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REMOVAL OF TRACE ORGANICS FROM GROUNDWATER USING GRANULAR ACTIVATED CARBON

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DENVER, CO

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13. ABSTRACT *(Maximum 200 words)*

CALGON CORPORATION HAS BEEN CONTRACTED TO DETERMINE THE FEASIBILITY OF REMOVING TRACE LEVELS OF DISSOLVED ORGANICS FROM CONTAMINATED GROUND WATER. THE PRIMARY CONTAMINANT WHICH WAS CONSIDERED DURING THIS PRELIMINARY REPORT WAS DIMP. BY MONITORING THE DIMP CONCENTRATIONS OF "BOG" WATER BEFORE AND AFTER CARBON TREATMENT, IT WAS POSSIBLE TO DETERMINE THE USEFULNESS OF GRANULAR ACTIVATED CARBON AS A WASTEWATER TREATMENT ALTERNATIVE.

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82160R22
ORIGINAL

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SARRM-IR

Preliminary Report - Calgon Granular Carbon System

Commander

Dir of IR

2 Feb 77
Mr. Loven/ckk/393

1. Inclosed for your review and information is the preliminary report on the pilot work involving the use of granular carbon columns. The report also makes an economic analysis of both the scaled up 10,000 gph powdered unit (omitting costs of carbon disposal) and the proposed 0 - 24,000 gph Calgon System. In addition, a planning implementation schedule has been included. This schedule integrates quite well with projected interim containment milestones.

2. Also included in the report is Calgon's amended contract proposal to implement the system at RMA.

1 Incl
as

IRWIN M. GLASSMAN
Director of IR

[redacted]

DEPARTMENT OF THE ARMY
HEADQUARTERS ROCKY MOUNTAIN ARSENAL
DENVER COLORADO 80240

SARRM-IR 2 Feb 77

SUBJECT: Preliminary Report - Calgon Granular Carbon System

Project Manager for Chemical Demil
and Installation Restoration
ATTN: DRCPM-DRR
Aberdeen Proving Ground, Maryland 21010

Inclosed for your review and information is a preliminary report and cost estimates for the Calgon Granular Carbon System.

1 Incl
as

JOHN P. BYRNE
COL, CmlC
Commanding

CONTENTS

ROCKY MOUNTAIN ARSENAL
DENVER, COLORADO 80240

2 FEB 77

ECONOMIC ANALYSIS -- CALGON SYSTEM

Assumption

a. System will be operational for test and treatment of construction phase groundwater during the period Oct - Dec 77.

b. Erection and start up will occur during the time period Jul - Sep 77.

c. Capacity of system will be 0 - 24,000 gallons per hour.

d. Operating costs are based on processing 10,000 gallons per hour groundwater throughout FY's 78 and 79.

e. Composition of groundwater treated is similar in organic content to bog water.

f. Costs based on total removal of DIMP, organo-sulfur compounds, etc., with upper operating limit set at 50 ppb DIMP.

	FY 77 Funds	FY 78 Funds
Calgon Service Contract	$115,000 *	$120,000 *
Equipment & Supplies	10,000	5,000
Operations & Maint (mnyr)	-0-	40,000
Utilities, 5 Kw average @ .02	-0-	1,000
	$125,000	$166,000

FY's 77 & 78 TOTAL: $291,000

Actual Costs: $172,250

* Provides nine months forward funding

ECONOMIC ANALYSIS - 10,000 GPH POWDERED CARBON

Assumption

a. System will be operational for test and treatment of construction phase groundwater during the period Oct - Dec 77.

b. Capacity of system will be 6,000 - 10,000 gallons per hour.

c. Operating costs are based on processing 10,000 gph groundwater throughout FY 78 & 79.

d. Composition of groundwater treated is similar in organic content to bog water.

e. Costs are based on approximately 98% removal of DIMP and other organics, with the upper operating limit set at 50 ppb DIMP.

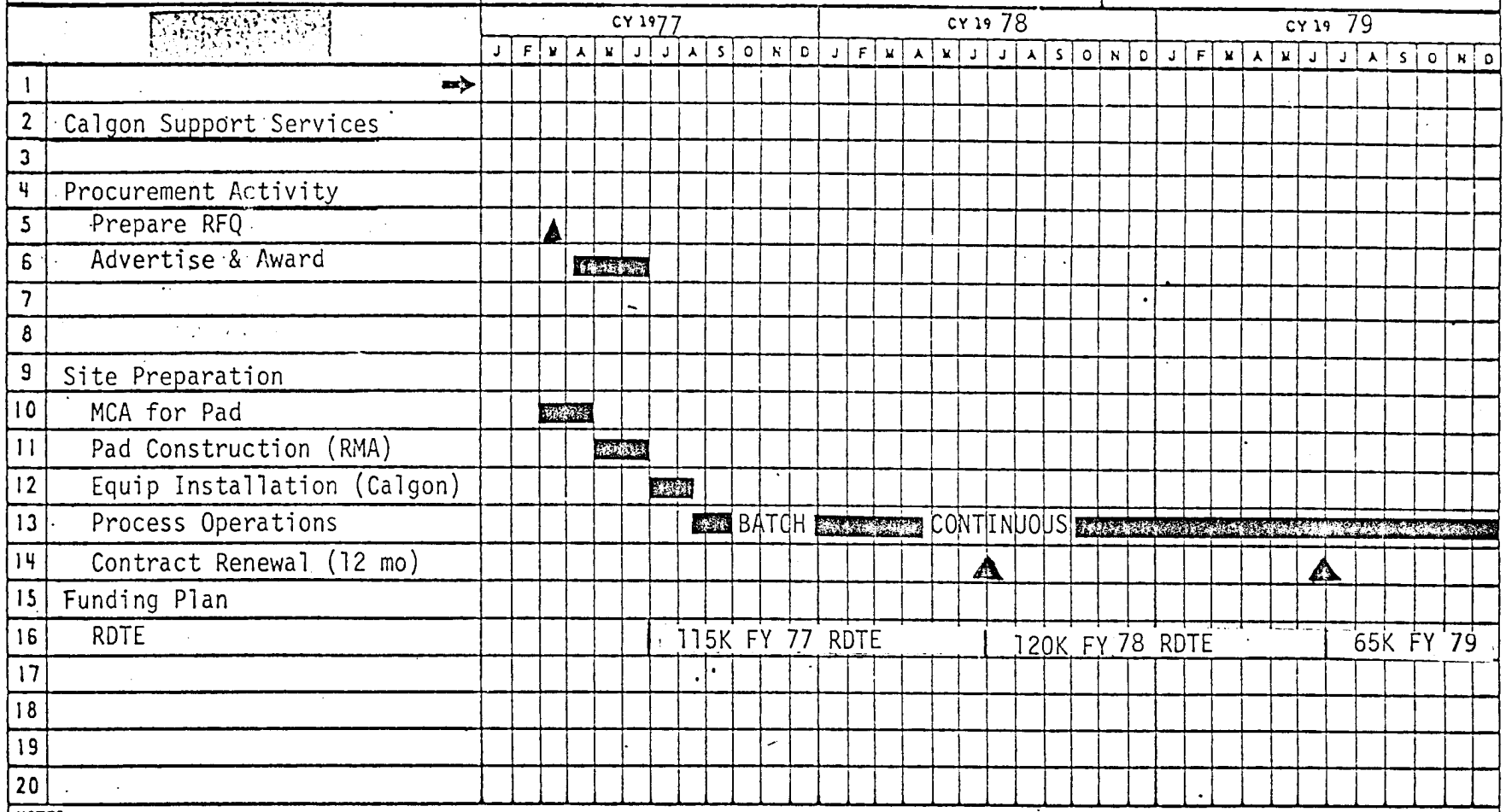
f. No provisions have been made for costs for ultimate disposal of spent carbon over and above temporary storage.

	FY 77 Funds	FY 78 Funds
Capital Improvements	$126,000	-0-
Carbon, 2.92 #/M Gal @ .24	-0-	$ 61,390
Cationic Polymer, .0375 #/M Gal @ $1	-0-	3,240
Anionic Polymer, .015 #/M Gal @ $1.52		2,000
Equipment & Supplies	-0-	5,000
Operations & Maint (4 mnyr)	-0-	160,000
Utilities 25 Kw @ .02	-0-	4,380
	$126,000	$236,010

FY's 77 & 78 TOTAL: $362,010

INSTALLATION RESTORATION PROGRAM

PLANNING SCHEDULE
PROCESS TECHNOLOGY



NOTES

REMOVAL OF TRACE ORGANICS FROM GROUNDWATER USING GRANULAR ACTIVATED CARBON

ROCKY MOUNTAIN ARSENAL
DENVER, COLORADO

Preliminary Report

Calgon Adsorption Systems
Calgon Corporation

January 25, 1977

INTRODUCTION

Calgon Corporation has been contracted by the Rocky Mountain Arsenal to determine the feasibility of removing trace levels of dissolved organics from contaminated groundwater. The primary contaminant which was considered during this preliminary report was DIMP. By monitoring the DIMP concentrations of "bog" water before and after carbon treatment it was possible to determine the usefulness of granular activated carbon as a wastewater treatment alternative. The results presented in this preliminary report represented an interpretation of data obtained within the past months, and constitutes a minor portion of all the data which is expected to result from on-going and future testing.

OBJECTIVES

The preliminary adsorption tests were completed to determine:

(1) Will granular activated carbon remove DIMP to predetermined levels?

(2) Will multi-media filters provide adequate pretreatment for the removal of suspended solids?

(3) What is granular activated carbon's capacity to remove DIMP?

(4) How much carbon is required to treat 10,000 gallons per hour of "bog" water, during a yearly period?

(5) Are extensive contact times required to remove trace levels of organics from the test wastewater?

(6) Is it beneficial to use virgin carbon versus previously reactivated carbon, in removing dissolved organics?

TEST PROCEDURE

Calgon delivered and set-up pilot scale multi-media filtration and carbon adsorption equipment to the Denver test site. Throughout the preliminary test period, Arsenal personnel operated, sampled, and monitored the pilot apparatus. All wastewater used during these tests was actual "bog" water. Batch quantities of fresh "bog" water were supplied to the test site every 3 to 4 days to simulate the changing conditions of the groundwater.

The Calgon pilot treatment system consisted of five (5) plexiglas circular (5 inch diameter) columns connected in series. The first column was the multi-media filter which consisted ot 0.25 ft^3 of sand, covered by 0.25 ft^3 of coal. Each of the four (4) remaining columns contained 15 pounds of granular activated carbon. Wastewater was pumped downward through all five of the columns at a flow of 0.25 gallons per minute. At a flow of 0.25 gallons per minute each one of the carbon columns provided a contact time of approximately 15 minutes, and thus the effluent from the fourth carbon column would represent the effect of a 60 minute contact time. During this test, one set of four carbon columns contained react carbon whereas a second set of four carbon columns contained virgin carbon. The two types of granular carbon were evaluated under identical conditions to verify any differences in adsorptive capacity.

Wastewater was first pumped through the pilot systems on November 26, 1976, and continuously added until January 10, 1977.

TEST RESULTS

Figure 1 illustrates the relationship between the sand filter effluent, DIMP concentrations, and the effluent DIMP concentrations of the first carbon column (react carbon) as a function of volume of waste treated. The effluent DIMP concentrations from carbon columns number 2, 3, and 4 were not presented because of their extremely low levels. Figure 2 illustrates a similar relationship between influent and effluent DIMP concentrations expect that the adsorbent was virgin carbon.

Visual inspection of the two DIMP breakthrough curves indicates that both types of granular activated carbon were capable of reducing DIMP from influent levels of 400 parts per billion to <50 parts per billion. However, the react carbon outperformed the virgin carbon in that larger volumes of wastewater could be treated using react carbon versus virgin carbon, in order to attain a given breakthrough DIMP concentration. These data indicate that there was no advantage of using virgin carbon as a full-scale adsorbent. One column of react carbon was capable of producing a low-level DIMP concentration for nearly two months. These data indicate that fifteen (15) minutes of adsorber contact time was sufficient to provide proper wastewater treatment. Since the breakthrough capacity of the virgin carbon (15 minutes contact time) was lower than the capacity of react carbon, further tests must be completed to verify the fact that 15 minutes is the proper contact time.

The capacity of carbon to adsorb organics is most frequently expressed in terms of milligrams of adsorbate removed per gram of carbon (for a given influent and effluent waste concentration). Carbon capacity was determined for this study, by integrating the area between the influent and effluent DIMP curves and dividing this quantity by the weight of carbon in a single carbon column.

Using an influent DIMP concentration of 415 parts per billion and an effluent breakpoint concentration of 50 parts per billion DIMP, the capacity of react carbon was calculated to be 3.8 mg. DIMP per gram of carbon, and the capacity of virgin carbon was 2.3 mg. DIMP per gram of carbon.

The quantity of carbon necessary to provide a given effluent DIMP concentration can be expressed as a usage rate. By interpreting Figures 1 and 2 it was concluded that for an effluent breakpoint concentration of 50 parts per billion DIMP, the react carbon usage rate was 0.9 pounds of carbon per 1000 gallons and the virgin carbon usage rate was 1.4 pounds of carbon per 1000 gallons. These usage rates are equivalent to 108 milligrams of carbon per liter (react) and 168 milligrams of carbon per liter (virgin). Carbon usage rate has been used to calculate the yearly carbon needs, assuming an influent DIMP concentration of 400 parts per billion and an effluent DIMP concentration of 50 parts per billion. Using a single fixed bed adsorber and a flow rate of 10,000 gallons per hour, the yearly carbon needs would be 79,000 pounds (react) or 123,000 pounds (virgin).

Throughout the preliminary test period the multi-media filters effectively reduced suspended solids concentrations entering the carbon columns such that head losses through the carbon column were minimal.

FURTHER TESTS

Additional wastewater testing is in progress at this time to provide the following information:

(1) GS/MS scan of raw and carbon treated wastewater.

(2) Inorganic characteristics of influent wastewater.

(3) Will adsorbed DIMP be totally decomposed when carbon is thermally reactivated?

(4) Is activated carbon returned to original quality after having adsorbed DIMP and subsequently having been thermally reactivated?

(5) What is the capacity of carbon, using well water with elevated DIMP concentrations?

(6) Is react carbon more efficient than virgin carbon, at elevated DIMP concentrations?

(7) Is 15 minutes contact time sufficient for proper adsorption of organics?

(8) What would be the cost of Calgon Adsorption Service (CAS) for elevated DIMP concentrations, and flow rate of 10,000 - 20,000 gallons per hour?

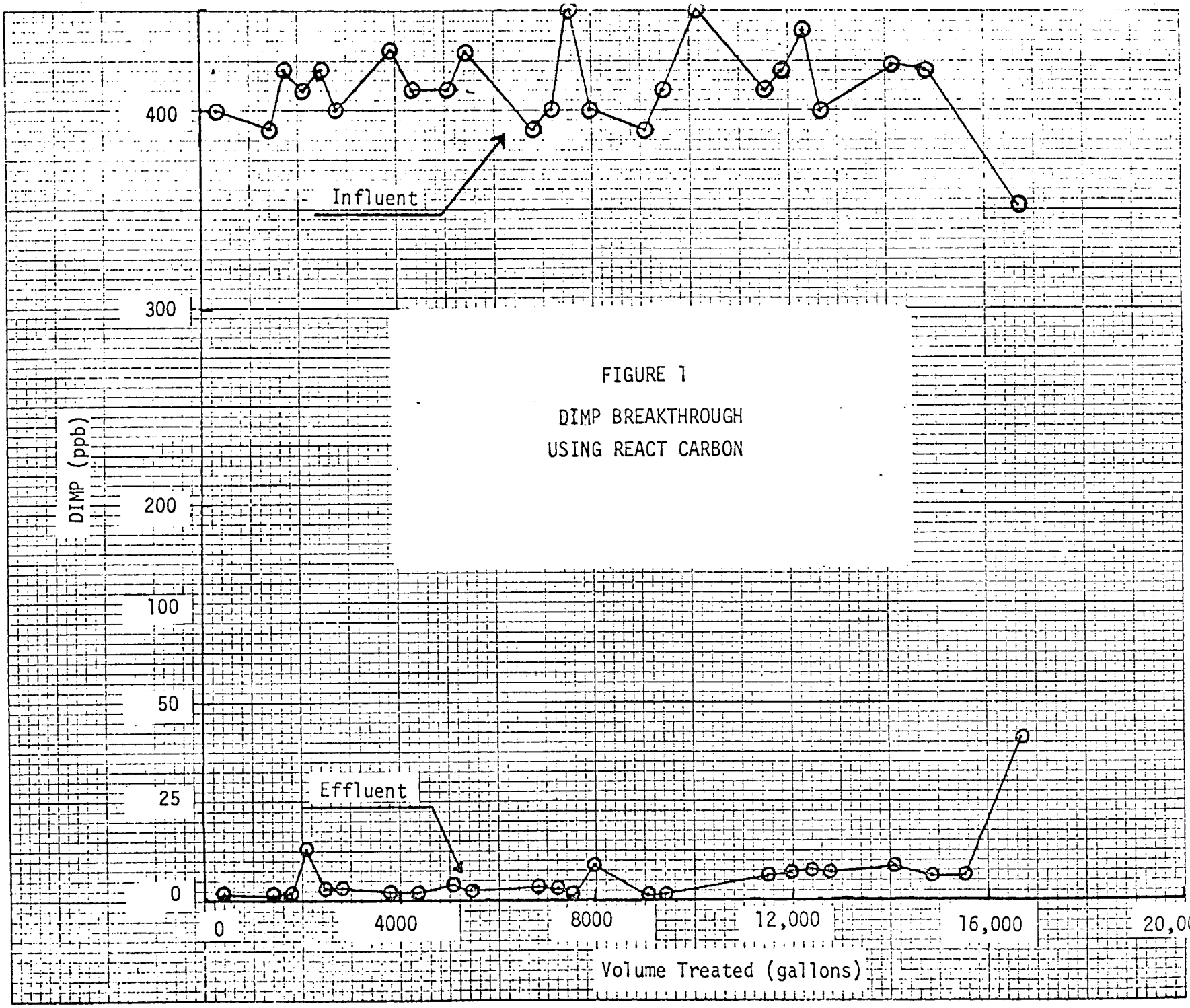


FIGURE 1

DIMP BREAKTHROUGH

USING REACT CARBON

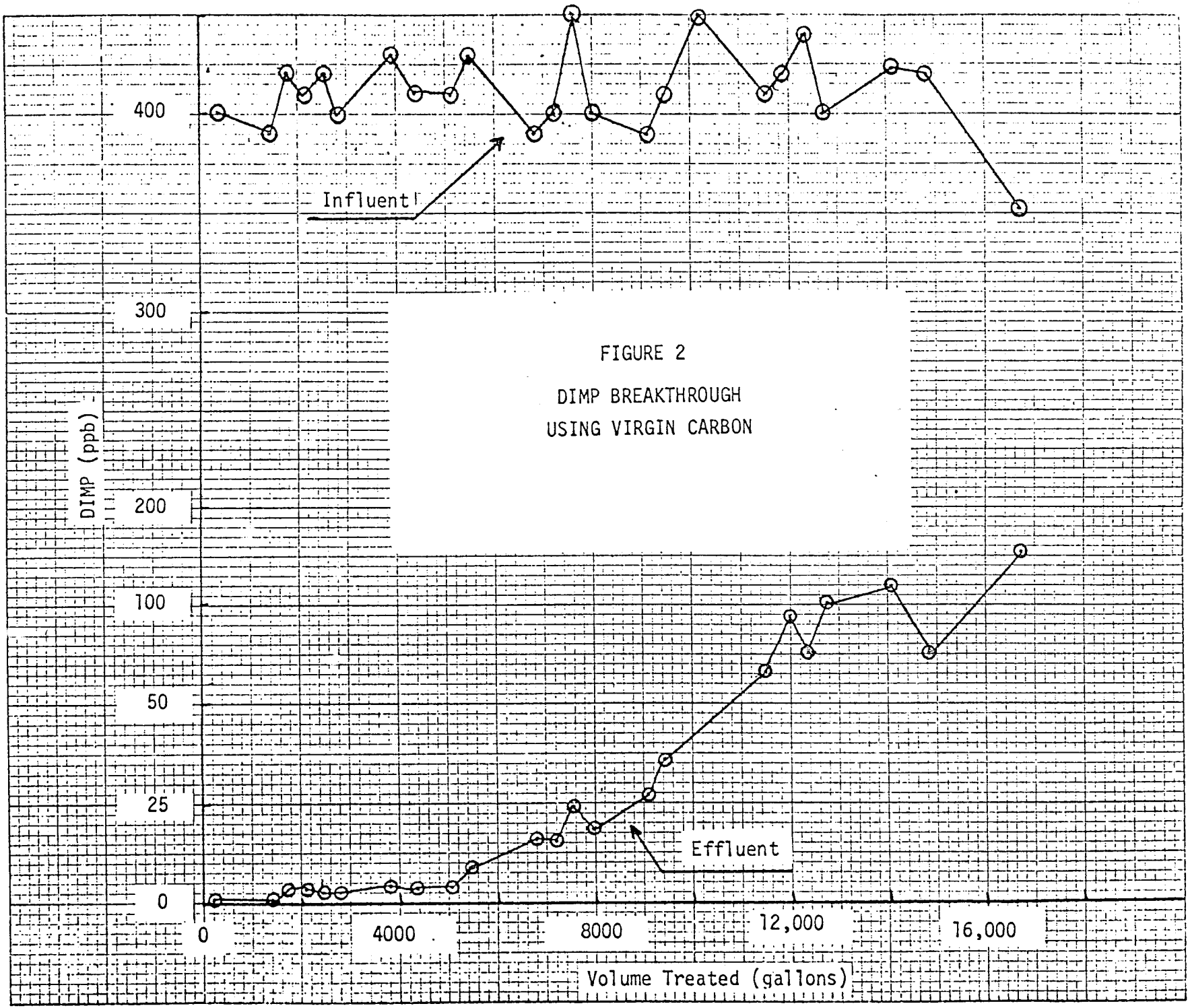


FIGURE 2

DIMP BREAKTHROUGH

USING VIRGIN CARBON

ROCKY MOUNTAIN ARSENAL
Denver, Colorado

ADDENDUM PROPOSAL NO. 711-1073
January 31, 1977

CALGON
CORPORATION
SUBSIDIARY OF MERCK & CO., INC.

CALGON ADSORPTION SYSTEMS CALGON CORPORATION 4800 WEST 34th ST. SUITE B-8 HOUSTON, TEXAS 77092 (713) 682-1301

January 31, 1977

Mr. I. Glassman
Director Installation Restoration
Building 612
Rocky Mountain Arsenal
Denver, Colorado 80240

ADDENDUM PROPOSAL NO. 711-1073

Dear Mr. Glassman:

I am writing to confirm details of our recent meeting with Carl Loven and Ed Berry in Denver on January 21, during which we discussed the utilization of Calgon's Adsorption Service for treatment of Rocky Mountain Arsenal's ground water contamination problem.

Our test work to-date, indicates that activated carbon adsorption can effectively treat Rocky Mountain Arsenal's ground water.

In the conversation with Carl and Ed, they indicated the the Arsenal's desire to begin operations approximately in August, 1977, at a flow of less than 10,000 gallons per hour. After operating about 6 months, the flow of water will increase to 10,000 gallons per hour. It is our understanding that in the next two or three years, the Arsenal will gradually increase to a 20,000 gallons per hour flow.

Due to the need for expansion in the future, we suggest that Rocky Mountain Arsenal begin operations with a system that can be easily modified in the future. Our engineers recommend starting with a system consisting of two adsorbers piped in series. At the 10,000 gallon per hour flow rate, this system would operate with one adsorber on stream and using the spare adsorber as a transfer vessel for changing out carbon. As the flow rate increases and the demand of the system necessitates two adsorbers, the system could be expanded easily by adding a transfer vessel. At that time, both adsorbers in series would be used to process the water and the added transfer tank would be used to change out exhausted carbon. We feel that by following this recommendation Rocky Mountain Arsenal will have more flexibility to grow with its needs.

Based on the aforementioned recommendations, we are offering a revised Proposal for the Calgon Adsorption Service to treat the Arsenal's ground water problem. The estimated fee includes all equipment described in the attached revised Exhibit A and the treatment of 10,000 gallons per hour for 365 days per year. The revised Exhibit A describes the responsibilities of Calgon and those of Rocky Mountain Arsenal. Based on test work currently being conducted by Calgon, we are confident that the Calgon Adsorption Service can meet Rocky Mountain Arsenal's treatment objectives.

Our estimated fee for the Calgon Adsorption Service

is .....$115,000.00 per year.

In our conversation with Carl and Ed, they expressed the Arsenal's desire to commence with the proposed ground water treatment program in August, 1977. In order to have the Calgon Adsorption System completely installed by August 1, 1977, a signed Calgon Adsorption Service Agreement must be submitted from Rocky Mountain Arsenal by May 1, 1977.

Negotiations of the Service Agreement should proceed in the near future in order to meet this schedule. We currently estimate the test work to be complete by the end of February, 1977. With this in mind, discussions of the Service Agreement could begin in March, 1977.

I will call you next week to further discuss the preparation of the Calgon Adsorption Service Agreement. If you have any questions, please do not hesitate to contact me.

Very truly yours,

Janet L. Thomas

Janet L. Thomas
Adsorption Systems Specialist

JLT:lh
Attachments

CALGON ADSORPTION SYSTEMS

ROCKY MOUNTAIN ARSENAL

DENVER, COLORADO

REVISED EXHIBIT "A"

JANUARY 28, 1977

CALGON ADSORPTION SYSTEM DESCRIPTION

Well water from the Rocky Mountain Arsenal will be pumped to the Granular Activated Carbon Calgon Adsorption System at an average rate of 10,000 gallons per hour. The raw well water is expected to be of the following quality.

pH	8.3
Total Organic Carbon (TOC)	7 mg/1
Soluble Organic Carbon (SOC)	7 mg/1
Suspended Solids	< 5 mg/1
Diisopropylemthlyene Phosphonate (DIMP)	400 ppb

The well water will be pumped to the Adsorption System for the reduction of dissolved organic contaminants. The Adsorption System will consist of two adsorbers piped for series or single stage operation. One adsorber will be filled with activated carbon the other will be empty. When the carbon in the adsorber becomes spent, it will be removed and a fresh bed of activated carbon will be placed in the second adsorber. The adsorber with the fresh bed of activated carbon will be placed back in service. Fresh activated carbon will be delivered by a Calgon truck, which will remove the spent carbon.

Effluent from the Adsorption System will be expected to be of the following quality:

pH	8.0 to 9.0
Suspended Solids	< 5.0 mg/1
DIMP	< 20.0 ppb

CALGON ADSORPTION SYSTEM

EXHIBIT "A"

ITEMS BY CALGON CORPORATION

1. Two Stage Adsorption System
2. Adsorption System Piping and Instrumentation
3. Granular Activated Carbon Transfer System
4. Transfer System Piping and Instrumentation
5. Building to House Adsorption System
6. Installation of the Building
7. Installation of Adsorption and Transfer Systems
8. Plant Start-up
9. Maintenance of Adsorption System
10. Periodic Monitoring of System
11. Periodic Pickup of Spent Carbon

ITEMS BY ROCKY MOUNTAIN ARSENAL

1. Site Preparation, Foundation and Truck Access Road to Adsorption Site
2. Operation of Adsorption System
3. Pumps and Flow Control System
4. Influent Piping to and Effluent Piping from Battery Limits
5. Utilities to Battery Limits and Operating Cost of Utilities
6. Process Performance Monitoring