

RAPPORT

Huvudstudie Alsterbro f.d. glasbruk

Karaktärisering av utfyllnadsmaterial och spridningsutredning

Framställd för:

Sveriges geologiska undersökning

Insänd av:

Golder Associates AB

P.O. Box 20127

SE-104 60, Stockholm, Sweden

+46 8 506 306 00

1786406

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BILAGOR

BILAGA A

Laboratorierapporter

1.0 INLEDNING

Denna rapport redovisar resultaten av det materialkaraktäriseringsarbete samt den spridningsutredning som Golder Associates AB (Golder) utfört vid Alsterbro före detta glasbruk i Nybro kommun, Kalmar län. Rapporten utgör en del av rapportserien Huvudstudie Alsterbro före detta glasbruk som Golder genomfört under 2018 och 2019 på uppdrag av Sveriges geologiska undersökning (SGU). I rapportserien ingår följande delrapporter:

- Fält- och resultatrapport
- Karaktärisering av utfyllnadsmaterial och spridningsutredning
- Riskbedömning
- Översiktlig åtgärdsutredning

2.0 METODER

2.1 Material och provurval

Karaktäriseringsarbetet har omfattat glasavfall, blandat utfyllnadsmaterial från det före detta bruksområdet samt ytliga sediment från den nedströms bruket belägna sjön Hinsaryd göl. Därtill har glasavfall, utfyllnadsmaterial, uppströms och nedströms belägna sediment samt naturlig morän studerats inom ramen för spridningsutredningen.

För arbetet har prover på respektive materialtyp först samlats in från området och sedan slagits samman till representativa samlingsprov. Delprover avsedda för olika typer av analyser och försök har därefter uttagits från de olika samlingsproverna. Nedan ges en kortfattad beskrivning av respektive undersökt materialtyp.

Glasavfall

Glasavfallet som studerats utgörs av en blandning av skärvor av krossad glasprodukt samt felsmälta glasklumpar i olika färger och fraktioner. Provmaterialet samlades in i samband med genomförda miljötekniska undersökningar under 2018, dels från utfyllnadsområdet som återfinns i områdets västra del (Utfyllnadsområde väst), dels från den inhägnade glashög som är belägen intill hyttans sydvästra gavel. För att säkerställa att samlingsprovet endast utgjorts av glasavfall och inte varit kontaminerat av jord eller annat material tvättades det noggrant med destillerat vatten innan det undersöktes. I laboratorierapporterna som återges i BILAGA A benämns de delprover som avser glasavfallet som GLS.18GASAML.1A, GLS.18GASAML.1B samt GLS.ALS_JORD.FF.

Figur 1: Klumpar av felsmält glas insamlade från utfyllnadsområdet vid det före detta glasbruket i Alsterbro. Materialet på bilden utgör ett delprov av det undersökta samlingsprovet på glasavfall



Blandat utfyllnadsmaterial

Det studerade utfyllnadsmaterialet utgörs av ett samlingsprov på de massor som återfinns i marken inom utfyllnadsområdet söder om hyttbyggnaden. Provets innehåll domineras av rivningsavfall såsom betong, tegel, plåt och sprängsten och består därutöver av missfärgad fyllnadssand med betydande inblandning av olikfärgat glasavfall samt inslag av obearbetad glasråvara s.k. mäng. I laborierapporterna som återges i BILAGA A benämns de delprover som avser det blandade utfyllnadsmaterialet som J.18GASAML.3A, J.18GASAML.3B samt BLAND.ALS_JORD.FF.

Figur 2: Fotografi över det blandade utfyllnadsmaterial som undersökts vid det före detta glasbruket i Alsterbro. Materialet utgörs av en blandning av rivningsavfall, glasavfall och mörkgrå fyllnadssand.



Bruksmarksmaterial

Bruksmarksmaterialet som undersökts utgörs av ett samlingsprov på ett större antal delprover på den jord och fyllning som återfinns inom det före detta bruksområdet. Provet består i huvudsak av en blandning av fyllnadssand och sandig morän med mindre inslag av mull och organiskt material och innehåller därtill smärre inslag av mäng och glasskärvor. I laborierapporterna som återges i BILAGA A benämns de delprover som avser det blandade utfyllnadsmaterialet som 18GASAML.2A.

Figur 3: Del av samlingsprovet på bruksmark från det före detta glasbruket i Alsterbro. Materialet består av en blandning av sandig morän och fyllnadssand med inslag av mäng och glas.



Morän

Provet på morän är inhämtat ca 20 m öster om Bölemåla busshållplats, 2,6 km nordväst om det före detta glasbruket. Provets syfte har varit att fungera som ett referensprov på naturlig och opåverkad jord. I laborierapporterna som återges i BILAGA A benämns moränprovet som J.18GA01REF.

Figur 4: Prov på naturlig morän från Bölemåla 2,6 km nordväst om det före detta glasbruket i Alsterbro. Materialet har utgjort referensmaterial under undersökningen.



Sediment

Prover på ytliga sediment i Hinsaryd göl (nedströms glasbruksområdet) har undersökts inom ramen för karaktäriseringsarbetet. Därtill har prover på både grundare och djupare sediment samt material från sedimentfällor, dels från Hinsaryd göl, dels från Stora Hindsjön (uppströms bruket) studerats i spridningsutrednings syfte. I laboratorierapporterna som återges i BILAGA A benämns proverna från Store Hindsjön som 18GA01S.1, 18GA01S.5 samt 18GA01S.SF. Provmaterialet som inhämtats i Hinsaryd göl omnämns 18GA03S.1, 18GA03S.5 samt 18GA03S.SF.

Figur 5: Sedimentkärna från Hinsaryd Göl nedströms Alsterbro före detta glasbruk.



2.2 Totalhaltsbestämning

För att erhålla en bred överblick över materialens kemiska sammansättningar har ett delprov på varje materialtyp varit föremål för totalhaltsanalys avseende metaller. I samband med analyserna har även provernas organiska innehåll avgjorts genom glödförlust. Samtliga analyser genomfördes vid ALS Scandinavias ackrediterade laboratorium i Luleå.

2.3 Sekventiell lakning

I syfte att avgöra materialens utlakningsegenskaper samt för att undersöka hur materialets metallinnehåll föreligger har sekventiella lakförsök utförts på ett delprov på respektive materialtyp. Under ett sekventiellt lakförsök extraheras det prövade materialets metallinnehåll stegvis med hjälp av olika typer av lakvätskor vars egenskaper har utformats för att efterlikna olika geokemiska miljöer. Resultaten från försöken ger även en indikation på hur stor andel av materialets metallinnehåll som är biotillgänglig samt hur olika processer påverkar metallernas utlakning och fastläggning.

En begränsning med sekventiell lakning som metod är att den enbart är utformad för metaller samt att studier har kunnat visa att den utlakning som initieras under de olika sekvenserna i viss mån kan "överlappa" (Hjorth, 2001) vilket leder till risk för att lakningspotential och metallförekomstsätt överskattas. Vidare ger metoden endast indikativ information om metallspecieringen d.v.s. information om i vilken huvudsaklig mineralform eller annan form som metallerna förekommer.

Hittills har inget standardiserat förfarande för sekventiell lakning framarbetats och antalet laksteg samt vilka lakvätskor som tillämpas varierar ofta vid olika laboratorier. De sekventiella lakförsök som har utförts inom ramen för denna studie har omfattat fem laksteg och utförts vid ALS Scandinavias laboratorium enligt den metodik som beskrivs av Hall et al., (1996a, 1996b). Försökens utformning är beprövad och liknande försök har utförts i andra projekt på en rad olika material såsom sediment, jord, slagg och gruvavfall (Thunberg, 2001; Carlsson, 2002; Holmström, 2004, 2005 med flera).

De sekventiella lakningarna har omfattat ett samlingsprov på bruksmarksjord, ett samlingsprov på glasavfall och ett samlingsprov utfyllnadsmassor. Vid lakningarna tillämpades följande lakschema:

- 1) Extraktion av lösliga, svagt adsorberade och karbonatbundna metaller genom lakning med natriumacetat (CH_3COONa) vid pH 5. Steget kan anses efterlikna ett naturligt försurningstillstånd samt i viss mån även representera hur det prövade materialet reagerar i kontakt med vatten.

- 2) Utlakning av metaller bundna till labila organiska föreningar såsom vissa "enkla" humus- och fulvosyror med hjälp av natriumpyrosfosfat ($\text{Na}_4\text{P}_2\text{O}_7$).
- 3) Reduktion av amorfa järn- och manganoxidhydroxider till lösliga och reducerade former (Fe(III) , Fe(II) , Mn(IV) och Mn(II)) med hjälp av hydroxylaminsaltsyra ($\text{NH}_2\text{OH}\cdot\text{HCl}$). Till viss del kan det mycket låga pH som lakvätskan håller även bidra till upplösningen. Steget kan anses efterlikna de förhållanden som uppkommer om redoxpotentialen sjunker (drastiskt) i naturen såsom genom minskad syrediffusion, höjd grundvattenyta eller förhöjd syreförbrukning orsakad av nedbrytning av organiskt material.

De tre första stegen kan även användas för att uppskatta teoretisk biotillgänglig andel.

- 4) Reduktion av mer kristallina järnoxider såsom götit, hematit och magnetit med hjälp av $\text{NH}_2\text{OH}\cdot\text{HCl}$ i 25 ättiksyra (CH_3COOH). Steget är i princip en kraftigare variant av steg 3.
- 5) I det sista steget används en starkt oxiderande lakvätska bestående av kaliumklorat (KClO_3) och saltsyra (HCl) för att laka ut stabila organiska föreningar samt för att lösa upp metallsulfider såsom pyrit, blyglans, zinkblände. Lakstegets avser att efterlikna en övergång från kraftigt reducerade till oxiderande geokemiska förhållanden och är förhållandevis kraftigt. Andelen metaller som inte är möjliga att lakas ut under steget (den s.k. residualfraktionen) är till största delen därför att anse som mycket hårt bunden till materialets matris och föreligger sannolikt förknippade med diverse silikater (och oxider).

2.4 Fuktkammarförsök

Ett fuktkammarförsök är ett så kallat accelererat kinetiskt laborietest som syftar till att återspegla naturens geokemiska vittringsprocesser. Resultatet från försöket visar hur vittring och utlakning av metaller från materialet förändras med tiden. Inför ett fuktkammarförsök siktas det material som ska undersökas till en fraktion <2 mm fraktion och placeras därefter i en sluten plastlåda, en s.k. cell, till vilken omväxlande torr och fuktig luft kan ledas. Försöket, som utförs i rumstemperatur och i sjudagarscykler, inleds med att låta materialet exponeras för torr luft under tre dygn och fortsätter sedan med att utsätta det för fuktig luft under nästkommande tre dygn. På den sjunde dagen tillsätts cellerna destillerat vatten som efter en timme hålls av, filtreras och analyseras med avseende på metaller och andra viktiga geokemiska parametrar. Innan nästa försökscykel inleds, återförs slutligen eventuellt bortfiltrerat material.

Fuktkammarförsökets målsättning är att halterna i lakvattnet ska uppnå s.k. steady state, vilket inträffar när lakvattenkoncentrationerna når stabila nivåer och följaktligen är desamma vecka efter vecka. Vid steady state sker de geokemiska reaktioner som inducerats under försöken i så pass liten omfattning att de halter som då framkommer av försöken ger en god indikation på hur mycket som kan komma att laka från det undersökta materialet över tid. Den information som kan erhållas vid ett fuktkammarförsök skiljer sig således från den som kan erhållas vid exempelvis ett tvåstegs skakförsök då ett sådant endast medger uppskattning av hur utlakning från ett material ter sig på kort sikt.

Inom ramen för studien har fuktkammarförsök utförts på dels ett samlingsprov på rent glas från delområde E dels ett samlingsprov på material från utfyllnadsområde väst (delområde A). Båda försöken genomfördes vid ALS Laboratorium i Burnaby, Kanada.

2.4.1 Geokemisk modellering med PHREEQC

För att utreda vilka mineralfaser som kan förekomma i materialet samt för att undersöka vilka av dessa som är styrande för metaller såsom As, Sb och Ba och Pb har geokemiska modelleringar utförts. Modelleringarna har baserats på analysresultaten från fuktkammarförsökets första och sista vecka för respektive material och genomförts med hjälp av det geokemiska modelleringsprogrammet PHREEQC (Parkhurst et.al, 1980, 1982, 1996, Parkhurst, 1995 och 1997) kopplat med elementdatabasen Minteq V.4.

Det bör betonas att resultat från modelleringsberäkningar enbart är indikativa och för att bekräfta beräkningarna kan till exempel mineralogiska undersökningar utföras. Ett annat valideringsalternativ är att beräkna mineralsammansättningen normativt, vilket är svårt att göra för en glasmatrix då de aktuella faserna till stor del är okända.

I modellkörningarna har även det pH som uppmätts i lakvattnet under fuktkammarförsökens första respektive sista vecka använts. Som värde för redoxpotentialen har programmets standardinställning använts vilket motsvarar att syresatta (oxiderande) förhållanden råder i det utfyllnadsmaterial som modellkörningarna gäller. Detta bedöms rimligt eftersom massorna inte är täckta och i huvudsak ligger ovan grundvattenytan i området och endast har en tunn täckning av matjord. Till vilken grad en lösning är över- eller undermättad gentemot ett mineral anges ofta med ett så kallade mättnadsindexet, SI (eng. "saturation index") där positivt SI indikerar att lösningen är övermättad gentemot mineralet och negativt SI indikerar att lösningen är undermättad. Vid positiva SI förväntas utfällningar av mineral förekomma. Eftersom denna typ av modelleringar är behäftade med osäkerheter har dock ett spann för SI på ± 2 ansetts vara grund nog för att anse att utfällning av mineral är möjlig.

2.4.2 Beräkning av utlakade mängder

Totala mängder som lakar per kilogram material under ett år har beräknats genom att räkna om de lakvattenhalter som erhållits vid fuktkammarförsöket enligt Ekvation 1 där $C_{material}$ är lakad mängd per kilogram material [mg/kg, år], $C_{fuktk.}$ är koncentrationen i lakvattnet då den nått en stabil nivå [mg/l, vecka], V är volymen vatten som använts i försöket och m är massan på det undersökta materialet. Multiplikation med 52 utförs för att överföra halterna från veckor till år.

$$C_{material} = C_{fuktk.} \times \frac{V}{m} \times 52 \quad (1)$$

Med hjälp av uppgifter avseende utfyllnadsområdets sammanlagda massa som härletts ur resultaten från Golders markundersökningar samt erhållna mängder i ekvation 1, så har den faktiska mängd metaller som varje år väntas laka ut från det område som utpekats som utfyllnadsområde samt det område som idag utgörs av en stor glashög i Alsterbro sedan beräknats enligt Ekvation 2 där $C_{element}$ är den eftersökta mängden av ett element som frigörs från utfyllnaden [kg/år], M_u är markfyllningens uppskattade massa [kg].

$$C_{element} = C_{material} \times M_u \quad (2)$$

2.5 Blyisotopstudier

I syfte att spåra källor samt avgöra pågående spridning av Pb från området har blyisotopsammansättningen i olika typer material från Alsterbro studerats. Naturligt utgörs Pb av en sammansättning av de stabila isotoperna ^{204}Pb , ^{206}Pb , ^{207}Pb och ^{208}Pb . Då ^{204}Pb är en s.k. primärisotop och övriga tre nybildas genom radioaktivt sönderfall ökar kvoten mellan nybildade isotoper, dvs. isotoper som bildas genom sönderfall, och ^{204}Pb med tiden. Att förhållandena mellan dessa isotoper varierar sålunda i olika geologiska system och bör därför även variera mellan olika blykällor till exempel malmer. Stabila blyisotoper har även tidigare använts av Östlund, (2005a och 2005b) i Oskarshamns hamn för att spåra föroreningarnas ursprung i de förorenade sedimenten. Kvoterna $^{206}\text{Pb}/^{204}\text{Pb}$, $^{207}\text{Pb}/^{204}\text{Pb}$ samt $^{208}\text{Pb}/^{204}\text{Pb}$ har också tidigare bland annat av Krauskopf och Bird (1995) ansetts kunna användas för att identifiera ursprungsmaterial i magmatiska bergarter och även ålder på olika material.

3.0 RESULTAT

3.1 Uppmätta totalhalter i prover på fyllnadsmaterial och jord

I Tabell 1 återges analysresultaten avseende de undersökta markmaterialens huvudsakliga beståndsdelar; materialens s.k. huvudelement. Därtill redovisas observerad glödförlust (LOI 1000°C) i respektive material. Av analysresultaten framgår att samtliga material huvudsakligen är uppbyggda av kiseldioxid (SiO₂) och därutöver innehåller stora andelar natriumoxid (Na₂O) och kalciumoxid (CaO). I utfyllnadsmaterialet, bruksmarksjorden och moränen har även ett högt innehåll av aluminiumoxid (Al₂O₃) kunnat observeras och i moränprovet noterades därtill att järn(III)oxid (Fe₂O₃) och kaliumoxid (K₂O) är viktiga huvudelement. Av uppmätta glödförluster att döma är det totala organiska innehållet (TOC) obetydligt i glasavfallet och relativt lågt i övriga undersökta materialtyper.

I Tabell 1 redovisas metallhalter som observerats vid analys av de olika materialen. För bedömning av halternas magnitud har resultaten jämförts med Naturvårdsverkets generella riktvärden för förorenade mark (Naturvårdsverket, 2016) som avser dels känslig markanvändning (KM), dels mindre känslig markanvändning (MKM). Därutöver har halterna ställts mot Avfall Sveriges (2019) rådande gränsvärden för farligt avfall (AS- FA).

Överlag uppvisar materialen mycket höga metallhalter. I glasavfallet överskrider både halten arsenik (As) och halten bly (Pb) gränsvärdet för AS-FA och i samma material föreligger kadmium (Cd), krom (Cr), koppar (Cu) och antimon (Sb) i halter över NVV-MKM. I utfyllnadsmaterialet har As, Pb, barium (Ba) konstaterats överskrida NVV-MKM och bruksmarksprovet har Pb noterats över AS-FA, As, Ba och Sb över NVV-MKM och Cd, Cu och Zn över NVV-KM. För referensprovet på morän noterades att endast Ba överskrider MKM och att övriga metaller föreligger i halter som underskrider de tillämpade rikt- och gränsvärdena.

Tabell 1: Totalhalter av huvudelement i jord och fyllnadsmaterial bestämda med ALS analyspaket MG-2 (% TS) samt uppmätt glödförlust (%) vid upphettning till 1000°C (LOI 1000°C).

Materialtyp	Glasavfall	Utfyllnadsmaterial	Bruksmark	Morän (referens)
SiO ₂	56,1	70	61,4	63,7
Al ₂ O ₃	0,34	11,7	8,8	13,6
CaO	5,26	3,66	4,78	2,39
Fe ₂ O ₃	0,23	3,34	3,35	4,44
K ₂ O	2,62	2,8	2,07	3,26
MgO	0,0305	0,69	0,726	1,2
MnO	0,0151	0,135	0,484	0,122
Na ₂ O	12,4	3,76	2,05	3,01
P ₂ O ₅	<0.01	0,264	0,316	0,228
TiO ₂	0,0339	0,542	0,343	0,6
Summa	77*	96,9	84,3	92,6
LOI 1000°C	0,2	5,8	13,6	4,9

Tabell 2: Totalhalter av metaller i jord och fyllnadsmaterial bestämda med ALS analyspaket MG-2 (mg/kg TS). Resultaten har jämförts med Naturvårdsverkets generella riktvärden för känslig markanvändning (NVV-KM) och mindre känslig markanvändning (NVV-MKM) samt Avfall Sveriges gränsvärde för farligt avfall (AS- FA).

Material- typ	Glasavfall	Utfyllnads- material	Bruksmark	Morän (referens)	NVV-KM	NVV-MKM	AS-FA
As	7670	388	809	2,73	10	25	1000
B	2440	21	47,6	<8	-	-	-
Ba	114	713	3430	825	200	300	50000
Be	<0.5	1,9	1,41	2,47	-	-	-
Cd	110	0,632	13,2	0,194	0,5	15	1000
Co	329	7,33	7,54	11,4	15	35	1000
Cr	157	39,6	44,9	49,2	80	150	10000
Cu	2360	28,7	81,1	19,2	80	200	2500
Hg	<0.01	0,0895	0,0999	0,033	0,25	2,5	50
Mo	<0.5	3,94	1,3	0,798	40	100	10000
Nb	<0.9	12,7	8,49	12,2	-	-	-
Ni	23,6	18,8	22,4	20,7	40	120	1000
Pb	38000	56,5	2560	33,2	50	400	2500
S	204	361	525	274	-	-	-
Sb	1080	262	212	1,08	12	30	10000
Sc	<0.9	7,3	5,59	11,2	-	-	-
Sn	4,02	3,01	3,54	2,07	-	-	-
Sr	27,8	237	306	322	-	-	-
U	0,256	4,84	2,01	3,18	-	-	-
V	3,88	47,3	41	64,4	100	200	10000
W	<0.9	13,8	1,13	1,03	-	-	-
Y	1,75	22,1	11,6	20,3	-	-	-
Zn	241	187	293	84,2	250	500	2500
Zr	16	188	139	240	-	-	-

3.2 Uppmätta totalhalter i prover på sediment

Resultaten av totalhaltsanalyser på sediment framgår av Tabell 3 som redovisar uppmätta huvudelementandelar samt Tabell 4 som presenterar observerade halter av övriga element. I tillämpbara fall har observerade halterna i Tabell 4 jämförts med Naturvårdsverkets miljökvalitetsnormer (MKN), riktvärden för skydd mot lång- respektive korttidseffekter framarbetade av kanadensiska naturvårdsverket (CCME), norska miljödirektoratet (NMD) samt den amerikanska informationssystemet RAIS. Av jämförelsen framgår att halterna As, Cd, Hg och Zn överskrider något riktvärde och därför är att anse som förhöjda. Vid jämförelse mellan uppströms och nedströms erhållna halter framgår vidare att vissa skillnader föreligger. Exempelvis är halterna av de glasbrukssignifikanta metallerna Sb och Pb något högre i djupare sediment nedan än ovan det tidigare bruket vilket tyder på att en historisk spridning inte kan uteslutas. Studeras de halter som uppmätts av dessa ämnen i ytliga sediment samt i de sedimenterade material som fällorna fångat upp framgår dock att skillnaderna är så pass små att eventuell sådan spridning sannolikt inte längre fortgår.

Tabell 3: Totalhalter av huvudelement i sediment bestämda med ALS analyspaket MG-2 (% TS) samt uppmätt glödförlust (%) vid upphettning till 1000°C (LOI 1000°C).

Lokal	Uppströms			Nedströms			
	Läge	Ytlig	Djup	Fälla	Ytlig	Djup	Fälla
TS		1	13,8	1,3	12,4	9,9	0,7
SiO ₂		40,5	53,8	37,7	35,3	51,9	46,3
Al ₂ O ₃		5,66	6,72	4,85	5,51	7,47	5,17
CaO		0,92	0,913	1,07	0,981	1,19	1,13
Fe ₂ O ₃		9,86	7,43	9,85	9,53	8,84	10,8
K ₂ O		0,46	0,643	0,462	0,465	0,425	0,541
MgO		0,343	0,299	0,34	0,345	0,317	0,39
MnO		-	-	2,06	-	-	3,09
MnO ₂		0,8	0,278	-	0,676	0,335	-
Na ₂ O		0,398	0,673	0,407	0,439	0,437	0,444
P ₂ O ₅		0,299	0,298	0,351	0,366	0,418	0,33
TiO ₂		0,176	0,2	0,129	0,191	0,187	0,165
Summa TC		59,4	71,3	57,2	53,8	71,5	68,4
LOI 1000°C		28,5	22,9	36,1	35,6	33,3	30,9

Tabell 4: Totalhalter av metaller i sediment bestämda med ALS analyspaket MG-2 (mg/kg TS). Resultaten har i tillämpliga fall jämförts med Naturvårdsverkets miljökvalitetsnormer (MKN), riktvärden för skydd mot lång- respektive korttidseffekter framarbetade av kanadensiska naturvårdsverket (CCME), norska miljödirektoratet (NMD) samt den amerikanska informationssystemet RAIS.

Lokal	Upströms			Nedströms			Jämförvärden		
Läge	Ytlig	Djup	Fälla	Ytlig	Djup	Fälla	Lång tid	Kort tid	Ref.
As	9,51	4,25	9,01	10,1	12,6	9,36	5,9	17	CCME
B	<10	<10	<10	<10	<9	<10	-	-	-
Ba	354	272	512	332	263	680	-	-	-
Be	8,49	5,71	11,3	8,47	9,81	11,1	-	-	-
Cd	3,45	1,32	3,94	4,82	5,2	3,08	2,3	-	MKN
Co	22	19,7	34,7	30	27,5	31,8	50	-	RAIS
Cr	24,7	25,7	22,5	26,1	26,5	28,9	37,3	90	CCME
Cu	34	16,5	33,7	38,6	53	31,1	35,7	197	CCME
Hg	0,306	0,0855	0,239	0,244	0,292	0,277	0,17	0,486	CCME
Mo	2,16	3,04	2,51	1,99	2,73	2,6	-	-	-
Nb	3,36	4,94	3,47	3,69	3,2	4,41	-	-	-
Ni	23,2	13,8	23	24,4	25,2	23	42	271	Norge
Pb	92,5	32,6	89,3	94,1	135	111	130	-	MKN
S	2110	2360	2830	3220	7940	2360	-	-	-
Sb	1,32	0,591	1,57	1,97	3,16	1,35	2	-	RAIS
Sc	8,13	7,01	5,48	7,17	6,31	6,63	-	-	-
Sn	6,17	1,16	3,7	5,02	6,52	5,78	-	-	-
Sr	65,6	85,1	101	72,1	68,2	95,1	-	-	-
U	7,49	5,27	8,71	8,49	8,19	7,19	-	-	-
V	48,8	41,5	52,1	48,8	44,6	62,8	-	-	-
W	0,943	<1	1,25	1,17	1,36	<1	-	-	-
Y	79,6	61,8	98,4	89,6	79,9	91,8	-	-	-
Zn	592	266	474	603	595	518	123	315	CCME
Zr	34,3	52,6	48,5	36,8	33,3	51,6	-	-	-

3.3 Utfall av sekventiell lakning

3.3.1 Sekventiell lakning av glasavfall

Av Figur 6 framgår att större delen av de metaller och övriga element som omfattats av analys fanns kvar i provresidualen efter försöket och således aldrig lakades ut. Totalt lakades 3% av det sammantagna Pb-innehållet och As-innehållet, 1% av Sb-innehållet och 6% av Ba-innehållet.

Resultatet tyder på att metallerna generellt sett är mycket hårt bundna i materialet och att de i huvudsak är associerade med svårlösliga oxider och silikater. På grund av att endast mycket låga andelar av metallinnehållet har varit möjligt att förknippa med andra, mer lösliga faser, pekar resultaten även på att eventuella förändringar i rådande geokemiska förhållanden inte skulle föranleda någon ökning av metallernas mobilitet annat än i en mycket liten omfattning.

3.3.2 Sekventiell lakning av utfyllnadsmaterial

Utfallet från försöket på blandat utfyllnadsmaterial redovisas i Figur 7. Enligt försöksresultatet kan 13% av provets totala mängd As associeras med organiskt material medan 17% är möjlig att förknippa med olika typer av järnhydroxider. Därtill befanns 14% av As-innehållet vara direkt utbytbar alternativt bundet till lättlösliga karbonater. Provets sammanlagda innehåll av Pb noterades till 20% vara bundet till organiskt material, 30% till olika typer av järnhydroxider och 18% till utbytbara och karbonatbundna faser. Sb observerades till ca 90% föreligga i residualfraktionen medan resterande 10% befanns jämt fördelad över de övriga faserna. Andelen Ba som lakades ut under försöket uppgick till ca 26% och undantaget residualfasen uppmättes högst andel av elementet (14%) i samband med det första laksteget som syftar till att lösa upp svaga absorberande och karbonatbundna faser.

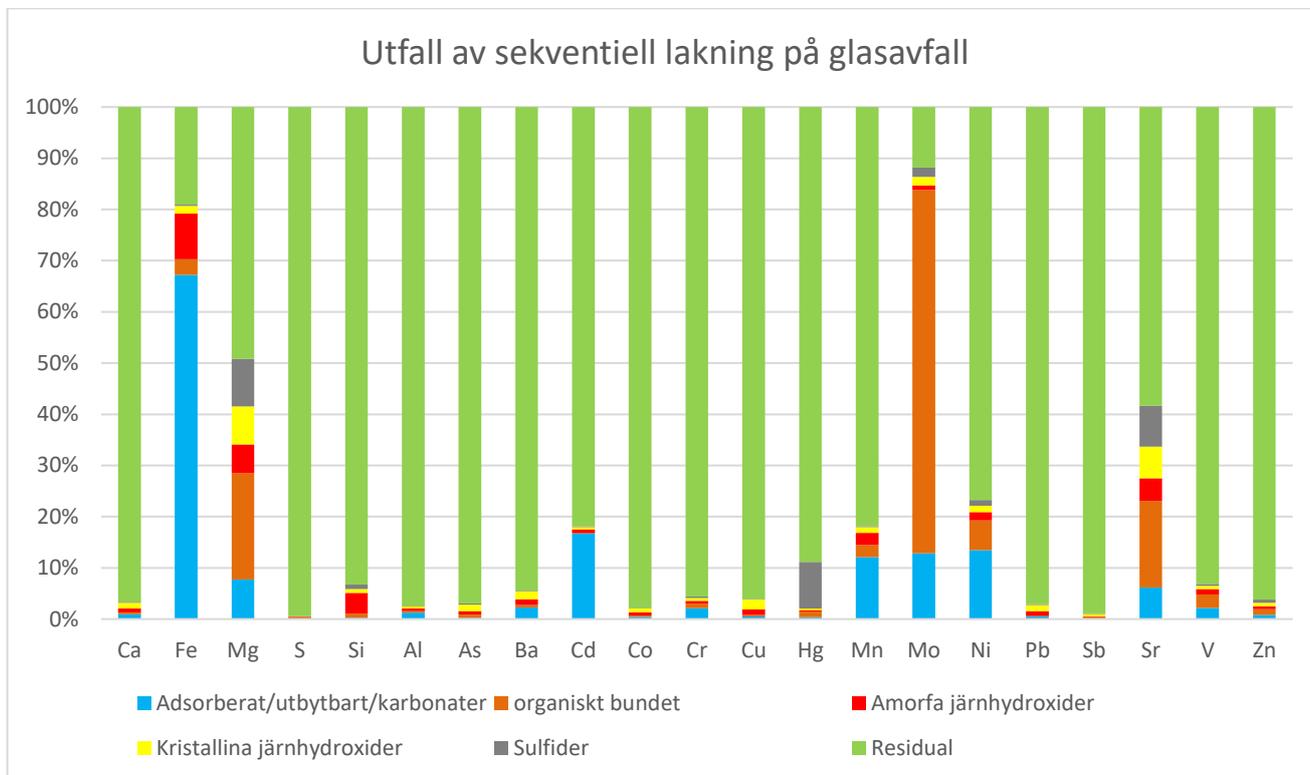
Resultaten visar att det blandade materialets metallinnehåll är mer benäget att laka jämfört med motsvarande innehåll i glasavfallet. Mot bakgrund av provets höga innehåll av As, Pb och Ba pekar utfallet vidare på att relativt omfattande utlakning av Pb och Ba sker från materialet till följd av upplösning av karbonater och jonbyte inducerade av endast mycket svaga sänkningar av pH samt att både Pb- och As-innehållet mobiliseras ytterligare när materialets organiska beståndsdelar bryts ned. Därtill medför affiniteten som Pb och As visar till järnhydroxydytor i materialet att ökad utlakning av dessa metaller är att vänta om materialet exponeras för reducerande förhållanden.

3.3.3 Sekventiell lakning av sediment

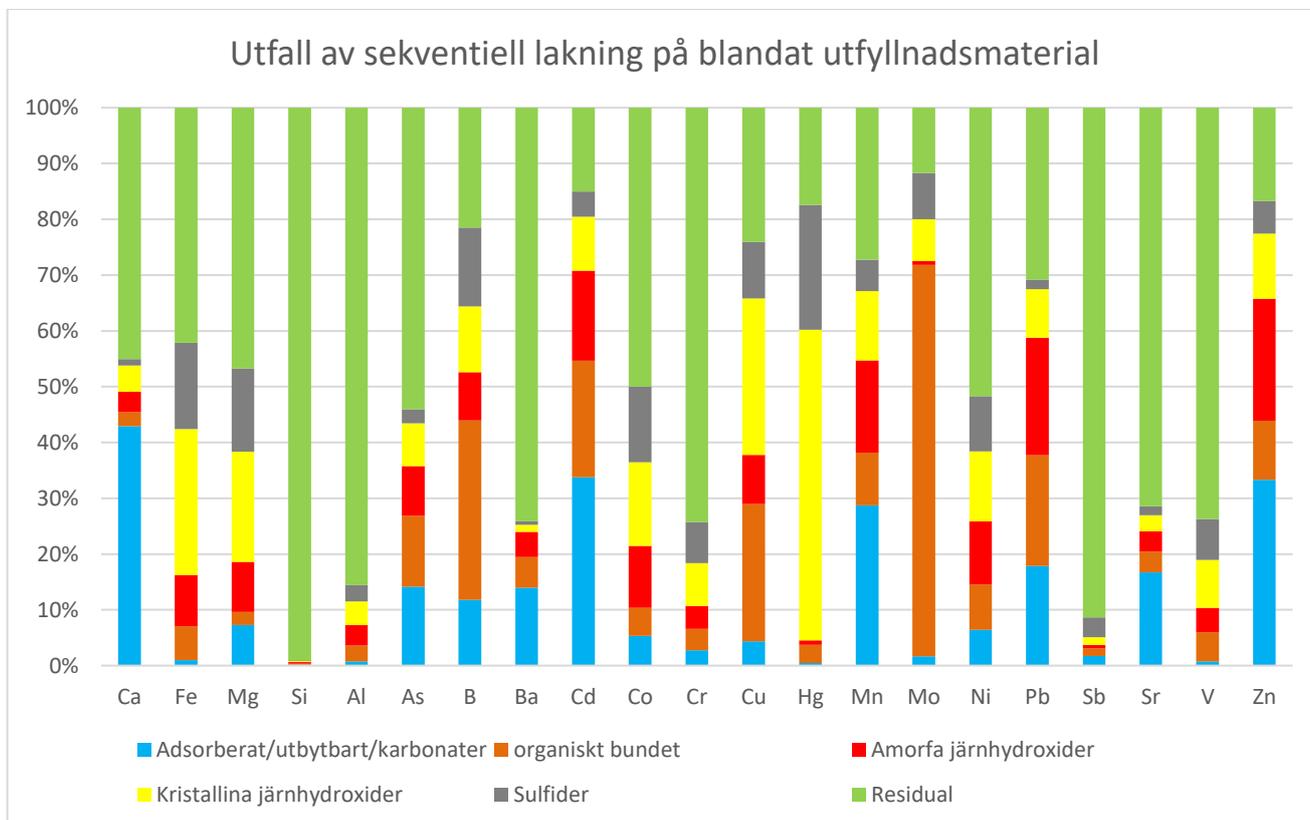
Jämfört med övriga typer av material uppvisade metallinnehållet i sedimentet högst benägenhet att laka metaller under försöket. Noteras bör dock att metallhalterna, i synnerhet Pb och As, påvisats lägre i sedimenten än i övriga material. Som framgår av Figur 8 lakades 85% av det sammantagna As-innehållet ut, 95% av Pb-innehållet, 45% av Sb-innehållet samt 61 % av Ba-innehållet ut under försöket. För såväl As som Pb noterades störst lakning äga rum till följd av upplösning av organiskt material samt under de laksteg som syftade till att lösa upp specier bundna till järnhydroxydytor. Därtill kunde båda metallerna till viss del förknippas med ytligt adsorberade och lättlösliga faser. Sb observerades huvudsakligen laka ut under de laksteg som syftade till att lösa upp kristallina järnhydroxider samt organiskt bundna förekomstformer. Vidare visade den sekventiella lakningen att det höga innehåll av Zn som kunde konstateras vid totalhaltsanalys på materialet, till stor del kunde knytas till ytligt adsorberade lättlösliga faser, organiska material samt amorfa järnhydroxider.

Att döma av försöksutfallet förekommer de glasbrukstypiska metallerna relativt mobila former och det är därför troligt att halterna av dessa varierar i bottenvattnet till följd av suspension/ re-suspension i sedimenten under året. Sett till att relativt höga haltandelar av metallerna har kunnat förknippas med redox-känsliga järnhydroxidbindningar är sedimentens fastläggningsförmåga sannolikt som svagast under vinter och sommarperioden eftersom förhållandena på sjöbotten är som mest reducerande under dessa perioder. På

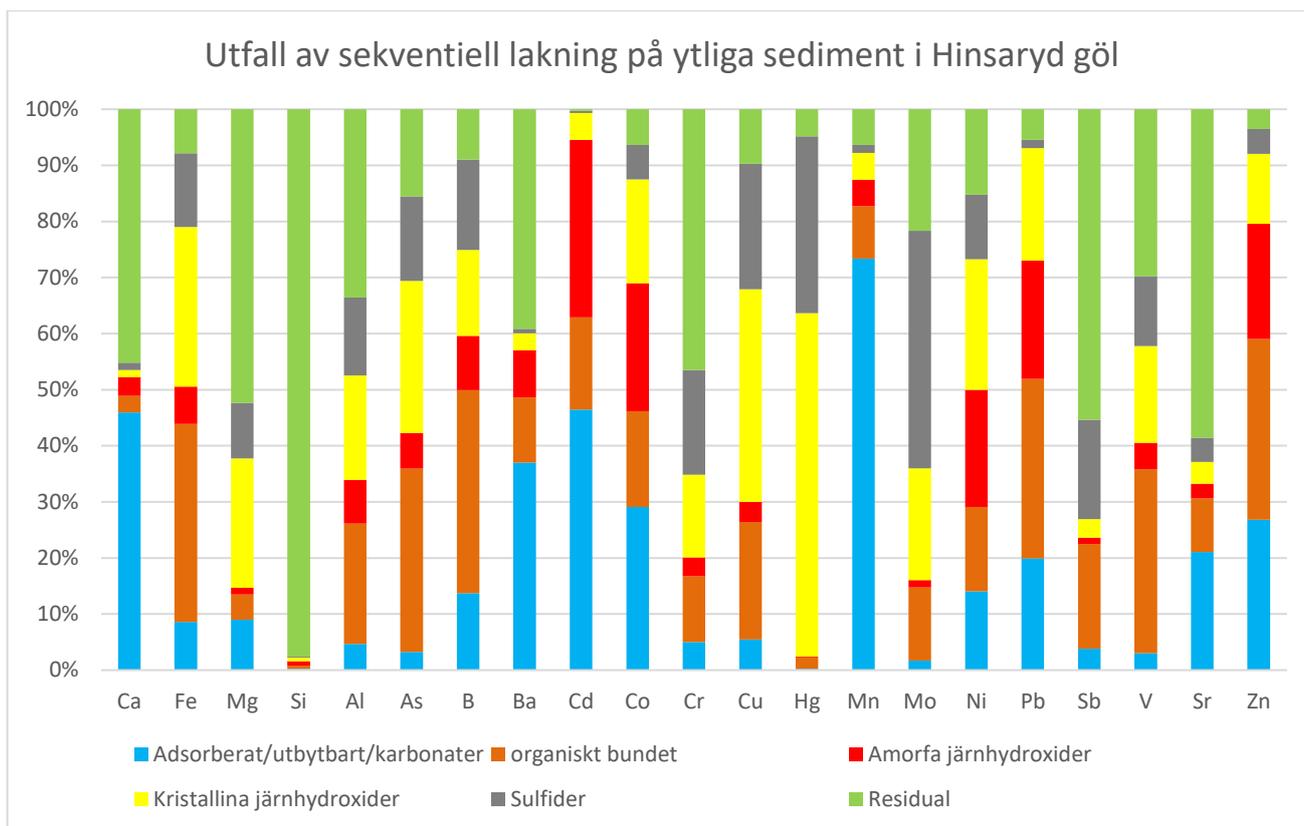
motsvarande vis minskar sannolikt andelen metaller som går i lösning under våren och hösten i och med den syresättning/ omblandning som sker då.



Figur 6: Utfall av sekventiell lakning på glasavfall från Alsterbros före detta glasbruk.



Figur 7: Utfall av sekventiell lakning på blandat utfyllnadsmaterial från Alsterbros före detta glasbruk.



Figur 8: Utfall av sekventiell lakning på ytliga sediment i Hinsaryd göl nedströms Alsterbros före detta glasbruk.

3.3.4 Bedömd biotillgänglighet utifrån sekventiell lakning

I Tabell 5 och Tabell 6 redovisas sammanställningar av hur lakningen av As, Ba, Pb och Sb fördelas procentuellt över olika laksteg för material från utfyllnadsområdet och i Tabell 7 presenteras motsvarande data för sedimentprovet från Hinsaryd göl. Tabellerna redovisar även de biotillgängliga metallandelar som beräknats som summan av utlakade delmängder under försökens inledande tre steg.

Att döma av resultaten är endast en liten andel av glasprovets konstaterat höga metallinnehåll att betrakta som biotillgängligt. Enligt bedömningssättet uppgår den biotillgängliga andelen As till ca 2% och av det sammantagna Ba innehållat uppskattas ca 4% vara tillgängligt för upptag av människor. För Pb och Sb noterades de biotillgängliga andelarna utgöra 2% respektive 1% av motsvarande totalhalt i glaset.

I utfyllnadsmaterialet förefaller metallerna vara betydligt mer biotillgängliga än i glasavfallet. För As bedöms att drygt en tredjedel av innehållet är biotillgängligt och för Ba uppgår motsvarande andel till en fjärdedel. Vidare tyder resultaten på att ca 60% av Pb-innehållet och 4% av Sb-innehållet är biotillgängligt.

I sedimentprovet har högst biotillgängliga metallandelar noterats. Utfallet visar bland annat att det höga totalinnehåll av Zn som uppmätts är att betrakta som biotillgängligt till 80% och vidare att ungefär 73% av Pb-innehållet föreligger på ett sådant vis att det är möjligt att tas upp i människokroppen. För Ba, As och Sb bedöms de biotillgängliga andelarna uppgå till 57%, 42% respektive 24%.

Tabell 5: Sammanställning av resultat från sekventiell lakning av blandat utfyllnadsmaterial. Resultaten avser procentuella andelar av total utlakad mängd.

Andel	Ca	Fe	Mg	Si	Al	As	B	Ba	Cd	Co	Cr	Cu	Hg	Mn	Mo	Ni	Pb	Sb	Sr	V	Zn
1. Lättillgängliga faser	43	1	7	0	1	14	12	14	34	5	3	4	0	29	2	6	18	2	17	1	33

2. Organiskt bundna faser	3	6	2	0	3	13	32	6	21	5	4	25	3	9	70	8	20	1	4	5	11
3. Amorfa järnhydroxider	4	9	9	0	4	9	9	5	16	11	4	9	1	17	1	11	21	1	4	4	22
4. Kristallina järnhydroxider	5	26	20	0	4	8	12	1	10	15	8	28	56	12	7	13	9	1	3	9	12
5. Sulfidbundna faser	1	15	15	0	3	2	14	1	5	14	7	10	22	6	8	10	2	3	2	7	6
Residual (silikater/ oxider)	45	42	47	99	86	54	22	74	15	50	74	24	17	27	12	52	31	91	71	74	17
Biotillgänglig andel, $\sum (1,2,3)$	49	16	19	1	7	36	53	24	71	21	11	38	5	55	73	26	59	4	24	10	66
Total utlakad andel	55	58	53	1	14	46	78	26	85	50	26	76	83	73	88	48	69	9	29	26	83

Tabell 6: Sammanställning av resultat från sekventiell lakning av glasavfall. Resultaten avser procentuella andelar av total utlakad mängd.

Andel	Ca	Fe	Mg	S	Si	Al	As	Ba	Cd	Co	Cr	Cu	Hg	Mn	Mo	Ni	Pb	Sb	Sr	V	Zn
1. Lättillgängliga faser	1	67	8	0	0	1	0	2	17	0	2	1	0	12	13	13	0	0	6	2	1
2. Organiskt bundna faser	0	3	21	0	1	0	1	0	0	0	1	0	1	2	71	6	0	0	17	3	1
3. Amorfa järnhydroxider	1	9	6	0	4	0	1	1	1	1	1	1	0	2	1	2	1	0	4	1	1
4. Kristallina järnhydroxider	1	1	7	0	1	0	1	2	0	1	1	2	0	1	2	1	1	0	6	1	1
5. Sulfidbundna faser	0	0	9	0	1	0	0	0	0	0	0	0	9	0	2	1	0	0	8	0	1
Residual (silikater/ oxider)	97	19	49	99	93	97	97	94	82	98	96	96	89	82	12	77	97	99	58	93	96
Biotillgänglig andel, $\sum (1,2,3)$	2	79	34	0	5	2	2	4	18	1	4	2	2	17	85	21	2	1	27	6	3
Total utlakad andel	3	81	51	1	7	3	3	6	18	2	4	4	11	18	88	23	3	1	42	7	4

Tabell 7: Sammanställning av resultat från sekventiell lakning av sediment. Resultaten avser procentuella andelar av total utlakad mängd.

Andel	Ca	Fe	Mg	Si	Al	As	B	Ba	Cd	Co	Cr	Cu	Hg	Mn	Mo	Ni	Pb	Sb	Sr	V	Zn
1. Lättillgängliga faser	46	9	9	0	5	3	14	37	46	29	5	5	0	73	2	14	20	4	21	3	27
2. Organiskt bundna faser	3	35	5	1	21	33	36	12	16	17	12	21	2	9	13	15	32	19	10	33	32
3. Amorfa järnhydroxider	3	7	1	1	8	6	10	8	32	23	3	4	0	5	1	21	21	1	3	5	21
4. Kristallina järnhydroxider	1	28	23	1	19	27	15	3	5	18	15	38	61	5	20	23	20	3	4	17	12
5. Sulfidbundna faser	1	13	10	0	14	15	16	1	0	6	19	22	32	1	42	11	1	18	4	12	4
Residual (silikater/ oxider)	45	8	52	98	34	16	9	39	0	6	46	10	5	6	22	15	5	55	59	30	4
Biotillgänglig andel, $\Sigma (1,2,3)$	52	51	15	2	34	42	60	57	95	69	20	30	2	87	16	50	73	24	33	41	80
Total utlakad andel	55	92	48	2	66	84	91	61	100	94	54	90	95	94	78	85	95	45	41	70	96

3.4 Utfall av fuktkammarförsök

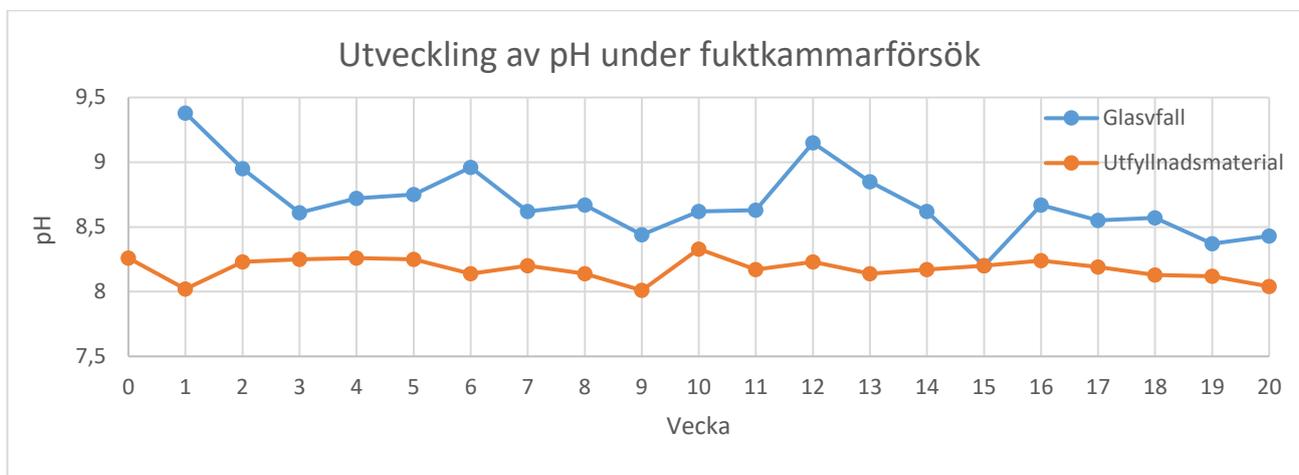
Utveckling av pH, alkalinitet och konduktivitet

I Figur 9 redovisas observerad utveckling av pH under fuktkammarförsöken. Av figuren framgår att glasavfallet givit upphov till ett alkaliskt lakvatten med pH-värden som inledningsvis legat runt 9,5 och som därefter stabiliserats kring 8,5 mot slutet av försöket. Som utvecklingskurvan visar steg pH momentant i lakvätskan från glasmaterialiet under försökets tolfte vecka. Den tillfälliga ökningen, som efterföljdes av en snabb pH-sänkning under de nästkommande två veckorna, tyder på att någon typ av kemisk reaktion har ägt rum i materialet. Vidare tyder den initiala pH-sänkningen hos glasavfallet på att det skett en ursköljning av metaller ur materialet under försökets inledning. Under försöket på blandat utfyllnadsmaterial nåddes steady state relativt omgående kring pH 8. På grund av att inga större pH-förändringar har kunnat skönjas under försöket antyder resultaten att varken ursköljningseffekter eller andra kemiska reaktioner har ägt rum i materialet i någon större utsträckning.

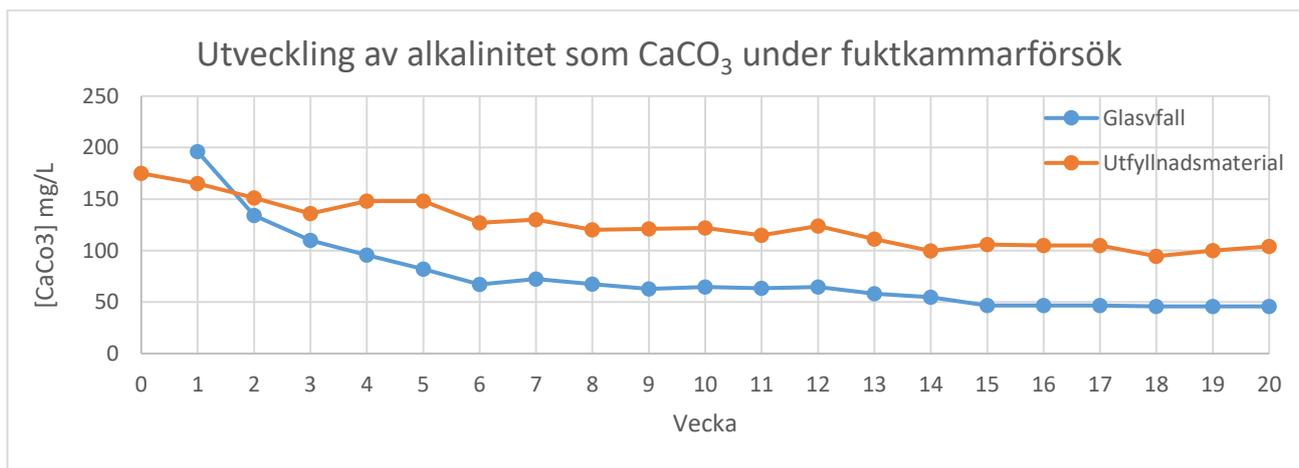
Materialens relativt höga kalk- och oxidinnehåll återspeglas i viss mån i Figur 10 där alkaliniteten redovisas som veckovis uppmätt halt kalciumkarbonat (CaCO_3). I glasavfallet uppmättes stabila CaCO_3 -nivåer på omkring 50 mg/L från och med vecka 15 och i utfyllnadsmaterialet nåddes steady-state vid ca 100 mg/L efter ungefär samma försökstid. Det erhållna utvecklingskurvornas svaga och påfallande jämna nedåtgående lutning antyder att buffrande reaktioner inte har skett i någon större utsträckning i något av materialen. Jämförs resultaten med den stabila pH-utvecklingen under försöken förefaller det vidare rimligt att halterna av CaCO_3 som observerats i lakvätskorna, huvudsakligen beror på att delar av materialets karbonatinnehåll har lösts upp av det tillsatta vattnet enkom snarare än som en konsekvens av pH-buffring. Viss buffring förefaller emellertid ha skett i glasavfallet som respons på den pH-sänkning som inträffade under försökets inledning.

Av Figur 11 framgår att konduktiviteten har varit hög i lakvattnen från materialen under försökens första veckor och att den sedan sjunkit och planat ut till stabila nivåer från och med vecka 6. Då konduktiviteten generellt är hög i lösningar med stora andelar av organiska element och eller till följd av höga metallhalter pekar resultaten

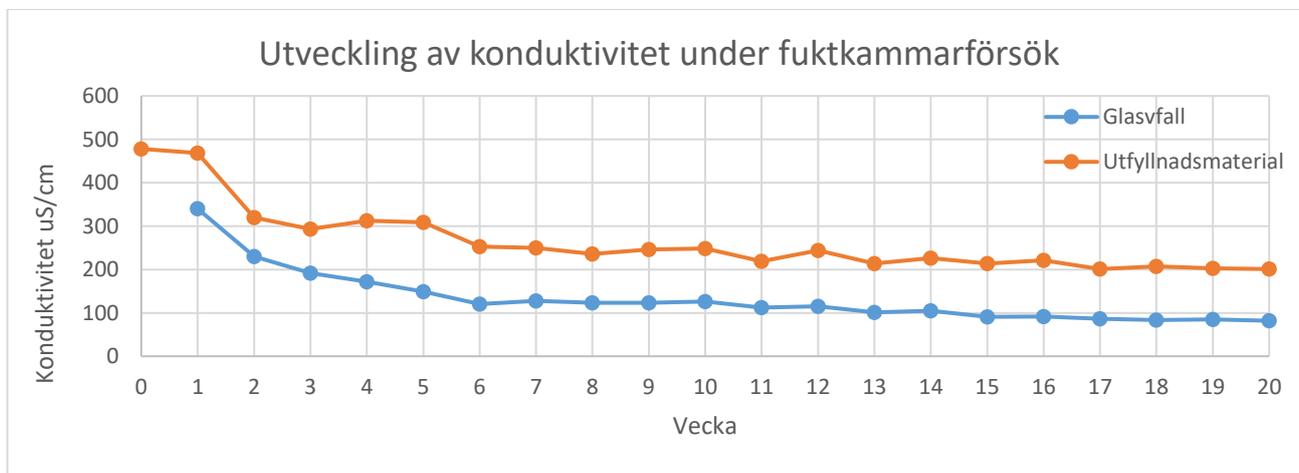
på att viss ursköljning av metaller från materialen har skett strax efter att försöken påbörjats och vidare att även delar av utfyllnadsmaterialets organiska innehåll har lösts upp under samma tidsperiod.



Figur 9: Utveckling av pH över tid under fukt-kammarförsök på glasavfall samt på utfyllnadsmaterial från Alsterbros före detta glasbruk.



Figur 10: Utveckling av alkalinitet uttryckt som CaCO_3 över tid under fukt-kammarförsök på glasavfall samt på utfyllnadsmaterial från Alsterbros före detta glasbruk.



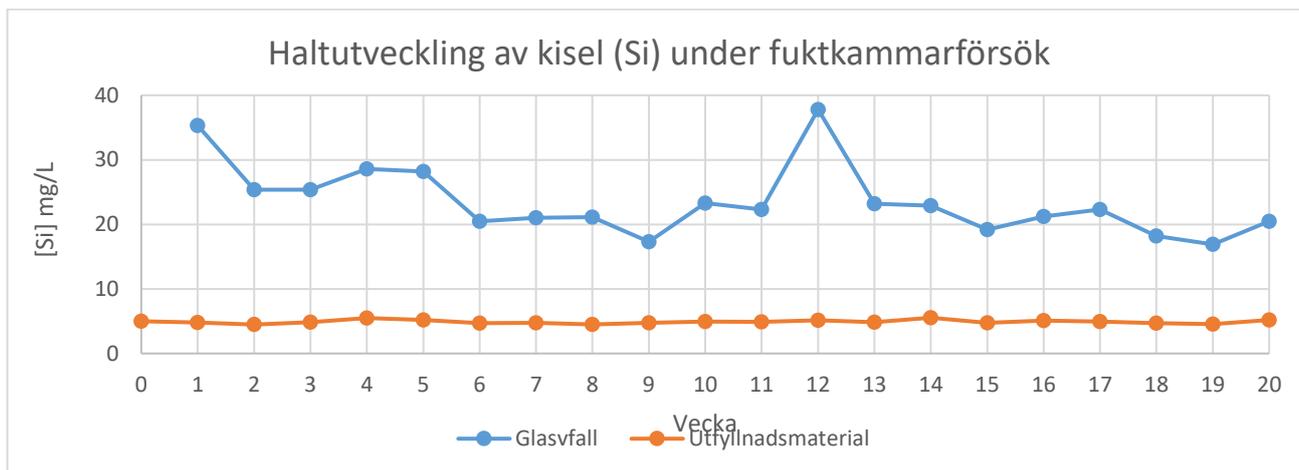
Figur 11: Utveckling av konduktivitet över tid under fukt-kammarförsök på glasavfall samt på utfyllnadsmaterial från Alsterbros före detta glasbruk.

Haltutveckling av huvudelement

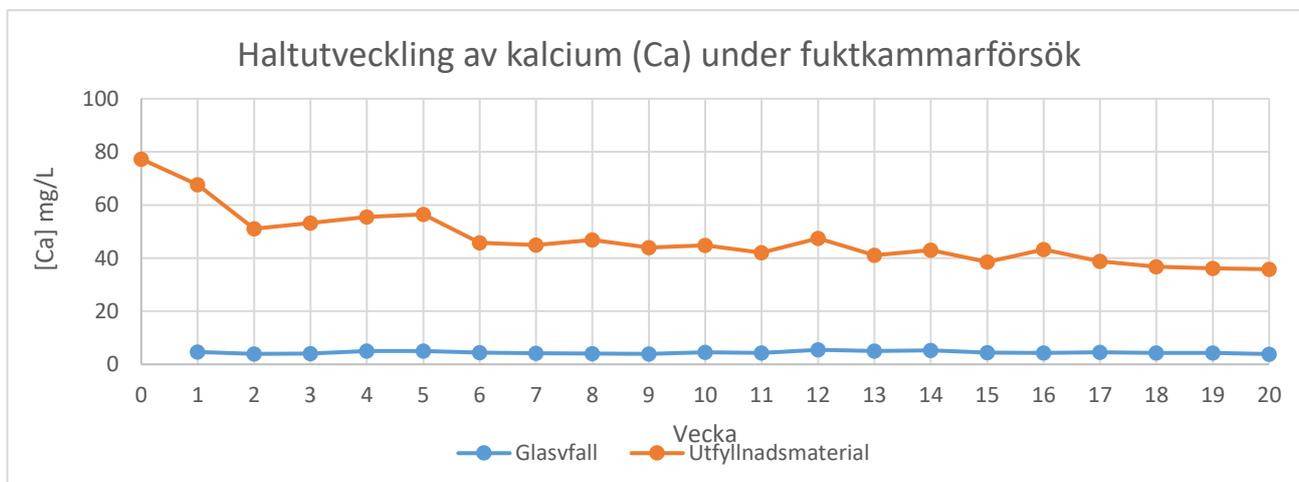
För att undersöka huruvida materialets huvudbeståndsdelar har vittrat under försöken har utvecklingen av huvudelementen Si, Na, Ca, K och Al studerats ingående.

Att döma av Figur 12 har påslag av Si varit möjliga att observera i både glasavfallets och det blandade utfyllnadsmaterialets lakvatten under försökens gång. För utfyllnadsmaterialet noterades en stadigvarande veckovis utlakning om ca 5 mg/L och för glasavfallet observerades halter som inledningsvis sjönk från ca 35 mg/L till ca 20 mg/L och därefter steg tillfälligt till ca 40 mg/L innan de återigen avtog något. Resultaten antyder att viss nedbrytning till följd av vittring sker över tid i båda materialtyperna och pekar därutöver på att vittringen av glas har förstärkts av att geokemiska processer ägt rum i materialet under försökets gång.

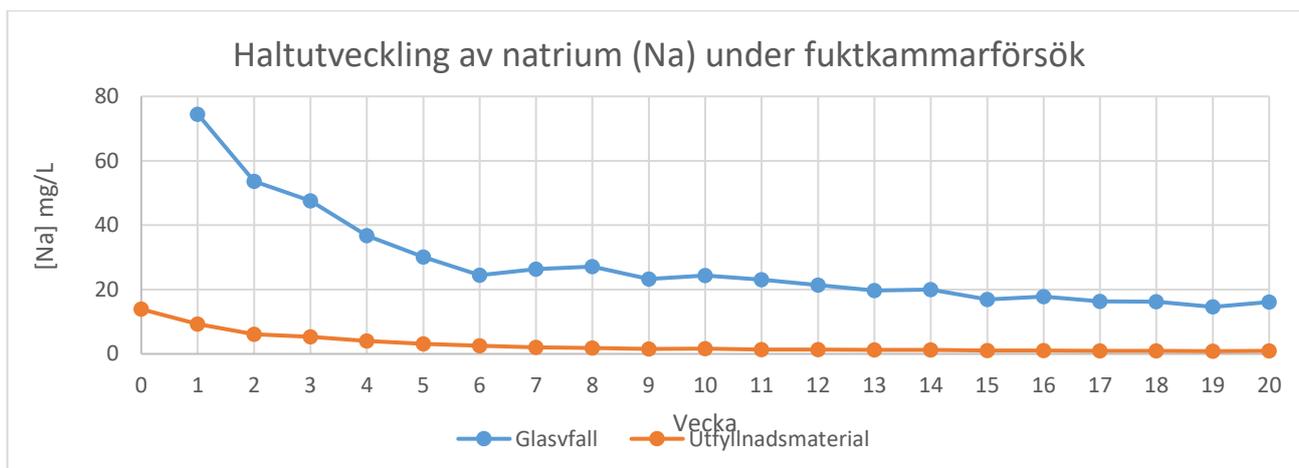
Som framgår av Figur 13 och Figur 14 har även delar av materialens Ca- och Na-innehåll vittrat och lakat ut under fukt-kammarförsöken. Vid försöket på glasavfall stabiliserades utlakningen av Ca omgående på halter kring 4mg/l medan Na-utlakningen efter inledande ursköljning om ca 50 - 70 mg/L nådde steady-state kring 15 mg/L mot slutet av försöket. För det blandade materialet nådde utlakningen av Na stabila halter på ca 1 mg/L från och med försökets sjunde vecka samtidigt som utlakningen av Ca stabiliserades på strax under 40 mg/L efter halva försökstiden.



Figur 12: Utveckling Si över tid under fukt-kammarförsök på glasavfall samt på utfyllnadsmaterial från Alsterbros före detta glasbruk.



Figur 13: Utveckling av Ca över tid under fukt-kammarförsök på glasavfall samt på utfyllnadsmaterial från Alsterbros före detta glasbruk.



Figur 14: Utveckling av Na över tid under fukt-kammarförsök på glasavfall samt på utfyllnadsmaterial från Alsterbros före detta glasbruk.

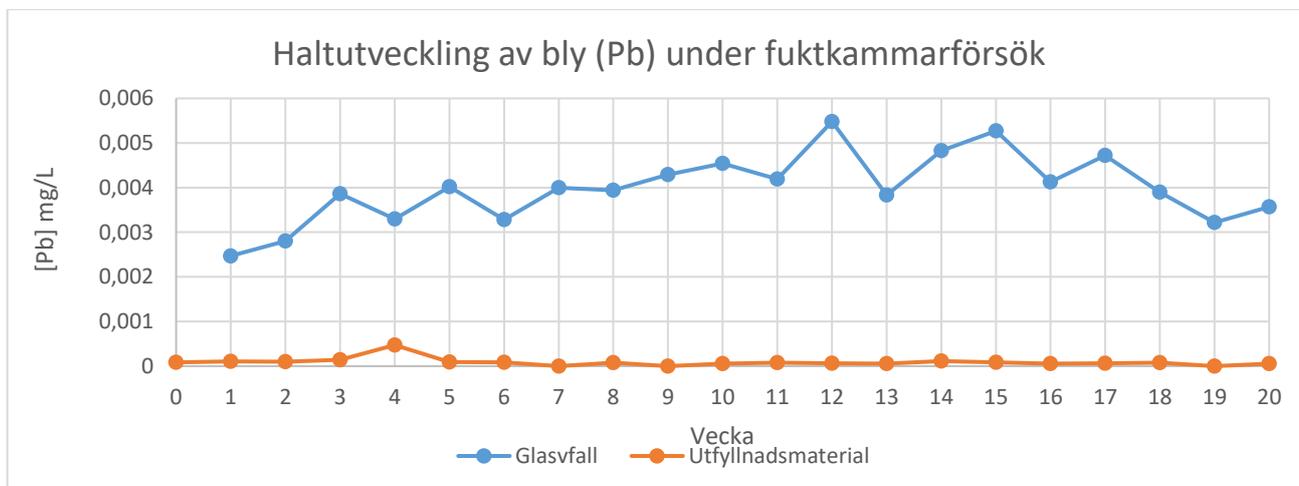
Haltutveckling av Pb, As, Sb och Ba

Att döma av resultaten avseende Pb som redovisas i Figur 15 har betydligt högre halter uppmätts under försöket på glas jämfört med försöket på blandat utfyllnadsmaterial. Utlakningen av Pb från glasavfallet noterades öka från ca 2 till 5,5 µg/L mellan första och elfte försöksveckan, fluktuerade därefter mellan 4 och 5 µg/L under efterföljande veckor och klingade avslutningsvis av till halter omkring 3 µg/L. Under försöket på blandat utfyllnadsmaterialet stabiliserades utlakningen tidigt på halter omkring 0,1 µg/L. Utfallet pekar tydligt på att glasavfallet innehåller icke-inerta egenskaper som gör att Pb lakas ut ur materialet och därtill att magnituden av denna utlakning påverkas till följd av att kemiska processer äger rum över tid. För blandmaterialet pekar resultaten på en utlakning av Pb som är konstant och som inte kommer att påverkas över tid.

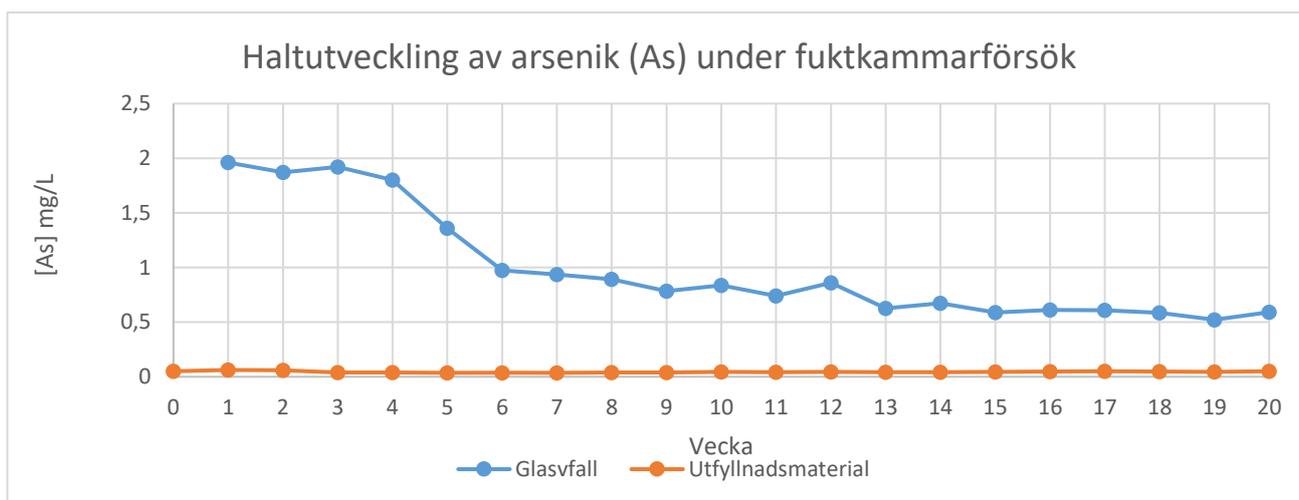
Även den erhållna haltutvecklingen av As visade sig vara högre i glasavfallet än från det blandade utfyllnadsmaterialet (Figur 15). Under försöket på glasavfall noterades en betydande utlakning av As med halter som initialt låg strax under 2 mg/L och som därefter avtog och stabiliserades kring 0,5–0,6 mg/L. För blandmaterialet nådde utlakningen steady state omgående på halter runt 40–50 µg/L. Försöken pekar på att den utlakning som kan väntas ske från materialen över tid är både betydande och konstant.

Den observerade haltutvecklingen för Sb redovisas i Figur 16. Under försöket på glas uppgick Sb-halterna till 0,1 mg/L under försökets början och avtog därefter succesivt till dess att mer eller mindre stabila nivåer antogs omkring 0,04 mg/L mot slutet av försöket. För utfyllnadsmaterialet sjönk lakvattenhalterna från initiala 0,1 mg/L till 0,02 mg/L under de första försöksveckorna och ökade därefter fram till och med den fjärde försöksveckan då utlakningen nådde steady state på ca 0,06 mg/L. Utfallet antyder att båda materialens Sb-innehåll till viss del utgörs av löst bundna specier som sköljs ut relativt lätt men också att metallen förekommer i mer hårt bundna former som tenderar att vittra i kontinuerlig takt.

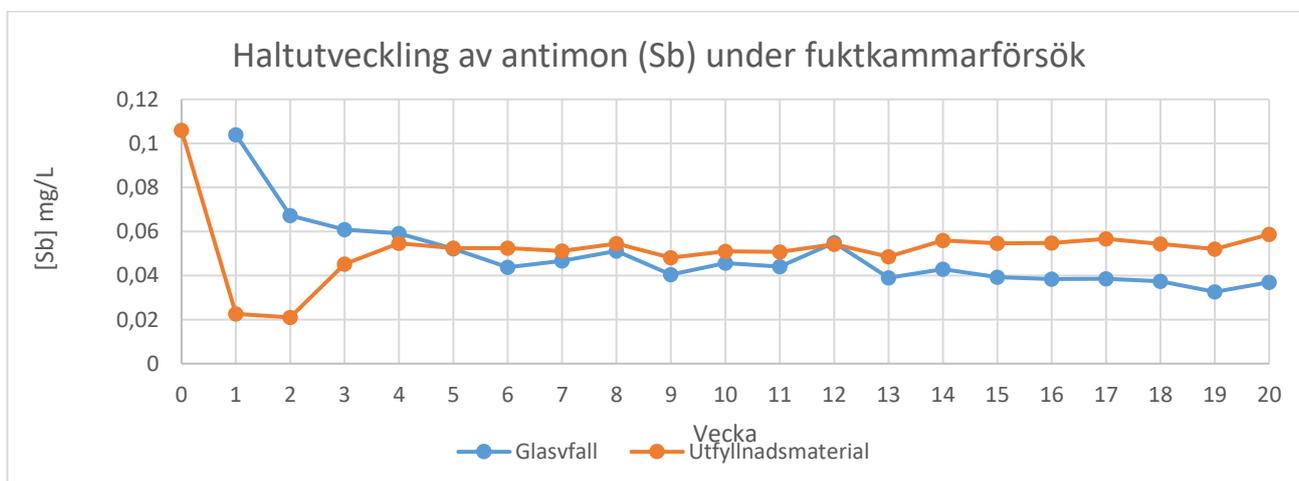
Resultatet av fukt-kammarförsöken med avseende på Ba redovisas i Figur 18. Av observerad haltutveckling framgår att lakvattenkoncentrationerna steg från 0,02 till 0,15 mg/L under glasavfallsförsöket och att utfallet mer eller mindre blev det omvända för blandmaterialet som gav upphov till lakvattenhalter som sjönk från ca 0,15 till 0,05 mg/L under försöksförloppet. Resultaten antyder att Ba-specierna i glasavfallet bryts ner över tid samt att nedbrytningen accelereras av vittringsprocesser i materialet. För blandmaterialet pekar utvecklingen på att löst fastlagda Ba-former tenderar att sköljas ut ur materialet då det kommer i kontakt med vatten.



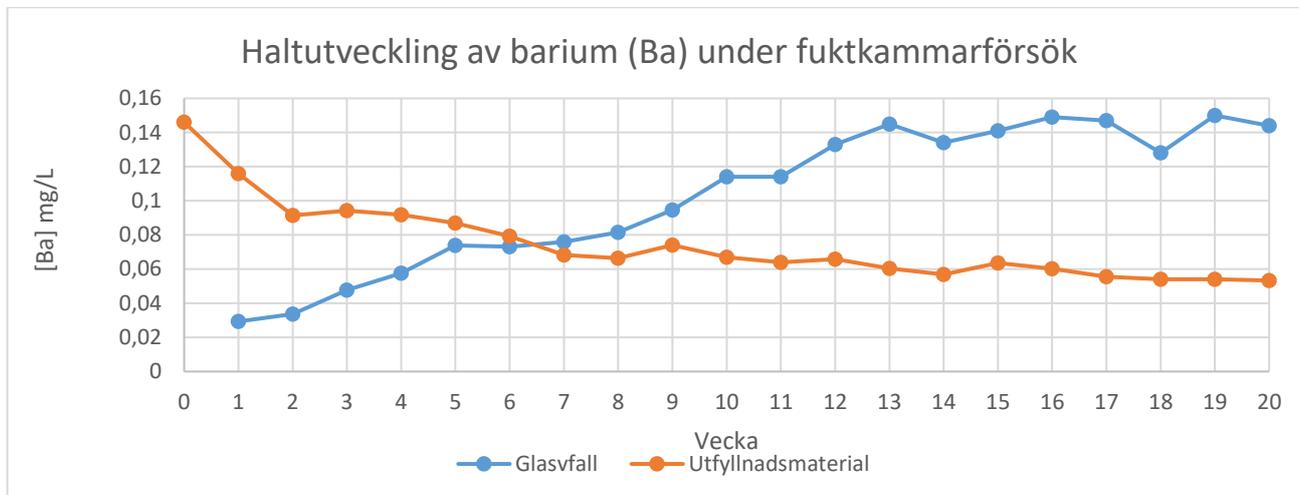
Figur 15: Utveckling av Pb över tid under fuktkammarförsök på glasavfall samt på utfyllnadsmaterial från Alsterbros före detta glasbruk.



Figur 16: Utveckling av As över tid under fuktkammarförsök på glasavfall samt på utfyllnadsmaterial från Alsterbros före detta glasbruk.



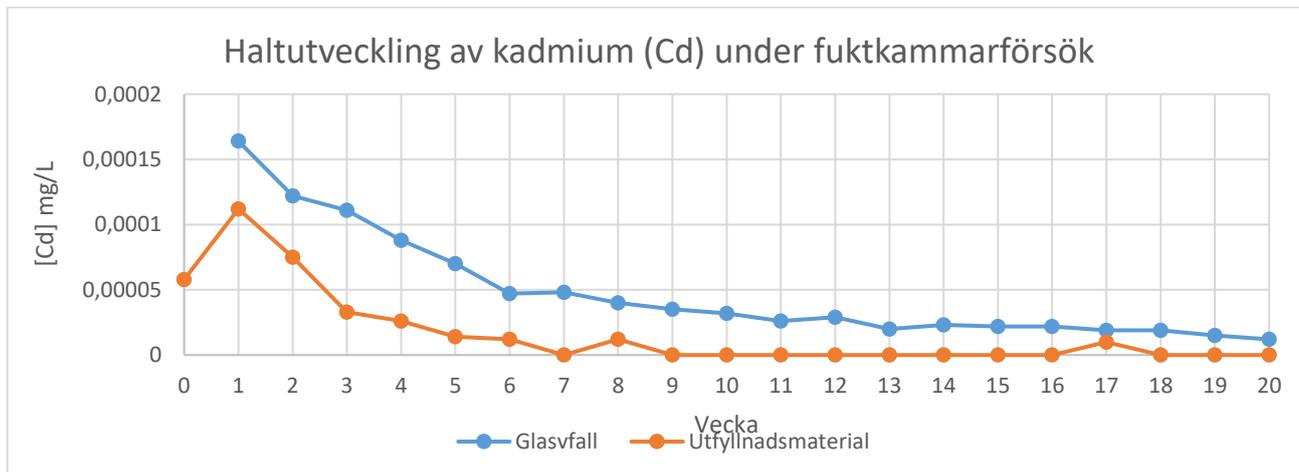
Figur 17: Utveckling av Sb över tid under fukt-kammarförsök på glasavfall samt på utfyllnadsmaterial från Alsterbros före detta glasbruk.



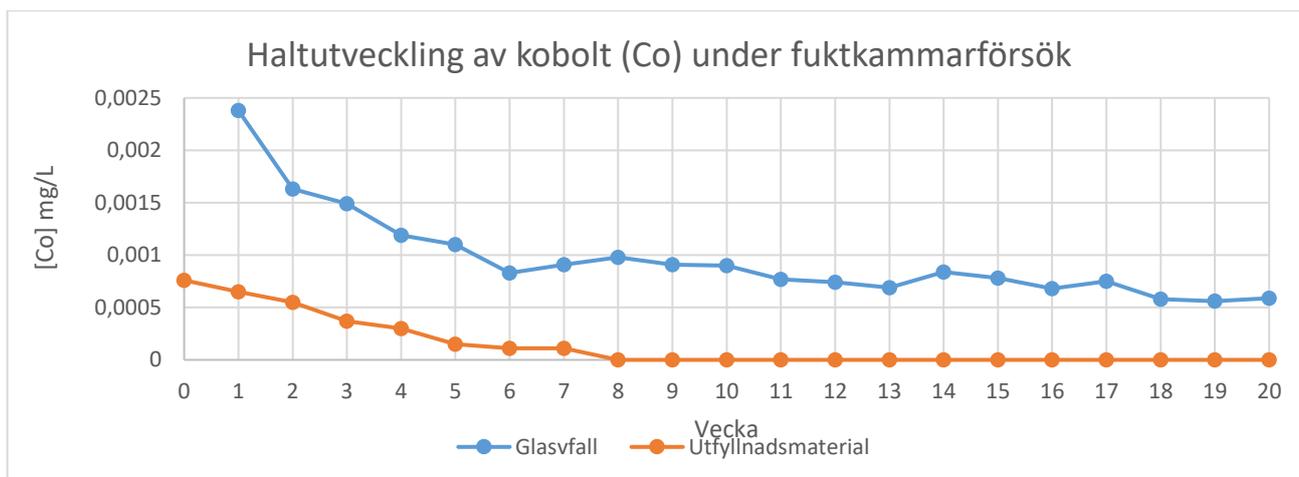
Figur 18: Utveckling av Ba över tid under fukt-kammarförsök på glasavfall samt på utfyllnadsmaterial från Alsterbros före detta glasbruk.

Haltutveckling av övriga element

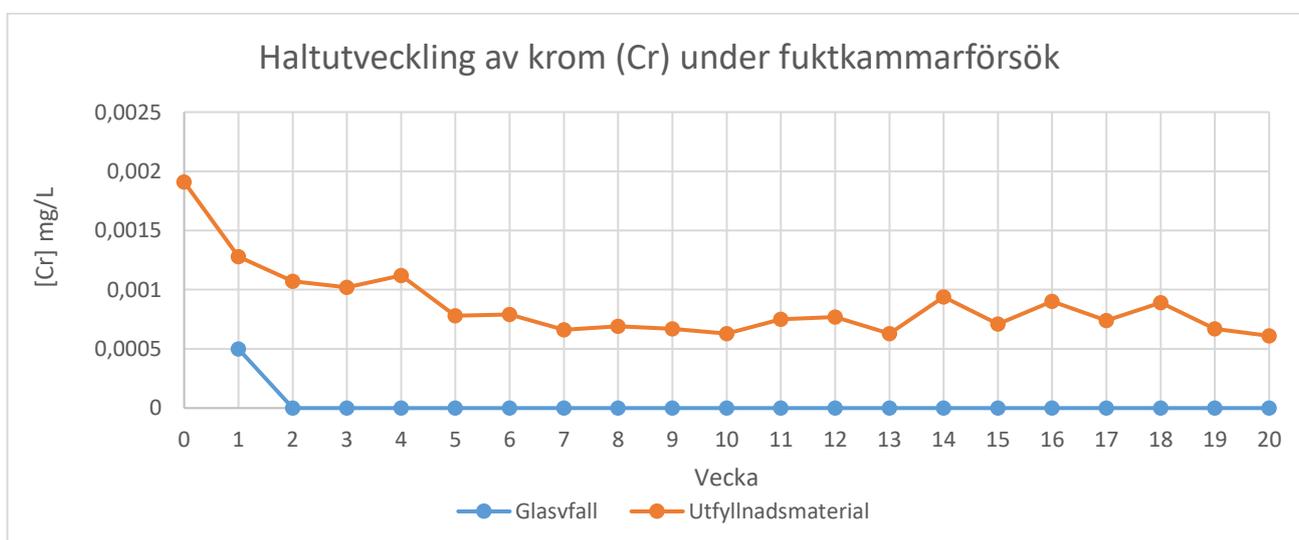
Haltutvecklingarna av Cd, Co och Cr, vilka framgår av Figur 19, Figur 20, Figur 21, visar att utlakningen av dessa metaller har varit som mest noterbar under de båda försökens inledning och halterna har klingat av i lakvätskorna ju längre försöken pågått. Resultaten tyder på att den mobilisering av Cd-, Co och Cr- som inducerats under försöken huvudsakligen har skett till följd av upplösning följt av ursköljning av löst sittande specier och vidare att hårdare bundna former av dessa metaller inte tycks ha varit föremål för någon vittrande process.



Figur 19: Utveckling av Cd över tid under fukt-kammarförsök på glasavfall samt på utfyllnadsmaterial från Alsterbros före detta glasbruk.



Figur 20: Utveckling av Co över tid under fukt-kammarförsök på glasavfall samt på utfyllnadsmaterial från Alsterbros före detta glasbruk.



Figur 21: Utveckling av Cr över tid under fukt-kammarförsök på glasavfall samt på utfyllnadsmaterial från Alsterbros före detta glasbruk.

3.4.1 Modelleringsresultat

I Tabell 8 redovisas de metallspecier som enligt simuleringarna i PHREEQC varit nära noll i mättnadsindex och vars upplösning därav varit styrande för metallhalterna i lakvattnen under fukt-kammarförsöken. Av modellberäkningarna framgår att olika former av kiseldioxid (SiO_2) och (CaCO_3) har reglerat halterna av Si respektive Ca i lakvattnet under både försöket på glasavfall och försöket på blandmaterial. För övriga huvudelement såsom Al- och Na-hydroxider/-oxider förefaller de styrande specierna utgöras av olika lerliknande mineralformer.

Enligt modelleringen styrs fastläggningen av Pb i glasavfallet av bly(III)hydroxid ($\text{Pb}(\text{OH})_2$) samt i någon mån även av cerrusit (PbCO_3) medan det för blandmaterialet inte har varit möjligt att påvisa något styrande Pb-mineral. Modellen visar vidare att mobiliseringen av Ba huvudsakligen sker till följd av upplösning av baryt (BaSO_4) i både glasavfallet och i blandmaterialet samt att fastläggningen av Cr regleras av krom(III)hydroxid $\text{Cr}(\text{OH})_3$ i båda materialen. Som Tabell 8 även anger så har mättnadsindex varit högre för flertalet ämnen under försökens inledning än under försökens slutskede vilket visar att alltmer undermättade lösningar har erhållits under försökens gång. Denna observation tyder i förlängningen på att upplösning och utlakning sker över tid från glasavfallet, vilket även bekräftas av utlakningskurvorna.

Trots att både Sb och As föreligger i höga totalhalter i glasavfallet och därtill påvisats laka i stor omfattning under lakförsöken har inga tydligt dominerade specier kunnat observeras under simuleringarna. Närmast lösningsjämvikt och därav mest troligt styrande specie för mobiliteten hos Sb är dock antimontetroxid (SbO₂). Vidare pekar resultaten på att As i samtliga lösningar huvudsakligen utgjorts av specier i dess femvärda form, arsenat (As(V)) och följaktligen att endast en mycket liten andel av metallen föreligger som arsenit (As(III)). Även om båda dessa oxidationstillstånd för As är att betrakta som toxiska brukar As(V) generellt anses vara mindre toxiskt än As (III).

Tabell 8: Specier vars mättnadsindex observerats nära 0 under simuleringar i PHREEQC och därav sannolikt styrande för urlakningen. I celler utan värden har observerade mättnadsindex varit antingen så pass höga eller låga att de exkluderats av modellen.

Mineral	Beteckning	Glasavfall 1	Glasavfall 20	Bland 1	Bland 20
Aragonit	CaCO ₃	0,51	-0,85	0,42	0,03
Barit	BaSO ₄	-2,01	-	-0,24	-1,73
Boehmit	AlOOH	-1,45	-0,86	0,55	0,38
Kalcit	CaCO ₃	0,69	-0,67	0,6	0,21
Cerussit	PbCO ₃	-1,59	-1,25	-2,74	-3,03
Kalcedon	SiO ₂	0,18	0,07	-0,56	0,52
Kromhydroxid	Cr(OH) ₃	0,5	-	0,97	-
Diaspor	AlOOH	0,25	0,84	2,25	2,09
Dolomit	CaMg(CO ₃) ₂	0,22	-3,18	-0,01	-0,43
Kaolinit	Al ₂ Si ₂ O ₅ (OH) ₄	0,08	1,02	2,61	2,34
Blyhydroxid	Pb(OH) ₂	-0,49	-0,61	-	-
Kvarts	SiO ₂	0,63	0,52	0,11	-0,07
Antimontetroxid	SbO ₂	-3,97	-2,5	-1,92	-1,53
Viterit	BaCO ₃	-1,88	-2,54	-2,59	-3,05
Zinkit	ZnO	-0,91	-	-2,48	-
Kristoballit	SiO ₂	-0,13	-	-0,76	-0,72
Dominerande As-form	As(V)	As(V)	As(V)	As(V)	As(V)

3.4.2 Beräknad utlakning baserad på fuktkammarförsök

Mängden metaller som årligen beräknas utlaka från utfyllnadsområde väst (Delområde A) framgår av Tabell 9 och inkluderar ca 17 kg Sb, 15 kg Ba och 14 kg As. Därtill uppskattas att ca 1,5 ton Si, 10,2 ton Ca samt 0,26 ton Na lakas varje år. Av

Tabell 10 som återger motsvarande resultat för den glashög som återfinns inom det undersökta området (Delområde E) framgår vidare att den årlig utlakningen beräknas uppgå till 2,3 kg As, 0,6 kg Ba, 0,15 kg Sb och 0,01 kg Pb. Därtill visar beräkningarna att 15 kg Ca, 81 kg Si och 63 kg Na bedöms laka ut under en ettårsperiod från delområdet.

Tabell 9: Beräknad veckovis respektive årlig utlakning per kilogram blandat utfyllnadsmaterial samt total lakning från utfyllnadsområdet (Delområde A). Tabellen redovisar endast de element som under fuktkammarförsöken har påträffats över laboratoriets detektionsgränser.

Ämne	Steady state konc. (cfukt)	Total lakad mängd per kg material glas (C_{glas})		Total lakmängd från delområde A ($C_{element}$)	
	mg/L	mg/kg material, vecka	mg/kg material, år	mg/år	kg/år
Al	0,0589	0,029	1,53	16798233	17
Sb	0,0587	0,029	1,53	16741193	17
As	0,0499	0,025	1,30	14231440	14
Ba	0,0533	0,027	1,39	15201117	15
B	0,025	0,013	0,65	7129980	7
Ca	35,8	17,900	930,80	10210131360	10210
Cr	0,00061	0,000	0,02	173972	0
Cu	0,00295	0,001	0,08	841338	1
Fe	0,033	0,017	0,86	9411574	9
Pb	0,000055	0,000	0,00	15686	0
Mg	2,23	1,115	57,98	635994216	636
Mn	0,00068	0,000	0,02	193935	0
Mo	0,00140	0,001	0,04	399279	0
Ni	0,00058	0,000	0,02	165416	0
K	3,54	1,770	92,04	1009605168	1010
Se	0,00035	0,000	0,01	99820	0
Si	5,18	2,590	134,68	1477331856	1477

Ämne	Steady state konc. (cfukt)	Total lakad mängd per kg material glas (c_{glas})		Total lakmängd från delområde A ($c_{element}$)	
	mg/L	mg/kg material, vecka	mg/kg material, år	mg/år	kg/år
Na	0,916	0,458	23,82	261242467	261
Sr	0,140	0,070	3,64	39927888	40
S	0,89	0,445	23,14	253827288	254
U	0,00131	0,001	0,03	373611	0
V	0,0025	0,001	0,07	712998	1

Tabell 10: Beräknad veckovis respektive årlig utlakning per kilogram blandat utfyllnadsmaterial (Delområde A) samt total lakning från den upplagda glashögen (Delområde E). Tabellen redovisar endast de element som under fukt-kammarförsöken har påträffats över laboratoriets detektionsgränser.

Ämne	Steady state konc. (cfukt)	Total lakad mängd per kg material glas (c_{glas})		Total lakmängd från delområde E ($c_{element}$)	
	mg/L	mg/kg material, vecka	mg/kg material, år	mg/år	kg/år
Al	0,0080	0,0038	0,20	31450	0,03
Sb	0,0369	0,0177	0,92	145061	0,15
As	0,591	0,2837	14,75	2323339	2,32
Ba	0,144	0,0691	3,59	566093	0,57
B	0,019	0,0091	0,47	74693	0,07
Cd	0,000012	0,0000	0,00	47	0,00
Ca	3,87	1,8576	96,60	15213744	15,21
Co	0,00059	0,0003	0,01	2319	0,00
Cu	0,00059	0,0003	0,01	2319	0,00
Pb	0,00357	0,0017	0,09	14034	0,01
Mg	0,0887	0,0426	2,21	348697	0,35
Mn	0,00395	0,0019	0,10	15528	0,02
K	0,357	0,1714	8,91	1403438	1,40

Ämne	Steady state konc. (cfukt)	Total lakad mängd per kg material glas (c_{glas})		Total lakmängd från delområde E ($c_{element}$)	
	mg/L	mg/kg material, vecka	mg/kg material, år	mg/år	kg/år
Se	0,00014	0,0001	0,00	550	0,00
Si	20,5	9,8400	511,68	80589600	80,59
Na	16,1	7,7280	401,86	63292320	63,29
Sr	0,00564	0,0027	0,14	22172	0,02
U	0,000019	0,0000	0,00	75	0,00

3.4.3 Kompletterande beräknad utlakning baserad på skakförsök

På grund av att fuktkammarförsöken endast medgivit beräkningar av utlakning från två av de sammanlagt fem delområden som återfinns vid glasbruket har även belastningsberäkningar baserade på resultaten från genomförda skakförsök utförts för samtliga områden. Då skakförsöken, till skillnad från fuktkammarförsöken, inte fångar upp eventuella geokemiska processer utan endast uppskattar den lakning som sker till följd av att de prövade materialet genomsköljs av vatten bör resultaten från dessa kompletterande beräkningar endast ses som indikativa mått på den belastning som *åtminstone* är att vänta från de olika områdena.

Tabell 11: Uppskattad årlig belastning baserad på resultat från genomförda skakförsök där förhållandet mellan mängd vatten och material varit 2:1 (L/S 2) samt delområdenas naturliga L/S- kvoter.

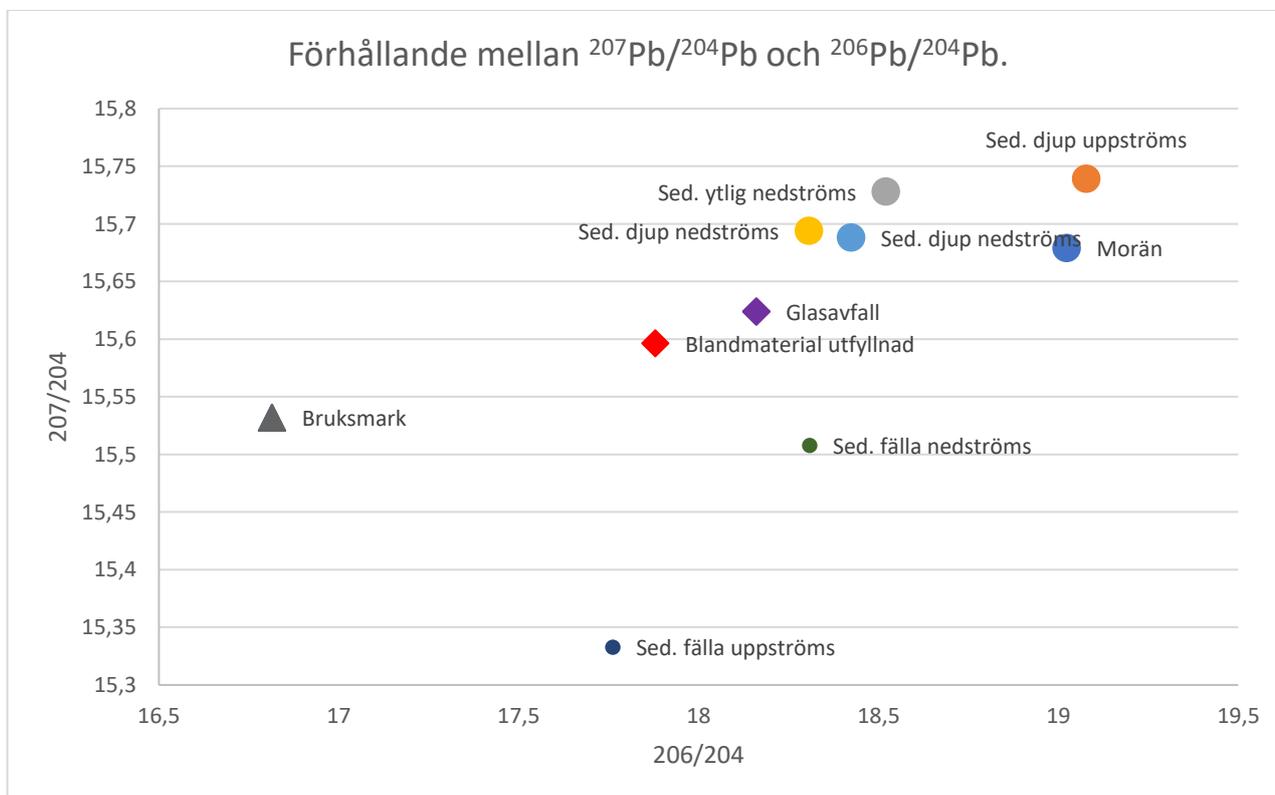
Ämne	Delområde A	Delområde B	Delområde C	Delområde D	Delområde E
	Årlig belastning	Årlig belastning	Årlig belastning (kg)	Årlig belastning (kg)	Årlig belastning (kg)
As	0,12	0,033	0,11	0,17	0,011
Ba	0,066	2,89	10,08	15,36	0,0028
Cd	$4,39 \cdot 10^{-5}$	0,00013	0,00047	0,00071	0,000056
Cr	0,0026	0,00051	0,0018	0,0027	0,000053
Cu	0,018	0,0058	0,020	0,031	0,00043
Mo	0,004	0,00047	0,0016	0,0025	0,000038
Ni	0,00092	0,00036	0,0013	0,0019	0,000015
Pb	0,0016	0,0058	0,020	0,031	0,0069
Sb	0,16	0,17	0,60	0,92	0,00091
Zn	0,013	0,0048	0,017	0,026	0,00069

Ämne	Delområde A	Delområde B	Delområde C	Delområde D	Delområde E
	Årlig belastning	Årlig belastning	Årlig belastning (kg)	Årlig belastning (kg)	Årlig belastning (kg)
DOC	25,78	28,51	99,57	151,63	0,12
Cl	16,27	2,49	8,69	13,23	0,13
F	0,24	0,21	0,74	1,13	1,51
SO4	25,47	4,74	16,55	25,21	0,56

3.5 Utfall av blyisotopstudier

Erhållna blyisotopkvoter har plottats mot varandra i sambandsdiagrammet i Figur 22. Som framgår av figuren har Pb observerats i liknande kvoter såväl i de djupare som i de ytligare sedimentproverna samt i provet på morän medan materialet från glasbruksområdet (glasavfall, utfyllnadsmaterial och bruksmarksmaterial) uppvisar helt annorlunda blyammansättning. Vidare kan noteras att materialet från sedimentfällorna uppvisar olika blysignaturer både sinsemellan och jämfört med övriga material.

Att blysignaturerna i sediment och morän befunnits mycket lika och att helt annorlunda signaturer påvisats i materialen från glasbruksområdet innebär att isotopstudien inte har kunnat påvisa spridning av bly från utfyllnadsområdet till omgivningen. Tvärtom tyder utfallet på att sådan spridning inte sker och att det bly som finns i sedimenten har sitt ursprung från omgivningen snarare än från den tidigare glasbruksverksamheten.



Figur 22: Sammanställning av resultat från blyisotopstudie vid och i anslutning till det före detta glasbruket i Alsterbro.

4.0 REFERENSER

Thunberg J. (2001) Weathering and Water Quality in an Area with Mineralized Till, Liikavaara, Northern Sweden. Licentiatavhandling, Luleå tekniska universitet 2001:59.

Carlsson E. (2002) Sulfide-rich Tailings Remediated by Soil Cover – Evaluation of cover efficiency and tailings geochemistry, Kristineberg, northern Sweden. Doktorsavhandling Luleå tekniska universitet 2002:44.

Hjort T. (2001) Metal speciation in fresh water sediments. Licentiat avhandling. Institutionen för Geologi och Geokemi. Stockholms Universitet.

Holmström (2004). Efterbehandling av sandmagasin i Stollbergsområdet – Huvudstudie, Effekter av äldre silver, bly och zinkbrytning i Smedjebackens kommun. Envipro Miljöteknik AB 2004-04-02.

Holmström H. och Eriksson H. (2005) Inventering och karaktärisering av avfallen vid Gladhammars gruvor. Projekt Gladhammars gruvor 2004:03.

Signatur sida

Golder Associates AB



Henrik Svanberg
Handläggare



Henning Holmström
Kvalitetsansvarig

HH/HS

Org.nr 556326-2418
VAT.no SE556326241801
Styrelsens säte: Stockholm

i:\projekt\2017\1786406 sgu - glasbruket i alsterbro\8.rapporter\karaktärisering\karaktärisering alsterbro slutgiltig 2019-10-18.docx

BILAGA A

Laboratorierapporter

REPORT OF ANALYSIS



Issued by: ALS Scandinavia AB, Aurorum 10, S-977 75 Luleå, Sweden
Client: Golder Associates AB
Date of receipt: 2018-09-24
Date of analysis: 2018-10-11
Order number (our): L1826996
Your reference: Dan Hermansson
Our reference: Iliia Rodushkin

Sample ID	Lab ID	$^{208}\text{Pb}/^{207}\text{Pb}$		$^{207}\text{Pb}/^{206}\text{Pb}$		$^{206}\text{Pb}/^{204}\text{Pb}$		$^{208}\text{Pb}/^{204}\text{Pb}$		$^{207}\text{Pb}/^{204}\text{Pb}$	
			2 SD		2 SD		2 SD		2 SD		2 SD
ALS.18GA01S.1	U11507889	2.4344	0.0026	0.85148	0.00074	18.424	0.015	38.190		15.688	
ALS.18GA01S.5	U11507890	2.4523	0.0026	0.82495	0.00067	19.078	0.036	38.595		15.739	
ALS.18GA03S.1	U11507891	2.4336	0.0029	0.84921	0.00062	18.521	0.026	38.275		15.728	
ALS.18GA03S.5	U11507892	2.4266	0.0027	0.85725	0.00079	18.307	0.012	38.082		15.694	

Comments

Samples was prepared by HNO₃ digestion

The analysis is carried out by MC-ICP-MS (NEPTUNE Plus) using internal standardization and external calibration with bracketing isotope SRMs

Analysis is carried out after double ion exchange separation

SD calculated from two independent consecutive measurements

Signature

Iliia Rodushkin
Associate Professor
LABORATORY MANAGER
ALS Scandinavia AB



REPORT OF ANALYSIS

Issued by: ALS Scandinavia AB, Aurorum 10, S-977 75 Luleå, Sweden
Client: Golder Associates AB
Date of receipt: 2019-01-11
Date of analysis: 2019-01-25
Order number (our): L1900998
Your reference: Henrik Svanberg
Our reference: Ilia Rodushkin

Sample ID	Lab ID	$^{208}\text{Pb}/^{207}\text{Pb}$		$^{207}\text{Pb}/^{206}\text{Pb}$		$^{206}\text{Pb}/^{204}\text{Pb}$		$^{208}\text{Pb}/^{204}\text{Pb}$	$^{207}\text{Pb}/^{204}\text{Pb}$
			2 SD		2 SD		2 SD		
ALS.J.18GASAML.1A	U11556480	2.4099	0.0004	0.86030	0.00006	18.161	0.003	37.651	15.624
ALS.J.18GASAML.2A	U11556481	2.3378	0.0003	0.92370	0.00006	16.815	0.003	36.310	15.532
ALS.J.18GASAML.3A	U11556482	2.3982	0.0004	0.87230	0.00008	17.880	0.005	37.404	15.596

Comments

Samples was prepared by AR+HF digestion
The analysis is carried out by MC-ICP-MS (NEPTUNE PLUS) using internal standardization
and external calibration with bracketing isotope SRMs
SD calculated from two independent consecutive measurements

Signature 

Ilia Rodushkin
Associate Professor
LABORATORY MANAGER
ALS Scandinavia AB

REPORT OF ANALYSIS



Issued by: ALS Scandinavia AB, Aurorum 10, S-977 75 Luleå, Sweden
Client: Golder Associates AB
Date of receipt: 2018-10-09
Date of analysis: 2018-10-19
Order number (our): L1828480
Your reference: Dan Hermansson
Our reference: Ilia Rodushkin

Sample ID	Lab ID	$^{208}\text{Pb}/^{207}\text{Pb}$		$^{207}\text{Pb}/^{206}\text{Pb}$		$^{206}\text{Pb}/^{204}\text{Pb}$		$^{208}\text{Pb}/^{204}\text{Pb}$	$^{207}\text{Pb}/^{204}\text{Pb}$
			2 SD		2 SD		2 SD		
ALS.J.18GA01REF	U11514181	2.4312	0.0023	0.82418	0.00045	19.024	0.013	38.119	15.679
ALS.J.18GA01REF	U11514181	2.4313	0.0020	0.82417	0.00036	19.024	0.011	38.119	15.679

Comments

Samples was prepared by HNO₃ digestion
The analysis is carried out by MC-ICP-MS (NEPTUNE Plus) using internal standartization and external calibration with bracketing isotope SRMs
Analysis is carried out after double ion exchange separation
SD calculated from two independent consequitive measurements

Signature Ilia Rodushkin

Ilia Rodushkin
Associate Professor
LABORATORY MANAGER
ALS Scandinavia AB

REPORT OF ANALYSIS



Issued by: ALS Scandinavia AB, Aurorum 10, S-977 75 Luleå, Sweden
Client: Golder Associates AB
Date of receipt: 2019-04-15
Date of analysis: 2019-05-08
Order number (our): L1911468
Your reference: Dan Hermansson
Our reference: Iliia Rodushkin

Sample ID	Lab ID	$^{208}\text{Pb}/^{207}\text{Pb}$	2 SD	$^{207}\text{Pb}/^{206}\text{Pb}$	2 SD	$^{206}\text{Pb}/^{204}\text{Pb}$	2 SD	$^{208}\text{Pb}/^{204}\text{Pb}$	$^{207}\text{Pb}/^{204}\text{Pb}$
ALS-18GA01S.SF	U11591227	2.4157	0.0024	0.86323	0.00058	17.762	0.018	37.040	15.333
ALS-18GA03S.SF	U11591228	2.4371	0.0027	0.84700	0.00064	18.309	0.022	37.793	15.508

Comments

Samples was prepared by HNO₃ digestion
The analysis is carried out by MC-ICP-MS (NEPTUNE Plus) using internal standardization
and external calibration with bracketing isotope SRMS
Analysis is carried out after double ion exchange separation
SD calculated from two independent consecutive measurements

Signature

A handwritten signature in blue ink, appearing to read 'Iliia Rodushkin', written over a horizontal line.

Iliia Rodushkin
Associate Professor
LABORATORY MANAGER
ALS Scandinavia AB



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 05-OCT-18
Report Date: 30-OCT-18 15:37 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2176702
Project P.O. #: Cycle#0
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Comments: Please note, the humidity cell ALS.BLAND.ALS_JORD.FF was initiated using material that was < the 1kg weight recommended in the reference method.

Shane Stack
Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2176702-1	L2176702-2		
		Description	Solid	Solid		
		Sampled Date	05-OCT-18	05-OCT-18		
		Sampled Time	12:00	12:00		
		Client ID	ALS.GLS.ALS_JOR D.FF-0	ALS.BLAND.ALS_J ORD.FF-0		
Grouping	Analyte					
SOIL						
Sample Preparation	Initial Weight (g)		1000	814		
Physical Tests	Conductivity (uS/cm)		225	478		
	pH (pH)		9.45	8.26		
Anions and Nutrients	Acidity (as CaCO3) (mg/L)		<3.0	<3.0		
	Alkalinity, Total (as CaCO3) (mg/L)		129	175		
	Ammonia, Total (as N) (mg/L)		0.0177	1.25		
	Bromide (Br) (mg/L)		<0.050	<0.050		
	Chloride (Cl) (mg/L)		<0.50	3.15		
	Fluoride (F) (mg/L)		0.045	0.313		
	Nitrate (as N) (mg/L)		0.0133	3.04		
	Nitrite (as N) (mg/L)		0.0045	3.28 ^{HTD}		
	Sulfate (SO4) (mg/L)		2.49	52.2		
Leachable Metals	Aluminum (Al)-Leachable (mg/L)		0.0457	0.117		
	Antimony (Sb)-Leachable (mg/L)		0.0695	0.106		
	Arsenic (As)-Leachable (mg/L)		1.67	0.0519		
	Barium (Ba)-Leachable (mg/L)		0.0172	0.146		
	Beryllium (Be)-Leachable (mg/L)		<0.00010	<0.00010		
	Bismuth (Bi)-Leachable (mg/L)		<0.00050	<0.00050		
	Boron (B)-Leachable (mg/L)		0.015	0.098		
	Cadmium (Cd)-Leachable (mg/L)		0.000138	0.000058		
	Calcium (Ca)-Leachable (mg/L)		2.56	77.3		
	Chromium (Cr)-Leachable (mg/L)		0.00094	0.00191		
	Cobalt (Co)-Leachable (mg/L)		0.00207	0.00076		
	Copper (Cu)-Leachable (mg/L)		0.00757	0.0184		
	Iron (Fe)-Leachable (mg/L)		0.034	0.066		
	Lead (Pb)-Leachable (mg/L)		0.00223	0.000083		
	Lithium (Li)-Leachable (mg/L)		0.0092	<0.0010		
	Magnesium (Mg)-Leachable (mg/L)		0.103	7.85		
	Manganese (Mn)-Leachable (mg/L)		0.0136	0.102		
	Mercury (Hg)-Leachable (mg/L)		0.0000113	0.0000146		
	Molybdenum (Mo)-Leachable (mg/L)		0.000202	0.00371		
	Nickel (Ni)-Leachable (mg/L)		0.00106	0.00350		
	Phosphorus (P)-Leachable (mg/L)		0.32	<0.30		
	Potassium (K)-Leachable (mg/L)		1.72	13.3		
Selenium (Se)-Leachable (mg/L)		0.00025	0.00135			
Silicon (Si)-Leachable (mg/L)		33.6	5.01			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2176702-1 Solid 05-OCT-18 12:00 ALS.GLS.ALS_JOR D.FF-0	L2176702-2 Solid 05-OCT-18 12:00 ALS.BLAND.ALS_J ORD.FF-0		
Grouping	Analyte				
SOIL					
Leachable Metals	Silver (Ag)-Leachable (mg/L)	0.000038	0.000013		
	Sodium (Na)-Leachable (mg/L)	55.6	13.9		
	Strontium (Sr)-Leachable (mg/L)	0.00669	0.324		
	Sulfur (S)-Leachable (mg/L)	0.76	20.0		
	Thallium (Tl)-Leachable (mg/L)	<0.000010	0.000051		
	Tin (Sn)-Leachable (mg/L)	<0.00010	<0.00010		
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010		
	Uranium (U)-Leachable (mg/L)	0.000335	0.00394		
	Vanadium (V)-Leachable (mg/L)	0.0053	0.0029		
	Zinc (Zn)-Leachable (mg/L)	0.0085	0.0062		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2176702-1 Solid 05-OCT-18 12:00 ALS.GLS.ALS_JOR D.FF-0	L2176702-2 Solid 05-OCT-18 12:00 ALS.BLAND.ALS_J ORD.FF-0		
Grouping	Analyte				
WATER					
Sample Preparation	Total Volume In (mL)	750	750		
	Total Volume Out (mL)	620	475		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Antimony (Sb)-Leachable	MS-B	L2176702-1, -2
Matrix Spike	Arsenic (As)-Leachable	MS-B	L2176702-1, -2
Matrix Spike	Silicon (Si)-Leachable	MS-B	L2176702-1, -2
Matrix Spike	Sodium (Na)-Leachable	MS-B	L2176702-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
HTD	Hold time exceeded for re-analysis or dilution, but initial testing was conducted within hold time.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.			
Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			

Reference Information

NH3-HCELL-F-VA Soil Ammonia - fluor. (H. Cell) ASTM D5744/J. ENV.MON. 2005-7,37-42, RSC

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-HCELL-IC-VA Soil Nitrite - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-HCELL-IC-VA Soil Nitrate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-HCELL-VA Soil pH - meter (H. Cell) ASTM D5744/APHA 4500-H pH Value

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

SO4-HCELL-IC-VA Soil Sulfate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg wwt - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 12-OCT-18
Report Date: 15-NOV-18 17:33 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2179686
Project P.O. #: Cycle#1
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Shane Stack
Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2179686-1	L2179686-2		
		Description	Solid	Solid		
		Sampled Date	12-OCT-18	12-OCT-18		
		Sampled Time	12:00	12:00		
		Client ID	ALS.GLS.ALS_JOR D.FF-1	ALS.BLAND.ALS_J ORD.FF-1		
Grouping	Analyte					
SOIL						
Physical Tests	Conductivity (uS/cm)		340	468		
	pH (pH)		9.38	8.02		
Anions and Nutrients	Acidity (as CaCO3) (mg/L)		<3.0	4.0		
	Alkalinity, Total (as CaCO3) (mg/L)		196	165		
	Ammonia, Total (as N) (mg/L)		0.0241	2.88		
	Bromide (Br) (mg/L)		<0.050	<0.050		
	Chloride (Cl) (mg/L)		<0.50	1.68		
	Fluoride (F) (mg/L)		0.046	0.315		
	Nitrate (as N) (mg/L)		0.0053	0.0976		
	Nitrite (as N) (mg/L)		0.0030	0.0296		
	Sulfate (SO4) (mg/L)		1.56	45.3		
	Leachable Metals	Aluminum (Al)-Leachable (mg/L)		0.0190	0.0849	
Antimony (Sb)-Leachable (mg/L)			0.104	0.0226		
Arsenic (As)-Leachable (mg/L)			1.96	0.0621		
Barium (Ba)-Leachable (mg/L)			0.0293	0.116		
Beryllium (Be)-Leachable (mg/L)			<0.00010	<0.00010		
Bismuth (Bi)-Leachable (mg/L)			<0.00050	<0.00050		
Boron (B)-Leachable (mg/L)			0.021	0.080		
Cadmium (Cd)-Leachable (mg/L)			0.000164	0.000112		
Calcium (Ca)-Leachable (mg/L)			4.69	67.6		
Chromium (Cr)-Leachable (mg/L)			0.00050	0.00128		
Cobalt (Co)-Leachable (mg/L)			0.00238	0.00065		
Copper (Cu)-Leachable (mg/L)			0.00604	0.0158		
Iron (Fe)-Leachable (mg/L)			<0.030	0.049		
Lead (Pb)-Leachable (mg/L)			0.00247	0.000104		
Lithium (Li)-Leachable (mg/L)			0.0095	<0.0010		
Magnesium (Mg)-Leachable (mg/L)			0.128	6.53		
Manganese (Mn)-Leachable (mg/L)			0.0153	0.230		
Mercury (Hg)-Leachable (mg/L)			0.0000074	0.0000069		
Molybdenum (Mo)-Leachable (mg/L)			0.000168	0.00474		
Nickel (Ni)-Leachable (mg/L)			0.00083	0.00360		
Phosphorus (P)-Leachable (mg/L)			<0.30	<0.30		
Potassium (K)-Leachable (mg/L)			1.57	12.1		
Selenium (Se)-Leachable (mg/L)			0.00020	0.00073		
Silicon (Si)-Leachable (mg/L)			35.3	4.78		
Silver (Ag)-Leachable (mg/L)		0.000021	<0.000010			
Sodium (Na)-Leachable (mg/L)		74.5	9.31			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2179686-1 Solid 12-OCT-18 12:00 ALS.GLS.ALS_JOR D.FF-1	L2179686-2 Solid 12-OCT-18 12:00 ALS.BLAND.ALS_J ORD.FF-1		
Grouping	Analyte				
SOIL					
Leachable Metals	Strontium (Sr)-Leachable (mg/L)	0.0115	0.289		
	Sulfur (S)-Leachable (mg/L)	0.60	16.2		
	Thallium (Tl)-Leachable (mg/L)	<0.000010	0.000061		
	Tin (Sn)-Leachable (mg/L)	<0.00010	<0.00010		
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010		
	Uranium (U)-Leachable (mg/L)	0.000474	0.00401		
	Vanadium (V)-Leachable (mg/L)	0.0038	0.0036		
	Zinc (Zn)-Leachable (mg/L)	0.0085	0.0097		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2179686-1 Solid 12-OCT-18 12:00 ALS.GLS.ALS_JOR D.FF-1	L2179686-2 Solid 12-OCT-18 12:00 ALS.BLAND.ALS_J ORD.FF-1		
Grouping	Analyte				
WATER					
Sample Preparation	Total Volume In (mL)	500	500		
	Total Volume Out (mL)	530	475		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Leachable	MS-B	L2179686-1, -2
Matrix Spike	Calcium (Ca)-Leachable	MS-B	L2179686-1, -2
Matrix Spike	Magnesium (Mg)-Leachable	MS-B	L2179686-1, -2
Matrix Spike	Strontium (Sr)-Leachable	MS-B	L2179686-1, -2
Matrix Spike	Ammonia, Total (as N)	MS-B	L2179686-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.			
Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			

Reference Information

NH3-HCELL-F-VA	Soil	Ammonia - fluor. (H. Cell)	ASTM D5744/J. ENV.MON. 2005-7,37-42, RSC
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.			
NO2-HCELL-IC-VA	Soil	Nitrite - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-HCELL-IC-VA	Soil	Nitrate - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
PH-HCELL-VA	Soil	pH - meter (H. Cell)	ASTM D5744/APHA 4500-H pH Value
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.			
SO4-HCELL-IC-VA	Soil	Sulfate - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg wwt - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 19-OCT-18
Report Date: 01-NOV-18 19:07 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2181144
Project P.O. #: Cycle#2
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Shane Stack
Account Manager

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ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700
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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID	L2181144-1 Solid 19-OCT-18 12:00 ALS.GLS.ALS_JOR D.FF-2	L2181144-2 Solid 19-OCT-18 12:00 ALS.BLAND.ALS_J ORD.FF-2			
Grouping	Analyte				
SOIL					
Physical Tests	Conductivity (uS/cm)	230	320		
	pH (pH)	8.95	8.23		
Anions and Nutrients	Acidity (as CaCO3) (mg/L)	<3.0	<3.0		
	Alkalinity, Total (as CaCO3) (mg/L)	134	151		
	Ammonia, Total (as N) (mg/L)	<0.0050	3.39		
	Bromide (Br) (mg/L)	<0.050	<0.050		
	Chloride (Cl) (mg/L)	<0.50	0.83		
	Fluoride (F) (mg/L)	0.034	0.358		
	Nitrate (as N) (mg/L)	<0.0050	0.0202		
	Nitrite (as N) (mg/L)	<0.0010	0.0062		
	Sulfate (SO4) (mg/L)	1.72	23.3		
	Leachable Metals	Aluminum (Al)-Leachable (mg/L)	0.0174	0.0889	
Antimony (Sb)-Leachable (mg/L)		0.0672	0.0210		
Arsenic (As)-Leachable (mg/L)		1.87	0.0587		
Barium (Ba)-Leachable (mg/L)		0.0336	0.0915		
Beryllium (Be)-Leachable (mg/L)		<0.00010	<0.00010		
Bismuth (Bi)-Leachable (mg/L)		<0.00050	<0.00050		
Boron (B)-Leachable (mg/L)		0.021	0.069		
Cadmium (Cd)-Leachable (mg/L)		0.000122	0.000075		
Calcium (Ca)-Leachable (mg/L)		3.88	51.0		
Chromium (Cr)-Leachable (mg/L)		<0.00050	0.00107		
Cobalt (Co)-Leachable (mg/L)		0.00163	0.00055		
Copper (Cu)-Leachable (mg/L)		0.00350	0.0145		
Iron (Fe)-Leachable (mg/L)		<0.030	0.058		
Lead (Pb)-Leachable (mg/L)		0.00280	0.000100		
Lithium (Li)-Leachable (mg/L)		0.0063	<0.0010		
Magnesium (Mg)-Leachable (mg/L)		0.114	4.77		
Manganese (Mn)-Leachable (mg/L)		0.0105	0.173		
Mercury (Hg)-Leachable (mg/L)		<0.0000050	<0.0000050		
Molybdenum (Mo)-Leachable (mg/L)		0.000075	0.00579		
Nickel (Ni)-Leachable (mg/L)		0.00058	0.00341		
Phosphorus (P)-Leachable (mg/L)		<0.30	<0.30		
Potassium (K)-Leachable (mg/L)		1.08	10.3		
Selenium (Se)-Leachable (mg/L)		0.00016	0.00064		
Silicon (Si)-Leachable (mg/L)		25.4	4.48		
Silver (Ag)-Leachable (mg/L)	<0.000010	<0.000010			
Sodium (Na)-Leachable (mg/L)	53.6	6.14			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2181144-1 Solid 19-OCT-18 12:00 ALS.GLS.ALS_JOR D.FF-2	L2181144-2 Solid 19-OCT-18 12:00 ALS.BLAND.ALS_J ORD.FF-2		
Grouping	Analyte				
SOIL					
Leachable Metals	Strontium (Sr)-Leachable (mg/L)	0.00956	0.219		
	Sulfur (S)-Leachable (mg/L)	<0.50	8.29		
	Thallium (Tl)-Leachable (mg/L)	<0.00010	0.000059		
	Tin (Sn)-Leachable (mg/L)	<0.00010	<0.00010		
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010		
	Uranium (U)-Leachable (mg/L)	0.000216	0.00284		
	Vanadium (V)-Leachable (mg/L)	0.0016	0.0037		
	Zinc (Zn)-Leachable (mg/L)	0.0043	<0.0030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2181144-1 Solid 19-OCT-18 12:00 ALS.GLS.ALS_JOR D.FF-2	L2181144-2 Solid 19-OCT-18 12:00 ALS.BLAND.ALS_J ORD.FF-2		
Grouping	Analyte				
WATER					
Sample Preparation	Total Volume In (mL)	500	500		
	Total Volume Out (mL)	490	470		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Antimony (Sb)-Leachable	MS-B	L2181144-1, -2
Matrix Spike	Barium (Ba)-Leachable	MS-B	L2181144-1, -2
Matrix Spike	Calcium (Ca)-Leachable	MS-B	L2181144-1, -2
Matrix Spike	Copper (Cu)-Leachable	MS-B	L2181144-1, -2
Matrix Spike	Molybdenum (Mo)-Leachable	MS-B	L2181144-1, -2
Matrix Spike	Strontium (Sr)-Leachable	MS-B	L2181144-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.			

Reference Information

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-HCELL-F-VA Soil Ammonia - fluor. (H. Cell) ASTM D5744/J. ENV.MON. 2005-7,37-42, RSC
 Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-HCELL-IC-VA Soil Nitrite - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
 Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-HCELL-IC-VA Soil Nitrate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
 Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-HCELL-VA Soil pH - meter (H. Cell) ASTM D5744/APHA 4500-H pH Value
 Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

SO4-HCELL-IC-VA Soil Sulfate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
 Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg wwt - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 26-OCT-18
Report Date: 09-NOV-18 15:36 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2185140
Project P.O. #: Cycle#3
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Shane Stack
Account Manager

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ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700
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ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2185140-1	L2185140-2		
		Description	Solid	Solid		
		Sampled Date	26-OCT-18	26-OCT-18		
		Sampled Time	12:00	12:00		
		Client ID	ALS.GLS.ALS_JOR D.FF-3	ALS.BLAND.ALS_J ORD.FF-3		
Grouping	Analyte					
SOIL						
Physical Tests	Conductivity (uS/cm)		192	293		
	pH (pH)		8.61	8.25		
Anions and Nutrients	Acidity (as CaCO3) (mg/L)		<3.0	<3.0		
	Alkalinity, Total (as CaCO3) (mg/L)		110	136		
	Ammonia, Total (as N) (mg/L)		0.0055	2.01		
	Bromide (Br) (mg/L)		<0.050	<0.050		
	Chloride (Cl) (mg/L)		<0.50	1.85		
	Fluoride (F) (mg/L)		<0.020	0.312		
	Nitrate (as N) (mg/L)		<0.0050	1.24		
	Nitrite (as N) (mg/L)		<0.0010	0.199		
	Sulfate (SO4) (mg/L)		1.20	14.2		
Leachable Metals	Aluminum (Al)-Leachable (mg/L)		0.0244	0.131		
	Antimony (Sb)-Leachable (mg/L)		0.0609	0.0452		
	Arsenic (As)-Leachable (mg/L)		1.92	0.0383		
	Barium (Ba)-Leachable (mg/L)		0.0477	0.0942		
	Beryllium (Be)-Leachable (mg/L)		<0.00010	<0.00010		
	Bismuth (Bi)-Leachable (mg/L)		<0.00050	<0.00050		
	Boron (B)-Leachable (mg/L)		0.022	0.072		
	Cadmium (Cd)-Leachable (mg/L)		0.000111	0.000033		
	Calcium (Ca)-Leachable (mg/L)		4.03	53.2		
	Chromium (Cr)-Leachable (mg/L)		<0.00050	0.00102		
	Cobalt (Co)-Leachable (mg/L)		0.00149	0.00037		
	Copper (Cu)-Leachable (mg/L)		0.00297	0.0133		
	Iron (Fe)-Leachable (mg/L)		<0.030	0.113		
	Lead (Pb)-Leachable (mg/L)		0.00386	0.000140		
	Lithium (Li)-Leachable (mg/L)		0.0051	<0.0010		
	Magnesium (Mg)-Leachable (mg/L)		0.122	4.99		
	Manganese (Mn)-Leachable (mg/L)		0.0111	0.0187		
	Mercury (Hg)-Leachable (mg/L)		<0.0000050	0.0000070		
	Molybdenum (Mo)-Leachable (mg/L)		<0.000050	0.00572		
	Nickel (Ni)-Leachable (mg/L)		<0.00050	0.00300		
	Phosphorus (P)-Leachable (mg/L)		<0.30	<0.30		
	Potassium (K)-Leachable (mg/L)		0.879	9.18		
	Selenium (Se)-Leachable (mg/L)		0.00010	0.00060		
	Silicon (Si)-Leachable (mg/L)		25.4	4.85		
Silver (Ag)-Leachable (mg/L)		<0.000010	<0.000010			
Sodium (Na)-Leachable (mg/L)		47.6	5.29			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2185140-1	L2185140-2			
		Description	Solid	Solid			
		Sampled Date	26-OCT-18	26-OCT-18			
		Sampled Time	12:00	12:00			
		Client ID	ALS.GLS.ALS_JOR D.FF-3	ALS.BLAND.ALS_J ORD.FF-3			
Grouping	Analyte						
SOIL							
Leachable Metals	Strontium (Sr)-Leachable (mg/L)	0.00924	0.205				
	Sulfur (S)-Leachable (mg/L)	<0.50	5.56				
	Thallium (Tl)-Leachable (mg/L)	<0.000010	0.000044				
	Tin (Sn)-Leachable (mg/L)	<0.00010	<0.00010				
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010				
	Uranium (U)-Leachable (mg/L)	0.000120	0.00199				
	Vanadium (V)-Leachable (mg/L)	0.0011	0.0036				
	Zinc (Zn)-Leachable (mg/L)	0.0053	<0.0030				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2185140-1	L2185140-2			
		Description	Solid	Solid			
		Sampled Date	26-OCT-18	26-OCT-18			
		Sampled Time	12:00	12:00			
		Client ID	ALS.GLS.ALS_JOR D.FF-3	ALS.BLAND.ALS_J ORD.FF-3			
Grouping	Analyte						
WATER							
Sample Preparation	Total Volume In (mL)	500	500				
	Total Volume Out (mL)	485	480				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Antimony (Sb)-Leachable	MS-B	L2185140-1, -2
Matrix Spike	Arsenic (As)-Leachable	MS-B	L2185140-1, -2
Matrix Spike	Barium (Ba)-Leachable	MS-B	L2185140-1, -2
Matrix Spike	Calcium (Ca)-Leachable	MS-B	L2185140-1, -2
Matrix Spike	Magnesium (Mg)-Leachable	MS-B	L2185140-1, -2
Matrix Spike	Potassium (K)-Leachable	MS-B	L2185140-1, -2
Matrix Spike	Sodium (Na)-Leachable	MS-B	L2185140-1, -2
Matrix Spike	Strontium (Sr)-Leachable	MS-B	L2185140-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)

Reference Information

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-HCELL-F-VA Soil Ammonia - fluor. (H. Cell) ASTM D5744/J. ENV.MON. 2005-7,37-42, RSC

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-HCELL-IC-VA Soil Nitrite - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-HCELL-IC-VA Soil Nitrate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-HCELL-VA Soil pH - meter (H. Cell) ASTM D5744/APHA 4500-H pH Value

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

SO4-HCELL-IC-VA Soil Sulfate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg wwt - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 02-NOV-18
Report Date: 16-NOV-18 12:47 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2188736
Project P.O. #: Cycle#4
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Shane Stack
Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2188736-1	L2188736-2			
Description	Solid	Solid			
Sampled Date	02-NOV-18	02-NOV-18			
Sampled Time	12:00	12:00			
Client ID	ALS.GLS.ALS_JOR D.FF-4	ALS.BLAND.ALS_J ORD.FF-4			
Grouping	Analyte				
SOIL					
Physical Tests	Conductivity (uS/cm)	172	312		
	pH (pH)	8.72	8.26		
Anions and Nutrients	Acidity (as CaCO3) (mg/L)	<3.0	<3.0		
	Alkalinity, Total (as CaCO3) (mg/L)	95.5	148		
	Ammonia, Total (as N) (mg/L)	<0.0050	0.19		
	Bromide (Br) (mg/L)	<0.050	<0.050		
	Chloride (Cl) (mg/L)	<0.50	2.38		
	Fluoride (F) (mg/L)	0.021	0.307		
	Nitrate (as N) (mg/L)	<0.0050	2.64		
	Nitrite (as N) (mg/L)	<0.0010	0.0679		
	Sulfate (SO4) (mg/L)	1.38	10.7		
Leachable Metals	Aluminum (Al)-Leachable (mg/L)	0.0213	0.375		
	Antimony (Sb)-Leachable (mg/L)	0.0591	0.0546		
	Arsenic (As)-Leachable (mg/L)	1.80	0.0376		
	Barium (Ba)-Leachable (mg/L)	0.0576	0.0918		
	Beryllium (Be)-Leachable (mg/L)	<0.00010	<0.00010		
	Bismuth (Bi)-Leachable (mg/L)	<0.00050	<0.00050		
	Boron (B)-Leachable (mg/L)	0.024	0.068		
	Cadmium (Cd)-Leachable (mg/L)	0.000088	0.000026		
	Calcium (Ca)-Leachable (mg/L)	4.97	55.5		
	Chromium (Cr)-Leachable (mg/L)	<0.00050	0.00112		
	Cobalt (Co)-Leachable (mg/L)	0.00119	0.00030		
	Copper (Cu)-Leachable (mg/L)	0.00202	0.0101		
	Iron (Fe)-Leachable (mg/L)	<0.030	0.276		
	Lead (Pb)-Leachable (mg/L)	0.00330	0.000472		
	Lithium (Li)-Leachable (mg/L)	0.0044	<0.0010		
	Magnesium (Mg)-Leachable (mg/L)	0.139	4.77		
	Manganese (Mn)-Leachable (mg/L)	0.00907	0.0116		
	Mercury (Hg)-Leachable (mg/L)	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Leachable (mg/L)	0.000054	0.00377		
	Nickel (Ni)-Leachable (mg/L)	<0.00050	0.00235		
	Phosphorus (P)-Leachable (mg/L)	<0.30	<0.30		
	Potassium (K)-Leachable (mg/L)	0.767	7.63		
	Selenium (Se)-Leachable (mg/L)	0.00010	0.00058		
	Silicon (Si)-Leachable (mg/L)	28.6	5.51		
Silver (Ag)-Leachable (mg/L)	<0.000010	<0.000010			
Sodium (Na)-Leachable (mg/L)	36.8	4.05			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2188736-1 Solid 02-NOV-18 12:00 ALS.GLS.ALS_JOR D.FF-4	L2188736-2 Solid 02-NOV-18 12:00 ALS.BLAND.ALS_J ORD.FF-4		
Grouping	Analyte				
SOIL					
Leachable Metals	Strontium (Sr)-Leachable (mg/L)	0.0112	0.216		
	Sulfur (S)-Leachable (mg/L)	<0.50	3.71		
	Thallium (Tl)-Leachable (mg/L)	<0.000010	0.000030		
	Tin (Sn)-Leachable (mg/L)	<0.00010	<0.00010		
	Titanium (Ti)-Leachable (mg/L)	<0.010	0.017		
	Uranium (U)-Leachable (mg/L)	0.000088	0.00228		
	Vanadium (V)-Leachable (mg/L)	<0.0010	0.0035		
	Zinc (Zn)-Leachable (mg/L)	0.0042	0.0075		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2188736-1 Solid 02-NOV-18 12:00 ALS.GLS.ALS_JOR D.FF-4	L2188736-2 Solid 02-NOV-18 12:00 ALS.BLAND.ALS_J ORD.FF-4		
Grouping	Analyte				
WATER					
Sample Preparation	Total Volume In (mL)	500	500		
	Total Volume Out (mL)	490	475		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Boron (B)-Leachable	MS-B	L2188736-1, -2
Matrix Spike	Magnesium (Mg)-Leachable	MS-B	L2188736-1, -2
Matrix Spike	Molybdenum (Mo)-Leachable	MS-B	L2188736-1, -2
Matrix Spike	Silicon (Si)-Leachable	MS-B	L2188736-1, -2
Matrix Spike	Sodium (Na)-Leachable	MS-B	L2188736-1, -2
Matrix Spike	Strontium (Sr)-Leachable	MS-B	L2188736-1, -2
Matrix Spike	Uranium (U)-Leachable	MS-B	L2188736-1, -2
Matrix Spike	Vanadium (V)-Leachable	MS-B	L2188736-1, -2
Matrix Spike	Ammonia, Total (as N)	MS-B	L2188736-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)

Reference Information

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-HCELL-F-VA Soil Ammonia - fluor. (H. Cell) ASTM D5744/J. ENV.MON. 2005-7,37-42, RSC

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-HCELL-IC-VA Soil Nitrite - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-HCELL-IC-VA Soil Nitrate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-HCELL-VA Soil pH - meter (H. Cell) ASTM D5744/APHA 4500-H pH Value

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

SO4-HCELL-IC-VA Soil Sulfate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg wwt - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 09-NOV-18
Report Date: 23-NOV-18 11:13 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2192181
Project P.O. #: Cycle#5
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Shane Stack
Account Manager

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ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700
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ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2192181-1 Solid 09-NOV-18 12:00 ALS.GLS.ALS_JOR D.FF-5	L2192181-2 Solid 09-NOV-18 12:00 ALS.BLAND.ALS_J ORD.FF-5		
Grouping	Analyte				
SOIL					
Physical Tests	Conductivity (uS/cm)	149	309		
	pH (pH)	8.75	8.25		
Anions and Nutrients	Acidity (as CaCO3) (mg/L)	<3.0	<3.0		
	Alkalinity, Total (as CaCO3) (mg/L)	82.0	148		
	Ammonia, Total (as N) (mg/L)	<0.0050	0.0060		
	Bromide (Br) (mg/L)	<0.050	<0.050		
	Chloride (Cl) (mg/L)	<0.50	2.18		
	Fluoride (F) (mg/L)	<0.020	0.343		
	Nitrate (as N) (mg/L)	<0.0050	1.86		
	Nitrite (as N) (mg/L)	<0.0010	0.0115		
	Sulfate (SO4) (mg/L)	1.16	8.62		
	Leachable Metals	Aluminum (Al)-Leachable (mg/L)	0.0191	0.0815	
Antimony (Sb)-Leachable (mg/L)		0.0522	0.0524		
Arsenic (As)-Leachable (mg/L)		1.36	0.0370		
Barium (Ba)-Leachable (mg/L)		0.0738	0.0869		
Beryllium (Be)-Leachable (mg/L)		<0.00010	<0.00010		
Bismuth (Bi)-Leachable (mg/L)		<0.00050	<0.00050		
Boron (B)-Leachable (mg/L)		0.023	0.057		
Cadmium (Cd)-Leachable (mg/L)		0.000070	0.000014		
Calcium (Ca)-Leachable (mg/L)		4.98	56.4		
Chromium (Cr)-Leachable (mg/L)		<0.00050	0.00078		
Cobalt (Co)-Leachable (mg/L)		0.00110	0.00015		
Copper (Cu)-Leachable (mg/L)		0.00184	0.00751		
Iron (Fe)-Leachable (mg/L)		<0.030	0.069		
Lead (Pb)-Leachable (mg/L)		0.00402	0.000093		
Lithium (Li)-Leachable (mg/L)		0.0032	<0.0010		
Magnesium (Mg)-Leachable (mg/L)		0.143	4.72		
Manganese (Mn)-Leachable (mg/L)		0.00845	0.00155		
Mercury (Hg)-Leachable (mg/L)		<0.0000050	<0.0000050		
Molybdenum (Mo)-Leachable (mg/L)		<0.000050	0.00285		
Nickel (Ni)-Leachable (mg/L)		<0.00050	0.00178		
Phosphorus (P)-Leachable (mg/L)		<0.30	<0.30		
Potassium (K)-Leachable (mg/L)		0.667	6.64		
Selenium (Se)-Leachable (mg/L)		<0.00010	0.00053		
Silicon (Si)-Leachable (mg/L)		28.2	5.18		
Silver (Ag)-Leachable (mg/L)		<0.000010	<0.000010		
Sodium (Na)-Leachable (mg/L)	30.1	3.14			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2192181-1	L2192181-2			
		Description	Solid	Solid			
		Sampled Date	09-NOV-18	09-NOV-18			
		Sampled Time	12:00	12:00			
		Client ID	ALS.GLS.ALS_JOR D.FF-5	ALS.BLAND.ALS_J ORD.FF-5			
Grouping	Analyte						
SOIL							
Leachable Metals	Strontium (Sr)-Leachable (mg/L)	0.0105	0.213				
	Sulfur (S)-Leachable (mg/L)	<0.50	3.18				
	Thallium (Tl)-Leachable (mg/L)	<0.000010	0.000018				
	Tin (Sn)-Leachable (mg/L)	<0.00010	<0.00010				
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010				
	Uranium (U)-Leachable (mg/L)	0.000070	0.00250				
	Vanadium (V)-Leachable (mg/L)	<0.0010	0.0027				
	Zinc (Zn)-Leachable (mg/L)	0.0039	<0.0030				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2192181-1	L2192181-2			
		Description	Solid	Solid			
		Sampled Date	09-NOV-18	09-NOV-18			
		Sampled Time	12:00	12:00			
		Client ID	ALS.GLS.ALS_JOR D.FF-5	ALS.BLAND.ALS_J ORD.FF-5			
Grouping	Analyte						
WATER							
Sample Preparation	Total Volume In (mL)	500	500				
	Total Volume Out (mL)	480	475				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Leachable	MS-B	L2192181-1, -2
Matrix Spike	Calcium (Ca)-Leachable	MS-B	L2192181-1, -2
Matrix Spike	Magnesium (Mg)-Leachable	MS-B	L2192181-1, -2
Matrix Spike	Strontium (Sr)-Leachable	MS-B	L2192181-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.			
Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			

Reference Information

NH3-HCELL-F-VA	Soil	Ammonia - fluor. (H. Cell)	ASTM D5744/J. ENV.MON. 2005-7,37-42, RSC
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.			
NO2-HCELL-IC-VA	Soil	Nitrite - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-HCELL-IC-VA	Soil	Nitrate - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
PH-HCELL-VA	Soil	pH - meter (H. Cell)	ASTM D5744/APHA 4500-H pH Value
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.			
SO4-HCELL-IC-VA	Soil	Sulfate - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg wwt - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 16-NOV-18
Report Date: 27-NOV-18 18:44 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2195209
Project P.O. #: Cycle#6
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Shane Stack
Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2195209-1	L2195209-2
		Description	Solid	Solid
		Sampled Date	16-NOV-18	16-NOV-18
		Sampled Time	12:00	12:00
		Client ID	ALS.GLS.ALS_JOR D.FF-6	ALS.BLAND.ALS_J ORD.FF-6
Grouping	Analyte			
SOIL				
Physical Tests	Conductivity (uS/cm)		120	253
	pH (pH)		8.96	8.14
Anions and Nutrients	Acidity (as CaCO3) (mg/L)		<3.0	<3.0
	Alkalinity, Total (as CaCO3) (mg/L)		67.0	127
	Ammonia, Total (as N) (mg/L)		<0.0050	0.0065
	Bromide (Br) (mg/L)		<0.050	<0.050
	Chloride (Cl) (mg/L)		<0.50	1.62
	Fluoride (F) (mg/L)		<0.020	0.408
	Nitrate (as N) (mg/L)		<0.0050	0.389
	Nitrite (as N) (mg/L)		<0.0010	0.0025
	Sulfate (SO4) (mg/L)		0.78	5.33
Leachable Metals	Aluminum (Al)-Leachable (mg/L)		0.0158	0.0813
	Antimony (Sb)-Leachable (mg/L)		0.0438	0.0525
	Arsenic (As)-Leachable (mg/L)		0.975	0.0368
	Barium (Ba)-Leachable (mg/L)		0.0732	0.0793
	Beryllium (Be)-Leachable (mg/L)		<0.00010	<0.00010
	Bismuth (Bi)-Leachable (mg/L)		<0.00050	<0.00050
	Boron (B)-Leachable (mg/L)		0.017	0.050
	Cadmium (Cd)-Leachable (mg/L)		0.000047	0.000012
	Calcium (Ca)-Leachable (mg/L)		4.40	45.8
	Chromium (Cr)-Leachable (mg/L)		<0.00050	0.00079
	Cobalt (Co)-Leachable (mg/L)		0.00083	0.00011
	Copper (Cu)-Leachable (mg/L)		0.00121	0.00670
	Iron (Fe)-Leachable (mg/L)		<0.030	0.073
	Lead (Pb)-Leachable (mg/L)		0.00328	0.000087
	Lithium (Li)-Leachable (mg/L)		0.0025	<0.0010
	Magnesium (Mg)-Leachable (mg/L)		0.112	3.42
	Manganese (Mn)-Leachable (mg/L)		0.00639	0.00172
	Mercury (Hg)-Leachable (mg/L)		<0.0000050	<0.0000050
	Molybdenum (Mo)-Leachable (mg/L)		0.000111	0.00242
	Nickel (Ni)-Leachable (mg/L)		<0.00050	0.00153
	Phosphorus (P)-Leachable (mg/L)		<0.30	<0.30
	Potassium (K)-Leachable (mg/L)		0.538	5.73
	Selenium (Se)-Leachable (mg/L)		0.00010	0.00053
	Silicon (Si)-Leachable (mg/L)		20.5	4.68
Silver (Ag)-Leachable (mg/L)		<0.000010	<0.000010	
Sodium (Na)-Leachable (mg/L)		24.5	2.50	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2195209-1 Solid 16-NOV-18 12:00 ALS.GLS.ALS_JOR D.FF-6	L2195209-2 Solid 16-NOV-18 12:00 ALS.BLAND.ALS_J ORD.FF-6		
Grouping	Analyte				
SOIL					
Leachable Metals	Strontium (Sr)-Leachable (mg/L)	0.00901	0.176		
	Sulfur (S)-Leachable (mg/L)	<0.50	1.89		
	Thallium (Tl)-Leachable (mg/L)	<0.000010	0.000017		
	Tin (Sn)-Leachable (mg/L)	<0.00010	<0.00010		
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010		
	Uranium (U)-Leachable (mg/L)	0.000054	0.00203		
	Vanadium (V)-Leachable (mg/L)	<0.0010	0.0028		
	Zinc (Zn)-Leachable (mg/L)	0.0032	0.0034		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2195209-1 Solid 16-NOV-18 12:00 ALS.GLS.ALS_JOR D.FF-6	L2195209-2 Solid 16-NOV-18 12:00 ALS.BLAND.ALS_J ORD.FF-6		
Grouping	Analyte				
WATER					
Sample Preparation	Total Volume In (mL)	500	500		
	Total Volume Out (mL)	485	490		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Antimony (Sb)-Leachable	MS-B	L2195209-1, -2
Matrix Spike	Arsenic (As)-Leachable	MS-B	L2195209-1, -2
Matrix Spike	Barium (Ba)-Leachable	MS-B	L2195209-1, -2
Matrix Spike	Calcium (Ca)-Leachable	MS-B	L2195209-1, -2
Matrix Spike	Silicon (Si)-Leachable	MS-B	L2195209-1, -2
Matrix Spike	Sodium (Na)-Leachable	MS-B	L2195209-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.			

Reference Information

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-HCELL-F-VA Soil Ammonia - fluor. (H. Cell) ASTM D5744/J. ENV.MON. 2005-7,37-42, RSC
 Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-HCELL-IC-VA Soil Nitrite - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
 Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-HCELL-IC-VA Soil Nitrate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
 Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-HCELL-VA Soil pH - meter (H. Cell) ASTM D5744/APHA 4500-H pH Value
 Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

SO4-HCELL-IC-VA Soil Sulfate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
 Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg wwt - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 23-NOV-18
Report Date: 07-DEC-18 16:02 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2198606
Project P.O. #: Cycle#7
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Shane Stack
Account Manager

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ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700
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ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2198606-1 Solid 23-NOV-18 12:00 ALS.GLS.ALS_JOR D.FF-7	L2198606-2 Solid 23-NOV-18 12:00 ALS.BLAND.ALS_J ORD.FF-7		
Grouping	Analyte				
SOIL					
Physical Tests	Conductivity (uS/cm)	128	250		
	pH (pH)	8.62	8.20		
Anions and Nutrients	Acidity (as CaCO3) (mg/L)	<3.0	<3.0		
	Alkalinity, Total (as CaCO3) (mg/L)	72.3	130		
	Ammonia, Total (as N) (mg/L)	<0.0050	0.0099		
	Bromide (Br) (mg/L)	<0.050	<0.050		
	Chloride (Cl) (mg/L)	<0.50	1.71		
	Fluoride (F) (mg/L)	<0.020	0.368		
	Nitrate (as N) (mg/L)	<0.0050	0.0822		
	Nitrite (as N) (mg/L)	<0.0010	0.0012		
	Sulfate (SO4) (mg/L)	0.78	4.71		
Leachable Metals	Aluminum (Al)-Leachable (mg/L)	0.0167	0.0621		
	Antimony (Sb)-Leachable (mg/L)	0.0467	0.0511		
	Arsenic (As)-Leachable (mg/L)	0.936	0.0371		
	Barium (Ba)-Leachable (mg/L)	0.0760	0.0682		
	Beryllium (Be)-Leachable (mg/L)	<0.00010	<0.00010		
	Bismuth (Bi)-Leachable (mg/L)	<0.00050	<0.00050		
	Boron (B)-Leachable (mg/L)	0.021	0.052		
	Cadmium (Cd)-Leachable (mg/L)	0.000048	<0.000010		
	Calcium (Ca)-Leachable (mg/L)	4.23	44.9		
	Chromium (Cr)-Leachable (mg/L)	<0.00050	0.00066		
	Cobalt (Co)-Leachable (mg/L)	0.00091	0.00011		
	Copper (Cu)-Leachable (mg/L)	0.00134	0.00612		
	Iron (Fe)-Leachable (mg/L)	<0.030	0.037		
	Lead (Pb)-Leachable (mg/L)	0.00400	<0.000050		
	Lithium (Li)-Leachable (mg/L)	0.0024	<0.0010		
	Magnesium (Mg)-Leachable (mg/L)	0.111	3.37		
	Manganese (Mn)-Leachable (mg/L)	0.00720	0.00113		
	Mercury (Hg)-Leachable (mg/L)	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Leachable (mg/L)	0.000485	0.00236		
	Nickel (Ni)-Leachable (mg/L)	<0.00050	0.00126		
	Phosphorus (P)-Leachable (mg/L)	<0.30	<0.30		
	Potassium (K)-Leachable (mg/L)	0.519	5.26		
	Selenium (Se)-Leachable (mg/L)	0.00013	0.00041		
	Silicon (Si)-Leachable (mg/L)	21.0	4.75		
Silver (Ag)-Leachable (mg/L)	<0.000010	<0.000010			
Sodium (Na)-Leachable (mg/L)	26.3	2.05			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2198606-1	L2198606-2		
	Description	Solid	Solid		
	Sampled Date	23-NOV-18	23-NOV-18		
	Sampled Time	12:00	12:00		
	Client ID	ALS.GLS.ALS_JOR D.FF-7	ALS.BLAND.ALS_J ORD.FF-7		
Grouping	Analyte				
SOIL					
Leachable Metals	Strontium (Sr)-Leachable (mg/L)	0.00800	0.180		
	Sulfur (S)-Leachable (mg/L)	<0.50	1.95		
	Thallium (Tl)-Leachable (mg/L)	<0.000010	0.000014		
	Tin (Sn)-Leachable (mg/L)	<0.00010	<0.00010		
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010		
	Uranium (U)-Leachable (mg/L)	0.000052	0.00181		
	Vanadium (V)-Leachable (mg/L)	<0.0010	0.0027		
	Zinc (Zn)-Leachable (mg/L)	0.0032	<0.0030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2198606-1	L2198606-2			
		Description	Solid	Solid			
		Sampled Date	23-NOV-18	23-NOV-18			
		Sampled Time	12:00	12:00			
		Client ID	ALS.GLS.ALS_JOR D.FF-7	ALS.BLAND.ALS_J ORD.FF-7			
Grouping	Analyte						
WATER							
Sample Preparation	Total Volume In (mL)	500	500				
	Total Volume Out (mL)	490	445				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Antimony (Sb)-Leachable	MS-B	L2198606-1, -2
Matrix Spike	Arsenic (As)-Leachable	MS-B	L2198606-1, -2
Matrix Spike	Barium (Ba)-Leachable	MS-B	L2198606-1, -2
Matrix Spike	Calcium (Ca)-Leachable	MS-B	L2198606-1, -2
Matrix Spike	Silicon (Si)-Leachable	MS-B	L2198606-1, -2
Matrix Spike	Sodium (Na)-Leachable	MS-B	L2198606-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.			

Reference Information

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-HCELL-F-VA Soil Ammonia - fluor. (H. Cell) ASTM D5744/J. ENV.MON. 2005-7,37-42, RSC
 Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-HCELL-IC-VA Soil Nitrite - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
 Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-HCELL-IC-VA Soil Nitrate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
 Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-HCELL-VA Soil pH - meter (H. Cell) ASTM D5744/APHA 4500-H pH Value
 Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

SO4-HCELL-IC-VA Soil Sulfate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
 Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg wwt - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 30-NOV-18
Report Date: 14-DEC-18 12:54 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2201801
Project P.O. #: Cycle#8
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Shane Stack
Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2201801-1 Solid 30-NOV-18 12:00 ALS.GLS.ALS_JOR D.FF-8	L2201801-2 Solid 30-NOV-18 12:00 ALS.BLAND.ALS_J ORD.FF-8		
Grouping	Analyte				
SOIL					
Physical Tests	Conductivity (uS/cm)	123	236		
	pH (pH)	8.67	8.14		
Anions and Nutrients	Acidity (as CaCO3) (mg/L)	<3.0	<3.0		
	Alkalinity, Total (as CaCO3) (mg/L)	67.3	120		
	Ammonia, Total (as N) (mg/L)	<0.0050	0.0150		
	Bromide (Br) (mg/L)	<0.050	<0.050		
	Chloride (Cl) (mg/L)	<0.50	1.91		
	Fluoride (F) (mg/L)	<0.020	0.361		
	Nitrate (as N) (mg/L)	0.0057	0.0236		
	Nitrite (as N) (mg/L)	<0.0010	<0.0010		
	Sulfate (SO4) (mg/L)	0.91	4.67		
	Leachable Metals	Aluminum (Al)-Leachable (mg/L)	0.0428	0.111	
Antimony (Sb)-Leachable (mg/L)		0.0511	0.0545		
Arsenic (As)-Leachable (mg/L)		0.892	0.0385		
Barium (Ba)-Leachable (mg/L)		0.0815	0.0664		
Beryllium (Be)-Leachable (mg/L)		<0.00010	<0.00010		
Bismuth (Bi)-Leachable (mg/L)		<0.00050	<0.00050		
Boron (B)-Leachable (mg/L)		0.023	0.048		
Cadmium (Cd)-Leachable (mg/L)		0.000040	0.000012		
Calcium (Ca)-Leachable (mg/L)		4.10	46.9		
Chromium (Cr)-Leachable (mg/L)		<0.00050	0.00069		
Cobalt (Co)-Leachable (mg/L)		0.00098	<0.00010		
Copper (Cu)-Leachable (mg/L)		0.00163	0.00555		
Iron (Fe)-Leachable (mg/L)		<0.030	0.048		
Lead (Pb)-Leachable (mg/L)		0.00394	0.000080		
Lithium (Li)-Leachable (mg/L)		0.0021	<0.0010		
Magnesium (Mg)-Leachable (mg/L)		0.103	3.15		
Manganese (Mn)-Leachable (mg/L)		0.00639	0.00109		
Mercury (Hg)-Leachable (mg/L)		<0.0000050	<0.0000050		
Molybdenum (Mo)-Leachable (mg/L)		0.000640	0.00255		
Nickel (Ni)-Leachable (mg/L)		<0.00050	0.00105		
Phosphorus (P)-Leachable (mg/L)		<0.30	<0.30		
Potassium (K)-Leachable (mg/L)		0.528	5.00		
Selenium (Se)-Leachable (mg/L)		0.00010	0.00042		
Silicon (Si)-Leachable (mg/L)		21.1	4.50		
Silver (Ag)-Leachable (mg/L)		<0.000010	<0.000010		
Sodium (Na)-Leachable (mg/L)	27.1	1.85			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2201801-1	L2201801-2		
	Description	Solid	Solid		
	Sampled Date	30-NOV-18	30-NOV-18		
	Sampled Time	12:00	12:00		
	Client ID	ALS.GLS.ALS_JOR D.FF-8	ALS.BLAND.ALS_J ORD.FF-8		
Grouping	Analyte				
SOIL					
Leachable Metals	Strontium (Sr)-Leachable (mg/L)	0.00765	0.182		
	Sulfur (S)-Leachable (mg/L)	<0.50	1.72		
	Thallium (Tl)-Leachable (mg/L)	<0.000010	0.000013		
	Tin (Sn)-Leachable (mg/L)	<0.00010	<0.00010		
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010		
	Uranium (U)-Leachable (mg/L)	0.000041	0.00160		
	Vanadium (V)-Leachable (mg/L)	<0.0010	0.0026		
	Zinc (Zn)-Leachable (mg/L)	<0.0030	<0.0030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2201801-1 Solid 30-NOV-18 12:00 ALS.GLS.ALS_JOR D.FF-8	L2201801-2 Solid 30-NOV-18 12:00 ALS.BLAND.ALS_J ORD.FF-8		
Grouping	Analyte				
WATER					
Sample Preparation	Total Volume In (mL)	500	500		
	Total Volume Out (mL)	475	500		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Tin (Sn)-Leachable	MB-LOR	L2201801-1, -2
Matrix Spike	Antimony (Sb)-Leachable	MS-B	L2201801-1, -2
Matrix Spike	Arsenic (As)-Leachable	MS-B	L2201801-1, -2
Matrix Spike	Barium (Ba)-Leachable	MS-B	L2201801-1, -2
Matrix Spike	Calcium (Ca)-Leachable	MS-B	L2201801-1, -2
Matrix Spike	Silicon (Si)-Leachable	MS-B	L2201801-1, -2
Matrix Spike	Sodium (Na)-Leachable	MS-B	L2201801-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)

Reference Information

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-HCELL-F-VA Soil Ammonia - fluor. (H. Cell) ASTM D5744/J. ENV.MON. 2005-7,37-42, RSC

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-HCELL-IC-VA Soil Nitrite - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-HCELL-IC-VA Soil Nitrate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-HCELL-VA Soil pH - meter (H. Cell) ASTM D5744/APHA 4500-H pH Value

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

SO4-HCELL-IC-VA Soil Sulfate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg wwt - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 07-DEC-18
Report Date: 21-DEC-18 17:56 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2204977
Project P.O. #: Cycle#9
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Shane Stack
Account Manager

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ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700
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ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2204977-1 Solid 07-DEC-18 12:00 ALS.GLS.ALS_JOR D.FF-9	L2204977-2 Solid 07-DEC-18 12:00 ALS.BLAND.ALS_J ORD.FF-9		
Grouping	Analyte				
SOIL					
Physical Tests	Conductivity (uS/cm)	123	246		
	pH (pH)	8.44	8.01		
Anions and Nutrients	Acidity (as CaCO3) (mg/L)	<3.0	3.2		
	Alkalinity, Total (as CaCO3) (mg/L)	62.7	121		
	Ammonia, Total (as N) (mg/L)	<0.0050 ^{HTD}	0.0121		
	Bromide (Br) (mg/L)	<0.050	<0.050		
	Chloride (Cl) (mg/L)	<0.50	1.69		
	Fluoride (F) (mg/L)	<0.020	0.352		
	Nitrate (as N) (mg/L)	<0.0050	0.162		
	Nitrite (as N) (mg/L)	<0.0010	0.0027		
	Sulfate (SO4) (mg/L)	0.66	3.97		
	Leachable Metals	Aluminum (Al)-Leachable (mg/L)	0.0132	0.0534	
Antimony (Sb)-Leachable (mg/L)		0.0405	0.0481		
Arsenic (As)-Leachable (mg/L)		0.785	0.0383		
Barium (Ba)-Leachable (mg/L)		0.0947	0.0740		
Beryllium (Be)-Leachable (mg/L)		<0.00010	<0.00010		
Bismuth (Bi)-Leachable (mg/L)		<0.00050	<0.00050		
Boron (B)-Leachable (mg/L)		0.021	0.042		
Cadmium (Cd)-Leachable (mg/L)		0.000035	<0.000010		
Calcium (Ca)-Leachable (mg/L)		3.94	44.0		
Chromium (Cr)-Leachable (mg/L)		<0.00050	0.00067		
Cobalt (Co)-Leachable (mg/L)		0.00091	<0.00010		
Copper (Cu)-Leachable (mg/L)		0.00128	0.00497		
Iron (Fe)-Leachable (mg/L)		<0.030	<0.030		
Lead (Pb)-Leachable (mg/L)		0.00429	<0.000050		
Lithium (Li)-Leachable (mg/L)		0.0019	<0.0010		
Magnesium (Mg)-Leachable (mg/L)		0.106	3.39		
Manganese (Mn)-Leachable (mg/L)		0.00701	0.00076		
Mercury (Hg)-Leachable (mg/L)		<0.0000050	<0.0000050		
Molybdenum (Mo)-Leachable (mg/L)		0.000129	0.00219		
Nickel (Ni)-Leachable (mg/L)		<0.00050	0.00108		
Phosphorus (P)-Leachable (mg/L)		<0.30	<0.30		
Potassium (K)-Leachable (mg/L)		0.468	4.98		
Selenium (Se)-Leachable (mg/L)		<0.00010	0.00037		
Silicon (Si)-Leachable (mg/L)		17.3	4.74		
Silver (Ag)-Leachable (mg/L)		<0.000010	<0.000010		
Sodium (Na)-Leachable (mg/L)	23.3	1.55			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2204977-1	L2204977-2		
	Description	Solid	Solid		
	Sampled Date	07-DEC-18	07-DEC-18		
	Sampled Time	12:00	12:00		
	Client ID	ALS.GLS.ALS_JOR D.FF-9	ALS.BLAND.ALS_J ORD.FF-9		
Grouping	Analyte				
SOIL					
Leachable Metals	Strontium (Sr)-Leachable (mg/L)	0.00698	0.169		
	Sulfur (S)-Leachable (mg/L)	<0.50	1.58		
	Thallium (Tl)-Leachable (mg/L)	<0.000010	0.000011		
	Tin (Sn)-Leachable (mg/L)	<0.00010	<0.00010		
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010		
	Uranium (U)-Leachable (mg/L)	0.000044	0.00176		
	Vanadium (V)-Leachable (mg/L)	<0.0010	0.0025		
	Zinc (Zn)-Leachable (mg/L)	0.0030	<0.0030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2204977-1	L2204977-2			
		Description	Solid	Solid			
		Sampled Date	07-DEC-18	07-DEC-18			
		Sampled Time	12:00	12:00			
		Client ID	ALS.GLS.ALS_JOR D.FF-9	ALS.BLAND.ALS_J ORD.FF-9			
Grouping	Analyte						
WATER							
Sample Preparation	Total Volume In (mL)		500	500			
	Total Volume Out (mL)		480	470			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Tin (Sn)-Leachable	B	L2204977-1, -2
Matrix Spike	Barium (Ba)-Leachable	MS-B	L2204977-1, -2
Matrix Spike	Calcium (Ca)-Leachable	MS-B	L2204977-1, -2
Matrix Spike	Magnesium (Mg)-Leachable	MS-B	L2204977-1, -2
Matrix Spike	Strontium (Sr)-Leachable	MS-B	L2204977-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
B	Method Blank exceeds ALS DQO. Associated sample results which are < Limit of Reporting or > 5 times blank level are considered reliable.
HTD	Hold time exceeded for re-analysis or dilution, but initial testing was conducted within hold time.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 14-DEC-18
Report Date: 31-DEC-18 15:23 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2209695
Project P.O. #: Cycle#10
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Shane Stack
Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2209695-1	L2209695-2			
Description	Solid	Solid			
Sampled Date	14-DEC-18	14-DEC-18			
Sampled Time	12:00	12:00			
Client ID	ALS.GLS.ALS_JOR D.FF-10	ALS.BLAND.ALS_J ORD.FF-10			
Grouping	Analyte				
SOIL					
Physical Tests	Conductivity (uS/cm)	126	248		
	pH (pH)	8.62	8.33		
Anions and Nutrients	Acidity (as CaCO3) (mg/L)	<3.0	<3.0		
	Alkalinity, Total (as CaCO3) (mg/L)	64.6	122		
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050		
	Bromide (Br) (mg/L)	<0.050	<0.050		
	Chloride (Cl) (mg/L)	<0.50	1.80		
	Fluoride (F) (mg/L)	<0.020	0.376		
	Nitrate (as N) (mg/L)	<0.0050	<0.0050		
	Nitrite (as N) (mg/L)	<0.0010	<0.0010		
	Sulfate (SO4) (mg/L)	0.48	3.41		
	Leachable Metals	Aluminum (Al)-Leachable (mg/L)	0.0139	0.0865	
Antimony (Sb)-Leachable (mg/L)		0.0457	0.0510		
Arsenic (As)-Leachable (mg/L)		0.836	0.0440		
Barium (Ba)-Leachable (mg/L)		0.114	0.0669		
Beryllium (Be)-Leachable (mg/L)		<0.00010	<0.00010		
Bismuth (Bi)-Leachable (mg/L)		<0.00050	<0.00050		
Boron (B)-Leachable (mg/L)		0.024	0.042		
Cadmium (Cd)-Leachable (mg/L)		0.000032	<0.000010		
Calcium (Ca)-Leachable (mg/L)		4.48	44.8		
Chromium (Cr)-Leachable (mg/L)		<0.00050	0.00063		
Cobalt (Co)-Leachable (mg/L)		0.00090	<0.00010		
Copper (Cu)-Leachable (mg/L)		0.00124	0.00513		
Iron (Fe)-Leachable (mg/L)		<0.030	0.039		
Lead (Pb)-Leachable (mg/L)		0.00454	0.000054		
Lithium (Li)-Leachable (mg/L)		0.0019	<0.0010		
Magnesium (Mg)-Leachable (mg/L)		0.112	3.17		
Manganese (Mn)-Leachable (mg/L)		0.00634	0.00084		
Mercury (Hg)-Leachable (mg/L)		<0.0000050	<0.0000050		
Molybdenum (Mo)-Leachable (mg/L)		<0.000050	0.00253		
Nickel (Ni)-Leachable (mg/L)		<0.00050	0.00100		
Phosphorus (P)-Leachable (mg/L)		<0.30	<0.30		
Potassium (K)-Leachable (mg/L)		0.517	5.11		
Selenium (Se)-Leachable (mg/L)		<0.00010	0.00038		
Silicon (Si)-Leachable (mg/L)		23.3	4.96		
Silver (Ag)-Leachable (mg/L)		<0.000010	<0.000010		
Sodium (Na)-Leachable (mg/L)	24.4	1.62			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2209695-1	L2209695-2			
		Description	Solid	Solid			
		Sampled Date	14-DEC-18	14-DEC-18			
		Sampled Time	12:00	12:00			
		Client ID	ALS.GLS.ALS_JOR D.FF-10	ALS.BLAND.ALS_J ORD.FF-10			
Grouping	Analyte						
SOIL							
Leachable Metals	Strontium (Sr)-Leachable (mg/L)	0.00798	0.170				
	Sulfur (S)-Leachable (mg/L)	<0.50	1.50				
	Thallium (Tl)-Leachable (mg/L)	<0.000010	0.000011				
	Tin (Sn)-Leachable (mg/L)	<0.00010	<0.00010				
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010				
	Uranium (U)-Leachable (mg/L)	0.000036	0.00197				
	Vanadium (V)-Leachable (mg/L)	<0.0010	0.0028				
	Zinc (Zn)-Leachable (mg/L)	<0.0030	<0.0030				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2209695-1 Solid 14-DEC-18 12:00 ALS.GLS.ALS_JOR D.FF-10	L2209695-2 Solid 14-DEC-18 12:00 ALS.BLAND.ALS_J ORD.FF-10		
Grouping	Analyte				
WATER					
Sample Preparation	Total Volume In (mL)	500	500		
	Total Volume Out (mL)	475	480		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Aluminum (Al)-Leachable	MS-B	L2209695-1, -2
Matrix Spike	Calcium (Ca)-Leachable	MS-B	L2209695-1, -2
Matrix Spike	Cobalt (Co)-Leachable	MS-B	L2209695-1, -2
Matrix Spike	Copper (Cu)-Leachable	MS-B	L2209695-1, -2
Matrix Spike	Iron (Fe)-Leachable	MS-B	L2209695-1, -2
Matrix Spike	Magnesium (Mg)-Leachable	MS-B	L2209695-1, -2
Matrix Spike	Manganese (Mn)-Leachable	MS-B	L2209695-1, -2
Matrix Spike	Strontium (Sr)-Leachable	MS-B	L2209695-1, -2
Matrix Spike	Sulfur (S)-Leachable	MS-B	L2209695-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)

Reference Information

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-HCELL-F-VA Soil Ammonia - fluor. (H. Cell) ASTM D5744/J. ENV.MON. 2005-7,37-42, RSC

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-HCELL-IC-VA Soil Nitrite - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-HCELL-IC-VA Soil Nitrate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-HCELL-VA Soil pH - meter (H. Cell) ASTM D5744/APHA 4500-H pH Value

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

SO4-HCELL-IC-VA Soil Sulfate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg wwt - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 21-DEC-18
Report Date: 07-JAN-19 18:38 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2213536
Project P.O. #: Cycle#11
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Shane Stack
Account Manager

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ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700
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ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2213536-1	L2213536-2		
		Description	Solid	Solid		
		Sampled Date	21-DEC-18	21-DEC-18		
		Sampled Time	12:00	12:00		
		Client ID	ALS.GLS.ALS_JOR D.FF-11	ALS.BLAND.ALS_J ORD.FF-11		
Grouping	Analyte					
SOIL						
Physical Tests	Conductivity (uS/cm)	112	219			
	pH (pH)	8.63	8.17			
Anions and Nutrients	Acidity (as CaCO3) (mg/L)	<3.0	<3.0			
	Alkalinity, Total (as CaCO3) (mg/L)	63.5	115			
	Ammonia, Total (as N) (mg/L)	<0.0050	0.0077			
	Bromide (Br) (mg/L)	<0.050	<0.050			
	Chloride (Cl) (mg/L)	<0.50	1.72			
	Fluoride (F) (mg/L)	<0.020	0.352			
	Nitrate (as N) (mg/L)	0.0078	0.104			
	Nitrite (as N) (mg/L)	<0.0010	<0.0010			
	Sulfate (SO4) (mg/L)	0.36	2.93			
	Leachable Metals	Aluminum (Al)-Leachable (mg/L)	0.0108	0.0739		
Antimony (Sb)-Leachable (mg/L)		0.0440	0.0508			
Arsenic (As)-Leachable (mg/L)		0.740	0.0415			
Barium (Ba)-Leachable (mg/L)		0.114	0.0640			
Beryllium (Be)-Leachable (mg/L)		<0.00010	<0.00010			
Bismuth (Bi)-Leachable (mg/L)		<0.00050	<0.00050			
Boron (B)-Leachable (mg/L)		0.025	0.040			
Cadmium (Cd)-Leachable (mg/L)		0.000026	<0.000010			
Calcium (Ca)-Leachable (mg/L)		4.31	42.0			
Chromium (Cr)-Leachable (mg/L)		<0.00050	0.00075			
Cobalt (Co)-Leachable (mg/L)		0.00077	<0.00010			
Copper (Cu)-Leachable (mg/L)		0.00116	0.00503			
Iron (Fe)-Leachable (mg/L)		<0.030	0.050			
Lead (Pb)-Leachable (mg/L)		0.00419	0.000074			
Lithium (Li)-Leachable (mg/L)		0.0018	<0.0010			
Magnesium (Mg)-Leachable (mg/L)		0.103	2.69			
Manganese (Mn)-Leachable (mg/L)		0.00547	0.00089			
Mercury (Hg)-Leachable (mg/L)		<0.0000050	<0.0000050			
Molybdenum (Mo)-Leachable (mg/L)		<0.000050	0.00222			
Nickel (Ni)-Leachable (mg/L)		<0.00050	0.00088			
Phosphorus (P)-Leachable (mg/L)		<0.30	<0.30			
Potassium (K)-Leachable (mg/L)		0.480	4.63			
Selenium (Se)-Leachable (mg/L)		0.00014	0.00045			
Silicon (Si)-Leachable (mg/L)		22.3	4.91			
Silver (Ag)-Leachable (mg/L)	<0.000010	<0.000010				
Sodium (Na)-Leachable (mg/L)	23.1	1.36				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L2213536-1	L2213536-2			
Description	Solid	Solid			
Sampled Date	21-DEC-18	21-DEC-18			
Sampled Time	12:00	12:00			
Client ID	ALS.GLS.ALS_JOR D.FF-11	ALS.BLAND.ALS_J ORD.FF-11			
Grouping	Analyte				
SOIL					
Leachable Metals	Strontium (Sr)-Leachable (mg/L)	0.00744	0.160		
	Sulfur (S)-Leachable (mg/L)	<0.50	1.24		
	Thallium (Tl)-Leachable (mg/L)	<0.000010	0.000011		
	Tin (Sn)-Leachable (mg/L)	<0.00020 ^{DLB}	<0.00020 ^{DLB}		
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010		
	Uranium (U)-Leachable (mg/L)	0.000032	0.00174		
	Vanadium (V)-Leachable (mg/L)	<0.0010	0.0026		
	Zinc (Zn)-Leachable (mg/L)	0.0033	0.0087		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2213536-1 Solid 21-DEC-18 12:00 ALS.GLS.ALS_JOR D.FF-11	L2213536-2 Solid 21-DEC-18 12:00 ALS.BLAND.ALS_J ORD.FF-11		
Grouping	Analyte				
WATER					
Sample Preparation	Total Volume In (mL)	500	500		
	Total Volume Out (mL)	470	480		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Tin (Sn)-Leachable	MB-LOR	L2213536-1, -2
Matrix Spike	Silicon (Si)-Leachable	MS-B	L2213536-1, -2
Matrix Spike	Sodium (Na)-Leachable	MS-B	L2213536-1, -2
Matrix Spike	Vanadium (V)-Leachable	MS-B	L2213536-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLB	Detection Limit Raised. Analyte detected at comparable level in Method Blank.
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.			

Reference Information

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-HCELL-F-VA Soil Ammonia - fluor. (H. Cell) ASTM D5744/J. ENV.MON. 2005-7,37-42, RSC
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-HCELL-IC-VA Soil Nitrite - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-HCELL-IC-VA Soil Nitrate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-HCELL-VA Soil pH - meter (H. Cell) ASTM D5744/APHA 4500-H pH Value
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

SO4-HCELL-IC-VA Soil Sulfate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg wwt - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 28-DEC-18
Report Date: 11-JAN-19 12:02 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2213878
Project P.O. #: Cycle#12
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Shane Stack
Account Manager

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ALS CANADA LTD Part of the ALS Group An ALS Limited Company

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2213878-1	L2213878-2		
		Description	Solid	Solid		
		Sampled Date	28-DEC-18	28-DEC-18		
		Sampled Time	12:00	12:00		
		Client ID	ALS.GLS.ALS_JOR D.FF-12	ALS.BLAND.ALS_J ORD.FF-12		
Grouping	Analyte					
SOIL						
Physical Tests	Conductivity (uS/cm)	115	244			
	pH (pH)	9.15	8.23			
Anions and Nutrients	Acidity (as CaCO3) (mg/L)	<3.0	<3.0			
	Alkalinity, Total (as CaCO3) (mg/L)	64.7	124			
	Ammonia, Total (as N) (mg/L)	<0.0050	0.0172			
	Bromide (Br) (mg/L)	<0.050	<0.050			
	Chloride (Cl) (mg/L)	<0.50	1.87			
	Fluoride (F) (mg/L)	<0.020	0.368			
	Nitrate (as N) (mg/L)	0.0054	0.275			
	Nitrite (as N) (mg/L)	0.0012	0.0071			
	Sulfate (SO4) (mg/L)	<0.30	3.30			
	Leachable Metals	Aluminum (Al)-Leachable (mg/L)	0.0143	0.0748		
Antimony (Sb)-Leachable (mg/L)		0.0550	0.0542			
Arsenic (As)-Leachable (mg/L)		0.859	0.0439			
Barium (Ba)-Leachable (mg/L)		0.133	0.0658			
Beryllium (Be)-Leachable (mg/L)		<0.00010	<0.00010			
Bismuth (Bi)-Leachable (mg/L)		<0.00050	<0.00050			
Boron (B)-Leachable (mg/L)		0.028	0.037			
Cadmium (Cd)-Leachable (mg/L)		0.000029	<0.000010			
Calcium (Ca)-Leachable (mg/L)		5.46	47.5			
Chromium (Cr)-Leachable (mg/L)		<0.00050	0.00077			
Cobalt (Co)-Leachable (mg/L)		0.00074	<0.00010			
Copper (Cu)-Leachable (mg/L)		0.00099	0.00470			
Iron (Fe)-Leachable (mg/L)		<0.030	0.044			
Lead (Pb)-Leachable (mg/L)		0.00548	0.000062			
Lithium (Li)-Leachable (mg/L)		0.0016	<0.0010			
Magnesium (Mg)-Leachable (mg/L)		0.109	2.81			
Manganese (Mn)-Leachable (mg/L)		0.00509	0.00087			
Mercury (Hg)-Leachable (mg/L)		<0.0000050	0.0000058			
Molybdenum (Mo)-Leachable (mg/L)		<0.000050	0.00237			
Nickel (Ni)-Leachable (mg/L)		<0.00050	0.00086			
Phosphorus (P)-Leachable (mg/L)		<0.30	<0.30			
Potassium (K)-Leachable (mg/L)		0.492	4.62			
Selenium (Se)-Leachable (mg/L)		0.00014	0.00039			
Silicon (Si)-Leachable (mg/L)		37.8	5.14			
Silver (Ag)-Leachable (mg/L)	<0.000010	<0.000010				
Sodium (Na)-Leachable (mg/L)	21.4	1.31				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2213878-1	L2213878-2			
		Description	Solid	Solid			
		Sampled Date	28-DEC-18	28-DEC-18			
		Sampled Time	12:00	12:00			
		Client ID	ALS.GLS.ALS_JOR D.FF-12	ALS.BLAND.ALS_J ORD.FF-12			
Grouping	Analyte						
SOIL							
Leachable Metals	Strontium (Sr)-Leachable (mg/L)	0.00843	0.179				
	Sulfur (S)-Leachable (mg/L)	<0.50	1.27				
	Thallium (Tl)-Leachable (mg/L)	<0.000010	0.000011				
	Tin (Sn)-Leachable (mg/L)	<0.00010	<0.00010				
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010				
	Uranium (U)-Leachable (mg/L)	0.000028	0.00190				
	Vanadium (V)-Leachable (mg/L)	<0.0010	0.0026				
	Zinc (Zn)-Leachable (mg/L)	0.0031	<0.0030				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2213878-1 Solid 28-DEC-18 12:00 ALS.GLS.ALS_JOR D.FF-12	L2213878-2 Solid 28-DEC-18 12:00 ALS.BLAND.ALS_J ORD.FF-12		
Grouping	Analyte				
WATER					
Sample Preparation	Total Volume In (mL)	500	500		
	Total Volume Out (mL)	490	445		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Antimony (Sb)-Leachable	MS-B	L2213878-1, -2
Matrix Spike	Arsenic (As)-Leachable	MS-B	L2213878-1, -2
Matrix Spike	Barium (Ba)-Leachable	MS-B	L2213878-1, -2
Matrix Spike	Calcium (Ca)-Leachable	MS-B	L2213878-1, -2
Matrix Spike	Silicon (Si)-Leachable	MS-B	L2213878-1, -2
Matrix Spike	Sodium (Na)-Leachable	MS-B	L2213878-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.			

Reference Information

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-HCELL-F-VA Soil Ammonia - fluor. (H. Cell) ASTM D5744/J. ENV.MON. 2005-7,37-42, RSC
 Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-HCELL-IC-VA Soil Nitrite - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
 Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-HCELL-IC-VA Soil Nitrate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
 Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-HCELL-VA Soil pH - meter (H. Cell) ASTM D5744/APHA 4500-H pH Value
 Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

SO4-HCELL-IC-VA Soil Sulfate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
 Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg wwt - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 04-JAN-19
Report Date: 14-JAN-19 16:23 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2215789
Project P.O. #: Cycle#13
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Shane Stack
Account Manager

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ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2215789-1	L2215789-2		
		Description	Solid	Solid		
		Sampled Date	04-JAN-19	04-JAN-19		
		Sampled Time	12:00	12:00		
		Client ID	ALS.GLS.ALS_JOR D.FF-13	ALS.BLAND.ALS_J ORD.FF-13		
Grouping	Analyte					
SOIL						
Physical Tests	Conductivity (uS/cm)		101	214		
	pH (pH)		8.85	8.14		
Anions and Nutrients	Acidity (as CaCO3) (mg/L)		<3.0	<3.0		
	Alkalinity, Total (as CaCO3) (mg/L)		58.1	111		
	Ammonia, Total (as N) (mg/L)		0.0060	0.0145		
	Bromide (Br) (mg/L)		<0.050	<0.050		
	Chloride (Cl) (mg/L)		<0.50	1.32		
	Fluoride (F) (mg/L)		<0.020	0.343		
	Nitrate (as N) (mg/L)		<0.0050	0.260		
	Nitrite (as N) (mg/L)		<0.0010	0.0055		
	Sulfate (SO4) (mg/L)		0.35	2.79		
	Leachable Metals	Aluminum (Al)-Leachable (mg/L)		0.0104	0.0649	
Antimony (Sb)-Leachable (mg/L)			0.0390	0.0486		
Arsenic (As)-Leachable (mg/L)			0.625	0.0421		
Barium (Ba)-Leachable (mg/L)			0.145	0.0603		
Beryllium (Be)-Leachable (mg/L)			<0.00010	<0.00010		
Bismuth (Bi)-Leachable (mg/L)			<0.00050	<0.00050		
Boron (B)-Leachable (mg/L)			0.019	0.035		
Cadmium (Cd)-Leachable (mg/L)			0.000020	<0.000010		
Calcium (Ca)-Leachable (mg/L)			5.05	41.1		
Chromium (Cr)-Leachable (mg/L)			<0.00050	0.00063		
Cobalt (Co)-Leachable (mg/L)			0.00069	<0.00010		
Copper (Cu)-Leachable (mg/L)			0.00067	0.00432		
Iron (Fe)-Leachable (mg/L)			<0.030	0.041		
Lead (Pb)-Leachable (mg/L)			0.00383	0.000058		
Lithium (Li)-Leachable (mg/L)			0.0013	<0.0010		
Magnesium (Mg)-Leachable (mg/L)			0.125	2.63		
Manganese (Mn)-Leachable (mg/L)			0.00484	0.00074		
Mercury (Hg)-Leachable (mg/L)			<0.0000050	0.0000055		
Molybdenum (Mo)-Leachable (mg/L)			<0.000050	0.00186		
Nickel (Ni)-Leachable (mg/L)			<0.00050	0.00077		
Phosphorus (P)-Leachable (mg/L)			<0.30	<0.30		
Potassium (K)-Leachable (mg/L)			0.420	4.21		
Selenium (Se)-Leachable (mg/L)			<0.00010	0.00029		
Silicon (Si)-Leachable (mg/L)			23.2	4.84		
Silver (Ag)-Leachable (mg/L)			<0.000010	<0.000010		
Sodium (Na)-Leachable (mg/L)		19.7	1.21			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2215789-1	L2215789-2			
		Description	Solid	Solid			
		Sampled Date	04-JAN-19	04-JAN-19			
		Sampled Time	12:00	12:00			
		Client ID	ALS.GLS.ALS_JOR D.FF-13	ALS.BLAND.ALS_J ORD.FF-13			
Grouping	Analyte						
SOIL							
Leachable Metals	Strontium (Sr)-Leachable (mg/L)	0.00771	0.146				
	Sulfur (S)-Leachable (mg/L)	<0.50	0.74				
	Thallium (Tl)-Leachable (mg/L)	<0.000010	0.000010				
	Tin (Sn)-Leachable (mg/L)	<0.00010	<0.00010				
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010				
	Uranium (U)-Leachable (mg/L)	0.000039	0.00148				
	Vanadium (V)-Leachable (mg/L)	<0.0010	0.0024				
	Zinc (Zn)-Leachable (mg/L)	<0.0030	<0.0030				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2215789-1 Solid 04-JAN-19 12:00 ALS.GLS.ALS_JOR D.FF-13	L2215789-2 Solid 04-JAN-19 12:00 ALS.BLAND.ALS_J ORD.FF-13		
Grouping	Analyte				
WATER					
Sample Preparation	Total Volume In (mL)	500	500		
	Total Volume Out (mL)	450	540		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Leachable	MS-B	L2215789-1, -2
Matrix Spike	Calcium (Ca)-Leachable	MS-B	L2215789-1, -2
Matrix Spike	Magnesium (Mg)-Leachable	MS-B	L2215789-1, -2
Matrix Spike	Strontium (Sr)-Leachable	MS-B	L2215789-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.			
Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			

Reference Information

NH3-HCELL-F-VA Soil Ammonia - fluor. (H. Cell) ASTM D5744/J. ENV.MON. 2005-7,37-42, RSC

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-HCELL-IC-VA Soil Nitrite - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-HCELL-IC-VA Soil Nitrate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-HCELL-VA Soil pH - meter (H. Cell) ASTM D5744/APHA 4500-H pH Value

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

SO4-HCELL-IC-VA Soil Sulfate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg wwt - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 11-JAN-19
Report Date: 31-JAN-19 18:35 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2219267
Project P.O. #: Cycle#14
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Heather McKenzie
Account Manager

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ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700
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ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2219267-1	L2219267-2		
		Description	Solid	Solid		
		Sampled Date	11-JAN-19	11-JAN-19		
		Sampled Time	12:00	12:00		
		Client ID	ALS.GLS.ALS_JOR D.FF-14	ALS.BLAND.ALS_J ORD.FF-14		
Grouping	Analyte					
SOIL						
Physical Tests	Conductivity (uS/cm)		105	226		
	pH (pH)		8.62	8.17		
Anions and Nutrients	Acidity (as CaCO3) (mg/L)		<3.0	<3.0		
	Alkalinity, Total (as CaCO3) (mg/L)		54.6	99.6		
	Ammonia, Total (as N) (mg/L)		<0.0050	0.0080		
	Bromide (Br) (mg/L)		<0.050	<0.050		
	Chloride (Cl) (mg/L)		<0.50	1.43		
	Fluoride (F) (mg/L)		<0.020	0.350		
	Nitrate (as N) (mg/L)		<0.0050	1.45		
	Nitrite (as N) (mg/L)		<0.0010	0.0055		
	Sulfate (SO4) (mg/L)		0.33	2.91		
Leachable Metals	Aluminum (Al)-Leachable (mg/L)		0.0131	0.107		
	Antimony (Sb)-Leachable (mg/L)		0.0429	0.0560		
	Arsenic (As)-Leachable (mg/L)		0.672	0.0415		
	Barium (Ba)-Leachable (mg/L)		0.134	0.0569		
	Beryllium (Be)-Leachable (mg/L)		<0.00010	<0.00010		
	Bismuth (Bi)-Leachable (mg/L)		<0.00050	<0.00050		
	Boron (B)-Leachable (mg/L)		0.022	0.034		
	Cadmium (Cd)-Leachable (mg/L)		0.000023	<0.000010		
	Calcium (Ca)-Leachable (mg/L)		5.24	43.0		
	Chromium (Cr)-Leachable (mg/L)		<0.00050	0.00094		
	Cobalt (Co)-Leachable (mg/L)		0.00084	<0.00010		
	Copper (Cu)-Leachable (mg/L)		0.00089	0.00388		
	Iron (Fe)-Leachable (mg/L)		<0.030	0.068		
	Lead (Pb)-Leachable (mg/L)		0.00483	0.000114		
	Lithium (Li)-Leachable (mg/L)		0.0014	<0.0010		
	Magnesium (Mg)-Leachable (mg/L)		0.130	2.94		
	Manganese (Mn)-Leachable (mg/L)		0.00599	0.00122		
	Mercury (Hg)-Leachable (mg/L)		<0.0000050	<0.0000050		
	Molybdenum (Mo)-Leachable (mg/L)		<0.000050	0.00254		
	Nickel (Ni)-Leachable (mg/L)		<0.00050	0.00070		
	Phosphorus (P)-Leachable (mg/L)		<0.30	<0.30		
	Potassium (K)-Leachable (mg/L)		0.459	4.37		
	Selenium (Se)-Leachable (mg/L)		<0.00010	0.00022		
	Silicon (Si)-Leachable (mg/L)		22.9	5.54		
	Silver (Ag)-Leachable (mg/L)		<0.000010	<0.000010		
Sodium (Na)-Leachable (mg/L)		20.0	1.20			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2219267-1	L2219267-2			
		Description	Solid	Solid			
		Sampled Date	11-JAN-19	11-JAN-19			
		Sampled Time	12:00	12:00			
		Client ID	ALS.GLS.ALS_JOR D.FF-14	ALS.BLAND.ALS_J ORD.FF-14			
Grouping	Analyte						
SOIL							
Leachable Metals	Strontium (Sr)-Leachable (mg/L)	0.00815	0.165				
	Sulfur (S)-Leachable (mg/L)	<0.50	1.15				
	Thallium (Tl)-Leachable (mg/L)	<0.000010	<0.000010				
	Tin (Sn)-Leachable (mg/L)	<0.00010	<0.00010				
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010				
	Uranium (U)-Leachable (mg/L)	0.000031	0.00150				
	Vanadium (V)-Leachable (mg/L)	<0.0010	0.0026				
	Zinc (Zn)-Leachable (mg/L)	<0.0030	<0.0030				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2219267-1 Solid 11-JAN-19 12:00 ALS.GLS.ALS_JOR D.FF-14	L2219267-2 Solid 11-JAN-19 12:00 ALS.BLAND.ALS_J ORD.FF-14		
Grouping	Analyte				
WATER					
Sample Preparation	Total Volume In (mL)	500	500		
	Total Volume Out (mL)	500	450		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Molybdenum (Mo)-Leachable	MB-LOR	L2219267-1, -2
Matrix Spike	Antimony (Sb)-Leachable	MS-B	L2219267-1, -2
Matrix Spike	Arsenic (As)-Leachable	MS-B	L2219267-1, -2
Matrix Spike	Barium (Ba)-Leachable	MS-B	L2219267-1, -2
Matrix Spike	Calcium (Ca)-Leachable	MS-B	L2219267-1, -2
Matrix Spike	Magnesium (Mg)-Leachable	MS-B	L2219267-1, -2
Matrix Spike	Potassium (K)-Leachable	MS-B	L2219267-1, -2
Matrix Spike	Strontium (Sr)-Leachable	MS-B	L2219267-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)

Reference Information

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-HCELL-F-VA Soil Ammonia - fluor. (H. Cell) ASTM D5744/J. ENV.MON. 2005-7,37-42, RSC

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-HCELL-IC-VA Soil Nitrite - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NH3-HCELL-IC-VA Soil Nitrate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-HCELL-VA Soil pH - meter (H. Cell) ASTM D5744/APHA 4500-H pH Value

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

SO4-HCELL-IC-VA Soil Sulfate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg wwt - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 18-JAN-19
Report Date: 28-JAN-19 16:48 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2221886
Project P.O. #: Cycle#15
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Heather McKenzie
Account Manager

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ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700
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ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2221886-1	L2221886-2		
		Description	Solid	Solid		
		Sampled Date	18-JAN-19	18-JAN-19		
		Sampled Time	12:00	12:00		
		Client ID	ALS.GLS.ALS_JOR D.FF-15	ALS.BLAND.ALS_J ORD.FF-15		
Grouping	Analyte					
SOIL						
Physical Tests	Conductivity (uS/cm)		91.0	214		
	pH (pH)		8.20	8.20		
Anions and Nutrients	Acidity (as CaCO3) (mg/L)		<3.0	<3.0		
	Alkalinity, Total (as CaCO3) (mg/L)		46.6	106		
	Ammonia, Total (as N) (mg/L)		<0.0050	0.0150		
	Bromide (Br) (mg/L)		<0.050	<0.050		
	Chloride (Cl) (mg/L)		<0.50	1.32		
	Fluoride (F) (mg/L)		<0.020	0.336		
	Nitrate (as N) (mg/L)		<0.0050	0.592		
	Nitrite (as N) (mg/L)		<0.0010	0.0023		
	Sulfate (SO4) (mg/L)		0.54	2.45		
Leachable Metals	Aluminum (Al)-Leachable (mg/L)		0.0152	0.0780		
	Antimony (Sb)-Leachable (mg/L)		0.0393	0.0546		
	Arsenic (As)-Leachable (mg/L)		0.587	0.0438		
	Barium (Ba)-Leachable (mg/L)		0.141	0.0635		
	Beryllium (Be)-Leachable (mg/L)		<0.00010	<0.00010		
	Bismuth (Bi)-Leachable (mg/L)		<0.00050	<0.00050		
	Boron (B)-Leachable (mg/L)		0.018	0.030		
	Cadmium (Cd)-Leachable (mg/L)		0.000022	<0.000010		
	Calcium (Ca)-Leachable (mg/L)		4.37	38.6		
	Chromium (Cr)-Leachable (mg/L)		<0.00050	0.00071		
	Cobalt (Co)-Leachable (mg/L)		0.00078	<0.00010		
	Copper (Cu)-Leachable (mg/L)		0.00086	0.00381		
	Iron (Fe)-Leachable (mg/L)		<0.030	0.051		
	Lead (Pb)-Leachable (mg/L)		0.00527	0.000086		
	Lithium (Li)-Leachable (mg/L)		0.0012	<0.0010		
	Magnesium (Mg)-Leachable (mg/L)		0.0996	2.54		
	Manganese (Mn)-Leachable (mg/L)		0.00577	0.00094		
	Mercury (Hg)-Leachable (mg/L)		<0.0000050	0.0000050		
	Molybdenum (Mo)-Leachable (mg/L)		<0.000050	0.00169		
	Nickel (Ni)-Leachable (mg/L)		<0.00050	0.00081		
	Phosphorus (P)-Leachable (mg/L)		<0.30	<0.30		
	Potassium (K)-Leachable (mg/L)		0.392	4.00		
	Selenium (Se)-Leachable (mg/L)		<0.00010	0.00021		
	Silicon (Si)-Leachable (mg/L)		19.2	4.76		
	Silver (Ag)-Leachable (mg/L)		<0.000010	<0.000010		
Sodium (Na)-Leachable (mg/L)		16.9	1.02			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2221886-1 Solid 18-JAN-19 12:00 ALS.GLS.ALS_JOR D.FF-15	L2221886-2 Solid 18-JAN-19 12:00 ALS.BLAND.ALS_J ORD.FF-15		
Grouping	Analyte				
SOIL					
Leachable Metals	Strontium (Sr)-Leachable (mg/L)	0.00699	0.151		
	Sulfur (S)-Leachable (mg/L)	<0.50	0.81		
	Thallium (Tl)-Leachable (mg/L)	<0.000010	<0.000010		
	Tin (Sn)-Leachable (mg/L)	0.00011	<0.00010		
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010		
	Uranium (U)-Leachable (mg/L)	0.000027	0.00154		
	Vanadium (V)-Leachable (mg/L)	<0.0010	0.0027		
	Zinc (Zn)-Leachable (mg/L)	<0.0030	<0.0030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2221886-1 Solid 18-JAN-19 12:00 ALS.GLS.ALS_JOR D.FF-15	L2221886-2 Solid 18-JAN-19 12:00 ALS.BLAND.ALS_J ORD.FF-15		
Grouping	Analyte				
WATER					
Sample Preparation	Total Volume In (mL)	500	500		
	Total Volume Out (mL)	480	500		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Tin (Sn)-Leachable	MB-LOR	L2221886-1, -2
Matrix Spike	Antimony (Sb)-Leachable	MS-B	L2221886-1, -2
Matrix Spike	Arsenic (As)-Leachable	MS-B	L2221886-1, -2
Matrix Spike	Barium (Ba)-Leachable	MS-B	L2221886-1, -2
Matrix Spike	Calcium (Ca)-Leachable	MS-B	L2221886-1, -2
Matrix Spike	Magnesium (Mg)-Leachable	MS-B	L2221886-1, -2
Matrix Spike	Potassium (K)-Leachable	MS-B	L2221886-1, -2
Matrix Spike	Strontium (Sr)-Leachable	MS-B	L2221886-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)

Reference Information

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-HCELL-F-VA Soil Ammonia - fluor. (H. Cell) ASTM D5744/J. ENV.MON. 2005-7,37-42, RSC

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-HCELL-IC-VA Soil Nitrite - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NH3-HCELL-IC-VA Soil Nitrate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-HCELL-VA Soil pH - meter (H. Cell) ASTM D5744/APHA 4500-H pH Value

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

SO4-HCELL-IC-VA Soil Sulfate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg wwt - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 25-JAN-19
Report Date: 04-FEB-19 14:48 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2224275
Project P.O. #: Cycle#16
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Heather McKenzie
Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2224275-1	L2224275-2		
		Description	Solid	Solid		
		Sampled Date	25-JAN-19	25-JAN-19		
		Sampled Time	12:00	12:00		
		Client ID	ALS.GLS.ALS_JOR D.FF-16	ALS.BLAND.ALS_J ORD.FF-16		
Grouping	Analyte					
SOIL						
Physical Tests	Conductivity (uS/cm)		91.7	221		
	pH (pH)		8.67	8.24		
Anions and Nutrients	Acidity (as CaCO3) (mg/L)		<3.0	<3.0		
	Alkalinity, Total (as CaCO3) (mg/L)		46.8	105		
	Ammonia, Total (as N) (mg/L)		<0.0050	<0.0050		
	Bromide (Br) (mg/L)		<0.050	<0.050		
	Chloride (Cl) (mg/L)		<0.50	1.32		
	Fluoride (F) (mg/L)		<0.020	0.344		
	Nitrate (as N) (mg/L)		0.0067	1.34		
	Nitrite (as N) (mg/L)		<0.0010	0.0142		
	Sulfate (SO4) (mg/L)		0.35	2.37		
	Leachable Metals	Aluminum (Al)-Leachable (mg/L)		0.0118	0.0760	
Antimony (Sb)-Leachable (mg/L)			0.0384	0.0548		
Arsenic (As)-Leachable (mg/L)			0.611	0.0474		
Barium (Ba)-Leachable (mg/L)			0.149	0.0602		
Beryllium (Be)-Leachable (mg/L)			<0.00010	<0.00010		
Bismuth (Bi)-Leachable (mg/L)			<0.00050	<0.00050		
Boron (B)-Leachable (mg/L)			0.019	0.029		
Cadmium (Cd)-Leachable (mg/L)			0.000022	<0.000010		
Calcium (Ca)-Leachable (mg/L)			4.29	43.2		
Chromium (Cr)-Leachable (mg/L)			<0.00050	0.00090		
Cobalt (Co)-Leachable (mg/L)			0.00068	<0.00010		
Copper (Cu)-Leachable (mg/L)			0.00078	0.00361		
Iron (Fe)-Leachable (mg/L)			<0.030	0.038		
Lead (Pb)-Leachable (mg/L)			0.00413	0.000053		
Lithium (Li)-Leachable (mg/L)			0.0011	<0.0010		
Magnesium (Mg)-Leachable (mg/L)			0.0911	2.43		
Manganese (Mn)-Leachable (mg/L)			0.00451	0.00079		
Mercury (Hg)-Leachable (mg/L)			<0.0000050	<0.0000050		
Molybdenum (Mo)-Leachable (mg/L)			<0.000050	0.00165		
Nickel (Ni)-Leachable (mg/L)			<0.00050	0.00060		
Phosphorus (P)-Leachable (mg/L)			<0.30	<0.30		
Potassium (K)-Leachable (mg/L)			0.402	4.30		
Selenium (Se)-Leachable (mg/L)			<0.00010	0.00026		
Silicon (Si)-Leachable (mg/L)			21.2	5.09		
Silver (Ag)-Leachable (mg/L)		<0.000010	<0.000010			
Sodium (Na)-Leachable (mg/L)		17.8	1.02			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2224275-1	L2224275-2		
	Description	Solid	Solid		
	Sampled Date	25-JAN-19	25-JAN-19		
	Sampled Time	12:00	12:00		
	Client ID	ALS.GLS.ALS_JOR D.FF-16	ALS.BLAND.ALS_J ORD.FF-16		
Grouping	Analyte				
SOIL					
Leachable Metals	Strontium (Sr)-Leachable (mg/L)	0.00604	0.150		
	Sulfur (S)-Leachable (mg/L)	<0.50	0.84		
	Thallium (Tl)-Leachable (mg/L)	<0.000010	<0.000010		
	Tin (Sn)-Leachable (mg/L)	<0.00010	<0.00010		
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010		
	Uranium (U)-Leachable (mg/L)	0.000022	0.00149		
	Vanadium (V)-Leachable (mg/L)	<0.0010	0.0026		
	Zinc (Zn)-Leachable (mg/L)	<0.0030	<0.0030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2224275-1 Solid 25-JAN-19 12:00 ALS.GLS.ALS_JOR D.FF-16	L2224275-2 Solid 25-JAN-19 12:00 ALS.BLAND.ALS_J ORD.FF-16		
Grouping	Analyte				
WATER					
Sample Preparation	Total Volume In (mL)	500	500		
	Total Volume Out (mL)	495	470		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Antimony (Sb)-Leachable	MS-B	L2224275-1, -2
Matrix Spike	Arsenic (As)-Leachable	MS-B	L2224275-1, -2
Matrix Spike	Barium (Ba)-Leachable	MS-B	L2224275-1, -2
Matrix Spike	Calcium (Ca)-Leachable	MS-B	L2224275-1, -2
Matrix Spike	Magnesium (Mg)-Leachable	MS-B	L2224275-1, -2
Matrix Spike	Potassium (K)-Leachable	MS-B	L2224275-1, -2
Matrix Spike	Strontium (Sr)-Leachable	MS-B	L2224275-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.			

Reference Information

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-HCELL-F-VA Soil Ammonia - fluor. (H. Cell) ASTM D5744/J. ENV.MON. 2005-7,37-42, RSC
 Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-HCELL-IC-VA Soil Nitrite - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
 Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-HCELL-IC-VA Soil Nitrate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
 Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-HCELL-VA Soil pH - meter (H. Cell) ASTM D5744/APHA 4500-H pH Value
 Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

SO4-HCELL-IC-VA Soil Sulfate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
 Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg wwt - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 01-FEB-19
Report Date: 12-FEB-19 17:38 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2227528
Project P.O. #: Cycle#17
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Heather McKenzie
Account Manager

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ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700
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ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2227528-1	L2227528-2		
		Description	Solid	Solid		
		Sampled Date	01-FEB-19	01-FEB-19		
		Sampled Time	12:00	12:00		
		Client ID	ALS.GLS.ALS_JOR D.FF-17	ALS.BLAND.ALS_J ORD.FF-17		
Grouping	Analyte					
SOIL						
Physical Tests	Conductivity (uS/cm)		86.4	201		
	pH (pH)		8.55	8.19		
Anions and Nutrients	Acidity (as CaCO3) (mg/L)		<3.0	<3.0		
	Alkalinity, Total (as CaCO3) (mg/L)		46.7	105		
	Ammonia, Total (as N) (mg/L)		<0.0050	0.0084		
	Bromide (Br) (mg/L)		<0.050	<0.050		
	Chloride (Cl) (mg/L)		<0.50	1.20		
	Fluoride (F) (mg/L)		<0.020	0.358		
	Nitrate (as N) (mg/L)		<0.0050	0.756		
	Nitrite (as N) (mg/L)		<0.0010	<0.0010		
	Sulfate (SO4) (mg/L)		0.45	1.83		
Leachable Metals	Aluminum (Al)-Leachable (mg/L)		0.0144	0.0669		
	Antimony (Sb)-Leachable (mg/L)		0.0385	0.0567		
	Arsenic (As)-Leachable (mg/L)		0.608	0.0503		
	Barium (Ba)-Leachable (mg/L)		0.147	0.0555		
	Beryllium (Be)-Leachable (mg/L)		<0.00010	<0.00010		
	Bismuth (Bi)-Leachable (mg/L)		<0.00050	<0.00050		
	Boron (B)-Leachable (mg/L)		0.019	0.028		
	Cadmium (Cd)-Leachable (mg/L)		0.000019	0.000010		
	Calcium (Ca)-Leachable (mg/L)		4.59	38.8		
	Chromium (Cr)-Leachable (mg/L)		<0.00050	0.00074		
	Cobalt (Co)-Leachable (mg/L)		0.00075	<0.00010		
	Copper (Cu)-Leachable (mg/L)		0.00073	0.00343		
	Iron (Fe)-Leachable (mg/L)		<0.030	0.031		
	Lead (Pb)-Leachable (mg/L)		0.00472	0.000060		
	Lithium (Li)-Leachable (mg/L)		<0.0010	<0.0010		
	Magnesium (Mg)-Leachable (mg/L)		0.103	2.16		
	Manganese (Mn)-Leachable (mg/L)		0.00539	0.00063		
	Mercury (Hg)-Leachable (mg/L)		<0.0000050	<0.0000050		
	Molybdenum (Mo)-Leachable (mg/L)		<0.000050	0.00155		
	Nickel (Ni)-Leachable (mg/L)		<0.00050	0.00071		
	Phosphorus (P)-Leachable (mg/L)		<0.30	<0.30		
	Potassium (K)-Leachable (mg/L)		0.394	3.64		
	Selenium (Se)-Leachable (mg/L)		<0.00010	0.00025		
	Silicon (Si)-Leachable (mg/L)		22.3	4.96		
	Silver (Ag)-Leachable (mg/L)		<0.000010	<0.000010		
Sodium (Na)-Leachable (mg/L)		16.3	0.923			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2227528-1	L2227528-2			
		Description	Solid	Solid			
		Sampled Date	01-FEB-19	01-FEB-19			
		Sampled Time	12:00	12:00			
		Client ID	ALS.GLS.ALS_JOR D.FF-17	ALS.BLAND.ALS_J ORD.FF-17			
Grouping	Analyte						
SOIL							
Leachable Metals	Strontium (Sr)-Leachable (mg/L)		0.00659	0.141			
	Sulfur (S)-Leachable (mg/L)		<0.50	0.89			
	Thallium (Tl)-Leachable (mg/L)		<0.000010	<0.000010			
	Tin (Sn)-Leachable (mg/L)		<0.00010	<0.00010			
	Titanium (Ti)-Leachable (mg/L)		<0.010	<0.010			
	Uranium (U)-Leachable (mg/L)		0.000023	0.00141			
	Vanadium (V)-Leachable (mg/L)		<0.0010	0.0026			
	Zinc (Zn)-Leachable (mg/L)		0.0035	<0.0030			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2227528-1 Solid 01-FEB-19 12:00 ALS.GLS.ALS_JOR D.FF-17	L2227528-2 Solid 01-FEB-19 12:00 ALS.BLAND.ALS_J ORD.FF-17		
Grouping	Analyte				
WATER					
Sample Preparation	Total Volume In (mL)	500	500		
	Total Volume Out (mL)	500	500		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Leachable	MS-B	L2227528-1, -2
Matrix Spike	Calcium (Ca)-Leachable	MS-B	L2227528-1, -2
Matrix Spike	Magnesium (Mg)-Leachable	MS-B	L2227528-1, -2
Matrix Spike	Strontium (Sr)-Leachable	MS-B	L2227528-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.			
Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			

Reference Information

NH3-HCELL-F-VA Soil Ammonia - fluor. (H. Cell) ASTM D5744/J. ENV.MON. 2005-7,37-42, RSC

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-HCELL-IC-VA Soil Nitrite - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-HCELL-IC-VA Soil Nitrate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-HCELL-VA Soil pH - meter (H. Cell) ASTM D5744/APHA 4500-H pH Value

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

SO4-HCELL-IC-VA Soil Sulfate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg wwt - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 08-FEB-19
Report Date: 22-FEB-19 17:45 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2230228
Project P.O. #: Cycle#18
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Heather McKenzie
Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2230228-1 Solid 08-FEB-19 12:00 ALS.GLS.ALS_JOR D.FF-18	L2230228-2 Solid 08-FEB-19 12:00 ALS.BLAND.ALS_J ORD.FF-18		
Grouping	Analyte				
SOIL					
Physical Tests	Conductivity (uS/cm)	83.4	207		
	pH (pH)	8.57	8.13		
Anions and Nutrients	Acidity (as CaCO3) (mg/L)	<3.0	<3.0		
	Alkalinity, Total (as CaCO3) (mg/L)	45.8	94.5		
	Ammonia, Total (as N) (mg/L)	<0.0050	0.0180		
	Bromide (Br) (mg/L)	<0.050	<0.050		
	Chloride (Cl) (mg/L)	<0.50	1.20		
	Fluoride (F) (mg/L)	<0.020	0.348		
	Nitrate (as N) (mg/L)	<0.0050	1.59		
	Nitrite (as N) (mg/L)	<0.0010	0.0058		
	Sulfate (SO4) (mg/L)	0.33	2.43		
	Leachable Metals	Aluminum (Al)-Leachable (mg/L)	0.0110	0.0783	
Antimony (Sb)-Leachable (mg/L)		0.0374	0.0544		
Arsenic (As)-Leachable (mg/L)		0.585	0.0475		
Barium (Ba)-Leachable (mg/L)		0.128	0.0541		
Beryllium (Be)-Leachable (mg/L)		<0.00010	<0.00010		
Bismuth (Bi)-Leachable (mg/L)		<0.00050	<0.00050		
Boron (B)-Leachable (mg/L)		0.019	0.025		
Cadmium (Cd)-Leachable (mg/L)		0.000019	<0.000010		
Calcium (Ca)-Leachable (mg/L)		4.34	36.8		
Chromium (Cr)-Leachable (mg/L)		<0.00050	0.00089		
Cobalt (Co)-Leachable (mg/L)		0.00058	<0.00010		
Copper (Cu)-Leachable (mg/L)		0.00085	0.00318		
Iron (Fe)-Leachable (mg/L)		0.033	0.049		
Lead (Pb)-Leachable (mg/L)		0.00390	0.000075		
Lithium (Li)-Leachable (mg/L)		0.0011	<0.0010		
Magnesium (Mg)-Leachable (mg/L)		0.0945	2.32		
Manganese (Mn)-Leachable (mg/L)		0.00407	0.00089		
Mercury (Hg)-Leachable (mg/L)		<0.0000050	<0.0000050		
Molybdenum (Mo)-Leachable (mg/L)		<0.000050	0.00197		
Nickel (Ni)-Leachable (mg/L)		<0.00050	0.00063		
Phosphorus (P)-Leachable (mg/L)		<0.30	<0.30		
Potassium (K)-Leachable (mg/L)		0.377	3.64		
Selenium (Se)-Leachable (mg/L)		<0.00010	0.00030		
Silicon (Si)-Leachable (mg/L)		18.2	4.71		
Silver (Ag)-Leachable (mg/L)		<0.000010	<0.000010		
Sodium (Na)-Leachable (mg/L)	16.2	0.935			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2230228-1	L2230228-2			
		Description	Solid	Solid			
		Sampled Date	08-FEB-19	08-FEB-19			
		Sampled Time	12:00	12:00			
		Client ID	ALS.GLS.ALS_JOR D.FF-18	ALS.BLAND.ALS_J ORD.FF-18			
Grouping	Analyte						
SOIL							
Leachable Metals	Strontium (Sr)-Leachable (mg/L)	0.00640	0.154				
	Sulfur (S)-Leachable (mg/L)	<0.50	0.77				
	Thallium (Tl)-Leachable (mg/L)	<0.000010	<0.000010				
	Tin (Sn)-Leachable (mg/L)	0.00023	0.00012				
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010				
	Uranium (U)-Leachable (mg/L)	0.000022	0.00147				
	Vanadium (V)-Leachable (mg/L)	<0.0010	0.0025				
	Zinc (Zn)-Leachable (mg/L)	0.0040	0.0054				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2230228-1 Solid 08-FEB-19 12:00 ALS.GLS.ALS_JOR D.FF-18	L2230228-2 Solid 08-FEB-19 12:00 ALS.BLAND.ALS_J ORD.FF-18		
Grouping	Analyte				
WATER					
Sample Preparation	Total Volume In (mL)	500	500		
	Total Volume Out (mL)	475	485		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Aluminum (Al)-Leachable	MS-B	L2230228-1, -2
Matrix Spike	Calcium (Ca)-Leachable	MS-B	L2230228-1, -2
Matrix Spike	Cobalt (Co)-Leachable	MS-B	L2230228-1, -2
Matrix Spike	Copper (Cu)-Leachable	MS-B	L2230228-1, -2
Matrix Spike	Iron (Fe)-Leachable	MS-B	L2230228-1, -2
Matrix Spike	Magnesium (Mg)-Leachable	MS-B	L2230228-1, -2
Matrix Spike	Manganese (Mn)-Leachable	MS-B	L2230228-1, -2
Matrix Spike	Strontium (Sr)-Leachable	MS-B	L2230228-1, -2
Matrix Spike	Sulfur (S)-Leachable	MS-B	L2230228-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)

Reference Information

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-HCELL-F-VA Soil Ammonia - fluor. (H. Cell) ASTM D5744/J. ENV.MON. 2005-7,37-42, RSC

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-HCELL-IC-VA Soil Nitrite - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-HCELL-IC-VA Soil Nitrate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-HCELL-VA Soil pH - meter (H. Cell) ASTM D5744/APHA 4500-H pH Value

Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

SO4-HCELL-IC-VA Soil Sulfate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg wwt - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 15-FEB-19
Report Date: 05-MAR-19 12:02 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2233595
Project P.O. #: Cycle#19
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Heather McKenzie
Account Manager

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ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700
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ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2233595-1	L2233595-2		
		Description	Solid	Solid		
		Sampled Date	15-FEB-19	15-FEB-19		
		Sampled Time	12:00	12:00		
		Client ID	ALS.GLS.ALS_JOR D.FF-19	ALS.BLAND.ALS_J ORD.FF-19		
Grouping	Analyte					
SOIL						
Physical Tests	Conductivity (uS/cm)		84.7	203		
	pH (pH)		8.37	8.12		
Anions and Nutrients	Acidity (as CaCO3) (mg/L)		<3.0	<3.0		
	Alkalinity, Total (as CaCO3) (mg/L)		45.8	99.9		
	Ammonia, Total (as N) (mg/L)		0.0124	0.0216		
	Bromide (Br) (mg/L)		<0.050	<0.050		
	Chloride (Cl) (mg/L)		<0.50	1.06		
	Fluoride (F) (mg/L)		<0.020	0.329		
	Nitrate (as N) (mg/L)		0.0073	1.82		
	Nitrite (as N) (mg/L)		<0.0010	0.0081		
	Sulfate (SO4) (mg/L)		<0.30	1.65		
Leachable Metals	Aluminum (Al)-Leachable (mg/L)		0.0077	0.0671		
	Antimony (Sb)-Leachable (mg/L)		0.0326	0.0521		
	Arsenic (As)-Leachable (mg/L)		0.522	0.0447		
	Barium (Ba)-Leachable (mg/L)		0.150	0.0541		
	Beryllium (Be)-Leachable (mg/L)		<0.00010	<0.00010		
	Bismuth (Bi)-Leachable (mg/L)		<0.00050	<0.00050		
	Boron (B)-Leachable (mg/L)		0.018	0.024		
	Cadmium (Cd)-Leachable (mg/L)		0.000015	<0.000010		
	Calcium (Ca)-Leachable (mg/L)		4.27	36.1		
	Chromium (Cr)-Leachable (mg/L)		<0.00050	0.00067		
	Cobalt (Co)-Leachable (mg/L)		0.00056	<0.00010		
	Copper (Cu)-Leachable (mg/L)		<0.00050	0.00284		
	Iron (Fe)-Leachable (mg/L)		<0.030	0.038		
	Lead (Pb)-Leachable (mg/L)		0.00322	<0.000050		
	Lithium (Li)-Leachable (mg/L)		<0.0010	<0.0010		
	Magnesium (Mg)-Leachable (mg/L)		0.0975	2.02		
	Manganese (Mn)-Leachable (mg/L)		0.00400	0.00079		
	Mercury (Hg)-Leachable (mg/L)		<0.0000050	<0.0000050		
	Molybdenum (Mo)-Leachable (mg/L)		<0.000050	0.00131		
	Nickel (Ni)-Leachable (mg/L)		<0.00050	0.00054		
	Phosphorus (P)-Leachable (mg/L)		<0.30	<0.30		
	Potassium (K)-Leachable (mg/L)		0.354	3.30		
	Selenium (Se)-Leachable (mg/L)		<0.00010	0.00018		
	Silicon (Si)-Leachable (mg/L)		16.9	4.55		
Silver (Ag)-Leachable (mg/L)		<0.000010	<0.000010			
Sodium (Na)-Leachable (mg/L)		14.6	0.847			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2233595-1	L2233595-2		
	Description	Solid	Solid		
	Sampled Date	15-FEB-19	15-FEB-19		
	Sampled Time	12:00	12:00		
	Client ID	ALS.GLS.ALS_JOR D.FF-19	ALS.BLAND.ALS_J ORD.FF-19		
Grouping	Analyte				
SOIL					
Leachable Metals	Strontium (Sr)-Leachable (mg/L)	0.00631	0.146		
	Sulfur (S)-Leachable (mg/L)	<0.50	0.65		
	Thallium (Tl)-Leachable (mg/L)	<0.000010	<0.000010		
	Tin (Sn)-Leachable (mg/L)	<0.00010	<0.00010		
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010		
	Uranium (U)-Leachable (mg/L)	0.000024	0.00130		
	Vanadium (V)-Leachable (mg/L)	<0.0010	0.0024		
	Zinc (Zn)-Leachable (mg/L)	<0.0030	<0.0030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2233595-1	L2233595-2			
		Description	Solid	Solid			
		Sampled Date	15-FEB-19	15-FEB-19			
		Sampled Time	12:00	12:00			
		Client ID	ALS.GLS.ALS_JOR D.FF-19	ALS.BLAND.ALS_J ORD.FF-19			
Grouping	Analyte						
WATER							
Sample Preparation	Total Volume In (mL)	500	500				
	Total Volume Out (mL)	500	490				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Silicon (Si)-Leachable	MS-B	L2233595-1, -2
Matrix Spike	Sodium (Na)-Leachable	MS-B	L2233595-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.			
Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			
NH3-HCELL-F-VA	Soil	Ammonia - fluor. (H. Cell)	ASTM D5744/J. ENV.MON. 2005-7,37-42, RSC
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			

Reference Information

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-HCELL-IC-VA Soil Nitrite - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-HCELL-IC-VA Soil Nitrate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-HCELL-VA Soil pH - meter (H. Cell) ASTM D5744/APHA 4500-H pH Value
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

SO4-HCELL-IC-VA Soil Sulfate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg wwt - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 22-FEB-19
Report Date: 08-MAR-19 17:18 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2236165
Project P.O. #: Cycle#20
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Heather McKenzie
Account Manager

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ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2236165-1	L2236165-2		
		Description	Solid	Solid		
		Sampled Date	22-FEB-19	22-FEB-19		
		Sampled Time	12:00	12:00		
		Client ID	ALS.GLS.ALS_JOR D.FF-20	ALS.BLAND.ALS_J ORD.FF-20		
Grouping	Analyte					
SOIL						
Physical Tests	Conductivity (uS/cm)		81.8	201		
	pH (pH)		8.43	8.04		
Anions and Nutrients	Acidity (as CaCO3) (mg/L)		<3.0	<3.0		
	Alkalinity, Total (as CaCO3) (mg/L)		45.8	104		
	Ammonia, Total (as N) (mg/L)		<0.0050	0.0352		
	Bromide (Br) (mg/L)		<0.050	<0.050		
	Chloride (Cl) (mg/L)		<0.50	1.13		
	Fluoride (F) (mg/L)		<0.020	0.324		
	Nitrate (as N) (mg/L)		<0.0050	1.04		
	Nitrite (as N) (mg/L)		<0.0010	0.0041		
	Sulfate (SO4) (mg/L)		<0.30	1.75		
Leachable Metals	Aluminum (Al)-Leachable (mg/L)		0.0080	0.0589		
	Antimony (Sb)-Leachable (mg/L)		0.0369	0.0587		
	Arsenic (As)-Leachable (mg/L)		0.591	0.0499		
	Barium (Ba)-Leachable (mg/L)		0.144	0.0533		
	Beryllium (Be)-Leachable (mg/L)		<0.00010	<0.00010		
	Bismuth (Bi)-Leachable (mg/L)		<0.00050	<0.00050		
	Boron (B)-Leachable (mg/L)		0.019	0.025		
	Cadmium (Cd)-Leachable (mg/L)		0.000012	<0.000010		
	Calcium (Ca)-Leachable (mg/L)		3.87	35.8		
	Chromium (Cr)-Leachable (mg/L)		<0.00050	0.00061		
	Cobalt (Co)-Leachable (mg/L)		0.00059	<0.00010		
	Copper (Cu)-Leachable (mg/L)		0.00059	0.00295		
	Iron (Fe)-Leachable (mg/L)		<0.030	0.033		
	Lead (Pb)-Leachable (mg/L)		0.00357	0.000055		
	Lithium (Li)-Leachable (mg/L)		<0.0010	<0.0010		
	Magnesium (Mg)-Leachable (mg/L)		0.0887	2.23		
	Manganese (Mn)-Leachable (mg/L)		0.00395	0.00068		
	Mercury (Hg)-Leachable (mg/L)		<0.0000050	<0.0000050		
	Molybdenum (Mo)-Leachable (mg/L)		<0.000050	0.00140		
	Nickel (Ni)-Leachable (mg/L)		<0.00050	0.00058		
	Phosphorus (P)-Leachable (mg/L)		<0.30	<0.30		
	Potassium (K)-Leachable (mg/L)		0.357	3.54		
	Selenium (Se)-Leachable (mg/L)		0.00014	0.00035		
	Silicon (Si)-Leachable (mg/L)		20.5	5.18		
Silver (Ag)-Leachable (mg/L)		<0.000010	<0.000010			
Sodium (Na)-Leachable (mg/L)		16.1	0.916			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2236165-1	L2236165-2			
		Description	Solid	Solid			
		Sampled Date	22-FEB-19	22-FEB-19			
		Sampled Time	12:00	12:00			
		Client ID	ALS.GLS.ALS_JOR D.FF-20	ALS.BLAND.ALS_J ORD.FF-20			
Grouping	Analyte						
SOIL							
Leachable Metals	Strontium (Sr)-Leachable (mg/L)	0.00564	0.140				
	Sulfur (S)-Leachable (mg/L)	<0.50	0.89				
	Thallium (Tl)-Leachable (mg/L)	<0.000010	<0.000010				
	Tin (Sn)-Leachable (mg/L)	<0.00010	<0.00010				
	Titanium (Ti)-Leachable (mg/L)	<0.010	<0.010				
	Uranium (U)-Leachable (mg/L)	0.000019	0.00131				
	Vanadium (V)-Leachable (mg/L)	<0.0010	0.0025				
	Zinc (Zn)-Leachable (mg/L)	<0.0030	<0.0030				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2236165-1	L2236165-2			
		Description	Solid	Solid			
		Sampled Date	22-FEB-19	22-FEB-19			
		Sampled Time	12:00	12:00			
		Client ID	ALS.GLS.ALS_JOR D.FF-20	ALS.BLAND.ALS_J ORD.FF-20			
Grouping	Analyte						
WATER							
Sample Preparation	Total Volume In (mL)	500	500				
	Total Volume Out (mL)	480	500				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Antimony (Sb)-Leachable	MS-B	L2236165-1, -2
Matrix Spike	Arsenic (As)-Leachable	MS-B	L2236165-1, -2
Matrix Spike	Barium (Ba)-Leachable	MS-B	L2236165-1, -2
Matrix Spike	Calcium (Ca)-Leachable	MS-B	L2236165-1, -2
Matrix Spike	Magnesium (Mg)-Leachable	MS-B	L2236165-1, -2
Matrix Spike	Strontium (Sr)-Leachable	MS-B	L2236165-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ACY-HCELL-TITR-VA	Soil	Acidity - titration (H. Cell)	ASTM D5744/APHA 2310 Acidity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009)			
This analysis is carried out using procedures adapted from APHA Method 2310 "Acidity". Acidity is determined by potentiometric titration to a specified endpoint.			
Samples of industrial wastes, acid mine drainage, or other solutions that contain appreciable amounts of hydrolyzable metal ions such as aluminum, iron, and manganese may require hot peroxide treatment to ensure oxidation and hydrolysis of reduced forms of polyvalent cations. Acidity results may be highly variable if this procedure is not followed. Results in this report for 'Acidity (as CaCO3)' have not been peroxide treated.			
Lab deionized water is used in the creation of the samples for acidity testing. Although of very low ionic strength, the water does have pH <8.3, and hence inherent acidity, and may contribute measurable acidity levels near the limit of reporting.			
ALK-HCELL-TITR-VA	Soil	Alkalinity - titration (H. Cell)	ASTM D5744/APHA 2320 Alkalinity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-HCELL-IC-VA	Soil	Bromide - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CL-HCELL-IC-VA	Soil	Chloride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-HCELL-VA	Soil	Conductivity - meter (H. Cell)	ASTM D5744/APHA 2510 Conductivity
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-HCELL-VA	Soil	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
F-HCELL-IC-VA	Soil	Fluoride - IC (H. Cell)	ASTM D5744/EPA 300.1 (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HG-D-HCELL-CVAA-VA	Soil	Mercury CVAA (H. Cell)	ASTM D5744/APHA 3030B/EPA 1631E (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-HCELL-CCMS-VA	Soil	Metals (dis.) - ICPMS (H. Cell)	ASTM D5744/APHA 3030B/6020A (mod)
Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).			
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.			

Reference Information

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-HCELL-F-VA Soil Ammonia - fluor. (H. Cell) ASTM D5744/J. ENV.MON. 2005-7,37-42, RSC
 Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-HCELL-IC-VA Soil Nitrite - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
 Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-HCELL-IC-VA Soil Nitrate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
 Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-HCELL-VA Soil pH - meter (H. Cell) ASTM D5744/APHA 4500-H pH Value
 Leachate is prepared according to ASTM D5744 and MEND (Price, 2009).

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode.

SO4-HCELL-IC-VA Soil Sulfate - IC (H. Cell) ASTM D5744/EPA 300.1 (mod)
 Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

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The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

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mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

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N/A - Result not available. Refer to qualifier code and definition for explanation.

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Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



GOLDER ASSOCIATES AB
ATTN: Gustaf Sunden
FE 211 838 80
Froson ** *** **

Date Received: 22-FEB-19
Report Date: 21-MAR-19 18:03 (MT)
Version: FINAL

Client Phone: 468-506-3060

Certificate of Analysis

Lab Work Order #: L2236168
Project P.O. #: Cycle#Final Residue
Job Reference: SGU-GLASBRUKET I ALSTERBRO
C of C Numbers:
Legal Site Desc:

Heather McKenzie
Account Manager

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ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700
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ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID	L2236168-1	L2236168-2		
		Description	Solid	Solid		
		Sampled Date	22-FEB-19	22-FEB-19		
		Sampled Time	12:00	12:00		
		Client ID	ALS.GLS.ALS_JOR D.FF-FINAL RESIDUE	ALS.BLAND.ALS_J ORD.FF-FINAL RESIDUE		
Grouping	Analyte					
SOIL						
Sample Preparation	Initial Weight (g)	1000	814			
	Final-Weight (g)	998	809			

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
---------------	--------	------------------	--------------------

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----------------------------	---------------------

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

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mg/kg wwt - milligrams per kilogram based on wet weight of sample.

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N/A - Result not available. Refer to qualifier code and definition for explanation.

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Ankomstdatum **2018-10-31**
 Utfärdad **2018-12-17**

Golder Associates AB
Henrik Svanberg

Box 20127
104 60 Stockholm
Sweden

Projekt **1786406**

Analys: LMG2

Er beteckning	ALS.18GA03S.1					
	Residual					
Labnummer	U11526032					
Parameter	Resultat	Mätosäkerhet (±)	Enhet	Metod	Utf	Sign
Bortplockat material*	-----		%	1	I	ASAP
TS	-----	2.0	%	2	I	TV
SiO ₂ *	57.4		% TS	1	S	IDJO
Al ₂ O ₃ *	3.25		% TS	1	S	IDJO
CaO*	0.476		% TS	1	S	IDJO
Fe ₂ O ₃ *	0.703		% TS	1	S	IDJO
K ₂ O*	0.743		% TS	1	S	IDJO
MgO*	0.214		% TS	1	S	IDJO
MnO*	0.0469		% TS	1	S	IDJO
Na ₂ O*	0.628		% TS	1	S	IDJO
P ₂ O ₅ *	0.0340		% TS	1	S	IDJO
TiO ₂ *	0.221		% TS	1	S	IDJO
Summa*	63.7		% TS	1	I	IDJO
As*	1.42		mg/kg TS	1	S	DKA
B*	5.58		mg/kg TS	1	S	DKA
Ba*	146		mg/kg TS	1	S	IDJO
Be*	0.645		mg/kg TS	1	S	IDJO
Cd*	<0.02		mg/kg TS	1	S	DKA
Co*	1.99		mg/kg TS	1	S	DKA
Cr*	13.4		mg/kg TS	1	S	IDJO
Cu*	2.77		mg/kg TS	1	S	DKA
Hg*	<0.02		mg/kg TS	1	G	ELEN
Mo*	<0.5		mg/kg TS	1	S	DKA
Nb*	4.69		mg/kg TS	1	S	IDJO
Ni*	3.29		mg/kg TS	1	S	DKA
Pb*	4.39		mg/kg TS	1	S	ENMU
S*	606		mg/kg TS	1	S	DKA
Sb*	0.890		mg/kg TS	1	S	ENMU
Sc*	2.83		mg/kg TS	1	S	IDJO
Sn*	1.29		mg/kg TS	1	S	DKA
Sr*	67.5		mg/kg TS	1	S	IDJO
U*	0.944		mg/kg TS	1	S	IDJO
V*	16.0		mg/kg TS	1	S	IDJO
W*	<0.9		mg/kg TS	1	S	IDJO
Y*	4.91		mg/kg TS	1	S	IDJO
Zn*	19.8		mg/kg TS	1	S	DKA
Zr*	62.5		mg/kg TS	1	S	IDJO



	Metod
1	<p>Analysprovet har torkats vid 50°C och elementhalterna har TS-korrigerats till 105°C.</p> <p>Provet har behandlats enligt följande: Smältning med LiBO₂ och upplösning med HNO₃ enligt ASTM D3682: 2013 och ASTM D4503: 2008. Upplösning har skett med HNO₃/HCl/HF enligt SS EN 13656: 2003.</p> <p>Analys med ICP-SFMS har skett enligt SS EN ISO 17294-2: 2016 samt EPA-metod 200.8: 1994.</p> <p>Notera att rapporteringsgränser kan påverkas om det t.ex. finns behov av extra spädning pga provmatrisen men även om provmängden är begränsad.</p> <p>Reviderad 2018-04-26</p>
2	Analys enligt SS 02 81 13-1 Torrsubstansbestämning.

	Godkännare
ASAP	Åsa Apelqvist
DKA	Dan Krekula
ELEN	Elina Engström
ENMU	Enrico Muth
IDJO	Ida Jonsson
TV	Tiina Vikeväinen

	Utf ¹
G	AFS
I	Man.Inm.
S	ICP-SFMS

* efter parameternamn indikerar icke ackrediterad analys.

Mätosäkerheten anges som en utvidgad osäkerhet (enligt definitionen i "Evaluation of measurement data - Guide to the expression of uncertainty in measurement", JCGM 100:2008 Corrected version 2010) beräknad med täckningsfaktor lika med 2 vilket ger en konfidensnivå på ungefär 95%.

Mätosäkerhet anges endast för detekterade ämnen med halter över rapporteringsgränsen.

Mätosäkerhet från underleverantör anges oftast som en utvidgad osäkerhet beräknad med täckningsfaktor 2. För ytterligare information kontakta laboratoriet.

Denna rapport får endast återges i sin helhet, om inte utfärdande laboratorium i förväg skriftligen godkänt annat. Resultaten gäller endast det identifierade, mottagna och provade materialet.

Beträffande laboratoriets ansvar i samband med uppdrag, se aktuell produktkatalog eller vår webbplats www.alsglobal.se

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¹ Utförande teknisk enhet (inom ALS Scandinavia) eller anlitat laboratorium (underleverantör).

Rapport

Sida 1 (7)



L1832414

17XSDRAUJEE



Ankomstdatum **2018-11-08**
Utfärdad **2018-12-12**

Golder Associates AB
Henrik Svanberg

Box 20127
104 60 Stockholm
Sweden

Projekt **1781984**

Analys: LV3A

Er beteckning	ALS.GIs.18GASAML.1A					
	Steg 1					
Provtagare	Dan Hermansson					
Labnummer	U11529514					
Parameter	Resultat	Mätosäkerhet (\pm)	Enhet	Metod	Utf	Sign
Krossning & Malning *	ja		Stålfat	1	I	JOLU
TS innan lakning	99.6	2%	%	2	I	ANRE
Invägning *	1.1632		g	3	I	ANRE
Volym tillsatt *	41.6		ml	3	I	ANRE
Volym efter filtrering *	40		ml	3	I	ANRE
Ca	11.8	2.0	mg/l	1	R	EL
Fe	52.3	6.3	mg/l	1	R	EL
Mg	<2		mg/l	1	R	EL
Si	3.35	0.42	mg/l	1	R	EL
Al	149	31	μ g/l	1	H	NIPA
As	2720	468	μ g/l	1	H	NIPA
B	<400		μ g/l	1	R	EL
Ba	64.6	12.7	μ g/l	1	H	NIPA
Cd	1290	160	μ g/l	1	R	EL
Co	37.2	7.6	μ g/l	1	H	NIPA
Cr	105	21	μ g/l	1	H	NIPA
Cu	294	59	μ g/l	1	H	NIPA
Hg	<0.02		μ g/l	1	F	EVRI
Mn	573	68	μ g/l	1	R	EL
Mo	7.59	1.61	μ g/l	1	H	NIPA
Ni	96.6	19.5	μ g/l	1	H	NIPA
Pb	5090	877	μ g/l	1	R	EL
Sb	41.1	9.9	μ g/l	1	H	NIPA
Sr	<200		μ g/l	1	R	EL
V	3.42	0.72	μ g/l	1	H	NIPA
Zn	95.4	33.7	μ g/l	1	H	NIPA

Rapport

Sida 2 (7)



L1832414

17XSDRAUJEE



Er beteckning	ALS.GIs.18GASAML.1A					
	Steg 2					
Provtagare	Dan Hermansson					
Labnummer	U11529515					
Parameter	Resultat	Mätosäkerhet (\pm)	Enhet	Metod	Utf	Sign
TS innan lakning	99.6	2%	%	2	I	ANRE
Invägning*	1.1632		g	3	I	ANRE
Volym tillsatt*	112		ml	3	I	ANRE
Volym efter filtrering*	112		ml	3	I	ANRE
Ca	<4		mg/l	1	R	EL
Fe	0.886	0.295	mg/l	1	H	NIPA
Mg	<2		mg/l	1	R	EL
Si	14.0	1.7	mg/l	1	R	EL
Al	178	278	μ g/l	1	H	NIPA
As	279	61	μ g/l	1	H	NIPA
B	<400		μ g/l	1	R	EL
Ba	<10		μ g/l	1	H	NIPA
Cd	<3		μ g/l	1	H	NIPA
Co	6.04	5.36	μ g/l	1	H	NIPA
Cr	<30		μ g/l	1	H	NIPA
Cu	62.0	16.7	μ g/l	1	H	NIPA
Hg	<0.02		μ g/l	1	F	EVRI
Mn	42.0	27.2	μ g/l	1	H	NIPA
Mo	<30		μ g/l	1	H	NIPA
Ni	<30		μ g/l	1	H	NIPA
Pb	660	127	μ g/l	1	H	NIPA
Sb	37.4	9.7	μ g/l	1	H	NIPA
Sr	<200		μ g/l	1	R	EL
V	<3		μ g/l	1	H	NIPA
Zn	<100		μ g/l	1	H	NIPA

Rapport

Sida 3 (7)



L1832414

17XSDRAUJEE



Er beteckning	ALS.GIs.18GASAML.1A					
	Steg 3					
Provtagare	Dan Hermansson					
Labnummer	U11529516					
Parameter	Resultat	Mätosäkerhet (\pm)	Enhet	Metod	Utf	Sign
TS innan lakning	99.6	2%	%	2	I	ANRE
Invägning *	1.1632		g	3	I	ANRE
Volym tillsatt *	30		ml	3	I	ANRE
Volym efter filtrering *	30		ml	3	I	ANRE
Ca	13.2	2.1	mg/l	1	R	EL
Fe	9.63	1.17	mg/l	1	R	EL
Mg	<2		mg/l	1	R	EL
Si	7.47	0.94	mg/l	1	R	EL
Al	3200	634	μ g/l	1	H	NIPA
As	1520	260	μ g/l	1	H	NIPA
B	760	95	μ g/l	1	R	EL
Ba	43.8	8.7	μ g/l	1	H	NIPA
Cd	81.9	13.7	μ g/l	1	H	NIPA
Co	70.0	14.3	μ g/l	1	H	NIPA
Cr	39.0	7.9	μ g/l	1	H	NIPA
Cu	823	107	μ g/l	1	R	EL
Hg	<0.02		μ g/l	1	F	EVRI
Mn	153	32	μ g/l	1	H	NIPA
Mo	0.714	0.398	μ g/l	1	H	NIPA
Ni	15.9	3.2	μ g/l	1	H	NIPA
Pb	12900	2140	μ g/l	1	R	EL
Sb	71.7	17.3	μ g/l	1	H	NIPA
Sr	<200		μ g/l	1	R	EL
V	2.26	0.48	μ g/l	1	H	NIPA
Zn	92.7	32.7	μ g/l	1	H	NIPA

Rapport

Sida 4 (7)



L1832414

17XSDRAUJEE



Er beteckning	ALS.GIs.18GASAML.1A					
	Steg 4					
Provtagare	Dan Hermansson					
Labnummer	U11529517					
Parameter	Resultat	Mätosäkerhet (\pm)	Enhet	Metod	Utf	Sign
TS innan lakning	99.6	2%	%	2	I	ANRE
Invägning*	1.1632		g	3	I	ANRE
Volym tillsatt*	40		ml	3	I	ANRE
Volym efter filtrering*	37		ml	3	I	ANRE
Ca	14.8	2.2	mg/l	1	R	EL
Fe	1.21	0.15	mg/l	1	R	EL
Mg	<2		mg/l	1	R	EL
Si	2.32	0.32	mg/l	1	R	EL
Al	462	92	μ g/l	1	H	NIPA
As	984	169	μ g/l	1	H	NIPA
B	1100	144	μ g/l	1	R	EL
Ba	45.7	10.1	μ g/l	1	H	NIPA
Cd	33.8	5.7	μ g/l	1	H	NIPA
Co	60.9	12.5	μ g/l	1	H	NIPA
Cr	28.0	5.8	μ g/l	1	H	NIPA
Cu	1150	139	μ g/l	1	R	EL
Hg	<0.02		μ g/l	1	F	EVRI
Mn	55.9	11.7	μ g/l	1	H	NIPA
Mo	1.04	0.43	μ g/l	1	H	NIPA
Ni	9.24	2.18	μ g/l	1	H	NIPA
Pb	13400	2110	μ g/l	1	R	EL
Sb	186	45	μ g/l	1	H	NIPA
Sr	<200		μ g/l	1	R	EL
V	1.01	0.22	μ g/l	1	H	NIPA
Zn	80.6	28.4	μ g/l	1	H	NIPA

Rapport

Sida 5 (7)



L1832414

17XSDRAUJEE



Er beteckning	ALS.GIs.18GASAML.1A					
	Steg 5					
Provtagare	Dan Hermansson					
Labnummer	U11529518					
Parameter	Resultat	Mätosäkerhet (\pm)	Enhet	Metod	Utf	Sign
TS innan lakning	99.6	2%	%	2	I	ANRE
Invägning *	1.1632		g	3	I	ANRE
Volym tillsatt *	50		ml	3	I	ANRE
Volym efter filtrering *	50		ml	3	I	ANRE
Ca	<4		mg/l	1	R	EL
Fe	0.170	0.035	mg/l	1	H	NIPA
Mg	<2		mg/l	1	R	EL
Si	2.43	0.33	mg/l	1	R	EL
Al	406	80	μ g/l	1	H	NIPA
As	307	53	μ g/l	1	H	NIPA
B	<400		μ g/l	1	R	EL
Ba	3.55	0.75	μ g/l	1	H	NIPA
Cd	9.55	1.59	μ g/l	1	H	NIPA
Co	8.80	1.85	μ g/l	1	H	NIPA
Cr	14.2	2.9	μ g/l	1	H	NIPA
Cu	80.6	16.1	μ g/l	1	H	NIPA
Hg	0.202	0.022	μ g/l	1	F	EVRI
Mn	7.65	1.91	μ g/l	1	H	NIPA
Mo	0.900	0.435	μ g/l	1	H	NIPA
Ni	6.60	1.39	μ g/l	1	H	NIPA
Pb	1660	318	μ g/l	1	H	NIPA
Sb	30.7	7.4	μ g/l	1	H	NIPA
Sr	<200		μ g/l	1	R	EL
V	0.517	0.175	μ g/l	1	H	NIPA
Zn	64.6	22.7	μ g/l	1	H	NIPA

	Metod
1	<p>Analys av lakvatten. Vid analys av metaller har provet surgjorts med 1 ml salpetersyra(suprapur) per 100 ml. Vid analys av W har provet ej surgjorts. För analys av Ag har provet konserverats med HCl.</p> <p>Analys med ICP-SFMS har skett enligt SS EN ISO 17294-1, 2 (mod) samt EPA-metod 200.8 (mod). Analys med ICP-AES har skett enligt SS EN ISO 11885 (mod) samt EPA-metod 200.7 (mod). Analys av Hg med AFS har skett enligt SS EN ISO 17852.</p> <p>Notera att rapporteringsgränser kan påverkas om det t.ex. finns behov av extra spädning pga provmatrisen men även om provmängden är begränsad.</p> <p>Om laktestet har utförts av ALS i Luleå, för omräknade halter till mg/kg TS se rapport eller bilaga.</p>
2	Analys enligt SS 028113-1.
3	Provupparbetning.

	Godkännare
ANRE	Annika Reimhagen
EL	Erik Lidman
EVRI	Evy Rickefors
JOLU	Jonas Lundgren
NIPA	Nicola Pallavicini

	Utf ¹
F	AFS
H	ICP-SFMS
I	Man.Inm.
R	ICP-AES

* efter parameternamn indikerar icke ackrediterad analys.

Mätosäkerheten anges som en utvidgad osäkerhet (enligt definitionen i "Evaluation of measurement data - Guide to the expression of uncertainty in measurement", JCGM 100:2008 Corrected version 2010) beräknad med täckningsfaktor lika med 2 vilket ger en konfidensnivå på ungefär 95%.

Mätosäkerhet anges endast för detekterade ämnen med halter över rapporteringsgränsen.

Mätosäkerhet från underleverantör anges oftast som en utvidgad osäkerhet beräknad med täckningsfaktor 2. För ytterligare information kontakta laboratoriet.

Denna rapport får endast återges i sin helhet, om inte utfärdande laboratorium i förväg skriftligen godkänt annat. Resultaten gäller endast det identifierade, mottagna och provade materialet.

Beträffande laboratoriets ansvar i samband med uppdrag, se aktuell produktkatalog eller vår webbplats www.alsglobal.se

¹ Utförande teknisk enhet (inom ALS Scandinavia) eller anlitat laboratorium (underleverantör).

Rapport

Sida 7 (7)



L1832414

17XSDRAUJEE



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Rapport

Sida 1 (7)



L1831651

17FNJ1G5XNC



Ankomstdatum **2018-11-02**
Utfärdad **2018-12-06**

Golder Associates AB
Henrik Svanberg

Box 20127
104 60 Stockholm
Sweden

Projekt **1786406**

Analys: LV3A

Er beteckning	ALS.18GASAML.3B					
	Steg 1					
Labnummer	U11526826					
Parameter	Resultat	Mätosäkerhet (\pm)	Enhet	Metod	Utf	Sign
Malning stålfat *	ja		ArbMom	1	I	STRO
TS innan lakning	96.2	2%	%	2	I	ANRE
Invägning *	1.0830		g	3	I	ANRE
Volym tillsatt *	41.6		ml	3	I	ANRE
Volym efter filtrering *	40		ml	3	I	ANRE
Ca	295	37	mg/l	4	R	EL
Fe	5.64	0.69	mg/l	4	R	EL
Mg	8.38	1.03	mg/l	4	R	EL
Si	16.1	1.9	mg/l	4	R	EL
Al	7210	1130	μ g/l	4	R	EL
As	1510	260	μ g/l	4	H	NIPA
B	<400		μ g/l	4	R	EL
Ba	3120	486	μ g/l	4	R	EL
Cd	6.32	1.06	μ g/l	4	H	NIPA
Co	10.7	2.2	μ g/l	4	H	NIPA
Cr	27.6	5.6	μ g/l	4	H	NIPA
Cu	32.8	6.6	μ g/l	4	H	NIPA
Hg	<0.02		μ g/l	4	F	ELEN
Mn	8640	1020	μ g/l	4	R	EL
Mo	0.942	0.424	μ g/l	4	H	NIPA
Ni	30.6	6.1	μ g/l	4	H	NIPA
Pb	264	51	μ g/l	4	H	NIPA
Sb	179	43	μ g/l	4	H	NIPA
Sr	1230	174	μ g/l	4	R	EL
V	9.14	1.90	μ g/l	4	H	NIPA
Zn	1860	227	μ g/l	4	R	EL

Rapport

Sida 2 (7)



L1831651

17FNJ1G5XNC



Er beteckning	ALS.18GASAML.3B					
	Steg 2					
Labnummer	U11526827					
Parameter	Resultat	Mätosäkerhet (\pm)	Enhet	Metod	Utf	Sign
Invägning *	1.0830		g	3	I	ANRE
Volym tillsatt *	112		ml	3	I	ANRE
Volym efter filtrering *	112		ml	3	I	ANRE
Ca	6.44	1.46	mg/l	4	R	EL
Fe	13.0	1.6	mg/l	4	R	EL
Mg	<2		mg/l	4	R	EL
Si	5.43	0.66	mg/l	4	R	EL
Al	10500	1750	μ g/l	4	R	EL
As	506	87	μ g/l	4	H	NIPA
B	<400		μ g/l	4	R	EL
Ba	461	93	μ g/l	4	R	EL
Cd	<3		μ g/l	4	H	NIPA
Co	3.78	5.17	μ g/l	4	H	NIPA
Cr	<30		μ g/l	4	H	NIPA
Cu	68.7	21.1	μ g/l	4	H	NIPA
Hg	0.0275	0.0187	μ g/l	4	F	EVRI
Mn	1050	125	μ g/l	4	R	EL
Mo	<30		μ g/l	4	H	NIPA
Ni	<30		μ g/l	4	H	NIPA
Pb	108	22	μ g/l	4	H	NIPA
Sb	52.4	12.9	μ g/l	4	H	NIPA
Sr	<200		μ g/l	4	R	EL
V	22.6	5.5	μ g/l	4	H	NIPA
Zn	219	41	μ g/l	4	R	EL

Rapport

Sida 3 (7)



L1831651

17FNJ1G5XNC



Er beteckning	ALS.18GASAML.3B					
	Steg 3					
Labnummer	U11526828					
Parameter	Resultat	Mätosäkerhet (\pm)	Enhet	Metod	Utf	Sign
Invägning *	1.0830		g	3	I	ANRE
Volym tillsatt *	30		ml	3	I	ANRE
Volym efter filtrering *	30		ml	3	I	ANRE
Ca	34.9	4.6	mg/l	4	R	EL
Fe	73.3	8.9	mg/l	4	R	EL
Mg	14.3	1.7	mg/l	4	R	EL
Si	38.7	4.6	mg/l	4	R	EL
Al	50800	7850	μ g/l	4	R	EL
As	1320	233	μ g/l	4	H	NIPA
B	<400		μ g/l	4	R	EL
Ba	1400	225	μ g/l	4	R	EL
Cd	4.18	0.73	μ g/l	4	H	NIPA
Co	31.1	6.4	μ g/l	4	H	NIPA
Cr	57.5	11.7	μ g/l	4	H	NIPA
Cu	92.2	18.5	μ g/l	4	H	NIPA
Hg	0.0247	0.0187	μ g/l	4	F	EVRI
Mn	6900	812	μ g/l	4	R	EL
Mo	<1		μ g/l	4	H	NIPA
Ni	75.3	16.8	μ g/l	4	H	NIPA
Pb	430	82	μ g/l	4	H	NIPA
Sb	91.3	22.0	μ g/l	4	H	NIPA
Sr	374	53	μ g/l	4	R	EL
V	72.5	14.9	μ g/l	4	H	NIPA
Zn	1690	207	μ g/l	4	R	EL

Rapport

Sida 4 (7)



L1831651

17FNJ1G5XNC



Er beteckning	ALS.18GASAML.3B					
	Steg 4					
Labnummer	U11526829					
Parameter	Resultat	Mätosäkerhet (\pm)	Enhet	Metod	Utf	Sign
Invägning *	1.0830		g	3	I	ANRE
Volym tillsatt *	40		ml	3	I	ANRE
Volym efter filtrering *	36		ml	3	I	ANRE
Ca	33.4	4.4	mg/l	4	R	EL
Fe	156	19	mg/l	4	R	EL
Mg	23.6	2.8	mg/l	4	R	EL
Si	22.2	2.6	mg/l	4	R	EL
Al	43700	6760	μ g/l	4	R	EL
As	852	146	μ g/l	4	H	NIPA
B	<400		μ g/l	4	R	EL
Ba	287	56	μ g/l	4	H	NIPA
Cd	1.89	0.33	μ g/l	4	H	NIPA
Co	31.3	6.4	μ g/l	4	H	NIPA
Cr	80.8	16.5	μ g/l	4	H	NIPA
Cu	219	32	μ g/l	4	R	EL
Hg	1.30	0.08	μ g/l	4	F	EVRI
Mn	3890	458	μ g/l	4	R	EL
Mo	4.33	1.18	μ g/l	4	H	NIPA
Ni	62.8	12.8	μ g/l	4	H	NIPA
Pb	133	25	μ g/l	4	H	NIPA
Sb	149	36	μ g/l	4	H	NIPA
Sr	221	31	μ g/l	4	R	EL
V	105	22	μ g/l	4	H	NIPA
Zn	678	87	μ g/l	4	R	EL

Rapport

Sida 5 (7)



L1831651

17FNJ1G5XNC



Er beteckning	ALS.18GASAML.3B					
	Steg 5					
Labnummer	U11526830					
Parameter	Resultat	Mätosäkerhet (\pm)	Enhet	Metod	Utf	Sign
Invägning *	1.0830		g	3	I	ANRE
Volym tillsatt *	50		ml	3	I	ANRE
Volym efter filtrering *	50		ml	3	I	ANRE
Ca	6.44	1.46	mg/l	4	R	EL
Fe	73.9	9.0	mg/l	4	R	EL
Mg	14.3	1.7	mg/l	4	R	EL
Si	7.40	0.91	mg/l	4	R	EL
Al	23900	3700	μ g/l	4	R	EL
As	220	38	μ g/l	4	H	NIPA
B	<400		μ g/l	4	R	EL
Ba	124	24	μ g/l	4	H	NIPA
Cd	0.704	0.130	μ g/l	4	H	NIPA
Co	22.7	4.6	μ g/l	4	H	NIPA
Cr	62.2	12.7	μ g/l	4	H	NIPA
Cu	63.4	12.6	μ g/l	4	H	NIPA
Hg	0.419	0.030	μ g/l	4	F	EVRI
Mn	1400	165	μ g/l	4	R	EL
Mo	3.86	0.86	μ g/l	4	H	NIPA
Ni	39.4	7.9	μ g/l	4	H	NIPA
Pb	21.3	4.1	μ g/l	4	H	NIPA
Sb	301	73	μ g/l	4	H	NIPA
Sr	<200		μ g/l	4	R	EL
V	71.9	14.7	μ g/l	4	H	NIPA
Zn	272	44	μ g/l	4	R	EL

	Metod
1	Analys enligt provberedning, malning stålfat.
2	Analys enligt SS 028113-1.
3	Provupparbetning.
4	<p>Analys av lakvatten. Vid analys av metaller har provet surgjorts med 1 ml salpetersyra(suprapur) per 100 ml. Vid analys av W har provet ej surgjorts. För analys av Ag har provet konserverats med HCl.</p> <p>Analys med ICP-SFMS har skett enligt SS EN ISO 17294-1, 2 (mod) samt EPA-metod 200.8 (mod). Analys med ICP-AES har skett enligt SS EN ISO 11885 (mod) samt EPA-metod 200.7 (mod). Analys av Hg med AFS har skett enligt SS EN ISO 17852.</p> <p>Notera att rapporteringsgränser kan påverkas om det t.ex. finns behov av extra spädning pga provmatrisen men även om provmängden är begränsad.</p> <p>Om laktestet har utförts av ALS i Luleå, för omräknade halter till mg/kg TS se rapport eller bilaga.</p>

	Godkännare
ANRE	Annika Reimhagen
EL	Erik Lidman
ELEN	Elina Engström
EVRI	Evy Rickefors
NIPA	Nicola Pallavicini
STRO	Stanislav Rodushkin

	Utf ¹
F	AFS
H	ICP-SFMS
I	Man.Inm.
R	ICP-AES

* efter parameternamn indikerar icke ackrediterad analys.

Mätosäkerheten anges som en utvidgad osäkerhet (enligt definitionen i "Evaluation of measurement data - Guide to the expression of uncertainty in measurement", JCGM 100:2008 Corrected version 2010) beräknad med täckningsfaktor lika med 2 vilket ger en konfidensnivå på ungefär 95%.

Mätosäkerhet anges endast för detekterade ämnen med halter över rapporteringsgränsen.

Mätosäkerhet från underleverantör anges oftast som en utvidgad osäkerhet beräknad med täckningsfaktor 2. För ytterligare information kontakta laboratoriet.

¹ Utförande teknisk enhet (inom ALS Scandinavia) eller anlitat laboratorium (underleverantör).

Rapport

Sida 7 (7)



L1831651

17FNJ1G5XNC



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Rapport

Sida 1 (7)



L1831451

17CIW0ORP33



Ankomstdatum **2018-10-31**
Utfärdad **2018-12-05**

Golder Associates AB
Henrik Svanberg

Box 20127
104 60 Stockholm
Sweden

Projekt **1786406**

Analys: LV3A

Er beteckning	ALS.18GA03S.1					
	Steg 1					
Labnummer	U11526017					
Parameter	Resultat	Mätosäkerhet (\pm)	Enhet	Metod	Utf	Sign
Malning stålfat *	Nej		ArbMom	1	I	ASAP
TS innan lakning	94.7	2%	%	2	I	ANRE
Invägning *	1.0037		g	3	I	ANRE
Volym tillsatt *	41.6		ml	3	I	ANRE
Ca	83.4	10.5	mg/l	4	R	EL
Fe	130	16	mg/l	4	R	EL
Mg	5.33	0.70	mg/l	4	R	EL
Si	13.9	1.6	mg/l	4	R	EL
Al	29000	4480	μ g/l	4	R	EL
As	7.17	1.72	μ g/l	4	H	NIPA
B	<400		μ g/l	4	R	EL
Ba	3320	517	μ g/l	4	R	EL
Cd	43.9	7.3	μ g/l	4	H	NIPA
Co	219	45	μ g/l	4	H	NIPA
Cr	34.9	7.2	μ g/l	4	H	NIPA
Cu	37.4	7.5	μ g/l	4	H	NIPA
Hg	<0.02		μ g/l	4	F	EVRI
Mn	101000	11900	μ g/l	4	R	EL
Mo	<1		μ g/l	4	H	NIPA
Ni	73.0	14.8	μ g/l	4	H	NIPA
Pb	386	74	μ g/l	4	H	NIPA
Sb	1.48	0.39	μ g/l	4	H	NIPA
Sr	587	83	μ g/l	4	R	EL
V	39.2	8.1	μ g/l	4	H	NIPA
Zn	3630	439	μ g/l	4	R	EL

Er beteckning	ALS.18GA03S.1					
	Steg 2					
Labnummer	U11526018					
Parameter	Resultat	Mätosäkerhet (\pm)	Enhet	Metod	Utf	Sign
Invägning *	1.0037		g	3	I	ANRE
Volym tillsatt *	112		ml	3	I	ANRE
Ca	<4		mg/l	4	R	EL
Fe	199	24	mg/l	4	R	EL
Mg	<2		mg/l	4	R	EL
Si	14.0	1.7	mg/l	4	R	EL
Al	49400	7640	μ g/l	4	R	EL
As	26.8	10.4	μ g/l	4	H	NIPA
B	<400		μ g/l	4	R	EL
Ba	389	86	μ g/l	4	H	NIPA
Cd	5.78	2.27	μ g/l	4	H	NIPA
Co	47.7	11.7	μ g/l	4	H	NIPA
Cr	30.3	10.7	μ g/l	4	H	NIPA
Cu	53.6	21.7	μ g/l	4	H	NIPA
Hg	0.0379	0.0188	μ g/l	4	F	EVRI
Mn	4780	566	μ g/l	4	R	EL
Mo	<30		μ g/l	4	H	NIPA
Ni	29.0	21.5	μ g/l	4	H	NIPA
Pb	230	46	μ g/l	4	H	NIPA
Sb	<5		μ g/l	4	H	NIPA
Sr	<200		μ g/l	4	R	EL
V	158	36	μ g/l	4	H	NIPA
Zn	1610	199	μ g/l	4	R	EL

Rapport

Sida 3 (7)



L1831451

17CIW00RP33



Er beteckning	ALS.18GA03S.1					
	Steg 3					
Labnummer	U11526019					
Parameter	Resultat	Mätosäkerhet (\pm)	Enhet	Metod	Utf	Sign
Invägning *	1.0037		g	3	I	ANRE
Volym tillsatt *	30		ml	3	I	ANRE
Ca	8.50	1.62	mg/l	4	R	EL
Fe	141	17	mg/l	4	R	EL
Mg	<2		mg/l	4	R	EL
Si	75.2	8.9	mg/l	4	R	EL
Al	66800	13200	μ g/l	4	H	NIPA
As	19.4	3.9	μ g/l	4	H	NIPA
B	<400		μ g/l	4	R	EL
Ba	1050	205	μ g/l	4	H	NIPA
Cd	41.4	6.9	μ g/l	4	H	NIPA
Co	238	49	μ g/l	4	H	NIPA
Cr	32.4	6.7	μ g/l	4	H	NIPA
Cu	34.1	6.9	μ g/l	4	H	NIPA
Hg	<0.02		μ g/l	4	F	EVRI
Mn	9100	1080	μ g/l	4	R	EL
Mo	<1		μ g/l	4	H	NIPA
Ni	151	33	μ g/l	4	H	NIPA
Pb	569	109	μ g/l	4	H	NIPA
Sb	0.610	0.157	μ g/l	4	H	NIPA
Sr	<200		μ g/l	4	R	EL
V	85.0	17.4	μ g/l	4	H	NIPA
Zn	3850	474	μ g/l	4	R	EL

Er beteckning	ALS.18GA03S.1					
	Steg 4					
Labnummer	U11526020					
Parameter	Resultat	Mätosäkerhet (\pm)	Enhet	Metod	Utf	Sign
Invägning *	1.0037		g	3	I	ANRE
Volym tillsatt *	47.5		ml	3	I	ANRE
Ca	<4		mg/l	4	R	EL
Fe	378	46	mg/l	4	R	EL
Mg	12.0	1.5	mg/l	4	R	EL
Si	37.3	4.4	mg/l	4	R	EL
Al	101000	15700	μ g/l	4	R	EL
As	52.5	10.6	μ g/l	4	H	NIPA
B	<400		μ g/l	4	R	EL
Ba	237	48	μ g/l	4	H	NIPA
Cd	3.95	0.75	μ g/l	4	H	NIPA
Co	122	25	μ g/l	4	H	NIPA
Cr	89.8	18.6	μ g/l	4	H	NIPA
Cu	228	46	μ g/l	4	H	NIPA
Hg	2.68	0.18	μ g/l	4	F	EVRI
Mn	5720	675	μ g/l	4	R	EL
Mo	4.85	2.11	μ g/l	4	H	NIPA
Ni	106	22	μ g/l	4	H	NIPA
Pb	340	65	μ g/l	4	H	NIPA
Sb	1.13	0.31	μ g/l	4	H	NIPA
Sr	<200		μ g/l	4	R	EL
V	196	40	μ g/l	4	H	NIPA
Zn	1470	179	μ g/l	4	R	EL

Rapport

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17CIW00RP33



Er beteckning	ALS.18GA03S.1					
	Steg 5					
Labnummer	U11526021					
Parameter	Resultat	Mätosäkerhet (\pm)	Enhet	Metod	Utf	Sign
Invägning *	1.0037		g	3	I	ANRE
Volym tillsatt *	50		ml	3	I	ANRE
Ca	<4		mg/l	4	R	EL
Fe	166	20	mg/l	4	R	EL
Mg	4.87	0.66	mg/l	4	R	EL
Si	9.97	1.18	mg/l	4	R	EL
Al	71400	11000	μ g/l	4	R	EL
As	27.7	4.9	μ g/l	4	H	NIPA
B	<400		μ g/l	4	R	EL
Ba	61.3	13.6	μ g/l	4	H	NIPA
Cd	0.318	0.089	μ g/l	4	H	NIPA
Co	38.6	8.0	μ g/l	4	H	NIPA
Cr	108	22	μ g/l	4	H	NIPA
Cu	128	26	μ g/l	4	H	NIPA
Hg	1.31	0.12	μ g/l	4	F	EVRI
Mn	1660	195	μ g/l	4	R	EL
Mo	9.82	2.12	μ g/l	4	H	NIPA
Ni	49.8	10.9	μ g/l	4	H	NIPA
Pb	23.4	4.5	μ g/l	4	H	NIPA
Sb	5.73	1.41	μ g/l	4	H	NIPA
Sr	<200		μ g/l	4	R	EL
V	134	27	μ g/l	4	H	NIPA
Zn	495	66	μ g/l	4	R	EL

	Metod
1	Analys enligt provberedning, malning stålfat.
2	Analys enligt SS 028113-1.
3	Provupparbetning.
4	<p>Analys av lakvatten. Vid analys av metaller har provet surgjorts med 1 ml salpetersyra(suprapur) per 100 ml. Vid analys av W har provet ej surgjorts. För analys av Ag har provet konserverats med HCl.</p> <p>Analys med ICP-SFMS har skett enligt SS EN ISO 17294-1, 2 (mod) samt EPA-metod 200.8 (mod). Analys med ICP-AES har skett enligt SS EN ISO 11885 (mod) samt EPA-metod 200.7 (mod). Analys av Hg med AFS har skett enligt SS EN ISO 17852.</p> <p>Notera att rapporteringsgränser kan påverkas om det t.ex. finns behov av extra spädning pga provmatrisen men även om provmängden är begränsad.</p> <p>Om laktestet har utförts av ALS i Luleå, för omräknade halter till mg/kg TS se rapport eller bilaga.</p>

	Godkännare
ANRE	Annika Reimhagen
ASAP	Åsa Apelqvist
EL	Erik Lidman
EVRI	Evy Rickefors
NIPA	Nicola Pallavicini

	Utf ¹
F	AFS
H	ICP-SFMS
I	Man.Inm.
R	ICP-AES

* efter parameternamn indikerar icke ackrediterad analys.

Mätosäkerheten anges som en utvidgad osäkerhet (enligt definitionen i "Evaluation of measurement data - Guide to the expression of uncertainty in measurement", JCGM 100:2008 Corrected version 2010) beräknad med täckningsfaktor lika med 2 vilket ger en konfidensnivå på ungefär 95%.

Mätosäkerhet anges endast för detekterade ämnen med halter över rapporteringsgränsen.

Mätosäkerhet från underleverantör anges oftast som en utvidgad osäkerhet beräknad med täckningsfaktor 2. För ytterligare information kontakta laboratoriet.

Denna rapport får endast återges i sin helhet, om inte utfärdande laboratorium i förväg skriftligen godkänt annat.

¹ Utförande teknisk enhet (inom ALS Scandinavia) eller anlitat laboratorium (underleverantör).

Rapport

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17CIW0ORP33



Resultaten gäller endast det identifierade, mottagna och provade materialet.

Beträffande laboratoriets ansvar i samband med uppdrag, se aktuell produktkatalog eller vår webbplats www.alsglobal.se

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Rapport

Sida 1 (4)



L1831650

15NAAAL53QI



Ankomstdatum **2018-11-02**
Utfärdad **2018-11-15**

Golder Associates AB
Henrik Svanberg

Box 20127
104 60 Stockholm
Sweden

Projekt **1786406**

Analys: TC-3

Er beteckning	ALS.J.18GASAML.3B					
Provtagare	Henrik Svanberg					
Labnummer	U11526825					
Parameter	Resultat	Mätosäkerhet (\pm)	Enhet	Metod	Utf	Sign
Malning stälfat *	ja		ArbMom	1	I	STRO
TS *	82.7		%	2	W	TV
SiO ₂	70.0	12.7	% TS	3	H	DKA
Al ₂ O ₃	11.7	2.1	% TS	3	H	DKA
CaO	3.66	0.61	% TS	3	H	DKA
Fe ₂ O ₃	3.34	0.66	% TS	3	H	DKA
K ₂ O	2.80	0.46	% TS	3	H	DKA
MgO	0.690	0.121	% TS	3	H	DKA
MnO	0.135	0.023	% TS	3	H	DKA
Na ₂ O	3.76	0.75	% TS	3	H	DKA
P ₂ O ₅	0.264	0.042	% TS	3	H	DKA
TiO ₂	0.542	0.097	% TS	3	H	DKA
Summa *	96.9		% TS	3	I	DKA
LOI 1000°C	5.8	5%	% TS	4	V	SIH
As	388	121	mg/kg TS	3	H	ENMU
B	21.0	5.6	mg/kg TS	3	H	ENMU
Ba	713	166	mg/kg TS	3	H	DKA
Be	1.90	0.42	mg/kg TS	3	H	ENMU
Cd	0.632	0.100	mg/kg TS	3	H	ENMU
Co	7.33	1.63	mg/kg TS	3	H	DKA
Cr	39.6	7.0	mg/kg TS	3	H	DKA
Cu	28.7	6.2	mg/kg TS	3	H	ENMU
Hg	0.0895	0.0189	mg/kg TS	3	F	EVRI
Mo	3.94	0.79	mg/kg TS	3	H	ENMU
Nb	12.7	1.8	mg/kg TS	3	H	DKA
Ni	18.8	3.8	mg/kg TS	3	H	ENMU
Pb	56.5	14.0	mg/kg TS	3	H	ENMU
S	361	72	mg/kg TS	3	H	ENMU
Sb	262	46	mg/kg TS	3	H	COPA
Sc	7.30	1.23	mg/kg TS	3	H	DKA
Sn	3.01	0.57	mg/kg TS	3	H	ENMU
Sr	237	39	mg/kg TS	3	H	DKA
U	4.84	0.74	mg/kg TS	3	H	DKA
V	47.3	6.7	mg/kg TS	3	H	DKA
W	13.8	2.3	mg/kg TS	3	H	DKA
Y	22.1	3.1	mg/kg TS	3	H	DKA
Zn	187	34	mg/kg TS	3	H	ENMU

Rapport

Sida 2 (4)



L1831650

15NAAAL53QI



Er beteckning	ALS.J.18GASAML.3B					
Provtagare	Henrik Svanberg					
Labnummer	U11526825					
Parameter	Resultat	Mätosäkerhet (\pm)	Enhet	Metod	Utf	Sign
Zr	188	34	mg/kg TS	3	H	DKA

	Metod
1	Analys enligt provberedning, malning stålfat.
2	Analys enligt SS 02 81 13-1 Torrsubstansbestämning.
3	<p>Analysprovet har torkats vid 50°C och elementhalterna har TS-korrigerats till 105°C.</p> <p>Provet har behandlats enligt följande: Smältning med LiBO₂ och upplösning med HNO₃ enligt ASTM D3682: 2013 och ASTM D4503: 2008. Upplösning har skett med HNO₃/HCl/HF enligt SS EN 13656: 2003.</p> <p>Analys med ICP-SFMS har skett enligt SS EN ISO 17294-2: 2016 samt EPA-metod 200.8: 1994.</p> <p>Notera att rapporteringsgränser kan påverkas om det t.ex. finns behov av extra spädning pga provmatrisen men även om provmängden är begränsad.</p> <p>Reviderad 2018-04-26</p>
4	Analys enligt LOI 1000°C.

	Godkännare
COPA	Cora Paulukat
DKA	Dan Krekula
ENMU	Enrico Muth
EVRI	Evy Rickefors
SIH	Simon Hällström
STRO	Stanislav Rodushkin
TV	Tiina Vikeväinen

	Utf ¹
F	AFS
H	ICP-SFMS
I	Man.lnm.
V	Våtkemi
W	Våtkemi

* efter parameternamn indikerar icke ackrediterad analys.

Mätosäkerheten anges som en utvidgad osäkerhet (enligt definitionen i "Evaluation of measurement data - Guide to the expression of uncertainty in measurement", JCGM 100:2008 Corrected version 2010) beräknad med täckningsfaktor lika med 2 vilket ger en konfidensnivå på ungefär 95%.

Mätosäkerhet anges endast för detekterade ämnen med halter över rapporteringsgränsen.

¹ Utförande teknisk enhet (inom ALS Scandinavia) eller anlitat laboratorium (underleverantör).

Rapport

Sida 4 (4)



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15NAAAL53QI



Mätosäkerhet från underleverantör anges oftast som en utvidgad osäkerhet beräknad med täckningsfaktor 2. För ytterligare information kontakta laboratoriet.

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