THE USE OF THE
MULTI-FLOW DRAINAGE SYSTEM
AT THE
FRESH KILLS LANDFILL

STATEN ISLAND, NEW YORK

Prepared By:

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INTRODUCTION

The Fresh Kills Landfill located on Staten Island, New York, is approximately 3,000 acres in size and is the largest landfill in the United States (refer to Figure 1 for a map showing the regional location of the project site). Stone & Webster Engineering Corporation (SWEC) is currently (March 1996) supervising and managing the construction of a Leachate Mitigation System at the Fresh Kills Landfill, on behalf of the City of New York Department of Sanitation. The Leachate Mitigation System at the landfill is to consist of a leachate (groundwater) collection, distribution and treatment system. A "relatively" high elevation of the water-table aquifer at the project site hindered the construction of a leachate treatment plant; hence, a de-watering system was installed to lower the elevation of the water-table aquifer. The Multi-Flow Drainage System was installed by SWEC as a primary component of this de-watering system. The following text includes a summary of the Leachate Mitigation System, a description of the installation of the Multi-Flow Drainage System, performance results of the Multi-Flow, and conclusions regarding the use of the Multi-Flow Drainage System for de-watering purposes.

LEACHATE MITIGATION SYSTEM

A Leachate Mitigation System (LMS) is currently being installed at the Fresh Kills Landfill site. The LMS consists of a system to collect, distribute and remediate contaminated groundwater (leachate). Construction of the LMS will be completed in phases: Phase I, a leachate treatment plant has been completed; Phase II, the expansion of an existing leachate treatment plant, is currently under construction. Expansion of the existing leachate treatment plant had been hindered by a "relatively" high elevation of the water-table aquifer. The elevation of groundwater at the construction area was approximately two (2) $\pm$ feet above land surface. To lower the elevation of the water-table aquifer at the construction area, SWEC proposed a de-watering system. The de-watering system was designed to reduce the elevation of groundwater at the area of construction to below land surface; and hence enable the construction of the new treatment plant. Stone & Webster Engineering Corporation proposed a traditional crushed stone drainage for the de-watering system; however, upon learning of the Multi-Flow Drainage System, SWEC chose to install Multi-Flow. Refer to Exhibit A for correspondence between SWEC and Multi-Flow Systems, Inc (dated October 7, 1994) regarding the decision to install the Multi-Flow Drainage System.

INSTALLATION OF THE MULTI-FLOW DRAINAGE SYSTEM

In March, 1995, Stone & Webster Engineering Corporation installed the Multi-Flow Drainage System along the perimeter of the treatment plant construction area. The Multi-Flow was installed to a depth of five (5) $\pm$ feet below land surface (refer to Figure2 for a schematic showing the location of the Multi-Flow and other pertinent features). Two (2) parallel 1,800 foot lengths of 18 inch Multi-Flow were installed at the north and east perimeter of the construction area (refer to Figure 2). During installation, the groundwater elevation was approximately two (2) $\pm$ feet above land surface; the Multi-

Flow was placed within a wire structure and submerged within a trench to a depth of approximately five (5) ± feet below land surface. The trench was subsequently infilled to land surface with crushed stone. (*note: Multi-Flow Systems, Inc recommends the use of coarse sand as backfill material; crushed stone was used by SWEC at the project site due to difficulties of infilling the trench with sand through seven feet of water). The gradient of the drainage system trends from west to east, and after a 90 degree turn, from north to south to the discharge point (refer to Figure 2 for groundwater flow directions). Groundwater which enters the Multi-Flow discharges to a concrete sump; when the water level within the sump approaches the elevation of the discharge point, two (2) pumps automatically activate to distribute the groundwater to the existing treatment plant for remediation.

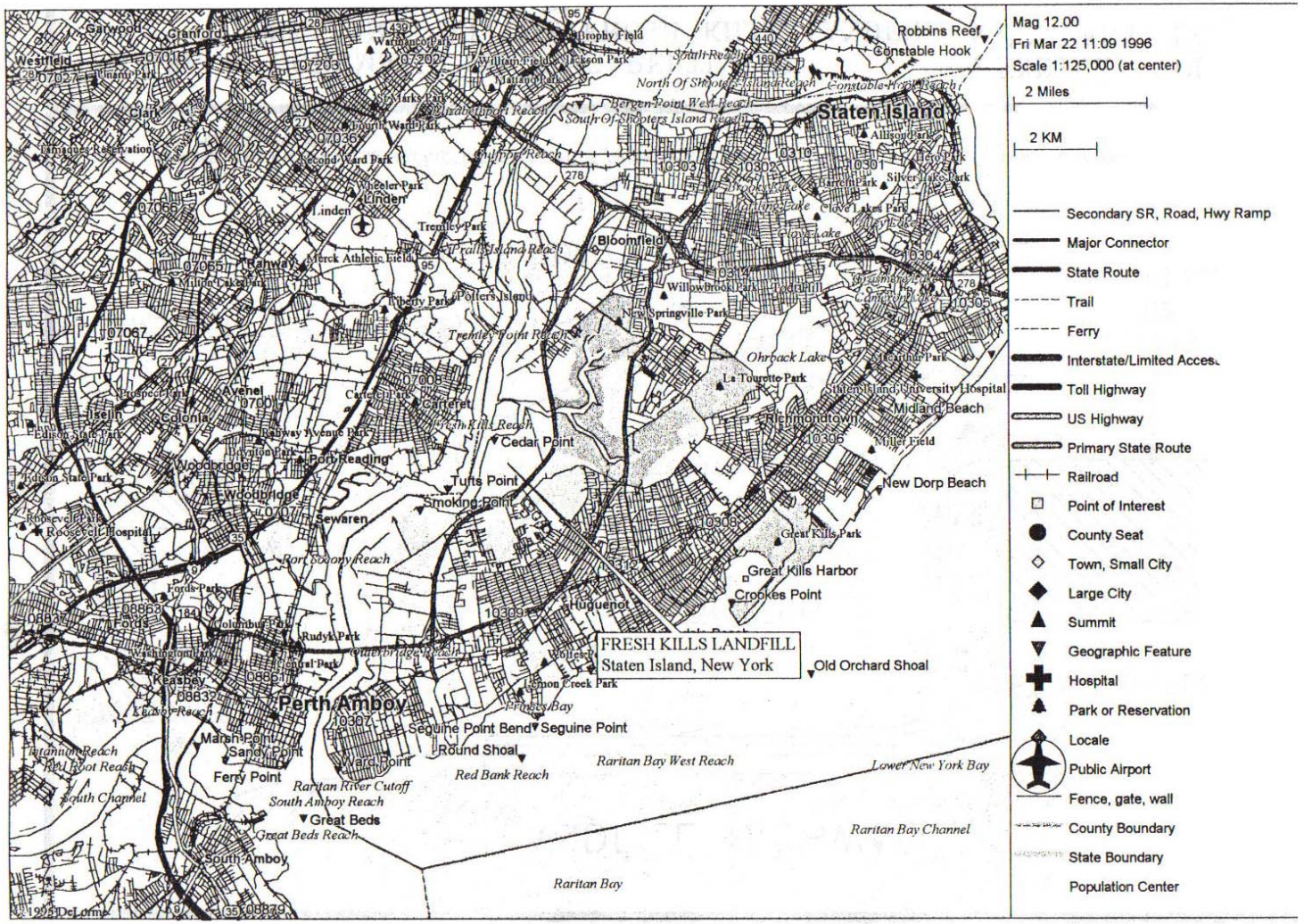
PERFORMANCE RESULTS OF THE MULTI-FLOW DRAINAGE SYSTEM

The Multi-Flow Drainage System has been operating at the Fresh Kills Landfill for approximately one (1) year (between March 1995 and March 1996). Flow rates within the Multi-Flow range between 1,260 gallons per day (GPD) and 39,000 GPD; the average flow rate within the drainage system is between 12,000 GPD and 24,000 GPD. Refer to Exhibit B for flow rate data provided by SWEC. According to SWEC personnel, the efficiency of the system has not decreased since startup of the de-watering system. The flow rate of the drainage system decreases as the elevation of the water-table aquifer stabilizes; as the elevation of the water-table aquifer rises, flow rates through the system increase. As evidence of the continued efficiency of the Multi-Flow Drainage System, flow rates through the system increased dramatically (from approximately 3,600 GPD to 23,700 GPD in a 48 hour period) after heavy rains in late January 1996. This suggests that groundwater flow through the system is limited only to the elevation of groundwater.

CONCLUSIONS

Stone & Webster Engineering Corporation has installed the Multi-Flow Drainage System at the Fresh Kills Landfill, located on Staten Island, New York. The Multi-Flow was installed as a constituent of a de-watering system to lower the elevation of the water-table aquifer, and hence, to enable the construction of a Leachate Mitigation System. An average flow of between 12,000 GPD and 24,000 GPD of leachate has flowed through the Multi-Flow Drainage System from startup (March 1995) to the present (March 1996). According to SWEC personnel, the efficiency of flow through the Multi-Flow has not decreased during the year of operation. A dramatic increase in flow through the system in late January 1996 (subsequent to heavy rainfall) suggests that flow rates through the system have been limited only to the elevation of the water-table aquifer.

FIGURE 1. Regional Location of Project Site



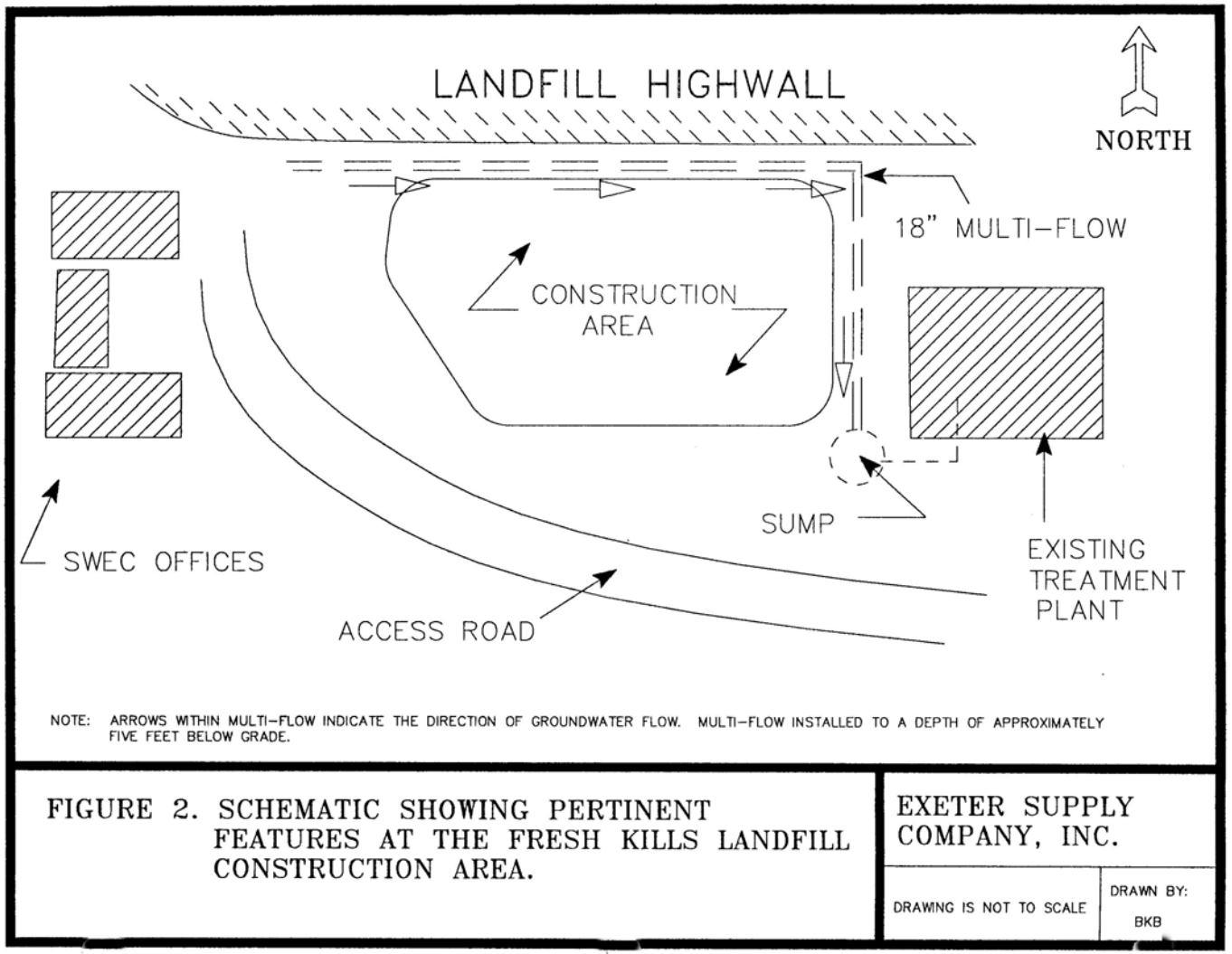


FIGURE 2. SCHEMATIC SHOWING PERTINENT FEATURES AT THE FRESH KILLS LANDFILL CONSTRUCTION AREA.

EXETER SUPPLY COMPANY, INC.

DRAWING IS NOT TO SCALE

DRAWN BY: BKB

EXHIBIT A
Correspondence Between Stone & Webster Engineering Corporation And Multi-Flow Systems, Inc (dated October 7, 1994)

LEACHATE MITIGATION SYSTEM — October 7, 1994
SITE PREPARATION, GRADING AND DRAINAGE — J.O. No. 03776.20
CAPITAL PROJECT NO. S111/303D — CN-MF-94-001

Multi-Flow Drainage System
PO Box 128
Prinsburg, MN 56281

Subject: **LANDFILL USE FOR MULTI-FLOW SYSTEM**

Dear Mr. Plowman:

Stone & Webster Engineering Corporation (SWEC) is providing construction management services to the city of New York, Department of Sanitation at the Fresh Kills Landfill on Staten Island, New York. The Fresh Kills Landfill encompasses approximately 3000 acres, and is the largest landfill in the United States. It began operation in 1948, and continues to dispose of 14,000 tons of municipal solid waste daily, 306 days per year.

The Leachate Mitigation System consist of approximately 8.5 miles of soil/bentonite slurry walls, a collection system, a forced main to transport leachate, and two (2) treatment plants with 1,050,000/gpd capacity. The project is planned for construction to be accomplished in phases. Phase I, the Veterans Avenue Leachate Treatment Plant is completed and on line. Phase II, will include expansion of the existing treatment plant to the full capacity of the system. Phase III & IV comprise the containment and collection system. As a part of the expanded treatment plant construction effort, it was decided to pre-excavate the plant area to elevation +16'-o", and install a crushed Stone Drainage System to 4'-0" below the existing water table. Upon learning of the Multi-Flow System however, we thought it would be beneficial to test your system by substituting the crushed stone with Multi-Flow and course sand. Further, prior telecoms with you have proved interesting and informative to the drainage criteria we have established.

The attached write up clearly defines the approach we will take in installing the system. Your assistance and cooperation in this effort will be appreciated. All test data we obtain will of course be shared with Multi-Flow.

Should you require further information or clarification, please advise.

JGN/krw
Cc: R. Lucks
P. Dunlop
File

Very truly yours,

J.G. Novak
Construction Manager

EXHIBIT B
Flow Rate Data Collected Between July 20, 1995 and February 25, 1996

Influent Leachate Flows to VALTP

Date	Gorman-Rupp Pump Station
05-Jun-95	18,630 gpd
06-Jun-95	18,630 gpd
07-Jun-95	20,170 gpd
08-Jun-95	5,699 gpd
09-Jun-95	
10-Jun-95	
11-Jun-95	
12-Jun-95	
13-Jun-95	
14-Jun-95	
15-Jun-95	
16-Jun-95	
17-Jun-95	
18-Jun-95	
19-Jun-95	
20-Jun-95	
21-Jun-95	
22-Jun-95	
23-Jun-95	
24-Jun-95	
25-Jun-95	
26-Jun-95	32,400 gpd
27-Jun-95	33,120 gpd
28-Jun-95	22,789 gpd
29-Jun-95	21,201 gpd
30-Jun-95	
01-Jul-95	
02-Jul-95	
03-Jul-95	
04-Jul-95	
05-Jul-95	
06-Jul-95	
07-Jul-95	11,117 gpd
08-Jul-95	
09-Jul-95	
10-Jul-95	32,889 gpd
11-Jul-95	
12-Jul-95	
13-Jul-95	
14-Jul-95	
15-Jul-95	
16-Jul-95	
17-Jul-95	
18-Jul-95	39,000 gpd
19-Jul-95	11,760 gpd

Date	Gorman-Rupp Pump Station
20-Jul-95	23,500 gpd
21-Jul-95	22,000 gpd
22-Jul-95	
23-Jul-95	
24-Jul-95	20,310 gpd
25-Jul-95	14,410 gpd
26-Jul-95	
27-Jul-95	
28-Jul-95	9,178 gpd
29-Jul-95	21,109 gpd
30-Jul-95	20,191 gpd
31-Jul-95	18,355 gpd
01-Aug-95	11,536 gpd
02-Aug-95	
03-Aug-95	
04-Aug-95	
05-Aug-95	
06-Aug-95	
07-Aug-95	22,684 gpd
08-Aug-95	24,633 gpd
09-Aug-95	21,834 gpd
10-Aug-95	19,610 gpd
11-Aug-95	19,402 gpd
12-Aug-95	18,700 gpd
13-Aug-95	17,700 gpd
14-Aug-95	17,049 gpd
15-Aug-95	15,728 gpd
16-Aug-95	15,079 gpd
17-Aug-95	17,883 gpd
18-Aug-95	14,834 gpd
19-Aug-95	
20-Aug-95	
21-Aug-95	15,462 gpd
22-Aug-95	13,320 gpd
23-Aug-95	11,852 gpd
24-Aug-95	13,720 gpd
25-Aug-95	12,087 gpd
26-Aug-95	
27-Aug-95	
28-Aug-95	11,552 gpd
29-Aug-95	12,007 gpd
30-Aug-95	12,249 gpd
31-Aug-95	13,224 gpd
01-Sep-95	13,930 gpd
02-Sep-95	
03-Sep-95	
04-Sep-95	

Influent Leachate Flows to VALTP

Date	Gorman-Rupp Pump Station
05-Sep-95	11,267 gpd
06-Sep-95	10,551 gpd
07-Sep-95	12,087 gpd
08-Sep-95	11,852 gpd
09-Sep-95	
10-Sep-95	
11-Sep-95	9,558 gpd
12-Sep-95	10,141 gpd
13-Sep-95	11,408 gpd
14-Sep-95	11,775 gpd
15-Sep-95	9,710 gpd
16-Sep-95	
17-Sep-95	
18-Sep-95	11,929 gpd
19-Sep-95	10,372 gpd
20-Sep-95	11,267 gpd
21-Sep-95	11,775 gpd
22-Sep-95	13,035 gpd
23-Sep-95	
24-Sep-95	
25-Sep-95	
26-Sep-95	20,040 gpd
27-Sep-95	15,728 gpd
28-Sep-95	12,500 gpd
29-Sep-95	10,313 gpd
30-Sep-95	
01-Oct-95	
02-Oct-95	10,801 gpd
03-Oct-95	12,500 gpd
04-Oct-95	
05-Oct-95	33,115 gpd
06-Oct-95	26,801 gpd
07-Oct-95	
08-Oct-95	
09-Oct-95	
10-Oct-95	11,852 gpd
11-Oct-95	11,130 gpd
12-Oct-95	11,625 gpd
13-Oct-95	11,408 gpd
14-Oct-95	
15-Oct-95	
16-Oct-95	
17-Oct-95	19,823 gpd
18-Oct-95	16,145 gpd
19-Oct-95	13,648 gpd
20-Oct-95	16,445 gpd
21-Oct-95	

Stone & Webster Engineering Corpor
YCC Dewatering Operations

Date	Multiflow Volume
23-Oct-95	12,000
24-Oct-95	12,000
25-Oct-95	12,000
26-Oct-95	12,000
27-Oct-95	11,406
28-Oct-95	0
29-Oct-95	0
30-Oct-95	20,000
31-Oct-95	20,468
01-Nov-95	12,000
02-Nov-95	17,570
03-Nov-95	12,000
04-Nov-95	0
05-Nov-95	0
06-Nov-95	12,000
07-Nov-95	12,000
08-Nov-95	9,589
09-Nov-95	12,000
10-Nov-95	12,000
11-Nov-95	0
12-Nov-95	0
13-Nov-95	18,423
14-Nov-95	12,762
15-Nov-95	24,305
16-Nov-95	0
17-Nov-95	11,267
18-Nov-95	0
19-Nov-95	0
20-Nov-95	0
21-Nov-95	0
22-Nov-95	10,526
23-Nov-95	0
24-Nov-95	0
25-Nov-95	0
26-Nov-95	0
27-Nov-95	22,790
28-Nov-95	9,540
29-Nov-95	9,540
30-Nov-95	9,540

Date	Multiflow Volume
01-Dec-95	0
02-Dec-95	0
03-Dec-95	0
04-Dec-95	7,855
05-Dec-95	4,418
06-Dec-95	0
07-Dec-95	0
08-Dec-95	0
09-Dec-95	0
10-Dec-95	0
11-Dec-95	0
12-Dec-95	0
13-Dec-95	0
14-Dec-95	2,367
15-Dec-95	6,312
16-Dec-95	6,312
17-Dec-95	6,312
18-Dec-95	1,260
19-Dec-95	0
20-Dec-95	0
21-Dec-95	0
22-Dec-95	0
23-Dec-95	0
24-Dec-95	0
25-Dec-95	0
26-Dec-95	0
27-Dec-95	0
28-Dec-95	0
29-Dec-95	0
30-Dec-95	0
31-Dec-95	0
01-Jan-96	0
02-Jan-96	0
03-Jan-96	0
04-Jan-96	0
05-Jan-96	0
06-Jan-96	0
07-Jan-96	0
08-Jan-96	0
09-Jan-96	0

Date	Multiflow Volume
10-Jan-96	7,200
11-Jan-96	10,800
12-Jan-96	5,400
13-Jan-96	5,400
14-Jan-96	5,400
15-Jan-96	5,850
16-Jan-96	5,850
17-Jan-96	3,600
18-Jan-96	9,900
19-Jan-96	23,700
20-Jan-96	23,700
21-Jan-96	23,700
22-Jan-96	17,100
23-Jan-96	16,200
24-Jan-96	6,300
25-Jan-96	10,800
26-Jan-96	0
27-Jan-96	0
28-Jan-96	0
29-Jan-96	0
30-Jan-96	0
31-Jan-96	0
01-Feb-96	0
02-Feb-96	0
03-Feb-96	0
04-Feb-96	0
05-Feb-96	0
06-Feb-96	0
07-Feb-96	13,500
08-Feb-96	11,700
09-Feb-96	8,100
10-Feb-96	8,100
11-Feb-96	8,100
12-Feb-96	6,300
13-Feb-96	4,500
14-Feb-96	6,300
15-Feb-96	3,600
16-Feb-96	4,800
17-Feb-96	4,800
18-Feb-96	4,800

Date	Multiflow Volume
19-Feb-96	6,300
20-Feb-96	2,700
21-Feb-96	off
22-Feb-96	off
23-Feb-96	4,500
24-Feb-96	4,500
25-Feb-96	4,500