Argonne National Laboratory

Preliminary Feasibility Study

MASTER

**Injection of
Radioactive Waste by
Hydraulic Fracturing at
West Valley, New York**

Supplement 1 - Cost Estimate

MAY 1978

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by

Acres American Incorporated

Buffalo, New York

in association with

Terra Tek Incorporated

Salt Lake City, Utah

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Argonne National Laboratory

Preliminary Feasibility Study

**INJECTION OF
RADIOACTIVE WASTE BY
HYDRAULIC FRACTURING AT
WEST VALLEY, NEW YORK**

Contract No. 31-109-38-4238

Volume 4 — Supplement 1

May 1978

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241

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VOLUME 1 - EXECUTIVE SUMMARY

VOLUME 2 - TEXT

VOLUME 3 - APPENDICES

VOLUME 4 - SUPPLEMENT 1

FOREWORD

This study was undertaken by Acres American Incorporated under Contract 31-109-38-4238 to Argonne National Laboratory, dated February 17, 1978. The technical authority at Argonne National Laboratory was C. Luner, Environmental Input Studies Division. TerraTek Incorporated of Salt Lake City, Utah, acted as Subconsultants to Acres on this study.

The principal authors of this report were A. S. Burgess and S. N. Thompson of Acres. R. G. Charlwood of Acres provided general consultation and review.

Acres wish to acknowledge the assistance and comments from C. Luner, and N. Beskid at Argonne National Laboratory and H. O. Weeren at Oak Ridge National Laboratory.

May 1978

D. C. Willett
Acres American Incorporated

TABLE OF CONTENTS

Supplement 1

	<u>Page</u>
1 - INTRODUCTION -----	1
2 - PROCESS DESCRIPTION -----	3
3 - COST ESTIMATE -----	7
4 - SCHEDULE -----	14

FIGURES

LIST OF FIGURES

<u>No.</u>	<u>Title</u>
1	Process Flow Chart
2	Solids Handling System
3	Process System
4	Schedule

1 - INTRODUCTION

This supplement is in support of the Preliminary Feasibility Study for the Injection of Radioactive Waste by Hydraulic Fracturing at West Valley, New York (Volumes 2 and 3), and provides a process description, capital and operating cost estimates, and schedule suitable for an injection facility at West Valley.

These estimates, which have been partly based on cost data from the new Oak Ridge National Laboratory (ORNL) injection facility, assume a total of 3 million gallons of waste/grout mix to be injected in 200,000-gallon batches on a summer monthly interval over a period of 2 years.

The capital costs presented in this supplement are based on the purchase of new equipment and do not include any retrievable costs for equipment resale.

The capital cost estimates have been divided into direct and indirect cost. The direct costs include those costs for specific pieces of equipment and labor, while indirect costs include costs for engineering and design. Certain site-specific items and miscellaneous materials and equipment which could not be reliably estimated at this time due to lack of data, have been grouped under "unsubstantiated lump sum" (ULS).

The conceptual facility used in this cost estimate includes the construction of four 50,000-gallon storage tanks for the interim storage of the waste material removed from the present storage tanks. Alternate schemes to include the use of the empty storage tank presently on site may be assessed for potential cost savings.

The operating costs are based on past experience at ORNL, updated to reflect escalation of costs to 1978.

The schedule presented in this supplement provides the estimated times required for proof testing, facility design, construction, operation and decommissioning. This schedule is approximate and may be affected by licensing and regulatory delays. Shortening of the schedule may be achieved by conducting some tasks in parallel and increasing injection volumes.

Estimates are based on 1978 prices; no allowance has been made for escalation to the time of construction.

A contingency sum has been included to reflect the imprecise level of knowledge of requirements and costs for the facility.

2 - PROCESS DESCRIPTION

Disposal of wastes by hydrofracturing and injection comprises mixing liquid wastes with preblended dry solids and injecting the resulting grout mix under pressure at depth in a shale stratum (Figure 1).

The process system outlined below has been sized for injection batches of 200,000 gallons of grout, equivalent to about 143,000 gallons of diluted waste. It is estimated that a total of 3,000,000 gallons of grout will be required for disposal of the present waste volume (see Volume 2, Section 7). A further study is required to optimize the injection batch size, taking account of capital cost implications, rock mechanics and safety constraints.

2.1 - Bulk Solids Handling

The bulk solids handling system is shown in Figure 2. Bulk solids (cement, fly ash, attapulgite and pottery clay) will be delivered to the site and stored in the respective bulk storage tanks. The solids will be fed to a scale tank by air slides where they will be measured and transferred to the blending tanks. Blending will be performed by repeated pneumatic transfers between the blending tanks. The solids will then be fed to the 9,000 ft³ capacity bulk blended solids tanks.

The blended solids tanks have been sized to provide storage for one batch requirement (200,000 gallons of grout). However, if a batch size greater than this is required, then weighing, blending and transfer to one blended solids tank can be performed concurrently with feed of blended solids to the mixing hopper from the other blended solids tank.

At the time of injection, the solids will be pneumatically conveyed from the blended solids tank to a small metering tank above the mixing cell. The metering tank is required to meter the solids into the mixing hopper prior to the solids-liquid mixing.

2.2 - Waste Handling System

At present, the neutralized and acid wastes are contained in tanks 8D2 and 8D4 respectively. Tanks 8D1 and 8D3 are spares for these tanks. It is anticipated that the waste will be agitated and transferred on a piecemeal basis to the respective spare tanks where it will be sampled, diluted and treated as required. It is understood that this aspect is presently being investigated by another study team. Cost estimates for this operation have not been made as part of this hydrofracture study.

Following mixing and dilution, the waste will be transferred via a stainless steel doubly-contained pipe to storage tanks at the injection facility. Here, sufficient waste, approximately 143,000 gallons, will be stored in 50,000-gallon stainless steel tank in a partially-lined concrete vault. It is proposed that four tanks be installed, permitting a minimum of one spare tank capacity at any time.

At the time of injection, pumps will transfer the waste via stainless steel doubly-contained lines to the mixing cell, where it will be mixed with the preblended solids. At this time, any additives, such as retarders, will be added to the mix.

2.3 - Mixing and Injection Process

Before injection starts, the casing and shale must be slotted using a sand-water mixture pumped at high pressure through a tubing string. The hole will then be pressurized with water until hydraulic fracturing starts. The waste will then be pumped into the jet mixer in the mixing cell where it will be continuously combined with the solids. The flow of the solids is controlled by a mass flowmeter to obtain the required mix. The grout flows to an agitator from where it feeds the suction side of a positive displacement injection pump. It will be pumped through a tubing string into the base of the hole.

Upon completion of injection of the waste grout, the system will be flushed with a water grout and finally with water. The grout will be injected, but the flushing water will be returned to the waste storage tanks. After a few days, by which time the grout has setup, the well will be allowed to bleed back any liquid into the waste storage tanks for incorporation into future injections.

2.4 - Monitoring System

Eight observation wells will be located at distances of 200 to 800 ft around the injection well to determine the location and orientation of the grout sheet. Eight rock cover wells will also be installed to enable any increase in the fracturing above the injection to be detected by abnormal variations in shut-in pressure tests. In addition, a series of benchmarks will be installed spaced at about 200-ft intervals to allow surface uplift to be monitored.

2.5 - Safety Systems

All process systems involving the radioactive waste will be designed to appropriate codes and safety practices. This would include shielding of all waste process equipment, and leak detection systems in the waste storage tank vault and in the doubly-contained transfer lines. Spare capacity (one tank) will be required at all times for the waste storage. In the event of a wellhead rupture, waste would be dumped into an emergency tank. A standby injection pump will also be provided.

3 - COST ESTIMATE

For the capital cost estimate, costs are divided into direct costs (equipment and labor, installation and construction) and indirect costs (design, supervision, contingency). All costs are 1978 dollars. "Lump sum" items are abbreviated LS. Items which cannot be reliably estimated at this time due to lack of data are designated "unsubstantiated lump sum" items, ULS.

3.1 - Direct Capital Costs

3.1.1 - Initial Preparation

Initial preparation costs include site preparation (roads, drainage, fences, provision of utilities), drilling and logging of the injection, observation and rock cover wells, installation of monuments and miscellaneous instrumentation.

<u>Item</u>	<u>No.</u>	<u>Unit Cost (\$)</u>	<u>Total Cost (\$)</u>
Injection well to 1,500-ft depth, including installation of 5-1/2-in. casing for full depth and geophysical logging	1	76,000	76,000
Observation wells to 2,000-ft depth, including coring through significant horizons, installation of casing to full depth and geophysical logging	8	68,000	544,000
Rock cover wells to 600-ft depth with casing to 200 ft	8	16,300	130,400

<u>Item</u>	<u>No.</u>	<u>Unit Cost (\$)</u>	<u>Total Cost (\$)</u>
Installation of surface monuments	60	100	6,000
Miscellaneous equipment and instrumentation	ULS	50,000	50,000
Site grading, drainage roads, fencing, etc	ULS	50,000	50,000
TOTAL			<u>856,400</u>

3.1.2 - Waste Transfer Pipe

The waste transfer pipe will run from the existing waste tank area to the storage tanks at the injection facility. It will comprise a stainless steel doubly-contained 6-in. line buried to a depth of about 10 ft. However, since the location of the injection facility itself has yet to be decided, the length of the run cannot be determined. For the purpose of this cost estimate, a length of 2,000 ft has been assumed.

<u>Item</u>	<u>No.</u>	<u>Unit Cost (\$)</u>	<u>Total Cost (\$)</u>
6-in. diameter doubly-contained stainless steel transfer pipe, including supply, excavation, installation, backfilling and testing	2,000 ft	250	500,000

3.1.3 - Waste Storage Tanks

Waste will be pumped through the transfer line from the existing plant area to waste storage tanks at the injection facility. Four 50,000-gallon stainless steel tanks will be located in a concrete vault, partially lined with stainless steel. This permits storage of 150,000 gallons of waste with one tank available as spare. The cost estimate is based on costs for the new ORNL facility, scaled to reflect the smaller capacity required at West Valley.

<u>Item</u>	<u>No.</u>	<u>Unit Cost (\$)</u>	<u>Total Cost (\$)</u>
50,000-gallon stainless steel tank	4	130,000	520,000
Excavation and construction of concrete vault, including partial stainless steel lining	LS	700,000	700,000
Pumps	LS	200,000	200,000
Piping, valves and miscellaneous control and instrumentation equipment	ULS	600,000	<u>600,000</u>
			<u>2,020,000</u>

3.1.4 - Dry Solids Storage and Handling

The cost estimates presented below are based largely upon the new ORNL facility with the addition of a bulk storage hopper for cement.

<u>Item</u>	<u>No.</u>	<u>Unit Cost (\$)</u>	<u>Total Cost (\$)</u>
Bulk solids storage tanks:			
3,000 cubic ft capacity	2	25,000	50,000
8,000 cubic ft capacity	2	69,000	138,000
9,000 cubic ft capacity	2	78,000	156,000
Scale tank	1	10,000	10,000
Blending tanks	2	10,000	20,000
Compressors and air dryers:			
30 psig	1	50,000	50,000
100 psig	1	18,000	18,000
Piping, air slides and miscellaneous equipment	LS	250,000	250,000
Construction and installation	LS	120,000	<u>120,000</u>
			<u>812,000</u>

3.1.5 - Process Mixing and Injection

The cost estimates presented below are based upon the new ORNL facility. Shielding requirements for ORNL are designed for a maximum activity of 20 pCi/gallon for the grout mix. The grout mix proposed for West Valley (Volume 2, Section 8.2) has an activity of less than 8 pCi/gallon.

<u>Item</u>	<u>No.</u>	<u>Unit Cost (\$)</u>	<u>Total Cost (\$)</u>
Injection facility building including foundation excavation, building construction, services and finishing for mixing cell, injection cell, control room, and associated facilities	LS	600,000	600,000

<u>Item</u>	<u>No.</u>	<u>Unit Cost (\$)</u>	<u>Total Cost (\$)</u>
Process piping, valves, tanks, supply, installation and testing	LS	400,000	400,000
Process HVAC	LS	100,000	100,000
Injection pumps and prime movers	2	155,000	310,000
Well head fittings and Christmas tree	1	25,000	25,000
Well tubing	10,000 ft	4	40,000
Process instrumentation, supply and installation	LS	200,000	<u>200,000</u>
			<u>1,675,000</u>

3.2 - Indirect Capital Cost

Indirect costs will include conceptual and detail design, preparation and submission for licensing, quality control and construction supervision. In view of the nature of this project, a lump sum of 20 percent of the direct costs has been assumed.

Because of the preliminary state of the definition of the requirements and design of the facility, a contingency sum must be included in the cost estimate. This sum covers:

- (i) items omitted from the cost estimate
- (ii) items insufficiently defined to permit accurate cost estimate
- (iii) estimator's bias
- (iv) uncertainty in estimate.

A sum of 25 percent of the direct costs is proposed for the contingency sum for this level of cost estimate.

<u>Item</u>	<u>Total Cost</u> (<u>\$</u>)
Design, licensing, quality control and site supervision	1,157,000
Contingency on direct costs	<u>1,447,000</u>
	<u>2,604,000</u>

3.3 - Operational Costs

Operational cost estimates are based upon ORNL experience (de Laguna et al, 1968). Labor and material costs have been escalated 250 and 200 percent respectively to bring the rates to a 1978 dollar base.

Dry solids	\$.12 per gallon
Injection operating crew	\$15,000.00 per injection
Injection support (maintenance, blending, health physics)	\$10,000.00 per injection
Monitoring	\$60,000.00 per year.

On the basis of sixteen injections over a 2-year period, the operating cost would be \$.29 per gallon of grout injected.

3.4 - Decommissioning Costs

An unsubstantiated lump sum of \$500,000 is estimated for decommissioning the facility. Salvage value of components is not considered in this figure.

3.5 - Cost Summary

Direct Capital Costs	\$	\$
Site preparation	856,400	
Waste transfer pipe	500,000	
Waste storage tanks	2,020,000	
Dry solids storage and handling	812,000	
Process mixing and injection	<u>1,675,000</u>	5,863,400
Indirect capital costs		2,604,000
Operational costs		880,000
Decommissioning costs		<u>500,000</u>
TOTAL		<u><u>9,747,400</u></u>

4 - SCHEDULE

Figure 4 is a seven-phase preliminary schedule for the pre-feasibility through decommissioning of an injection facility at West Valley. The schedule, which covers a period of 5-1/2 years, includes extensive geotechnical studies, proof testing, facility design, construction, operation and decommissioning. The schedule may encounter delays due to licensing and regulatory procedures.

The injection schedule (Phase 6) is based on sixteen injections of 200,000-gallon batches of waste and grout. Each injection is estimated to require a 1-month period. This assumes a period of 2 to 3 weeks for the agitation and pumping of the radioactive waste material from their present storage tanks to the interim 50,000-gallon tanks at the injection facility. Based on the ORNL experience, each injection is estimated to require 5 working days. Approximately 2-1/2 to 3 days are required to unload, blend and store the grout materials on site and make pre-injection equipment checks. One day is required for mixing and injection and 1 day for general cleanup.

Injections are scheduled for the warmer seasons with no operations being conducted from the months of December through March.

FIG. 1

PROCESS FLOW CHART

FIG. 2

SOLIDS HANDLING SYSTEM

NOTE
ONLY TWO TANKS SHOWN
FOR CLARITY

PROCESS SYSTEM

FIG. 3

FIG. 4
PROPOSED HIGH-LEVEL RADIOACTIVE WASTE INJECTION PROGRAM
AT WEST VALLEY, NEW YORK