. Yields achieved on barley are almost hard to believe. Using banded starter N and P and \$00 pounds of sulphursoil preplant, we have achieved as high as 178. bushels per scre. One main reason that sulphurze is so good on barley is because this material stiffens the straw, overcoming the problem of lodging, which links the barvestable yield. The same year one farmer got the 178 bushelyicid, the university test farm in western leaho using the same variety, Steptoe, got 123 bushels per acre. Record gields were also achieved with both persend bean seed crops. Many farmers using the product reported less insect and disease problems. This fact was retified by fieldmen working for the seed companies. Gardeners reported tomatoes expening sooner when in the past they had mostly green tomatoes that just didn't seem to ripen.

BENEFITS

There were many other benefits reported, with the most universal being an improvement in soil structure. This was the case according to potato and beet growers who were having better results harvesting these crops. They reported softer soil, which allowed them to harvest the whole beet without breaking off the tap root, thereby not leaving part of the crop in the field. Less soil clung to the beets, meaning less soil hauled and more beets.

Potato growers had very clean potatoes. They had no problem with the sticky soil adhering to the potato. The potatoes were firmer and kept much better. Yield increases were evident and controlled tests showed 40 100 pound

sacks increase per acre.

Most of the successes with sulphursoil were on high pH calcareous western soils. Sodium in the irrigation water builds up on the soil colloid, causing the soil to lose structure and pH to rise thereby inhibiting availability of phosphorus and trace minerals to the plants. The rapid acidifying effect of sulphursoil eliminates this problem by reversing the build up of sodium on the colloid. This is accomplished by dissolving lime to form soluble calcium, which effects an ion exchange reaction which substitutes calcium for sodium on the soil colloid. This allows the sodium to leech away as sodium suifate. The soil colloid becomes dominated by calcium, hence a stable, friable, crumb structure is formed instead of the gummy condition caused by sodium. This benefit occurred in one season with the costs ranging from \$25 to \$50 per acre, depending on the severity of the problems. Land has been reclaimed in Utah that had salted up so bad that only kochia and wild sunflowers were growing. This kind of dramatic change in a field that has been taken out of crop production may require several tons of sulphursoil to change it so alfalfa can be successfully grown. Bear in mind that most irrigated areas in the world have been failures with time due to sodium and lime buildup and loss of structure. Sulphursoil is able to reverse this process at a low cost. This is one reason why I feel that it is one of the most underrated. materials in agriculture. It is effective at increasing phosphate and trace mineral availability and is feared by the commercial fertilizer industry for that reason. .

FOR ALKALINE SOILS

Sulphursoil's high acid (pH 1.4) and sulfur content (20%) are responsible for its great benefit on alkaline soils, as are its available iron, cobalt, molybdenum, etc. It is the only sulfur product that is natural and labeled for these elements. What causes it to be so effective at low rates on soils that do not have a sodium problem? This took me several years to discover. Why does it stiffen straw of grain? Why does it increase phosphate in the plant? Why does it cause a dramatic decrease in insect and disease problems? These properties are no longer a mystery. My research has discovered a substance which previous research has proved can do the things stated above. It took a conversation with a Japanese agronomist for me to learn what may be causing some of the beneficial effects observed. Subsequent data from Rothamsted Research Farm in England supports my findings. Rothamsted is the oldest soil research ... farm in the world and test plots.have been maintained there since 1862. What makes sulphursoil do the following: increase phosphate in the soil and the plant, decrease lodging, resist insects and disease, increase yields and protein levels?

Silicic acid, which is an acid form of silica Si (OH) 4, has been shown to increase the available phosphate. In fact, in some soils response to phosphate fertilizers can be predicted by testing for! levels of silicic acid. It may be true thes? using any form of phosphate fertilizer is a waste of money if sufficient levels of silicic acid are not present. Recent tests have shown that sulphursoil contains over 5% silicic acid. My experience? shows that phosphate test levels increase in southern Idaho with yearly application of 250 to 500 pounds of sulphursoil. No phosphate fertilizer has been used for six or more years and alfalfa yields are the highest in the area.;

Sulphursoil also decreases lodging, disease and insects, perhaps for their same reason. Silica strengthens the cells walls of plants, making them stiffer and harder. This makes it very difficult for insects to penetrate the plants defenses. This is also true of plant diseases. Sulfur levels increase dramatically, possibly causing a repellent effect. Sulfur is also an extremely effective fungicide. Trace element levels are increased as well, increasing the health of the plant and its resistance levels.

BACKGROUND FACTORS

There are many factors that make sulphursoil effective. Sulphursoil is a geothermal deposit, found only in southern Utah, with lesser amounts in j Yellowstone Park. It is extracted from the bottom of geothermal pools. The geothermal fluids in these pools contain all known elements and are highly acidic. Acids have bad publicity and are claimed to kill soil microorganisms and earthworms. But what we have seen with sulphursoil is an increase in

beneficial bacteria, and a big increase in earthworm populations, sometimes in soils where earthworms were never observed. Bear in mind that my observations are on high ph western soils. Soils in most humid areas are acidic and must be limed. Much smaller amounts of sulphursoil are used as not to aggravate an existing acid condition.

Sulphursoil is not a cure-all. It is a practical tool to use for several situations—higher levels for high pH soils and small amounts for acid soils. Remember pH is a critical factor and must be maintained in a reasonable range for optimum plant growth. The usual range is from 6.5 to 7.5. Lime has been used for a long time on acid soils to change the pH. But, it has always been thought that there was no practical way to reduce pH on alkali soils, so farmers try to treat the symptoms with lots of phosphate and trace minerals. I have found this to be a treadmill only. benefiting the fertilizer dealer. The answer is to treat the disease. I have .. done just that, and it has been the only way of increasing production on most irrigated soils I've worked with. It has also been shown in recent research that sulfur increases N fixation by legumes. It is also well known that iron, cobalt and molybdenum are required by nitrogen fixing organisms. Sulphursoil contains these elements and others in abundance in an available form. Why then is sulfursoil not widely accepted by farmers? One reason may be that it is judged by its sulfur content alone (20%). Many farmers decide on what

much offers acoused up using anhydrous ammonia, even though much is lost to the air, and it solubilizes valuable humus causing deterioration of their soil structure. The old "single factor approach" mentality, whereby complex decisions are made simply by price per unit criteria, has been the downfall of many a shortsighted farmer. Many "eco" types are scared off by the acids and sulfur contained in sulphursoil. This is unfortunate because without mild acidification, most irrigated, calcarious soils. have pH too high to support much of a bacterial population and earthworms are rare. Those same soils treated show dramatic increase in earthworm

by price alone,

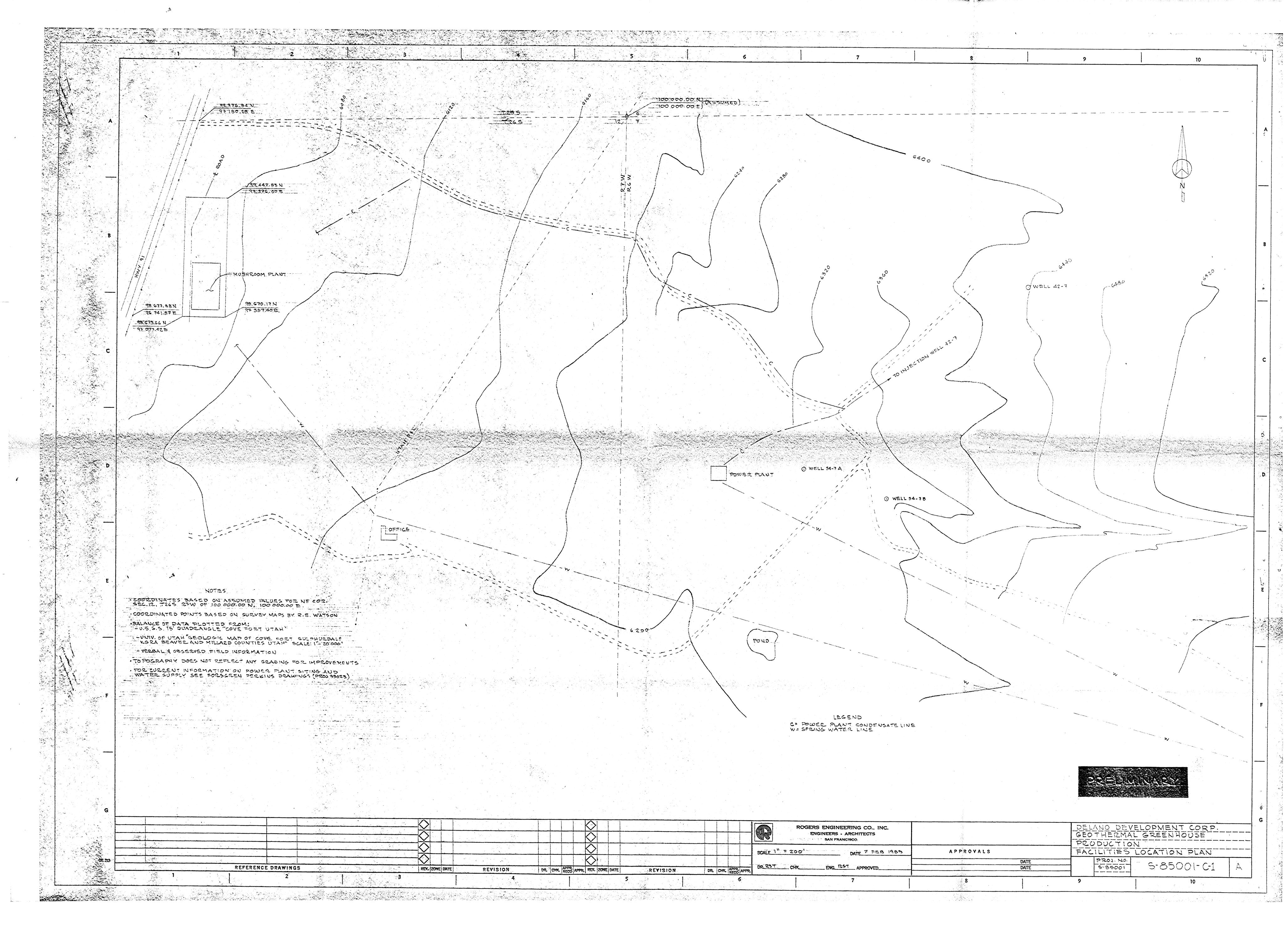
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existent and burning is necessary. The facts remain that sulphursoil is the most underrated product in agriculture. It does the job claimed for it by its producers. It has stood the test of time. It is a 100% natural product and it is inexpensive. Over the years I have seen people scramble for miracle products or more commercia! fertilizers, all to no avail. I have also seen growers' costs go down while yields and quality go up by using natures most valuable gift to

populations. Decomposition of crop

residue is rapid when normally it is non-

western farmers, sulphursoil.





Rogers Engineering Co., Inc. 467 Hamilton Ave., Suite 29 Palo Alto, California 94301

March 15, 1985

Delano Development Corporation #1 Sulphurdale, P.O. Box 1086 Beaver, Utah, 84713

In reply refer to: S-85001

Attention: Mr. Thomas Canada, Senior Vice-President

Subject: Pipeline from Geothermal Plant Area to D.D.C. Geothermal

Greenhouse Area

Dear Tom,

Enclosed as indicated on the transmittal sheet we include three sets of drawings and a comparative cost estimate for the pipeline.

We recommend that construction of a pipeline to transport condensate from the power plant to the mushroom plant be deferred until the operating characteristics of the steam wells and condensate availability can be more accurately assessed. The well characteristics can better be determined after several months' operation of the power plant. Further, the reliability of the spring water supply system may lead to the conclusion that the well condensate should be used for cooling tower operation.

Current criteria guarantees only 200-240 gpm of condensate. Under this condition the boiler must be operated at full capacity during the winter if heat is to be available for the drier.

The flowsheet is based on a condensate flow of 400gpm. This is the flow estimated to be produced by two wells when 5MW are being generated. This quantity will supply the 3.4 million Btu's required to supplant the boiler for greenhouse heating, and will also provide heating for the mushroom drier. This aspect of the flowsheet should be reviewed after the tests by the drier manufacturers have been completed, and drier heat requirements can be finalized.

In the summer, excess heating capacity willbe available, at which time some of the condensate should be diverted to the reinjection well, 42-7.

The flowsheet includes 50% standby capacity for heat exchangers.
This is achieved by providing 2 units, each 50% of required capacity. As an active at the greenhouse and at the drier.

100% standby capacity is included for pumps. Power reliability should be reviewed to determine whether or not pumps should be dual drive so that pumps could be engine driven in the event of a power outage.



Rogers

Storage capacity of the condensate receiving tank is shown as 24 hours, and this requirement should be reviewed after the power plant is in operation. The cool condensate surge tank has a capacity of 4 hours storage, and this is not impacted by power plant operations.

It is recommended that an overall flow sheet be prepared for product handling as well as detailed specifications for all equipment not yet ordered.

In addition, a schedule should be prepared showing time for procurement, fabrication, delivery and installation of all equipment and materials on the project.

As we had agreed on January 30, 1985, Rogers Engineering Co., Inc.'s estimate for this work was not to exceed \$12,000 total cost to Delano Development Corp. My estimate was based on approximately 173 manhours of our engineers' time at not to exceed \$50. per hour, and approximately \$3000. in reimbursable expenses. At this time we are within budget; however, we have not received all of our telephone bills yet.

We have certainly enjoyed working with you and your staff. We trust that we can be of continuing assistance going forward.

Yours very truly,

Herbert Rogers, Jr., President

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Delano Devel Corp #1 Sulphurdale POBOX# 1086 Beaver, UT 84713

Atten: Mr Thomas Canada, Senior Vice-Pres

Subject: Pipe Line from Power Plant Area to

D.D.C. Geothermal Greenhouse Area

Dear Tom,

PI Enclosed as indicated on the transmittal sheet we are enclosing 4 sets of drawings the and a comparative cost estimate to typipe line.

AP2 (Attached)

We recommend that construction of a pipeline to transport condensate from the power plant to the mushroom plant be deferred until the operating characteristics of the steam wells and condensate availability can be more accurately assessed. The well characteristics can better be determined after several months' operation of the power plant. Further, the reliability of the spring water supply system may lead to the conclusion that the well condensate should be used for cooling tower operation.

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was based on approximately 173 man hours

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of our Engineers of the Approximately \$3000.- in

reimbursable
expenses. The appears of the At this time we are

within budget, however we have not recieved

all of our telephone bills yet this time.

P12 - We have certainly enjoyed working with your

Staff. We trust that we can be of continuing
assistance going forward.

YVTI

R



Rogers Engineering Co., Inc. 467 Hamilton Ave., Suite 29 Palo Alto, CA 94301

September 9, 1986

Mr. Thomas Canada 3390 Snoody Road Bloomington, Ind. 47401

SUBJECT: Mushroom Facilities of Delano Development Corporation

Located at Sulphurdale, Utah

Dear Tom,

Enclosed is the information we have prepared concerning the proposed pipeline to supply heat for your Sulphurdale Mushroom Facilities.

Heat Requirements at this time:

5,000,000 Btu at Growing Plant 1,000,000 Btu at Dehydrators and Others Total required = 6,000,000 Btu available at site.

Alternative Methods of obtaining this amount of heat:

1. Use of Condensate from M.E.I. Geothermal Electric Power Generating Plant.

1.1 For the condensate to meet the heat requirements above, the quantity required must be 400 gallons per minute @ 200°F., and should be available at the starting point of the 6" FRP (Bond Strand) pipeline.

1.2 Condensate from the Mushroom Plant must be pumped back up grade to Injection Well #42 at elevation 6,440 feet (at least 400 feet above Mushroom Plant)

2. Use spring water available at Power Plant, and install Steam to Water Heat Exchangers near Power Plant.

2.1 Pipeline would then be operating at 230°F. with hot water, but should be 6" Steel pipe (not FRP), and the quantity of water would be approximately 330 Gpm!

2.2 Water could be discharged into the local drainage system.

2.3 Steam required for this system would be approximately 30,000 pounds per hour!

3. Use steam from Geothermal Wells #42-7A & 42-7B by tapping the steam pipeline from these wells before the steam enters the Electric Power Generating Plant.

3.1 This steam pipeline would be 6" steel schedule 40 with 2" of insulation with expansion loops, and would be supported on stanchions

approximately 3 feet above ground.

3.2 The 6" steam pipeline would be receiving approximately 7,000#/hr of steam at 275°F.

3.3 The condensate from the pipeline, Steam to Water Heat Exchangers, etc.

would be approximately 15 Gpm.

3.4 We recommend an open holding pond to cool the condensate, and then a 2" FRP buried line back to either the condensate tank at the Electric Power Plant, or to the reinjection well.

The pump required for this reinjection line would be a 10 to 15 horse power electric motor driven pump.

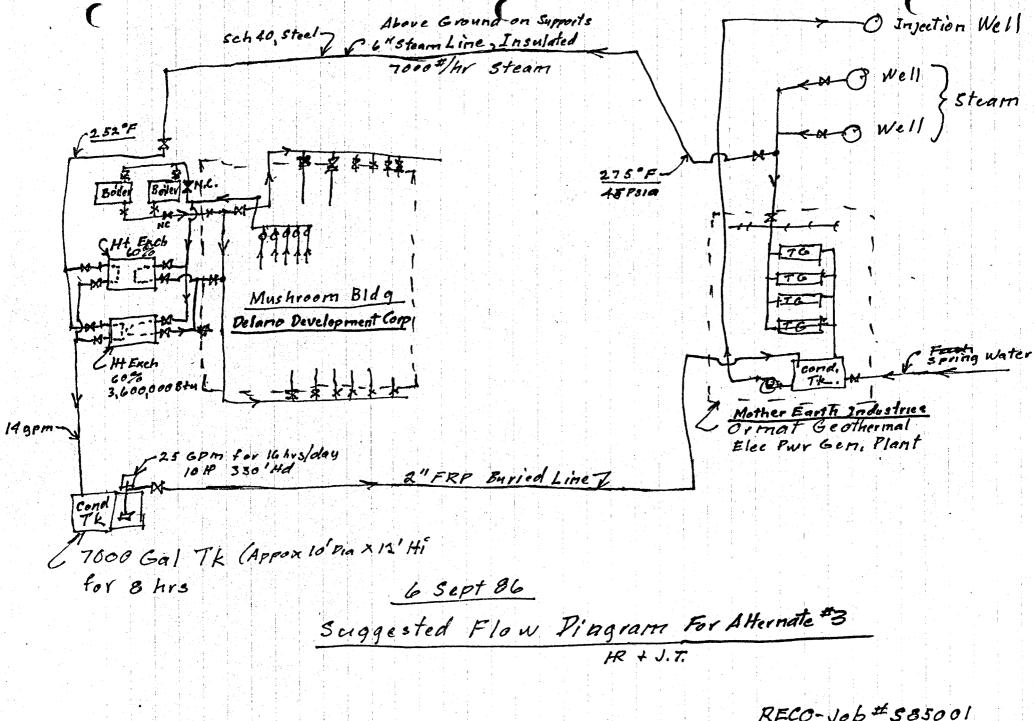
I am sending a copy of this letter, as you suggested, to Jay Haugh of M.E.I. and will contact him concerning some of the problems on permits, etc.

Yours very truly,

Herbert Rogers, Jr.

enclosure: Sketch and cost estimate - alternate #3

cc : Mr. Jay Hauth, Mother Earth Industries



RECO-VOB# \$85001 6 Sept 86 PR

Extra cost for P15 * Exp. Bends
64 Sch 40 Steam Line Alternate 1/4 917/86 Summary Pum 1-[1. Survey/layout voute & pipe supports
2. Dvill holes
3. Standnions
4. " placement
5. Extra pipe for exp. 180ps. 17 x 5,200 = \$ 2,400 4,200 9.000 15 810 w/ pyze # 28,450 1. Call for ingula price locally — 2. Back out painting Pipe Installa from C/E Article B- T28.54/LF = 5,200 = 1.17 =

(Note that this figure includes pointing instead of insulation) # 173, 640 Total = \$ 202,090 \$6,100. Pipe Insulation \$1.00/ft \$6,000 C- Main Stm Valve at PWY Plf Installed Ht Exch's + Install \$12,000x2= 24,000. \$23B, 190 A+B+C = Contingey Plus 10% 9282,200 €50 \$30000,-32,000 = 36,008 Engineering 12% Total = \$294,200 Use -\$300,000,-

Cost for 2" FRP Condensate Return Line

4100 Lin ft at \$16,30 = \$99,430.

8,000 Gal Storage Tk = \$10,000

Elec Pp - Stainless Steel, 10 HP
2" x 2½" Size, 2 Stage Bentin (259pm) = 10,000

\$119,430,10% Conting \$131,430.
Engrig 10% \$13,140
\$144,570.-

Summary! 6"Stl School Steam Pipe Line \$380,000.-2" FRP (Bond Strand) Buried Line, 144,570.-

For Total Project Use \$450,000