Rudersdal Kommune
Att.: Tobias Benjamin Uglebjerg, Jeppe Emlund Smith
Klima, Natur og Miljø | Teknik og Miljø |
Øverødvej 2
2840 Holte

København | 2024-07-16

Ansøgning om §19-tilladelse i forbindelse med oprensning ved stimuleret reduktiv nedbrydning (SRD) og kemisk reduktion (ISCR) med tilsætning af udvalgte reaktanter på Blokken 25A i Birkerød

Efter aftale med Region Hovedstaden anmodes hermed om tilladelse til afværge af forureningsfanen på lokaliteten Blokken 25A i Birkerød ved tilsætning af nulvalent jern og andre beskrevne stoffer til grundvandsmagasinet for kemisk reduktion (ISCR) samt stimuleret reduktiv nedbrydning (SRD). Formålet med projektet er at reducere den nuværende risiko for grundvandsressourcen i området.

Tilsætning af substrat/elektrondonor til grundvandet kræver i Danmark tilladelse i henhold til Miljøbeskyttelseslovens §19.

Vi ansøger om tilladelse til tilsætning af følgende 3 reaktantblandinger til pilotforsøg og dernæst udvælges, den mest velegnede reaktantblanding til fuld-skala afværgeforanstaltninger:

- NANOFER25 (nZVI), økologisk melasse og Dehalococcoides bakteriekultur (KB1®)
- Ferox Plus og Dehalococcoides bakteriekultur (KB1®)
- 3-D Microemulsion® (3DMe) og Dehalococcoides bakteriekultur (KB1®)

Der vil blive udført pilotforsøg med reaktantblandingerne 1 og 2. Såfremt de viser sig at være tilfredsstillende for videre anvendelse, bliver reaktantblanding 3 ikke taget i anvendelse. Såfremt reaktantblandingerne 1 og 2 ikke virker tilfredsstillende, vil reaktantblanding 3 blive taget i anvendelse. Derfor ansøges om §19 tilladelse til anvendelse af alle 3 reaktantblandinger.

De 3 reaktantblandinger igangsætter forskellige fjernelsesprocesser af de klorerede opløsningsmidler: Reaktantblandingerne 1 og 2 består af nulvalent jern, organisk stof samt de bakterier (Dehalococcoides), der kan nedbryde klorerede opløsningsmidler fuldstændig. Disse to reaktantblandinger sørger derfor både for kemisk reduktion og for mikrobiel nedbrydning af forureningsstofferne.

Reaktantblanding 3 består af organisk stof og bakterier (de samme som i 1 og 2) og understøtter derfor alene mikrobiel nedbrydning af forureningsstofferne. Reaktanterne og processerne er uddybet i afsnit 3.

1 Historik

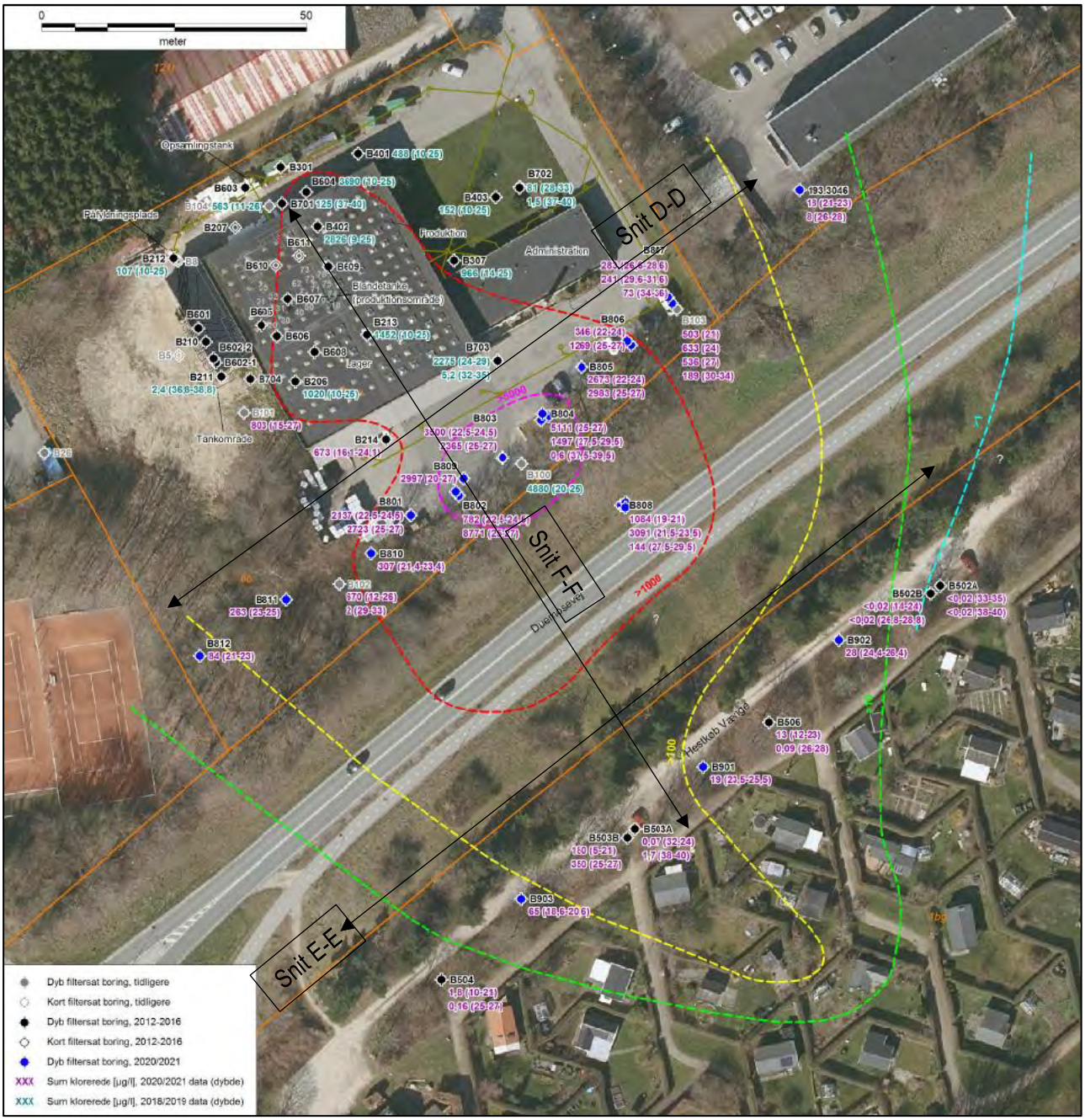
Matriklen er kortlagt som forurenet på vidensniveau 2 i henhold til Lov om forurenet jord og er beliggende i et område med særlige drikkevandsinteresser (OSD). Region Hovedstaden har i perioden 2019-2024 udført en række miljøundersøgelser på ejendommen /1/, og der er i 2022 etableret en afværgeforanstaltning i forhold til kildeområderne i form af en ventilation under kildeområdet ved og under produktionsbygningen på ejendommen. Afværgen hindre mod yderlig spredning af forurening fra kildeområdet til forureningsfanen, ved konstant at borventilere forureningen fra den dybe umættede zone under kildeområdet.

På baggrund af miljøundersøgelserne er det besluttet at gennemføre en afværgeindsats i den mest forurenede del af forureningsfanen. Oprensningen forventes udført ved at tilsætte reagenser til grundvandet, der stimulerer en kemisk fjernelse og samtidig en mikrobiel nedbrydning af forureningsstofferne. Den præcise fjernelsesproces og reaktantvalg afgøres vha. pilotforsøg. Formålet med afværgeforanstaltningerne er at reducere risikoen for grundvandsressourcen og indvingen i området.

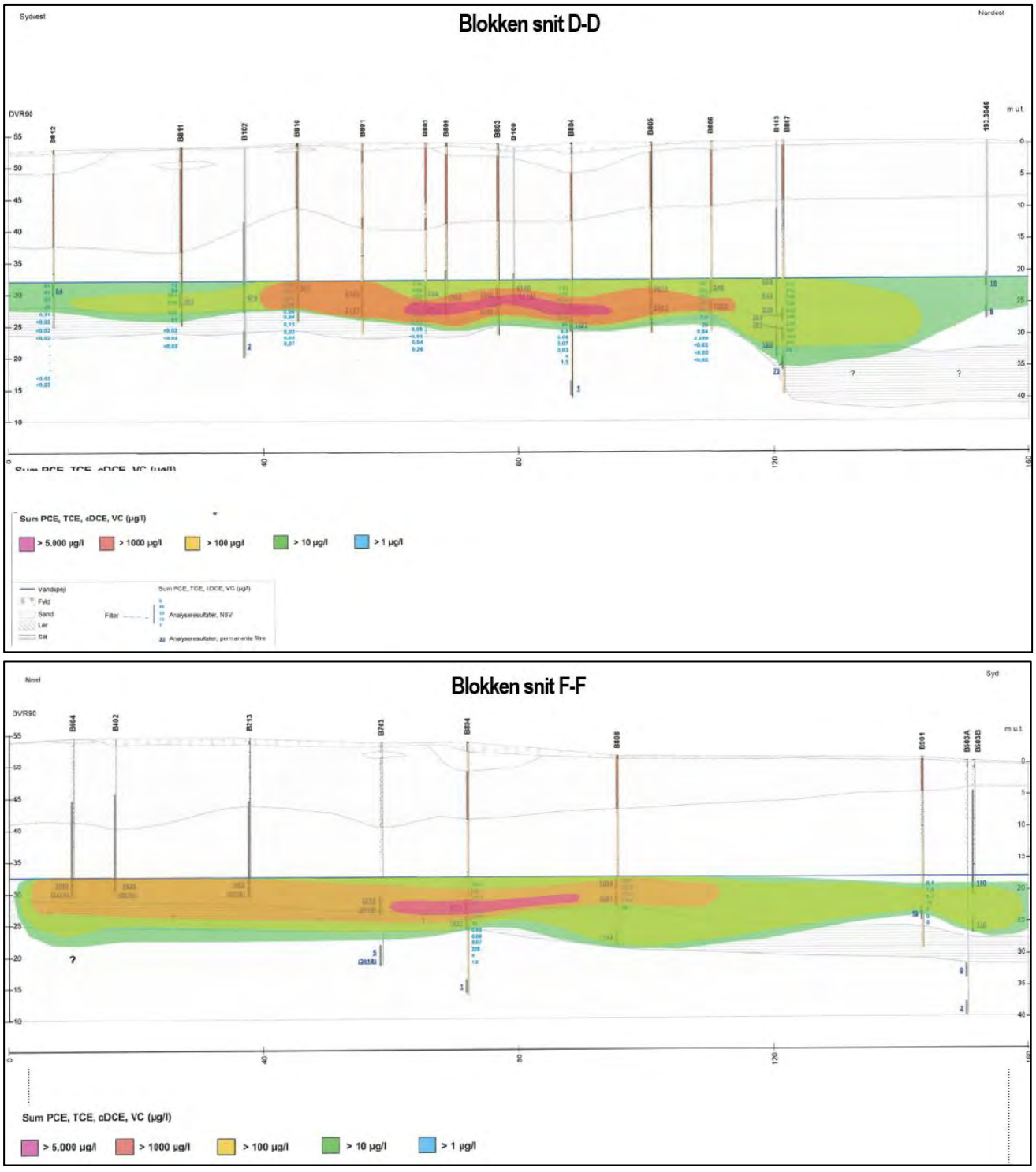
2 Forureningssituation

Grundvandsforureningen er senest analyseret med en omfattende moniteringsrunde i 2021 /1/. Resultaterne heraf fremgår af tabel 1. Den højeste koncentration er påvist i boring B101-2, hvor der er påvist 10.000 µg sum chlorerede/l /1/. Overordnet ses der overvejende cis-DCE og visse steder TCE og trans-DCE i boringerne. Hovedparten af de påviste koncentrationer i boringerne overskrider grundvandskvalitetskriterierne for sum af chlorerede opløsningsmidler. Lokaliteten ligger indenfor et område med særlige drikkevandsinteresser og indenfor indvindingsopland til almen vandforsyning. Forureningen udgør en risiko overfor grundvandsressourcen i området.

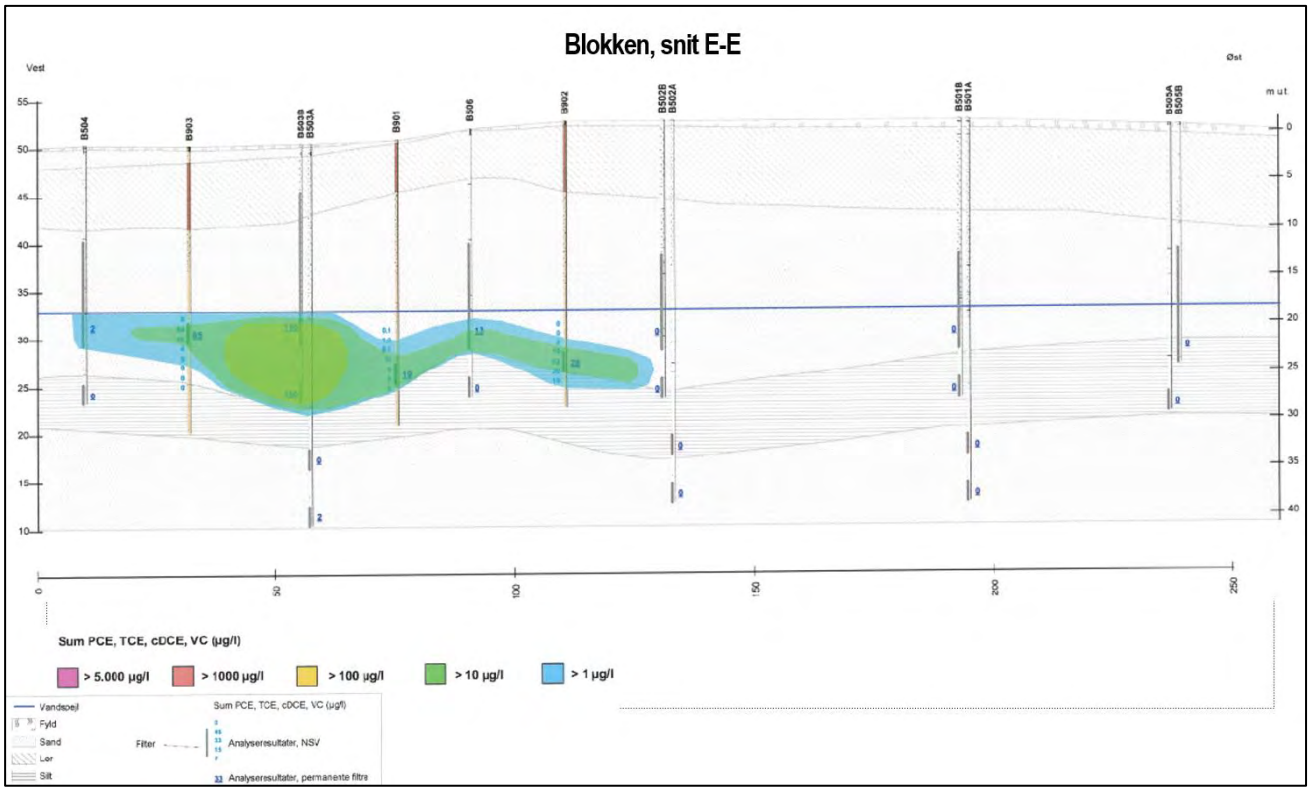
Den nyeste situationsplan og det opdaterede snit for geologi og grundvandsforureningen er vedlagt i bilag A og gengivet i figur 1 og 2.



Figur 1. Situationsplan af forureningsbilledet fra 2012-2021. Snit D-D, F-F og E-E vist i figuren (større udgave fremgår af bilag A).



Figur 2.(fortsættes på næste side). Situationssnit af forureningsbilledet primært fra 2021. (større udgave fremgår af bilag A).



Figur 2 (fortsat). Situationssnit af forureningsbilledet primært fra 2021. (større udgave fremgår af bilag A).

3 Afværgemetoder

3.1 Stimuleret Reduktiv Dechlorering (SRD)

Reduktiv dechlorering er en afværgemetode, hvor de naturlige nedbrydningsprocesser i grundvandet stimuleres ved tilsætning af elektrondonorer ("biostimulering"), næringsstoffer og/eller bakterier ("bioaugmentation"). Ved anaerob dechlorering sker en nedbrydning af PCE/TCE til cis-1,2-dichlorethylen, vinylchlorid og til sidst ethen. Anaerob dechlorering er en redoxproces, hvor bakterier benytter de chlorerede opløsningsmidler som elektronacceptor til generering af energi. Processen kan forløbe naturligt i forurenede grundvandssystemer under stærkt reducerende redoxforhold, men vil ofte være begrænset af mangel på elektrondonorer. I Danmark er det normalt at tilsætte de specifikke bakterier, der står for den fulde nedbrydningsproces.

3.2 Stimuleret kemisk reduktion (ZVI)

Nulvalent jern (ZVI) har været anvendt i flere år i reaktive barrierer til behandling af chlorerede opløsningsmidler. Den primære mekanisme for nedbrydning er igennem abiotisk reduktion. ZVI kan også fremme biologiske processer ved, at jernkorrosion resulterer i dannelsen af brint, som efterfølgende anvendes som elektrondonor af bakterierne. Kombinationen af abiotisk og biotisk stimulering gør, at teknologien med fordel kan anvendes i kombination med SRD, evt. som efterpoleringstrin af cis-DCE eller VC restforurening.

3.3 Afværgemetode på Blokken

På Blokken 25A vurderes den mest optimale proces at være en kombination af kemisk reduktion med et Jern-præparat og mikrobiel nedbrydning ved tilsætning af organisk stof og specifikke nedbrydere. Alternativt vil fuld-skala afværgen blive gennemført med mikrobiel nedbrydning uden tilsætning af jern. Pilotforsøg på lokaliteten vil blive afgørende for det endelige valg af reaktanter og dermed afværgeproces.

Når pilotforsøgene er slut, og resultatbearbejdningen er foretaget, designes fuldskala afværge med recirkulering af de reaktanter, der har vist sig mest optimale for den specifikke lokalitet sammen med KB1 bakterierne. Fuldskala projektet udføres overordnet ens, uanset det endelige reaktantvalg. Princippet er at tilsætte reaktanterne til grundvandsmagasinet i eksisterende boringer samt ved direkte Spin-injektioner. For at opnå bedst mulig kontakt mellem de tilsatte reaktanter og det forurenede grundvand vil der blive foretaget en recirkulation af vandet. Overordnet set anvendes et recirkuleringsprincip med oppumpning fra nogle boringer og reinfiltration i andre boringer, for at opnå en effektiv reaktionszone i det mest forurenede område af grundvandet. Efter fordeling af reaktanterne ophører recirkulationssystemet og processerne følges ved monitering. På nuværende tidspunkt er fuldskala oprensningen ikke fuldt afklaret, og dimensioneringen og projekteringen af den afhænger meget af resultatet af pilotforsøgene.

De reaktantblandingerne, der er relevante i dette projekt er:

1. NANOFER25 (nZVI), økologisk melasse og Dehalococcoides bakteriekultur (KB1®)
2. Ferox Plus og Dehalococcoides bakteriekultur (KB1®)
3. 3-D Microemulsion® (3DMe) og Dehalococcoides bakteriekultur (KB1®)

Af tabel 1 fremgår en beskrivelse af stofferne.

Tabel 1. Reaktanter og sammensætninger.

Kombinationer	Producent	Aktive stoffer	Udvælges til pilottest
NANOFER25 Økologisk roemelasse KB1®	Nanoiron Sukkerfabrikker	nZVI Substrat/elektrondonor Dehalococcoides	Ja
Ferox Plus KB1®	Hepure	eZVI, soyabønneolie, natriumlaktat, emulgatorer, fortykningsmidler og næringsstoffer herunder nitrogen, fosfor og vitamin B12 Dehalococcoides	Ja
3-D Microemulsion® (3DMe) KB1®	Regenesis	Elektrondonor, laktat, emulgerede fedtsyrer Dehalococcoides	Måske: Afgøres efter pilottest af de øvrige. Anvendes kun hvis de øvrige produkter fejler

Datablade for stofferne fremgår af appendiks A.

4 Beskrivelse af produkter og risikovurdering heraf

4.1 NANOFER25

NANOFER25 er et nanoskala nulvalent jernprodukt, som produceres af NanoIron i Tjekkiet. Produktet er en reaktiv opløsning bestående af 20% nZVI med en partikelstørrelse <50 nm og 80% vand. Produktet findes også på pulverform, og kan opblandes på lokaliteten. Af producentens hjemmeside fremgår flere vellykkede fuldskalaprojekter, hvilket også er Geos erfaring, som bl.a. har anvendt produktet i forbindelse med oprensning af chlorerede opløsningsmidler på flere transformerstationer i Danmark. Derudover har NanoIron været

involveret i NanoRem projektet (et stort EU-projekt), hvilket betyder, at dokumentationsniveauet generelt er godt.

Produktet indeholder ingen stoffer, der er kategoriseret som farlige jf. CLP (Forordning (EC) nr. 1272/2008 om klassificering, mærkning og emballering).

4.2 Økologisk roemelasse

Økologisk roemelasse udvindes i forbindelse med sukkerproduktionen og anvendes især i dyrefoder. I forbindelse med afværgeforanstaltninger anvendes roemelassen som kulstofkilde til de bakterier, som bidrager til nedbrydning af chlorerede opløsningsmidler og nedbrydningsprodukter heraf.

Økologisk roemelasse indeholder ingen farlige stoffer, og der vurderes ikke at være risiko forbundet med brug af produktet.

4.3 Ferox Plus eZVI

Ferox Plus eZVI er et emulgeret nulvalent jernprodukt som produceres af Hepure i USA. Opløsningen består af ZVI, vegetabilsk olie (soyabønneolie), vand, vitaminer og næringsstoffer (herunder natriumlaktat), og er producentens mest mobile jernprodukt. Af Hepures hjemmeside fremgår flere vellykkede fuldskalaprojekter, hvor man har opnået en høj oprensningsgrad. I Danmark har man tidligere opnået gode resultater med producentens mindre mobile søsterprodukt Ferox Flow, som er et klassisk ZVI produkt uden tilsætningsstoffer (dette er dog ikke anvendeligt i dette projekt, hvor der ønskes en højere mobilitet, for at opnå den bedste fordeling i magasinet, hvorfor vi anvender Ferox Plus).

Produktet er et mZVI-produkt tilsat organisk materiale. Der vurderes ikke at være risiko forbundet med brug af produktet.

4.4 3-D Microemulsion® (3DMe)

3DMe er et injicerbart flydende materiale specielt designet til in situ afværgeprojekter, i grundvandsmagasiner, hvor stimuleret reduktiv dechlorering er muligt. Produktet består af laktakt, propylacetat og fedtsyrer, og bidrager derfor med tre forskellige typer af elektrondonorer i SRD processen. 3DMe har en lang levetid i grundvandet (op til 4 år), og dermed en langtidsvirkning på forureningskomponenterne. Der er udført mange vellykkede fuldskala oprensninger med 3DMe i Danmark.

Produktet indeholder ingen farlige stoffer, og der vurderes ikke at være risiko ved brug af produktet.

4.5 KB-1®

KB-1® er en naturligt forekommende, ikke-patogen mikrobiel kultur, der indeholder Dehalococcoides (Dhc), den eneste gruppe af mikroorganismer, der er dokumenteret til at fremme fuldstændig dechlorering af chlorerede opløsningsmidler og nedbrydningsprodukter heraf til slutprodukterne ethen og ethan. KB-1® produceres af den canadiske firma Sirem, og har været anvendt i forbindelse med mange oprensningsprojekter i Danmark. KB-1® er den bedst dokumenterede bakteriekultur af sin type, og der er ikke forbundet risiko med brug af produktet.

4.6 Tracer (Bromid)

Sammen med reaktanterne, vil der under pilotforsøgene tilsættes en tracer – i dette projekt anvendes bromid (Br^-), som er blandt de foretrukne stoffer anvendt til tracertests i grundvand og har været anvendt til dette formål i mere end 100 år. Der er ikke forbundet risiko med anvendelse af Br^-.

5 Pilotforsøg

Forud for pilotforsøgene skal redoxforholdene, som på nuværende tidspunkt ikke er gunstige for biotisk nedbrydning, ændres til reducerende forhold. Dette vil blive gjort ved tilsætning af elektrondonor (økologisk roemelasse). Efter tilsætning af melassen vil forholdene i magasinet blive moniteret, og når de optimale forhold er til stede, vil vi gå videre med pilotforsøgene.

Formålet med pilotforsøgene er at udvælge den bedst egnede reaktantblanding til fuldskala forsøgene. Med pilotforsøgene testes dels reaktanternes mobilitet i grundvandet og dels reaktanternes effektivitet i forhold til forureningsfjernelse.

Først laves redoxforholdene om til reduktive forhold. Herefter gennemføres pilotforsøgene som injektions- og pumpeforsøg, såkaldte push-pull forsøg i to eksisterende boringer, dvs én reaktantblanding i hver boring. så testes reaktantblanding 1 og 2, der er de jernholdige reaktantblandinger. Som tidligere nævnt tages den 3. reaktantblanding kun i brug, hvis de to andre ikke virker som ønsket. Derudover udføres et mini-recirkuleringsforsøg imellem 2 udvalgte boringer med den reaktant, som viser de bedste resultater i push-pull forsøgene.

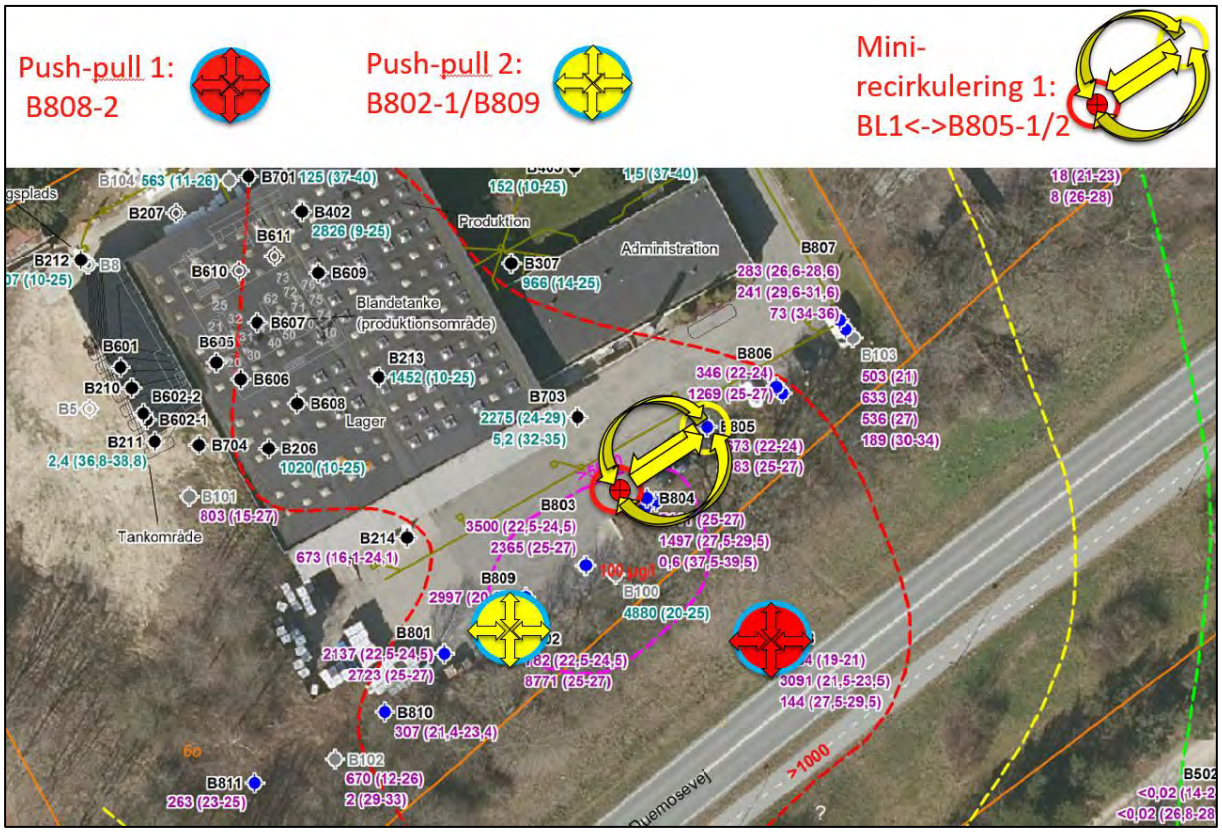
De 3 faser er følgende:

- Fase 1: Ændring af redoxforhold ved tilsætning af elektrondonor i ca. 11 boringer
- Fase 2: 2 Push-Push-Pull tests i 2 forskellige udvalgte boringer
    - Test A: Indledende mobilitets-test
    - Test B: efterfølgende reaktivitets-test
- Fase 3: 1 Mini-Recirkuleringstest imellem 2 udvalgte boringer

I forbindelse med pilotforsøgene gennemføres løbende målinger af reaktantblandingen og af det vand, der pumpes op fra formationen. Vandprøverne analyseres for redox, pH, ilt, ledningsevne, forureningskomponenter, ethen, ethan, acetylen, jern, NVOC og bromid.

Ved pilottestene opsamles det oppumpede vand i tanke. Alt oppumpet vand ledes tilbage i de pågældende boringer, når pilottestene er færdige. Vandet vil indeholde de samme reaktanter, som der skal anvendes i fuld skala oprensningen, hvor vandet også pumpes rundt og reinjiceres i magasinet. Der forventes oppumpet mere grundvand end der injiceres, hvorfor vi vil sikre, at vi har kapacitet til denne vandmængde.

Der er planlagt pilottest (push-pull) i boring B808 og B802 med hver sin reaktantblanding og mini-recirkulationstest i boring BL1 (pumpeboring) og B805 (injektion og infiltration i filter 1 og 2), som vist i figur 3.

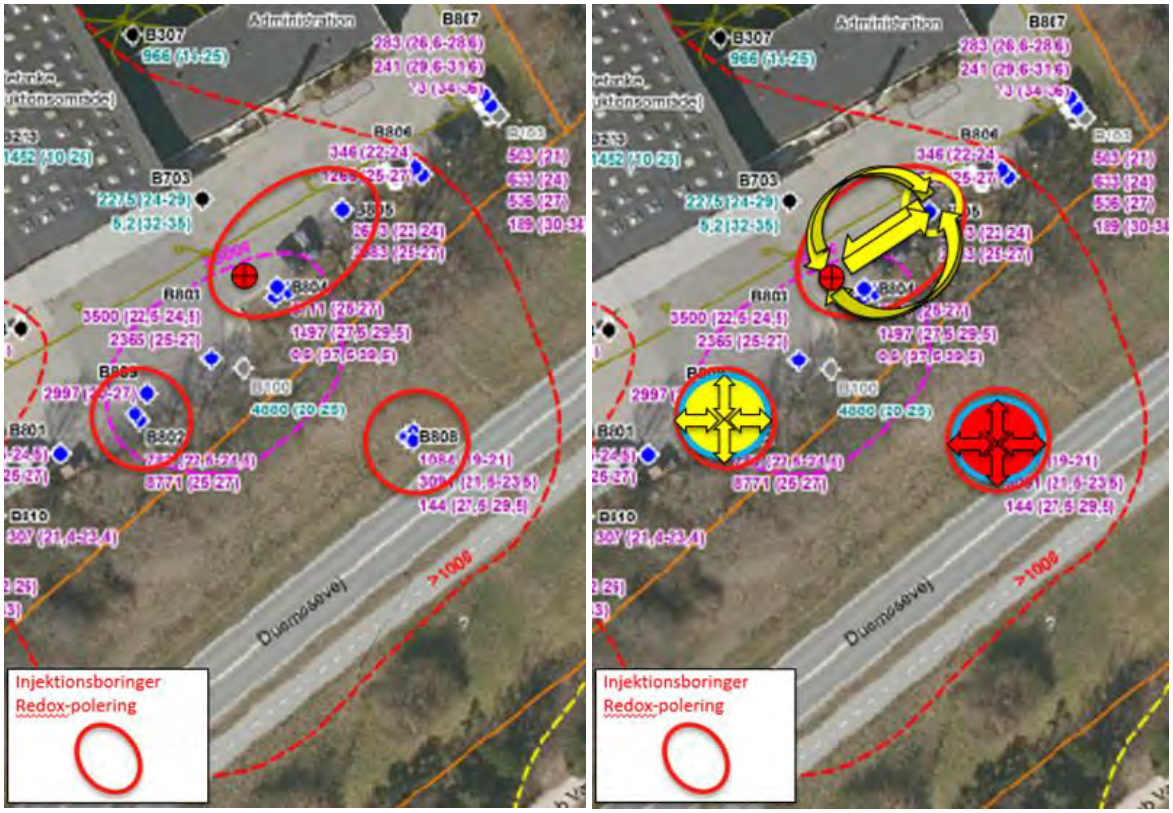


Figur 3. Pilotforøg med udvalgte boringer til udførsel af push-pull.

5.1 Fase 1: Ændring af redoxforholdene

Redoxforholdene er som nævnt ikke optimale for igangsætning af SRD/ISCR, idet der endnu ikke er fuldstændige anerobe forhold i magasinet. I første fase vil elektrondonor derfor blive tilført til grundvandet (uden bakterier). Når så der i en fase 2 er leverum for bakterierne, vil disse blive tilført (KB1®) sammen med den valgte elektrondonor/reaktant.

Vi vil benytte økologisk roemelasse som kulstofkilde/donor og foretage injicering i en bred vifte af boringer for at få en så bred dækning som muligt. På figur 4 ses forventede injektionsboringer til ændring af redoxforhold.



Figur 4. Præ-pilotforsøg med de relevante udvalgte boringer til donorintroduktion for ændring af redoxforhold.

Der anvendes 4 boringer (7 filtre) og injiceres i flere boringer samtidigt. I alt skal tilføres 4 m^3 melasse opblandet i vand i forholdet 1:7 (I alt 32 m^3 blanding). Det vil med de forventede hydrauliske parametre have en varighed af 2-4 dage at få injiceret. Halvdelen af blandingen introduceres til området hvor minirecirkulationsforsøget skal udføres, mens det resterende doseres ved de 2 push-pull forsøg.

5.2 Fase 2: Push-pull forsøg

Push-pull forsøgene er skitseret i tabel 2.

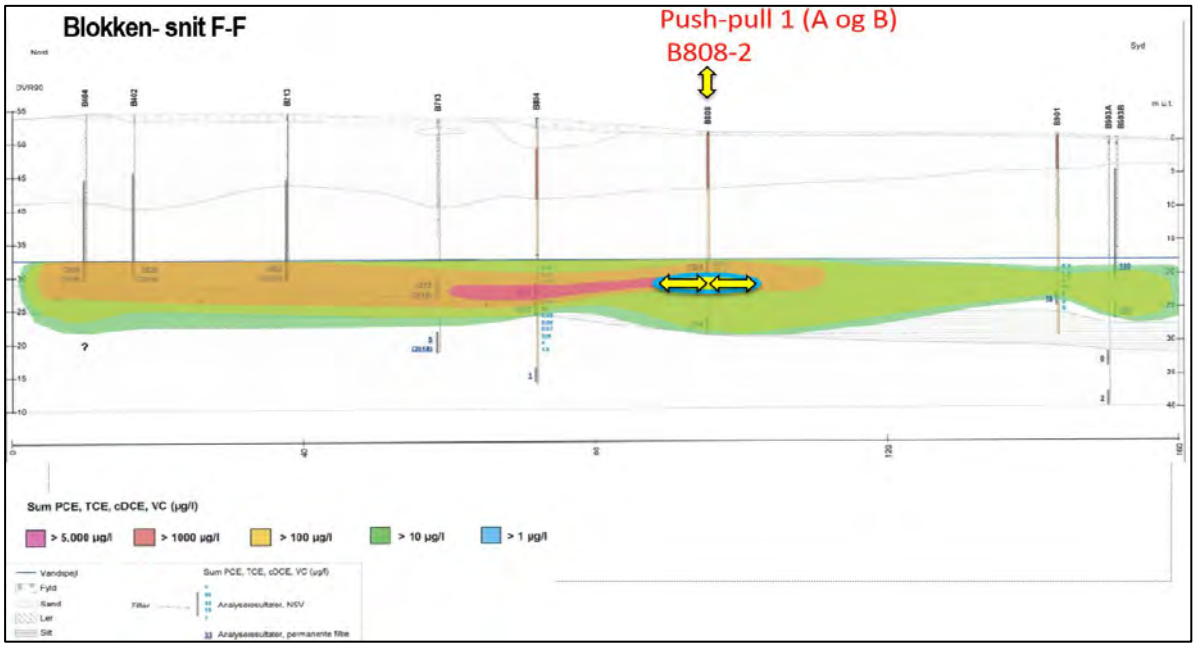
Tabel 2 Oversigt over push-pull forsøg

	Reaktantblanding 1	Reaktantblanding 2
Boring	B808-2	B802-1
Mobilitetstest	Test 1A	Test 2A
Reaktivitetstest	Test 1B	Test 2B

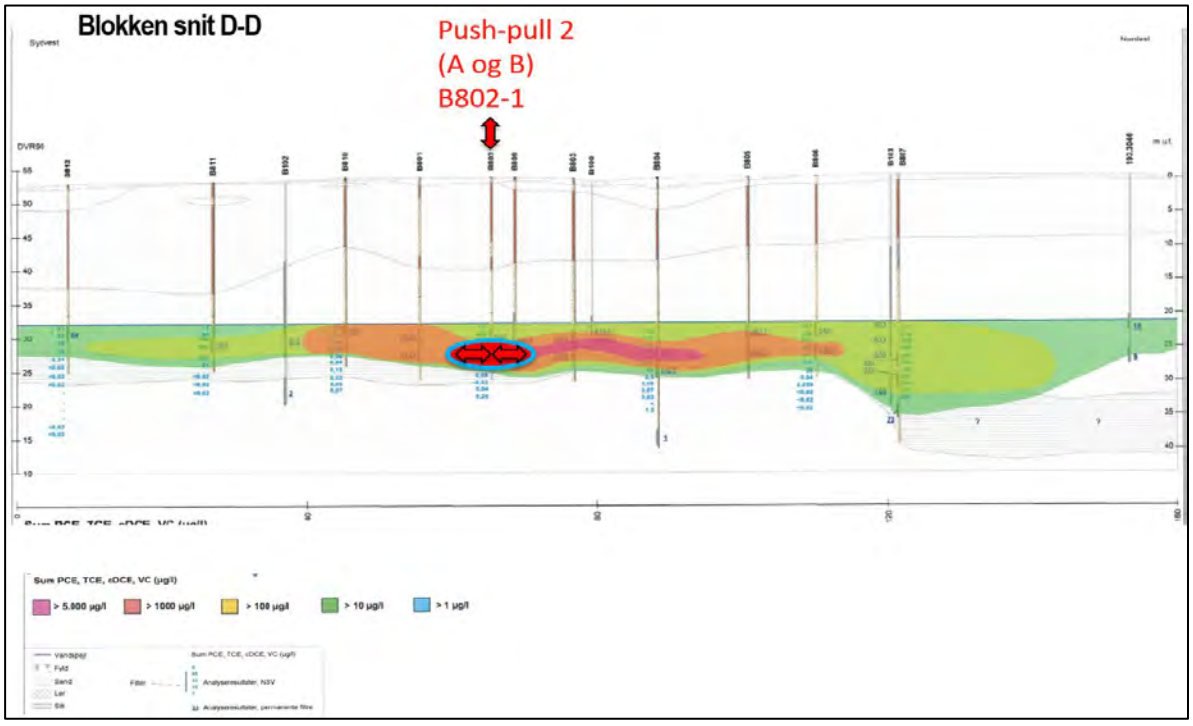
Mobilitetstestene (Test 1A og Test 2A) udføres uden tilsætning af bakterier og uden pause imellem tilsætning af reaktanter til grundvandet og den efterfølgende oppumpning. Ved disse tests undersøges forholdene omkring hvordan og i hvilken grad, vi kan få reatanterne injiceret og spredt ud i grundvandet.

Reaktivitetstestene (Test 1B og Test 2B) udføres med tilsætning af bakterier, for at teste reaktiviteten. Endvidere er der en pause mellem tilsætning til grundvandsmagasinet og den efterfølgende oppumpning på ca. 2 uger, hvor reaktanterne han have en effekt i forhold til forureningen.

De første forsøg (test 1-A og 1-B) udføres i den nedstrøms boring, B808-2, som vist i figur 5 (Ø63mm). Som reaktanter benyttes i de første forsøg økologisk roemelasse, NANOFER25 (nZVI), bakterier (KB1) (test B), og som tracer benyttes bromid.



Figur 5. Pilotforøg med udvalgte boringer til udførsel af push-pull.



Figur 6. Pilotforøg med udvalgte boringer til udførsel af push-pull.

Det andet forsøg (test 2A og 2B) udføres i B802-1, jf. figur 6. Som reaktant i det andet forsøg bruges Ferox Plus og bakterier (KB1) (test 2-B), og som tracer benyttes bromid.

I forbindelse med push-pull forsøgene gennemføres løbende målinger af reaktantblandingen og af det vand, der pumpes op fra formationen. Prøverne analyseres for redox, pH, forureningskomponenter, ethen, ethan, acetylen, bromid, jern, NVOC m.m.

Reaktantblandingerne blandes i palletanke med oppumpet grundvand fra de respektive boringer i stedet for at introducere postevand. Hermed laves der ikke om på vandkemien i testene,

Ved testene opsamles det oppumpede vand i tanke. Alt oppumpet vand ledes tilbage i de to boringer, når de to test er færdige. Vandet vil indeholde de samme reaktanter, som der skal anvendes i fuld skala oprensningen, hvor vandet også pumpes rundt og reinjiceres i magasinet.

5.2.1 Push-pull forsøg med reaktantblanding 1 (Test 1A) – mængder

I pilotforsøg med reaktantblanding 1 (mobilitetstest 1A i boring B808-2) anvendes økologisk roemelasse og NANOFER25 (nZVI) og som tracer benyttes bromid. Der anvendes følgende mængder i alt til mobilitetsforsøget:

Der oppumpes 2.500 l grundvand fra boring B808-2 til at lave reaktant-blanding 1. Deri opblandes:

- 30 kg NANOFER25 (2.000 mg/l nZVI aktivstof)
- 500 l økologisk melasse

Til forsøget anvendes tracer, 3 kg KBr (bromid) svarende til en koncentration på 1.000 mg KBr/l.

Reaktantblandingen opbevares i 3 palletanke og injiceres til grundvandet, om muligt med et flow på 0,5 m^3/t i 6 timer. Oppumpningen sættes efterfølgende straks i gang. I løbet af oppumpningen udtages prøver til analyse af relevante forureningskomponenter samt tracer for vurdering af reaktantens mobilitet (og evt. nedbrydning). Det oppumpede grundvand opbevares i tanke og ledes først tilbage til boringen efter Test 1B er færdig.

5.2.2 Push-pull forsøg med reaktantblanding 1 (Test 1B) – mængder

I pilotforsøg med reaktantblanding 2 (reaktivitetstest 1B i boring B808-2) anvendes økologisk roemelasse, NANOFER25 (nZVI), bakterier (KB1) og som tracer benyttes bromid. Der anvendes følgende mængder i alt til reaktivitetsforsøget:

Der oppumpes 2.500 l grundvand fra boring B808-2 til at lave reaktant-blanding 1. Deri opblandes:

- 30 kg NANOFER25 (2.000 mg/l nZVI aktivstof)
- 500 l økologisk melasse
- 0,021 l KB1 bakterier

Til forsøget anvendes tracer, 3 kg KBr (bromid) svarende til en koncentration på 1.000 mg KBr/l.

Reaktantblandingen opbevares i 3 palletanke og injiceres til grundvandet, om muligt med et flow på 0,5 m^3/t i 6 timer. Der ventes ca. 2 uger før der forteges en oppumpning af det injecerede vand fra boringen. Det oppumpede grundvand opbevares i tanke og ledes tilbage til boringen når Test 1B er færdig.

5.2.3 Push-pull forsøg med reaktantblanding 2 (Test 2A) – mængder

I pilotforsøg med reaktantblanding 2 (mobilitetstest 2A i boring B802-1) anvendes Ferox Plus og som tracer benyttes bromid. Mht. mængder oppumpes 2.500 l grundvand fra boring B802-1 til at lave reaktantblanding 2. Deri opblandes 500 kg Ferox plus. Til forsøget anvendes tracer, ca. 3 kg KBr (bromid) svarende til en koncentration på ca. 1.000 mg KBr/l.

Reaktantblandingen opbevares i 3 palletanke og injiceres til grundvandet, om muligt med et flow på 0,5 m^3/t i 3 timer. Oppumpningen sættes efterfølgende straks i gang. I løbet af oppumpningen udtages prøver til analyse af relevante forureningskomponenter samt tracer for vurdering af reaktantens mobilitet (og evt. nedbrydning). Det oppumpede grundvand opbevares i tanke og ledes først tilbage til boringen efter Test 2B er færdig.

5.2.4 Push-pull forsøg med reaktantblanding 2 (Test 2B) – mængder

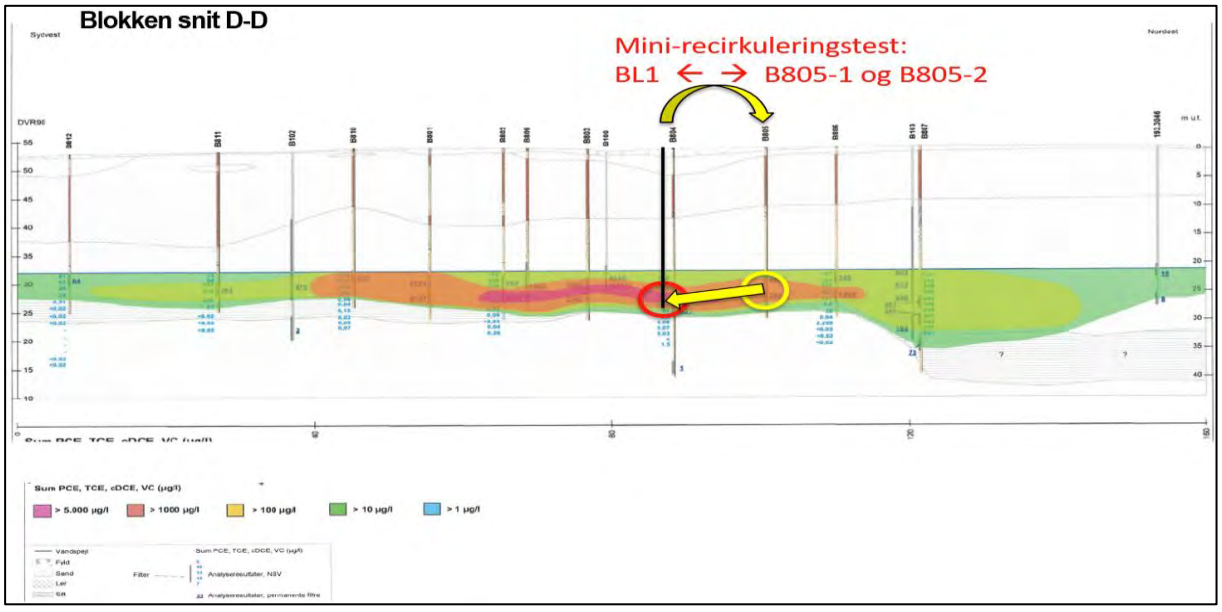
I pilotforsøg med reaktantblanding 2 (reaktivitetstest 2B i boring B802-1) anvendes Ferox Plus, bakterier (KB1) og som tracer benyttes bromid. Mht. mængder oppumpes 2.500 l grundvand fra boring B802-1 til at lave reaktantblanding 2. Deri opblandes 500 kg Ferox plus og 0,021 l KB1 bakterier.

Til forsøget anvendes tracer i form af ca. 3 kg KBr (bromid) svarende til en koncentration på ca. 1.000 mg KBr/l.

Reaktantblandingen opbevares i 3 palletanke og injiceres til grundvandet, om muligt med et flow på 0,5 m^3/t i 6 timer. Der ventes ca. 2 uger før der forteges en oppumpning af det injecerede vand fra boringen. Det oppumpede grundvand opbevares i tanke og ledes tilbage til boringen når Test 2B er færdig.

5.3 Fase 3: Fase 3: Mini-recirkuleringstest

Der udføres et mini-recirkuleringsforsøg imellem 2 tætliggende boringer med den mest optimale reaktantblanding bestemt ved push-pull forsøgene, jf. figur 7.



Figur 7. Pilotforøg med udvalgte boringer til udførelse af recirkuleringstests.

Mini-recirkuleringstesten udføres i boring BL1 (pumpeboring) og B805-1 og B805-2 (infiltrationsboring). Forsøget er skitseret i figur 3 og 7.

Afstanden mellem B805-1 og B805-2 er ca. 12 meter og filterstørrelserne er 5 meter i BL1 (23-27 mut) og 2x2 meter i B805-1 og B805-2 (25-27 mut og 22-24 mut). Der skønnes et omtrentligt påvirket volumen ved testen på ca. 150-225 m^3 afhængig af porøsiteten og dispersiviteten mv. Der forventes en gennemløbstid for en cyklus på mellem ca. 1 og 10 dage afhængig af, hvilken gradient der opnås imellem pumpe- og infiltrationsboring. Dette er styret af, hvor let det er at reinfiltrere stofferne og hænger sammen med filtertab og boringens virkningsgrad sammenholdt med reaktanternes viskositet mv.

Efter injektion af reaktanter vil forsøget fortsætte med recirkulation af vandet mellem boringerne i en periode på ca. 4-6 uger. Længden af perioden vil afhænge af de løbende resultater, idet der meget gerne skulle ses en effekt i form af en verifikation af, at reaktanterne er fordelt i hele volumenet mellem boringerne samt en reduceret forurening.

5.3.1 Mini-recirkuleringstest med reaktantblanding 1 - mængder

Såfremt reaktantblanding 1 viser sig mest optimal ved push-pull forsøgene, vil denne tages i anvendelse sammen med KB1 bakterier i det følgende mini-recirkuleringsforsøg. Pumpeboring er BL1 og injektions- og infiltrationsboring er B805-1 og B805-2. Der anvendes økologisk roemelasse og NANOFER25 (nZVI), KB1 bakterier, og som tracer benyttes bromid. Der anvendes følgende mængder:

- Oppumpning af 5.000 l grundvand fra boring BL1 til at lave reaktant-blanding 1. Deri opblandes:
    - 60 kg NANOFER25 (2.000 mg/l nZVI aktivstof)
    - 1.000 l økologisk melasse
    - 0,042 l KB1 bakterier

Til forsøget anvendes tracer, 6 kg KBr (bromid) svarende til en koncentration på 1.000 mg KBr/l.

Reaktantblandingen opbevares i 6 palletanke og injiceres til grundvandet, om muligt med et flow på 1 m^3/t i 6 timer.

5.3.2 Mini-recirkuleringstest med reaktantblanding 2 - mængder

Såfremt reaktantblanding 2 viser sig mest optimal ved push-pull forsøgene, vil denne tages i anvendelse sammen med KB1 bakterier i det følgende mini-recirkuleringsforsøg. Pumpeboring er BL1 og injektions- og infiltrationsboring er B805-1 og B805-2. Der anvendes Ferox Plus, bakterier (KB1) og som tracer benyttes bromid. Der anvendes følgende mængder:

- Oppumpning af 5.000 l grundvand fra boring BL1 til at lave reaktantblanding 2. Deri opblandes:
    - 1.000 kg Ferox plus
    - 0,042 l KB1 bakterier.

Til forsøget anvendes tracer i form af ca. 3 kg KBr (bromid) svarende til en koncentration på ca. 1.000 mg KBr/l.

Reaktantblandingen opbevares i 3 palletanke og injiceres til grundvandet, om muligt med et flow på 1 m^3/t i 6 timer.

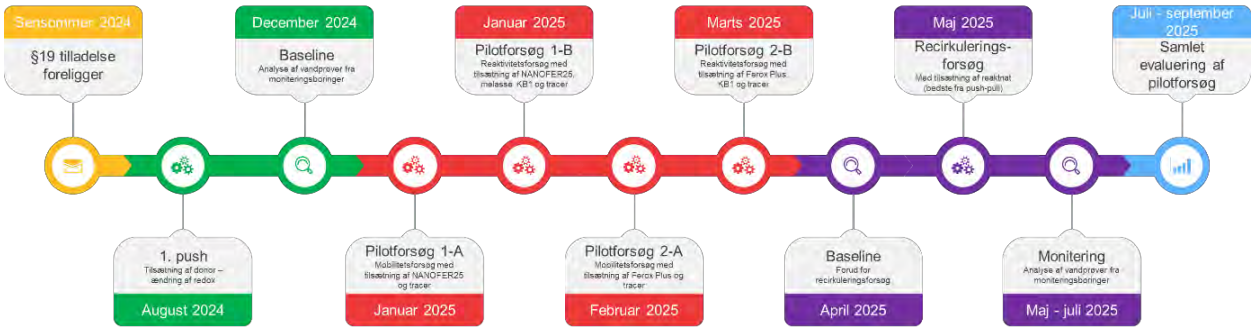
6 Setup for fuldskala afværge

Når pilotforsøgene er slut, og resultatbearbejdningen er foretaget, designes fuldskala afværge med recirkulering af de reaktanter, der har vist sig mest optimale for den specifikke lokalitet sammen med KB1 bakterierne. På nuværende tidspunkt er forholdene omkring fuldskala oprensningen ikke fuldt afklaret, da de afhænger meget af resultatet af pilotforsøgene. Hvis det viser sig at recirkulering og aktiv oprensning har den ønskede effekt, kan det være løsningen. Der skal i forbindelse med fuldskala afværgen sandsynligvis etableres nogle flere filterboringer, evt. suppleret med injektionsboringer, evt. med spinn-injection metoden, som allerede er afprøvet på lokaliteten med succes. En kombination mellem disse metoder vurderes pt. at være en potentiel afværgeløsning.

I forbindelse med detailprojekteringen vil der blive fremsendt en supplerende §19 ansøgning, som omhandler Reaktanter, der skal benyttes i fuldskala oprensningen.

7 Tidsplan

Pilottests ønskes om muligt igangsat i 3. kvartal af 2024. Tidslinje er vist i figur 8 og vedlagt i bilag B i større udgave sammen med en egentlig tidsplan. Der er usikkerhed om igangsætning af især de første poster.



Figur 8. Omtrentlig tidslinje til udførsel af pilotforsøg og fuld skala afværge.

8 Afsluttende bemærkninger

I tilfælde af at De ønsker yderligere oplysninger eller har kommentarer, er De som nævnt velkommen til at henvende Dem til undertegnede.

9 Referencer

/1/ Region Hovedstaden. Blokken 25, Birkerød. Rapport om fluxtransekt. Cowi, april 2021.

Bilag

A Snit for geologi og grundvandsforureningen

B Tidslinje og tidsplan

Appendiks

A Specifikationer for:

- Melasse
- NANOFER25
- 3DMe
- Ferox Plus
- KB1

Med venlig hilsen
Geo

John Ulrik Bastrup
+45 3174 0117
jub@geo.dk

Sofie Kamille Schultz
+45 3174 0228
sks@geo.dk

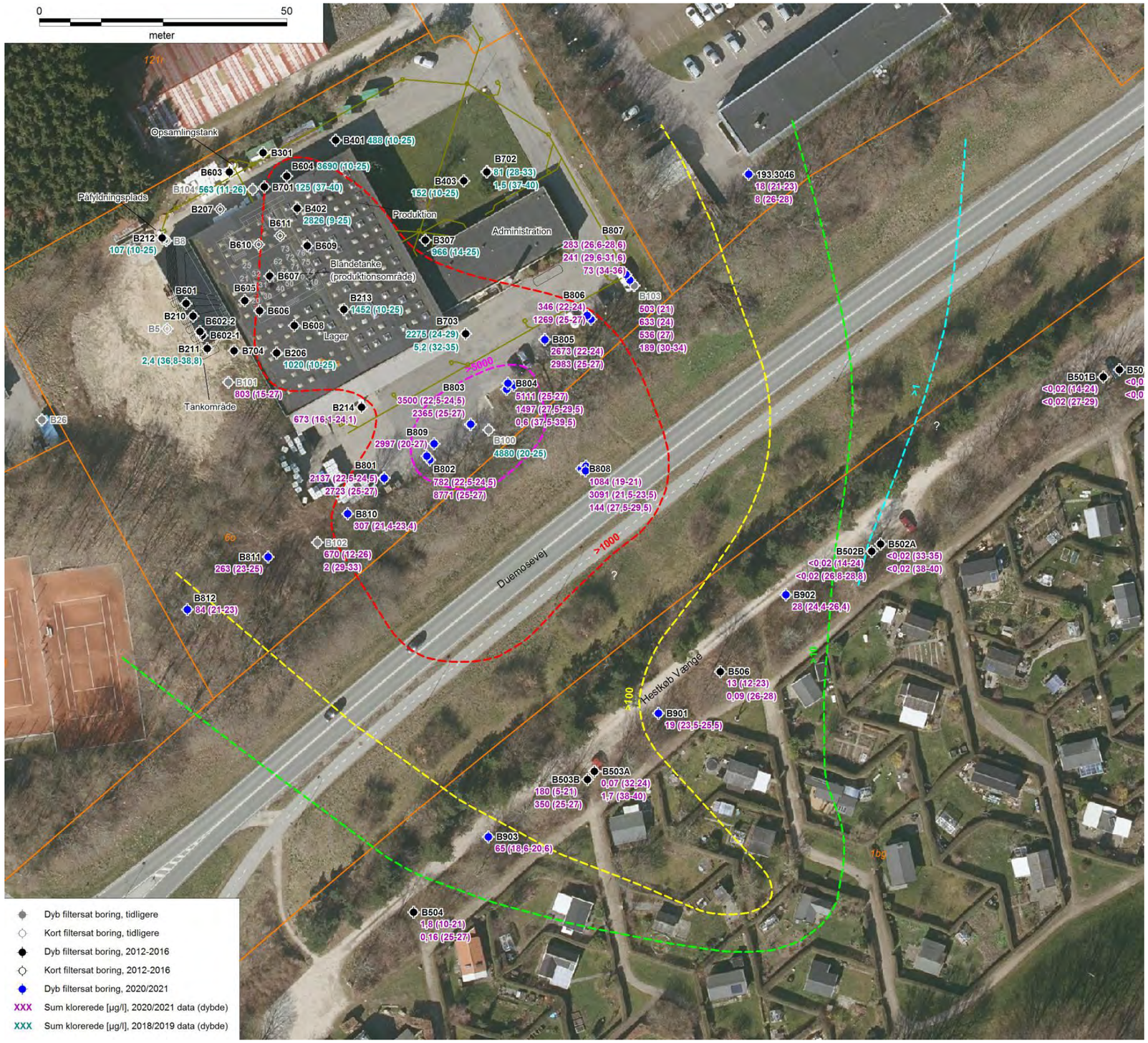
Situationsplaner og –snit

Blokken, BL — Project: 208086

Udført: JUB

Dato: 2024-07-03 — Bilag: A

Geo
København +45 4588 4444
Aarhus +45 8627 3111

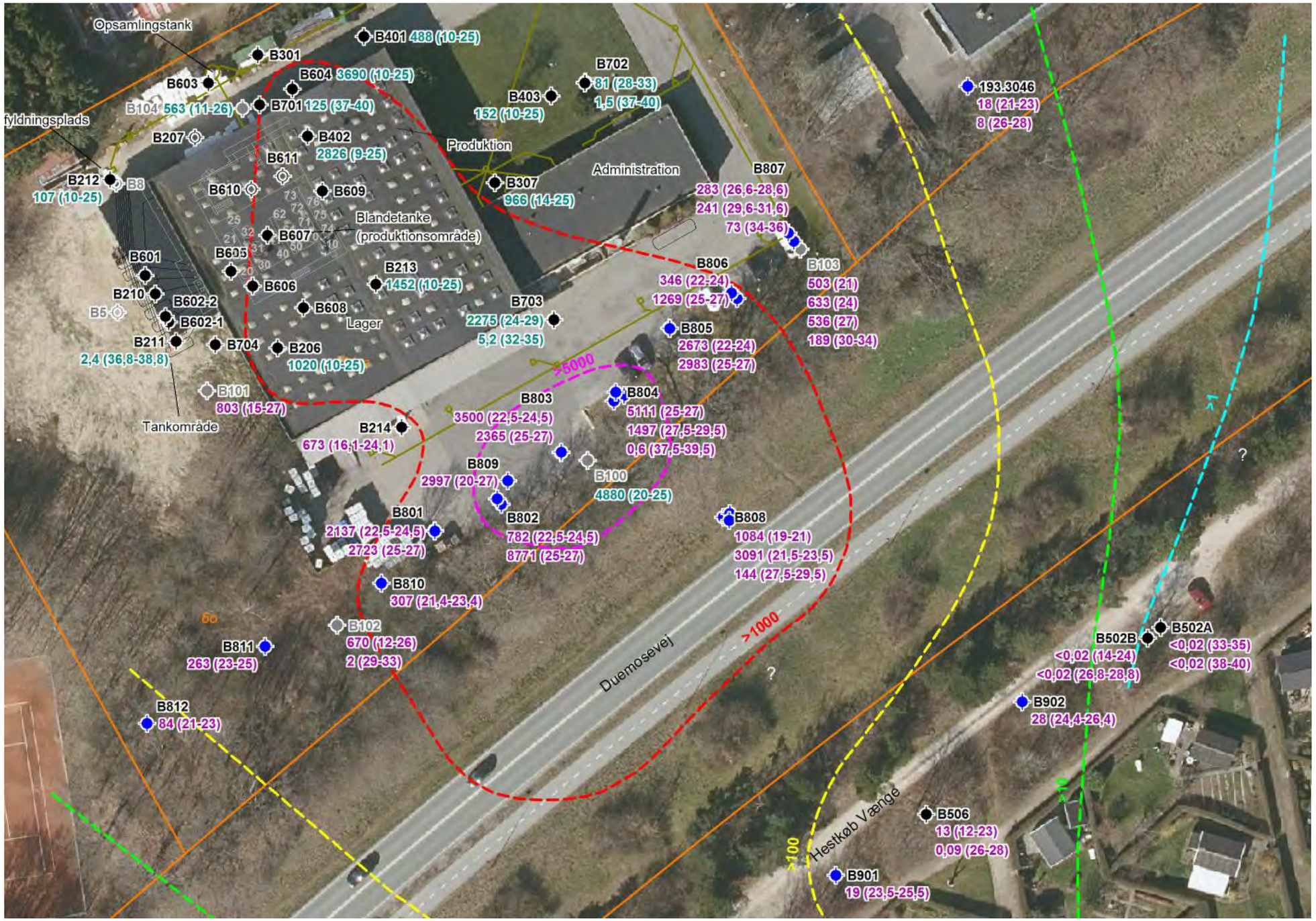


Situationsplaner og –snit

Blokken, BL — Project: 208086

Udført: JUB

Dato: 2024-07-03 — Bilag: A

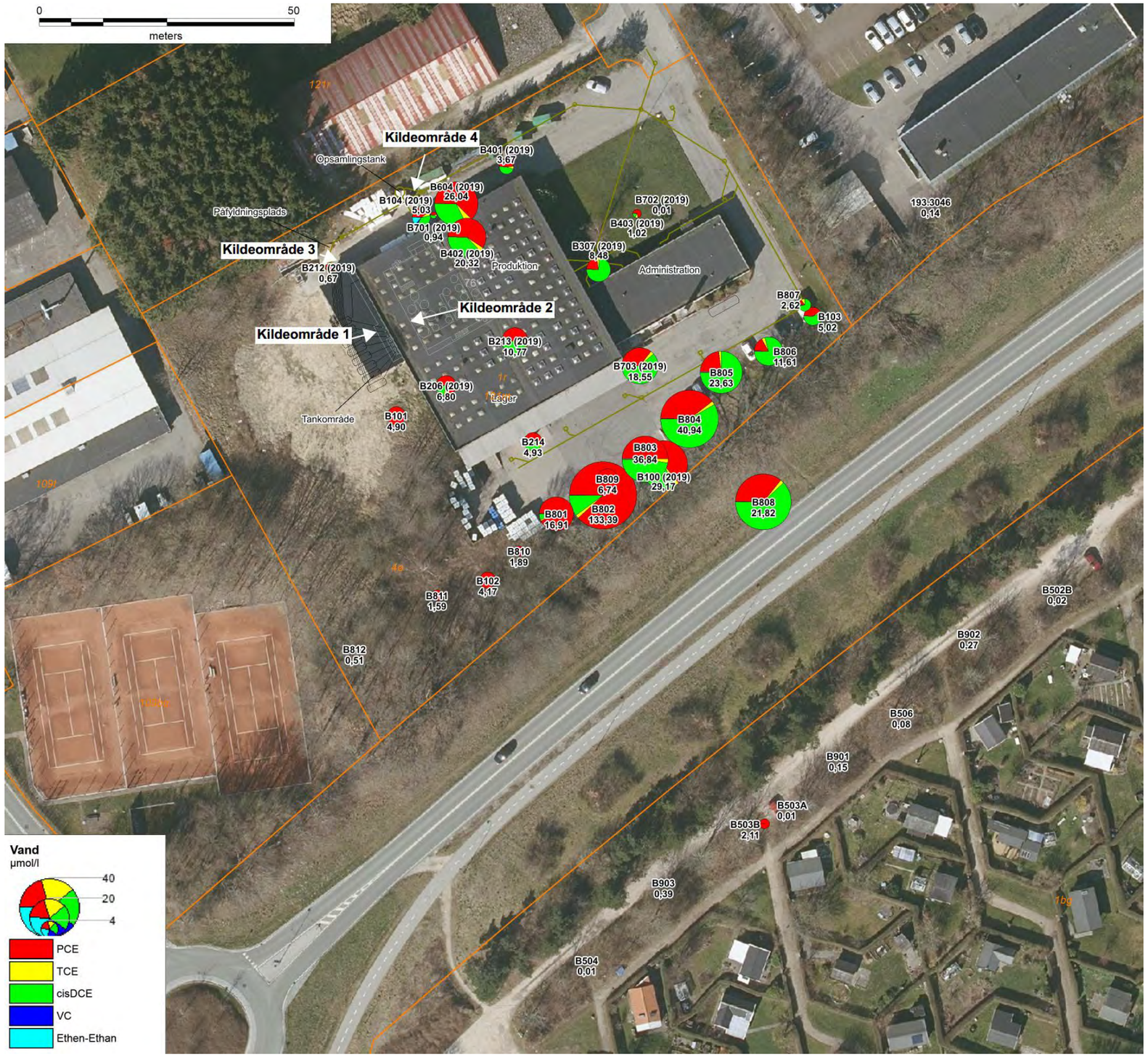


Situationsplaner og –snit

Blokken, BL — Project: 208086

Udført: JUB

Dato: 2024-07-03 — Bilag: A



Situationsplaner og –snit

Blokken, BL — Project: 208086

Udført: JUB

Dato: 2024-07-03 — Bilag: A

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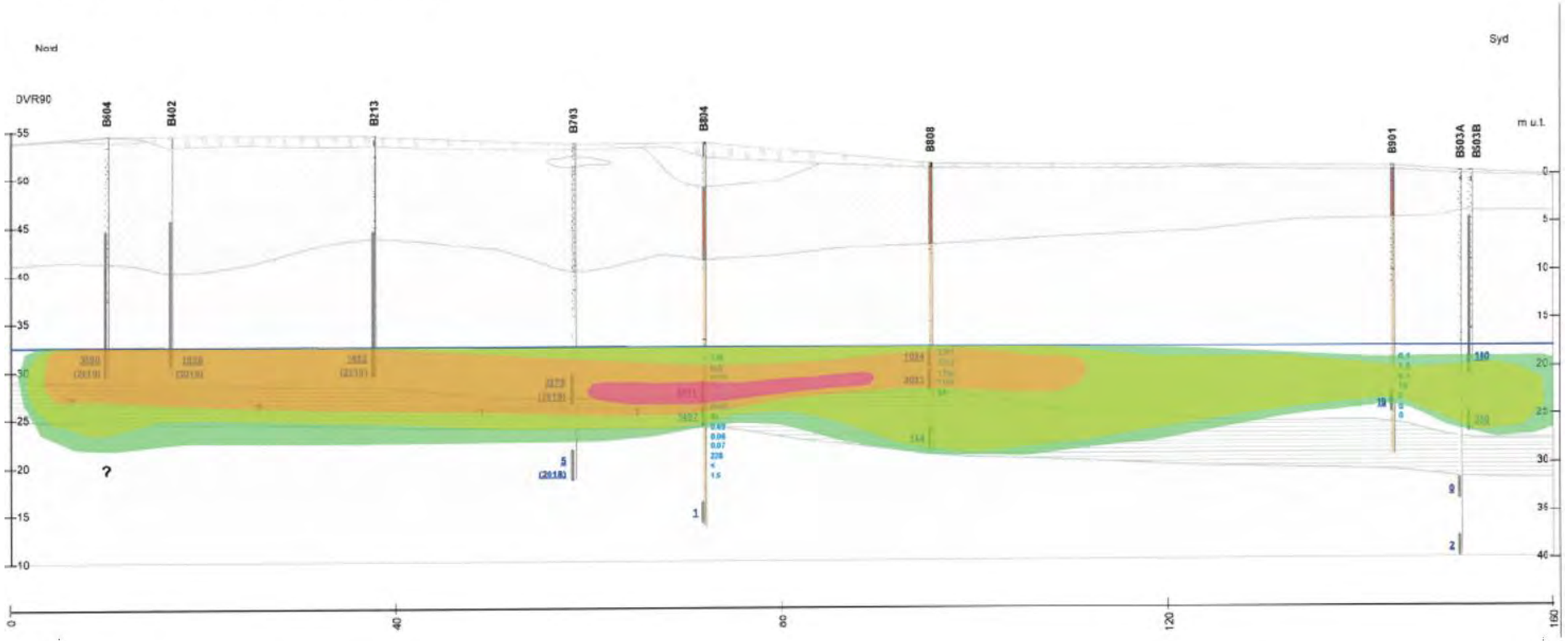
Blokken- snit F



Sum PCE, TCE, cDCE, VC (µg/l)

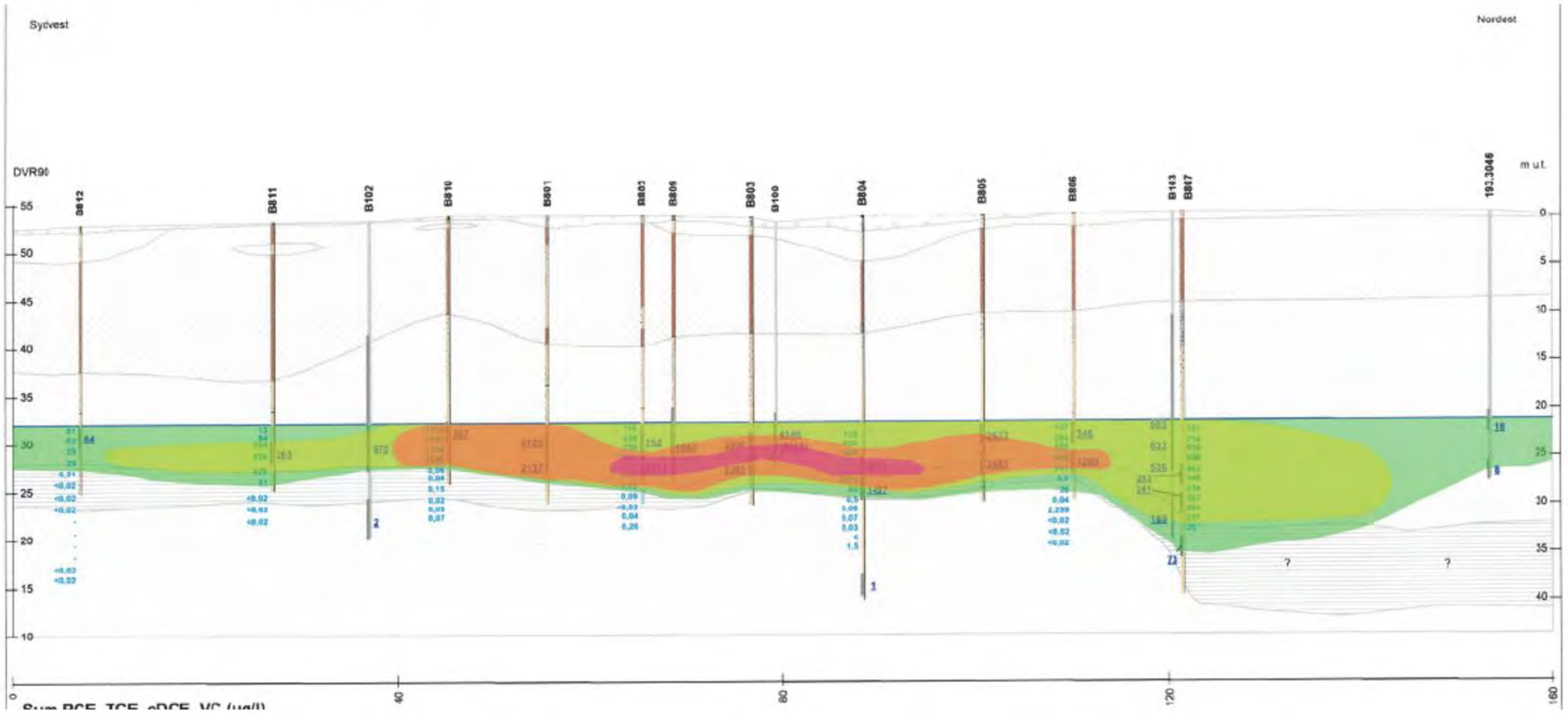
> 5.000 µg/l | > 1000 µg/l | > 100 µg/l | > 10 µg/l | > 1 µg/l

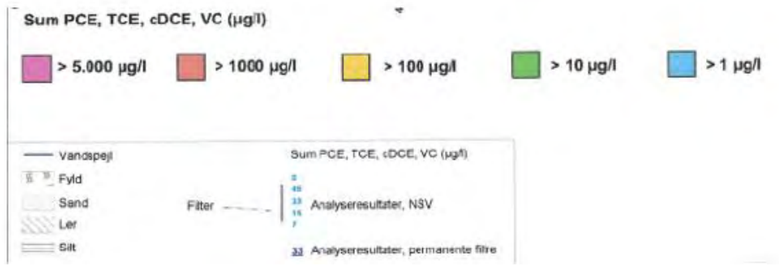
Vandspejl
Fyld
Sand
Ler
Silt
Filter
Sum PCE, TCE, cDCE, VC (µg/l)
Analyseresultater, NSV
Analyseresultater, permanente filte

Situationsplaner og –snit

Blokken, BL — Project: 208086
Udført: JUB
Dato: 2024-07-03 — Bilag: A

Blokken snit D





Situationsplaner og –snit

Blokken, BL — Project: 208086

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København +45 4588 4444
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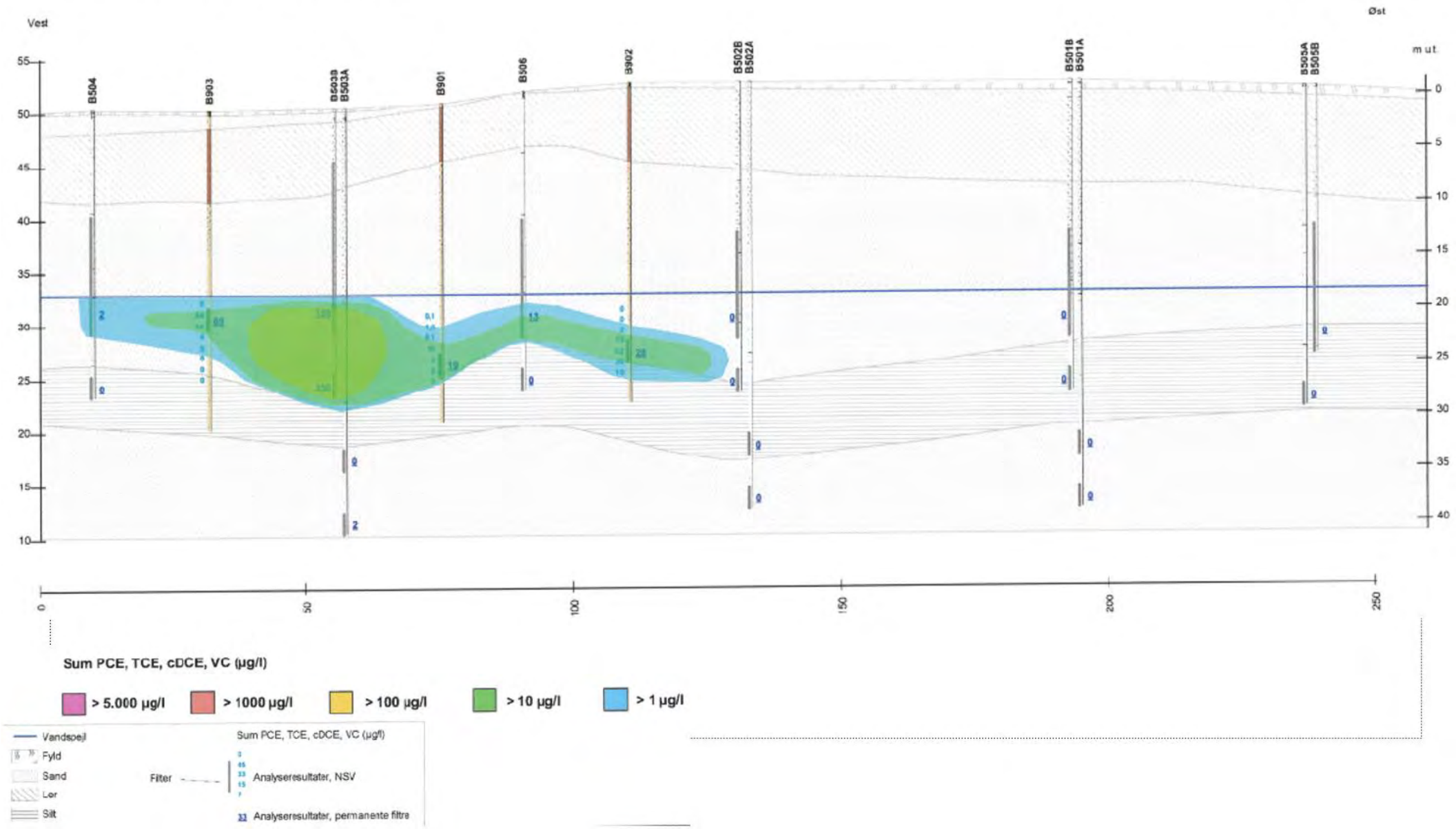
Blokken, snit E



Situationsplaner og –snit

Blokken, BL — Project: 208086

Udført: JUB

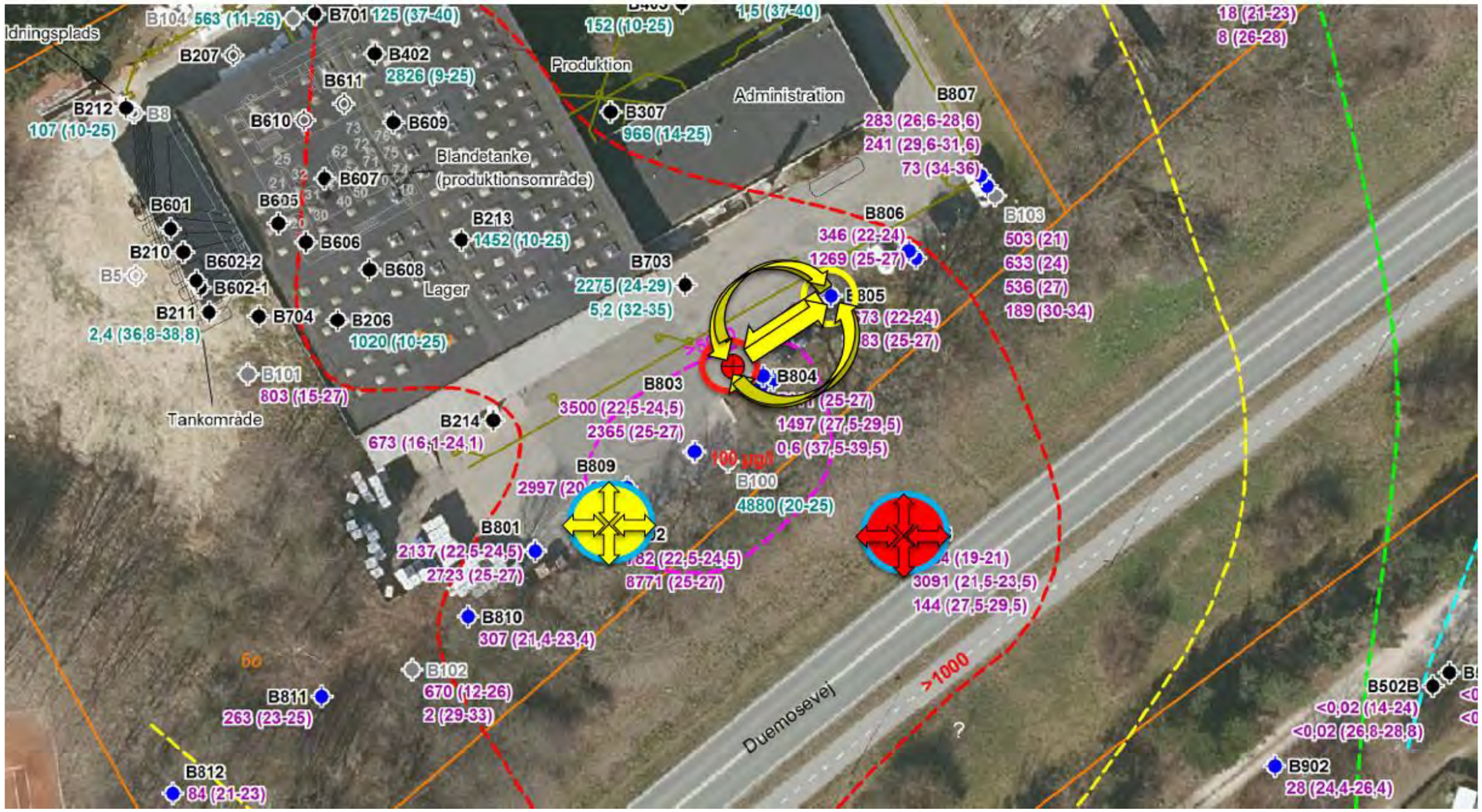
Dato: 2024-07-03 — Bilag: A

Pilot tests i BL:

Push-pull 1:
B808-2

Push-pull 2:
B802-1

Mini-
recirkulering 1:
BL1<->B805-1/2



Situationsplaner og –snit

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Udført: JUB

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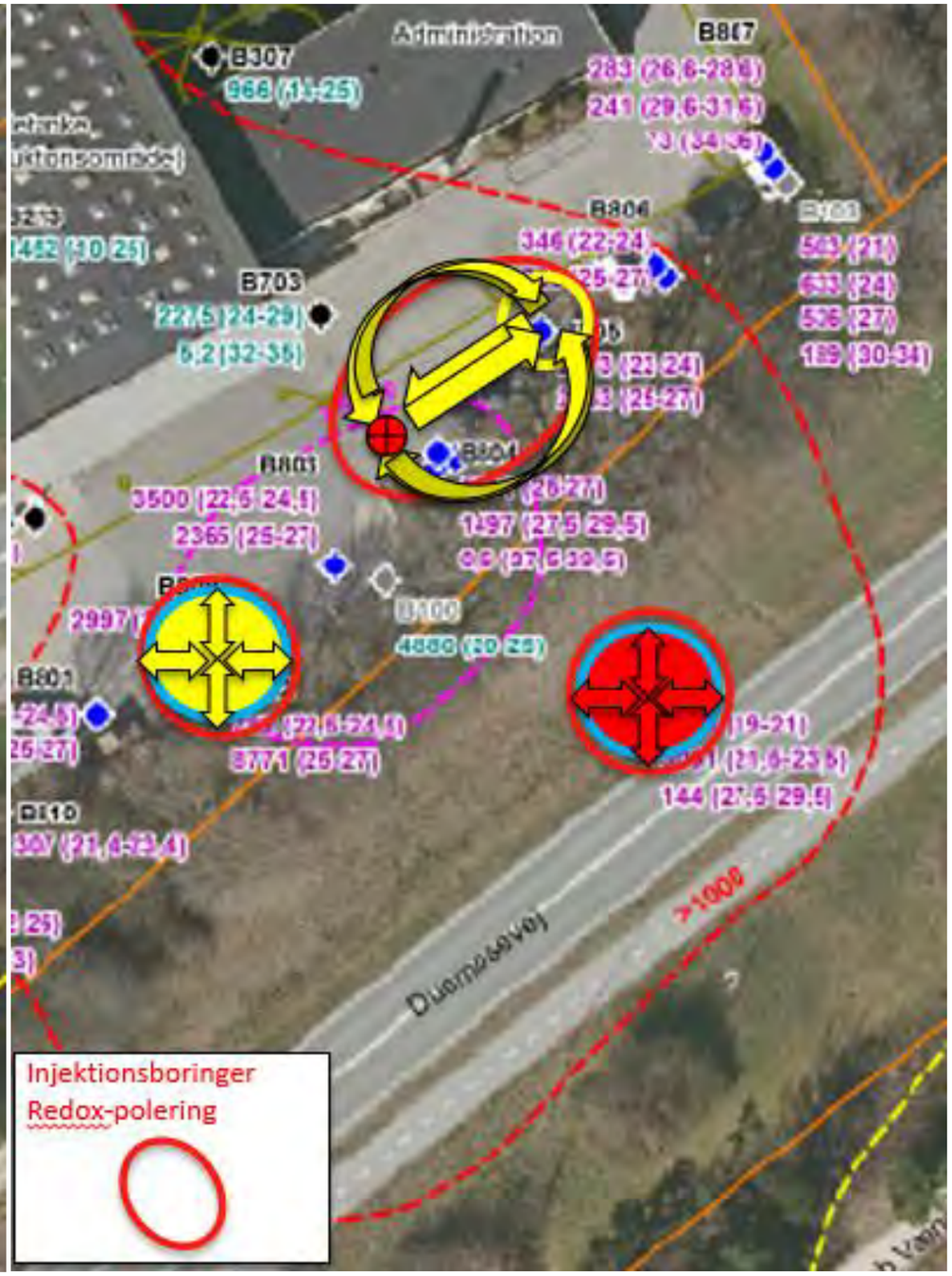


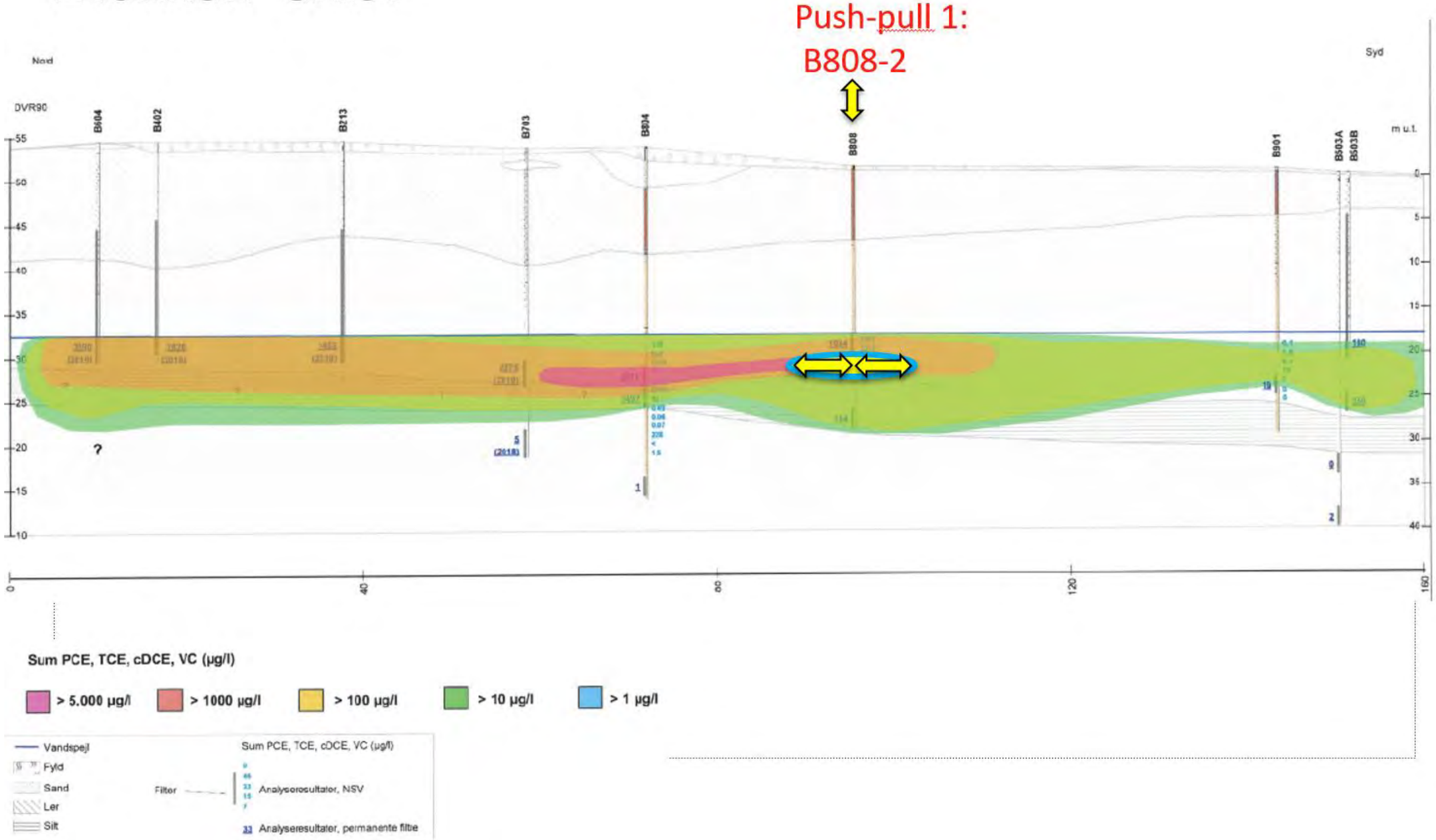
Situationsplaner og –snit

Blokken, BL — Project: 208086

Udført: JUB

Dato: 2024-07-03 — Bilag: A

Blokken- snit F



Situationsplaner og –snit

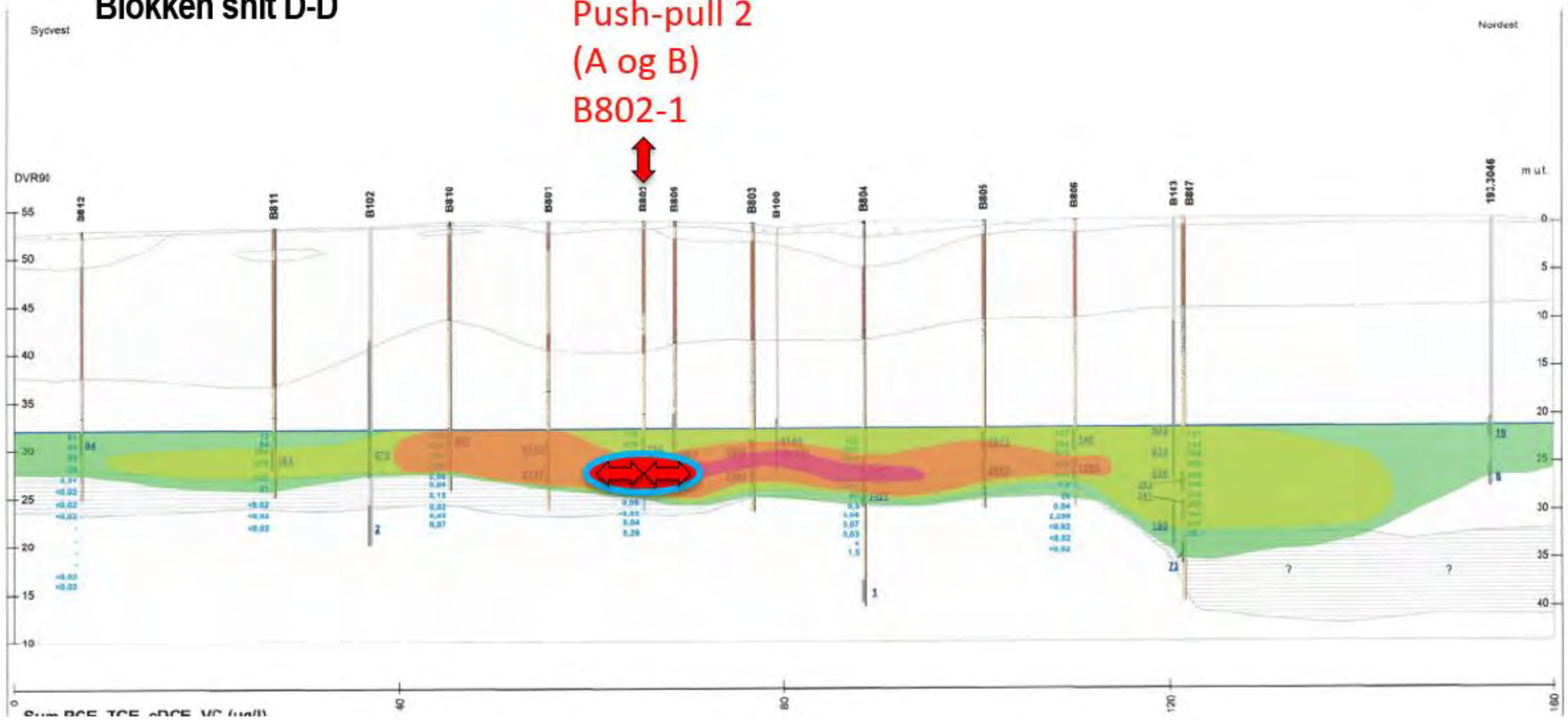
Blokken, BL — Project: 208086

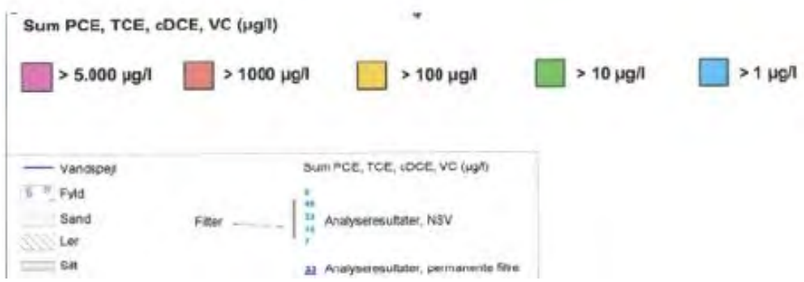
Udført: JUB

Dato: 2024-07-03 — Bilag: A

Blokken snit D-D

Push-pull 2
(A og B)
B802-1



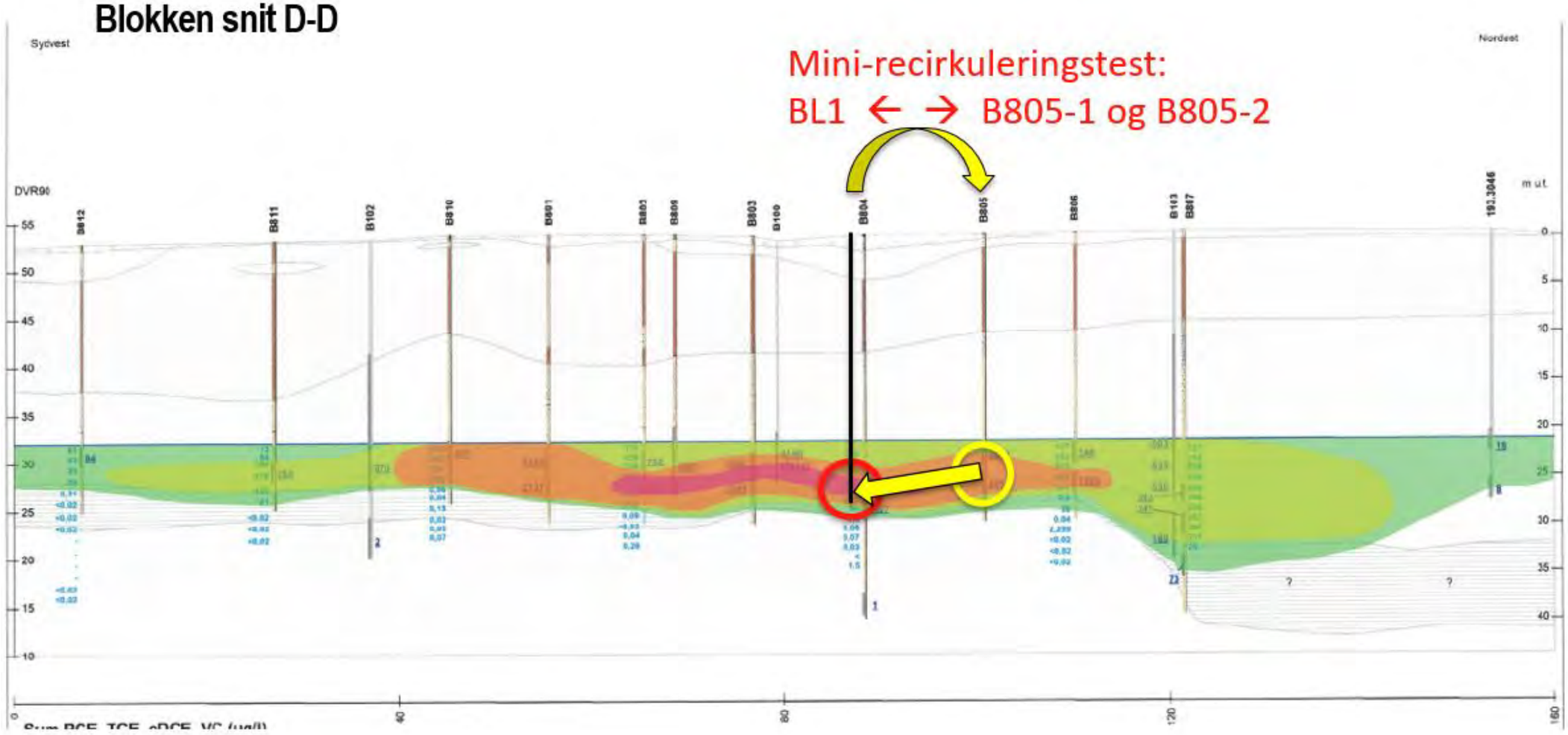


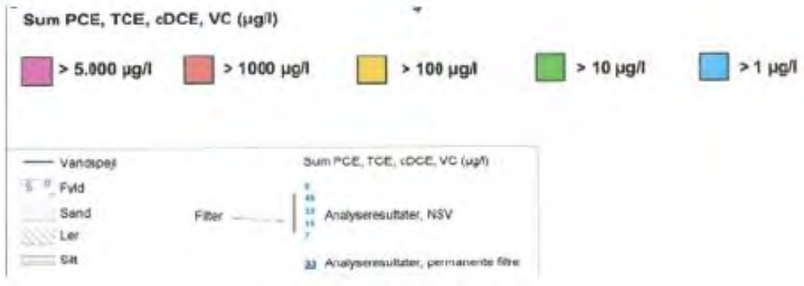
Situationsplaner og –snit

Blokken, BL — Project: 208086
Udført: JUB
Dato: 2024-07-03 — Bilag: A

Geo
København +45 4588 4444
Aarhus +45 8627 3111

Blokken snit D-D



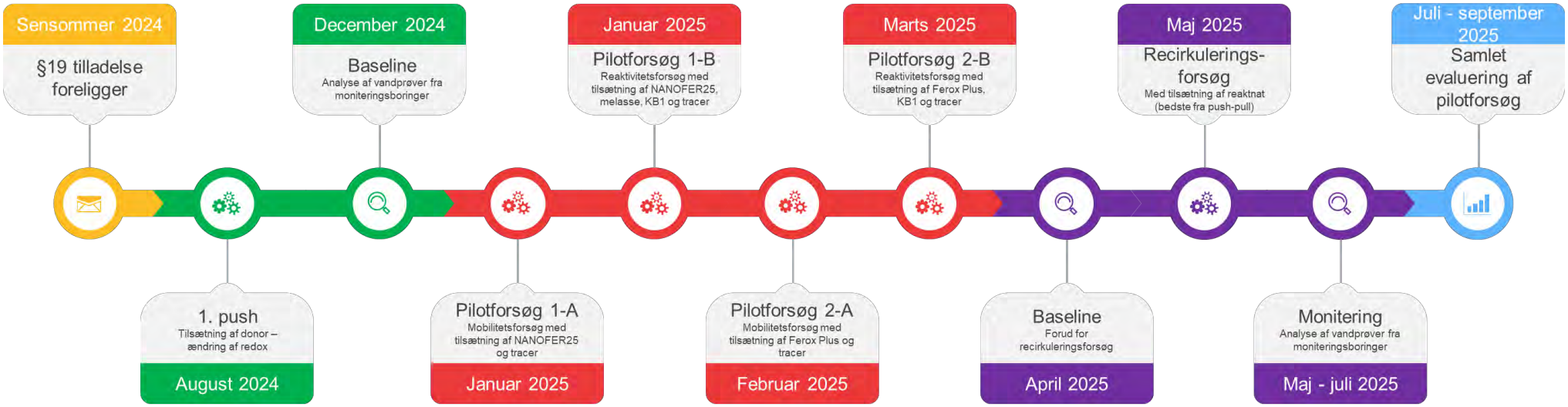


Situationsplaner og –snit

Blokken, BL — Project: 208086

Udført: JUB

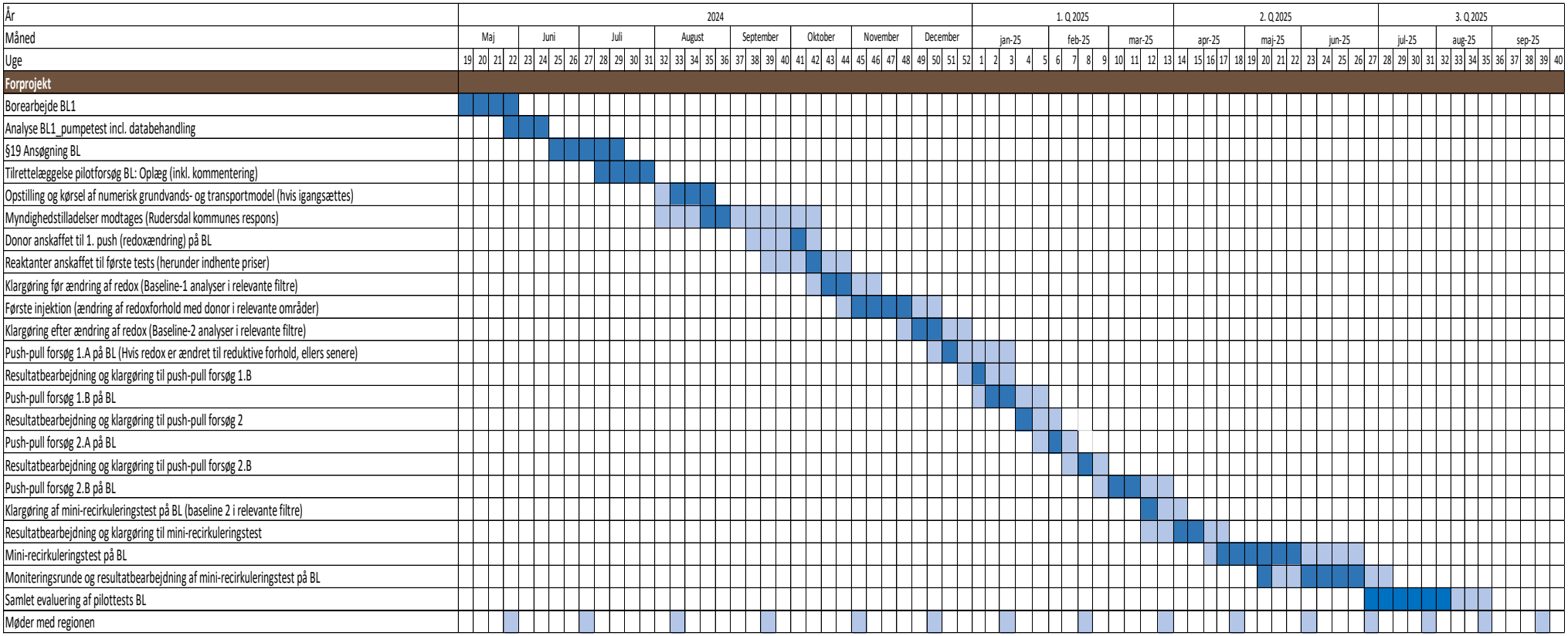
Dato: 2024-07-03 — Bilag: A



Tidslinje og -plan – Blokken 25A, Birkerød

Udført af:	sks	Projekt: 208086
Dato:	2024-07-03	Bilag: B

Geo
København +45 4588 4444
Aarhus +45 8627 3111



Tidslinje og -plan – Blokken 25A, Birkerød

Udført af: sks Projekt: 208086

Dato: 2024-07-03 Bilag: B

København +45 4588 4444

Aarhus +45 8627 3111

Appendix A

Specifikationer for:

- Melasse
- NANOFER25
- 3DMe
- Ferox Plus
- KB1

Projekt 208086 Blokken 25A. Birkerød

BIO ZUCKERRÜBENMELASSE
(KONTROLLIERT BIOLOGISCHER ANBAU)

Parameter	**Value**
TS-Gehalt	76 – 79 %
Total Sugars	Min. 47 %
Ash	Ca. 7,0 %
Rohprotein	Ca. 13 %

BIO ZUCKERROHRMELASSE + FAIRTRADE
(KONTROLLIERT BIOLOGISCHER ANBAU)

Parameter	**Value**
Brix	Ca. 80 %
Invert	14 – 22 %
Sucrose	30 – 45 %
Total Sugars	50 – 60 %
Ash	Max 12 %
pH	5,0 -6,0
Color (Absorbance, 430nm)	1.4 – 1.8

Die Zusammensetzung der Melasse ist abhängig von der Zusammensetzung des verarbeiteten Zuckerrohr/ Zuckerrübe und daher natürlichen Schwankungen unterworfen.

SECTION 1: IDENTIFICATION OF THE SUBSTANCE / MIXTURE AND OF THE COMPANY/UNDERTAKING

1.1 Product identifier:
The trade name of the mixture: NANOFER 25
REACH No.: A registration number is not available for this substance as the substance or its uses are exempted from registration, the annual tonnage does not require a registration or the registration is envisaged for a later registration deadline.

1.2 Relevant identified uses of the substance or mixture and uses advised against
Relevant identified uses: for laboratory usage, for industrial usage, it is highly applicable in the reduction technologies of ground water remediation and waste water treatment.

1.3 Details of the supplier of the Safety Data Sheet
- Supplier: NANO IRON, s.r.o.
- Street address: Štefánikova 116
- Country ID/Postcode/Place: (CZ) Czech Republic/66461/Rajhrad
- Telephone number/Fax: +420 513 033 633/ +420 547 230 212
- E-mail address: info@nanoiron.cz
- National contact: +420 513 033 633
- Identification number: 28298055

1.4 Emergency telephone number: +420 224 919 293 or +420 224 915 402 (non-stop medical service), TIS Praha, Na Bojišti 1, 128 08 Prague 2. Czech republic.

SECTION 2: HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

2.1.1 Classification according to Regulation (EC) No 1272/2008 [CLP]
Not a hazardous substance or mixture according to Regulation (EC) No. 1272/2008.

2.1.2. Classification according to Directive 67/548/EEC
Not a hazardous substance or mixture according to EC-directives 67/548/EEC or 1999/45/EC.

2.1.3 Additional information: none

2.2 Label elements
The product does not need to be labelled in accordance with EC directives or respective national laws.
Precautionary statement(s), P, in full
P210 Keep away from heat/sparks/open flames/hot surfaces. – No smoking.
P270 Do not eat, drink or smoke when using this product.
P280 Wear protective gloves/protective clothing/eye protection/ face protection.
P305+P351+P338IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
Supplemental Hazards
None

2.3 Other hazards
In contact with water may release small amounts of explosive hydrogen gas (less than 1l/1kg.h).

SECTION 3: COMPOSITION / INFORMATION ON INGREDIENTS

3.1 Substances: not applicable
3.2 Mixture:

Name :	CAS No. :	Weight % content	Classification according to 67/548/EEC	Classification according to Regulation (EC) No 1272/2008 (CLP).
Iron (Fe)	7439-89-6	(14-18)%	Iron is not classified as dangerous	Iron is not classified as dangerous
Magnetite (Fe_3O_4)	1309-38-2	(6-2)%	Magnetite is not classified as dangerous	Magnetite is not classified as dangerous
Carbon (C)	7440-44-0	(0-1)%	Carbon is not classified as dangerous	Carbon is not classified as dangerous
Water (H_2O)	7732-18-5	80%	Water is not classified as dangerous	Water is not classified as dangerous

Slurry of water, zero-valent iron nanoparticles and iron oxides.

SECTION 4: FIRST AID MEASURES

4.1 Description of first aid measures:
- Eye contact: Rinse eyes with large amounts of low pressure water and get immediate medical attention.
- Skin contact: Wash affected area with soap and water, get medical attention if irritation develops.
- Inhalation: Move to fresh air and get immediate medical attention.
- Ingestion: Drink plenty of water and induce vomiting, get immediate medical attention.
- Self-protection of the first aider: It was found none.

4.2 Most important symptoms and effects, both acute and delayed
See section 2.2 and section 11.

4.3 Indication of any immediate medical attention and special treatment needed
No data available.

SECTION 5: FIRE-FIGHTING MEASURES

5.1 Extinguishing media
Suitable extinguishing media: Extinguishing powder or sand.

5.2 Special hazards arising from the substance or mixture
After drying of the mixture dried powder could be accumulated with heat by oxidation in air, but will not be exploded. Do not scatter the particles.

5.3 Advice for firefighters
Warning! Use black glasses during firefighting – the danger of blindness. The metals burns with a dazzling light which can damage the retina. The eye protection is required. The protective equipment must be chosen according to the fire greatness. Appropriate protective breathing mask with independent air supply and possibly full protective clothing.
Cool by water the products in sealed containers which are near the fire. If possible, remove the products within undamaged containers from danger area. Contaminated extinguishing water must be stored separately, do not discharge it into the drains. The fire extinguishing water or used firefighting media with combustion residues must be disposed in accordance with relevant regulations.

SECTION 6: ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency
6.1.1 For non-emergency personnel
a) Avoid spreading of product. Wear of suitable protective equipment to prevent any contamination of skin, eyes and personal clothing. For personal protection see section 8. Avoid ingestion of product.
b) Do not let the product come into contact with oxidizing agents, acids, acetylene and ammonia.
6.1.2 For emergency responders
Wear of suitable protective equipment to prevent any contamination of skin, eyes and personal clothing. For personal protection see section 8.

6.2 Environmental precaution
Prevent further leakage or spillage if safe to do so. Do not let product enter to drains without permission from local authority.

6.3 Methods and material for containment and cleaning up:
6.3.1 For containment: Cover with inert, absorbent material and remove to water-filled container (particles react with water to iron oxide form) and dispose as non-hazardous waste.
6.3.2 For cleaning up: Flush with plenty of water.
6.3.3 Other information: Spill area may be slippery.
6.4 Reference to other sections: For disposal see section 13.

SECTION 7: HANDLING AND STORAGE

7.1 Precautions for safe handling
7.1.1. Recommendations:
(a) Excess pressure to be let off by carefully opening the container before use. Never open the container at the temperature over 35°C. Ensure sufficient ventilation. Avoid sparks and other sources of ignition. Homogenize material and use the whole volume best. If unused material left, keep it sealed with inert gas (nitrogen, argon);
(b) do not mix with oxidizing agents, acids, acetylene, ammonia;
(c) Do not allow the product conduction into drains, surface and ground water without permission from local authority.

7.1.2. Advice on general occupational hygiene:
(a) Do not eat, drink and smoke during the manipulation with the product;
(b) to wash hands after use; and
(c) to remove contaminated clothing and protective equipment before entering eating areas.

7.2 Conditions for safe storage, including any incompatibilities:
Store in a tightly sealed container in a cool (the most suitable temperatures are 1-5°C), dry and well-ventilated area. Material may degrade on storage unless refrigerated. Do not freeze!

7.3 Specific end use(s):
Part of the application mentioned in section 1.2 no other uses are reserved.

SECTION 8: EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters:
ACGIH TLV (1997) TWA 5mg/m^3 as Fe
OSHA PEL (1994) TWA 10mg/m^3 as Fe_2O_3

8.2 Exposure controls: Avoid eye and skin contact. Before breaks and after work wash your hands.

(a) Eye/face protection: Use of tightly fitted safety goggles (EN 166).
(b) Skin protection: Use appropriate protective gloves such as nitrile-rubber or butyl-rubber is recommended, minimum thickness of gloves 0.12 mm. Very appropriate is to use hand protective cream.

Use protective clothing with long sleeves, respectively safety proactive footwear (EN 344).

Environmental exposure controls

Do not allow the product conduction into drains, surface and ground water without permission from local authority.

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SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a) Appearance:	liquid (nanomaterial)
- Color:	black
- Granulometry:	d50 < 50nm
- Specific surface:	> 25m^2/g
- Specific gravity:	1.15 – 1.25 g/cm^3 (20°C)
- Surface charge:	zero (0)
- Zeta potential:	not applicable
b) Odour:	no odour
c) Odour threshold:	no odour
d) pH:	11 -12
e) Melting point/feezing point:	not applicable
f) Boiling point and boiling range:	not applicable
g) Flash point:	not applicable
h) Evaporation rate:	not applicable
(i) Flammability (solid, gas):	not applicable
(j) Upper/lower flammability or explosive limits:	not applicable
(k) Vapour pressure:	not applicable
(l) Vapour density:	not applicable
(m) Relative density:	not applicable
(n) Solubility(ies):	mixture is possible to thin in water
(o) Partition coefficient: n-octanol/water:	not applicable
(p) Auto-ignition temperature:	not applicable
(q) Decomposition temperature:	not applicable
(r) Viscosity:	not applicable
(s) Explosive properties:	not applicable
(t) Oxidizing properties:	not applicable

9.2 Other information

No data available

SECTION 10: STABILITY AND REACTIVITY

10.1 Reactivity

With water - a small volume of hydrogen is generated in water reaction (less than 1l/1kg·hr);

10.2 Chemical stability

Stable under recommended storage conditions;

10.3 Possibility of hazardous reactions:

Not applicable

10.4 Conditions to avoid:

Avoid air, elevated temperatures, ignition sources;

10.5 Incompatible materials:

Oxidizing agents, acids;

10.6 Hazardous decomposition products

Other decomposition products - no data available
In case of fire: see section 5

SECTION 11: TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

• Acute toxicity:

Acute toxicity of the product components	Iron – dry powder (CAS No: 7439-89-6)			
LD_{50}, oral, sewer rat:	30 000 mg/kg	-	-	-
LD_{50}, dermal, sewer rat or rabbit:	Not tested	-	-	-
LC_{50}, inhalation, sewer rat, for aerosols or particles for 4 hours:	Not tested	-	-	-

• Skin corrosion/irritation: no data available
• Serious eye damage/irritation: no data available
• Respiratory or skin sensitization: no data available

- Germ cell mutagenicity: no data available
- Carcinogenicity: no data available
- Reproductive toxicity: no data available
- Summary of evaluation of the CMR properties: no data available
- STOT-single exposure: no data available
- STOT-repeated exposure: no data available
- Aspiration hazard: no data available

SECTION 12: ECOLOGICAL INFORMATION

12.1 Toxicity

Acute toxicity of the product	**g/l**			
LC_{50} (96 hours, fishes):	12,4			
EC_{50} (48 hours, daphnia):	55,2			
IC_{50} (72 hours, algaes):	4,5			

12.2 Persistence and degradability
No data available
12.3 Bioaccumulative potential
No data available
12.4 Mobility in soil
No data available
12.5 Results of PBT and vPvB assessment
No data available
12.6 Other adverse effects
No data available
12.7 Additional information
No data available

SECTION 13: DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

13.1.1 Product
The mixture and its surpluses must be put only to specified area for waste and must be dispose together with the sorted waste, e.g. in waste incinerators.

13.1.2 Packaging
Empty containers completely. Hand empty containers over to authorized company that has permissions for their removal. Dispose waste in accordance with relevant local regulations with suitable devices. Sort and put other waste according to type of material into containers for recycling or to places specified by local authorities.

SECTION 14: TRASPORT INFORMATION

14.1 UN number
ADR/RID: - IMDG: - IATA: -

14.2 UN proper shipping name
ADR/RID: Not dangerous goods
IMDG: Not dangerous goods
IATA: Not dangerous goods

14.3 Transport hazard class(es)
ADR/RID: - IMDG: - IATA: -

14.4 Packaging group
ADR/RID: - IMDG: - IATA: -

14.5 Environmental hazards
ADR/RID: no IMDG Marine pollutant: no IATA: no

14.6 Special precautions for user
No data available.

SECTION 15: REGULATORY INFORMATION

This safety datasheet complies with the requirements of Regulation (EC) No. 1907/2006.

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture:
No data available

15.2 Chemical Safety Assessment:
No Chemical Safety Assessment has been carried out for this substance/mixture by the supplier.

SECTION 16: OTHER INFORMATION

All information, recommendations and suggestions appearing herein concerning NANO IRON, s.r.o. products are based upon tests and data believed to be reliable. However, it is the user's responsibility to determine the safety, toxicity and suitability for his/her own use of the product described herein. Since the actual use by others is beyond NANO IRON, s.r.o. control, it make no guarantee, expressed or implied, as to the effects of such use, the results to be obtained or the safety and toxicity of the product: nor do it assume any liability arising out of use, by others, of the product referred to herein. The information herein is not to be construed as absolutely complete since additional information may be necessary or desirable when particular or exceptional conditions or circumstances exist or because of applicable laws or government regulations.

Hepure Technologies Inc

Committed to Comprehensive Environmental Solutions

Ferox Plus

MATERIAL SAFETY DATA SHEET

According to OSHA and ANSI

Reviewed on 5/1/2013

1. Identification of Substance

Trade Name: Ferox Plus

Supplier: Hepure Technologies, Inc.
63 Main Street, Suite 203B
Flemington, NJ 08822

Emergency Information: 908-510-3835 Dr. Robert Kelley

2. Composition/Data on Components

Ingredient	CAS #	Weight%	Hazardous
Food grade edible soy bean oil	8001-22-7	30-40%	No
Iron	7439-89-6	10-40%	No
Emulsifiers, thickeners, and proprietary nutrient package containing nitrogen, phosphorus and vitamin B_{12}	Mixture	3 - 6%	No
Sodium Lactate	867-56-1	2 - 4%	Yes
Water	7732-18-5	10 - 55%	No

3. Hazards Identification

Hazard Description:
Information pertaining to particular dangers for man and environment

R 36/37 Irritating to eyes and respiratory system.

4. First Aid Measures

After inhalation

Supply fresh air. If required, provide artificial respiration. Keep patient warm. Seek medical advice.

After skin contact

Immediately wash with water and soap and rinse thoroughly. Seek immediate medical advice.

After eye contact

Rinse opened eye for several minutes under running water. Then consult a doctor.

After swallowing

Seek immediate medical advice.

Information for doctor

The following symptoms may occur: Nausea, Cramp, Gastric or intestinal disorders

5. Fire Fighting Measures

Suitable extinguishing agents: Extinguishing powder, dry chemical, sand, or graphite to smother fire. Use water only in mist/fog application to avoid spreading power/acclimated dust in surrounding area.

For safety reasons unsuitable extinguishing agents: Water, Carbon dioxide, Halogenated extinguisher

Protective equipment: Wear self-contained respirator. Wear fully protective impervious suit.

6. Accidental Release Measures

Person-related safety precautions:

Wear protective equipment. Keep unprotected persons away. Ensure adequate ventilation. Keep away from ignition sources.

Measures for cleaning/collecting:
Ensure adequate ventilation.
Keep away from ignition sources.

Additional information:
See section 7 for information on safe handling.
See section 8 for information on personal protection equipment.
See section 13 for disposal information.

7. Handing and Storage

Handling
Information for safe handling:
Keep container tightly sealed.
Store in cool, dry place in tightly closed containers.
Ensure good ventilation at the workplace.

Information about protection against explosions and fires:
Keep ignition sources away.

Storage
Requirements to be met by storerooms and receptacles:
No special requirements.

Information about storage in one common facility:
Do not store together with oxidizing and acidic materials.
Store away from halogens.
Further information about storage containers:
Keep container tightly sealed.
Store in cool, dry conditions in well sealed containers.

8. Exposure Controls and Personal Protection

Additional information about design of technical systems:
Properly operating chemical fume hood designed for hazardous chemicals and having an average face velocity of at least 100 feet per mile.

Components with limit values that require monitoring at the workplace: None required.

Additional Information: No data

Personal protective equipment

General protective and hygienic measures
The usual precautionary measures for handling chemicals should be followed.

Keep away from foodstuffs, beverages, and feed.
Remove all soiled and contaminated clothing immediately.
Wash hands before breaks and at the end of work.
Avoid contact with the eyes and skin.

Breathing Equipment: Use suitable respirator when high concentrations are present.

Protection of hands: Impervious gloves

Eye protection: Safety glasses, full face protection.

Body protection: Protective work clothing.

9. Physical and Chemical Properties

Form: Viscous Liquid
Color: Grey
Odor: Odorless

Change in condition
Melting point / Melting range: - 20º C
Boiling point / Boiling range: >300º C
Sublimation temperature / start: Not determined
Flash point: >250º C
Ignition temperature: Not determined
Decomposition temperature: Not determined

Explosion limits:
Lower: Not determined
Upper: Not determined

Vapor pressure at 20º C: 1 mm Hg
Density at 20º C (68º F): 1.44 g/cc

Solubility in / Miscibility with water: Insoluble

10. Stability and Reactivity

Thermal decomposition / conditions to be avoided:
Decomposition will not occur if used and stored according to specifications.
Materials to be avoided:
Acids, Water / moisture, Oxidizing agents, Halogens

Reacts with strong oxidizing agents
Dangerous products of decomposition: Metal oxide fume

11. Toxicological Information

Acute toxicity:

LD / LC50 values that are relevant for classification:		
Oral	LD50	20000 mg/kg (gpg) 30000 mg/kg (rat)
	LDLo	20 mg/kg (rbt)

Primary irritant effect:

On the skin: Irritant to skin and mucous membranes.
On the eye: Irritating effect.
Sensitization: No sensitizing effects known.

Other information (about experimental toxicity):

Tumorigenic effects have been observed with laboratory animals.

Subacute to chronic toxicity:

Iron compounds may cause vomiting, diarrhea, pink urine, black stool, and liver damage. May cause damage to the kidneys. Irritating to the respiratory tract, they may cause pulmonary fibrosis if dusts are inhaled.

Additional toxicological information:

To the best of our knowledge the acute and chronic toxicity of this substance is not fully known.
The Registry of Toxic Effects of Chemical Substances (RTECS) contains tumorigenic and/or carcinogenic and/or neoplastic data for components in this product.
No classification data on carcinogenic properties of this material is available from the EPA, IARC, NTP, OSHA, or ACGIH.

12. Ecological Information

General notes:

Do not allow material to be released to the environment without proper governmental permits.

13. Disposal Considerations

Product:
Recommendation:

Consult state, local or national regulations for proper disposal.

Uncleaned Packagings:

Recommendation:

Disposal must be made according to official regulations.

14. Transport Information

Shipping Information:
Not regulated as a hazardous material by DOT, IMO, or IATO.
Proper shipping-name (technical name): Emulsified Zero Valent Iron

15. Regulations

Product related hazard information:

Hazard symbols:

IX	Irritant

Risk phrases:

36 / 37	Irritating to eyes and respiratory system.

Safety phrases:

26	In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

National regulations
All components of this product are listed in the U.S. Environmental Protection Agency Toxic Substances Control Act Chemical Substance Inventory.

Information about limitation of use:
For use only by technically qualified individuals.

16. Other Information

Employees should use this information only as a supplement to other information gathered by them, and should make independent judgment of suitability of this information to ensure proper use and protect the healthy and safety of employees. This information is furnished without warranty, and any use of the product not in conformance with this Material Safety Data Sheet, or in combination with any other product or process, is the responsibility of the user.

SAFETY DATA SHEET

1. Identification

Product identifier **3-D Microemulsion® Factory Emulsified**

Other means of identification 3DME

Recommended use Remediation of soils and groundwater.

Recommended restrictions None known.

Manufacturer/Importer/Supplier/Distributor information

Company Name REGENESIS

Address 1011 Calle Sombra
San Clemente, CA 92673 USA

General information 949-366-8000

E-mail CustomerService@regenesis.com

Emergency phone number For Dangerous Goods Incidents ONLY (spill, leak, fire, exposure or accident), call CHEMTREC 24/7 at:

USA, Canada 1-800-424-9300

International +1 703-741-5970

2. Hazard(s) identification

Physical hazards Not classified.

Health hazards Not classified.

OSHA defined hazards Not classified.

Label elements

Hazard symbol None.

Signal word None.

Hazard statement The mixture does not meet the criteria for classification.

Precautionary statement

Prevention Observe good industrial hygiene practices.

Response Wash hands after handling.

Storage Store away from incompatible materials.

Disposal Dispose of waste and residues in accordance with local authority requirements.

Hazard(s) not otherwise classified (HNOC) None known.

Supplemental information None.

3. Composition/information on ingredients

Mixtures

Chemical name	CAS number	%
Fatty acid esters	-	40 - 60
Water	7732-18-5	35 - 45
Lactate oligomers	-	2 - 10
Sodium lactate	867-56-1	2 - 10
Surfactant	-	< 1

Composition comments All concentrations are in percent by weight unless otherwise indicated.
Contains no hazardous ingredients according to OSHA 29 CFR 1910.1200.

4. First-aid measures

Inhalation Move to fresh air. Call a physician if symptoms develop or persist.

Skin contact	Wash off with soap and water. Get medical attention if irritation develops and persists.
Eye contact	Rinse with water. Get medical attention if irritation develops and persists.
Ingestion	Rinse mouth. Get medical attention if symptoms occur.
Most important symptoms/effects, acute and delayed	Direct contact with eyes may cause temporary irritation. Prolonged skin contact may cause temporary irritation.
Indication of immediate medical attention and special treatment needed	Treat symptomatically.
General information	Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. Show this safety data sheet to the doctor in attendance.

5. Fire-fighting measures

Suitable extinguishing media	Water fog. Foam. Dry chemical powder. Carbon dioxide (CO2).
Unsuitable extinguishing media	Do not use water jet as an extinguisher, as this will spread the fire.
Specific hazards arising from the chemical	During fire, gases hazardous to health may be formed. Combustion products may include: carbon oxides, phosphorus oxides, metal oxides.
Special protective equipment and precautions for firefighters	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire fighting equipment/instructions	Move containers from fire area if you can do so without risk. Water spray should be used to cool containers.
Specific methods	Use standard firefighting procedures and consider the hazards of other involved materials.
General fire hazards	The product is an aqueous solution. After the water component evaporates, the remaining material will burn.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures	Keep unnecessary personnel away. For personal protection, see section 8 of the SDS.
Methods and materials for containment and cleaning up	This product is miscible in water. Spilled product may create a slipping hazard. Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Absorb in vermiculite, dry sand or earth and place into containers. Following product recovery, flush area with water. Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination. Never return spills to original containers for re-use. For waste disposal, see section 13 of the SDS.
Environmental precautions	Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling	Observe good industrial hygiene practices.
Conditions for safe storage, including any incompatibilities	Store in tightly closed container. Store away from incompatible materials (see Section 10 of the SDS). Recommended storage containers: plastic lined steel, plastic, glass, aluminum, stainless steel, reinforced fiberglass.

8. Exposure controls/personal protection

Occupational exposure limits	No exposure limits noted for ingredient(s).
Biological limit values	No biological exposure limits noted for the ingredient(s).
Appropriate engineering controls	Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Individual protection measures, such as personal protective equipment

Eye/face protection	Wear safety glasses with side shields (or goggles).
Skin protection	
Hand protection	Wear appropriate chemical resistant gloves. Suitable gloves can be recommended by the glove supplier.

Skin protection	
Other	Wear suitable protective clothing.
Respiratory protection	In case of insufficient ventilation, wear suitable respiratory equipment.
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
General hygiene considerations	Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance	
Physical state	Liquid.
Form	Liquid.
Color	White.
Odor	Odorless.
Odor threshold	Not available.
pH	6 - 8
Melting point/freezing point	Property has not been measured.
Initial boiling point and boiling range	212 °F (100 °C)
Flash point	> 199.94 °F (> 93.3 °C) Closed Cup
Evaporation rate	Not available.
Flammability (solid, gas)	Not applicable.
Upper/lower flammability or explosive limits	
Explosive limit - lower (%)	Property has not been measured.
Explosive limit - upper (%)	Property has not been measured.
Vapor pressure	Property has not been measured.
Vapor density	Property has not been measured.
Relative density	1 - 1.2
Solubility(ies)	
Solubility (water)	Miscible.
Partition coefficient (n-octanol/water)	Property has not been measured. Property has not been measured.
Auto-ignition temperature	Property has not been measured.
Decomposition temperature	Not applicable as the product is not unstable.
Viscosity	Not available.
Other information	
Density	Property has not been measured.
Explosive properties	Not explosive.
Kinematic viscosity	Property has not been measured.
Oxidizing properties	Not oxidizing.

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Undergoes hydrolysis in water to form lactic acid and soybean oil.
Possibility of hazardous reactions	No dangerous reaction known under conditions of normal use.
Conditions to avoid	Avoid temperatures exceeding the flash point. Contact with incompatible materials.
Incompatible materials	Strong oxidizing agents. Bases. Acids.
Hazardous decomposition products	No hazardous decomposition products are known.

11. Toxicological information

Information on likely routes of exposure

Inhalation Spray mists may cause respiratory tract irritation.

Skin contact May cause mild or temporary skin irritation upon prolonged and excessive contact.

Eye contact Direct contact with eyes may cause temporary irritation.

Ingestion May cause discomfort if swallowed.

Symptoms related to the physical, chemical and toxicological characteristics Direct contact with eyes may cause temporary irritation. Prolonged skin contact may cause temporary irritation.

Information on toxicological effects

Acute toxicity Not expected to be acutely toxic.

Skin corrosion/irritation Prolonged skin contact may cause temporary irritation.

Serious eye damage/eye irritation Direct contact with eyes may cause temporary irritation.

Respiratory or skin sensitization

Respiratory sensitization Not a respiratory sensitizer.

Skin sensitization This product is not expected to cause skin sensitization.

Germ cell mutagenicity No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

Carcinogenicity Not classifiable as to carcinogenicity to humans.

IARC Monographs. Overall Evaluation of Carcinogenicity

Not listed.

NTP Report on Carcinogens

Not listed.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1053)

Not listed.

Reproductive toxicity This product is not expected to cause reproductive or developmental effects.

Specific target organ toxicity - single exposure Not classified.

Specific target organ toxicity - repeated exposure Not classified.

Aspiration hazard Not an aspiration hazard.

12. Ecological information

Ecotoxicity The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

Components		Species	Test Results
Fatty acid esters (CAS -)			
Aquatic			
Acute			
Algae	EL50	Selenastrum capricornutum	> 854.9 mg/l, 72 hours
Fish	LL50	Pimephales promelas	> 1000 mg/l, 96 hours
Other	EL50	Daphnia sp.	> 1000 mg/l, 48 hours

Persistence and degradability No data is available on the degradability of this product.

Bioaccumulative potential No data available.

Mobility in soil The product is completely soluble in water. Expected to be mobile in soil.

Other adverse effects None known.

13. Disposal considerations

Disposal instructions Collect and reclaim or dispose in sealed containers at licensed waste disposal site.

Local disposal regulations Dispose in accordance with all applicable regulations.

Hazardous waste code	The waste code should be assigned in discussion between the user, the producer and the waste disposal company.
Waste from residues / unused products	Dispose in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).
Contaminated packaging	Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. Transport information

DOT

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not established.

15. Regulatory information

US federal regulations This product is not known to be a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

CERCLA Hazardous Substance List (40 CFR 302.4)

Not listed.

SARA 304 Emergency release notification

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1053)

Not listed.

Toxic Substances Control Act (TSCA)	All components of the mixture on the TSCA 8(b) inventory are designated “active”.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical	No

SARA 313 (TRI reporting)

Not regulated.

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA)	Not regulated.

US state regulations

US. Massachusetts RTK - Substance List

Not regulated.

US. New Jersey Worker and Community Right-to-Know Act

Not listed.

US. Pennsylvania Worker and Community Right-to-Know Law

Not listed.

US. Rhode Island RTK

Not regulated.

California Proposition 65

California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65): This material is not known to contain any chemicals currently listed as carcinogens or reproductive toxins. For more information go to www.P65Warnings.ca.gov.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Industrial Chemicals (AICIS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	Yes
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	No
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
Taiwan	Taiwan Chemical Substance Inventory (TCSI)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date 09-April-2015

Revision date 06-May-2022

Version # 04

HMIS® ratings

Health: 1
Flammability: 1
Physical hazard: 0
Personal protection: B

NFPA ratings

Disclaimer

Regenesis cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available.

SAFETY DATA SHEET

1. CHEMICAL IDENTIFICATION AND COMPANY INFORMATION

Product Name: **KB-1®**

Company Info:
SiREM
130 Stone Rd. W., Guelph, Ontario, Canada, N1G 3Z2
Phone: 519-822-2265
Toll Free, North America: 1-866-251-1747
Fax: 888-635-3470
www.siremlab.com

Emergency Phone Number: 519-822-2265 (for 24/7 assistance, contact poison center hotline in your jurisdiction).

Description: Microbial inoculum (non-pathogenic, non-hazardous) in growth media consisting of a dilute aqueous solution of mineral salts and nutrients.

Recommended Use: Bioremediation of contaminated groundwater.

Restrictions on Use: KB-1® product intended for laboratory research and field applications for cleanup of contaminated groundwater. Products are not intended to be used as human or animal therapeutics, cosmetics, agricultural or pesticide products, food additives, or as household chemicals.

2. HAZARDS IDENTIFICATION

GHS Classification: Not classified as “hazardous” per OSHA 29 CFR 1910.1200, “Hazard Communication”.

GHS Label elements, including hazard and precautionary statements: Not Applicable.

HMIS Rating:	**Health**	**Flammability**	**Physical Hazard**	**Personal Protection**
	1	0	0	B*
NFPA Rating:	**Health**	**Flammability**	**Reactivity**	**Special Hazard**
	1	0	0	N/A

* B = Safety Glasses, Gloves.

A review of available data indicates minimal potential for health effects related to normal use of this product. Microbial components are non-pathogenic. The product is not expected to be a health hazard as a result of inhalation of mists, ingestion or skin contact. Eye contact may result in mild irritation/redness. Normal hygiene precautions should be observed, including eye protection, skin protection, and hand washing. The potential exists for individuals with hypersensitivity to biological materials to exhibit allergic sensitivity to biological components of this product (see Section 4, “First Aid Measures”).

3. COMPOSITION/INFORMATION ON INGREDIENTS

KB-1® is a microbial culture grown in an aqueous dilute solution of mineral salts and nutrients classified as non-hazardous in accordance with provisions of OSHA 29 CFR 1910.1200, "Hazard Communication."

The microbial composition of KB-1®, as determined by phylogenetic analysis, includes:

Dehalococcoides sp.
Geobacter sp.
Methanomethylovorans sp.

Identification of organisms was obtained by matching 16S rRNA gene sequence of organisms in KB-1® to other known organisms. The characteristics of related organisms can be used to identify potential or likely characteristics of organisms in KB-1®.

4. FIRST AID MEASURES

Avoid direct contact with skin and eyes. In any case of any exposure which elicits a response, a physician should be consulted immediately.

Route of Entry	Symptoms	First Aid Procedures
Ingestion	Upset stomach, irritation of digestive tract.	Do not induce vomiting. Drink several cups of water. Seek medical attention.
Skin contact	Skin irritation – reddening, itching or inflammation.	Remove contaminated clothes. Wash skin with plenty of water and soap. Seek medical attention if irritation develops or open wounds are present.
Eye contact	Eye irritation – redness, tearing, blurred vision.	Rinse immediately with plenty of water for 15 – 20 minutes, lifting lower and upper eyelids occasionally (remove contact lenses if easily possible). Seek medical attention if undue irritation or redness occurs.
Inhalation of mist	Respiratory irritation, coughing, breathing difficulty.	Remove victim to fresh air. Administer first aid as appropriate for symptoms. Seek medical attention if serious symptoms occur.

5. FIRE FIGHTING MEASURES

General:	This material is non-flammable, consisting primarily of water, and poses no special hazards if involved in a fire situation.
Suitable extinguishing media:	If material is involved in fire situation, use extinguishing media suitable for surrounding fire.
Special protective equipment and precautions for firefighters:	No special equipment necessary; use equipment appropriate for surrounding fire.
Hazardous combustion products:	Not applicable.
Toxic gases produced:	Not applicable.
Shock/impact sensitivity:	Not shock sensitive.

6. ACCIDENTAL RELEASE MEASURES

Method of containment and cleanup:	Spilled KB-1® should be soaked up with sorbent and saturated with a 10% bleach solution (prepared by making a one in ten dilution of diluted standard bleach [normally sold at a strength of 5.25% sodium hypochlorite] to disinfect affected surfaces. Sorbent should be double bagged and disposed of as indicated in Section 13. After removal of sorbent, area should be washed with 10% bleach solution to disinfect. If liquid from the culture vessel is present on the fittings, non-designated tubing or exterior of the stainless steel pressure vessel liquid should be wiped off and the area washed with 10% bleach solution.
Ventilation:	No special ventilation is required in the event of the spill, as the material consists of water and non-volatile constituents. If the potential for generation of mist exists, open windows and provide adequate ventilation. If high levels of mist are encountered, use personal protective equipment indicated below.
Eye/skin protection:	Have eye-washing facilities readily available where eye contact can occur. Wash skin with soap and water. Use appropriate protective gloves when handling. Showering and changing into street clothes after work is recommended.
Protective equipment for airborne mist:	A NIOSH/MSHA approved dust mask or air purifying respirator with dust/mist filter is recommended where elevated concentrations of airborne mist are expected.

7. HANDLING AND STORAGE

Handling and storage precautions:	Use personal protective equipment (eye & skin protection) and hygiene measures (hand washing) to minimize contact with the material. KB-1® is shipped in stainless steel pressure vessels and connected to injection lines and inert gas is used to pressurize the vessel to displace the contents. KB-1® should be handled with care to avoid any spillage. Vessels are shipped with 1 to 5 pound per square inch (psi) pressure; valves should not be opened until connections to appropriate lines for subsurface injection are in place. During storage, avoid exposing stainless steel pressure vessels to undue temperature extremes (i.e., temperatures less than 0°C or greater than 30°C may result in harm to the microbial cultures and damage to the vessels). All valves should be in the closed position when the vessel is not pressurized to prevent the escape of gases and to maintain anaerobic conditions in the vessel.
Incompatibilities:	Avoid exposure of the culture to air as the presence of oxygen will kill the microbes.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

OSHA Permissible Exposure Limits (PELs): ACHIH Threshold Limit Values (TLVs):	No occupational exposure limits are established for microbial constituents. Mixture is not classified as "hazardous" in accordance with 29 CFR 1910.1200 "Hazard Communication," exceedance of exposure limits is not anticipated either under normal conditions of use, or as the result of an accidental release.
Engineering controls:	Generally not required under normal conditions of use. If method of use will result in significant mist generation, use under conditions of adequate ventilation.
Work practices:	Use good hygiene practices, avoid mist generation, and minimize contact with the material as a general precautionary measure.
Personal protective equipment:	Under normal conditions of use, wear safety glasses, protective gloves (latex, vinyl or nitrile) and steel toed footwear as general precautionary measures, particularly when opening pressure vessel valves or when pressurizing vessels to inject contents into the subsurface environment. For laboratory use, also wear lab coat. For higher risk of eye contact, wear safety goggles or face shield, as appropriate. Respiratory protection is not required under normal conditions of use (see Section 6, "Accidental Release Measures."

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance, physical state:	Aqueous liquid, dark grey, slightly turbid under anaerobic conditions, pink if exposed to air (oxygen).
Odor:	Pungent ("skunky") odor.
Solubility:	Soluble in water.
pH:	6.5 – 7.5
Melting range	Not determined, approximately equivalent to water.
Vapor density:	Not determined, approximately equivalent to water.
Vapor pressure:	Not determined, approximately equivalent to water.
Relative density:	Not determined, approximately equivalent to water.
Evaporation rate:	Not determined, approximately equivalent to water.
Initial Boiling point, boiling range	Not determined, approximately equivalent to water.
Flammability	Not flammable.
Partition coefficient	Not applicable
Auto-ignition temperature	Not applicable
Decomposition temperature:	No data, bacterial contents will decompose by heating.
Flash point	N/A

10. STABILITY AND REACTIVITY

Chemical stability and reactivity:	Stable and non-reactive.
Possibility of hazardous reactions:	Stable. Spontaneous hazardous chemical reactions / decomposition will not occur.
Conditions to avoid:	Maintain under anaerobic conditions to preserve product integrity (exposure to air/oxygen will kill microbes).
Incompatible materials:	Strong oxidizers, acids, water reactive materials.
Hazardous decomposition products:	Not applicable.
Shock sensitivity:	Not shock sensitive; will not decompose and form shock sensitive compounds.

11. TOXICOLOGICAL INFORMATION

Potential for pathogenicity: KB-1® has tested **negative** (i.e., the organisms are not present) for a variety of pathogenic organisms indicated below:

Pathogenic Organisms	Disease(s) Caused	Test Results
Salmonella sp.	*Typhoid fever, gastroenteritis*	Not Detected
Listeria monocytogenes	*Listerioses*	"
Vibrio sp.,	*Cholera, gastroenteritis*	"
Campylobacter sp.,	*Bacterial diarrhea*	"
Clostridia sp.,	*Food poisoning, botulism, tetanus, gas gangrene*	"
Bacillus anthracis	*Anthrax*	"
Pseudomonas aeruginosa	*Wound infection*	"
Yersinia sp.,	*Bubonic plague, intestinal infection*	"
Yeast and Mold	*Candidiasis, yeast infection etc.*	"
Fecal coliforms	*Indicator organisms for many human pathogens diarrhea, urinary tract infections*	"
Enterococci	*Various opportunistic infections*	"

While there is no evidence that virulent pathogenic organisms are present in KB-1®, there is potential that certain organisms in KB-1® may have the potential to act as opportunistic (mild) pathogens, particularly in individuals with open wounds and/or compromised immune systems. For this reason standard hygienic procedures such as hand washing after use should be observed.

12. ECOLOGICAL INFORMATION

This product is not rated as “hazardous” as either an acute or chronic ecological hazard, in accordance with the OSHA Hazard Communication standard, 29 CFR 1910.1200.

13. DISPOSAL CONSIDERATION

Material must be disinfected or sterilized prior to disposal. Consult local regulations prior to disposal.

14. TRANSPORT INFORMATION

U.S. (D.O.T.):	Proper Shipping Name:	Culture of Micro-organisms
	Hazard Class:	Not applicable
	UN/NA:	Not applicable
	Labels:	Not applicable
Canada (T.D.G.)	Proper Shipping Name:	Culture of Micro-organisms
	Hazard Class:	Not applicable
	UN/NA:	Not applicable
	Labels:	Not applicable
International: IMDG:	Proper Shipping Name:	Culture of Micro-organisms
	Hazard Class:	Not applicable
	UN/NA:	Not applicable
	Labels:	Not applicable
IATA:	Proper Shipping Name:	Culture of Micro-organisms
	Hazard Class:	Not applicable
	UN/NA:	Not applicable
	Labels:	Not applicable

15. REGULATORY INFORMATION

TSCA:	No
SARA TITLE III	
Section 302 (EHS) Ingredients:	No
Section 313 Ingredients:	No
Section 304 (EHS/CERCLA) Ingredients:	No
SARA TITLE III NOTIFICATION INFORMATION	
Acute Health Hazard:	No
Chronic Health Hazard:	No
Fire Hazard:	No
Sudden Release of Pressure Hazard:	No

16. OTHER INFORMATION

SiREM provides the information contained herein for hazard communication and safety planning purposes, based on existing information on each of the product components available in the literature; no independent testing was conducted on the final product. The above information is intended to be used only as a guide to the appropriate precautionary handling of this material by a properly trained person.