AGRA Earth & Environmental
ENGINEERING GLOBAL SOLUTIONS

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May 21, 1997
Project: WX-04010

Centra Gas Manitoba Inc.
444 St. Mary Avenue
Winnipeg, MB
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C.0463

Attention: **Mr. Andrew Galarnyk**

Dear Sir:

RE: MONITORING REPORT #2
IN-SITU BIOREMEDIATION PILOT STUDY
CENTRA GAS SUTHERLAND AVENUE OPERATIONS SITE
WINNIPEG, MANITOBA

AEE is pleased to provide this report summarizing monitoring of the in-situ bio-remediation pilot study currently being conducted at the Centra Gas Sutherland Avenue operations site in Winnipeg, Manitoba. This report describes monitoring completed between March 27 and April 1, 1997.

Monitoring Program

From March 27, 1997 to April 1, 1997, the second round of post ORC installation monitoring was completed at the two downstream well locations (MW's 05 and 14). The monitoring included in-situ tests for dissolved oxygen, carbon dioxide and temperature as well as laboratory analysis to determine general groundwater chemistry and concentrations of PAH's and BTEX. A number of additional tests were completed, including ammonia nitrogen, ortho-phosphate and PAH degrading microbes, however, the results of these tests were not available at the time of this report. In addition to the two downstream wells, dissolved oxygen, carbon dioxide, temperature and pH were determined at the two injection wells (IP 1 and IP 2).

The monitoring results are summarized in Tables I to III, as are the results of previous monitoring for comparative purposes. The well locations are shown on Figure 1.

ASSESSMENT OF RESULTS

Based on the monitoring results, the following comments are offered:

1. The test results show that the dissolved PAH and BTEX concentrations have reduced significantly at MW 5. While the results continue to be encouraging, further testing is required to confirm that a positive trend is occurring. At MW 14, the PAH and BTEX concentrations have generally increased slightly since December 1996.

2. The general water chemistry at MW 5 and MW 14 has changed little since the onset of the pilot study; with the exception of a reduced dissolved oxygen concentration, a slight increase in redox potential, a slight increase in chlorides and conductivity and a reduction in Potassium. The reduction in Potassium concentrations could be an indicator of increased bioactivity.

3. The dissolved oxygen (DO) concentrations are lower than preferred at the downstream wells. However, as noted previously, an increase in DO may never occur at the downstream wells, and in fact, a reduction in DO could potentially be an indicator that the rate of bio-remediation has been enhanced, thus consuming the dissolved oxygen. While this explains conditions at MW 05, the significant reduction at MW 14 is not easily explained, as the PAH and BTEX concentrations have not decreased. It is possible that the very high PAH levels noted at IP 2 in February 97 (an order of magnitude higher than at IP1) may be impacting the results at MW 14, as the groundwater moves towards the River. Given the high concentrations at IP 2, significant PAH degradation may be occurring, resulting in a reduction in DO at MW 14 without a corresponding reduction in PAH and BTEX concentrations.

But BTEX would be preferentially degraded before any PAH compounds!

4. At the injection wells, there has been a significant increase in the dissolved oxygen concentrations. While this has no direct correlation with the performance of the pilot program, it does provide a positive indication that the ORC socks are effectively delivering dissolved oxygen into the subsurface environment.

5. The pH at IP 1 remains elevated and the pH at IP 2 has also shown a slight increase. As noted previously, the elevated pH is expected and may be a future cause for concern. However as of yet, this trend has not been noted at the downstream wells to any significant degree.

SUMMARY

To summarize, the chemistry data to date, in particular at MW 5, continues to suggest that the groundwater at the site is capable of supporting a bioremediation program which can effectively reduce the dissolved hydrocarbon concentrations. To date, however, there has been no trend developed at MW 14. Although the preliminary chemistry data indicated that the groundwater at MW 5 was more suited to bioremediation than MW 14, the reason for the varying groundwater conditions and results to date is not known. Possible causes for the variation could be a difference in soil permeability at the injection wells, a difference in the level of microbial activity in the area of the wells (as noted by the varying heterotrophic plate counts in the baseline chemistry), the possible presence of old construction debris between IP2 and MW 14, a variation in the contaminants or the possible presence of harmful chemicals such as cyanide or manganese near MW 14.

The current flood conditions are expected to cause a significant change in the groundwater levels at the site, and in fact the groundwater flow direction may be temporarily reversed near the River. At present, the possible affect of the flood on the pilot study is not known.

Additional site monitoring will be completed in mid May 1997. If you have any questions in the mean time, please do not hesitate to contact this office.

Yours truly,

AGRA Earth & Environmental Limited

Harley Pankratz, P. Eng.
Manager; Winnipeg Operations

Reviewed By:
Jack Spadaro, PhD
Environmental Scientist

Dist: (2) Addressee
(1) Manitoba Environment; Attn: Mr. Rick Lemoine, P. Geol

TABLE I
COMPARATIVE RESULTS - DOWNSTREAM WELLS
GENERAL WATER CHEMISTRY

Parameter	MONITORING WELL NO.					
	MW 5			MW 14		
	Dec 96	Feb 97	Mar 97	Dec 96	Feb 97	Mar 97
Dissolved Oxygen (ppm)	4.2	3.2	1.6	5.4	2.8	0.2
Temperature (Degrees C)	8.5	6.5	6.7	7.9	7.7	7.1
Redox Potential (mV)	+125	-13	+131.5	+65	+124	+147.8
Dissolved Iron	21.1	33.7	34.0	23.2	26.6	18.0
Calcium	235	358	315	236	240	239
Magnesium	148	210	186	137	137	149
Potassium	16.6	7.8	5.0	14.3	10.4	8.8
Sodium	102	115	94	102	113	104
Bicarbonate	1190	1560	956	1050	1040	1050
Carbonate	<1	<1	<1	<1	<1	<1
Chloride	207	434	602	191	166	225
Hydroxide (as CaCO3)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrate as N	0.27	0.36	0.71	0.29	0.34	0.26
Sulphate	229	181	179	232	257	282
Conductivity (mS/cm)	2.40	3.52	3.45	2.31	2.42	2.67
pH (unitless)	7.26	7.19	7.34	7.26	7.28	7.60
Dissolved Inorganic Carbon	234	124	188	207	102	207
Dissolved Organic Carbon	19	19	18	21	18	25
Total Alkalinity (as CaCO3)	1090	1030	784	1050	852	860
CO2 (ppm)	NM	NM	775	NM	NM	>5000

Notes: All results in ug/l (parts per million) unless otherwise noted.

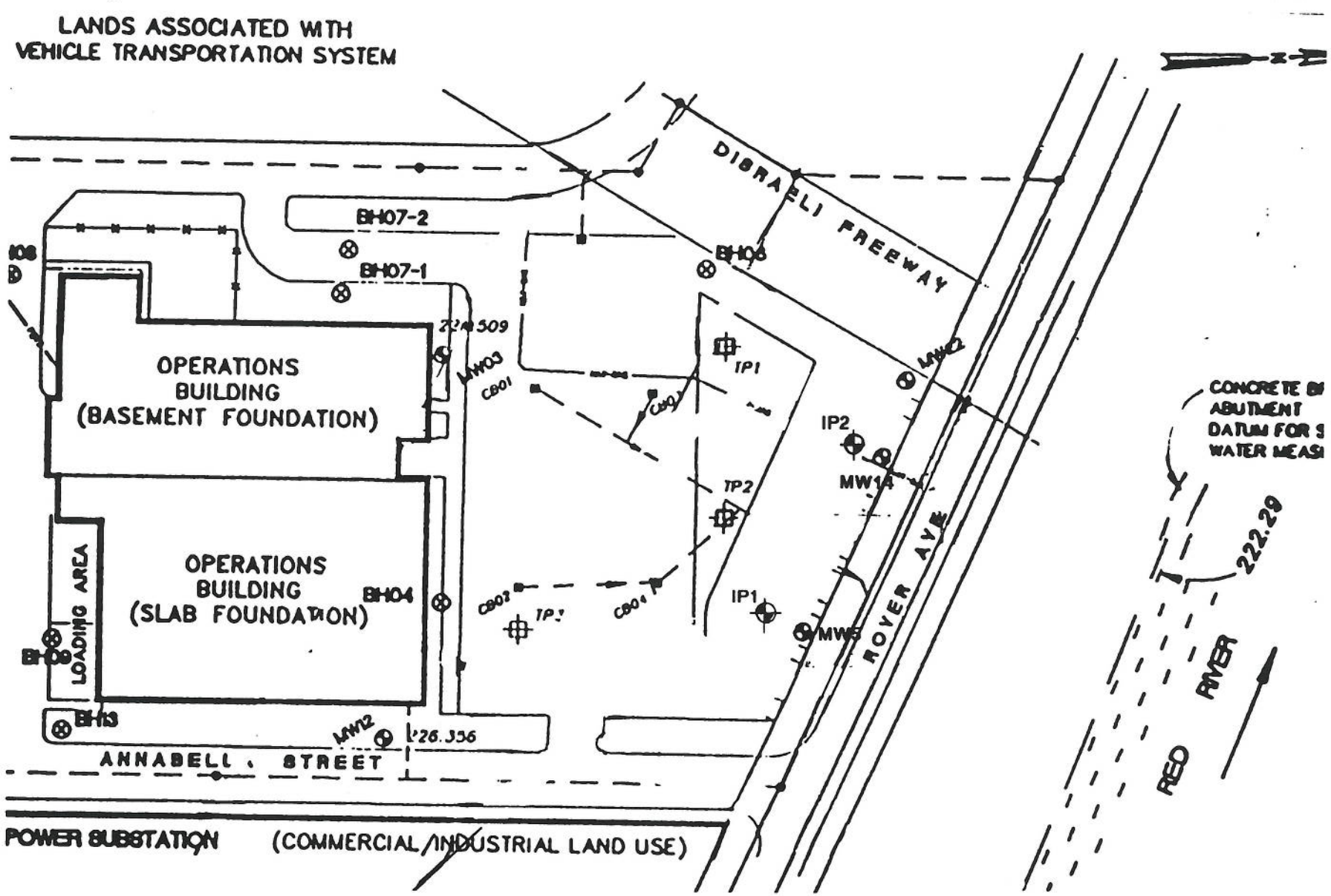
TABLE II
COMPARATIVE RESULTS - DOWNSTREAM WELLS
ORGANIC CHEMISTRY

Parameter	MONITORING WELL NO.			
	MW 5		MW 14	
	Dec 96	Mar 97	Dec 96	Mar 97
POLYCYCLIC AROMATIC HYDROCARBONS (PAH's)				
Naphthalene	0.13	0.039	0.20	1.2
Acenaphthylene	0.14	0.011	0.10	0.081
Acenaphthene	0.027	0.10	0.017	0.013
Fluorene	0.022	0.0015	0.014	0.014
Phenanthrene	0.024	0.0004	0.015	0.0078
Anthracene	0.0055	0.0004	0.0035	0.0022
Fluoranthene	0.0057	0.0002	0.0036	0.0022
Pyrene	0.0064	0.0008	0.0043	0.0066
Benzo(a)anthracene	0.0015	0.0001	0.0012	0.0014
Chrysene	0.0006	0.0001	0.0013	0.0013
Benzo(b)fluoranthene	0.0002	<0.0005	0.0013	0.0017
Benzo(k)fluoranthene	0.0005	<0.0005	0.0004	0.0007
Benzo(a)pyrene	0.0015	<0.0005	0.0013	0.0021
Indeno(1,2,3-cd)pyrene	0.0007	<0.0005	0.0007	0.0014
Dibenzo(a,h)anthracene	0.0001	<0.0005	0.0001	<0.0005
Benzo(g,h,i)perylene	0.0008	<0.0005	0.0009	0.0017
MONOCYCLIC AROMATIC HYDROCARBONS (MAH'S)				
Benzene	47	2.0	60	75
Toluene	4.0	0.027	5.5	8.9
Ethylbenzene	3.8	1.3	5.6	8.8
Xylenes	3.2	1.0	4.4	7.7

Note: All results in ug/l (parts per million).

TABLE III
COMPARATIVE RESULTS - INJECTION WELLS
GENERAL WATER CHEMISTRY

Parameter	INJECTION WELL NO.			
	IP1		IP2	
	Feb 97	Mar 97	Feb 97	Mar 97
POLYCYCLIC AROMATIC HYDROCARBONS (PAH's)				
Dissolved Oxygen (ppm)	6.3	19.7	4.6	24.1
pH (unitless)	9.02	9.82	7.54	7.73
Temperature (degrees Celsius)	NT	6.1	6.3	6.5
CO2 (ppm)	NT	>5000	NT	>5000



AGRA *Earth & Environmental Limited*		CENTRA GAS		SITE LOCATION PLAN BIOREMEDIATION PILOT STUDY SUTHERLAND AVENUE OPERATIONS SITE WINNIPEG, MANITOBA
Drawn: HP	Scale: As Shown	Date: MAR 1997	Project No: WX-04010	Figure: 1