Without Prejudice

Remediation Plan and Cost Estimate for Barons Hardware

214 Main Street
Site 5102, Plan 2605X, Block 6, Lot 28 to 35
Barons, Alberta

PREPARED FOR:
ASR Enterprises
Box 267
Irma, Alberta

PREPARED BY:
Hasegawa Engineering
Consulting Professional Engineers
A Division of 993997 Alberta Ltd.
1220 31st Street North
Lethbridge, Alberta
TIH 5J8

Environmental
Agricultural
Structural
Civil
Municipal

HASEGAWA ENGINEERING

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August 20, 2002

Mrs. Marie Read
ASR Enterprises
PO Box 267
Barons, Alberta
T0B 2H0

Dear Ms. Read,

Re: Remediation Plan and Cost Estimate for Barons Hardware

As per your request, Hasegawa Engineering has develop a remediation plan and cost estimate for Barons Hardware at 214 Main Street Site 5102, Plan 2605X, Block 6, Lot 28 to 35 Barons, Alberta.

We trust that the enclosed information meets your requirements. Please do not hesitate to contact us if you have any questions.

Yours truly,

Mark Hasegawa, P.Eng.
Environmental Engineer

MAH/cms

Enclosure

Executive Summary

The following is a document comparing options for remedial actions at the Barons Hardware site. Based on site conditions, two remedial criteria were applied to the site using onsite (commercial) and offsite (residential) criteria for soil and groundwater. Residential criteria was applied to the north 30 meters of the property following this application of multiple zoning on site. The area of contamination is adjacent to a former Turbo site where contamination was present and the gradient is towards the south and west it appears the contamination on site originated from the Turbo property.

The estimated volume of soil to be excavated from the site is 1170 m^3, of which 702 m^3 of that is contaminated above Alberta Environment standards (AENV). The total volume of water to be treated is estimated to be1480 m^3. The dilute or groundwater plume extends over both the onsite and offsite zones and therefore must be treated according to the respective remedial criteria.

The soil remediation options are somewhat limited as a result of the silty clay properties of the soil and the relatively small size of the soil plume impacted above Alberta Environment standards. As a result, the remedial options considered included soil excavation and either land farming onsite or disposal in a landfill.

The dilute plume treatment at this site is complex due to the presence of a building over much of the plume and the fine nature of the subsurface soils. Therefore the remedial options considered included:

- Modification of the existing soil vapor extraction system to act as a dual phase extraction system;
- Design injection of an oxidant to mineralize contaminants;
- Enhanced bioremediation of contaminants; or
- Risk Assessment

Based on available site information and cost it appears remedial options for the site are to land farm the contaminated soil onsite for soil remediation, and to inject an oxidant into the subsurface for groundwater remediation. The use of oxidant will be contingent on the results of bench scale tests confirming the feasibility of the process. An alternative to groundwater remediation is the preparation of a Risk Assessment.

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1.0 Introduction

Hasegawa Engineering was retained by Mrs. Marie Read of Edmonton, Alberta, to develop a remediation plan for the contaminated area on the property at Site 5102, Plan 2605X, Block 6, Lot 28 to 35 (currently 214 Main Street), in Barons, Alberta. The remediation plan will establish the most effective and cost efficient actions available to remediate the contaminated areas of soil and groundwater on the property.

The area of contamination is located adjacent to a former Turbo site where contamination was present. Since the gradient is towards the south and west it appears the contamination at the site originated from the Turbo property.

2.0 Extent of Impact

The remedial criteria for soil and groundwater for the site was set using onsite (commercial) and offsite (residential) criteria. Residential criteria was applied to the north 30 meters of the property following the application of multiple zoning on site.

Soil contamination on site covers an area of approximately 180 m^2 and extends to a depth of about 5 m, with an uncontaminated overburden in the upper 2 m. The total estimated volume of soil to be excavated is 1170 m^3, of which 702 m^3 of that is above AENV standards. A site map showing the extent of the soil contamination is on Figure 1 in Appendix A.

The contaminated groundwater covers an area of approximately 370 m^2 to a depth of about 4 m. The total estimated volume of water to be treated is 518 m^3 (assumes a porosity of 0.35). The groundwater plum extends over both the onsite and offsite zones and therefore must be treated according to the respective remedial criteria. A site map showing the extent of the groundwater contamination is on Figure 2 in Appendix A.

3.0 Remediation Options

3.1 SOIL/ SOURCE ZONE

Since the soil beneath the site consists of glacial till and silty clay (Hasegawa, 2002) and the size of the soil plume impacted above Alberta Environment standards is relatively small, the options for soil remediation are somewhat limited. As a result, the remedial options considered for this site are:

1. soil is excavated and land farmed onsite; or
2. soil is excavated and hauled to a landfill site for proper disposal

Land farming (onsite treatment) would involve the excavation of the soil, both the uncontaminated overburden and the contaminated soil. The contaminated soil would be separated and then spread 2 m high on a liner placed at the site. The soil would then be treated using an Alu bucket attached to an excavator. The soil would then be sampled and analyzed to determine effectiveness. Once the soil meets criteria, the soil would be replaced in the excavation.

The disposal of the soil to a landfill site also involves the excavation of both the contaminated and the uncontaminated overburden soils. The contaminated soil is separated and then hauled to a landfill site. Disposal costs are based on tones. Removing the soil and transporting it a regional landfill site is costly and after the soil has been submitted to a landfill it cannot be used again.

3.2 GROUNDWATER/DILUTE PLUME

Due to the presence of a building over much of the groundwater plume and the fine nature of the subsurface soils, the treatment of groundwater at this site will be complex. Therefore, the in-situ remedial options considered for this site include:

- Modification of the existing soil vapor extraction system to act as a dual phase extraction system;
- Injection of an oxidant to mineralize contaminants; or
- Enhanced bioremediation of contaminants.
- Risk Assessment once all source material is removed

Technology descriptions of the oxidation and bioremediation processes are included in Appendix B.

4.0 Cost Estimates Remediation Options

Summaries of estimated costs for each remedial action are included in the following tables. These estimates are based on the assumption that the subsurface conditions at the site are as shown in the Phase III site assessment.

4.1 SOIL/ SOURCE ZONE

The land farming treatment (Table 1) saves on both the costs of transportation and disposal. The disposal in a landfill (Table 2) costs more than the entire landfarming treatment process. The City of Lethbridge Regional Landfill was chosen for the disposal, as it is the nearest facility that would accept contaminated soil.

Table 1: Soil excavation and onsite treatment

Item	Unit cost	Amount	Total
Excavation	$4/m^3	1170 m^3	4,680
Stage clean soil	$4/ m^3	468 m^3	1,872
Liner for treatment area	$10/ m^2	351 m^2	3,510
Soil treatment	$15/ m^3	702 m^3	10,530
Soil replacement	$4/ m^3	702 m^3	2,808
Confirmatory Sampling	12 each	300	3,600
Site Supervision	5200	1	5,200
Project Management and Reporting	$95/hour	40	3,800
Sidewalk replacement	$15/ft^2	100	1,500
Regrading	$2/ m^2	200	400
Total Cost			**$37,900**

Table 2: Soil excavation and disposal at a landfill

Item	Unit cost	Amount	Total
Excavation	$4/ m^3	1170 m^3	4,680
Stage clean soil	$4/ m^3	468 m^3	1,872
Haul Contaminated soil	$7m^3	702 m^3	4,914
Soil Disposal	$60/ m^3	702 m^3	42,120
Soil replacement (minimal compaction)	$5/ m^3	702 m^3	3,510
Confirmatory Sampling	$300/ m^3	12	3,600
Site Supervision	$5200	1	5,200
Project Management and Reporting	$95/hour	40	3,800
Sidewalk replacement	$15/LF	100	1,500
Regrading	$2/ m^2	200	400
Total Cost			**$71,596**

4.2 GROUNDWATER/DILUTE PLUME

Even if soil remediation is used to mitigate most of the soil plume, there is still impacted above AENV standards beneath the building. This plume could be remediated by implementing one of the following options:

1. Oxidant injection (Fentons Reaction);
2. Enhanced bioremediation;
3. Dual phase extraction; or
4. Risk assessment

Use of a low chemical oxidant to degrade BTEX (benzene, toluene, ethyl-benzene and xylene) in-situ, eliminates the excavation task and reduces cost. In addition, the

degradation rates of BTEX are quite rapid (within few hours for complete decomposition) which reduces the remediation time frame compared to conventional dual phase extraction. Complete plume bioremediation in many cases is prevented due to some limiting factor such as lack of nutrients or bacteria, which could be added to facilitate bioremediation. There is also an existing soil vapour extraction system onsite, which could be converted to a dual phase extraction system for groundwater remediation. Finally, a risk assessment could be conducted to evaluate appropriate site-specific remediation standards at the site.

The outlines of cost estimates for groundwater remediation options are included in Table 3. For additional details on cost, please refer to Appendix C.

Table 3: Estimated costs for dilute plume remediation

Remediation Option	Estimated Cost
Oxidant Injections	$38,020
Enhanced Bioremediation	$33,520
Dual Phase Extraction	$47,520
Risk Assessment	$8,500

5.0 Conclusions and Recommendations

Considering costs of the methods available for the remediation of the contaminated area of soil and groundwater, it was concluded that the most effective and cost efficient remedial options are:

1. Excavate and land farm accessible soils onsite
2. Evaluate oxidation for application at the site
3. If feasible, apply oxidation to the remainder of the impacted soil and groundwater
4. If oxidation is not feasible, conduct a risk assessment to establish site specific remediation standards at the site.

The estimated cost for the proposed option is $78,920.

Appendix A

Figures

PERMIT TO PRACTICE
HASEGAWA ENGINEERING LTD.
Signature _____
Date _____
PERMIT NUMBER: P 582
The Association of Professional Engineers, Geologists and Geophysicist of Alberta

PROFESSIONAL ENGINEER ALBERTA
MARK HASEGAWA

LEGEND
SOIL BORING ⊗
MONITORING WELL ◒

N

MW-10
MW-9
BH9
MW-1
MW-8
BH12
BH8
BH7
OFFICE
CONC. BERM
ABOVE GROUND TANKS
STORAGE WAREHOUSE
BH2
BH4
BH1
BH3
PROPANE
BH6
MW-7
MW-5
BH5
MW-2
BH10
SIDEWALK
CONTAMINATED AREA - 180 m2
9 ppm generic remediation level
for commercial properties
MW-4
MW-3
MW-6
MAIN STREET

SCALE 1:250
0 5 10 15 20

Notes:

Contractor to check and verify all dimensions before construction, any errors and omissions reported to Engineer immediately.

Drawing not to be used for construction until so approved.

Do not scale Drawing.

All construction shall be in accordance with the latest code, may it be construction, mechanical, etc. code.

No	Revision	Date	By

Hasegawa Engineering
LETHBRIDGE OFFICE
1220 - 31 Street North
Lethbridge Alberta T1H 5J8
Ph: 328-2686
Fax: 328-2728
email:hasgm@telusplanet.net

CALGARY OFFICE
201,2816-21 Street NE
Calgary Alberta T2E 6Z2
Ph: 250-5261

CLIENT
MARIE READ

PROJECT TITLE
BARONS HARDWARE

DRAWING TITLE
Soil Contamination Area

DRAWN	H.E.
DESIGN	DMM
CHECKED	H.E.
APPROVED	H.E.
DATE	July 32, 2002
PROJECT NO.	01-009
SCALE	AS SHOWN
SHEET NO.	FIG.1

PERMIT TO PRACTICE
HASEGAWA ENGINEERING LTD.
Signature _____
Date _____
PERMIT NUMBER: P 582
The Association of Professional Engineers, Geologists and Geophysicist of Alberta

PROFESSIONAL ENGINEER ALBERTA
MARK HASEGAWA
APEGA

LEGEND
SOIL BORING ⊗
MONITORING WELL ⊕

N

MW-10
MW-9
BH9
MW-8
MW-1
BH12
BH8
BH7
BH11
PROPANE
BH6
MW-7
MW-5
BH5
BH10
MW-2
SIDEWALK
MW-4
MW-3
MW-6

CONTAMINATED AREA - 181 m2
3.5 ppm generic remediation level
for residential properties

CONTAMINATED AREA - 189 m2
16 ppm generic remediation
levels for commercial properties

CONC. BERM
ABOVE GROUND TANKS
STORAGE WAREHOUSE
OFFICE
BH2
BH4
BH1
BH3

0 5 10 15 20

MAIN STREET

SCALE 1:250

Notes:

Contractor to check and verify all dimensions before construction, any errors and omissions reported to Engineer immediately.

Drawing not to be used for construction until so approved.

Do not scale Drawing.

All construction shall be in accordance with the latest code, may it be construction, mechanical, etc. code.

No	Revision	Date	By

Hasegawa Engineering
LETHBRIDGE OFFICE
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CALGARY OFFICE
201,2816–21 Street NE
Calgary Alberta T2E 6Z2
Ph: 250–5261

CLIENT: MARIE READ

PROJECT TITLE: BARONS HARDWARE

DRAWING TITLE: Groundwater Contamination Area

DESIGN: H.E.	PROJECT NO.: 01–009
DRAWN: DMM	SCALE: AS SHOWN
CHECKED: H.E.	SHEET NO.: FIG.2
APPROVED: H.E.	
DATE ISSUED: July 31, 2002	

Appendix B

Technology Descriptions

Oxidation

Recently in-situ chemical oxidation has been proven as a viable remedial technology for remediation of soil and groundwater contaminated by various pollutants, including chlorinated solvents, petroleum hydrocarbons, and chlorinated aromatic pesticides. The two most common oxidizing agents used for in-situ chemical oxidation are hydrogen peroxide and potassium permanganate. Injection of hydrogen peroxide is typically combined with an iron catalyst under reduced pH conditions to generate powerful hydroxyl radicals (called Fenton's reaction). Since 1934, Fenton's Reagent has been recognized as an effective means for destroying organic compounds in wastewater and most recently as an in-situ treatment method for soil and groundwater. Fenton's Reagent is typically prepared using a solution of hydrogen peroxide, sulfuric acid, and ferrous sulfate heptahydrate. The dissolved iron acts as a catalyst for generating the hydroxyl radical, resulting in free-radical oxidation of the contaminant. In order to keep the iron in the ferrous state, a low pH needs to be maintained. The reaction can be performed successfully at a pH range between 5 and 7, but the optimal pH ranges are from 3 to 5. Obtaining the optimal subsurface pH condition is often limited by the soil buffering capacity, which is site-specific.

Potassium permanganate oxidation creates little heat or gas, therefore contaminant treatment occurs primarily through oxidation. Potassium permanganate is an oxidizing agent with a unique affinity for organic compounds containing carbon-carbon double bonds, aldehyde groups or hydroxyl groups. Under normal subsurface pH and temperature conditions, the primary oxidation reaction for chloroethenes involves spontaneous cleavage of the carbon-carbon bond. Once this double bond is broken, the highly unstable carbonyl groups are immediately converted to carbon dioxide through either hydrolysis or further oxidation by permanganate ion.

Selection of the proper oxidant is based on several factors (i.e., contaminant characteristics, site geochemical conditions, soil buffering conditions of site, etc.). Fenton's reagent is capable of oxidizing a wide range of compounds while potassium permanganate is more selective. However, potassium permanganate often provides more rapid destruction for specific compounds when compared to Fenton's reagent. The reaction process and potential by-products for both oxidants differ considerably. This treatability study will focus on the degradation of gasoline -- mainly BTEX contaminants found at the targeted UST site.

With proper design, chemical oxidation would have the capability to degrade the compound completely without extracting the fluid for aboveground treatment. A strong oxidant, such as Fenton's Reagent, could be injected into newly installed or pre-existing wells to treat the targeted area. Surbec has developed a process of using a low Fenton's Reagent concentration to treat various contaminants, including chlorinated solvents and BTEX. Use of a low chemical oxidant, like Fenton's Reagent or permanganate, to degrade BTEX in-situ, will eliminate the excavation task and reduce the total project

cost. In addition, the degradation rates of BTEX using these oxidants are quite rapid (within few hours for complete decomposition) which will reduce the remediation time frame compared to conventional dual phase extraction or other traditional remedial technologies

Bioremediation

Enhanced bioremediation is a technology commonly used to remediate dilute BTEX plumes. Many times complete plume bioremedaition is prevented due to some limiting factor. Once the limiting factor is identified it can be added to allow complete mineralization of the plume. Many times, the limiting factor is depletion of the electron donors that could include: Oxygen, sulfate, iron or carbon dioxide. Other limiting factors could include lack of nutrients, or bacteria. In most cases the bacteria exists in the subsurface but needs the proper conditions to grow.

Appendix C

Groundwater Cost Estimates

Dual Phase Extraction System

Labor

Category	Level	Rate	Hours	Total
	Senior Professional	$101.00 hr	10	$1,010
	Project Professional	$83.00 hr	20	$1,660
	Project Scientist	$75.00 hr	40	$3,000
	Staff Engineer	$53.00 hr	60	$3,180
	Technician	$42 00 hr	60	$2,520
	Administrative Assistant	$30 00 hr	10	$300
	Clerical Support	$23.00 hr	10	$230
		Subtotal 1		**$11,900**

ODC

Category	Level	Rate	Quantity	Total
Misc equipment		$2,000 00 mo	1.0	$2,000
Modify exisating system	2 tanks/month	$2,000.00 tot	1.0	$2,000
New blower		$5,000.00 ea	1.0	$5,000
Piping		$4,000.00 ls	1	$4,000
Air stripper		$10,000 00 ea	1	$10,000
		Subtotal 2		**$23,000**

Travel

Category	Level	Rate	Quantity	Total
Mileage	car	$0.31 km	1000	$310
Mileage	field vehicle	$0.31 km	1000	$310
Lodging		$85.00 day		$0
Meals		$35.00 day		$0
Air		$400 00 ea		$0
Auto rental		$50.00 LS		$0
Other		LS		$0
		Subtotal 3		**$620**

Subcontracts

Category	Contractor	Rate	Quantity	Total
Wells		$2,000.00 ea	4	$8,000
Electrical Contractor		$4,000.00 ls	1	$4,000
		Subtotal 4		**$12,000**
			0 0%	$0
Total				**$47,520**

Injection of an Oxidant

Labor

Category	Level	Rate	Hours	Total
	Senior Professional	$101.00 hr	10	$1,010
	Project Professional	$83 00 hr	20	$1,660
	Project Scientist	$75.00 hr	40	$3,000
	Staff Engineer	$53.00 hr	60	$3,180
	Technician	$42.00 hr	60	$2,520
	Administrative Assistant	$30.00 hr	10	$300
	Clerical Support	$23.00 hr	10	$230
		Subtotal 1		**$11,900**

ODC

Category	Level	Rate	Quantity	Total
Misc equipment		$3,000.00 mo	1.0	$3,000
Mixing/injection tank	2 tanks/month	$4,000.00 tot	1.0	$4,000
oxidant		$1.00 lb	2,500.0	$2,500
Piping		$4,000.00 ls	1	$4,000
		Subtotal 2		**$13,500**

Travel

Category	Level	Rate	Quantity	Total
Mileage	car	$0.31 km	1000	$310
Mileage	field vehicle	$0.31 km	1000	$310
Lodging		$85.00 day		$0
Meals		$35.00 day		$0
Air		$400.00 ea		$0
Auto rental		$50.00 LS		$0
Other		LS		$0
		Subtotal 3		**$620**

Subcontracts

Category	Contractor	Rate	Quantity	Total
Wells		$2,000.00 ea	4	$8,000
Treatabillity Study		$4,000.00 ea	1	$4,000
		Subtotal 4		**$12,000**
			0.0%	$0
Total				**$38,020**

Enhanced Bioremediation

Labor

Category	Level	Rate	Hours	Total
	Senior Professional	$101.00 hr	10	$1,010
	Project Professional	$83.00 hr	20	$1,660
	Project Scientist	$75.00 hr	40	$3,000
	Staff Engineer	$53.00 hr	60	$3,180
	Technician	$42 00 hr	60	$2,520
	Administrative Assistant	$30 00 hr	10	$300
	Clerical Support	$23.00 hr	10	$230
		Subtotal 1		**$11,900**

ODC

Category	Level	Rate	Quantity	Total
Misc equipment		$2,000.00 mo	1.0	$2,000
Mixing/injection tank	2 tanks/month	$2,000.00 tot	1.0	$2,000
Electron Donor		$1.00 lb	1,000.0	$1,000
Piping		$4,000 00 ls	1	$4,000
		Subtotal 2		**$9,000**

Travel

Category	Level	Rate	Quantity	Total
Mileage	car	$0.31 km	1000	$310
Mileage	field vehicle	$0.31 km	1000	$310
Lodging		$85.00 day		$0
Meals		$35.00 day		$0
Air		$400.00 ea		$0
Auto rental		$50.00 LS		$0
Other		LS		$0
		Subtotal 3		**$620**

Subcontracts

Category	Contractor	Rate	Quantity	Total
Wells		$2,000 00 ea	4	$8,000
Treatability Study		$4,000 00 ea	1	$4,000
		Subtotal 4		**$12,000**
			0 0%	$0
Total				**$33,520**