NIBIO
NORSK INSTITUTT FOR BIOØKONOMI

WISPE - Norge

Et verktøy for å beregne konsentrasjoner av plantevernmidler i overflatevann og grunnvann under norske forhold

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SAMMENDRAG/SUMMARY:

Datamodellen WISPE ble ferdigutviklet i 2013 for å kunne undersøke avrenning og utlekking av plantevernmidler i miljøet under norske forhold. Formålet med dette prosjektet har bl.a. vært å oppdatere WISPE-modellen og gjøre den enda mer brukervennlig. Modellverktøyet WISPE er videreutviklet blant annet i henhold til oppdateringer anbefalt for EU-modeller av det såkalte FOCUS-Repair-prosjektet. Mulighet for å kunne estimere effekten av vegetasjonssoner med ulik bredde er også lagt inn. Modellen er endret slik at det er blitt enklere å videreutvikle verktøyet og legge til nye data uten bruk av programmeringseksperter samt at det er enkelt å kjøre modellen med forskjellige klimafiler for å se på effekten av klimaendringer. Det er utviklet en brukermanual som skal gjøre det lettere å bruke modellen, både for forvaltning, industri og innen forskningen. Waterborne Environmental har stått for programmering og all teknisk utvikling i dette prosjektet. NIBIO har bidratt med data og kunnskap om norske forhold samt testing og innspill underveis. Waterborne har innhentet innspill fra plantevernmiddelindustrien samt utviklere i Europa som jobber med EU-modellene. Resultatene fra prosjektet er formidlet på ulike internasjonale konferanser og i et eget møte med Mattilsynet og en representant fra industrien (Bayer CropScience). Hovedleveransen fra prosjektet er det oppdaterte modellverktøyet og brukermanualen. Informasjon om modellen, brukermanualen og selve modellen gjøres tilgjengelig på NIBIOs nettsider i løpet av våren 2023.

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The computer model WISPE was developed in 2013 to investigate runoff and leaching of pesticides into the environment under Norwegian conditions. The purpose of this project has, among other things, been to update the WISPE model and to make it more user-friendly. The model tool has been further developed according to updates recommended for EU models by the FOCUS-Repair project. The possibility to estimate the effect of vegetation zones with different widths has also been included. The model has been adapted for further developments of the tool and addition of new data without the use of programming experts, and for easy exchange of climate files to run the model to assess effects of climate change. A user's manual has been developed to make it easier to use the model, both for authorities/regulators, industry and within research. Waterborne Environmental has been responsible for programming and all technical development in this project. NIBIO has contributed with data and knowledge about Norwegian conditions as well as testing. Waterborne has collected input from the pesticide industry as well as developers in Europe working with the EU models. The results from the project have been presented at various international conferences and in a separate meeting with the Norwegian Food Safety Authority and a representative from industry (Bayer CropScience). The main deliverable from the project is the updated model tool and user manual. Information about the model, the user manual and the model itself will be made available on NIBIO's website during spring 2023.

LAND/COUNTRY:	Norge
FYLKE/COUNTY:	Viken
KOMMUNE/MUNICIPALITY:	Ås
STED/LOKALITET:	Ås

GODKJENT /APPROVED	**PROSJEKTLEDER /PROJECT LEADER**
Marianne Stenrød	Roger Holten
MARIANNE STENRØD	**ROGER HOLTEN**

Forord

Denne rapporten presenterer resultatene fra prosjektene «Utredning om norske overfaltevannscenarier» (2020-2021) og «Oppdatering av modellen WISPE og de norske overflatevannscenariene» (2021-2023) finansiert over *Handlingsplan for bærekraftig bruk av plantevernmidler 2016-2020*.

Overordnet mål med prosjektene var å få på plass et verktøy som bidrar til en bedre miljøvurdering av plantevernmidler, dvs. en mer realistisk eksponerings- og risikovurdering tilpasset norske forhold, og som vil benyttes av industrien når plantevernmidler søkes godkjent i Norge.

Prosjektleder har vært Roger Holten (NIBIO). Deltakere i prosjektet har vært Randi Bolli (NIBIO), Amy Ritter (Waterborne Environmental) og Mark Cheplick (Waterborne Environmental). Alle prosjektdeltagerne fortjener stor takk for sitt engasjement og bidrag inn i prosjektet.

Ås, 05.06.2023

Roger Holten

Innhold

1 Sammendrag

Datamodellen WISPE ble ferdigutviklet i 2013 for å kunne undersøke avrenning og utlekking av plantevernmidler i miljøet under norske forhold. Formålet med dette prosjektet har bl.a. vært å oppdatere WISPE-modellen og gjøre den enda mer brukervennlig. Modellverktøyet WISPE er videreutviklet blant annet i henhold til oppdateringer anbefalt for EU-modeller av det såkalte FOCUS-Repair-prosjektet. Mulighet for å kunne estimere effekten av vegetasjonssoner med ulik bredde er også lagt inn. Modellen er endret slik at det er blitt enklere å videreutvikle verktøyet og legge til nye data uten bruk av programmeringseksperter samt at det er enkelt å kjøre modellen med forskjellige klimafiler for å se på effekten av klimaendringer. Det er utviklet en brukermanual som skal gjøre det lettere å bruke modellen, både for forvaltning, industri og innen forskningen. Waterborne Environmental har stått for programmering og all teknisk utvikling i dette prosjektet. NIBIO har bidratt med data og kunnskap om norske forhold samt testing og innspill underveis. Waterborne har innhentet innspill fra plantevernmiddelindustrien samt utviklere i Europa som jobber med EU-modellene. Resultatene fra prosjektet er formidlet på ulike internasjonale konferanser og i et eget møte med Mattilsynet og en representant fra industrien (Bayer CropScience). Hovedleveransen fra prosjektet er det oppdaterte modellverktøyet og brukermanualen. Informasjon om modellen, brukermanualen og selve modellen gjøres tilgjengelig på NIBIOs nettsider i løpet av våren 2023.

2 Innledning

2.1 Bakgrunn

Forurensing av overflatevann og grunnvann med plantevernmidler fra landbruket kan utgjøre et problem i akvatiske økosystemer og har økt behovet for verktøy som kan predikere skjebnen til plantevernmidler i miljøet. Innenfor det europeiske regelverket (EFSA, 2017, Linders et al., 2003, Linders, 2001) er det utviklet flere modeller som inkluderer scenarier for transport av plantevernmidler til overflatevann og grunnvann under europeiske forhold slik som f.eks. PEARL, PELMO, PRZM, SWASH og MACRO (Berg et al., 2016, Klein, 1995, Carousel et al., 2005, Roller J. A et al., 2003, Larsbo og Jarvis, 2003). Siden Norge ikke er medlem av EU og dermed ikke var en del av arbeidet med å utvikle modeller og scenarier for Europa, besluttet norske myndigheter å finansiere flere prosjekter med mål om å utvikle relevante nasjonale scenarier for både grunnvann og overflatevann (Bolli et al., 2011). To grunnvannscenarier og to overflatevannscenarier for Norge ble utviklet for hhv. modellene MACRO (Larsbo og Jarvis, 2003) og PRZM (Carousel et al., 2005). PRZM danner grunnlaget for modellskallet WISPE (The World Integrated System for Pesticide Exposure). En versjon av WISPE ble utviklet for Norge og ferdigstilt i 2013 (Bolli et al., 2013), der både norske grunnvanns- og overflatevannscenarier ble inkludert. På grunn av manglende midler har ikke modellen blitt vedlikeholdt eller oppdatert siden den ble lansert i 2013 og den har derfor ikke vært noe særlig i bruk. I Mattilsynets vurdering av mulig overflateavrenning av plantevernmidler kreves det modellering med alle EU-scenariene i modellen SWASH ved søknad om godkjenning i Norge. Dette inkluderer scenarier for både Sør- og Nord-Europa der både hellingsgrad, nedbør og temperaturer skiller seg vesentlig fra norske forhold, og scenarier er tidligere vurdert å være lite relevant for norske forhold (Prof. Nicholas Jarvis, Sveriges Lantbruksuniversitet, pers. med.). De norske datakravene har høstet mye kritikk, både fra næringa og fra plantevernmiddelindustrien. Vitenskapskomiteen for mat og miljø (VKM) har analysert ti scenarier som blir brukt til å modellere avrenning og drenering til overflatevann (VKM, 2021), der konklusjonen er at EU-scenariene, eller resultatene fra dem, må justeres for å dekke norske forhold eller at det må utvikles nye norske scenarier for våtere og kaldere forhold.

2.2 Mål med prosjektet og målgrupper

Overordnet mål for prosjektet har vært å bidra til en bedre miljøvurdering av plantevernmidler, dvs en mer realistisk eksponerings- og risikovurdering tilpasset norske forhold. Prosjektet skulle levere en oppdatert og mer brukervennlig WISPE-modell for norske forhold som kan brukes i vurderingen av eksponering av plantevernmidler i overflatevann slik som dammer, bekker og elver. Modellen skal kunne brukes av plantevernmiddelindustrien når de leverer eksponeringsvurderinger i forbindelse med søknad om godkjenning av plantevernmidler i Norge. Målet har også vært at modellen skal kunne oppdateres av NIBIO, og at NIBIO skal kunne utøve en viss brukerstøtte på modellen.

Målgruppen er både Mattilsynet, NIBIO/forskningsmiljøene og plantevernmiddelindustrien som får et nytt, oppdatert, veldokumentert og brukervennlig verktøy tilpasset norske forhold til bruk i vurderingen av plantevernmidler. Dette kan medvirke til bedre og mer realistiske eksponeringsvurderinger for plantevernmidler under norske forhold, som igjen er en forutsetning for å kunne bidra til et så miljøvennlig jordbruk som mulig.

3 Materiale og metoder

WISPE Norge ble utviklet for å forbedre modellen som ble ferdigstilt i 2013. WISPE er et sluttbrukerverktøy som omfatter flere modeller for å simulere plantevernmiddelkonsentrasjonen i overflatevann og grunnvann. PRZM (winPRZM (versjon 4.74)) er hovedmodellen som brukes til å estimere avrenning, erosjon og massetransport av plantevernmidler fra et felt eller nedbørsområde (Carousel, et al., 2005; FOCUS, 2003 Appendix K).

WISPE-modellen inkluderer klimadata, jordegenskaper og data for kulturene som er nødvendige for å gjennomføre simuleringene. Brukeren må oppgi informasjon om plantevernmiddelet slik som data for nedbrytning og sorpsjon samt sprøytetidspunkt og sprøytemetode. Kodingen i modellen er utført av Waterborne Environmental, Inc. og er basert på den tidligere utviklede modellen (Bolli et al., 2013).

Følgende modeller er implementert i WISPE-Norge:

PRZM (Pesticide Root Zone Model)
WISPE inkluderer PRZM (Carousel et al., 2005) som er en endimensjonal dynamisk, kompartment modell som kan brukes til å simulere kjemiske stoffers bevegelse i umettet sone like under rotsonen. Modellen består av to hovedkomponenter, hydrologi og kjemisk transport. Hydrologidelen for å kalkulere overflateavrenning og erosjon er basert på Soil Conservation Service kurvenummer teknikken og Universal Soil Loss Equation. I modellen blir evapotranspirasjon er estimert fra data på fordamping fra en overflate eller basert på målte data. Evapotranspirasjon er summen av fordamping fra kulturplantene, fordamping fra jord og transpirasjon fra kulturplantene. Vannbevegelsen er simulert ved bruk av jordparametere, inkludert feltkapasitet, visnegrense og mettet vanninnhold. Hver PRZM-simulering utføres ved å bruke 26 år med daglig nedbørsdata for å dekke årlige variasjoner i avrenningen. Simuleringene vil da beregne konsentrasjonen av et plantevernmiddel i overflateavrenningen ved kanten av et jorde, før det slippes ut i en vannforekomst. Ytterligere beskrivelser finnes i manualen for PRZM (Carousel et al., 2005).

EXAMS (Exposure Analysis Modelling System)
WISPE inkluderer modellen EXAMS (versjon 2.98.04) (Burns, 2004) som beregner konsentrasjonen av plantevernmidler i ulike vannforekomster (grøft, dam og bekk/elv). Denne estimerte konsentrasjonen (PEC) kan da sammenlignes direkte med giftighetsverdier for vannlevende organismer.

EXAMS mottar data for både avrenning og erosjon samt data ift sprøyting fra PRZM og beregner daglige konsentrasjoner. For overflatevann består WISPE-resultatene av predikerte miljøkonsentrasjoner (PECs) i vannsøylen og i sediment ved forskjellige eksponeringsvarigheter. EXAMS kan brukes til å vurdere skjebnen, eksponeringen og persistensen til syntetiske organiske kjemikalier i akvatiske økosystemer. Modellen tar hensyn til fordampning, sorpsjon, hydrolyse, biologisk nedbrytning og fotolyse av plantevernmiddelet. Siden EXAMS er en steady-state modell, modelleres vannforekomstene med et konstant volum.

Gjennomsnittskonsentrasjoner over flere år (26 år i WISPE) blir beregnet fra simuleringene som maksimalt årlig 24-timers gjennomsnitt, maksimalt årlig 96-timers gjennomsnitt, maksimalt årlig 21-dagers gjennomsnitt, maksimalt årlig 60-dagers gjennomsnitt, maksimalt årlig 90-dagers gjennomsnitt og årsgjennomsnitt. Makskonsentrasjoner beregnes også for hvert år. Versjonen av EXAMS som brukes i WISPE er versjon 2.98.04, april 2005.

ADAM (The Aquifer Dilution Assessment Model)
For grunnvann blir konsentrasjonen av et stoff på en viss dybde (PEC) beregnet av PRZM og modellen ADAM predikerer eksponeringen i en vannforekomst. ADAM estimerer plantevernmidlets fortynning, fordeling og persistens i en grunn, uavgrenset vannforekomst som mottar daglig massetilførsel (vann og plantevernmiddel) fra PRZM (Williams, 2010). Vannbevegelse i vannforekomsten skyldes mating av grunnvannet og lateral vanntransport.

PAT - Pesticide Application Timer

I tillegg til å velge eksakte datoer for sprøytetidspunktet, kan brukeren av WISPE bruke den implementerte PAT kalkulatoren. PAT beregner datoen for sprøyting i henhold til en standardprosedyre beskrevet i «Generic guidance for FOCUS surface water scenarios» (FOCUS, 2012).

Se vedlegg 2 for mer detaljerte beskrivelser av modellene som er inkludert i WISPE.

SWASH (Surface Water Scenarios Help) er beskrevet i Roller J. A et al. (2003)

4 Resultater og diskusjon

4.1 Utredning om norske overflatevannscenarier

Det har vært gjennomført en utredning om videreutvikling og bruk av overflatevannmodellen WISPE inkludert en sammenligning av denne med EU-modellen SWASH, for å avhjelpe Mattilsynets behov for en modell som beskriver norske forhold når det gjelder overflateavrenning av plantevernmidler på en akseptabel måte. Det er også vurdert muligheten for å inkludere deler av WISPE i en versjon av SWASH.

4.1.1 Testing av WISPE

Den versjonen av modellen vi hadde tilgjengelig (v. 1.00.00 Jul 31, 2013) ble i perioden 2020-2022 testet og brukt både i dette prosjektet og i et PhD-prosjekt ledet av NIVA (ECORISK2050, Mentzel et al., 2022). Modellen er bl.a. kjørt med ulike klimafiler og sett å fungere tilfredsstillende, også ift. det nye scenariet Heia som er lagt til. En tidligere versjon av modellen (v. 1.00.00, Jan 12, 2010) er av Mattilsynet rapportert å ha en del feil/mangler, men noen av disse manglene er senere blitt justert for i senere versjoner av modellen (Tabell 1). Gjenstående feil er ikke sett å ha noen innvirkning på testingen her eller på resultatene i NIVA-prosjektet. Med tanke på at en nyere versjon av modellen var tilgjengelig, og som også skulle videreutvikles med de norske scenariene, ble det ikke foretatt noe ytterligere testing av den eksisterende versjonen av modellen.

Tabell 1: Tidligere kjente feil/mangler ved WISPE (v. 1.00.00, Jan 12, 2010). Feilene er beskrevet på engelsk, men kommentert på norsk.

Feil nr.	Beskrivelse (engelsk)	Kommentar
1	The function "Display results for 10th %tile as Text File" doesn't work.	Fikset i nyere versjon av modellen.
2	The function "Print" only works when the display type is graphical. When the display type is Table the function doesn't work correctly for the options Terrestrial - Hydrology Balance and Groundwater – Leached Below 1 m Conc. and Leached Below Core Conc.	Det er ikke sett behov for denne funksjonen i denne delen av prosjektet og heller ikke sjekket videre.
3	The function "Export" only works for exporting graphs to wmf. files (metafiles). The function doesn't work for exporting tables.	Denne funksjonen virker i dagens versjon av modellen.
4	The sediment output seems to be too high and need some recalibration. There is also something wrong with the denomination of the sediment amount. The denomination in the screen display and in the text file does not correspond. The right denomination in the text file is metric ton/ha which corresponds with the denomination in the screen display and also with the output file (out.file) produced.	Dette ser ut til å være fikset i nyere versjoner av modellen. Benevning i 2013-versjonen av modellen er g/ha sediment, og dette stemmer overens både i den grafiske fremstillingen og i tabellene.
5	The TOXSWA shell, which simulates the water flow and pesticide behavior in water bodies at the edge of field scale (ditch, pond or stream), has not yet been applied to the model.	Bl.a. pga rettighetsspørsmål, er modellen EXAMS tilknyttet PRZM i WISPE for å kunne gi fortynning i vannforekomster som hhv. pond, stream og ditch. Det er i dette prosjektet foretatt en egen vurdering av TOXSWA vs. EXAMS i WISPE.

4.1.2 Sammenligninger av WISPE og EU-modellen FOCUS SWASH

I et samarbeid med utviklerne av WISPE og eksperter på PRZM i Waterborne Environmental i USA ble WISPE sammenlignet med FOCUS SWASH i en grundigere analyse. Disse analysene og resultatene ble samlet i en egen rapport (Vedlegg 1), men en oppsummering presenteres her. I første omgang ble massetilførselen av plantevernmidler sammenlignet, deretter sammenlignet man de predikerte miljøkonsentrasjonene, dvs PEC (Predicted Environmental Concentrations) for ulike vannforekomster. Det ble også gjort en sammenligning av hvordan norsk klima påvirker resultatene i forhold til europeisk klima.

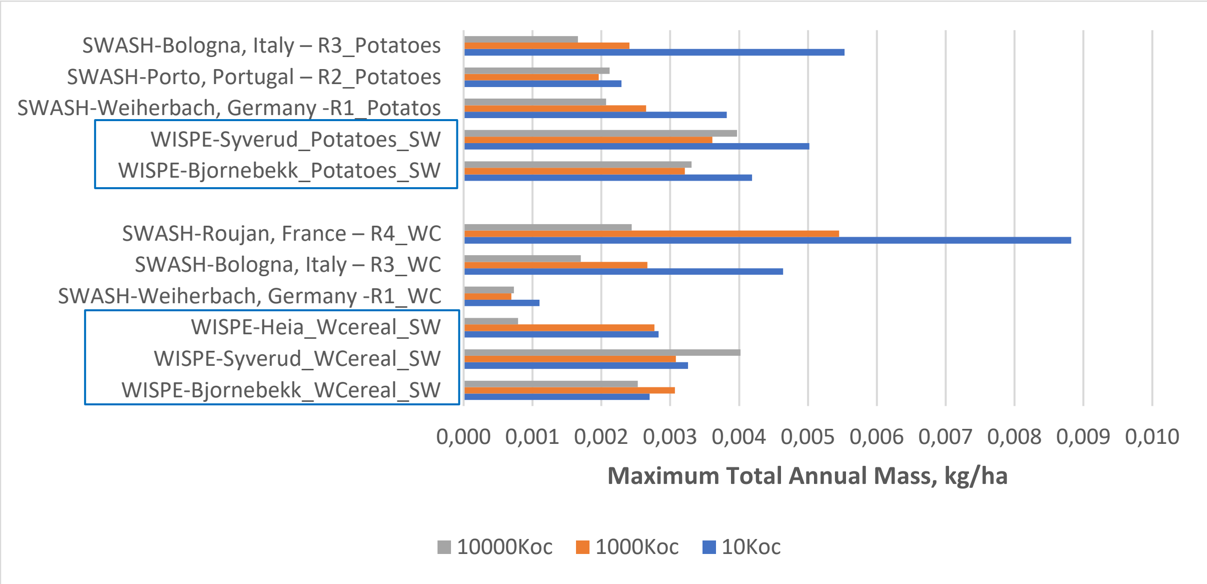
4.1.2.1 Massetilførsel

Massetilførselen til vannforekomstene, dvs mengden plantevernmidler som transporteres fra et jorde mot en evt. vannforekomst, ble undersøkt ved å kjøre kun modellen PRZM i WISPE og PRZM i SWASH. Man simulerte avrenning for tre ulike fiktive plantevernmidler fra hhv. høstkorn og potet. Alle egenskaper bortsett fra Koc ble holdt identiske for de tre stoffene, da Koc er antatt å være den parameteren med størst betydning ift. overflateavrenning. Detaljer om stoffenes kjemiske egenskaper og parametere som kultur og sprøytetidspunkt vises i Waterbornes rapport til NIBIO (Vedlegg 1).

Resultatene fra denne sammenligningen viser at den årlige totale massetilførselen er i samme størrelsesorden for de to modellene (Tabell 2 og Figur 1). Resultatene viser også at massetilførselen er høyere for stoffer som binder seg sterkere til jordpartikler enn mer mobile stoffer, dvs. at stoffer som bindes til partikler lettere transporteres med overflatevannet, enn mer mobile stoffer som lettere kan infiltrere jorda. Det er også kjørt en variansanalyse (ANOVA) og Tukey test av disse resultatene som viser at det ikke er signifikante forskjeller mellom de gjennomsnittlige massetilførslene i de ulike scenariene i hhv WISPE og SWASH. Disse analysene er kun gjort for en Koc-verdi, Koc=10, da det antas at endret Koc ikke vil endre forholdene mellom scenariene i seg selv, men kun verdiene for massetilførsel.

Tabell 2: Minimum og maksimum årlig massetilførsel for WISPE og SWASH for stoffer med ulik Koc.

		Total Annual Mass (kg/ha)					
		Koc=10		Koc=1000		Koc=10000	
Model	**Scenario**	**min**	**max**	**min**	**Max**	**min**	**max**
WISPE	Bjornebekk_WCereal_SW	9.77E-06	2.70E-03	5.71E-04	3.07E-03	6.64E-04	2.53E-03
WISPE	Syverud_WCereal_SW	5.86E-05	3.26E-03	6.93E-04	3.08E-03	9.77E-04	4.02E-03
WISPE	Heia_Wcereal_SW	3.12E-05	2.83E-03	5.82E-04	2.77E-03	1.29E-04	7.90E-04
SWASH	Weiherbach, Germany -R1_WC	7.82E-09	1.10E-03	7.30E-05	6.95E-04	1.80E-05	7.28E-04
SWASH	Bologna, Italy – R3_WC	4.48E-06	4.64E-03	1.06E-04	2.67E-03	3.50E-05	1.70E-03
SWASH	Roujan, France – R4_WC	1.56E-06	8.82E-03	3.56E-04	5.45E-03	1.07E-04	2.44E-03
WISPE	Bjornebekk_Potatoes_SW	3.11E-06	4.19E-03	6.67E-04	3.21E-03	5.94E-04	3.31E-03
WISPE	Syverud_Potatoes_SW	4.54E-06	5.02E-03	6.31E-04	3.61E-03	9.65E-04	3.97E-03
SWASH	Weiherbach, Germany -R1_Potatos	9.21E-09	3.82E-03	1.95E-04	2.65E-03	2.22E-04	2.07E-03
SWASH	Porto, Portugal – R2_Potatoes	2.25E-07	2.29E-03	1.72E-04	1.96E-03	1.97E-04	2.12E-03
SWASH	Bologna, Italy – R3_Potatoes	6.82E-06	5.53E-03	3.20E-04	2.41E-03	2.58E-04	1.66E-03



Figur 1: Maksimum årlig massetilførsel modellert av WISPE og SWASH for ulike scenarier og for stoffer med ulik Koc.

4.1.2.2 Predikert miljøkonsentrasjon – PEC

Sammenligningen av modellenes predikerte miljøkonsentrasjoner, dvs PEC-verdiene, ble gjort ved sammenligning av WISPEs tidsbestemte 90 percentil for den tidsvektede gjennomsnittlige eksponeringskonsentrasjonen (TWA) over 26 år, med den tidsvektede gjennomsnittlige eksponeringskonsentrasjonen for ett år i SWASH. PRZM i SWASH kjører 20 år, men TOXSWA plukker kun ett av de årene iht. gitte kriterier når PEC skal beregnes (Roller et al., 2003). I tillegg oppgir SWASH den såkalte Global Max-konsentrasjonen, og denne verdien er sammenlignet med den høyeste eksponeringskonsentrasjonen beregnet i løpet av de 26 årene WISPE simulerer (26-Yr Max) (Tabell 3).

Videre må det påpekes at SWASH bare simulerer avrenning til vannforekomstene «pond» og «stream» ved bruk av PRZM, mens MACRO benyttes for å simulere drenering til «ditch». Ingen resultater for «ditch» er derfor presentert, selv om WISPE kan simulere avrenning også til denne typen vannforekomst. Siden de ulike scenariene i WISPE og SWASH har avrenningsarealer som varierer i størrelse, er massetilførselen (kg/ha) fra arealene multiplisert med arealet (ha) for å få den totale massetilførselen som tilføres vannforekomstene.

Resultatene fra de to modellene (Tabell 3) er i samme størrelsesorden for «pond» og stream» ved Koc 1000. For Koc på 10 er PEC høyere for «pond» med WISPE enn SWASH for både høstkorn og potet, mens resultatet er mer likt for «stream». For en Koc på 10 000 er også PEC-verdiene like mellom modellene bortsett fra ved bruk på potet der PEC for «stream» er høyere for WISPE enn SWASH. Dette indikerer at selv om resultatene er sammenlignbare i mange tilfeller, er det også tilfeller der de norske scenariene gir høyere PEC-verdier enn SWASH og det er ikke lett å forutsi hvor og når disse høyere verdiene inntreffer.

Tabell 3: Predikerte miljøkonsentrasjoner (PEC) fra WISPE og SWASH for høstkorn og potet. Tidsvektede gjennomsnitt for 1, 4 og 21 dager er vist samt Global Max i Swash og Peak i WISPE.

Koc	WISPE Scenario	Field area, ha	Crop	Water-body	26-Yr Max	90th %ile TWA PECs, ug/L			SWASH Scenario	Field area, ha	Global Max, ug/L	TWA PECs, ug/L		
						1 day	4 days	21 days				1 day	4 days	21 days
10	Bjornebekk_WC	0.02	Winter cereal	Pond	0.073	0.065	0.064	0.063	Weiherbach-R1	0.45	0.018	0.017	0.017	0.016
10	Syverud_WC	0.04	Winter cereal	Pond	0.180	0.161	0.161	0.158						
10	Heia_WC	0.024	Winter cereal	Pond	0.099	0.087	0.086	0.085						
10	Bjornebekk_WC	0.02	Winter cereal	Stream	1.800	0.526	0.173	0.037	Weiherbach-R1	1	0.808	0.320	0.080	0.017
10	Syverud_WC	0.04	Winter cereal	Stream	3.570	1.458	0.441	0.089	Bologna–R3	1	7.234	3.783	1.217	0.232
10	Heia_WC	0.024	Winter cereal	Stream	2.160	0.806	0.252	0.051	Roujan–R4	1	6.735	2.887	0.737	0.141
10	Bjornebekk_P	0.02	Potatoes	Pond	0.096	0.065	0.064	0.063	Weiherbach-R1	0.45	0.007	0.007	0.007	0.007
10	Syverud_P	0.04	Potatoes	Pond	0.231	0.137	0.137	0.134						
10	Bjornebekk_P	0.02	Potatoes	Stream	2.490	0.631	0.161	0.031	Weiherbach-R1	1	1.318	0.568	0.142	0.028
10	Syverud_P	0.04	Potatoes	Stream	5.350	1.154	0.312	0.062	Porto–R2	1	6.266	1.644	0.537	0.102
10									Bologna-R3	1	8.711	3.592	1.161	0.227
1000	Bjornebekk_WC	0.02	Winter cereal	Pond	0.048	0.040	0.039	0.036	Weiherbach-R1	0.45	0.068	0.067	0.065	0.057
1000	Syverud_WC	0.04	Winter cereal	Pond	0.085	0.075	0.073	0.067						
1000	Heia_WC	0.024	Winter cereal	Pond	0.049	0.041	0.040	0.037						
1000	Bjornebekk_WC	0.02	Winter cereal	Stream	0.396	0.196	0.077	0.029	Weiherbach-R1	1	0.710	0.280	0.120	0.023
1000	Syverud_WC	0.04	Winter cereal	Stream	0.568	0.281	0.121	0.045	Bologna–R3	1	0.875	0.714	0.413	0.097
1000	Heia_WC	0.024	Winter cereal	Stream	0.352	0.173	0.073	0.026	Roujan–R4	1	1.210	0.836	0.490	0.119
1000	Bjornebekk_P	0.02	Potatoes	Pond	0.048	0.032	0.031	0.029	Weiherbach-R1	0.45	0.055	0.055	0.053	0.047
1000	Syverud_P	0.04	Potatoes	Pond	0.101	0.073	0.072	0.067						
1000	Bjornebekk_P	0.02	Potatoes	Stream	0.454	0.183	0.054	0.017	Weiherbach-R1	1	0.543	0.281	0.071	0.038
1000	Syverud_P	0.04	Potatoes	Stream	0.842	0.310	0.100	0.036	Porto–R2	1	0.213	0.126	0.056	0.023
1000									Bologna-R3	1	0.880	0.437	0.200	0.085
10000	Bjornebekk_WC	0.02	Winter cereal	Pond	0.011	0.008	0.006	0.005	Weiherbach-R1	0.45	0.014	0.014	0.013	0.010
10000	Syverud_WC	0.04	Winter cereal	Pond	0.027	0.020	0.017	0.014						
10000	Heia_WC	0.024	Winter cereal	Pond	0.005	0.003	0.003	0.002						
10000	Bjornebekk_WC	0.02	Winter cereal	Stream	0.143	0.070	0.033	0.012	Weiherbach-R1	1	0.089	0.051	0.026	0.005
10000	Syverud_WC	0.04	Winter cereal	Stream	0.383	0.163	0.076	0.029	Bologna–R3	1	0.079	0.071	0.042	0.012
10000	Heia_WC	0.024	Winter cereal	Stream	0.074	0.034	0.014	0.005	Roujan–R4	1	0.129	0.129	0.079	0.020
10000	Bjornebekk_P	0.02	Potatoes	Pond	0.018	0.013	0.010	0.007	Weiherbach-R1	0.45	0.013	0.013	0.013	0.011
10000	Syverud_P	0.04	Potatoes	Pond	0.044	0.030	0.025	0.018						
10000	Bjornebekk_P	0.02	Potatoes	Stream	0.311	0.143	0.048	0.017	Weiherbach-R1	1	0.077	0.054	0.014	0.006
10000	Syverud_P	0.04	Potatoes	Stream	0.751	0.373	0.125	0.044	Porto–R2	1	0.020	0.016	0.008	0.003
10000									Bologna-R3	1	0.080	0.062	0.021	0.009

4.1.3 Sammenligning mellom PRZM/TOXSWA og PRZM/EZAMS

4.1.3.1 Massetilførsel

WISPE inkluderer modellen EXAMS for å beregne konsentrasjonen av plantevernmidler i ulike vannforekomster, mens i SWASH brukes modellen TOXSWA til dette. Her har vi vurdert om om dette medfører store forskjeller i massetilførsel til vannforekomstene og dermed forskjeller i PEC-verdiene. Denne sammenligningen ble gjort ved at man kopierte PRZM-filen generert i SWASH (inkl. TOXSWA) over til WISPE (inkl. EXAMS). Resultatene for massetilførsel fra WISPE/EXAMS beregnet med denne SWASH PRZM-fila ble så sammenlignet med massetilførselen generert for en ordinær SWASH/TOXSWA-kjøring. På grunn av at SWASH-TOXSWA og WISPE-EXAMS simulerer ulikt antall år, ble simuleringene tilpasset slik at resultatene er sammenlignbare. PRZM i SWASH kjører f.eks. med 20 års klimadata, mens TOXSWA plukker resultatet fra ett av de årene som da presenteres. PRZM og EXAMS i WISPE kjører over 26 år og beregner i utgangspunktet en 90-persentil for 20 av disse årene som da presenteres.

Resultatene for massetilførsel viste nær identiske verdier for de to modellene. Disse dataene er oppsummert i vedleggene K-M (SWASH-PRZM + EXAMS) og F-H (SWASH PRZM) i Waterbornes rapport (Vedlegg 1).

4.1.3.2 Predikert miljøkonsentrasjon – PEC

Med bakgrunn i PRZM-filen fra SWASH-kjøringen som ble benyttet i sammenlikningen for massetilførsel, ble PEC for de to modellene beregnet for å se om det gir store forskjeller i PEC avhengig av om modellen kjører med TOXSWA eller EXAMS. I denne sammenligningen ble bare EU-scenariene benyttet. WISPEs 20-års maksimum PEC og 90-percentil er sammenlignet med SWASHs 1-års PEC.

Høyeste beregnede PEC, peak PEC i WISPE og Global Max PEC i SWASH, er også sammenlignet. For WISPE er dette alltid konsentrasjonen man ser umiddelbart etter sprøyting, mens for SWASH kan dette være den høyeste konsentrasjonen man ser i løpet av det året man plukker data fra. Som regel ser man også i SWASH at denne konsentrasjonen opptrer umiddelbart etter sprøyting, men dette behøver ikke alltid være tilfelle. Pga den svært ulike tidsrammen modellene presenterer resultater for (20 år for PRZM-EXAMS og 1 år for PRZM-TOXSWA), ble det også laget en sammenligning av EXAMS TWA PEC for 1 år mot TOXSWA TWA PEC, og da for eksponeringstider på 1, 4 og 21 dager.

Resultatene indikerer at PRZM-EXAMS PEC i de fleste tilfeller er høyere enn PRZM-TOXSWA (Tabell 4). Dette kan ifølge Waterborne skyldes at TOXSWA ikke nødvendigvis velger det året som gir høyest årlig PEC blant de 20 årene som kjøres i PRZM. WISPE og EXAMS bruker jo alle årene og beregner altså en 90-percentil over de 20 årene. Dette illustrerer noe av vanskeligheten med å sammenligne ulike modeller som har ulike framgangsmåter i hvordan beregningene gjøres og presenteres.

Simuleringer der man sammenlignet kun 1-års resultater er derfor også utført for å få mer sammenlignbare tall. Ved å beregne en «multipliar factor», MF, ved å dividere EXAMS PEC på TOXSWA PEC, kan man lett se om det er store forskjeller på de ulike PEC-verdiene. Er forholdet, eller MF, lik 1 er PEC-verdiene like, er MF>1 er EXAMS PEC høyere, og er MF<1 er TOXSWA PEC høyere. Resultatene viser at PEC-verdiene er ganske like for pond-scenariene i alle tilfeller av Koc både for høstkorn og potet med MF-verdier mellom 0.9 og 1.5. Variasjonen er derimot større for stream-scenariene, og da spesielt i høstkorn der f.eks. R3-Bologna-scenariet med EXAMS gir en PEC som er 168 ganger så høy som TOXSWAs estimerte PEC for et stoff med Koc 10 000. I simuleringene for stream med potet og et stoff med Koc på 10, er EXAMS-resultatene enten lavere eller like sammenlignet med TOXSWA-resultatene.

Waterborne forklarer noe av disse forskjellene med hvordan modellene simulerer vannvolumer og vannstrømninger/«flow» i stream-scenariet. TOXSWA simulerer varierende volum og flow slik at en nedbørepisode som gir mye avrenning/erosjon kan fortynne den ekstra mengden plantevernmiddel i det ekstra vannet. EXAMS' stream-senarie derimot har en såkalt «base flow» der volum og flow er konstant, men simulerer med høyere massetilførselen/mengde stoff. Dette gir da høyere konsentrasjon siden det bare er den ekstra massen som tilføres vannforekomsten, og ikke det ekstra vannet.

Tabell 4: Sammenligning av SWASH PEC med 20 års PRZM-EXAMS PEC. WG = Weiherbach, Germany; BI = Bologna, Italy; RF = Roujan, France; PP = Porto, Portugal.

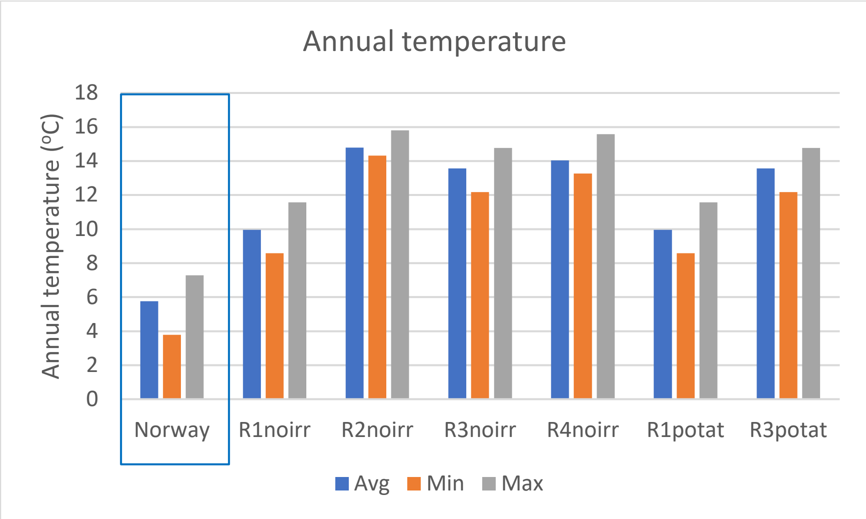
				SWASH Time-weighted Average PECs, ug/L						PRZM/EXAMS 90th% Time-weighted Average PECs, ug/L				
Koc	FOCUS Scenario	Crop	Water-body	Global Max, ug/L	1 day	4 days	21 days	100 days	20-Yr Max, ug/L	Peak	1 day	4 day	21 days	90 days
10	WG -R1	W cereal	Pond	0.0176	0.0175	0.0172	0.0158	0.0115	0.5770	0.5682	0.5672	0.5644	0.5521	0.4566
10	WG-R1	W cereal	Stream	0.8075	0.3196	0.0800	0.0167	0.0036	36.7000	31.9800	16.1700	4.2690	0.8234	0.1918
10	BI – R3	W cereal	Stream	7.2340	3.7830	1.2170	0.2321	0.0488	154.0000	131.6000	66.5500	17.5700	3.3570	0.7832
10	RF–R4	W cereal	Stream	6.7350	2.8870	0.7365	0.1407	0.0296	294.0000	127.9000	64.7200	17.2900	3.2870	0.7681
10	WG-R1	Potatoes	Pond	0.0073	0.0072	0.0071	0.0066	0.0044	1.9300	0.8902	0.8892	0.8855	0.8708	0.8245
10	WG-R1	Potatoes	Stream	1.3180	0.5684	0.1422	0.0277	0.0058	110.0000	43.0400	21.7500	7.0010	1.3340	0.3119
10	PP–R2	Potatoes	Stream	6.2660	1.6440	0.5365	0.1022	0.0215	65.2000	52.6400	26.6700	8.0270	1.6760	0.3909
10	BI–R3	Potatoes	Stream	8.7110	3.5920	1.1610	0.2273	0.0478	176.0000	95.6200	48.3000	13.2800	2.5370	0.5919
1000	WG-1	W cereal	Pond	0.0685	0.0675	0.0651	0.0572	0.0452	0.2910	0.2631	0.2591	0.2482	0.2121	0.1612
1000	WG-R1	W cereal	Stream	0.7097	0.2801	0.1198	0.0231	0.0102	12.8000	11.5200	5.8280	1.7350	0.4004	0.1040
1000	BI – R3	W cereal	Stream	0.8745	0.7140	0.4128	0.0972	0.0264	42.9000	42.0700	21.2800	6.0790	1.3630	0.3503
1000	RF–R4	W cereal	Stream	1.2100	0.8362	0.4904	0.1186	0.0282	135.0000	111.2000	56.2000	14.4400	2.9480	0.7450
1000	WG-R1	Potatoes	Pond	0.0553	0.0547	0.0532	0.0467	0.0367	1.1000	0.5427	0.5343	0.5128	0.4306	0.3520
1000	WG-R1	Potatoes	Stream	0.5433	0.2813	0.0706	0.0377	0.0140	33.0000	17.1200	8.6660	3.8150	0.7683	0.2345
1000	PP–R2	Potatoes	Stream	0.2132	0.1260	0.0564	0.0229	0.0081	32.3000	21.1800	10.7800	2.9670	1.0340	0.2919
1000	BI–R3	Potatoes	Stream	0.8800	0.4374	0.1998	0.0854	0.0296	35.3000	32.3600	16.3300	5.2840	1.0790	0.3001
10000	WG-1	W cereal	Pond	0.0141	0.0138	0.0131	0.0103	0.0071	0.1790	0.0771	0.0677	0.0488	0.0279	0.0200
10000	WG-R1	W cereal	Stream	0.0887	0.0511	0.0260	0.0050	0.0019	7.3200	4.4720	2.2650	0.6609	0.1885	0.0644
10000	BI – R3	W cereal	Stream	0.0790	0.0715	0.0416	0.0120	0.0045	18.6000	17.1400	8.6760	2.5560	0.6442	0.1773
10000	RF–R4	W cereal	Stream	0.1293	0.1293	0.0787	0.0200	0.0057	33.4000	27.6300	13.9700	3.9520	1.0450	0.3181
10000	WG-R1	Potatoes	Pond	0.0134	0.0133	0.0129	0.0114	0.0095	0.3500	0.1730	0.1517	0.1153	0.0597	0.0462
10000	WG-R1	Potatoes	Stream	0.0771	0.0542	0.0137	0.0060	0.0027	13.6000	7.2290	3.6590	1.6020	0.3743	0.1344
10000	PP–R2	Potatoes	Stream	0.0196	0.0158	0.0076	0.0030	0.0013	23.6000	16.0800	8.1780	2.2930	0.8834	0.2588
10000	BI–R3	Potatoes	Stream	0.0802	0.0617	0.0211	0.0088	0.0040	14.2000	12.7300	6.4240	2.0130	0.4748	0.1462

Tabell 5: Multipliar factors (MF) for å sammenligne PEC fra simuleringer over 1 år. MF beregnes ved å dividere EXAMS PEC på TOXSWA PEC. Er forholdet, eller MF, lik 1 er PEC-verdiene like, er MF>1 er EXAMS PEC høyere, og er MF<1 er TOXSWA PEC høyere.

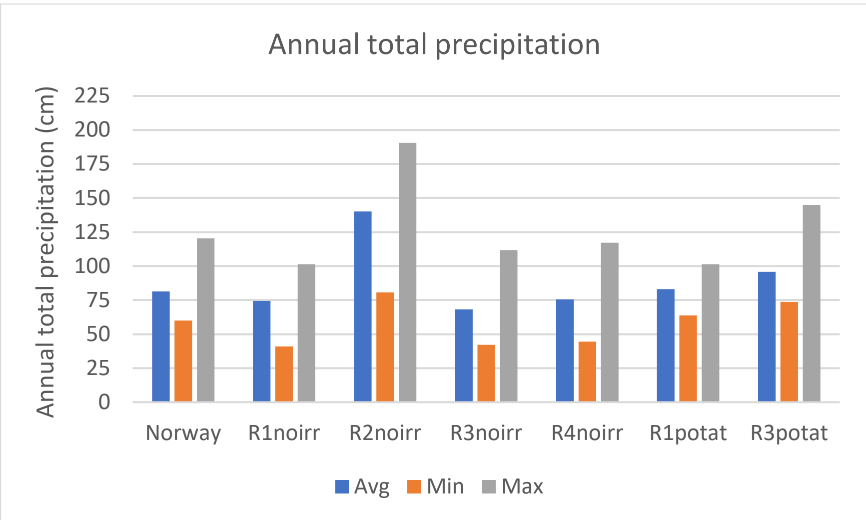
				Multiplier Factor			
Koc	SWASH scenario	Crop	Waterbody	Maximum	1 day	4 day	21 day
10	WG-R1	WC	Pond	1.0	1.0	1.0	1.1
10	WG-R1	WC	Stream	1.4	1.9	1.9	1.7
10	BI-R3	WC	Stream	10.2	9.9	12.0	12.0
10	RF-R4	WC	Stream	3.1	3.6	3.7	3.7
10	WG-R1	PO	Pond	1.0	1.0	1.0	1.1
10	WG-R1	PO	Stream	0.4	0.4	0.4	0.4
10	PP-R2	PO	Stream	0.6	1.1	1.2	1.2
10	BI-R3	PO	Stream	0.5	0.6	0.7	0.8
1000	WG-R1	WC	Pond	1.0	1.0	1.0	0.9
1000	WG-R1	WC	Stream	4.5	5.8	4.4	4.3
1000	BI-R3	WC	Stream	38.7	23.9	14.8	12.7
1000	RF-R4	WC	Stream	26.3	19.3	16.0	13.7
1000	WG-R1	PO	Pond	0.9	0.9	0.9	0.9
1000	WG-R1	PO	Stream	3.3	3.3	3.3	2.6
1000	PP-R2	PO	Stream	8.6	7.4	4.9	4.9
1000	BI-R3	PO	Stream	5.0	5.1	2.9	1.9
10000	WG-R1	WC	Pond	1.3	1.2	0.6	0.3
10000	WG-R1	WC	Stream	11.9	10.5	6.4	6.4
10000	BI-R3	WC	Stream	168.4	94.5	56.3	45.8
10000	RF-R4	WC	Stream	69.2	35.0	29.6	26.7
10000	WG-R1	PO	Pond	1.5	1.3	1.2	0.8
10000	WG-R1	PO	Stream	13.5	9.7	12.8	7.5
10000	PP-R2	PO	Stream	44.8	28.5	23.0	27.3
10000	BI-R3	PO	Stream	17.5	11.5	9.2	6.3

4.1.4 20-års simulering med norsk klima

Norsk klima er kaldere enn klimaet brukt i FOCUS scenariene (Figur 2) og nedbøren er relativt lik FOCUS scenariet fra Weiherbach (R1-potet) (Figur 3). Den norske klimafilen er basert på data for 26 år (1995-2010) og FOCUS SWASH er basert på 20 år (1975-1994).



Figur 2: Årlig temperatur (gjenommsnitt, min og maks) for Norge og europeisk klima brukt i FOCUS scenariene. R1=Weiherbach (Tyskland), R2= Porto (Portugal), R3=Bologna (Italia), R4=Roujan (Frankrike).



Figur 3: Årlig temperatur (gjenommsnitt, min og maks) for Norge og europeisk klima brukt i FOCUS scenariene. R1=Weiherbach (Tyskland), R2= Porto (Portugal), R3=Bologna (Italia), R4=Roujan (Frankrike).

4.1.4.1 Massetilførsel

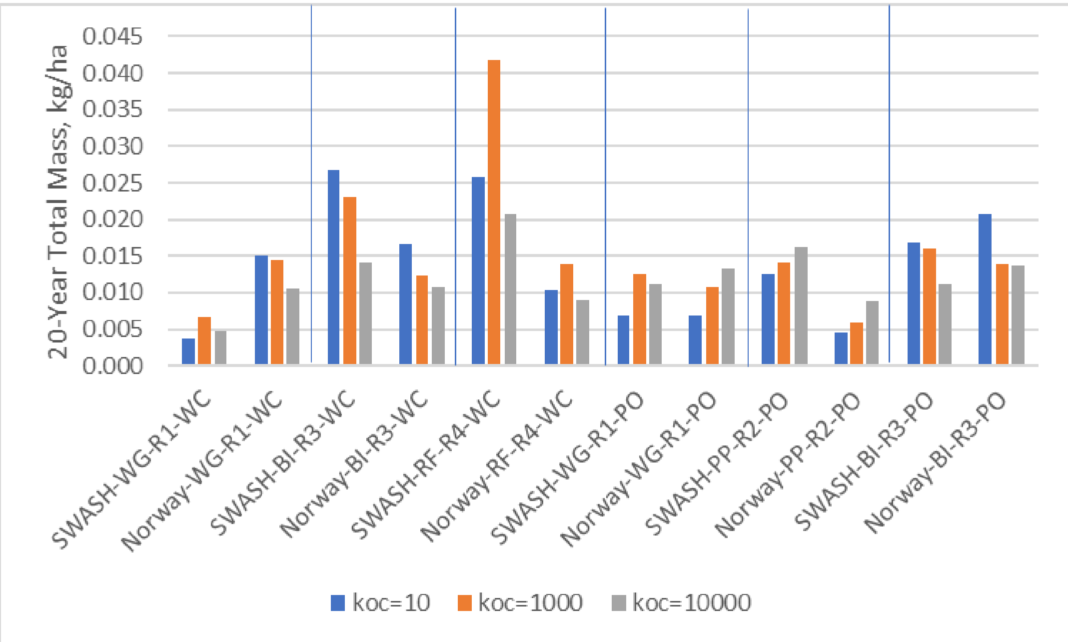
For å kunne se innvirkningen på klimaet, ble den PRZM-inputfila som ble generert i SWASH for EU-scenariene brukt i PRZM/EXAMS sammen med de norske klimadataene (1995-2010) som ligger i WISPE og deretter sammen med SWASH/EU-klimadata. Dette for å se om norsk klima ville ha betydning for massetilførsel og estimerte konsentrasjoner (PEC) i EU-scenariene.

Generelt ser det ut til at PRZM/EXAMS med EU-klima gir høyere 20-års total massetilførsel enn med norsk klima (Tabell 6 og Figur 4). Ser man mer nøye på dataene, ser man likevel at dette varierer mellom år avhengig av hvilken klimafil som produserer den høyeste avrenningen.

Tabell 6: 20-års total massetilførsel fra PRZM/EXAMS for SWASH-klima og norsk klima.

		20-Year Total Mass (kg/ha)		
Weather	**Scenario**	**Koc=10**	**Koc=1000**	**Koc=10000**
SWASH	Weiherbach, Germany -R1_WC	3.66E-03	6.62E-03	4.81E-03
Norway	Weiherbach, Germany -R1_WC	1.50E-02	1.45E-02	1.06E-02
SWASH	Bologna, Italy – R3_WC	2.67E-02	2.30E-02	1.40E-02
Norway	Bologna, Italy – R3_WC	1.66E-02	1.24E-02	1.07E-02
SWASH	Roujan, France – R4_WC	2.57E-02	4.18E-02	2.07E-02
Norway	Roujan, France – R4_WC	1.03E-02	1.39E-02	8.92E-03
SWASH	Weiherbach, Germany -R1_Potatos	6.93E-03	1.26E-02	1.12E-02
Norway	Weiherbach, Germany -R1_Potatos	6.91E-03	1.08E-02	1.33E-02
SWASH	Porto, Portugal – R2_Potatoes	1.25E-02	1.41E-02	1.62E-02
Norway	Porto, Portugal – R2_Potatoes	4.53E-03	5.96E-03	8.88E-03
SWASH	Bologna, Italy – R3_Potatoes	1.68E-02	1.60E-02	1.11E-02
Norway	Bologna, Italy – R3_Potatoes	2.07E-02	1.39E-02	1.36E-02

Figur 4: 20-års total massetilførsel fra PRZM/EXAMS for SWASH-klima og norsk klima.



4.1.4.2 Predikert miljøkonsentrasjon – PEC

Resultatene for PEC-beregningene viser at f.eks. PRZM/EXAMS med norsk klima gir høyere PEC-verdier i pond for høstkorn uansett Koc-verdier) sammenlignet med EU-klima (Tabell 7). Norsk klima ga også høyere PEC i R1 stream-scenariet i høstkorn, men ikke i de andre R-scenariene, der PEC ble lavere eller på samme nivå med norsk klima sammenlignet med EU-klima. I pond-scenariet med potet ble også PEC lavere med norsk klima enn med EU klima. Selv om klimadataene ble endret ble ikke sprøytedatoene endret, noe som kan ha innvirkning på resultatene her. Sprøytedato ble valgt ihht. nedbørsdataene i SWASH for å bl.a. inkludere nedbør innen 10 dager etter sprøyting, som er et krav til modellsimuleringene som gjøres for godkjenningen. I tillegg er det slik at SWASH ikke simulerer avrenning hvis temperaturen er under frysepunktet.

Tabell 7: Sammenligning av 20 års PEC-verdier fra PRZM/EXAMS for SWASH-scenarier (EU-scenarier) ved bruk av hhv EU-klima og norsk klima.

				SWASH Weather					Norway Weather				
				20-year	90th% Time-weighted Average PECs, ug/L				20-yea Max,	90th% Time-weighted Average PECs, ug/L			
Koc	SWASH scenario	Crop	Waterbody	Max, ug/L	Peak	1 day	4 day	21 day	ug/L	Peak	1 day	4 day	21 day
10	WG-R1	W cereal	Pond	0.577	0.568	0.567	0.564	0.552	2.010	1.803	1.794	1.793	1.773
10	WG-R1	W cereal	Stream	36.700	31.980	16.170	4.269	0.823	88.000	79.330	40.140	10.450	1.995
10	BI-R3	W cereal	Stream	154.000	131.600	66.550	17.570	3.357	81.300	80.740	40.860	10.770	2.046
10	RF-R4	W cereal	Stream	294.000	127.900	64.720	17.290	3.287	76.400	68.450	34.650	8.879	1.698
10	WG-R1	Potatoes	Pond	1.930	0.890	0.889	0.886	0.871	1.340	0.758	0.757	0.753	0.734
10	WG-R1	Potatoes	Stream	110.000	43.040	21.750	7.001	1.334	45.600	42.020	21.200	5.534	1.058
10	PP-R2	Potatoes	Stream	65.200	52.640	26.670	8.027	1.676	25.400	23.230	11.710	2.970	0.582
10	BI-R3	Potatoes	Stream	176.000	95.620	48.300	13.280	2.537	122.000	71.790	36.290	10.310	1.964
1000	WG-R1	W cereal	Pond	0.291	0.263	0.259	0.248	0.212	0.809	0.624	0.614	0.587	0.504
1000	WG-R1	W cereal	Stream	12.800	11.520	5.828	1.735	0.400	24.400	22.010	11.150	4.313	0.863
1000	BI-R3	W cereal	Stream	42.900	42.070	21.280	6.079	1.363	23.800	21.070	10.680	3.105	0.943
1000	RF-R4	W cereal	Stream	135.000	111.200	56.200	14.440	2.948	27.100	26.790	13.500	5.299	1.196
1000	WG-R1	Potatoes	Pond	1.100	0.543	0.534	0.513	0.431	0.421	0.354	0.350	0.341	0.299
1000	WG-R1	Potatoes	Stream	33.000	17.120	8.666	3.815	0.768	16.900	9.271	4.690	1.376	0.477
1000	PP-R2	Potatoes	Stream	32.300	21.180	10.780	2.967	1.034	6.870	5.158	2.608	0.872	0.179
1000	BI-R3	Potatoes	Stream	35.300	32.360	16.330	5.284	1.079	38.000	22.790	11.590	5.096	1.192
10000	WG-R1	W cereal	Pond	0.179	0.077	0.068	0.049	0.028	0.286	0.202	0.177	0.129	0.071
10000	WG-R1	W cereal	Stream	7.320	4.472	2.265	0.661	0.189	12.100	9.379	4.763	1.677	0.410
10000	BI-R3	W cereal	Stream	18.600	17.140	8.676	2.556	0.644	13.200	10.010	5.108	1.862	0.553
10000	RF-R4	W cereal	Stream	33.400	27.630	13.970	3.952	1.045	11.100	9.335	4.726	1.664	0.466
10000	WG-R1	Potatoes	Pond	0.350	0.173	0.152	0.115	0.060	0.177	0.146	0.128	0.100	0.056
10000	WG-R1	Potatoes	Stream	13.600	7.229	3.659	1.602	0.374	9.260	7.356	3.731	1.180	0.324
10000	PP-R2	Potatoes	Stream	23.600	16.080	8.178	2.293	0.883	5.960	3.246	1.661	0.677	0.181
10000	BI-R3	Potatoes	Stream	14.200	12.730	6.424	2.013	0.475	17.600	12.520	6.325	2.350	0.668

4.1.5 Videreutvikling av WISPE

WISPE med de to norske scenariene Bjørnebekk og Syverud ble i sin tid utviklet fordi det ble vurdert slik at EU-scenariene i SWASH ikke var relevante for norske forhold (Bolli et al., 2013). Bjørnebekk og Syverud er felter med jordtyper som er representative for større norske jordbruksarealer, spesielt på Østlandet. Klimaet i disse scenariene er hentet fra den meteorologiske stasjonen på Ås, og representerer således bare klimaet på Sør-Østlandet. Dette området kan sammenlignes med områder i både Sverige, Danmark og Nord-Tyskland og er derfor kanskje bedre representert av noen av de nordre EU-scenariene (kanskje spesielt R1 - Weiherbach), mens disse scenariene ikke er like representative for norske områder med både lavere temperaturer og mer nedbør. Tyske forskere og myndigheter har også vurdert EU-scenariene i SWASH til ikke å nødvendigvis være relevante for store deler av Tyskland, og har derfor argumentert for å etablere egne overflateavrenningsscenarier (Bach et al., 2017, Bach et al., 2016). Klima, og kanskje spesielt nedbør, er viktig for graden av overflateavrenning. For å kunne gjennomføre modellsimuleringer som er representative for større deler av Norge er det derfor også behov for å få lagt til flere scenarier i WISPE.

I dette prosjektet er det foretatt en innledende vurdering av muligheten for å enten få lagt de norske scenariene inn i SWASH, eller å få lagt enkeltfiler for norske scenarier over i SWASH på samme måte som de norske grunnvannsscenariene Rustad og Heia i modellen MACRO. Å endre den offisielle EU-versjonen av SWASH ser vi på som urealistisk både med tanke på kostnad og tidsperspektiv. Endring av EU-modeller er svært tidkrevende og kostbare prosesser da det må gjøres mye arbeid, både vitenskapelig og politisk, for å få slike endringer akseptert gjennom EU-systemet. Videre er metodikken for eksponeringsberegninger for overflatevann for tiden under revidering i EU (Adriaanse et al., 2020).

Alternativet til å få en versjon av de norske scenariene inn i den offisielle versjonen av SWASH er å tilgjengeliggjøre enkeltfiler som kan lastes ned og inkluderes i en «uoffisiell» versjon av SWASH, på samme måte som ble gjort for MACRO. Dette er heller ikke vurdert å være realistisk all den tid SWASH er en modell som består av flere undermodeller som henger sammen og dermed langt mer kompleks enn MACRO. Det vil være en langt mer krevende prosess å få dette til, også med tanke på rettighetsspørsmål ift. endringer som må gjøres i modellen.

I dette prosjektet ble WISPE videreutviklet ved at et nytt scenarie, Heia, ble inkludert i den versjonen av WISPE som var tilgjengelig i prosjektperioden og er også inkludert i den nyeste versjonen av modellen.

4.1.6 Oppsummering

Generelt kan man si at PEC-verdiene fra WISPE er i samme størrelsesorden som PEC-verdiene generert i SWASH, men med en del unntak. En sammenligning av resultater fra EXAMS vs TOXSWA viste at eksponeringskonsentrasjonene i dam (pond) fra modellene var mer i overensstemmelse med hverandre enn for elv/bekk (stream). Dette skyldes måten modellene er satt opp på ift. større nedbørsepisoder og hastighet og volum på vann som transporteres gjennom jordprofilet i modellen. Ved kun å se på massetilførselen, uten å endre vanntransport/strøm eller volum i vannforekomsten, resulterer dette i at EXAMS gir høyere PEC-verdier enn TOXSWA. SWASH-scenarier med norsk klima viste seg å gi lavere PEC-verdier, selv om dette heller ikke var konsekvent. Her er usikkerheten stor siden det opprinnelige sprøytetidspunktet i SWASH (som er satt ut fra EU-klima) ble beholdt pga. at PAT-kalkulatoren (Pesticide Application Timing) i SWASH ikke fungerte sammen med den norske klimafila.

Andre forskjeller mellom EXAMS og TOXSWA som også er viktig å påpeke inkluderer følgende:

• EXAMS kjøres over flere år og PEC (90 prosentilen) fra en 20-årssimulering er ikke det samme året som SWASH-simuleringen plukker ut.

• TOXSWA håndterer skuddår annerledes enn PRZM. Sprøytedatoen i PRZM som produserer avrennings-/erosjonsmasse hvis det er nedbør, blir da ikke nødvendigvis samme dag som gir avdrift i TOXSWA.

• EXAMS bruker daglige lufttemperaturer for vann og sediment, mens TOXSWA bruker månedlige verdier for temperaturer i vann og sediment. Nedbryting endres med temperatur og i kaldere klima som i Norge vil dette bety langsommere nedbrytning i vann/sediment.

• Vannforekomsten som er definert som elv/bekk (stream) i EXAMS har en konstant dybde, mens i TOXSWA endres dybden ved avrenningsepisodene.

• EXAMS simulerer avrenning over flere år, mens TOXSWA kun simulerer ett år.

4.2 Oppdatering av modellen WISPE og de norske overflatevannscenariene

WISPE er et datamodelleringsverktøy som er utviklet for å evaluere eksponering av plantevernmidler i miljøet. Modellverktøyet er i denne delen av prosjektet videreutviklet og oppdatert bl.a. i henhold til oppdateringer anbefalt for EU-modeller (Adriaanse et al., 2020). Videre er verktøyet gjort mer brukervennlig og feil/mangler fra første versjon er rettet opp.

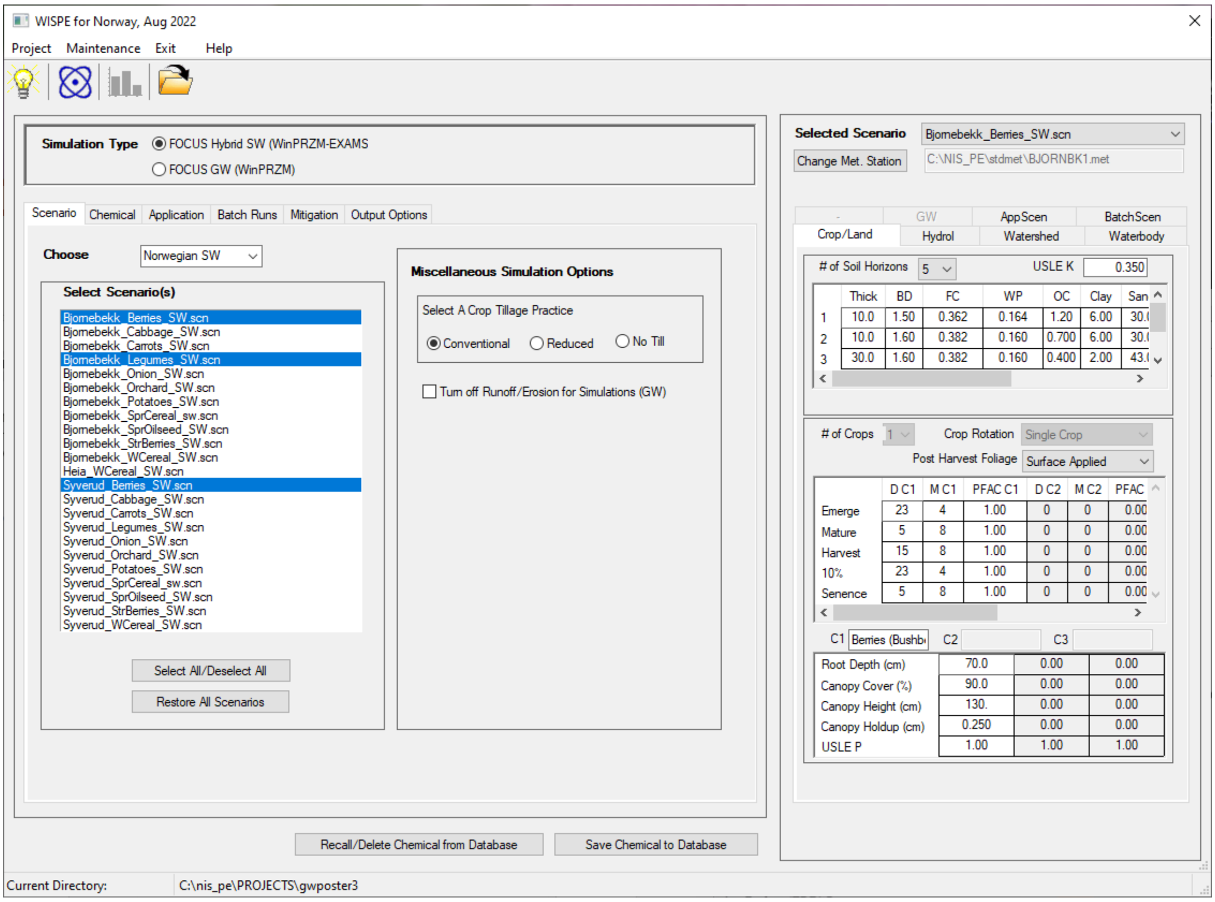
WISPE Norge gjør det mulig å estimere plantevernmiddeleksponeringen i overflate- og grunnvannsressurser under norske forhold for 11 ulike kulturer. Denne versjonen av WISPE Norge inkluderer i tillegg til de tre norske scenariene også alle FOCUS grunnvannsscenarier og overflateavrenningsscenarier (alle R-scenariene i SWASH). Det er også inkludert funksjonalitet for å kunne estimere effekten av vegetasjonssoner med ulik bredde på avrenningen. Modellen er bygget opp slik at det er blitt enklere å videreutvikle verktøyet og legge til nye scenarier samt at det er enkelt å modellere de ulike scenariene med forskjellige klimafiler for å evt. se på effekten av klimaendringer på avrenning og utlekking. Det er utviklet en detaljert brukermanual som skal gjøre det lettere å bruke modellen både for forvaltning, plantevernmiddelindustrien og innen forskningen (Vedlegg 2).

4.2.1 WISPE-Norge

WISPE-Norge ble designet for å predikere eksponeringen både i overflate- og grunnvann i henhold til FOCUS retningslinjene. Grunnvannsmodellen bør anses som ekvivalent med det frittstående PRZM FOCUS verktøyet som for tiden er i bruk. Overflatevannmodellen er ikke helt lik FOCUS sin, siden man i WISPE bruker EXAMS og ikke TOXSWA (kap. 2).

4.2.1.1 Scenarier og jordegenskaper

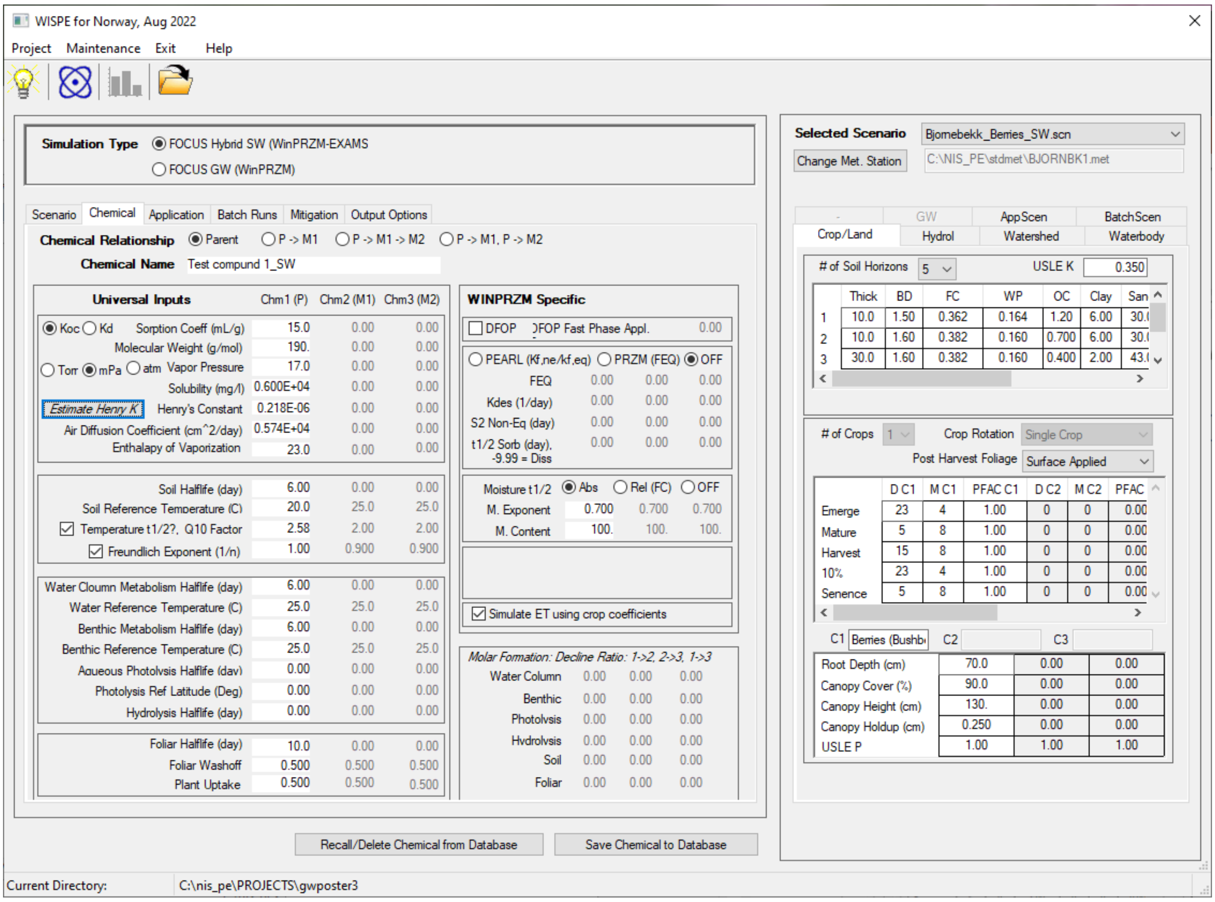
Man kan velge ett eller flere scenarier for simulering og de jordegenskapene som tilhører de enkelte scenariene vises på høyre side av skjermen (Figur 5). Nye scenarier kan opprettes ved å endre egenskaper og lagre disse i et eget «USER directory» eller med administrative rettigheter i et «OFFICIAL directory».



Figur 5: Eksempel på skjermbilde fra WISPE-Norge hvor man velger ulike scenarier og tilhørende jordegenskaper.

4.2.1.2 Kjemiske egenskaper og jordhydrologi

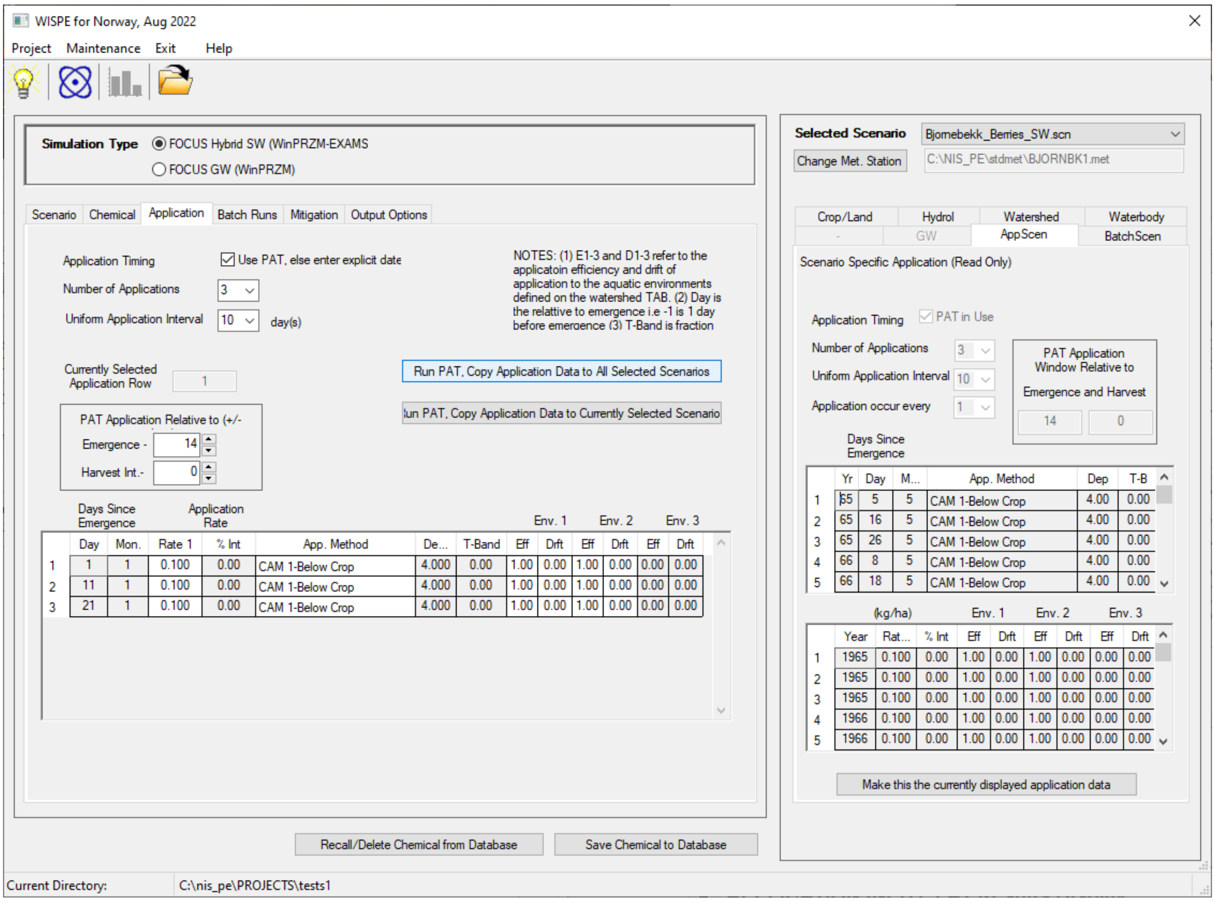
I fanen «Chemical» legger man inn de kjemiske egenskapene til stoffet (Figur 6). Alle egenskapene til morstoffet og metabolittene kan angis samtidig. Jordhydrologiske data slik som f.eks. kurvenummer kan revideres. En av oppdateringene i modellen er at man kan velge ulike klimafiler for hvert scenarie. Dette gjør at man bla. kan se på effekten av klimaendringer på avrenning og utlekking.



Figur 6: Eksempel på skjermbilde fra WISPE-Norge der man legger inn de kjemiske egenskapene til stoffet. Man får angitt de jordhydrologiske dataene til de ulike scenariene på høyre side av skjermen.

4.2.1.3 Data for sprøyting og bruk av PAT kalkulator

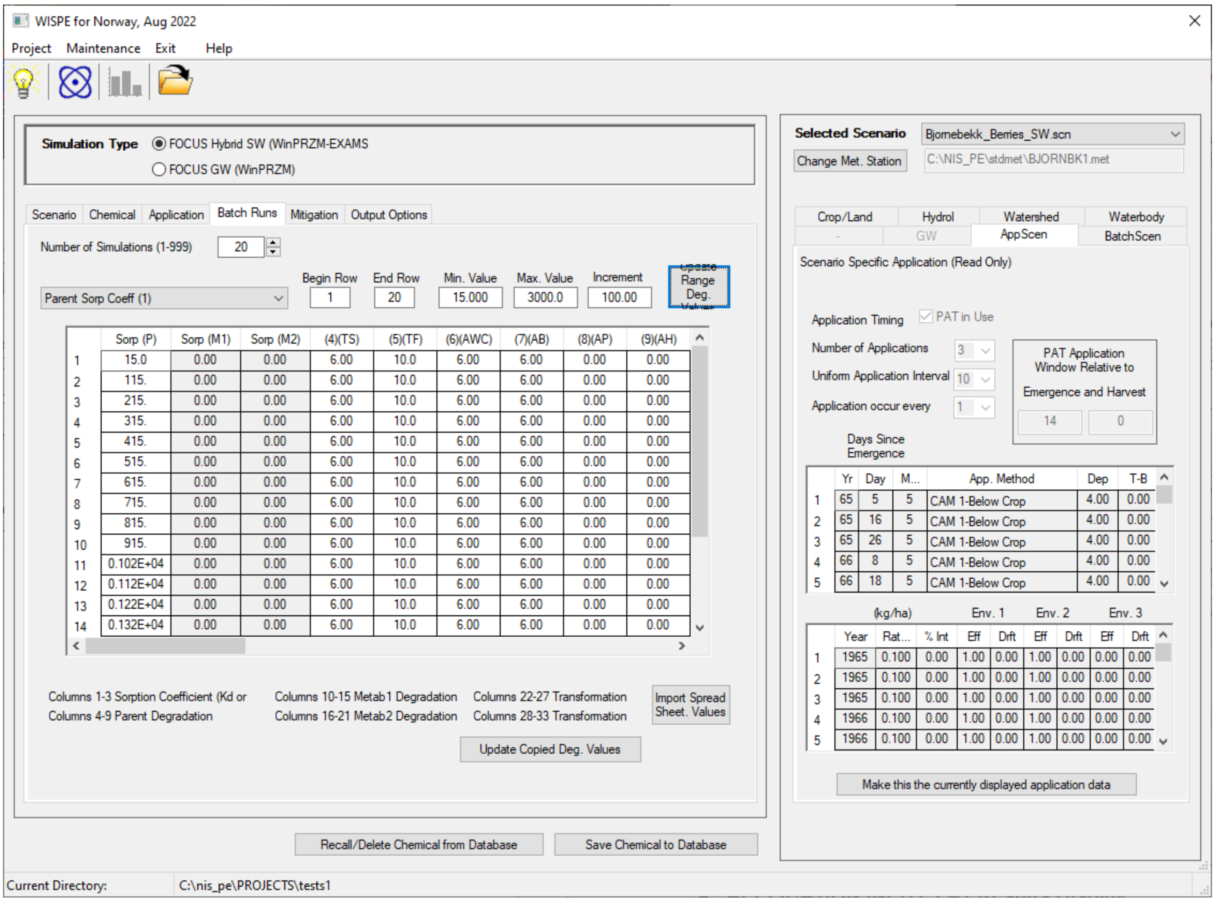
Komplekse mønstre for sprøyting/plantevernmiddelbruk kan enkelt lages i fanen «Application» som inkluderer metode for sprøyting, effektivitet og avdrift (Figur 7). Når det opprettes et overflatevannscenarie, er en frittstående versjon av PAT-kalkulatoren (Pesticide Application Timer) implementert der resultater for hvert scenarie vises. Scenarier for grunnvann bruker ikke PAT-kalkulatoren og data for sprøyting legges inn direkte.



Figur 7: Eksempel på skjermbilde fra WISPE-Norge der man legger inn data for applisering. Resultatene ved bruk av PAT kalkulatoren vises på høyre side av skjermen.

4.2.1.4 Sensitivitetsanalyse

I WISPE-Norge er det også mulig å gjøre en sensitivitetsanalyse for å evaluere og identifisere usikkerheter i halveringstider og sorpsjonsparametere for stoffet (Figur 8). Opptil 1000 simuleringer kan utføres for hvert valgte scenarie og opptil tre vannmiljø kan bli valgt for hvert overflatevannscenarie.

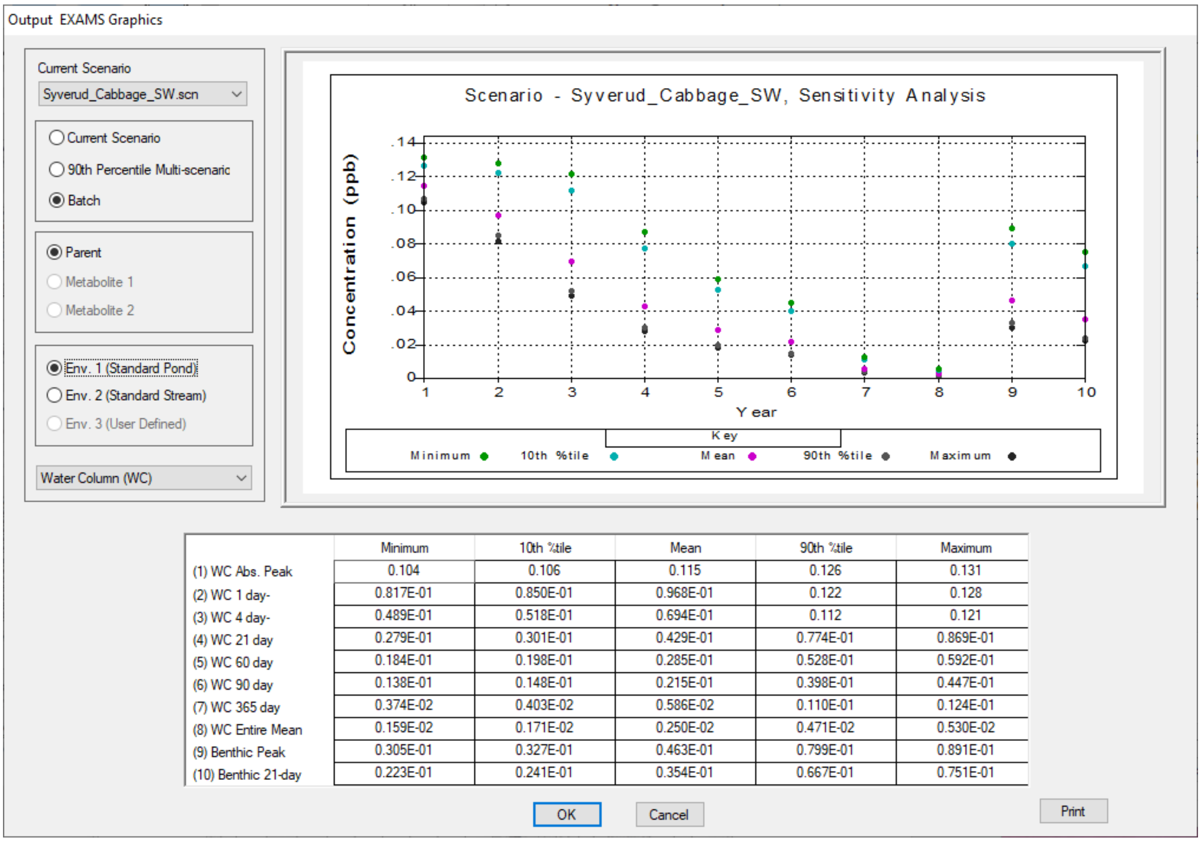


Figur 8 : Eksempel på skjermbilde fra WISPE-Norge der man kan gjøre en sensitivitetsanalyse.

4.2.1.5 Visualisering av resultater

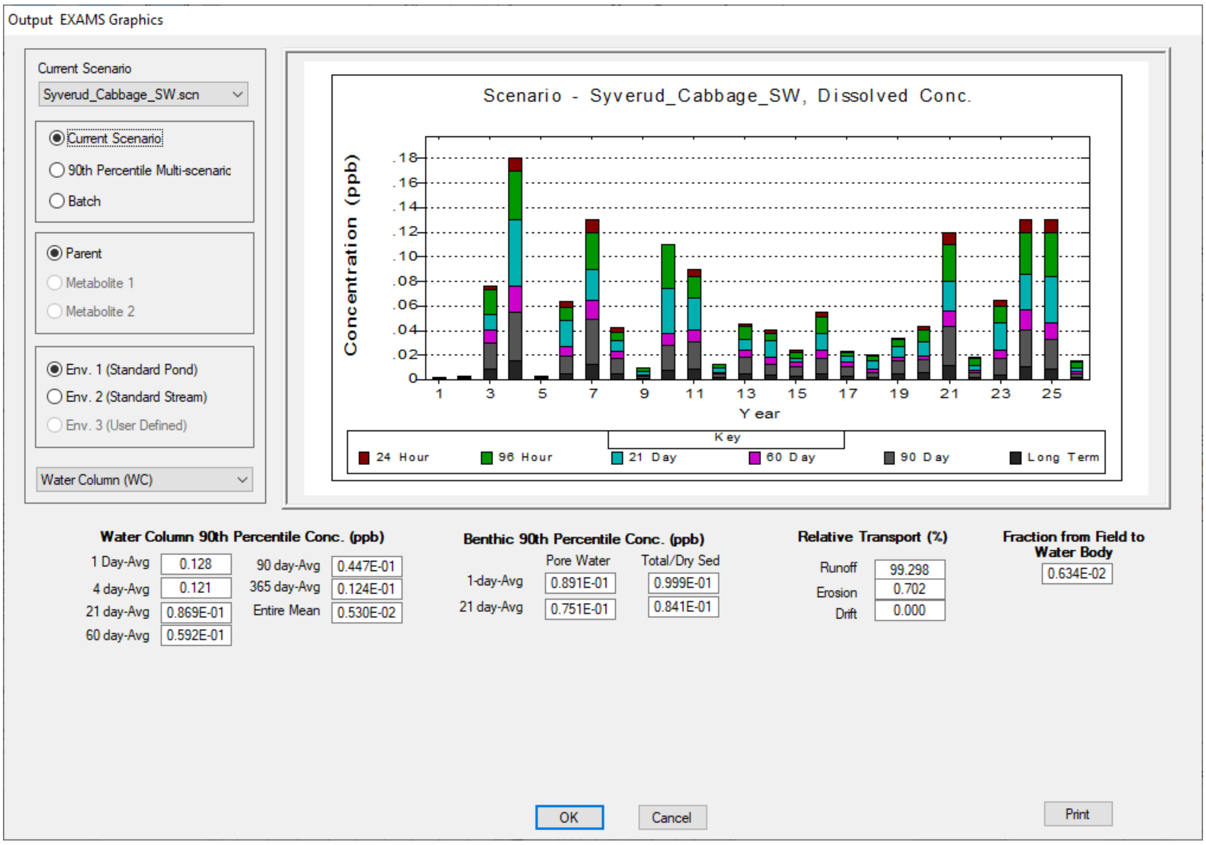
Resultater fra modellsimuleringene oppsummeres og visualiseres i flere vinduer. Figur 9 viser et eksempel på resultater fra en sensitivitetsanalyse som viser variasjonen i konsentrasjon med eksponeringstid i vann og sediment.

Figur 10 viser et eksempel på årlige resultater over en tidsperiode på 26 år for overflatevann og i sediment. Figur 11 viser årlige konsentrasjoner i grunnvann på 1 meter.

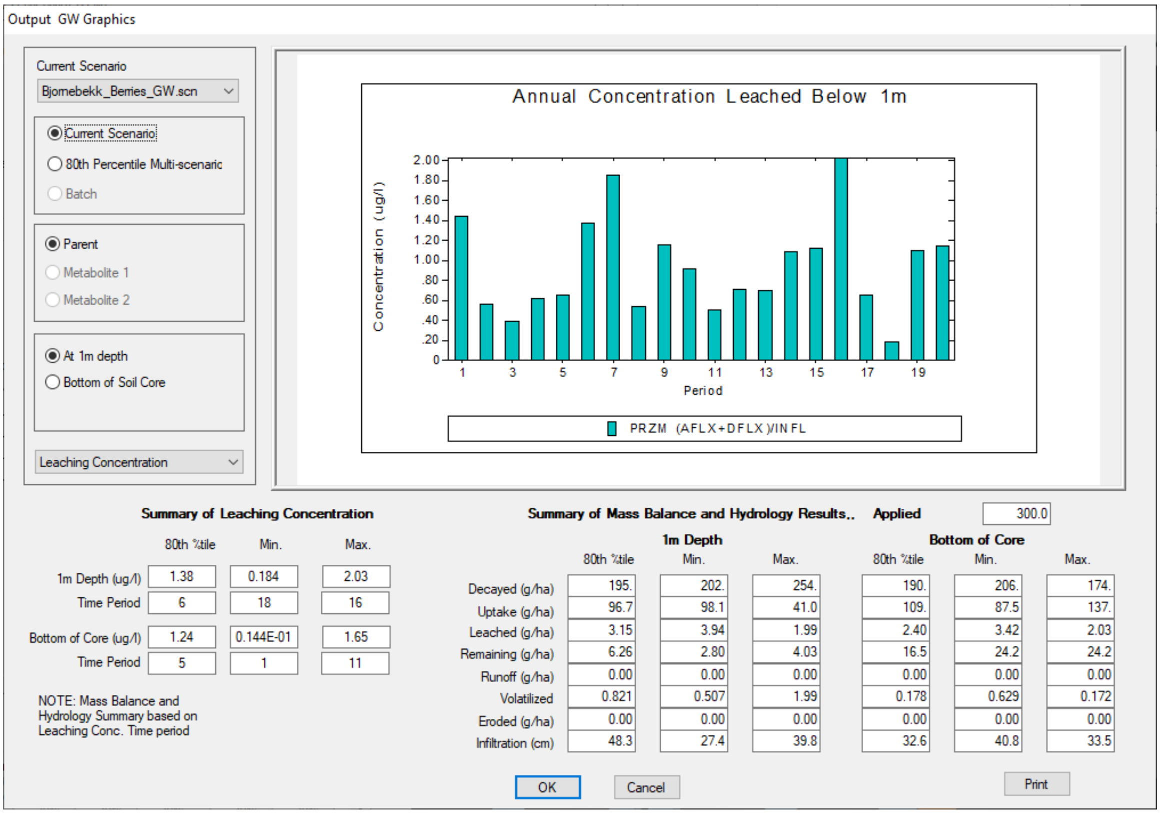


	Minimum	10th %tile	Mean	90th %tile	Maximum
(1) WC Abs. Peak	0.104	0.106	0.115	0.126	0.131
(2) WC 1 day-	0.817E-01	0.850E-01	0.968E-01	0.122	0.128
(3) WC 4 day-	0.489E-01	0.518E-01	0.694E-01	0.112	0.121
(4) WC 21 day	0.279E-01	0.301E-01	0.429E-01	0.774E-01	0.869E-01
(5) WC 60 day	0.184E-01	0.198E-01	0.285E-01	0.528E-01	0.592E-01
(6) WC 90 day	0.138E-01	0.148E-01	0.215E-01	0.398E-01	0.447E-01
(7) WC 365 day	0.374E-02	0.403E-02	0.586E-02	0.110E-01	0.124E-01
(8) WC Entire Mean	0.159E-02	0.171E-02	0.250E-02	0.471E-02	0.530E-02
(9) Benthic Peak	0.305E-01	0.327E-01	0.463E-01	0.799E-01	0.891E-01
(10) Benthic 21-day	0.223E-01	0.241E-01	0.354E-01	0.667E-01	0.751E-01

Figur 9: Eksempel på en sensitivitetsanalyse.



Figur 10: Eksempel på tidsserieresultater i en vannforekomst og i sediment.



Figur 11: Eksempel på årlige konsentrasjoner i grunnvann på 1 meter.

4.2.2 Testing av modell

For å teste modellen ble det kjørt simuleringer for de to norske scenariene Bjørnebekk og Syverud for plantevernmidlene MCPA, boskalid og benzovindiflupyr som har ulike egenskaper mhp. nedbryting og sorpsjon. MCPA og benzovindiflupyr ble simulert i vårkorn, mens boskalid ble simulert i gulrot.

4.2.2.1 Simulering med ulike klimafiler

WISPE-Norge har blitt videreutviklet slik at det er mulig å kjøre de ulike scenariene med forskjellige klimafiler. Dette kan da brukes for å f.eks. se på effekten av klimaendringer på avrenning og utlekking. Ved denne testingen ble de ulike scenariene simulert med to forskjellige klimafiler. Den ene klimafilen besto av historiske data, mens den andre besto av et framtidsscenarie. Begge klimafilene inneholdt data for 26 år.

Som vi ser av resultatene for alle tre plantevernmidlene og alle scenariene, så gir de to ulike klimasceniariene kun små forskjeller i den predikerte konsentrasjonen av plantevernmiddelet i de ulike vannforekomstene. Testene som ble utført i dette prosjektet ga en makskonsentrasjon (konsentrasjonen ved 1 d) av MCPA og benzovindiflupyr som var lavere for vårkorn i både dam og elv/bekk ved bruk av framtidsscenarier enn ut fra historiske data (tabell 8 og 9). For boskalid i gulrot ble makskonsentrasjonen høyere ved bruk av framtidsscenariet (tabell 10).

Klimadata for framtidsscenariet som ligger i WISPE-Norge ble beregnet med utgangspunkt i klimanormalen fra 1961-1990. Ny klimanormal (1991-2020) for bruk ved beregning av framtidige prognoser ble tatt i bruk fra 1. januar 2021. Den nye normalperioden (1991-2020) er på grunn av klimaendringene varmere enn den forrige normalperioden (1961-1990) (www.met.no). Høyere temperatur kan gi mer nedbryting, men resultatet er avhengig av sprøytetidspunktet og om det er nedbør eller ikke i tiden rundt sprøytetidspunktet. På grunn av klimaendringene er det ønskelig å oppdatere klimafilene i WISPE-Norge etter den nye klimanormalen og også lage en oppdatert klimafil med beregninger over hvordan klimaet vil se ut fram i tid (klimaframskriving).

Tabell 8: Konsentrasjon av MCPA i vannforekomst (90 prosentilen, µg/L). Simulert med historiske klimadata og framtidsscenarier.

	Tidsvektet gjennomsnitt (µg/L)			
	Historiske klimadata		Framtidsscenarie	
	Dam	Elv/bekk	Dam	Elv/bekk
Bjørnebekk - vårkorn				
1 d	9,05	4,27	8,91	4,09
4 d	8,51	1,71	8,38	1,31
21 d	7,11	0,466	6,99	0,41
60 d	5,22	0,169	5,24	0,181
90 d	4,24	0,115	4,27	0,129
365 d	1,39	0,029	1,39	0,035
Hele perioden	1,33	0,017	1,33	0,024
Syverud - vårkorn				
1 d	9,18	10,1	8,97	9,93
4 d	8,64	3,10	8,44	3,35
21 d	7,42	0,756	7,16	0,825
60 d	5,46	0,292	5,54	0,365
90 d	4,46	0,204	4,57	0,256
365 d	1,45	0,052	1,52	0,073
Hele perioden	1,38	0,028	1,43	0,048

Tabell 9: Konsentrasjon av benzovindiflupyr i vannforekomst (90 prosentilen, µg/L). Simulert med historiske klimadata og framtidsscenarier.

	Tidsvektet gjennomsnitt (µg/L)			
	Historiske klimadata		Framtidsscenarie	
	Dam	Elv/bekk	Dam	Elv/bekk
Bjørnebekk - vårkorn				
1 d	1,82	0,386	1,79	0,347
4 d	1,69	0,144	1,66	0,153
21 d	1,65	0,051	1,62	0,057
60 d	1,65	0,029	1,62	0,026
90 d	1,65	0,022	1,62	0,021
365 d	1,62	0,008	1,60	0,008
Hele perioden	0,901	0,005	0,899	0,005
Syverud - vårkorn				
1 d	2,85	1,20	2,71	1,22
4 d	2,72	0,472	2,59	0,576
21 d	2,71	0,186	2,56	0,199
60 d	2,71	0,106	2,55	0,089
90 d	2,71	0,080	2,55	0,076
365 d	2,66	0,028	2,52	0,027
Hele perioden	1,40	0,018	1,38	0,016

Tabell 10: Konsentrasjon av boskalid i vannforekomst (90 prosentilen, µg/L). Simulert med historiske klimadata og framtidsscenarier.

	Tidsvektet gjennomsnitt (µg/L)			
	Historiske klimadata		Framtidsscenarie	
	Dam	Elv/bekk	Dam	Elv/bekk
Bjørnebekk - gulrot				
1 d	17,5	0,653	18,9	1,44
4 d	17,2	0,243	18,7	0,486
21 d	17,0	0,078	18,5	0,146
60 d	17,0	0,039	18,5	0,072
90 d	17,0	0,029	18,5	0,056
365 d	16,7	0,013	18,2	0,021
Hele perioden	9,12	0,009	9,95	0,015
Syverud - gulrot				
1 d	21,6	1,73	25,7	3,08
4 d	21,3	0,622	25,5	1,40
21 d	21,3	0,222	25,5	0,428
60 d	21,3	0,123	25,5	0,203
90 d	21,3	0,094	25,4	0,156
365 d	20,9	0,034	25,1	0,057
Hele perioden	11,2	0,024	13,5	0,038

4.2.2.2 Simulering av avrenning ved bruk av vegetasjonssoner

I modellen er det inkludert en funksjonalitet for å kunne estimere effekten av vegetasjonssoner med ulik bredde på avrenningen. Man kan velge mellom vegetasjonssoner med bredde 5-10 m (40 % reduksjon i konsentrasjonen i vannforekomsten), 10-20 m (65 % reduksjon i konsentrasjonen i vannforekomsten) og mer enn 20 m (80 % reduksjon i konsentrasjonen i vannforekomsten) (SETAC, 2013). I 2015 innførte Mattilsynet krav om 10 meter brede vegetasjonssoner (vegeterte buffersoner) i Norge som et risikoreduserende tiltak for plantevernmidler som er utsatt for overflateavrenning. I testingen som ble utført ble det derfor simulert med en vegetasjonssone på 5-10 m (Tabell 11 og 12). Resultatene viste at innføring av en vegetasjonssone reduserte konsentrasjonen av det mobile stoffet MCPA i mindre grad (18-25 % for alle simulerte år i bekk/elv) enn den reduserte konsetrasjonen av benzovindiflupyr (40 % for alle simulerte år i bekk/elv), som bindes sterkere til partikler. Dette følger teorien om at vegetasjonssoner fanger partikler og reduserer avrenningen av partikkelbundne stoffer i større grad enn mer vannløselige stoffer som oftest infiltrerer jorda og i mindre grad når vannforekomsten uansett. Man ser det samme bildet for dammer, men reduksjonen er langt mindre for begge stoffene, noe som i hovedsak skyldes mindre avrenning/erosjon til dammer enn til bekker/elver og at vegetasjonssonen dermer ikke har noen effekt.

Selv om funksjonen som er lagt inn i modellen er basert på forskningsdata (SETAC, 2013), er det en svært enkel %-vis reduksjon i konsentrasjonene, men ved å knytte modellen til f.eks. VFSMOD, en modell for beregning av vegetasjonssoner eller SWAN, en tiltaksmodell, kunne man i større grad sett hvilken effekt ulike tiltak har på avrenning av plantevernmidler.

Tabell 11: Konsentrasjon av MCPA i vannforekomst (90 prosentilen, µg/L) simulert med og uten vegetasjonssone og beregnet reduksjon i konsentrasjonene.

	Tidsvektet gjennomsnitt (µg/L)				Reduksjon i konsentrasjon, %	
	Uten vegetasjonssone		Med vegetasjonssone			
	Dam	**Elv/bekk**	**Dam**	**Elv/bekk**	**Dam**	**Elv/bekk**
Bjørnebekk-vårkorn						
1 d	9.05	4.27	9	3.43	0.6	19.7
4 d	8.51	1.71	8.47	1.34	0.5	21.6
21 d	7.11	0.466	7.01	0.34	1.4	27.0
60 d	5.22	0.169	5.13	0.123	1.7	27.2
90 d	4.24	0.115	4.18	0.084	1.4	27.0
365 d	1.39	0.029	1.37	0.021	1.4	27.6
Hele perioden	1.33	0.017	1.32	0.014	0.8	17.6
Syverud - vårkorn						
1 d	9.18	10.1	9.07	6.04	0.01	40.2
4 d	8.64	3.1	8.53	1.95	0.01	37.1
21 d	7.42	0.756	7.2	0.514	0.03	32.0
60 d	5.46	0.292	5.28	0.197	0.03	32.5
90 d	4.46	0.204	4.3	0.136	0.04	33.3
365 d	1.45	0.052	1.41	0.035	0.03	32.7
Hele perioden	1.38	0.028	1.35	0.021	0.02	25.0

Tabell 12: Konsentrasjon av benzovindiflupyr i vannforekomst (90 prosentilen, µg/L) simulert med og uten vegetasjonssone og beregnet reduksjon i konsentrasjonene.

	Tidsvektet gjennomsnitt (µg/L)				Reduksjon i konsentrasjon, %	
	Uten vegetasjonssone		Med vegetasjonssone			
	Dam	Elv/bekk	Dam	Elv/bekk	Dam	Elv/bekk
Bjørnebekk-vårkorn						
1 d	1.82	0.386	1.68	0.232	7.7	39.9
4 d	1.69	0.144	1.55	0.086	8.3	40.3
21 d	1.65	0.051	1.51	0.03	8.5	41.2
60 d	1.65	0.029	1.5	0.017	9.1	41.4
90 d	1.65	0.022	1.5	0.013	9.1	40.9
365 d	1.62	0.008	1.48	0.005	8.6	37.5
Hele perioden	0.901	0.005	0.828	0.003	8.1	40.0
Syverud - vårkorn						
1 d	2.85	1.2	2.29	0.724	0.20	39.7
4 d	2.72	0.472	2.16	0.283	0.21	40.0
21 d	2.71	0.186	2.13	0.112	0.21	39.8
60 d	2.71	0.106	2.13	0.064	0.21	39.6
90 d	2.71	0.08	2.13	0.048	0.21	40.0
365 d	2.66	0.028	2.1	0.017	0.21	39.3
Hele perioden	1.4	0.018	1.13	0.011	0.19	38.9

5 Konklusjon

Overordnet mål for prosjektet har vært å bidra til en bedre miljøvurdering av plantevernmidler, dvs en mer realistisk eksponerings- og risikovurdering tilpasset norske forhold. Formålet med prosjektet var å oppdatere og videreutvikle modellen WISPE blant annet i henhold til oppdateringer anbefalt for EU-modeller fra FOCUS-Repair prosjektet (Adriaanse et al., 2020).

Ut fra de analysene og modellsammenligningene som er gjort i prosjektet kan det konkluderes med at modellen WISPE med de norske scenariene gir eksponeringskonsentrasjoner i samme størrelsesorden som modellen SWASH med EU-scenarier, men det er noen avvik fra det generelle bildet. I noen tilfeller gir de norske scenariene med norske klima- og jorddata, høyere simulerte eksponeringskonsentrasjoner enn EU-scenariene. Det er også vist at å bruke norske klimadata sammen med EU-scenarier kan gi høyere eksponeringskonsentrasjon i enkelttilfeller, men at dette bildet kan være påvirket av modellens valg av sprøytetidspunkt.

De norske scenariene som er utviklet er representative for en begrenset andel av norske jordbruksområder, både med tanke på jordsmonn og klima, så det er behov for å videreutvikle WISPE med flere norske scenarier, spesielt for områder som er våtere og kaldere enn dagens scenarier. I prosjektet har derfor WISPE-Norge blitt oppdatert og videreutviklet slik at det nå er enklere å legge til nye scenarier og nye klimafiler. Selv om det alltid er nyttig å ha feltforsøk til grunn for å justere modeller iht virkeligheten, er ikke dette nødvendig i denne versjonen av modellen, da mer teoretiske scenarier kan legges til i tilfeller man ikke har feltdata tilgjengelig. Mulighet for å kunne estimere effekten av vegetasjonssoner med ulik bredde er også lagt inn og simuleringer der denne funksjonaliteten er brukt viser en reduksjon i eksponeringskonsetrasjonen, både for vannløselige stoffer og stoffer som bindes sterkere til partikler. Funksjonen som er lagt til i denne modellen er en relativt enkel konsentrasjonsreduksjon, men på sikt er det ønskelig å knytte WISPE til modellen VFSMOD eller SWAN som begge er mer rafinerte modeller for vurdering av risikoreduserende tiltak.

Den nye versjonen av WISPE-Norge er et verktøy oppdatert i henhold til flere av de viktigste anbefalingene fra et arbeid gjort for å vurdere en oppdatering av EU-modellene som benyttes for å estimere overflateavrenning. Modellen er utbedret og det er både enklere å kjøre modellen og hente ut resultater. Videre er det nå enkelt å endre eksisterende scenarier eller lage helt nye scenarier. Det er også enkelt å bytte ut klimafiler, slik at man kan undersøke effekten av klimaendringer på en enkel måte. Det er utviklet en brukermanual som gjør det lettere å bruke modellen og den skal gjøres tilgjengelig for nedlasting slik at den kan benyttes fritt innen forskning og av myndigheter og industri.

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Vedlegg

Vedlegg 1 – Rapport fra Waterborne. Sammenligning av WISPE scenarier med FOCUS SWASH scenarier

Vedlegg 2 – Brukermanual for WISPE–Norge

TITLE

Comparison of WISPE Scenarios to FOCUS SWASH Scenarios

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1.0 EXECUTIVE SUMMARY

The objective of this study was to compare the surface water results from simulations with Norwegian scenarios in WISPE with simulations from FOCUS SWASH scenarios. WISPE includes the Pesticide Root Zone Model (PRZM) to simulate runoff, erosion, and pesticide mass fluxes in a field and the Exposure Analysis Modeling System (EXAMS) to simulate the dissipation in a waterbody. SWASH also uses the PRZM model but TOXSWA (TOXic substances in Surface Waters) is used to simulate the pesticide concentrations in a waterbody. The simulations were made with a generic chemical with varying the adsorption coefficient (10 L/kg, 1000 L/kg, and 10000 L/kg). A single pre-emergent application of 0.1 kg/ha with no drift and 100% efficiency was modeled using the winter cereal and potato scenarios. Other comparisons were also part of this study such as predicted environmental concentrations (PECs) from EXAMS versus TOXSWA and the impact of Norway weather compared to EU weather.

Overall, the WISPE PECs were within the range of the SWASH PECs. An analysis of EXAMS versus TOXSWA showed that the pond values matched better than the stream values. This could be attributed to EXAMS having constant volume and only receiving mass without changing the flow of the waterbody causing higher PECs than in TOXSWA which has variable flow and volume. SWASH scenarios with the Norway weather tended to produce lower PECs. However, it should be noted that the simulations with the Norway weather kept the SWASH application date that was determined by the Pesticide Application Timing (PAT) calculator within SWASH based on the EU scenario rainfall. PAT was not available to use with the Norway weather. Additionally, when determining sensitivity, it is better to isolate the impact of one change at a time (i.e., different weather).

2.0 INTRODUCTION

The World Integrated System for Pesticide Exposure (WISPE) model was originally developed by Waterborne Environmental, Inc. for the Norwegian Food Safety Authority (NFSA) in a project cooperation with Professor Ole Martin Eklo and Randi Bolli at Bioforsk (since 2015 NIBIO) and Roger Holten (at the Norwegian Food Safety Authority at the time). WISPE is a computer modelling tool that predicts pesticide exposure in surface water and groundwater associated with pesticide use in Norwegian conditions. WISPE includes the Pesticide Root Zone Model (PRZM) to simulate runoff, erosion, and pesticide mass fluxes in a field and the Exposure Analysis Modeling System (EXAMS) to simulate the dissipation in a waterbody. For surface water, WISPE results consist of predicted environmental concentrations (PECs) in the water column and the benthic zone at different exposure durations. For groundwater, PECs at a certain depth are calculated by PRZM and the ADAM model is included that predicts the exposure in an aquifer. Norwegian crop scenarios were developed to simulate the most common crops in Norway using Norwegian weather, soils and crop timing (planting, emergence, harvest dates). This report focuses on two of the surface water crop scenarios (winter cereals and potatoes).

Currently, NFSA is using the full set of FOCUS surface water scenarios in FOCUS SWASH (SWASH) for the registration of pesticides to the Norwegian market instead of WISPE. However, the EU scenarios for surface runoff may not be relevant for Norwegian conditions. Therefore, the objective of this study was to compare the surface water results from simulations with Norwegian scenarios in WISPE with simulations from SWASH EU scenarios and to document the results.

3.0 MODELS

3.1 Introduction

The WISPE framework includes the Pesticide Root Zone Model (PRZM) which is a model to generate runoff, erosion and chemical movement in runoff and erosion from a field. The mass chemical loadings generated from PRZM are transferred into the Exposure Analysis Modelling System (EXAMS) to predict environmental concentrations (PECs). WISPE includes standard crop scenarios that were developed specifically for Norway using Norwegian soils, weather, and cropping practices. The FOCUS SWASH (Surface Water Scenarios Help) tool also utilizes the PRZM model but it is linked to the TOXSWA (TOXic substances in Surface Waters) model to calculate PECs in standard water bodies using standard EU crop scenarios.

3.2 PRZM model

PRZM was developed by the USEPA for use in regulatory risk assessment (Carousel, et al., 2005). The version of the PRZM in WISPE and SWASH is an updated version: winPRZM (version 4.5.2, 2013). WinPRZM includes non-linear Freundlich type sorption as well as temperature/moisture dependent degradation in the soil. PRZM is a dynamic, compartmental model for use in simulating water and chemical movement in unsaturated soil systems within and below the plant root zone. The model simulates time-varying hydrologic behavior on a daily time step, including physical processes of runoff, infiltration, erosion, and evapotranspiration. The chemical transport component of PRZM calculates pesticide uptake by plants, surface runoff, erosion, decay, vertical movement, foliar loss, dispersion and retardation. PRZM includes the ability to simulate metabolites, irrigation, and hydraulic transport below the root zone.

Each PRZM modelling scenario represents a unique combination of climatic conditions, crop specific management practices, soil specific properties, site specific hydrology, and pesticide specific application and dissipation processes. Each PRZM simulation is conducted using multiple years of daily rainfall data to cover year-to-year variability in runoff. Daily edge-of-field loadings of pesticides dissolved in runoff waters and sorbed to sediment, as predicted by PRZM, are discharged into a standard waterbody.

3.3 EXAMS model

To calculate PECs in surface water bodies in the WISPE model, the Exposure Analysis Modelling System, EXAMS (Burns, 2004) is used in conjunction with PRZM. EXAMS is also a numerical process model, but it simulates the processes that occur in the waterbody rather than on the agricultural field. EXAMS receives the runoff and erosion (off-target mass loadings) and spray drift loading from PRZM transfer files and estimates the concentration in the waterbody on a day-to-day time step.

EXAMS can be used to assess the fate, exposure, and persistence of synthetic organic chemicals in aquatic ecosystems. It accounts for volatilization, sorption, hydrolysis, biodegradation, and photolysis of the pesticide. Since EXAMS is a steady-state model, the water bodies are modelled as having constant volume. Multiple-year (26 years in WISPE) pesticide time-weighted average concentrations are calculated from the simulations as the maximum annual 24-hour, maximum annual 96-hour average, maximum annual 21-day average, maximum annual 60-day average, maximum annual 90-day average and annual average. Peak concentrations are also calculated for each year. The version of EXAMS used in WISPE is version 2.98.04, April 2005.

3.4 TOXSWA

SWASH uses the TOXSWA model to simulate water and chemical fluxes from surface runoff and erosion from PRZM. TOXSWA also receives the spray drift loadings from PRZM transfer files. The model is able to simulate varying flows and water depths. Therefore, the volume and depth in the waterbody changes over time. Four processes are considered in TOXSWA: transport, transformation, sorption, and volatilization (Beltman, et. al., 2018). Pesticides in the water layer are transported by advection and dispersion. Diffusion is included in the sediment layer. In the SWASH surface water scenarios, transport across the water-sediment interface only takes place by diffusion. Sorption to suspended sediments, sediment and macrophytes is simulated.

The TOXSWA model performs on an hourly time step for a one-year simulation. PECs are generated for a global maximum, 1-day, 2-day, 3-day, 4-day, 7-day, 14-day, 21-day, 28-day, 42-day, 50-day and 100-day. Maximum time-weighted average concentrations are also calculated for these same duration periods.

4.0 MODEL SIMULATIONS

4.1 Introduction

To compare the WISPE and SWASH model results, two standard crop scenarios were selected from WISPE and SWASH (winter cereals and potatoes). A generic chemical was created with varying Kocs (10, 1000, and 10000 L/kg) to test variation in the model results with respect to adsorption properties of chemicals. Example WISPE PRZM and EXAMS input files for a Koc of 10 L/kg are shown in Appendix A. This appendix shows an example of a pond and a stream environment for EXAMS. Appendix B has examples of the PRZM input files for a Koc of 10 L/kg for SWASH and includes example TOXSWA input files for a pond and stream.

4.2 Physical and Chemical Properties

A generic chemical was created for the model simulations. To determine if there is a difference in the variation of concentrations between the models with adsorption, three Koc were run: 10, 1000, and 10000 L/kg. The physical and chemical properties used in the modeling are shown in Table 1. The soil metabolism half-life, aerobic aquatic metabolism half-life and anaerobic aquatic half-life were assumed to be 100 days with stable hydrolysis and aquatic photolysis.

Table 1 Chemical Properties and Environmental Fate Parameters

Parameter	Value
Molecular weight	250 g/mol
Vapor pressure (25 °C)	1.0×10^{-12} torr
Aqueous solubility (25°C)	30.0 mg/L
Hydrolysis half-life (25°C)	Stable
Aqueous photolysis half-life (25°C)	Stable
Aerobic soil metabolism half-life (25°C)	100 days
Aerobic aquatic metabolism half-life (20°C)	100 days
Anaerobic aquatic metabolism half-life (25°C)	100 days
Partition coefficients (Koc)	10, 1000, and 10000 L/kg
1/n	0.9

4.3 Crop Scenarios and Pesticide Use Pattern

Winter cereal and potato standard crop scenarios from WISPE and SWASH were selected for the comparison analysis. A single application of 0.1 kg/ha as a pre-emergent with no drift

(0%) and 100% efficiency was simulated. Table 2 lists the crops and timing of application. The WISPE model had application one day prior to emergence, the same date for all 26 years. SWASH uses PAT (Pesticide Application Timing calculator) to determine the application date for the 20-year PRZM run. PAT selects an application date that has at least 10 mm of precipitation within ten days following application. However, only one year of PRZM output data is passed onto the TOXSWA model. The table shows the application range and the date selected for the one-year TOXSWA simulation.

The WISPE model included a new (2020) scenario for winter cereals (Heia) that is modeled with a 3-ha field and a 100-m hydraulic length. However, for this analysis, the field size was set to the actual field trial plots since the other scenarios use the field plot size. Therefore, the WISPE winter cereal crop scenario for Heia was changed from a 3-ha field to a 0.024-ha field plot (24 m x 10 m). The hydraulic length was changed from 100 m to 24.5 m.

Table 2 Crop Scenarios for Aquatic Exposure Modelling

Model	Crop Scenario	Application Date[1]	Application Range[2]
WISPE	Bjornebekk – Winter Cereals	14-Sept	--
WISPE	Syverud – Winter Cereals	14-Sept	--
WISPE	Heia – Winter Cereals	14-Sept	--
WISPE	Bjornebekk – Potatoes	9-June	--
WISPE	Syverud - Potatoes	9-June	--
SWASH	Weiherbach, Germany-R1 – Winter Cereals	12-Oct-78	12-Oct to 11-Nov
SWASH	Bologna, Italy–R3 – Winter Cereals	15-Nov-80	31-Oct to 30-Nov
SWASH	Roujan, France–R4 – Winter Cereals	18-Oct-79	10-Oct to 9-Nov
SWASH	Weiherbach, Germany-R1 – Potatoes	26-Apr-84	4-Apr to 4-May
SWASH	Porto, Portugal–R2 – Potatoes	6-Mar-78	12-Feb to 14-Mar
SWASH	Bologna, Italy–R3 - Potatoes	10-Mar-80	10-Mar to 9-Apr

[1]WISPE uses the same date for all 26 years, SWASH date is the year used in TOXSWA.
[2]Application date range used in SWASH, not applicable to WISPE.

5.0 WISPE – SWASH COMPARISON

5.1 Mass Loadings

The winter cereal and potato scenarios were simulated in WISPE and in SWASH. In WISPE, PRZM ran a 26-year simulation and the PRZM model was run for 20 years in SWASH. The annual total runoff mass (RFLX) and erosion mass (EFLX) were calculated for each year and also the entire simulation. As indicated in Table 2, the WISPE PRZM simulations had the same application date for every year. The SWASH PRZM simulations had different application dates each year. Table 3 summarizes the minimum and maximum annual total mass loadings (RFLX+EFLX) for each crop scenario and Koc. In general, the annual mass loadings are within the same range when comparing WISPE to SWASH. The table also shows how the total mass (minimum and maximum) change with the varied Koc value. Appendix C, Appendix D, and Appendix E present the annual mass loads from the WISPE scenarios with a Koc of 10 L/kg, 1000 L/kg, and 10000 L/kg, respectively. Appendix F thru Appendix H present the annual mass loadings from SWASH for the three Koc values (10, 1000, 10000 L/kg), respectively. The appendices show the runoff mass and erosion mass separately for each year for each scenario. As expected, as the Koc increases, the mass in the dissolved runoff decreases and the mass in the eroded sediment increases. The mass is presented in kg/ha to normalize the comparison. The scenarios have different field areas and the mass is multiplied by the field area for a total mass into the waterbody.

Table 3 Summary of Minimum and Maximum Annual Total Loadings

		Total Annual Mass, kg/ha					
		koc=10		koc=1000		koc=10000	
Model	Scenario	min	max	min	Max	min	max
WISPE	Bjornebekk_WCereal_SW	9.77E-06	2.70E-03	5.71E-04	3.07E-03	6.64E-04	2.53E-03
WISPE	Syverud_WCereal_SW	5.86E-05	3.26E-03	6.93E-04	3.08E-03	9.77E-04	4.02E-03
WISPE	Heia_Wcereal_SW	3.12E-05	2.83E-03	5.82E-04	2.77E-03	1.29E-04	7.90E-04
SWASH	Weiherbach, Germany -R1_WC	7.82E-09	1.10E-03	7.30E-05	6.95E-04	1.80E-05	7.28E-04
SWASH	Bologna, Italy – R3_WC	4.48E-06	4.64E-03	1.06E-04	2.67E-03	3.50E-05	1.70E-03
SWASH	Roujan, France – R4_WC	1.56E-06	8.82E-03	3.56E-04	5.45E-03	1.07E-04	2.44E-03
WISPE	Bjornebekk_Potatoes_SW	3.11E-06	4.19E-03	6.67E-04	3.21E-03	5.94E-04	3.31E-03
WISPE	Syverud_Potatoes_SW	4.54E-06	5.02E-03	6.31E-04	3.61E-03	9.65E-04	3.97E-03
SWASH	Weiherbach, Germany -R1_Potatos	9.21E-09	3.82E-03	1.95E-04	2.65E-03	2.22E-04	2.07E-03
SWASH	Porto, Portugal – R2_Potatoes	2.25E-07	2.29E-03	1.72E-04	1.96E-03	1.97E-04	2.12E-03
SWASH	Bologna, Italy – R3_Potatoes	6.82E-06	5.53E-03	3.20E-04	2.41E-03	2.58E-04	1.66E-03

5.2 Predicted Environmental Concentrations

A comparison of the PECs running WISPE versus SWASH as reported per the model output (90^{th} percentile time-weighted average [TWA] exposure duration concentrations for a WISPE 26-year run and one-year TWA exposure concentrations for SWASH). SWASH also reports the global maximum concentration; so for comparison purposes, a maximum overall simulation peak concentration from the 26 year simulation is provided from the WISPE runs. This value isn't typically included in the PEC evaluation of risk in WISPE. Also, only pond and stream water bodies are modeled in SWASH using PRZM for runoff/erosion. The ditch waterbody in SWASH is only used for MACRO drainage simulations. Therefore, Table 4 shows the PECs in the water column for the two models for winter cereal and potato crop scenarios. The table highlights the water bodies and crops. For example, all the winter cereal with a pond waterbody are highlighted in blue so it is easier to compare “like” scenarios between WISPE and SWASH. It can be seen that the PECs from WISPE compared to SWASH that they are within the same range for Koc=1000 for pond and stream environments. The WISPE winter cereal and potato pond PECs are higher than the SWASH PECs for Koc=10 L/kg but fall in between range of PECs for the streams. For Koc=10000 L/kg, the PECs for WISPE were within the range of SWASH PECs with the exception of potato stream PECs which were higher for WISPE. The table below only shows the maximum, 1-day, 4-day and 21-day PECs. Appendix I shows all the exposure duration PECs for WISPE and Appendix J shows all the exposure duration PECs for SWASH as would be reported in a risk assessment.

Table 4 includes the field size for the WISPE scenarios and the SWASH scenarios. The waterbody surface areas are the same (pond = 0.09 ha, stream = 0.01 ha). The mass loading in kg/ha is multiplied by field area for the total mass loading transported into the waterbody. The field to waterbody surface areas ratios ranged from 0.02:0.09 to 0.04:09 for WISPE pond scenarios. The field to waterbody surface area ratio for SWASH pond scenarios if 0.45:0.09. For the stream scenarios in WISPE, the field to waterbody surface area ratio ranges from 0.02:0.01 to 0.04:0.01. The ratio is SWASH is 1:0.01 for streams.

Table 4 WISPE and SWASH PECs for winter cereal and potato crop scenarios

						90th %ile TWA PECs, ug/L						TWA PECs, ug/L		
Koc	WISPE Scenario	Field area, ha	Crop	Water-body	26-Yr Max	1 day	4 days	21 days	SWASH Scenario	Field area, ha	Global Max, ug/L	1 day	4 days	21 days
10	Bjornebekk_WC	0.02	Winter cereal	Pond	0.073	0.065	0.064	0.063	Weiherbach-R1	0.45	0.018	0.017	0.017	0.016
10	Syverud_WC	0.04	Winter cereal	Pond	0.180	0.161	0.161	0.158						
10	Heia_WC	0.024	Winter cereal	Pond	0.099	0.087	0.086	0.085						
10	Bjornebekk_WC	0.02	Winter cereal	Stream	1.800	0.526	0.173	0.037	Weiherbach-R1	1	0.808	0.320	0.080	0.017
10	Syverud_WC	0.04	Winter cereal	Stream	3.570	1.458	0.441	0.089	Bologna–R3	1	7.234	3.783	1.217	0.232
10	Heia_WC	0.024	Winter cereal	Stream	2.160	0.806	0.252	0.051	Roujan–R4	1	6.735	2.887	0.737	0.141
10	Bjornebekk_P	0.02	Potatoes	Pond	0.096	0.065	0.064	0.063	Weiherbach-R1	0.45	0.007	0.007	0.007	0.007
10	Syverud_P	0.04	Potatoes	Pond	0.231	0.137	0.137	0.134						
10	Bjornebekk_P	0.02	Potatoes	Stream	2.490	0.631	0.161	0.031	Weiherbach-R1	1	1.318	0.568	0.142	0.028
10	Syverud_P	0.04	Potatoes	Stream	5.350	1.154	0.312	0.062	Porto–R2	1	6.266	1.644	0.537	0.102
10									Bologna-R3	1	8.711	3.592	1.161	0.227
1000	Bjornebekk_WC	0.02	Winter cereal	Pond	0.048	0.040	0.039	0.036	Weiherbach-R1	0.45	0.068	0.067	0.065	0.057
1000	Syverud_WC	0.04	Winter cereal	Pond	0.085	0.075	0.073	0.067						
1000	Heia_WC	0.024	Winter cereal	Pond	0.049	0.041	0.040	0.037						
1000	Bjornebekk_WC	0.02	Winter cereal	Stream	0.396	0.196	0.077	0.029	Weiherbach-R1	1	0.710	0.280	0.120	0.023
1000	Syverud_WC	0.04	Winter cereal	Stream	0.568	0.281	0.121	0.045	Bologna–R3	1	0.875	0.714	0.413	0.097
1000	Heia_WC	0.024	Winter cereal	Stream	0.352	0.173	0.073	0.026	Roujan–R4	1	1.210	0.836	0.490	0.119
1000	Bjornebekk_P	0.02	Potatoes	Pond	0.048	0.032	0.031	0.029	Weiherbach-R1	0.45	0.055	0.055	0.053	0.047
1000	Syverud_P	0.04	Potatoes	Pond	0.101	0.073	0.072	0.067						
1000	Bjornebekk_P	0.02	Potatoes	Stream	0.454	0.183	0.054	0.017	Weiherbach-R1	1	0.543	0.281	0.071	0.038
1000	Syverud_P	0.04	Potatoes	Stream	0.842	0.310	0.100	0.036	Porto–R2	1	0.213	0.126	0.056	0.023
1000									Bologna-R3	1	0.880	0.437	0.200	0.085
10000	Bjornebekk_WC	0.02	Winter cereal	Pond	0.011	0.008	0.006	0.005	Weiherbach-R1	0.45	0.014	0.014	0.013	0.010
10000	Syverud_WC	0.04	Winter cereal	Pond	0.027	0.020	0.017	0.014						
10000	Heia_WC	0.024	Winter cereal	Pond	0.005	0.003	0.003	0.002						
10000	Bjornebekk_WC	0.02	Winter cereal	Stream	0.143	0.070	0.033	0.012	Weiherbach-R1	1	0.089	0.051	0.026	0.005
10000	Syverud_WC	0.04	Winter cereal	Stream	0.383	0.163	0.076	0.029	Bologna–R3	1	0.079	0.071	0.042	0.012
10000	Heia_WC	0.024	Winter cereal	Stream	0.074	0.034	0.014	0.005	Roujan–R4	1	0.129	0.129	0.079	0.020
10000	Bjornebekk_P	0.02	Potatoes	Pond	0.018	0.013	0.010	0.007	Weiherbach-R1	0.45	0.013	0.013	0.013	0.011
10000	Syverud_P	0.04	Potatoes	Pond	0.044	0.030	0.025	0.018						
10000	Bjornebekk_P	0.02	Potatoes	Stream	0.311	0.143	0.048	0.017	Weiherbach-R1	1	0.077	0.054	0.014	0.006
10000	Syverud_P	0.04	Potatoes	Stream	0.751	0.373	0.125	0.044	Porto–R2	1	0.020	0.016	0.008	0.003
10000									Bologna-R3	1	0.080	0.062	0.021	0.009

6.0 SWASH PRZM/TOXSWA VERSUS PRZM/EXAMS COMPARISON

6.1 Mass Loadings

The PRZM file generated in SWASH was run with the PRZM and EXAMS versions in WISPE. In SWASH, PRZM simulations are 20 years but TOXSWA is only one year. The mass loadings from the PRZM .zts file from SWASH was compared to the PRZM .zts file running the SWASH scenarios with PRZM and EXAMS (WISPE versions). Appendix K thru Appendix M shows the total loads from runoff and erosion for each year for Koc of 10, 1000, and 10000 L/kg, respectively. If compared to Appendix F thru Appendix H, the mass loadings are almost identical. However, there are a couple of scenarios that have a slightly different mass for the first year.

The full 20-year simulation for SWASH crop scenarios was run with PRZM/EXAMS. Then EXAMS was rerun with the 2 years that matched the TOXSWA simulation. EXAMS has mass transfer files that contain runoff and erosion mass that may have occurred from January 1 to December 31. Mass loads in the transfer files were removed if they occurred before or after the TOXSWA run. For example, the Weiherbach, Germany – R1 winter cereals TOXSWA file started with loads on 1-October-1978 and ended on 30-September-1979. If the EXAMS mass transfer file for 1978 had mass runoff or erosion loads before 1-October-1978, the loads were removed. The 1979 mass transfer file was adjusted to remove any runoff or erosion loads after 30-September.

6.2 Predicted Environmental Concentrations

The 20-year maximum PEC and the 90th percentile PECs were compared to the 1-year TOXSWA PECs in Table 5 . SWASH only reports one year of PECs but the 20-year EXAMS simulation reports PECs for all 20 years and the 90th percentile PEC is used in risk assessments. The table shows the comparions of PECs that would be reported in a risk assessment for exposure durations. The PRZM/EXAMS peak PEC is the instantaneous concentration for the 90th percentile year and the 20-year maximum PEC is the highest peak PEC over the 20-year simulation. The SWASH model reports a global maximum PEC for the one-year simulation. The PRZM/EXAMS PECs are higher than the SWASH PECs especially the stream waterbody. This is not surprising since the year that is selected for the TOXSWA simulation is not necessarily the year producing the highest maximum annual PECs over 20 years. Appendix N has all the exposure duration PECs for each scenario for all three Kocs.

Table 5 Comparison of SWASH PECs with 20-year PRZM/EXAMS PECs

Koc	FOCUS Scenario	Crop	Water-body	SWASH Global Max, ug/L	SWASH Time-weighted Average PECs, ug/L 1 day	4 days	21 days	100 days	PRZM/EXAMS 20-Yr Max, ug/L	PRZM/EXAMS 90th% Time-weighted Average PECs, ug/L Peak	1 day	4 day	21 days	90 days
10	WG -R1	W cereal	Pond	0.0176	0.0175	0.0172	0.0158	0.0115	0.5770	0.5682	0.5672	0.5644	0.5521	0.4566
10	WG-R1	W cereal	Stream	0.8075	0.3196	0.0800	0.0167	0.0036	36.7000	31.9800	16.1700	4.2690	0.8234	0.1918
10	BI – R3	W cereal	Stream	7.2340	3.7830	1.2170	0.2321	0.0488	154.0000	131.6000	66.5500	17.5700	3.3570	0.7832
10	RF–R4	W cereal	Stream	6.7350	2.8870	0.7365	0.1407	0.0296	294.0000	127.9000	64.7200	17.2900	3.2870	0.7681
10	WG-R1	Potatoes	Pond	0.0073	0.0072	0.0071	0.0066	0.0044	1.9300	0.8902	0.8892	0.8855	0.8708	0.8245
10	WG-R1	Potatoes	Stream	1.3180	0.5684	0.1422	0.0277	0.0058	110.0000	43.0400	21.7500	7.0010	1.3340	0.3119
10	PP–R2	Potatoes	Stream	6.2660	1.6440	0.5365	0.1022	0.0215	65.2000	52.6400	26.6700	8.0270	1.6760	0.3909
10	BI–R3	Potatoes	Stream	8.7110	3.5920	1.1610	0.2273	0.0478	176.0000	95.6200	48.3000	13.2800	2.5370	0.5919
1000	WG-1	W cereal	Pond	0.0685	0.0675	0.0651	0.0572	0.0452	0.2910	0.2631	0.2591	0.2482	0.2121	0.1612
1000	WG-R1	W cereal	Stream	0.7097	0.2801	0.1198	0.0231	0.0102	12.8000	11.5200	5.8280	1.7350	0.4004	0.1040
1000	BI – R3	W cereal	Stream	0.8745	0.7140	0.4128	0.0972	0.0264	42.9000	42.0700	21.2800	6.0790	1.3630	0.3503
1000	RF–R4	W cereal	Stream	1.2100	0.8362	0.4904	0.1186	0.0282	135.0000	111.2000	56.2000	14.4400	2.9480	0.7450
1000	WG-R1	Potatoes	Pond	0.0553	0.0547	0.0532	0.0467	0.0367	1.1000	0.5427	0.5343	0.5128	0.4306	0.3520
1000	WG-R1	Potatoes	Stream	0.5433	0.2813	0.0706	0.0377	0.0140	33.0000	17.1200	8.6660	3.8150	0.7683	0.2345
1000	PP–R2	Potatoes	Stream	0.2132	0.1260	0.0564	0.0229	0.0081	32.3000	21.1800	10.7800	2.9670	1.0340	0.2919
1000	BI–R3	Potatoes	Stream	0.8800	0.4374	0.1998	0.0854	0.0296	35.3000	32.3600	16.3300	5.2840	1.0790	0.3001
10000	WG-1	W cereal	Pond	0.0141	0.0138	0.0131	0.0103	0.0071	0.1790	0.0771	0.0677	0.0488	0.0279	0.0200
10000	WG-R1	W cereal	Stream	0.0887	0.0511	0.0260	0.0050	0.0019	7.3200	4.4720	2.2650	0.6609	0.1885	0.0644
10000	BI – R3	W cereal	Stream	0.0790	0.0715	0.0416	0.0120	0.0045	18.6000	17.1400	8.6760	2.5560	0.6442	0.1773
10000	RF–R4	W cereal	Stream	0.1293	0.1293	0.0787	0.0200	0.0057	33.4000	27.6300	13.9700	3.9520	1.0450	0.3181
10000	WG-R1	Potatoes	Pond	0.0134	0.0133	0.0129	0.0114	0.0095	0.3500	0.1730	0.1517	0.1153	0.0597	0.0462
10000	WG-R1	Potatoes	Stream	0.0771	0.0542	0.0137	0.0060	0.0027	13.6000	7.2290	3.6590	1.6020	0.3743	0.1344
10000	PP–R2	Potatoes	Stream	0.0196	0.0158	0.0076	0.0030	0.0013	23.6000	16.0800	8.1780	2.2930	0.8834	0.2588
10000	BI–R3	Potatoes	Stream	0.0802	0.0617	0.0211	0.0088	0.0040	14.2000	12.7300	6.4240	2.0130	0.4748	0.1462

WG = Weiherbach, Germany; BI = Bologna, Italy; RF = Roujan, France; PP = Porto, Portugal

Table 6 presents the EXAMS TWA PECs for a 1-year run comparison with the TOXSWA TWA PECs for 1-day,4-day, and 21-day exposure durations (Appendix O shows all exposure durations for EXAMS). The table also shows the date of the maximum PEC. The maximum PECs occurred on the same dates for the Koc=10 L/kg simulations but did not always match for the other two Kocs. When looking at the table, it can be seen that the pond PECs are comparable. For example, with Koc of 1000 L/kg for potatoes (Weiherbach, Germany-R1 pond) the TOXSWA global max PEC is 0.055 µg/L, and the EXAMS peak PEC is 0.052 µg/L. However, the stream PECs in EXAMS tend to be higher. For example,for potatoes (Weiherbach, Germany- R1 stream) with Koc of 1000 L/kg, the TOXSWA global max is 0.543 µg/L while the EXAMS peak is 1.82 µg/L. Another way to look at the results is calculating multiplier factors (MFs) to express the potential magnitude of difference in the EXAMS concentration compared to the TOXSWA concentration. The concept is simple: the EXAMS PEC is compared to the corresponding value for the TOXSWA scenario and exposure duration. The resulting multiplier effect is determined as shown in Equation 1. An MF =1 means that the PECs match. An MF >1 means that the EXAMS PEC is higher than the TOXSWA PEC and an MF <1 means that the EXAMS PEC is lower than the TOXSWA PEC.

$$Multiplier\ factor\ (MF)\ \text{for PEC} = \frac{EXAMS\ PEC}{TOXSWA\ PEC}$$

Equation 1: Derivation of the multiplier factor.

Looking at the MFs in Table 7, it is easier to see the magnitude of EXAMS PECs higher or lower than the SWASH PECs. It shows that the pond PECs match fairly well for all crops and Koc values (0.9 to 1.5). The Bologna, Italy-R3 winter cereal stream scenarios produced the highest variation (e.g., the EXAMS PEC for the Koc=10000 L/kg was 168.4 times higher). The EXAMS PECs for the potato stream scenarios for Koc=10 L/kg showed lower or matching PECs compared to SWASH.

A reason for the higher EXAMS stream scenarios is that the TOXSWA model has varying volume and flow. Therefore, a big rainfall event causing a high amount of runoff/erosion mass can be diluted by the amount of runoff water added to the stream and higher flow. The EXAMS stream has a baseflow but the volume and flow remain constant but still has the same amount of mass coming in as the TOXSWA run. This can cause the the EXAMS PECs to be higher because only the mass is input into the waterbody and it does not include the additional runoff water which would reduce the concentration.

Table 6 1-Year Simulation Comparison of TOXSWA and EXAMS PECs

					TOXSWA results					EXAMS Results				
							TWA PECs, ug/L					TWA PECs, ug/L		
Koc	SWASH scenario	Crop	Water-body	Year	Max day	Global Max, ug/L	1 day	4 days	21 days	Max day	Peak, ug/L	1 day	4 days	21 days
10	WG-R1	W cereal	Pond	1978	25-Oct-78	0.0176	0.0175	0.0172	0.0158	25-Oct-78	0.0176	0.0176	0.0175	0.0171
10	WG-R1	W cereal	Stream	1978	25-Oct-78	0.8075	0.3196	0.0800	0.0167	25-Oct-78	1.1700	0.5930	0.1500	0.0286
10	BI-R3	W cereal	Stream	1980	26-Nov-80	7.2340	3.7830	1.2170	0.2321	26-Nov-80	73.8000	37.3000	14.6000	2.7900
10	RF-R4	W cereal	Stream	1979	22-Oct-79	6.7350	2.8870	0.7365	0.1407	22-Oct-79	20.7000	10.4000	2.7200	0.5260
10	WG-R1	Potatoes	Pond	1984	7-May-84	0.0073	0.0072	0.0071	0.0066	7-May-84	0.0073	0.0073	0.0073	0.0072
10	WG-R1	Potatoes	Stream	1984	7-May-84	1.3180	0.5684	0.1422	0.0277	7-May-84	0.4880	0.2470	0.0624	0.0124
10	PP-R2	Potatoes	Stream	1977	14-Mar-78	6.2660	1.6440	0.5365	0.1022	14-Mar-78	3.6300	1.8400	0.6430	0.1230
10	BI-R3	Potatoes	Stream	1980	15-Mar-80	8.7110	3.5920	1.1610	0.2273	15-Mar-80	3.9900	2.0200	0.8470	0.1900
1000	WG-R1	W cereal	Pond	1978	31-Dec-78	0.0685	0.0675	0.0651	0.0572	31-Dec-78	0.0704	0.0691	0.0636	0.0515
1000	WG-R1	W cereal	Stream	1978	25-Oct-78	0.7097	0.2801	0.1198	0.0231	31-Dec-78	3.2200	1.6200	0.5240	0.0999
1000	BI-R3	W cereal	Stream	1980	26-Nov-80	0.8745	0.7140	0.4128	0.0972	27-Nov-80	33.8000	17.1000	6.1200	1.2300
1000	RF-R4	W cereal	Stream	1979	22-Oct-79	1.2100	0.8362	0.4904	0.1186	26-Oct-79	31.8000	16.1000	7.8300	1.6200
1000	WG-R1	Potatoes	Pond	1984	21-Jun-84	0.0553	0.0547	0.0532	0.0467	30-May-84	0.0519	0.0509	0.0483	0.0427
1000	WG-R1	Potatoes	Stream	1984	20-May-84	0.5433	0.2813	0.0706	0.0377	30-May-84	1.8200	0.9210	0.2350	0.0974
1000	PP-R2	Potatoes	Stream	1977	14-Mar-78	0.2132	0.1260	0.0564	0.0229	29-Apr-78	1.8400	0.9270	0.2780	0.1130
1000	BI-R3	Potatoes	Stream	1980	15-Mar-80	0.8800	0.4374	0.1998	0.0854	22-Mar-80	4.4100	2.2300	0.5870	0.1610
10000	WG-R1	W cereal	Pond	1978	31-Dec-78	0.0141	0.0138	0.0131	0.0103	31-Dec-78	0.0187	0.0160	0.0079	0.0036
10000	WG-R1	W cereal	Stream	1978	25-Oct-78	0.0887	0.0511	0.0260	0.0050	31-Dec-78	1.0600	0.5370	0.1670	0.0320
10000	BI-R3	W cereal	Stream	1980	26-Nov-80	0.0790	0.0715	0.0416	0.0120	27-Nov-80	13.3000	6.7500	2.3400	0.5520
10000	RF-R4	W cereal	Stream	1979	17-Oct-79	0.1293	0.1293	0.0787	0.0200	26-Oct-79	8.9500	4.5200	2.3300	0.5330
10000	WG-R1	Potatoes	Pond	1984	2-Feb-85	0.0134	0.0133	0.0129	0.0114	22-Nov-84	0.0199	0.0176	0.0150	0.0092
10000	WG-R1	Potatoes	Stream	1984	20-May-84	0.0771	0.0542	0.0137	0.0060	22-Nov-84	1.0400	0.5270	0.1750	0.0449
10000	PP-R2	Potatoes	Stream	1977	16-Mar-78	0.0196	0.0158	0.0076	0.0030	7-Dec-77	0.8780	0.4490	0.1760	0.0817
10000	BI-R3	Potatoes	Stream	1980	16-Mar-80	0.0802	0.0617	0.0211	0.0088	22-Mar-80	1.4000	0.7080	0.1940	0.0554

WG = Weiherbach, Germany; BI = Bologna, Italy; RF = Roujan, France; PP = Porto, Portugal. TWA = Time-weighted Average

Table 7 Multiplier Factors Comparing the 1-Year Simulations

Koc	SWASH scenario	Crop	Waterbody	Multiplier Factor			
				Maximum	1 day	4 day	21 day
10	WG-R1	WC	Pond	1.0	1.0	1.0	1.1
10	WG-R1	WC	Stream	1.4	1.9	1.9	1.7
10	BI-R3	WC	Stream	10.2	9.9	12.0	12.0
10	RF-R4	WC	Stream	3.1	3.6	3.7	3.7
10	WG-R1	PO	Pond	1.0	1.0	1.0	1.1
10	WG-R1	PO	Stream	0.4	0.4	0.4	0.4
10	PP-R2	PO	Stream	0.6	1.1	1.2	1.2
10	BI-R3	PO	Stream	0.5	0.6	0.7	0.8
1000	WG-R1	WC	Pond	1.0	1.0	1.0	0.9
1000	WG-R1	WC	Stream	4.5	5.8	4.4	4.3
1000	BI-R3	WC	Stream	38.7	23.9	14.8	12.7
1000	RF-R4	WC	Stream	26.3	19.3	16.0	13.7
1000	WG-R1	PO	Pond	0.9	0.9	0.9	0.9
1000	WG-R1	PO	Stream	3.3	3.3	3.3	2.6
1000	PP-R2	PO	Stream	8.6	7.4	4.9	4.9
1000	BI-R3	PO	Stream	5.0	5.1	2.9	1.9
10000	WG-R1	WC	Pond	1.3	1.2	0.6	0.3
10000	WG-R1	WC	Stream	11.9	10.5	6.4	6.4
10000	BI-R3	WC	Stream	168.4	94.5	56.3	45.8
10000	RF-R4	WC	Stream	69.2	35.0	29.6	26.7
10000	WG-R1	PO	Pond	1.5	1.3	1.2	0.8
10000	WG-R1	PO	Stream	13.5	9.7	12.8	7.5
10000	PP-R2	PO	Stream	44.8	28.5	23.0	27.3
10000	BI-R3	PO	Stream	17.5	11.5	9.2	6.3

7.0 20-YEAR SIMULATIONS WITH NORWAY WEATHER

7.1 Weather

In order to see the impact of the weather, the SWASH crop scenarios were simulated with the Norway weather. Norway weather files have data from 1965 to 1990. The SWASH weather files have data for 20 years from 1975 to 1994. The SWASH input files years were changed to match the Norway weather but only the first 20 years were run (1965 to 1984) because the application dates in SWASH were selected with the PAT tool and there weren't dates given for an additional six years. The two weather files for Norway (Bjornebekk and Syverud) both have the same weather data. The winter cereals scenarios in SWASH (R1, R3, R4) use the R1noirr.met, R3noirr.met, and R4noirr.met files. The potato scenarios in SWASH (R1, R2, R3) use the R1potato.met, R2noirr.met, and R3potato.met, resepectively. Table 8 and Table 9 show the annual total precipitation and annual average temperatures, respectively. Overall, Norway has colder average temperatures. The average annual total rainfall in Norway is most like R1noirr and R1potat SWASH weather files.

Table 8 Summary of Annual Total Precipitaion for SWASH and Norway Weather

			Annual Total Precipitation, cm					
Year	Norway	Year	R1noirr	R2noirr	R3noirr	R4noirr	R1potat	R3potat
1965	61.42	1975	82.03	112.66	81.55	70.20	88.03	108.55
1966	60.06	1976	64.83	143.44	80.19	102.38	85.83	107.19
1967	72.63	1977	69.99	190.57	69.67	99.53	75.99	90.67
1968	61.11	1978	96.25	170.66	76.66	72.00	96.25	100.66
1969	81.20	1979	69.57	171.21	73.19	84.17	81.57	103.19
1970	76.22	1980	83.30	124.08	72.40	49.71	83.30	93.40
1971	70.93	1981	101.45	135.42	54.57	62.29	101.45	78.57
1972	94.96	1982	91.34	130.19	63.29	64.85	91.34	93.29
1973	72.55	1983	71.19	137.72	46.11	55.10	86.19	82.11
1974	90.76	1984	82.94	183.89	72.69	81.17	85.94	93.69
1975	90.60	1985	69.58	150.53	42.28	57.49	72.58	75.28
1976	74.41	1986	90.30	158.69	96.96	95.05	96.30	117.96
1977	104.73	1987	81.02	186.73	45.10	117.16	81.02	78.10
1978	102.54	1988	93.52	125.65	49.63	95.95	99.52	73.63
1979	75.16	1989	63.23	136.86	69.24	44.40	78.23	87.24
1980	89.24	1990	62.36	116.14	55.80	58.26	77.36	85.80
1981	74.65	1991	51.84	130.92	48.75	50.00	63.84	81.75
1982	81.41	1992	59.05	80.66	111.82	99.79	74.05	144.82
1983	72.84	1993	62.81	105.34	83.28	65.99	74.81	116.28
1984	83.50	1994	40.93	112.61	70.54	85.87	67.93	103.54
1985	85.08							
1986	69.21							
1987	65.39							
1988	79.96							
1989	105.89							
1990	120.57							
Avg	81.42[1]		74.38	140.20	68.19	75.57	83.08	95.79
Min	60.06[1]		40.93	80.66	42.28	44.4	63.84	73.63
Max	120.57[1]		101.45	190.57	111.82	117.16	101.45	144.82

[1]Based on 26 years (1965 to 1990), 20 year (1965 to 1984) average = 79.55 cm, minimum = 60.06 cm, maximum = 104.73 cm

Table 9 Summary of Annual Average Temperature for SWASH and Norway Weather

			Annual Average Temperature, °C					
Year	Norway	Year	R1noirr	R2noirr	R3noirr	R4noirr	R1potat	R3potat
1965	7.11	1975	9.58	14.31	13.78	13.54	9.58	13.78
1966	5.44	1976	10.08	14.44	12.98	13.59	10.08	12.98
1967	5.28	1977	10.22	14.37	13.59	13.61	10.22	13.59
1968	4.87	1978	8.80	14.56	12.18	13.26	8.80	12.18
1969	4.16	1979	9.24	14.56	12.64	13.97	9.24	12.64
1970	4.80	1980	9.43	14.56	12.84	13.37	9.43	12.84
1971	4.74	1981	9.38	15.23	13.20	14.07	9.38	13.20
1972	5.88	1982	9.88	14.82	14.24	14.87	9.88	14.24
1973	6.59	1983	10.11	14.95	13.62	14.30	10.11	13.62
1974	6.24	1984	9.35	14.58	12.41	13.47	9.35	12.41
1975	3.79	1985	8.59	15.04	12.83	13.28	8.59	12.83
1976	5.05	1986	9.45	14.69	13.90	13.84	9.45	13.90
1977	3.97	1987	9.15	14.77	13.77	13.60	9.15	13.77
1978	6.06	1988	10.75	15.31	14.27	14.12	10.75	14.27
1979	7.02	1989	10.73	15.81	13.82	14.89	10.73	13.82
1980	7.29	1990	11.56	14.94	14.27	14.68	11.56	14.27
1981	6.17	1991	9.60	14.34	13.58	14.01	9.60	13.58
1982	6.62	1992	10.96	14.47	14.47	14.40	10.96	14.47
1983	5.68	1993	10.85	15.17	14.01	14.37	10.85	14.01
1984	5.86	1994	11.58	14.85	14.77	15.57	11.58	14.77
1985	5.82							
1986	4.73							
1987	6.78							
1988	5.99							
1989	6.32							
1990	7.26							
Avg	5.75[1]		9.96	14.79	13.56	14.04	9.96	13.56
Min	3.79[1]		8.59	14.31	12.18	13.26	8.59	12.18
Max	7.29[1]		11.58	15.81	14.77	15.57	11.58	14.77

[1]Based on 26 years (1965 to 1990), 20 year (1965 to 1984) average = 5.63 °C, minimum = 3.79 °C, maximum = 7.29 °C

7.2 Mass Loadings

A summary table of the 20-year total mass comparison is shown in Table 10. For most scenarios and Kocs, the 20-year total runoff is higher with the SWASH scenarios. However, when looking at the annual runoff and erosion tables in Appendix P thru Appendix R compared to the mass annual tables with the SWASH weather, the mass varies annually as to which weather file produces the highest runoff.

Table 10 20-Year Total Mass from PRZM/EXAMS for SWASH and Norway Weather

Weather	Scenario	20-Year Total Mass, kg/ha		
		koc=10	koc=1000	koc=10000
SWASH	Weiherbach, Germany -R1_WC	3.66E-03	6.62E-03	4.81E-03
Norway	Weiherbach, Germany -R1_WC	1.50E-02	1.45E-02	1.06E-02
SWASH	Bologna, Italy – R3_WC	2.67E-02	2.30E-02	1.40E-02
Norway	Bologna, Italy – R3_WC	1.66E-02	1.24E-02	1.07E-02
SWASH	Roujan, France – R4_WC	2.57E-02	4.18E-02	2.07E-02
Norway	Roujan, France – R4_WC	1.03E-02	1.39E-02	8.92E-03
SWASH	Weiherbach, Germany -R1_Potatos	6.93E-03	1.26E-02	1.12E-02
Norway	Weiherbach, Germany -R1_Potatos	6.91E-03	1.08E-02	1.33E-02
SWASH	Porto, Portugal – R2_Potatoes	1.25E-02	1.41E-02	1.62E-02
Norway	Porto, Portugal – R2_Potatoes	4.53E-03	5.96E-03	8.88E-03
SWASH	Bologna, Italy – R3_Potatoes	1.68E-02	1.60E-02	1.11E-02
Norway	Bologna, Italy – R3_Potatoes	2.07E-02	1.39E-02	1.36E-02

7.3 Predicted Environmental Concentrations

Table 11 presents the PRZM/EXAMS PECs for 20 year simulations of SWASH scenarios comparing SWASH weather and Norway weather. The winter cereal pond PECs were higher with the Norway weather for all three Kocs while the potato pond scenario had lower PECs. The Weiherbach, Germany-R1winter cereals scenario with the stream environment had higher PECs with the Norway weather. The other stream scenarios generated lower PECs with Norway weather or about the same (Bologna, Italy-R3 potatoes). However, the application dates were selected based on the SWASH weather station precipitation occurring within ten days off application. This may not have occurred using the Norway weather. Additionally, runoff does not occur until the temperature is above freezing.

Table 11 Comparison of 20-Year PECs from PRZM/EXAMS for SWASH scenarios using SWASH and Norway Weather

				SWASH Weather					Norway Weather				
	SWASH			20-year	90th% Time-weighted Average PECs, ug/L				20-yea Max,	90th% Time-weighted Average PECs, ug/L			
Koc	scenario	Crop	Waterbody	Max, ug/L	Peak	1 day	4 day	21 day	ug/L	Peak	1 day	4 day	21 day
10	WG-R1	W cereal	Pond	0.577	0.568	0.567	0.564	0.552	2.010	1.803	1.794	1.793	1.773
10	WG-R1	W cereal	Stream	36.700	31.980	16.170	4.269	0.823	88.000	79.330	40.140	10.450	1.995
10	BI-R3	W cereal	Stream	154.000	131.600	66.550	17.570	3.357	81.300	80.740	40.860	10.770	2.046
10	RF-R4	W cereal	Stream	294.000	127.900	64.720	17.290	3.287	76.400	68.450	34.650	8.879	1.698
10	WG-R1	Potatoes	Pond	1.930	0.890	0.889	0.886	0.871	1.340	0.758	0.757	0.753	0.734
10	WG-R1	Potatoes	Stream	110.000	43.040	21.750	7.001	1.334	45.600	42.020	21.200	5.534	1.058
10	PP-R2	Potatoes	Stream	65.200	52.640	26.670	8.027	1.676	25.400	23.230	11.710	2.970	0.582
10	BI-R3	Potatoes	Stream	176.000	95.620	48.300	13.280	2.537	122.000	71.790	36.290	10.310	1.964
1000	WG-R1	W cereal	Pond	0.291	0.263	0.259	0.248	0.212	0.809	0.624	0.614	0.587	0.504
1000	WG-R1	W cereal	Stream	12.800	11.520	5.828	1.735	0.400	24.400	22.010	11.150	4.313	0.863
1000	BI-R3	W cereal	Stream	42.900	42.070	21.280	6.079	1.363	23.800	21.070	10.680	3.105	0.943
1000	RF-R4	W cereal	Stream	135.000	111.200	56.200	14.440	2.948	27.100	26.790	13.500	5.299	1.196
1000	WG-R1	Potatoes	Pond	1.100	0.543	0.534	0.513	0.431	0.421	0.354	0.350	0.341	0.299
1000	WG-R1	Potatoes	Stream	33.000	17.120	8.666	3.815	0.768	16.900	9.271	4.690	1.376	0.477
1000	PP-R2	Potatoes	Stream	32.300	21.180	10.780	2.967	1.034	6.870	5.158	2.608	0.872	0.179
1000	BI-R3	Potatoes	Stream	35.300	32.360	16.330	5.284	1.079	38.000	22.790	11.590	5.096	1.192
10000	WG-R1	W cereal	Pond	0.179	0.077	0.068	0.049	0.028	0.286	0.202	0.177	0.129	0.071
10000	WG-R1	W cereal	Stream	7.320	4.472	2.265	0.661	0.189	12.100	9.379	4.763	1.677	0.410
10000	BI-R3	W cereal	Stream	18.600	17.140	8.676	2.556	0.644	13.200	10.010	5.108	1.862	0.553
10000	RF-R4	W cereal	Stream	33.400	27.630	13.970	3.952	1.045	11.100	9.335	4.726	1.664	0.466
10000	WG-R1	Potatoes	Pond	0.350	0.173	0.152	0.115	0.060	0.177	0.146	0.128	0.100	0.056
10000	WG-R1	Potatoes	Stream	13.600	7.229	3.659	1.602	0.374	9.260	7.356	3.731	1.180	0.324
10000	PP-R2	Potatoes	Stream	23.600	16.080	8.178	2.293	0.883	5.960	3.246	1.661	0.677	0.181
10000	BI-R3	Potatoes	Stream	14.200	12.730	6.424	2.013	0.475	17.600	12.520	6.325	2.350	0.668

WG = Weiherbach, Germany; BI = Bologna, Italy; RF = Roujan, France; PP = Porto, Portugal. TWA = Time-weighted Average

8.0 CONCLUSIONS

The objective of this study was to compare the surface water results from simulations with Norwegian scenarios in WISPE with simulations from SWASH scenarios. Other comparisons were also part of this study such as PECs from EXAMS versus TOXSWA and the impact of Norway weather to PECs.

Overall, the WISPE PECs were within the range of the SWASH PECs. An analysis of EXAMS versus TOXSWA showed that the pond values matched better than the stream values. Only receiving mass without changing the flow or volume of the waterbody causes the higher PECs in EXAMS. SWASH scenarios with the Norway weather tended to produce lower PECs. However, it should be noted that the simulations with the Norway weather kept the SWASH application date that was determined by the Pesticide Application Timing (PAT) calculator within SWASH based on the EU scenario rainfall. PAT was not available to use with the Norway weather. Additionally, when determining sensitivity, it is better to isolate the impact of one change at a time (i.e., different weather).

Some other differences between EXAMS and TOXSWA besides variable flow should be noted:

- EXAMS is run for multiple years and comparing the 90th percentile PEC from a 20 - year run isn't always the same year as the SWASH simulation.
- TOXSWA handles leap years differently than PRZM. Therefore, the date of application in PRZM produces runoff/erosion mass if there is rainfall isn't the same day as drift in TOXSWA. For example, R3-ps-.inp has application on March 11, 1980. The TOXSWA file has drift on March 10, 1980.
- EXAMS uses daily air temperatures for water and sediment. TOXSWA uses monthly water and sediment temperatures. The aquatic aerobic and aerobic degradation changes with temperature. In colder climates, this would mean slower degradation in water/sediment.

9.0 REFERENCES

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APPENDICES SECTION

Appendix A - Example input files (PRZM and EXAMS) for KOC = 10 L/kg

Winter Cereals – CW003b.inp (PRZM file)

```
WISPE - Norway v 1.00.00  (Jul 31, 2013)
*** Title of input file
Short description of file
    1.00    0.20       0   10.00       1       1
       4
   0.350   0.150   1.000   0.020               3   13.00    5.00
       1
       1    0.16   95.00   90.00       1   0   0   0    0.00  100.00
       1       5
0101 0508 1508 0109 1509
.900 .900 .200 .500 1.00
.017 .017 .017 .017 .017
  90   84   76   90   90
      26
  15 965   5 866  15 866       1
  15 966   5 867  15 867       1
  15 967   5 868  15 868       1
  15 968   5 869  15 869       1
  15 969   5 870  15 870       1
  15 970   5 871  15 871       1
  15 971   5 872  15 872       1
  15 972   5 873  15 873       1
  15 973   5 874  15 874       1
  15 974   5 875  15 875       1
  15 975   5 876  15 876       1
  15 976   5 877  15 877       1
  15 977   5 878  15 878       1
  15 978   5 879  15 879       1
  15 979   5 880  15 880       1
  15 980   5 881  15 881       1
  15 981   5 882  15 882       1
  15 982   5 883  15 883       1
  15 983   5 884  15 884       1
  15 984   5 885  15 885       1
  15 985   5 886  15 886       1
  15 986   5 887  15 887       1
  15 987   5 888  15 888       1
  15 988   5 889  15 889       1
  15 989   5 890  15 890       1
  15 990   5 891  15 891       1
Chemical Input Data:
      26       1       0       0
Parent Chemical_Koc1
  14 965  0 1 4.00 .1000 1.00 .000
  14 966  0 1 4.00 .1000 1.00 .000
  14 967  0 1 4.00 .1000 1.00 .000
  14 968  0 1 4.00 .1000 1.00 .000
  14 969  0 1 4.00 .1000 1.00 .000
  14 970  0 1 4.00 .1000 1.00 .000
  14 971  0 1 4.00 .1000 1.00 .000
  14 972  0 1 4.00 .1000 1.00 .000
  14 973  0 1 4.00 .1000 1.00 .000
  14 974  0 1 4.00 .1000 1.00 .000
  14 975  0 1 4.00 .1000 1.00 .000
  14 976  0 1 4.00 .1000 1.00 .000
  14 977  0 1 4.00 .1000 1.00 .000
  14 978  0 1 4.00 .1000 1.00 .000
  14 979  0 1 4.00 .1000 1.00 .000
  14 980  0 1 4.00 .1000 1.00 .000
  14 981  0 1 4.00 .1000 1.00 .000
  14 982  0 1 4.00 .1000 1.00 .000
  14 983  0 1 4.00 .1000 1.00 .000
  14 984  0 1 4.00 .1000 1.00 .000
  14 985  0 1 4.00 .1000 1.00 .000
  14 986  0 1 4.00 .1000 1.00 .000
```

```
  14 987  0 1 4.00 .1000 1.00 .000
  14 988  0 1 4.00 .1000 1.00 .000
  14 989  0 1 4.00 .1000 1.00 .000
  14 990  0 1 4.00 .1000 1.00 .000
     0.       1    0.50
Brief description of soil properties
  500.00          0   0   2   0   0   0   2   1   0   0
 4300.00 .46E-12   22.70
  0.9000
 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.95 20.0
 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6
    2.58   20.00
       2    0.70    1.00
       5
       1  10.000   1.500   0.362   0.000   0.000   0.000
         0.00693 0.00693 0.00000
           0.100   0.362   0.164   1.200   0.120
           12.60   45.00   25.00    0.00    0.00
       2  10.000   1.600   0.382   0.000   0.000   0.000
         0.00693 0.00693 0.00000
           5.000   0.382   0.160   0.700   0.070
           12.60   45.00   25.00    0.00    0.00
       3  30.000   1.600   0.382   0.000   0.000   0.000
         0.00139 0.00139 0.00000
           5.000   0.382   0.160   0.400   0.040
           12.60   45.00   25.00    0.00    0.00
       4  50.000   1.600   0.382   0.000   0.000   0.000
         0.00139 0.00139 0.00000
           5.000   0.382   0.160   0.400   0.040
           12.60   45.00   25.00    0.00    0.00
       5 400.000   1.600   0.382   0.000   0.000   0.000
         0.00000 0.00000 0.00000
           5.000   0.382   0.160   0.400   0.040
           12.60   45.00   25.00    0.00    0.00
       0
    WATR    YEAR      10    PEST    YEAR      10    CONC    YEAR      10   1
      11    DAY
    PRCP    TSER   1   1   1.0
    TCON1   TAVE   1 101   1.0E3
    TCON1   TAVE 102 104   1.0E3
    TCON1   TAVE 105 107   1.0E3
    RFLX1   TSER 100 100   1.0E5
    EFLX1   TSER 100 100   1.0E5
    RUNF    TSER 100 100   1.0
    ESLS    TSER 100 100   1.0E3
    AFLX1   TSER 100 100   1.0E5
    DFLX1   TSER 100 100   1.0E5
    INFL    TSER 100 100   1.0
```

<u>Winter Cereals – CW004b.inp (PRZM file)</u>

```
WISPE - Norway v 1.00.00  (Jul 31, 2013)
*** Title of input file
Short description of file
    1.00    0.20       0   10.00       1       1
       4
   0.380   0.190   1.000   0.040               3   13.00   12.00
       1
       1    0.16   95.00   90.00       1   0   0   0    0.00  100.00
       1       5
0101 0508 1508 0109 1509
.900 .900 .200 .500 1.00
.017 .017 .017 .017 .017
  90   84   76   90   90
      26
  15 965   5 866  15 866       1
  15 966   5 867  15 867       1
  15 967   5 868  15 868       1
  15 968   5 869  15 869       1
  15 969   5 870  15 870       1
  15 970   5 871  15 871       1
  15 971   5 872  15 872       1
  15 972   5 873  15 873       1
  15 973   5 874  15 874       1
  15 974   5 875  15 875       1
  15 975   5 876  15 876       1
  15 976   5 877  15 877       1
  15 977   5 878  15 878       1
  15 978   5 879  15 879       1
  15 979   5 880  15 880       1
  15 980   5 881  15 881       1
  15 981   5 882  15 882       1
  15 982   5 883  15 883       1
  15 983   5 884  15 884       1
  15 984   5 885  15 885       1
  15 985   5 886  15 886       1
  15 986   5 887  15 887       1
  15 987   5 888  15 888       1
  15 988   5 889  15 889       1
  15 989   5 890  15 890       1
  15 990   5 891  15 891       1
Chemical Input Data:
      26       1       0       0
Parent Chemical_Koc1
  14 965  0 1 4.00 .1000 1.00 .000
  14 966  0 1 4.00 .1000 1.00 .000
  14 967  0 1 4.00 .1000 1.00 .000
  14 968  0 1 4.00 .1000 1.00 .000
  14 969  0 1 4.00 .1000 1.00 .000
  14 970  0 1 4.00 .1000 1.00 .000
  14 971  0 1 4.00 .1000 1.00 .000
  14 972  0 1 4.00 .1000 1.00 .000
  14 973  0 1 4.00 .1000 1.00 .000
  14 974  0 1 4.00 .1000 1.00 .000
  14 975  0 1 4.00 .1000 1.00 .000
  14 976  0 1 4.00 .1000 1.00 .000
  14 977  0 1 4.00 .1000 1.00 .000
  14 978  0 1 4.00 .1000 1.00 .000
  14 979  0 1 4.00 .1000 1.00 .000
  14 980  0 1 4.00 .1000 1.00 .000
  14 981  0 1 4.00 .1000 1.00 .000
  14 982  0 1 4.00 .1000 1.00 .000
  14 983  0 1 4.00 .1000 1.00 .000
  14 984  0 1 4.00 .1000 1.00 .000
  14 985  0 1 4.00 .1000 1.00 .000
  14 986  0 1 4.00 .1000 1.00 .000
  14 987  0 1 4.00 .1000 1.00 .000
  14 988  0 1 4.00 .1000 1.00 .000
  14 989  0 1 4.00 .1000 1.00 .000
```

```
  14 990  0 1 4.00 .1000 1.00 .000
      0.       1    0.50
Brief description of soil properties
  500.00           0   0   2   0   0   0   2   1   0   0
 4300.00 .46E-12   22.70
  0.9000
 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.95 20.0
 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6
    2.58   20.00
       2    0.70    1.00
       6
       1  10.000   1.400   0.407   0.000   0.000   0.000
         0.00693 0.00693 0.00000
           0.100   0.407   0.120   3.200   0.320
           12.60   45.00   25.00    0.00    0.00
       2  15.000   1.400   0.407   0.000   0.000   0.000
         0.00693 0.00693 0.00000
           5.000   0.407   0.120   3.200   0.320
           12.60   45.00   25.00    0.00    0.00
       3  25.000   1.690   0.330   0.000   0.000   0.000
         0.00139 0.00139 0.00000
           5.000   0.330   0.160   0.400   0.040
           12.60   45.00   25.00    0.00    0.00
       4  20.000   1.690   0.311   0.000   0.000   0.000
         0.00139 0.00139 0.00000
           5.000   0.311   0.180   0.630   0.063
           12.60   45.00   25.00    0.00    0.00
       5  30.000   1.690   0.311   0.000   0.000   0.000
         0.00139 0.00139 0.00000
           5.000   0.311   0.180   0.630   0.063
           12.60   45.00   25.00    0.00    0.00
       6 400.000   1.690   0.311   0.000   0.000   0.000
         0.00000 0.00000 0.00000
           5.000   0.311   0.180   0.630   0.063
           12.60   45.00   25.00    0.00    0.00
       0
    WATR    YEAR       10    PEST    YEAR       10    CONC    YEAR       10   1
      11    DAY
    PRCP    TSER   1   1   1.0
    TCON1   TAVE   1 101   1.0E3
    TCON1   TAVE 102 104   1.0E3
    TCON1   TAVE 105 107   1.0E3
    RFLX1   TSER 100 100   1.0E5
    EFLX1   TSER 100 100   1.0E5
    RUNF    TSER 100 100   1.0
    ESLS    TSER 100 100   1.0E3
    AFLX1   TSER 100 100   1.0E5
    DFLX1   TSER 100 100   1.0E5
    INFL    TSER 100 100   1.0
```

Winter Cereals – WC004b.inp (PRZM file)

```
WISPE - Norway v 1.00.00  (Jul 31, 2013)
*** Title of input file
Short description of file
    1.00    0.20       0   10.00       1       1
       4
   0.240   0.010   0.600   3.000               2    0.10  100.00  -- Changed to .024 and 24.5
       1
       1    0.16   95.00   90.00       1   0   0   0    0.00  100.00
       1       5
0101 0508 1508 0109 1509
.900 .900 .200 .500 1.00
.017 .017 .017 .017 .017
  90   84   76   90   90
      26
  15 965   5 866  15 866       1
  15 966   5 867  15 867       1
  15 967   5 868  15 868       1
  15 968   5 869  15 869       1
  15 969   5 870  15 870       1
  15 970   5 871  15 871       1
  15 971   5 872  15 872       1
  15 972   5 873  15 873       1
  15 973   5 874  15 874       1
  15 974   5 875  15 875       1
  15 975   5 876  15 876       1
  15 976   5 877  15 877       1
  15 977   5 878  15 878       1
  15 978   5 879  15 879       1
  15 979   5 880  15 880       1
  15 980   5 881  15 881       1
  15 981   5 882  15 882       1
  15 982   5 883  15 883       1
  15 983   5 884  15 884       1
  15 984   5 885  15 885       1
  15 985   5 886  15 886       1
  15 986   5 887  15 887       1
  15 987   5 888  15 888       1
  15 988   5 889  15 889       1
  15 989   5 890  15 890       1
  15 990   5 891  15 891       1
Chemical Input Data:
      26       1       0       0
Parent Chemical_Koc1
  14 965  0 1 4.00 .1000 1.00 .000
  14 966  0 1 4.00 .1000 1.00 .000
  14 967  0 1 4.00 .1000 1.00 .000
  14 968  0 1 4.00 .1000 1.00 .000
  14 969  0 1 4.00 .1000 1.00 .000
  14 970  0 1 4.00 .1000 1.00 .000
  14 971  0 1 4.00 .1000 1.00 .000
  14 972  0 1 4.00 .1000 1.00 .000
  14 973  0 1 4.00 .1000 1.00 .000
  14 974  0 1 4.00 .1000 1.00 .000
  14 975  0 1 4.00 .1000 1.00 .000
  14 976  0 1 4.00 .1000 1.00 .000
  14 977  0 1 4.00 .1000 1.00 .000
  14 978  0 1 4.00 .1000 1.00 .000
  14 979  0 1 4.00 .1000 1.00 .000
  14 980  0 1 4.00 .1000 1.00 .000
  14 981  0 1 4.00 .1000 1.00 .000
  14 982  0 1 4.00 .1000 1.00 .000
  14 983  0 1 4.00 .1000 1.00 .000
  14 984  0 1 4.00 .1000 1.00 .000
  14 985  0 1 4.00 .1000 1.00 .000
  14 986  0 1 4.00 .1000 1.00 .000
  14 987  0 1 4.00 .1000 1.00 .000
  14 988  0 1 4.00 .1000 1.00 .000
  14 989  0 1 4.00 .1000 1.00 .000
```

```
  14 990  0 1 4.00 .1000 1.00 .000
      0.       1    0.50
Brief description of soil properties
  500.00           0   0   2   0   0   0   2   1   0   0
 4300.00 .46E-12   22.70
  0.9000
 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.95 20.0
 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6
    2.58   20.00
       2    0.70    1.00
       6
       1  10.000   1.400   0.417   0.000   0.000   0.000
         0.00693 0.00693 0.00000
           0.100   0.417   0.149   2.200   0.220
           12.60   45.00   25.00    0.00    0.00
       2  20.000   1.400   0.417   0.000   0.000   0.000
         0.00693 0.00693 0.00000
           5.000   0.417   0.149   2.200   0.220
           12.60   45.00   25.00    0.00    0.00
       3  10.000   1.690   0.361   0.000   0.000   0.000
         0.00139 0.00139 0.00000
           5.000   0.361   0.069   0.300   0.030
           12.60   45.00   25.00    0.00    0.00
       4  20.000   1.680   0.365   0.000   0.000   0.000
         0.00139 0.00139 0.00000
           5.000   0.365   0.093   0.100   0.010
           12.60   45.00   25.00    0.00    0.00
       5  40.000   1.730   0.346   0.000   0.000   0.000
         0.00139 0.00139 0.00000
           5.000   0.346   0.068   0.100   0.010
           12.60   45.00   25.00    0.00    0.00
       6 400.000   1.730   0.346   0.000   0.000   0.000
         0.00000 0.00000 0.00000
           5.000   0.346   0.068   0.100   0.010
           12.60   45.00   25.00    0.00    0.00
       0
    WATR    YEAR      10    PEST    YEAR      10    CONC    YEAR      10   1
      11    DAY
    PRCP    TSER   1   1   1.0
    TCON1   TAVE   1 101   1.0E3
    TCON1   TAVE 102 104   1.0E3
    TCON1   TAVE 105 107   1.0E3
    RFLX1   TSER 100 100   1.0E5
    EFLX1   TSER 100 100   1.0E5
    RUNF    TSER 100 100   1.0
    ESLS    TSER 100 100   1.0E3
    AFLX1   TSER 100 100   1.0E5
    DFLX1   TSER 100 100   1.0E5
    INFL    TSER 100 100   1.0
```

Potatoes – PS003b.inp (PRZM file)

```
WISPE - Norway v 1.00.00  (Jul 31, 2013)
*** Title of input file
Short description of file
    1.00    0.20       0   10.00       1       1
       4
   0.350   0.150   1.000   0.020               3   13.00    5.00
       1
       1    0.15   60.00   80.00       1   0   0   0    0.00   50.00
       1       5
0101 1006 1009 2009 1910
.900 .900 .200 .500 1.00
.017 .017 .017 .017 .017
  91   91   89   89   91
      26
  10 665  10 965  20 965       1
  10 666  10 966  20 966       1
  10 667  10 967  20 967       1
  10 668  10 968  20 968       1
  10 669  10 969  20 969       1
  10 670  10 970  20 970       1
  10 671  10 971  20 971       1
  10 672  10 972  20 972       1
  10 673  10 973  20 973       1
  10 674  10 974  20 974       1
  10 675  10 975  20 975       1
  10 676  10 976  20 976       1
  10 677  10 977  20 977       1
  10 678  10 978  20 978       1
  10 679  10 979  20 979       1
  10 680  10 980  20 980       1
  10 681  10 981  20 981       1
  10 682  10 982  20 982       1
  10 683  10 983  20 983       1
  10 684  10 984  20 984       1
  10 685  10 985  20 985       1
  10 686  10 986  20 986       1
  10 687  10 987  20 987       1
  10 688  10 988  20 988       1
  10 689  10 989  20 989       1
  10 690  10 990  20 990       1
Chemical Input Data:
      26       1       0       0
Parent Chemical_Koc1
   9 665  0 1 4.00 .1000 1.00 .000
   9 666  0 1 4.00 .1000 1.00 .000
   9 667  0 1 4.00 .1000 1.00 .000
   9 668  0 1 4.00 .1000 1.00 .000
   9 669  0 1 4.00 .1000 1.00 .000
   9 670  0 1 4.00 .1000 1.00 .000
   9 671  0 1 4.00 .1000 1.00 .000
   9 672  0 1 4.00 .1000 1.00 .000
   9 673  0 1 4.00 .1000 1.00 .000
   9 674  0 1 4.00 .1000 1.00 .000
   9 675  0 1 4.00 .1000 1.00 .000
   9 676  0 1 4.00 .1000 1.00 .000
   9 677  0 1 4.00 .1000 1.00 .000
   9 678  0 1 4.00 .1000 1.00 .000
   9 679  0 1 4.00 .1000 1.00 .000
   9 680  0 1 4.00 .1000 1.00 .000
   9 681  0 1 4.00 .1000 1.00 .000
   9 682  0 1 4.00 .1000 1.00 .000
   9 683  0 1 4.00 .1000 1.00 .000
   9 684  0 1 4.00 .1000 1.00 .000
   9 685  0 1 4.00 .1000 1.00 .000
   9 686  0 1 4.00 .1000 1.00 .000
   9 687  0 1 4.00 .1000 1.00 .000
   9 688  0 1 4.00 .1000 1.00 .000
   9 689  0 1 4.00 .1000 1.00 .000
```

```
   9 690  0 1 4.00 .1000 1.00 .000
      0.       1    0.50
Brief description of soil properties
  500.00          0   0   2   0   0   0   2   1   0   0
 4300.00 .46E-12   22.70
  0.9000
 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.95 20.0
 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6
    2.58   20.00
       2    0.70    1.00
       5
       1  10.000   1.500   0.362   0.000   0.000   0.000
         0.00693 0.00693 0.00000
           0.100   0.362   0.164   1.200   0.120
           12.60   45.00   25.00    0.00    0.00
       2  10.000   1.600   0.382   0.000   0.000   0.000
         0.00693 0.00693 0.00000
           5.000   0.382   0.160   0.700   0.070
           12.60   45.00   25.00    0.00    0.00
       3  30.000   1.600   0.382   0.000   0.000   0.000
         0.00139 0.00139 0.00000
           5.000   0.382   0.160   0.400   0.040
           12.60   45.00   25.00    0.00    0.00
       4  50.000   1.600   0.382   0.000   0.000   0.000
         0.00139 0.00139 0.00000
           5.000   0.382   0.160   0.400   0.040
           12.60   45.00   25.00    0.00    0.00
       5 400.000   1.600   0.382   0.000   0.000   0.000
         0.00000 0.00000 0.00000
           5.000   0.382   0.160   0.400   0.040
           12.60   45.00   25.00    0.00    0.00
       0
    WATR    YEAR      10    PEST    YEAR      10    CONC    YEAR      10   1
      11    DAY
    PRCP    TSER   1   1   1.0
    TCON1   TAVE   1 101   1.0E3
    TCON1   TAVE 102 104   1.0E3
    TCON1   TAVE 105 107   1.0E3
    RFLX1   TSER 100 100   1.0E5
    EFLX1   TSER 100 100   1.0E5
    RUNF    TSER 100 100   1.0
    ESLS    TSER 100 100   1.0E3
    AFLX1   TSER 100 100   1.0E5
    DFLX1   TSER 100 100   1.0E5
    INFL    TSER 100 100   1.0
```

Potatoes – PS004b.inp (PRZM file)

```
WISPE - Norway v 1.00.00  (Jul 31, 2013)
*** Title of input file
Short description of file
    1.00    0.20       0   10.00       1       1
       4
   0.380   0.190   1.000   0.040               3   13.00   12.00
       1
       1    0.15   60.00   80.00       1   0   0   0    0.00   50.00
       1       5
0101 1006 1009 2009 1910
.900 .900 .200 .500 1.00
.017 .017 .017 .017 .017
  91   91   89   89   91
      26
  10 665  10 965  20 965       1
  10 666  10 966  20 966       1
  10 667  10 967  20 967       1
  10 668  10 968  20 968       1
  10 669  10 969  20 969       1
  10 670  10 970  20 970       1
  10 671  10 971  20 971       1
  10 672  10 972  20 972       1
  10 673  10 973  20 973       1
  10 674  10 974  20 974       1
  10 675  10 975  20 975       1
  10 676  10 976  20 976       1
  10 677  10 977  20 977       1
  10 678  10 978  20 978       1
  10 679  10 979  20 979       1
  10 680  10 980  20 980       1
  10 681  10 981  20 981       1
  10 682  10 982  20 982       1
  10 683  10 983  20 983       1
  10 684  10 984  20 984       1
  10 685  10 985  20 985       1
  10 686  10 986  20 986       1
  10 687  10 987  20 987       1
  10 688  10 988  20 988       1
  10 689  10 989  20 989       1
  10 690  10 990  20 990       1
Chemical Input Data:
      26       1       0       0
Parent Chemical_Koc1
   9 665  0 1 4.00 .1000 1.00 .000
   9 666  0 1 4.00 .1000 1.00 .000
   9 667  0 1 4.00 .1000 1.00 .000
   9 668  0 1 4.00 .1000 1.00 .000
   9 669  0 1 4.00 .1000 1.00 .000
   9 670  0 1 4.00 .1000 1.00 .000
   9 671  0 1 4.00 .1000 1.00 .000
   9 672  0 1 4.00 .1000 1.00 .000
   9 673  0 1 4.00 .1000 1.00 .000
   9 674  0 1 4.00 .1000 1.00 .000
   9 675  0 1 4.00 .1000 1.00 .000
   9 676  0 1 4.00 .1000 1.00 .000
   9 677  0 1 4.00 .1000 1.00 .000
   9 678  0 1 4.00 .1000 1.00 .000
   9 679  0 1 4.00 .1000 1.00 .000
   9 680  0 1 4.00 .1000 1.00 .000
   9 681  0 1 4.00 .1000 1.00 .000
   9 682  0 1 4.00 .1000 1.00 .000
   9 683  0 1 4.00 .1000 1.00 .000
   9 684  0 1 4.00 .1000 1.00 .000
   9 685  0 1 4.00 .1000 1.00 .000
   9 686  0 1 4.00 .1000 1.00 .000
   9 687  0 1 4.00 .1000 1.00 .000
   9 688  0 1 4.00 .1000 1.00 .000
   9 689  0 1 4.00 .1000 1.00 .000
```

```
   9 690  0 1 4.00 .1000 1.00 .000
      0.       1    0.50
Brief description of soil properties
  500.00           0   0   2   0   0   0   2   1   0   0
 4300.00 .46E-12   22.70
  0.9000
 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.20 0.95 20.0
 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6 12.6
    2.58   20.00
       2    0.70    1.00
       6
       1  10.000   1.400   0.407   0.000   0.000   0.000
         0.00693 0.00693 0.00000
           0.100   0.407   0.120   3.200   0.320
           12.60   45.00   25.00    0.00    0.00
       2  15.000   1.400   0.407   0.000   0.000   0.000
         0.00693 0.00693 0.00000
           5.000   0.407   0.120   3.200   0.320
           12.60   45.00   25.00    0.00    0.00
       3  25.000   1.690   0.330   0.000   0.000   0.000
         0.00139 0.00139 0.00000
           5.000   0.330   0.160   0.400   0.040
           12.60   45.00   25.00    0.00    0.00
       4  20.000   1.690   0.311   0.000   0.000   0.000
         0.00139 0.00139 0.00000
           5.000   0.311   0.180   0.630   0.063
           12.60   45.00   25.00    0.00    0.00
       5  30.000   1.690   0.311   0.000   0.000   0.000
         0.00139 0.00139 0.00000
           5.000   0.311   0.180   0.630   0.063
           12.60   45.00   25.00    0.00    0.00
       6 400.000   1.690   0.311   0.000   0.000   0.000
         0.00000 0.00000 0.00000
           5.000   0.311   0.180   0.630   0.063
           12.60   45.00   25.00    0.00    0.00
       0
    WATR    YEAR      10    PEST    YEAR      10    CONC    YEAR      10   1
      11    DAY
    PRCP    TSER   1   1   1.0
    TCON1   TAVE   1 101   1.0E3
    TCON1   TAVE 102 104   1.0E3
    TCON1   TAVE 105 107   1.0E3
    RFLX1   TSER 100 100   1.0E5
    EFLX1   TSER 100 100   1.0E5
    RUNF    TSER 100 100   1.0
    ESLS    TSER 100 100   1.0E3
    AFLX1   TSER 100 100   1.0E5
    DFLX1   TSER 100 100   1.0E5
    INFL    TSER 100 100   1.0
```

Winter Cereals – CW003b.exa (EXAMS file)

```
SET OUTFIL(1) = YES
SET OUTFIL(6) = YES
SET OUTFIL(7) = YES
!
CHEM NAME IS Parent Chemical_Koc1
SET MWT(1)=    250.00
SET SOL(1,1)= 30.00
SET MP(1)=-99.00
SET KOC(1)=     10.00
SET VAPR(1)= 0.000
SET KBACS(*,1,1)=0.2888E-03
SET QTBTS(*,1,1)= 25.00
SET QTBAS(*,1,1)= 2.000
SET KBACW(*,1,1)=0.2888E-03
SET QTBTW(*,1,1)= 25.00
SET QTBAW(*,1,1)= 2.000
SET KDP(1,1)= 0.000
SET KBH(1,1,1)= 0.000
SET KNH(1,1,1)= 0.000
SET KAH(1,1,1)= 0.000
!
!
!
READ ENV eupond.exv
READ METEOROLOGY BJORNBK1.MET
SET YEAR1 = 1965
ECHO OFF
!
READ PRZM C1CW003b.D65
SET CLOUD(*)=0.0
SET EVAP(*,*)=0.0
SET RAIN(*)=0.0
SET NPSFL(*,*)=0.0
SET NPSED(*,*)=0.0
RUN
!
READ PRZM C1CW003b.D66
SET CLOUD(*)=0.0
SET EVAP(*,*)=0.0
SET RAIN(*)=0.0
SET NPSFL(*,*)=0.0
SET NPSED(*,*)=0.0
CONTINUE
!
**** lines removed for years 1967 to 1989 for brevity
!
READ PRZM C1CW003b.D90
SET CLOUD(*)=0.0
SET EVAP(*,*)=0.0
SET RAIN(*)=0.0
SET NPSFL(*,*)=0.0
SET NPSED(*,*)=0.0
CONTINUE
!
QUIT
```

Winter Cereals – CW003c.exa (EXAMS file)

```
SET OUTFIL(1) = YES
SET OUTFIL(6) = YES
SET OUTFIL(7) = YES
!
CHEM NAME IS Parent Chemical_Koc1
SET MWT(1)=    250.00
SET SOL(1,1)= 30.00
SET MP(1)=-99.00
SET KOC(1)=     10.00
SET VAPR(1)= 0.000
SET KBACS(*,1,1)=0.2888E-03
SET QTBTS(*,1,1)= 25.00
SET QTBAS(*,1,1)= 2.000
SET KBACW(*,1,1)=0.2888E-03
SET QTBTW(*,1,1)= 25.00
SET QTBAW(*,1,1)= 2.000
SET KDP(1,1)= 0.000
SET KBH(1,1,1)= 0.000
SET KNH(1,1,1)= 0.000
SET KAH(1,1,1)= 0.000
!
!
!
READ ENV eustream.exv
READ METEOROLOGY BJORNBK1.MET
SET YEAR1 = 1965
ECHO OFF
!
READ PRZM C1CW003b.D65
SET CLOUD(*)=0.0
SET EVAP(*,*)=0.0
SET RAIN(*)=0.0
SET NPSFL(*,*)=0.0
SET NPSED(*,*)=0.0
SET STFLO(1,*)=5.60
RUN
!
READ PRZM C1CW003b.D66
SET CLOUD(*)=0.0
SET EVAP(*,*)=0.0
SET RAIN(*)=0.0
SET NPSFL(*,*)=0.0
SET NPSED(*,*)=0.0
SET STFLO(1,*)=5.60
CONTINUE
!
**** lines removed for years 1967 to 1989 for brevity
!
READ PRZM C1CW003b.D90
SET CLOUD(*)=0.0
SET EVAP(*,*)=0.0
SET RAIN(*)=0.0
SET NPSFL(*,*)=0.0
SET NPSED(*,*)=0.0
SET STFLO(1,*)=5.60
CONTINUE
!
QUIT
```

Appendix B - Example input files (PRZM and TOXSWA) for Koc = 10 L/kg

Winter Cereals – R1-CW-.inp (PRZM file)

```
FOCUS_PRZM_SW_4.3.1, 27 Apr. 2015                       PRZM 4.63 Apr. 2015
                    Simulation Location: R1Crop: Cereals, Winter
    0.84    0.20       0   15.00       1       1
       4
    0.42    0.33    0.50    0.45               3    3.00   20.00
       1
       1    0.15   99.00   90.00       3   0   0   0    0.00  100.00
       1       4
1211 1006 3107 0111
0.20 0.20 0.40 0.90
0.10 0.10 0.10 0.10
  81   81   86   91
      20
  121175  100676  310776       1
  121176  100677  310777       1
  121177  100678  310778       1
  121178  100679  310779       1
  121179  100680  310780       1
  121180  100681  310781       1
  121181  100682  310782       1
  121182  100683  310783       1
  121183  100684  310784       1
  121184  100685  310785       1
  121185  100686  310786       1
  121186  100687  310787       1
  121187  100688  310788       1
  121188  100689  310789       1
  121189  100690  310790       1
  121190  100691  310791       1
  121191  100692  310792       1
  121192  100693  310793       1
  121193  100694  310794       1
  121194  100695  310795       1
Chemical Input Data:
      20       1       0       0
NIBIO_10
  261075  0 1 4.000.1000 1.00 0.00
  231076  0 1 4.000.1000 1.00 0.00
  141077  0 1 4.000.1000 1.00 0.00
  121078  0 1 4.000.1000 1.00 0.00
  241079  0 1 4.000.1000 1.00 0.00
  201080  0 1 4.000.1000 1.00 0.00
  251081  0 1 4.000.1000 1.00 0.00
  171082  0 1 4.000.1000 1.00 0.00
  121083  0 1 4.000.1000 1.00 0.00
  151084  0 1 4.000.1000 1.00 0.00
  251085  0 1 4.000.1000 1.00 0.00
  121086  0 1 4.000.1000 1.00 0.00
   31187  0 1 4.000.1000 1.00 0.00
  151088  0 1 4.000.1000 1.00 0.00
  181089  0 1 4.000.1000 1.00 0.00
  171090  0 1 4.000.1000 1.00 0.00
  251091  0 1 4.000.1000 1.00 0.00
  181092  0 1 4.000.1000 1.00 0.00
  301093  0 1 4.000.1000 1.00 0.00
  191094  0 1 4.000.1000 1.00 0.00
      0.       1    0.50
Soil Series:         R1          36
  100.00           0   0   2   0   0   0   2   1   0
 4300.00 .45E-12   22.70
  0.9000
 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.96 10.0
 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0
    2.58   20.00
       2    0.70    1.00
```

```
    4
    1  10.000   1.350   0.338   0.000   0.000   0.000
      0.00693 0.00693 0.00000
        0.100   0.338   0.141   1.200   0.120
        10.00    5.00   13.00    0.00    0.00
    2  20.000   1.350   0.338   0.000   0.000   0.000
      0.00693 0.00693 0.00000
        5.000   0.338   0.141   1.200   0.120
        10.00    5.00   13.00    0.00    0.00
    3  30.000   1.450   0.286   0.000   0.000   0.000
      0.00693 0.00693 0.00000
        5.000   0.286   0.111   0.300   0.030
        10.00    6.00   11.00    0.00    0.00
    4  40.000   1.480   0.277   0.000   0.000   0.000
      0.00693 0.00693 0.00000
        5.000   0.277   0.108   0.100   0.010
        10.00    5.00   11.00    0.00    0.00
    0
WATR    YEAR      10    PEST    YEAR      10    CONC    YEAR      10   0
   7    DAY
RUNF    TSER   0   0  10.0
ESLS    TSER   0   0  1.E3
PRCP    TSER   0   0  10.0
INFL    TSER 118 118  10.0
RFLX1   TSER   0   0  1.E7
EFLX1   TSER   0   0  1.E7
TPAP    TSER   0   0  1.0
```

Winter Cereals – R3-CW-.inp (PRZM file)

```
FOCUS_PRZM_SW_4.3.1, 27 Apr. 2015                       PRZM 4.63 Apr. 2015
                    Simulation Location: R3Crop: Cereals, Winter
    0.84    0.20       0   25.00       1       1
       4
    0.25    0.66    0.50    0.45               3    5.00   20.00
       1
       1    0.15  120.00   90.00       3   0   0   0    0.00  100.00
       1       4
0112 1005 0107 0111
0.20 0.20 0.40 0.90
0.10 0.10 0.10 0.10
  81   81   86   91
      20
  011275  100576  010776       1
  011276  100577  010777       1
  011277  100578  010778       1
  011278  100579  010779       1
  011279  100580  010780       1
  011280  100581  010781       1
  011281  100582  010782       1
  011282  100583  010783       1
  011283  100584  010784       1
  011284  100585  010785       1
  011285  100586  010786       1
  011286  100587  010787       1
  011287  100588  010788       1
  011288  100589  010789       1
  011289  100590  010790       1
  011290  100591  010791       1
  011291  100592  010792       1
  011292  100593  010793       1
  011293  100594  010794       1
  011294  100595  010795       1
Chemical Input Data:
      20       1       0       0
NIBIO_10
  201175  0 1 4.000.1000 1.00 0.00
  161176  0 1 4.000.1000 1.00 0.00
   31177  0 1 4.000.1000 1.00 0.00
  151178  0 1 4.000.1000 1.00 0.00
   11179  0 1 4.000.1000 1.00 0.00
  161180  0 1 4.000.1000 1.00 0.00
  211181  0 1 4.000.1000 1.00 0.00
  311082  0 1 4.000.1000 1.00 0.00
  261183  0 1 4.000.1000 1.00 0.00
   91184  0 1 4.000.1000 1.00 0.00
   61185  0 1 4.000.1000 1.00 0.00
  101186  0 1 4.000.1000 1.00 0.00
  311087  0 1 4.000.1000 1.00 0.00
  121188  0 1 4.000.1000 1.00 0.00
  151189  0 1 4.000.1000 1.00 0.00
  191190  0 1 4.000.1000 1.00 0.00
   41191  0 1 4.000.1000 1.00 0.00
   51192  0 1 4.000.1000 1.00 0.00
  241193  0 1 4.000.1000 1.00 0.00
  311094  0 1 4.000.1000 1.00 0.00
      0.       1    0.50
Soil Series:         R3           38
  160.00           0   0   2   0   0   0   2   1   0
 4300.00 .45E-12   22.70
  0.9000
 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.96 10.0
 13.5 13.5 13.5 13.5 13.5 13.5 13.5 13.5 13.5 13.5 13.5 13.5
    2.58   20.00
       2    0.70    1.00
       5
       1  10.000   1.460   0.370   0.000   0.000   0.000
         0.00693 0.00693 0.00000
```

```
       0.100   0.370   0.220   1.000   0.100
       13.50   23.00   34.00    0.00    0.00
   2  35.000   1.460   0.370   0.000   0.000   0.000
     0.00693 0.00693 0.00000
       5.000   0.370   0.220   1.000   0.100
       13.50   23.00   34.00    0.00    0.00
   3  30.000   1.490   0.350   0.000   0.000   0.000
     0.00693 0.00693 0.00000
       5.000   0.350   0.210   1.000   0.100
       13.50   25.00   33.00    0.00    0.00
   4  70.000   1.520   0.360   0.000   0.000   0.000
     0.00693 0.00693 0.00000
       5.000   0.360   0.210   0.350   0.035
       13.50   17.00   35.00    0.00    0.00
   5  15.000   1.540   0.360   0.000   0.000   0.000
     0.00693 0.00693 0.00000
       5.000   0.360   0.220   0.290   0.029
       13.50   14.00   36.00    0.00    0.00
   0
WATR    YEAR      10    PEST    YEAR      10    CONC    YEAR      10   0
   7    DAY
RUNF    TSER   0   0  10.0
ESLS    TSER   0   0  1.E3
PRCP    TSER   0   0  10.0
INFL    TSER 118 118  10.0
RFLX1   TSER   0   0  1.E7
EFLX1   TSER   0   0  1.E7
TPAP    TSER   0   0  1.0
```

Winter Cereals – R4-CW-.inp (PRZM file)

```
FOCUS_PRZM_SW_4.3.1, 27 Apr. 2015                       PRZM 4.63 Apr. 2015
                    Simulation Location: R4Crop: Cereals, Winter
    0.84    0.20       0   25.00       1       1
       4
    0.26    0.66    0.50    0.45               2    5.00   20.00
       1
       1    0.15  120.00   90.00       3   0   0   0    0.00  100.00
       1       4
1011 1505 1507 0111
0.20 0.20 0.40 0.90
0.10 0.10 0.10 0.10
  81   81   86   91
      20
  101175  150576  150776       1
  101176  150577  150777       1
  101177  150578  150778       1
  101178  150579  150779       1
  101179  150580  150780       1
  101180  150581  150781       1
  101181  150582  150782       1
  101182  150583  150783       1
  101183  150584  150784       1
  101184  150585  150785       1
  101185  150586  150786       1
  101186  150587  150787       1
  101187  150588  150788       1
  101188  150589  150789       1
  101189  150590  150790       1
  101190  150591  150791       1
  101191  150592  150792       1
  101192  150593  150793       1
  101193  150594  150794       1
  101194  150595  150795       1
Chemical Input Data:
      20       1       0       0
NIBIO_10
  101075  0 1 4.000.1000 1.00 0.00
  151076  0 1 4.000.1000 1.00 0.00
  101077  0 1 4.000.1000 1.00 0.00
  101078  0 1 4.000.1000 1.00 0.00
  181079  0 1 4.000.1000 1.00 0.00
  131080  0 1 4.000.1000 1.00 0.00
   61181  0 1 4.000.1000 1.00 0.00
  271082  0 1 4.000.1000 1.00 0.00
  101083  0 1 4.000.1000 1.00 0.00
  151084  0 1 4.000.1000 1.00 0.00
  151085  0 1 4.000.1000 1.00 0.00
   21186  0 1 4.000.1000 1.00 0.00
  311087  0 1 4.000.1000 1.00 0.00
  301088  0 1 4.000.1000 1.00 0.00
  101089  0 1 4.000.1000 1.00 0.00
  141090  0 1 4.000.1000 1.00 0.00
  161091  0 1 4.000.1000 1.00 0.00
  161092  0 1 4.000.1000 1.00 0.00
  221093  0 1 4.000.1000 1.00 0.00
  121094  0 1 4.000.1000 1.00 0.00
      0.       1    0.50
Soil Series:         R4          40
  300.00           0   0   2   0   0   0   2   1   0
 4300.00 .45E-12   22.70
  0.9000
 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.96 10.0
 14.0 14.0 14.0 14.0 14.0 14.0 14.0 14.0 14.0 14.0 14.0 14.0
    2.58   20.00
       2    0.70    1.00
       5
       1  10.000   1.520   0.260   0.000   0.000   0.000
         0.00693 0.00693 0.00000
```

```
       0.100   0.260   0.160   0.600   0.060
       14.00   53.00   25.00    0.00    0.00
   2  20.000   1.520   0.260   0.000   0.000   0.000
     0.00693 0.00693 0.00000
       5.000   0.260   0.160   0.600   0.060
       14.00   53.00   25.00    0.00    0.00
   3  30.000   1.500   0.270   0.000   0.000   0.000
     0.00693 0.00693 0.00000
       5.000   0.270   0.160   0.600   0.060
       14.00   53.00   25.00    0.00    0.00
   4 110.000   1.490   0.145   0.000   0.000   0.000
     0.00693 0.00693 0.00000
       5.000   0.145   0.060   0.080   0.008
       14.00   69.00    7.00    0.00    0.00
   5 130.000   1.500   0.160   0.000   0.000   0.000
     0.00693 0.00693 0.00000
       5.000   0.160   0.070   0.080   0.008
       14.00   65.00    8.00    0.00    0.00
   0
WATR    YEAR      10    PEST    YEAR      10    CONC    YEAR      10   0
   7    DAY
RUNF    TSER   0   0  10.0
ESLS    TSER   0   0  1.E3
PRCP    TSER   0   0  10.0
INFL    TSER 118 118  10.0
RFLX1   TSER   0   0  1.E7
EFLX1   TSER   0   0  1.E7
TPAP    TSER   0   0  1.0
```

Potatoes – R1-PS-.inp (PRZM file)

```
FOCUS_PRZM_SW_4.3.1, 27 Apr. 2015                       PRZM 4.63 Apr. 2015
                    Simulation Location: R1Crop: Potatoes
    0.94    0.20       0   15.00       1       1
       4
    0.42    0.33    0.50    0.45               3    3.00   20.00
       1
       1    0.15   70.00   80.00       3   0   0   0    0.00  100.00
       1       4
0505 2506 0809 0111
0.20 0.20 0.40 0.90
0.10 0.10 0.10 0.10
  82   82   87   91
      20
  050575  250675  080975       1
  050576  250676  080976       1
  050577  250677  080977       1
  050578  250678  080978       1
  050579  250679  080979       1
  050580  250680  080980       1
  050581  250681  080981       1
  050582  250682  080982       1
  050583  250683  080983       1
  050584  250684  080984       1
  050585  250685  080985       1
  050586  250686  080986       1
  050587  250687  080987       1
  050588  250688  080988       1
  050589  250689  080989       1
  050590  250690  080990       1
  050591  250691  080991       1
  050592  250692  080992       1
  050593  250693  080993       1
  050594  250694  080994       1
Chemical Input Data:
      20       1       0       0
NIBIO_10
  10 475  0 1 4.000.1000 1.00 0.00
  14 476  0 1 4.000.1000 1.00 0.00
   4 477  0 1 4.000.1000 1.00 0.00
  14 478  0 1 4.000.1000 1.00 0.00
   5 479  0 1 4.000.1000 1.00 0.00
  14 480  0 1 4.000.1000 1.00 0.00
  15 481  0 1 4.000.1000 1.00 0.00
  18 482  0 1 4.000.1000 1.00 0.00
  21 483  0 1 4.000.1000 1.00 0.00
  27 484  0 1 4.000.1000 1.00 0.00
  18 485  0 1 4.000.1000 1.00 0.00
   5 486  0 1 4.000.1000 1.00 0.00
   5 487  0 1 4.000.1000 1.00 0.00
   5 488  0 1 4.000.1000 1.00 0.00
  29 489  0 1 4.000.1000 1.00 0.00
   4 490  0 1 4.000.1000 1.00 0.00
  19 491  0 1 4.000.1000 1.00 0.00
   5 492  0 1 4.000.1000 1.00 0.00
   6 493  0 1 4.000.1000 1.00 0.00
   3 594  0 1 4.000.1000 1.00 0.00
      0.       1    0.50
Soil Series:         R1          42
  100.00           0   0   2   0   0   0   2   1   0
 4300.00 .45E-12   22.70
  0.9000
 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.96 10.0
 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0 10.0
    2.58   20.00
       2    0.70    1.00
       4
       1  10.000   1.350   0.338   0.000   0.000   0.000
         0.00693 0.00693 0.00000
```

```
       0.100   0.338   0.141   1.200   0.120
       10.00    5.00   13.00    0.00    0.00
   2  20.000   1.350   0.338   0.000   0.000   0.000
     0.00693 0.00693 0.00000
       5.000   0.338   0.141   1.200   0.120
       10.00    5.00   13.00    0.00    0.00
   3  30.000   1.450   0.286   0.000   0.000   0.000
     0.00693 0.00693 0.00000
       5.000   0.286   0.111   0.300   0.030
       10.00    6.00   11.00    0.00    0.00
   4  40.000   1.480   0.277   0.000   0.000   0.000
     0.00693 0.00693 0.00000
       5.000   0.277   0.108   0.100   0.010
       10.00    5.00   11.00    0.00    0.00
   0
WATR    YEAR      10    PEST    YEAR      10    CONC    YEAR      10   0
   7    DAY
RUNF    TSER   0   0  10.0
ESLS    TSER   0   0  1.E3
PRCP    TSER   0   0  10.0
INFL    TSER 118 118  10.0
RFLX1   TSER   0   0  1.E7
EFLX1   TSER   0   0  1.E7
TPAP    TSER   0   0  1.0
```

Potatoes – R2-PS-.inp (PRZM file)

```
FOCUS_PRZM_SW_4.3.1, 27 Apr. 2015                       PRZM 4.63 Apr. 2015
                    Simulation Location: R2Crop: Potatoes
    0.94    0.20       0   25.00       1       1
       4
    0.19    0.66    0.50    0.45               2    5.00   20.00
       1
       1    0.15   70.00   80.00       3   0   0   0    0.00  100.00
       1       4
1503 3005 1506 0111
0.20 0.20 0.40 0.90
0.10 0.10 0.10 0.10
  78   78   83   88
      20
  150375  300575  150675       1
  150376  300576  150676       1
  150377  300577  150677       1
  150378  300578  150678       1
  150379  300579  150679       1
  150380  300580  150680       1
  150381  300581  150681       1
  150382  300582  150682       1
  150383  300583  150683       1
  150384  300584  150684       1
  150385  300585  150685       1
  150386  300586  150686       1
  150387  300587  150687       1
  150388  300588  150688       1
  150389  300589  150689       1
  150390  300590  150690       1
  150391  300591  150691       1
  150392  300592  150692       1
  150393  300593  150693       1
  150394  300594  150694       1
Chemical Input Data:
      20       1       0       0
NIBIO_10
  18 275  0 1 4.000.1000 1.00 0.00
  26 276  0 1 4.000.1000 1.00 0.00
   1 377  0 1 4.000.1000 1.00 0.00
   6 378  0 1 4.000.1000 1.00 0.00
  24 279  0 1 4.000.1000 1.00 0.00
  24 280  0 1 4.000.1000 1.00 0.00
  12 281  0 1 4.000.1000 1.00 0.00
  13 282  0 1 4.000.1000 1.00 0.00
   4 383  0 1 4.000.1000 1.00 0.00
  12 284  0 1 4.000.1000 1.00 0.00
  19 285  0 1 4.000.1000 1.00 0.00
   3 386  0 1 4.000.1000 1.00 0.00
   2 387  0 1 4.000.1000 1.00 0.00
  14 288  0 1 4.000.1000 1.00 0.00
  12 289  0 1 4.000.1000 1.00 0.00
  15 290  0 1 4.000.1000 1.00 0.00
  12 291  0 1 4.000.1000 1.00 0.00
  10 392  0 1 4.000.1000 1.00 0.00
   1 393  0 1 4.000.1000 1.00 0.00
  23 294  0 1 4.000.1000 1.00 0.00
      0.       1    0.50
Soil Series:         R2          44
  100.00          0   0   2   0   0   0   2   1   0
 4300.00 .45E-12   22.70
  0.9000
 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.96 10.0
 14.8 14.8 14.8 14.8 14.8 14.8 14.8 14.8 14.8 14.8 14.8 14.8
    2.58   20.00
       2    0.70    1.00
       5
       1  10.000   1.150   0.360   0.000   0.000   0.000
         0.00693 0.00693 0.00000
```

```
       0.100   0.360   0.180   4.000   0.400
       14.80   67.00   14.00    0.00    0.00
   2  10.000   1.150   0.360   0.000   0.000   0.000
     0.00693 0.00693 0.00000
       5.000   0.360   0.180   4.000   0.400
       14.80   67.00   14.00    0.00    0.00
   3  25.000   1.290   0.270   0.000   0.000   0.000
     0.00693 0.00693 0.00000
       5.000   0.270   0.140   2.400   0.240
       14.80   72.00   12.00    0.00    0.00
   4  20.000   1.360   0.190   0.000   0.000   0.000
     0.00693 0.00693 0.00000
       5.000   0.190   0.100   0.800   0.080
       14.80   75.00   12.00    0.00    0.00
   5  35.000   1.410   0.170   0.000   0.000   0.000
     0.00693 0.00693 0.00000
       5.000   0.170   0.080   0.500   0.050
       14.80   74.00   10.00    0.00    0.00
   0
WATR    YEAR      10    PEST    YEAR      10    CONC    YEAR      10   0
   7    DAY
RUNF    TSER   0   0  10.0
ESLS    TSER   0   0  1.E3
PRCP    TSER   0   0  10.0
INFL    TSER 118 118  10.0
RFLX1   TSER   0   0  1.E7
EFLX1   TSER   0   0  1.E7
TPAP    TSER   0   0  1.0
```

Potatoes – R3-PS-.inp (PRZM file)

```
FOCUS_PRZM_SW_4.3.1, 27 Apr. 2015                        PRZM 4.63 Apr. 2015
                    Simulation Location: R3Crop: Potatoes
    0.94    0.20       0   25.00       1       1
       4
    0.25    0.66    0.50    0.45               3    5.00   20.00
       1
       1    0.15   60.00   80.00       3   0   0   0    0.00  100.00
       1       4
1004 3005 0109 0111
0.20 0.20 0.40 0.90
0.10 0.10 0.10 0.10
  82   82   87   91
      20
  100475  300575  010975       1
  100476  300576  010976       1
  100477  300577  010977       1
  100478  300578  010978       1
  100479  300579  010979       1
  100480  300580  010980       1
  100481  300581  010981       1
  100482  300582  010982       1
  100483  300583  010983       1
  100484  300584  010984       1
  100485  300585  010985       1
  100486  300586  010986       1
  100487  300587  010987       1
  100488  300588  010988       1
  100489  300589  010989       1
  100490  300590  010990       1
  100491  300591  010991       1
  100492  300592  010992       1
  100493  300593  010993       1
  100494  300594  010994       1
Chemical Input Data:
      20       1       0       0
NIBIO_10
  19 375  0 1 4.000.1000 1.00 0.00
   4 476  0 1 4.000.1000 1.00 0.00
  21 377  0 1 4.000.1000 1.00 0.00
  12 378  0 1 4.000.1000 1.00 0.00
  10 379  0 1 4.000.1000 1.00 0.00
  11 380  0 1 4.000.1000 1.00 0.00
  20 381  0 1 4.000.1000 1.00 0.00
  22 382  0 1 4.000.1000 1.00 0.00
  10 383  0 1 4.000.1000 1.00 0.00
  20 384  0 1 4.000.1000 1.00 0.00
   1 485  0 1 4.000.1000 1.00 0.00
  15 386  0 1 4.000.1000 1.00 0.00
  28 387  0 1 4.000.1000 1.00 0.00
  17 388  0 1 4.000.1000 1.00 0.00
  10 389  0 1 4.000.1000 1.00 0.00
  14 390  0 1 4.000.1000 1.00 0.00
  25 391  0 1 4.000.1000 1.00 0.00
  13 392  0 1 4.000.1000 1.00 0.00
   6 493  0 1 4.000.1000 1.00 0.00
  21 394  0 1 4.000.1000 1.00 0.00
      0.       1    0.50
Soil Series:         R3          46
  160.00           0   0   2   0   0   0   2   1   0
 4300.00 .45E-12   22.70
  0.9000
 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.18 0.96 10.0
 13.5 13.5 13.5 13.5 13.5 13.5 13.5 13.5 13.5 13.5 13.5 13.5
    2.58   20.00
       2    0.70    1.00
       5
       1  10.000   1.460   0.370   0.000   0.000   0.000
         0.00693 0.00693 0.00000
```

```
       0.100    0.370    0.220    1.000    0.100
       13.50    23.00    34.00     0.00     0.00
   2  35.000    1.460    0.370    0.000    0.000    0.000
     0.00693 0.00693 0.00000
       5.000    0.370    0.220    1.000    0.100
       13.50    23.00    34.00     0.00     0.00
   3  30.000    1.490    0.350    0.000    0.000    0.000
     0.00693 0.00693 0.00000
       5.000    0.350    0.210    1.000    0.100
       13.50    25.00    33.00     0.00     0.00
   4  70.000    1.520    0.360    0.000    0.000    0.000
     0.00693 0.00693 0.00000
       5.000    0.360    0.210    0.350    0.035
       13.50    17.00    35.00     0.00     0.00
   5  15.000    1.540    0.360    0.000    0.000    0.000
     0.00693 0.00693 0.00000
       5.000    0.360    0.220    0.290    0.029
       13.50    14.00    36.00     0.00     0.00
   0
WATR    YEAR       10    PEST    YEAR       10    CONC    YEAR       10   0
   7    DAY
RUNF    TSER   0   0  10.0
ESLS    TSER   0   0  1.E3
PRCP    TSER   0   0  10.0
INFL    TSER 118 118  10.0
RFLX1   TSER   0   0  1.E7
EFLX1   TSER   0   0  1.E7
TPAP    TSER   0   0  1.0
```

Winter Cereals R1 Pond Example – 96.txw (TOXSWA file)

```
*-----------------------------------------------------------------------------------------------
* Input file for TOXSWA
*
* This file is intended to be used by expert users.
*
* E-mail: toxswa@pesticidemodels.nl
*-----------------------------------------------------------------------------------------------
* (c) Wageningen University & Research
*

* Section 0: Run identification
* Section 1: Control
* Section 2: Waterbody
* Section 3: Hydrology
* Section 4: Sediment
* Section 5: Weather
* Section 6: Temperature
* Section 7: Substance
* Section 8: Loadings
* Section 9: Initial and boundary conditions for mass balance equations
* Section 10: Output control

* This input file considers the current scenario. Input that is not needed for
* this scenario is omitted. For a description of the full input file, see the
* user manual for the FOCUS & ascii version or in your TOXSWA download package.

*-----------------------------------------------------------------------------------------------
*-----------------------------------------------------------------------------------------------
* Section 0: Run identification
*
*-----------------------------------------------------------------------------------------------

R1_Pond                    Location          ! Name of the location [1|25 characters]
R1_POND                    WaterbodyID       ! ID of the water body [1|25 characters]
FOCUS                      SedimentTypeID    ! Name of sediment type [1|25 characters]
NIBIO_10                   SubstanceName     ! Name of parent substance [1|25 characters]
FOCUS_EXAMPLE              ApplicationScheme ! Name of the application scheme [1|25
characters]


*-----------------------------------------------------------------------------------------------
*----------------------------------------------------------------------------------------------
* Section 1: Control
*
*-----------------------------------------------------------------------------------------------

FOCUS        CallingProgram        ! Release type of scenario [FOCUS]
5.5.3        CallingProgramVersion ! Version numbers for model, interface and database,
                                   ! respectively

01-Oct-1978 TimStart   ! Start date of simulation [01-Jan-1900 – 31-Dec-9999]
30-Sep-1979 TimEnd     ! End date of simulation [01-Jan-1900 – 31-Dec-9999]

Hourly       OptInp     ! Option for hourly or daily input data of lateral entries [Hourly,
Daily]

* OptHyd: options for hydrology simulation
* Only       Simulate only hydrology
* OnLine     Simulate hydrology and substance
* OffLine    Assumption hydrology has been simulated, runID.hyd file must be present
* Automatic TOXSWA checks if hydrology file (runID.hyd) exists; so, hydrology
*            simulation is skipped
OnLine       OptHyd     ! Option selected for hydrology simulation
                        ! [Only, OnLine, OffLine, Automatic]

600.         TimStpHyd (s)    ! Calculation time step for hydrology [0.001|3600]

* OptTem: options for temperature simulation
```

```
* Only      Simulate only temperature
* OnLine    Simulate temperature and substance
* OffLine   Assumption temperature has been simulated, runID.tem file must be present
* Automatic TOXSWA checks if the temperature file (runID.tem) exists; so, temperature
*           simulation is skipped
OnLine      OptTem    ! Option selected for temperature simulation
                       ! [Only, OnLine, OffLine, Automatic, ExtModel]

Calc        OptTimStp        ! Time step substance simulation options (Input, Calc)
Yes         OptCalcStabilityWater ! Option for check of stability of the numerical solution
for
                                   ! the water layer
Yes         OptCalcStabilitySediment ! Option for check of stability of the numerical
solution for
                                   ! the sediment [Yes, No]
                                   ! Yes = Full check on stability
                                   ! No = Check on positivity

    * If OptTimStp is 'Calc' then specify
    600.        MaxTimStpWat (s) ! Maximum calculation time step in water layer [0.001|3600]
    600.        MaxTimStpSed (s) ! Maximum calculation time step in sediment [0.001|3600]

*-----------------------------------------------------------------------------------------------
*-----------------------------------------------------------------------------------------------
* Section 2: Waterbody
*
*-----------------------------------------------------------------------------------------------

* WaterBody table: description of waterbody
* Len           Length [0.05|]
* NumSeg        Number of segments [1|]
* WidWatSys     Width of the bottom of water system [0.05|100]
* SloSidWatSys  Side slope  of the water system [0|10]
* DepWatDefPer  Water depth defining perimeter for exchange between water layer
*               and sediment [0|lowest water depth]

table WaterBody
Len       NumSeg    WidWatSys SloSidWatSys DepWatDefPer
(m)       (-)       (m)       (-)          (m)
30.       1         30.       1E-005       0.01
end_table

15.         ConSus (g.m-3)       ! Concentration of suspended solids [0|100000]
0.09        CntOmSusSol (g.g-1)  ! Mass ratio of organic matter in suspended solids [0|1]
0.          AmaMphWatLay (g.m-2) ! Dry mass of macrophyte biomass per m2 bottom [0|1000]

*-----------------------------------------------------------------------------------------------
*-----------------------------------------------------------------------------------------------
* Section  3: Hydrology: general
*   Section 3a: General
*-----------------------------------------------------------------------------------------------

Transient           OptFloWat             ! Option for water flow (Constant, Transient)
    * If OptFloWat is 'Transient' then specify
    Pond        OptWaterSystemType  ! Water system type [Pond, WaterCourse]


*-----------------------------------------------------------------------------------------------
* Section 3b: Constant water flow
*
* If OptFloWat is 'Constant'
*-----------------------------------------------------------------------------------------------


*-----------------------------------------------------------------------------------------------
* Section 3c: Variable water flow: pond
*
* If OptFloWat is 'Transient' and OptWaterSystemType is 'Pond'
*-----------------------------------------------------------------------------------------------
```

```
0.45        AreaSurPndInp (ha)  ! Size of surrounding area discharging excss water into the
pond
                                ! [0|100]
5.754       QBasPndInp (m3.d-1) ! Base flow, i.e. inflow into pond [0|50]
1.          HgtCrePnd (m)       ! Height of the weir crest at outflow [0.1|5]
0.5         WidCrePnd (m)       ! Width of the weir crest at outflow [0.01|10]

    * If application option OptLoa is 'PRZM' then specify
    0.06        AreaErsSurPndInp (ha)  ! Size of the eroding area around the pond [0|100]

*-----------------------------------------------------------------------------------------------
* Section 3d: Variable water flow: watercourse
*
* If OptFloWat is 'Transient' and OptWaterSystemType is 'WaterCourse'
*-----------------------------------------------------------------------------------------------


*-----------------------------------------------------------------------------------------------
*-----------------------------------------------------------------------------------------------
* Section 4: Sediment
*
*-----------------------------------------------------------------------------------------------
*SedimentProfile table: thickness and number of layers in horizon
* ThiHor  Thickness of horizon [0.0001|-]
* NumLay  Number of layers in horizon [1|500]
table SedimentProfile
ThiHor    NumLay
(m)
0.004     4
0.006     3
0.01      2
0.03      3
0.02      1
0.03      1
end_table

Input       OptSedProperties   ! Sediment properties for ThetaSat and CofDifRel [Input, Calc]

* SedimentProperties table: properties for each horizon:
* Nr        Number horizon [1|500]
* Rho       Bulk density [10|3000]
* CntOm     Organic matter mass content [0|1]
* If OptSedProperties 'Input' then specify ThetaSat and CofDifRel
* ThetaSat  Saturated water content [0.001|0.999]
* CofDifRel Relative diffusion coefficient [0|1]
table  horizon SedimentProperties
Nr        Rho       CntOm     ThetaSat  CofDifRel
          (kg.m-3)  (kg.kg-1) (m3.m-3)  (-)
1         800.      0.09      0.6       0.6
2         800.      0.09      0.6       0.6
3         800.      0.09      0.6       0.6
4         800.      0.09      0.6       0.6
5         800.      0.09      0.6       0.6
6         800.      0.09      0.6       0.6
end_table

0.          FlwWatSpg (m3.m-2.d-1) ! Percolation rate through the sediment [-0.01|0.01]

* DispersionLength table: dispersion length for each horizon
* Nr            Horizon number [1|500]
* LenDisSedLiq  Dispersion length of solute in liquid phase (m) [0.01|1]
table  horizon DispersionLength
Nr        LenDisSedLiq
          (m)
1         0.015
2         0.015
3         0.015
4         0.015
5         0.015
6         0.015
end_table
```

```
*-----------------------------------------------------------------------------------------------
*-----------------------------------------------------------------------------------------------

* Section 5: Weather section
*
*-----------------------------------------------------------------------------------------------

Weiherbach                       MeteoStation  MeteoStation   ! Name of file with meteo data
(*.met)

Monthly            OptMetInp ! Input data [Monthly]

*-----------------------------------------------------------------------------------------------
*-----------------------------------------------------------------------------------------------

* Section 6: Temperature
*
*-----------------------------------------------------------------------------------------------

*-----------------------------------------------------------------------------------------------
*-----------------------------------------------------------------------------------------------

* Section  7: Substance
*   Section 7a: general
*-----------------------------------------------------------------------------------------------

* Compounds table: first entry is parent, next entries are metabolites [1|15 characters]
table compounds                      ! List of substances
NIBIO_10
end_table

* FraPrtDauWat table: parent-daughter relationships transformation in water
* Column 1: fraction formed from parent into daughter [0|]
* Column 2: name of parent
* Column 3: name of daughter
table FraPrtDauWat (mol.mol-1)
end_table

* FraPrtDauSed table: parent-daughter relationships transformation in sediment
* Column 1: fraction formed from parent into daughter [0|]
* Column 2: name of parent
* Column 3: name of daughter
table FraPrtDauSed (mol.mol-1)
end_table

*-----------------------------------------------------------------------------------------------
* Section 7b: Substance properties for parent NIBIO_10
* (note extension of parameter name is substance code)
*-----------------------------------------------------------------------------------------------

250.        MolMas_NIBIO_10 (g.mol-1)         ! Molar mass of parent substance [10.0 - 10000]

* Volatilization from water layer
1.33E-10    PreVapRef_NIBIO_10 (Pa)           ! Saturated vapour pressure of substance
[0|2e5]
20.         TemRefVap_NIBIO_10 (C)            ! Reference temperature for saturated vapour
pressure
                                                    ! [0|40]
95.         MolEntVap_NIBIO_10 (kJ.mol-1)     ! Molar enthalpy of vaporization [-200|200]
30.         SlbWatRef_NIBIO_10 (mg.L-1)       ! Water solubility of substance [0.001|1e6]
25.         TemRefSlb_NIBIO_10 (C)            ! Reference temperature for water solubility
[0|40]
27.         MolEntSlb_NIBIO_10 (kJ.mol-1)     ! Molar enthalpy of dissolution  [-200|200]

* Diffusion in liquid phase
4.3E-5      CofDifWatRef_NIBIO_10 (m2.d-1)    ! Reference diffusion coefficient in water
[0|2E-3]

* Sorption
5.8         KomSed_NIBIO_10 (L.kg-1)          ! Freundlich coefficient of  equilibrium
sorption for
```

```
                                                ! sediment [0|1e7]
1.          ConLiqRefSed_NIBIO_10 (mg.L-1)    ! Reference concentration in liquid phase for
                                                ! Freundlich coefficient for sediment
[0.001|100]
0.9         ExpFreSed_NIBIO_10 (-)            ! Freundlich exponent  in sediment [0.1|1.5]
5.8         KomSusSol_NIBIO_10 (L.kg-1)       ! Freundlich coefficient of  equilibrium
sorption
                                                ! for suspended solids [0|1e7]
1.          ConLiqRefSusSol_NIBIO_10 (mg.L-1) ! Reference concentration in liquid phase
                                                ! for Freundlich sorption coefficient
for
                                                ! suspended solids [0.001|100]
0.9         ExpFreSusSol_NIBIO_10 (-)         ! Freundlich exponent suspended solids
[0.1|1.5]
0.          CofSorMph_NIBIO_10 (L.kg-1)       ! Coefficient for linear sorption on
                                                ! macrophytes [0|1e7]

* Transformation in water
100.        DT50WatRef_NIBIO_10 (d)           ! Half-life transformation in water at
reference
                                                ! temperature [0.1|1e5]
20.         TemRefTraWat_NIBIO_10 (C)         ! Reference temperature for half-life measured
in
                                                ! water [5|30]
65.4        MolEntTraWat_NIBIO_10 (kJ.mol-1)  ! Molar activation enthalpy of transformation
in
                                                ! water [0|200]

* Transformation in sediment
100.        DT50SedRef_NIBIO_10 (d)           ! Half-life transformation in sediment at
reference
                                                ! temperature [0.1|1e5]
20.         TemRefTraSed_NIBIO_10 (C)         ! Reference temperature for half-life in
sediment
                                                ! [5|30]
65.4        MolEntTraSed_NIBIO_10 (kJ.mol-1)  ! Molar activation enthalpy of transformation
in
                                                ! sedment [0|200]


*----------------------------------------------------------------------------------------------
*----------------------------------------------------------------------------------------------
* Section 8: Loadings
*
*----------------------------------------------------------------------------------------------
* OptLoa options for loading type
* DriftOnly  spray drift only entry route
* MACRO      drainage calculated by MACRO
* PRZM       runoff and erosion calculated by PRZM
PRZM        OptLoa         ! Loading option [DriftOnly, PEARL, MACRO, PRZM, GEM]

* Loadings table: details on spray drift, and stretch for all loading types
* Column 1  Date and time of application, relevant if OptLoa is 'DriftOnly', otherwise
*           the date is a dummy value
* Column 2  Type of loading [Drift]
* Column 3  Drift deposition (mg.m-2) [0|]
* Column 4  Start of stretch of watercourse loaded by all loading types (m) [0|1e4]
* Column 5  End of stretch of watercourse loaded by all loading types (m) [0|1e4]
table Loadings
30-Dec-1899    drift     0.0000E+000  0.        30.
end_table

    * If OptLoa is 'PRZM' then specify details of runoff
    0.          WidFldRnf (m)       ! Width of field contributing runoff [0|1000]
    0.          WidFldErs (m)       ! Width of field contributing erosion [0|1000]
    0.1         RatInfDir (-)       ! Ratio of infiltraton water added to runoff water [0|1]
    0.01        ThiLayErs (m)       ! Thickness of upper sediment layer to which erosion mass
                                    ! is added [1e-5|1]

    * If OptLoa is 'MACRO' or OptLoa is 'PRZM' then specify path and file names of files
    * Table lateral entries files of soil substances, including metabolites (path+name)
```

```
    table Soil Substances
    D:\SWASH\Projects\NIBIO_10\PRZM\cereals_winter\00040-C1.p2t
    end_table

    * If OptHyd is 'transient' then specify details of catchment
    No          OptUpsInp           ! Upstream catchment treated [Yes, No]
    0.          RatAreaUpsApp (-)   ! Ratio of upstream catchment treated [0|1]

*-----------------------------------------------------------------------------------------------
*-----------------------------------------------------------------------------------------------
* Section 9: Initial and boundary conditions for mass balance equations
*
*-----------------------------------------------------------------------------------------------

* Initial conditions

0.          ConSysWatIni (g.m-3)  ! Initial total concentration in water layer [0|-]

* CntSysSedIni table: initial total substance content in sediment
* If metabolites are included then initail contents for these substances are set to zero
* Column 1  Depth in sediment (m) [0|-]
* Column 2  Substance content (mg.kg-1) [0|-]
table interpolate CntSysSedIni (mg.kg-1)
end_table

* Boundary conditions
0.          ConAir (g.m-3)        ! Concentration  in air [0|-]

0.          ConWatSpg (g.m-3)     ! Concentration in incoming seepage water [0|-]

*-----------------------------------------------------------------------------------------------
*-----------------------------------------------------------------------------------------------
* Section  10: Output control
*   Section 10a: General
*-----------------------------------------------------------------------------------------------

No          OptDelOutFiles   ! Remove *.out file after simulation [Yes|No]
* DateFormat: options for format of date and time in the output file
* DaysFromSta   Print number of days since start of simulation
* DaysFrom1900  Print number of days since 1900
* Years         Print years
DaysFromSta           DateFormat       DateFormat [DaysFromSta, DaysFrom1900, Years]

* RealFormat: format of the ordinary output - use FORTRAN notation:
* e is scientific notation, g  is general notation,
* then the number of positions, then the number of digits
e14.6                 RealFormat       ! Format of ordinary output

* OptDelTimPrn: options for output time step
* Hour,Day,Decade,Month,Year  Time step for output
* Automatic                   Length of simulation period
* Other                       User defined
Hour        OptDelTimPrn  ! Output time step [Hour|Day|Decade|Month|Year|
                          ! Automatic|Other]

0.05        ThiLayTgt (m)    ! Depth defining the thickness of the target sediment layer
                             ! for output of (averaged) content [1e-5|1]

All       OptOutputDistances ! Options for distances of water layer grid points at which
                             ! output can be obtained[None, All, table]

table      OptOutputDepths  ! Options for depths of sediment grid poinst at which
                            ! output can be obtained [None, All, table]

    * If OptOutputDepths is 'table' then specify
    * OutputDepths-table: depths of sediment nodes at which output can be obtained
    * Column 1   Depth (m) [0|-]
    table OutputDepths (m)
    end_table
```

```
* Specify dates for output of additional profiles; options set via OptOutputDistances and
* OptOutputDepths are used
* HorVertProfiles table: profiles in horizontal direction for water layer and in vertical
* direction for sediment are given; values given are:
* Water layer: output distance, water depth, total and dissolved concentration,
* Sediment: output node water layer, output depth, pore volume, total and dissolved
* concentration.
table HorVertProfiles
end_table

* Specify type of summary report
FOCUS                  OptReport        ! [FOCUS]
Yes                    ExposureReport   ! Exposure report [Yes|No]

*-----------------------------------------------------------------------------------------------
* Section 10b: Additional options for Dutch registration report
*
* If OptReport is 'DutchRegistration'
*-----------------------------------------------------------------------------------------------

*-----------------------------------------------------------------------------------------------
* Section 10c: Print variables in *.out file
* State variables, fluxes and rates given as momentary values.
* Volume,energy and mass changes given as cumulative values.
*-----------------------------------------------------------------------------------------------

* Specify for all print variables whether output is wanted [Yes, No]
* When print variable is not in file; TOXSWA assumes 'No'

* PrintCumulatives: options for printing cumulatives of volume, energy and mass fluxes
* Yes   : cumulative terms have been summed up from start of simulation and have been
*         allocated to the last moment of the period considered
* No    : cumulative terms have been summed up from start of user defined output time step
*         OptDelTimPrn and have been allocated to the last moment of the period
*         considered
No          PrintCumulatives ! [Yes, No]

* Hydrology
No          print_DepWat             ! Water depth (m)
No          print_QBou               ! Discharge (m3.s-1)
No          print_VelWatFlw          ! Flow velocity (m.d-1)
No          print_VolErrWatLay       ! Volume error in waterbody (m3)

* Lateral entries (expressed per m2 adjacent field)
    * If OptLoa is 'PRZM'
    No          print_VvrLiqRnf           ! Runoff (+ infiltration) water flow (m3.m-2.hr-1)
    No          print_FlmRnf              ! Runoff substance flux (g.m-2.hr-1)
    No          print_FlmErs              ! Erosion substance flux (g.m-2.hr-1)

* Concentrations and contents in water layer segments as specified by
* OptOutputDistances
Yes         print_ConLiqWatLay       ! Concentration dissolved in water (g.m-3)
No          print_CntSorMph          ! Content sorbed to macrophytes (g.kg-1)
No          print_CntSorSusSol       ! Content sorbed to suspended solids (g.kg-1)
No          print_ConSysWatLay       ! Total concentration in water (g.m-3)

* Concentrations and contents in sediment below water layer segments as specified by
* OptOutputDistances and OptOutputDepths
No          print_ConLiqSed          ! Concentration in pore water sediment (g.m-3)
No          print_CntSorSed          ! Content sorbed to sediment (g.kg-1)
No          print_ConSysSed          ! Total content in sediment (g.m-3)
Yes         print_CntSedTgt          ! Total content in target layer sediment  (g.kg-1)
No          print_ConLiqSedTgt       ! Concentration in pore water in target layer
                                     ! sediment (g.m-3)
No          print_CntSorSedTgt       ! Content sorbed in target layer sediment (g.kg-1)

* Distribution in entire water layer
Yes         print_MasLiqWatLay       ! Mass in liquid phase in water layer (g)
Yes         print_MasSorSusSol       ! Mass sorbed to suspended solids in water layer (g)
Yes         print_MasSorMph          ! Mass sorbed to macrophytes in water layer (g)
```

```
* Distribution in entire sediment
Yes         print_MasLiqSed          ! Mass in liquid phase in sediment (g)
Yes         print_MasSorSed          ! Mass sorbed in sediment (g)

* Mass balance for entire water layer
Yes         print_MasWatLay          ! Mass in water layer (g)
Yes         print_MasDrfWatLay       ! Mass entered in water layer by spray drift (g)
Yes         print_MasDraWatLay       ! Mass entered in water layer by drainage (g)
Yes         print_MasRnfWatLay       ! Mass entered in water layer by runoff (g)
Yes         print_MasSedInWatLay     ! Mass penetrated into sediment from water layer (g)
Yes         print_MasSedOutWatLay    ! Mass transferred from sediment into water layer (g)
Yes         print_MasDwnWatLay       ! Mass flowed across downstream boundary out of
                                     ! water layer (g)
Yes         print_MasUpsWatLay       ! Mass flowed across upstream boundary into water
                                     ! layer (g)
Yes         print_MasTraWatLay       ! Mass transformed in water layer (g)
Yes         print_MasForWatLay       ! Mass formed in water layer (g)
Yes         print_MasVolWatLay       ! Mass volatilised from water layer (g)
No          print_MasErrWatLay       ! Mass error in water layer (g)

* Mass balance sediment
Yes         print_MasSed             ! Mass in sediment (g)
Yes         print_MasTraSed          ! Mass transformed in sediment (g)
Yes         print_MasForSed          ! Mass formed in sediment (g)
Yes         print_MasWatLayInSed     ! Mass transfered into water layer from sediment
                                     ! layer (g)
Yes         print_MasWatLayOutSed    ! Mass transfered from water layer into sediment
                                     ! layer (g)
Yes         print_MasDwnSed          ! Mass leaving sediment across lower boundary (g)
Yes         print_MasErsSed          ! Mass entering sediment by erosion (g)
No          print_MasErrSed          ! Mass error in sediment (g)

*----------------------------------------------------------------------------------------------
* End of TOXSWA input file
*----------------------------------------------------------------------------------------------
```

Winter Cereals R1 Stream Example – 97.txw (TOXSWA file)

```
*-----------------------------------------------------------------------------------------------
* Input file for TOXSWA
*
* This file is intended to be used by expert users.
*
* E-mail: toxswa@pesticidemodels.nl
*-----------------------------------------------------------------------------------------------
* (c) Wageningen University & Research
*

* Section 0: Run identification
* Section 1: Control
* Section 2: Waterbody
* Section 3: Hydrology
* Section 4: Sediment
* Section 5: Weather
* Section 6: Temperature
* Section 7: Substance
* Section 8: Loadings
* Section 9: Initial and boundary conditions for mass balance equations
* Section 10: Output control

* This input file considers the current scenario. Input that is not needed for
* this scenario is omitted. For a description of the full input file, see the
* user manual for the FOCUS & ascii version or in your TOXSWA download package.

*-----------------------------------------------------------------------------------------------
*----------------------------------------------------------------------------------------------
* Section 0: Run identification
*
*-----------------------------------------------------------------------------------------------

R1_Stream                 Location           ! Name of the location [1|25 characters]
R1_STREAM                 WaterbodyID        ! ID of the water body [1|25 characters]
FOCUS                     SedimentTypeID     ! Name of sediment type [1|25 characters]
NIBIO_10                  SubstanceName      ! Name of parent substance [1|25 characters]
FOCUS_EXAMPLE             ApplicationScheme ! Name of the application scheme [1|25
characters]


*-----------------------------------------------------------------------------------------------
*-----------------------------------------------------------------------------------------------
* Section 1: Control
*
*-----------------------------------------------------------------------------------------------

FOCUS       CallingProgram        ! Release type of scenario [FOCUS]
5.5.3       CallingProgramVersion ! Version numbers for model, interface and database,
                                  ! respectively

01-Oct-1978 TimStart   ! Start date of simulation [01-Jan-1900 – 31-Dec-9999]
30-Sep-1979 TimEnd     ! End date of simulation [01-Jan-1900 – 31-Dec-9999]

Hourly      OptInp     ! Option for hourly or daily input data of lateral entries [Hourly,
Daily]

* OptHyd: options for hydrology simulation
* Only      Simulate only hydrology
* OnLine    Simulate hydrology and substance
* OffLine   Assumption hydrology has been simulated, runID.hyd file must be present
* Automatic TOXSWA checks if hydrology file (runID.hyd) exists; so, hydrology
*           simulation is skipped
OnLine      OptHyd     ! Option selected for hydrology simulation
                       ! [Only, OnLine, OffLine, Automatic]

600.        TimStpHyd (s)    ! Calculation time step for hydrology [0.001|3600]

* OptTem: options for temperature simulation
```

```
* Only      Simulate only temperature
* OnLine    Simulate temperature and substance
* OffLine   Assumption temperature has been simulated, runID.tem file must be present
* Automatic TOXSWA checks if the temperature file (runID.tem) exists; so, temperature
*           simulation is skipped
OnLine      OptTem    ! Option selected for temperature simulation
                       ! [Only, OnLine, OffLine, Automatic, ExtModel]

Calc        OptTimStp        ! Time step substance simulation options (Input, Calc)
Yes         OptCalcStabilityWater ! Option for check of stability of the numerical solution
for
                                     ! the water layer
Yes         OptCalcStabilitySediment ! Option for check of stability of the numerical
solution for
                                     ! the sediment [Yes, No]
                                     ! Yes = Full check on stability
                                     ! No = Check on positivity

    * If OptTimStp is 'Calc' then specify
    600.        MaxTimStpWat (s) ! Maximum calculation time step in water layer [0.001|3600]
    600.        MaxTimStpSed (s) ! Maximum calculation time step in sediment [0.001|3600]

*-----------------------------------------------------------------------------------------------
*-----------------------------------------------------------------------------------------------

* Section 2: Waterbody
*
*-----------------------------------------------------------------------------------------------

* WaterBody table: description of waterbody
* Len           Length [0.05|]
* NumSeg        Number of segments [1|]
* WidWatSys     Width of the bottom of water system [0.05|100]
* SloSidWatSys  Side slope  of the water system [0|10]
* DepWatDefPer  Water depth defining perimeter for exchange between water layer
*               and sediment [0|lowest water depth]

table WaterBody
Len       NumSeg    WidWatSys SloSidWatSys DepWatDefPer
(m)       (-)       (m)       (-)          (m)
100.      20        1.        1E-005       0.01
end_table

15.         ConSus (g.m-3)       ! Concentration of suspended solids [0|100000]
0.09        CntOmSusSol (g.g-1)  ! Mass ratio of organic matter in suspended solids [0|1]
0.          AmaMphWatLay (g.m-2) ! Dry mass of macrophyte biomass per m2 bottom [0|1000]

*-----------------------------------------------------------------------------------------------
*-----------------------------------------------------------------------------------------------

* Section  3: Hydrology: general
*   Section 3a: General
*-----------------------------------------------------------------------------------------------

Transient           OptFloWat             ! Option for water flow (Constant, Transient)
    * If OptFloWat is 'Transient' then specify
    WaterCourse OptWaterSystemType  ! Water system type [Pond, WaterCourse]

    * If OptWaterSystemType is 'WaterCourse' then specify
    Fischer     OptDis   ! Dispersion calculation method [Input, Fischer]


*-----------------------------------------------------------------------------------------------
* Section 3b: Constant water flow
*
* If OptFloWat is 'Constant'
*-----------------------------------------------------------------------------------------------


*-----------------------------------------------------------------------------------------------
* Section 3c: Variable water flow: pond
```

```
*
* If OptFloWat is 'Transient' and OptWaterSystemType is 'Pond'
*-----------------------------------------------------------------------------------------------

*-----------------------------------------------------------------------------------------------
* Section 3d: Variable water flow: watercourse
*
* If OptFloWat is 'Transient' and OptWaterSystemType is 'WaterCourse'
*-----------------------------------------------------------------------------------------------

100.        AreaUpsWatCrsInp (ha)  ! Area of upstream catchment [0|1e4]
191.8       QBasWatCrsInp (m3.d-1) ! Base flow from upstream catchment [0|1e4]
0.001       SloBotRepCha (-)       ! Slope bottom representative channel [0|0.01]
0.5         HgtCreRepCha (m)       ! Height of the weir crest [0.01|5]
0.5         WidCreRepCha (m)       ! Width of the weir crest [0.01|10]
110.        LenRepCha (m)          ! Length representative channel [10|2000]
1.          WidBotRepCha (m)       ! Width bottom representative channel [0.1 - 10]
11.         CofRghRef (s-1)        ! Value Manning coefficient for bottom roughness at 1 m
                                   ! water depth in water body [1|100]
1.2         CofVelHea (m.s-1)      ! Energy coefficient due to non-uniform distribution of
                                   ! flow velocities in cross section [1.1|1.5]

*-----------------------------------------------------------------------------------------------
*-----------------------------------------------------------------------------------------------

* Section 4: Sediment
*
*-----------------------------------------------------------------------------------------------

*SedimentProfile table: thickness and number of layers in horizon
* ThiHor  Thickness of horizon [0.0001|-]
* NumLay  Number of layers in horizon [1|500]
table SedimentProfile
ThiHor    NumLay
(m)
0.004     4
0.006     3
0.01      2
0.03      3
0.02      1
0.03      1
end_table

Input       OptSedProperties   ! Sediment properties for ThetaSat and CofDifRel [Input, Calc]

* SedimentProperties table: properties for each horizon:
* Nr        Number horizon [1|500]
* Rho       Bulk density [10|3000]
* CntOm     Organic matter mass content [0|1]
* If OptSedProperties 'Input' then specify ThetaSat and CofDifRel
* ThetaSat  Saturated water content [0.001|0.999]
* CofDifRel Relative diffusion coefficient [0|1]
table  horizon SedimentProperties
Nr        Rho       CntOm     ThetaSat  CofDifRel
          (kg.m-3)  (kg.kg-1) (m3.m-3)  (-)
1         800.      0.09      0.6       0.6
2         800.      0.09      0.6       0.6
3         800.      0.09      0.6       0.6
4         800.      0.09      0.6       0.6
5         800.      0.09      0.6       0.6
6         800.      0.09      0.6       0.6
end_table

0.          FlwWatSpg (m3.m-2.d-1) ! Percolation rate through the sediment [-0.01|0.01]

* DispersionLength table: dispersion length for each horizon
* Nr            Horizon number [1|500]
* LenDisSedLiq  Dispersion length of solute in liquid phase (m) [0.01|1]
table  horizon DispersionLength
Nr        LenDisSedLiq
          (m)
```

```
1         0.015
2         0.015
3         0.015
4         0.015
5         0.015
6         0.015
end_table

*-----------------------------------------------------------------------------------------------
*-----------------------------------------------------------------------------------------------

* Section 5: Weather section
*
*-----------------------------------------------------------------------------------------------

Weiherbach                       MeteoStation  MeteoStation   ! Name of file with meteo data
(*.met)

Monthly            OptMetInp ! Input data [Monthly]

*-----------------------------------------------------------------------------------------------
*-----------------------------------------------------------------------------------------------

* Section 6: Temperature
*
*-----------------------------------------------------------------------------------------------

*-----------------------------------------------------------------------------------------------
*-----------------------------------------------------------------------------------------------

* Section  7: Substance
*   Section 7a: general
*-----------------------------------------------------------------------------------------------

* Compounds table: first entry is parent, next entries are metabolites [1|15 characters]
table compounds                      ! List of substances
NIBIO_10
end_table

* FraPrtDauWat table: parent-daughter relationships transformation in water
* Column 1: fraction formed from parent into daughter [0|]
* Column 2: name of parent
* Column 3: name of daughter
table FraPrtDauWat (mol.mol-1)
end_table

* FraPrtDauSed table: parent-daughter relationships transformation in sediment
* Column 1: fraction formed from parent into daughter [0|]
* Column 2: name of parent
* Column 3: name of daughter
table FraPrtDauSed (mol.mol-1)
end_table

*-----------------------------------------------------------------------------------------------
* Section 7b: Substance properties for parent NIBIO_10
* (note extension of parameter name is substance code)
*----------------------------------------------------------------------------------------------

250.        MolMas_NIBIO_10 (g.mol-1)         ! Molar mass of parent substance [10.0 - 10000]

* Volatilization from water layer
1.33E-10    PreVapRef_NIBIO_10 (Pa)           ! Saturated vapour pressure of substance
[0|2e5]
20.         TemRefVap_NIBIO_10 (C)            ! Reference temperature for saturated vapour
pressure
                                                     ! [0|40]
95.         MolEntVap_NIBIO_10 (kJ.mol-1)     ! Molar enthalpy of vaporization [-200|200]
30.         SlbWatRef_NIBIO_10 (mg.L-1)       ! Water solubility of substance [0.001|1e6]
25.         TemRefSlb_NIBIO_10 (C)            ! Reference temperature for water solubility
[0|40]
27.         MolEntSlb_NIBIO_10 (kJ.mol-1)     ! Molar enthalpy of dissolution  [-200|200]
```

```
* Diffusion in liquid phase
4.3E-5      CofDifWatRef_NIBIO_10 (m2.d-1)    ! Reference diffusion coefficient in water
[0|2E-3]

* Sorption
5.8         KomSed_NIBIO_10 (L.kg-1)          ! Freundlich coefficient of  equilibrium
sorption for
                                                     ! sediment [0|1e7]
1.          ConLiqRefSed_NIBIO_10 (mg.L-1)    ! Reference concentration in liquid phase for
                                                     ! Freundlich coefficient for sediment
[0.001|100]
0.9         ExpFreSed_NIBIO_10 (-)            ! Freundlich exponent  in sediment [0.1|1.5]
5.8         KomSusSol_NIBIO_10 (L.kg-1)       ! Freundlich coefficient of  equilibrium
sorption
                                                     ! for suspended solids [0|1e7]
1.          ConLiqRefSusSol_NIBIO_10 (mg.L-1) ! Reference concentration in liquid phase
                                                     ! for Freundlich sorption coefficient
for
                                                     ! suspended solids [0.001|100]
0.9         ExpFreSusSol_NIBIO_10 (-)         ! Freundlich exponent suspended solids
[0.1|1.5]
0.          CofSorMph_NIBIO_10 (L.kg-1)       ! Coefficient for linear sorption on
                                                     ! macrophytes [0|1e7]

* Transformation in water
100.        DT50WatRef_NIBIO_10 (d)           ! Half-life transformation in water at
reference
                                                     ! temperature [0.1|1e5]
20.         TemRefTraWat_NIBIO_10 (C)         ! Reference temperature for half-life measured
in
                                                     ! water [5|30]
65.4        MolEntTraWat_NIBIO_10 (kJ.mol-1)  ! Molar activation enthalpy of transformation
in
                                                     ! water [0|200]

* Transformation in sediment
100.        DT50SedRef_NIBIO_10 (d)           ! Half-life transformation in sediment at
reference
                                                     ! temperature [0.1|1e5]
20.         TemRefTraSed_NIBIO_10 (C)         ! Reference temperature for half-life in
sediment
                                                     ! [5|30]
65.4        MolEntTraSed_NIBIO_10 (kJ.mol-1)  ! Molar activation enthalpy of transformation
in
                                                     ! sedment [0|200]


*-----------------------------------------------------------------------------------------------
*-----------------------------------------------------------------------------------------------

* Section 8: Loadings
*
*-----------------------------------------------------------------------------------------------

* OptLoa options for loading type
* DriftOnly  spray drift only entry route
* MACRO      drainage calculated by MACRO
* PRZM       runoff and erosion calculated by PRZM
PRZM        OptLoa         ! Loading option [DriftOnly, PEARL, MACRO, PRZM, GEM]

* Loadings table: details on spray drift, and stretch for all loading types
* Column 1  Date and time of application, relevant if OptLoa is 'DriftOnly', otherwise
*           the date is a dummy value
* Column 2  Type of loading [Drift]
* Column 3  Drift deposition (mg.m-2) [0|]
* Column 4  Start of stretch of watercourse loaded by all loading types (m) [0|1e4]
* Column 5  End of stretch of watercourse loaded by all loading types (m) [0|1e4]
table Loadings
30-Dec-1899    drift     0.0000E+000  0.        100.
end_table
```

```
    * If OptLoa is 'PRZM' then specify details of runoff
    100.        WidFldRnf (m)       ! Width of field contributing runoff [0|1000]
    20.         WidFldErs (m)       ! Width of field contributing erosion [0|1000]
    0.1         RatInfDir (-)       ! Ratio of infiltraton water added to runoff water [0|1]
    0.01        ThiLayErs (m)       ! Thickness of upper sediment layer to which erosion mass
                                    ! is added [1e-5|1]

    * If OptLoa is 'MACRO' or OptLoa is 'PRZM' then specify path and file names of files
    * Table lateral entries files of soil substances, including metabolites (path+name)

    table Soil Substances
    D:\SWASH\Projects\NIBIO_10\PRZM\cereals_winter\00040-C1.p2t
    end_table

    * If OptHyd is 'transient' then specify details of catchment
    Yes         OptUpsInp           ! Upstream catchment treated [Yes, No]
    0.2         RatAreaUpsApp (-)   ! Ratio of upstream catchment treated [0|1]

*-----------------------------------------------------------------------------------------------
*-----------------------------------------------------------------------------------------------

* Section 9: Initial and boundary conditions for mass balance equations
*
*-----------------------------------------------------------------------------------------------

* Initial conditions

0.          ConSysWatIni (g.m-3)  ! Initial total concentration in water layer [0|-]

* CntSysSedIni table: initial total substance content in sediment
* If metabolites are included then initail contents for these substances are set to zero
* Column 1  Depth in sediment (m) [0|-]
* Column 2  Substance content (mg.kg-1) [0|-]
table interpolate CntSysSedIni (mg.kg-1)
end_table

* Boundary conditions
0.          ConAir (g.m-3)        ! Concentration  in air [0|-]

0.          ConWatSpg (g.m-3)     ! Concentration in incoming seepage water [0|-]

*-----------------------------------------------------------------------------------------------
*-----------------------------------------------------------------------------------------------

* Section  10: Output control
*   Section 10a: General
*-----------------------------------------------------------------------------------------------

No          OptDelOutFiles   ! Remove *.out file after simulation [Yes|No]
* DateFormat: options for format of date and time in the output file
* DaysFromSta   Print number of days since start of simulation
* DaysFrom1900  Print number of days since 1900
* Years         Print years
DaysFromSta           DateFormat       DateFormat [DaysFromSta, DaysFrom1900, Years]

* RealFormat: format of the ordinary output - use FORTRAN notation:
* e is scientific notation, g  is general notation,
* then the number of positions, then the number of digits
e14.6                 RealFormat       ! Format of ordinary output

* OptDelTimPrn: options for output time step
* Hour,Day,Decade,Month,Year  Time step for output
* Automatic                   Length of simulation period
* Other                       User defined
Hour        OptDelTimPrn  ! Output time step [Hour|Day|Decade|Month|Year|
                          ! Automatic|Other]

0.05        ThiLayTgt (m)    ! Depth defining the thickness of the target sediment layer
                             ! for output of (averaged) content [1e-5|1]
```

```
All       OptOutputDistances ! Options for distances of water layer grid points at which
                             ! output can be obtained[None, All, table]

table      OptOutputDepths  ! Options for depths of sediment grid poinst at which
                            ! output can be obtained [None, All, table]

    * If OptOutputDepths is 'table' then specify
    * OutputDepths-table: depths of sediment nodes at which output can be obtained
    * Column 1   Depth (m) [0|-]
    table OutputDepths (m)
    end_table

* Specify dates for output of additional profiles; options set via OptOutputDistances and
* OptOutputDepths are used
* HorVertProfiles table: profiles in horizontal direction for water layer and in vertical
* direction for sediment are given; values given are:
* Water layer: output distance, water depth, total and dissolved concentration,
* Sediment: output node water layer, output depth, pore volume, total and dissolved
* concentration.
table HorVertProfiles
end_table

* Specify type of summary report
FOCUS                 OptReport        ! [FOCUS]
Yes                   ExposureReport   ! Exposure report [Yes|No]

*----------------------------------------------------------------------------------------------
* Section 10b: Additional options for Dutch registration report
*
* If OptReport is 'DutchRegistration'
*----------------------------------------------------------------------------------------------

*----------------------------------------------------------------------------------------------
* Section 10c: Print variables in *.out file
* State variables, fluxes and rates given as momentary values.
* Volume,energy and mass changes given as cumulative values.
*----------------------------------------------------------------------------------------------

* Specify for all print variables whether output is wanted [Yes, No]
* When print variable is not in file; TOXSWA assumes 'No'

* PrintCumulatives: options for printing cumulatives of volume, energy and mass fluxes
* Yes   : cumulative terms have been summed up from start of simulation and have been
*         allocated to the last moment of the period considered
* No    : cumulative terms have been summed up from start of user defined output time step
*         OptDelTimPrn and have been allocated to the last moment of the period
*         considered
No          PrintCumulatives ! [Yes, No]

* Hydrology
No          print_DepWat             ! Water depth (m)
No          print_QBou               ! Discharge (m3.s-1)
No          print_VelWatFlw          ! Flow velocity (m.d-1)
No          print_VolErrWatLay       ! Volume error in waterbody (m3)

* Lateral entries (expressed per m2 adjacent field)
    * If OptLoa is 'PRZM'
    No          print_VvrLiqRnf           ! Runoff (+ infiltration) water flow (m3.m-2.hr-1)
    No          print_FlmRnf              ! Runoff substance flux (g.m-2.hr-1)
    No          print_FlmErs              ! Erosion substance flux (g.m-2.hr-1)

* Concentrations and contents in water layer segments as specified by
* OptOutputDistances
Yes         print_ConLiqWatLay       ! Concentration dissolved in water (g.m-3)
No          print_CntSorMph          ! Content sorbed to macrophytes (g.kg-1)
No          print_CntSorSusSol       ! Content sorbed to suspended solids (g.kg-1)
No          print_ConSysWatLay       ! Total concentration in water (g.m-3)

* Concentrations and contents in sediment below water layer segments as specified by
* OptOutputDistances and OptOutputDepths
No          print_ConLiqSed          ! Concentration in pore water sediment (g.m-3)
```

```
No          print_CntSorSed          ! Content sorbed to sediment (g.kg-1)
No          print_ConSysSed          ! Total content in sediment (g.m-3)
Yes         print_CntSedTgt          ! Total content in target layer sediment  (g.kg-1)
No          print_ConLiqSedTgt       ! Concentration in pore water in target layer
                                     ! sediment (g.m-3)
No          print_CntSorSedTgt       ! Content sorbed in target layer sediment (g.kg-1)

* Distribution in entire water layer
Yes         print_MasLiqWatLay       ! Mass in liquid phase in water layer (g)
Yes         print_MasSorSusSol       ! Mass sorbed to suspended solids in water layer (g)
Yes         print_MasSorMph          ! Mass sorbed to macrophytes in water layer (g)

* Distribution in entire sediment
Yes         print_MasLiqSed          ! Mass in liquid phase in sediment (g)
Yes         print_MasSorSed          ! Mass sorbed in sediment (g)

* Mass balance for entire water layer
Yes         print_MasWatLay          ! Mass in water layer (g)
Yes         print_MasDrfWatLay       ! Mass entered in water layer by spray drift (g)
Yes         print_MasDraWatLay       ! Mass entered in water layer by drainage (g)
Yes         print_MasRnfWatLay       ! Mass entered in water layer by runoff (g)
Yes         print_MasSedInWatLay     ! Mass penetrated into sediment from water layer (g)
Yes         print_MasSedOutWatLay    ! Mass transferred from sediment into water layer (g)
Yes         print_MasDwnWatLay       ! Mass flowed across downstream boundary out of
                                     ! water layer (g)
Yes         print_MasUpsWatLay       ! Mass flowed across upstream boundary into water
                                     ! layer (g)
Yes         print_MasTraWatLay       ! Mass transformed in water layer (g)
Yes         print_MasForWatLay       ! Mass formed in water layer (g)
Yes         print_MasVolWatLay       ! Mass volatilised from water layer (g)
No          print_MasErrWatLay       ! Mass error in water layer (g)

* Mass balance sediment
Yes         print_MasSed             ! Mass in sediment (g)
Yes         print_MasTraSed          ! Mass transformed in sediment (g)
Yes         print_MasForSed          ! Mass formed in sediment (g)
Yes         print_MasWatLayInSed     ! Mass transfered into water layer from sediment
                                     ! layer (g)
Yes         print_MasWatLayOutSed    ! Mass transfered from water layer into sediment
                                     ! layer (g)
Yes         print_MasDwnSed          ! Mass leaving sediment across lower boundary (g)
Yes         print_MasErsSed          ! Mass entering sediment by erosion (g)
No          print_MasErrSed          ! Mass error in sediment (g)

*--------------------------------------------------------------------------------------------
* End of TOXSWA input file
*--------------------------------------------------------------------------------------------
```

Appendix C – WISPE 26-Year Mass Totals from Field (Koc = 10)

	Bjornebekk_WCereal_SW		Syverud_WCereal_SW		Heia_Wcereal_SW		Bjornebekk_Potatoes_SW		Syverud_Potatoes_SW	
Year	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha
1965	1.16E-03	1.40E-06	1.58E-03	5.37E-06	1.38E-03	2.90E-08	8.16E-05	3.04E-08	4.11E-05	1.94E-08
1966	5.68E-04	3.74E-05	1.00E-03	7.33E-05	8.09E-04	5.46E-07	4.20E-06	6.01E-13	3.05E-05	4.21E-11
1967	2.19E-04	1.97E-08	4.12E-04	1.33E-07	3.42E-04	3.00E-09	4.34E-04	1.58E-07	6.31E-04	8.64E-07
1968	5.58E-04	1.35E-08	8.30E-04	1.28E-07	7.45E-04	2.17E-09	3.32E-04	8.21E-09	6.33E-04	1.10E-07
1969	1.07E-04	2.23E-09	1.90E-04	1.82E-08	1.52E-04	3.37E-10	1.64E-05	9.77E-11	2.33E-05	9.81E-10
1970	6.79E-04	2.81E-08	1.18E-03	2.80E-07	9.68E-04	4.48E-09	8.62E-04	1.28E-04	1.01E-03	2.32E-04
1971	6.14E-04	1.31E-08	7.32E-04	9.35E-08	6.80E-04	1.76E-09	2.43E-03	4.37E-06	2.53E-03	1.81E-05
1972	4.86E-04	3.87E-08	8.37E-04	2.74E-07	6.99E-04	5.00E-09	1.67E-03	1.17E-06	1.44E-03	4.31E-06
1973	2.22E-03	3.74E-07	3.26E-03	2.39E-06	2.83E-03	4.97E-08	3.98E-05	7.59E-10	7.22E-05	6.30E-09
1974	4.84E-04	3.13E-08	7.30E-04	2.10E-07	6.53E-04	4.13E-09	5.35E-05	1.35E-10	9.95E-05	2.22E-09
1975	4.80E-04	4.00E-05	6.93E-04	8.29E-05	5.95E-04	6.00E-07	8.48E-05	2.55E-07	9.84E-05	7.96E-08
1976	9.77E-06	2.81E-12	5.86E-05	2.11E-10	3.12E-05	1.55E-12	9.03E-05	3.42E-09	1.40E-04	1.79E-08
1977	1.51E-04	8.83E-10	4.25E-04	1.88E-08	2.94E-04	2.21E-10	1.03E-03	1.92E-04	9.00E-04	3.06E-04
1978	2.34E-04	1.18E-08	4.15E-04	1.00E-07	3.46E-04	2.02E-09	3.96E-04	4.90E-08	4.54E-04	2.12E-07
1979	9.69E-05	5.32E-09	1.92E-04	1.45E-08	1.49E-04	4.37E-10	2.31E-04	8.99E-07	2.19E-04	9.68E-07
1980	1.96E-03	4.74E-07	2.28E-03	1.96E-06	2.19E-03	4.22E-08	1.23E-04	4.89E-09	2.66E-04	2.96E-08
1981	4.66E-04	4.42E-05	5.68E-04	4.49E-05	4.82E-04	4.64E-07	5.48E-04	1.76E-07	5.43E-04	7.75E-07
1982	1.35E-03	6.25E-07	1.46E-03	3.08E-06	1.42E-03	5.59E-08	3.35E-05	8.42E-10	8.10E-05	8.68E-09
1983	7.98E-05	6.24E-10	1.75E-04	4.71E-09	1.26E-04	7.58E-11	4.06E-04	7.08E-08	5.24E-04	3.68E-07
1984	2.70E-03	1.59E-06	2.68E-03	6.71E-06	2.71E-03	1.53E-07	1.96E-04	1.66E-08	2.95E-04	7.10E-08
1985	7.57E-04	1.90E-08	1.34E-03	2.17E-07	1.11E-03	3.65E-09	4.18E-03	1.46E-05	4.97E-03	4.72E-05
1986	2.28E-03	7.57E-05	2.77E-03	1.50E-04	2.61E-03	1.25E-06	2.65E-04	1.06E-07	2.19E-04	3.04E-07
1987	2.86E-04	5.93E-07	7.53E-04	2.40E-06	5.46E-04	2.11E-08	7.57E-04	1.04E-07	8.84E-04	6.10E-07
1988	1.60E-03	3.70E-06	1.95E-03	1.05E-05	1.82E-03	2.86E-07	1.16E-03	5.84E-06	1.63E-03	9.96E-06
1989	2.01E-04	2.13E-09	4.74E-04	2.35E-08	3.43E-04	3.28E-10	1.03E-03	1.45E-04	9.24E-04	2.52E-04
1990	1.49E-03	4.33E-07	1.73E-03	1.99E-06	1.68E-03	4.04E-08	3.11E-06	2.81E-11	4.54E-06	3.00E-11
Total	2.12E-02	2.07E-04	2.87E-02	3.87E-04	2.57E-02	3.57E-06	1.64E-02	4.93E-04	1.87E-02	8.74E-04

Appendix D – WISPE 26-Year Mass Totals from Field (Koc = 1000)

	Bjornebekk_WCereal_SW		Syverud_WCereal_SW		Heia_Wcereal_SW		Bjornebekk_Potatoes_SW		Syverud_Potatoes_SW	
Year	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha
1965	1.27E-03	1.22E-04	6.88E-04	4.14E-04	9.15E-04	1.01E-05	6.26E-04	4.14E-05	4.08E-04	2.22E-04
1966	2.28E-03	1.63E-04	1.53E-03	6.14E-04	1.90E-03	1.60E-05	1.23E-03	7.11E-05	9.89E-04	4.03E-04
1967	8.12E-04	3.34E-05	8.17E-04	1.88E-04	8.56E-04	4.00E-06	1.14E-03	2.86E-04	8.82E-04	8.47E-04
1968	5.44E-04	2.74E-05	5.72E-04	1.22E-04	5.80E-04	2.35E-06	1.16E-03	3.99E-04	8.03E-04	1.11E-03
1969	1.74E-03	5.20E-05	1.44E-03	4.31E-04	1.61E-03	8.50E-06	8.34E-04	3.94E-05	9.10E-04	2.74E-04
1970	1.79E-03	8.74E-05	1.47E-03	4.42E-04	1.64E-03	1.09E-05	1.32E-03	5.41E-04	1.14E-03	1.20E-03
1971	1.44E-03	6.18E-05	1.26E-03	2.96E-04	1.37E-03	6.30E-06	1.37E-03	4.22E-04	1.04E-03	1.04E-03
1972	1.53E-03	4.82E-05	1.54E-03	2.81E-04	1.60E-03	5.45E-06	1.10E-03	3.30E-04	1.12E-03	7.13E-04
1973	1.61E-03	1.34E-04	1.20E-03	4.65E-04	1.37E-03	1.47E-05	9.04E-04	8.18E-05	8.09E-04	3.68E-04
1974	1.54E-03	5.94E-05	1.35E-03	3.42E-04	1.49E-03	7.45E-06	1.31E-03	1.65E-04	1.13E-03	7.07E-04
1975	7.94E-04	1.03E-04	8.84E-04	2.94E-04	8.71E-04	5.01E-06	1.44E-03	1.29E-04	1.26E-03	7.75E-04
1976	1.07E-03	2.83E-05	8.87E-04	2.36E-04	9.91E-04	4.39E-06	7.46E-04	1.71E-04	6.62E-04	5.92E-04
1977	2.98E-03	8.45E-05	2.49E-03	5.91E-04	2.75E-03	1.55E-05	1.66E-03	5.46E-04	1.76E-03	1.16E-03
1978	6.59E-04	2.43E-05	9.80E-04	1.33E-04	8.82E-04	2.78E-06	1.75E-03	2.76E-04	1.46E-03	9.93E-04
1979	8.93E-04	1.77E-05	8.16E-04	1.67E-04	8.87E-04	2.70E-06	1.12E-03	2.12E-04	8.32E-04	7.60E-04
1980	1.77E-03	9.44E-05	1.49E-03	4.07E-04	1.65E-03	9.53E-06	1.18E-03	2.07E-04	1.11E-03	7.18E-04
1981	1.98E-03	1.52E-04	1.62E-03	4.67E-04	1.82E-03	1.08E-05	1.27E-03	2.64E-04	1.14E-03	7.29E-04
1982	1.37E-03	6.08E-05	1.16E-03	3.19E-04	1.27E-03	7.44E-06	1.11E-03	1.41E-04	1.02E-03	6.32E-04
1983	1.52E-03	5.87E-05	1.18E-03	3.52E-04	1.35E-03	9.04E-06	1.27E-03	2.35E-04	1.03E-03	7.83E-04
1984	1.56E-03	8.05E-05	1.58E-03	3.39E-04	1.63E-03	8.05E-06	1.61E-03	2.73E-04	1.49E-03	1.00E-03
1985	9.27E-04	6.54E-05	1.13E-03	2.34E-04	1.12E-03	5.88E-06	2.34E-03	8.72E-04	1.57E-03	2.05E-03
1986	1.95E-03	2.27E-04	1.47E-03	6.47E-04	1.71E-03	1.34E-05	1.08E-03	9.21E-05	9.77E-04	3.90E-04
1987	1.31E-03	9.74E-05	1.00E-03	3.93E-04	1.14E-03	1.07E-05	1.16E-03	3.26E-04	9.02E-04	8.39E-04
1988	1.09E-03	6.80E-05	9.74E-04	2.93E-04	1.06E-03	6.54E-06	1.30E-03	4.11E-04	1.02E-03	1.10E-03
1989	2.60E-03	1.12E-04	2.14E-03	5.87E-04	2.37E-03	1.71E-05	1.54E-03	4.57E-04	1.45E-03	1.08E-03
1990	2.12E-03	7.59E-05	2.02E-03	4.03E-04	2.15E-03	9.42E-06	1.20E-03	7.05E-05	1.37E-03	4.14E-04
Total	3.91E-02	2.14E-03	3.37E-02	9.45E-03	3.70E-02	2.24E-04	3.27E-02	7.06E-03	2.83E-02	2.09E-02

Appendix E – WISPE 26-Year Mass Totals from Field (Koc = 10000)

Year	Bjornebekk_WCereal_SW		Syverud_WCereal_SW		Heia_Wcereal_SW		Bjornebekk_Potatoes_SW		Syverud_Potatoes_SW	
	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha
1965	1.53E-04	5.11E-04	6.43E-05	9.13E-04	9.36E-05	3.50E-05	9.38E-05	5.01E-04	4.10E-05	9.24E-04
1966	3.80E-04	1.02E-03	1.64E-04	1.93E-03	2.41E-04	7.96E-05	2.45E-04	9.67E-04	1.13E-04	1.81E-03
1967	2.67E-04	6.20E-04	1.24E-04	1.47E-03	1.80E-04	4.16E-05	2.76E-04	1.68E-03	1.24E-04	2.60E-03
1968	2.04E-04	5.74E-04	1.00E-04	1.43E-03	1.42E-04	3.19E-05	2.58E-04	1.80E-03	1.18E-04	2.69E-03
1969	4.52E-04	1.16E-03	2.18E-04	2.47E-03	3.08E-04	8.09E-05	3.29E-04	9.28E-04	1.65E-04	1.78E-03
1970	5.03E-04	1.20E-03	2.38E-04	2.61E-03	3.41E-04	8.21E-05	4.14E-04	1.89E-03	1.98E-04	3.09E-03
1971	4.53E-04	1.02E-03	2.14E-04	2.17E-03	3.08E-04	6.78E-05	3.85E-04	1.78E-03	1.79E-04	2.66E-03
1972	5.74E-04	9.75E-04	2.92E-04	2.31E-03	4.09E-04	7.56E-05	4.53E-04	1.49E-03	2.36E-04	2.45E-03
1973	4.23E-04	8.04E-04	2.09E-04	1.76E-03	2.94E-04	7.10E-05	3.02E-04	9.22E-04	1.61E-04	1.67E-03
1974	4.82E-04	1.03E-03	2.39E-04	2.29E-03	3.41E-04	7.16E-05	4.25E-04	1.73E-03	2.10E-04	2.83E-03
1975	3.70E-04	6.99E-04	1.95E-04	1.75E-03	2.71E-04	5.22E-05	4.82E-04	2.07E-03	2.40E-04	3.33E-03
1976	3.09E-04	7.99E-04	1.52E-04	1.69E-03	2.15E-04	5.78E-05	2.58E-04	1.04E-03	1.31E-04	1.59E-03
1977	9.10E-04	1.62E-03	4.37E-04	3.58E-03	6.28E-04	1.62E-04	7.11E-04	2.19E-03	3.55E-04	3.61E-03
1978	4.90E-04	5.27E-04	2.65E-04	1.35E-03	3.70E-04	5.91E-05	5.97E-04	2.06E-03	3.06E-04	3.01E-03
1979	3.00E-04	7.48E-04	1.52E-04	1.66E-03	2.12E-04	4.84E-05	2.99E-04	1.55E-03	1.47E-04	2.25E-03
1980	4.98E-04	1.03E-03	2.46E-04	2.28E-03	3.46E-04	8.63E-05	4.02E-04	1.48E-03	2.03E-04	2.46E-03
1981	5.31E-04	1.13E-03	2.58E-04	2.33E-03	3.65E-04	8.57E-05	4.06E-04	1.47E-03	2.01E-04	2.37E-03
1982	3.90E-04	8.14E-04	1.98E-04	1.88E-03	2.76E-04	5.99E-05	3.61E-04	1.52E-03	1.85E-04	2.58E-03
1983	3.83E-04	8.89E-04	1.85E-04	1.87E-03	2.63E-04	5.93E-05	3.47E-04	1.64E-03	1.67E-04	2.57E-03
1984	5.97E-04	1.04E-03	3.00E-04	2.37E-03	4.23E-04	1.02E-04	5.51E-04	1.97E-03	2.77E-04	3.01E-03
1985	5.14E-04	9.19E-04	2.61E-04	2.12E-03	3.80E-04	8.93E-05	5.65E-04	2.74E-03	2.67E-04	3.69E-03
1986	4.45E-04	1.10E-03	2.17E-04	2.17E-03	3.05E-04	7.07E-05	3.36E-04	1.10E-03	1.68E-04	1.83E-03
1987	3.32E-04	7.99E-04	1.60E-04	1.68E-03	2.28E-04	5.22E-05	3.11E-04	1.62E-03	1.50E-04	2.47E-03
1988	3.32E-04	7.72E-04	1.69E-04	1.80E-03	2.38E-04	5.04E-05	3.50E-04	1.88E-03	1.71E-04	2.91E-03
1989	7.72E-04	1.39E-03	3.75E-04	3.11E-03	5.34E-04	1.31E-04	5.93E-04	1.78E-03	2.95E-04	2.88E-03
1990	7.69E-04	1.15E-03	3.85E-04	2.61E-03	5.44E-04	1.07E-04	6.00E-04	1.38E-03	3.08E-04	2.46E-03
Total	1.18E-02	2.43E-02	5.82E-03	5.36E-02	8.25E-03	1.91E-03	1.03E-02	4.12E-02	5.12E-03	6.55E-02

Appendix F – SWASH 20 -Year Mass Totals from Field (Koc = 10)

	Weiherbach,Ger-R1_WC		Bologna, Italy – R3_WC		Roujan, France – R4_WC		Weiherbach,Ger-R1_PO		Porto, Portugal – R2_PO		Bologna, Italy – R3_PO	
Year	**RFLX, kg/ha**	**EFLX, kg/ha**	**RFLX, kg/ha**	**EFLX, kg/ha**	**RFLX, kg/ha**	**EFLX, kg/ha**	**RFLX, kg/ha**	**EFLX, kg/ha**	**RFLX, kg/ha**	**EFLX, kg/ha**	**RFLX, kg/ha**	**EFLX, kg/ha**
1975	8.31E-06	1.07E-11	5.55E-04	1.69E-07	1.27E-04	7.13E-11	9.21E-09	1.06E-16	2.75E-04	1.44E-08	1.07E-05	2.21E-12
1976	3.52E-07	1.71E-13	9.86E-04	1.74E-07	6.59E-04	6.36E-08	1.79E-03	2.27E-07	5.72E-04	1.09E-07	1.54E-04	2.84E-09
1977	3.24E-05	7.85E-11	2.80E-03	1.05E-06	9.64E-04	1.93E-08	3.41E-07	4.69E-13	5.95E-04	4.60E-08	5.53E-03	4.14E-06
1978	3.62E-05	1.07E-10	9.69E-04	8.50E-08	1.56E-06	1.16E-10	8.72E-05	3.94E-10	1.51E-04	5.57E-08	4.20E-04	1.39E-08
1979	3.86E-04	6.48E-09	4.21E-03	5.94E-07	6.47E-04	3.88E-08	1.67E-04	3.45E-09	1.44E-03	2.29E-06	1.11E-03	3.07E-08
1980	1.67E-04	3.17E-08	3.43E-03	7.36E-07	1.70E-04	1.77E-09	1.10E-05	1.11E-11	4.55E-05	3.68E-09	2.34E-04	1.34E-08
1981	7.82E-09	4.47E-16	6.18E-06	4.49E-12	1.75E-04	9.36E-10	3.82E-03	2.08E-06	4.97E-04	1.40E-08	5.27E-05	6.63E-10
1982	1.10E-03	1.49E-07	4.64E-03	2.22E-06	2.35E-03	2.73E-07	9.55E-05	6.48E-10	2.04E-03	1.12E-04	2.95E-04	2.18E-08
1983	1.17E-04	4.50E-09	3.88E-05	1.31E-10	8.82E-03	1.05E-06	6.61E-05	4.75E-10	2.87E-06	9.03E-13	7.24E-04	6.99E-08
1984	1.13E-05	7.07E-11	2.47E-04	1.08E-08	1.98E-04	1.34E-09	1.52E-05	3.14E-11	1.81E-04	2.99E-08	1.47E-05	1.14E-10
1985	1.08E-03	2.46E-08	3.17E-04	8.51E-08	3.46E-06	1.30E-12	6.13E-05	1.82E-08	1.08E-04	1.12E-08	6.82E-06	1.16E-11
1986	6.92E-05	8.83E-10	9.34E-04	6.81E-08	1.56E-03	4.53E-08	1.08E-04	3.16E-09	1.58E-03	1.69E-06	1.75E-04	3.91E-08
1987	5.02E-05	1.44E-09	1.75E-03	3.52E-07	1.04E-03	4.79E-08	5.81E-05	2.77E-12	1.18E-05	9.01E-11	1.99E-05	1.77E-10
1988	5.47E-05	2.92E-10	1.36E-03	2.38E-07	8.28E-04	5.06E-08	1.58E-04	7.17E-09	1.95E-04	7.50E-08	1.64E-04	4.81E-08
1989	5.59E-05	2.85E-10	6.35E-06	8.05E-10	8.17E-04	8.51E-08	8.14E-06	5.04E-12	1.45E-03	7.84E-07	6.90E-04	1.70E-07
1990	1.01E-04	7.78E-10	1.73E-03	7.35E-08	3.77E-04	4.87E-09	2.58E-05	5.48E-12	3.60E-04	6.74E-08	2.64E-03	1.08E-06
1991	7.67E-06	2.01E-11	6.34E-04	4.06E-08	7.24E-04	6.74E-08	6.72E-05	1.83E-09	2.29E-03	4.10E-06	1.52E-04	7.73E-09
1992	2.91E-04	3.67E-09	6.05E-04	3.37E-08	1.58E-04	6.10E-09	8.70E-06	5.40E-10	2.05E-05	1.08E-10	3.17E-03	1.78E-06
1993	8.45E-05	3.25E-08	4.48E-06	3.80E-11	4.24E-03	4.72E-07	2.28E-05	2.28E-11	2.25E-07	1.10E-12	5.96E-04	6.78E-08
1994	9.96E-09	1.83E-16	2.00E-03	2.36E-07	1.93E-03	7.20E-08	3.60E-04	3.81E-08	5.37E-04	1.28E-07	5.84E-04	1.38E-07
Total	3.66E-03	2.57E-07	2.72E-02	6.17E-06	2.58E-02	2.30E-06	6.93E-03	2.38E-06	1.24E-02	1.21E-04	1.67E-02	7.62E-06

Appendix G – SWASH 20 -Year Mass Totals from Field (Koc = 1000)

	Weiherbach,Ger-R1_WC		Bologna, Italy – R3_WC		Roujan, France – R4_WC		Weiherbach,Ger-R1_PO		Porto, Portugal – R2_PO		Bologna, Italy – R3_PO	
Year	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha
1975	7.72E-05	1.53E-06	1.23E-04	1.23E-05	3.46E-04	1.03E-05	6.61E-04	6.76E-06	1.89E-04	2.48E-05	4.32E-04	6.50E-06
1976	1.42E-04	9.16E-07	7.09E-04	6.93E-05	2.61E-03	3.13E-05	7.51E-04	1.13E-04	5.50E-04	1.58E-04	3.98E-04	8.38E-06
1977	3.05E-04	5.13E-05	2.24E-03	4.25E-04	3.82E-03	6.40E-05	2.36E-04	1.68E-06	5.51E-04	2.02E-04	1.42E-03	3.63E-04
1978	5.16E-04	3.66E-06	1.53E-03	2.16E-04	9.92E-04	3.06E-06	2.47E-03	1.78E-04	4.23E-04	1.85E-05	6.51E-04	2.45E-05
1979	3.72E-04	5.55E-05	1.57E-03	4.22E-04	2.08E-03	3.63E-05	4.69E-04	5.48E-05	6.11E-04	1.13E-04	7.27E-04	9.97E-05
1980	1.23E-04	2.12E-06	1.36E-03	3.43E-04	1.36E-03	8.73E-05	4.79E-04	6.04E-05	2.24E-04	2.23E-05	4.00E-04	2.77E-05
1981	3.13E-04	2.25E-06	1.06E-04	4.69E-07	8.96E-04	7.77E-06	1.31E-03	2.50E-04	1.10E-03	8.59E-04	3.76E-04	5.44E-06
1982	5.59E-04	2.17E-05	1.14E-03	2.49E-04	3.11E-03	2.72E-04	7.54E-04	1.37E-04	5.46E-04	4.09E-04	4.90E-04	2.50E-05
1983	1.37E-04	3.13E-06	1.89E-04	1.90E-06	3.65E-03	2.43E-04	4.84E-04	2.96E-05	4.18E-04	2.20E-05	1.01E-03	1.07E-04
1984	3.35E-04	4.44E-06	6.95E-04	6.92E-05	3.66E-03	1.61E-04	3.01E-04	4.14E-06	6.66E-04	1.55E-04	4.92E-04	1.05E-05
1985	5.64E-04	1.14E-04	2.00E-04	1.43E-05	5.91E-04	2.40E-06	2.90E-04	5.04E-06	3.42E-04	8.71E-05	3.86E-04	1.12E-05
1986	6.60E-04	3.48E-05	1.27E-03	1.62E-04	1.48E-03	2.79E-05	5.69E-04	3.10E-05	5.09E-04	1.37E-04	5.47E-04	3.11E-05
1987	7.23E-05	6.97E-07	1.42E-03	1.55E-04	1.91E-03	4.29E-05	2.08E-04	2.30E-05	4.33E-04	1.98E-05	9.98E-04	2.75E-05
1988	4.47E-04	8.04E-06	2.43E-04	4.44E-05	9.22E-04	5.76E-05	1.90E-04	5.07E-06	3.26E-04	5.23E-05	4.09E-04	4.71E-06
1989	5.30E-04	5.40E-05	6.13E-04	2.43E-06	1.34E-03	2.14E-05	3.52E-04	7.27E-06	9.18E-04	6.38E-04	1.20E-03	7.87E-05
1990	1.90E-04	9.28E-06	1.93E-03	2.52E-04	8.07E-04	2.70E-05	3.60E-04	7.13E-06	3.03E-04	6.45E-05	2.12E-03	2.89E-04
1991	9.98E-05	1.49E-06	1.54E-03	1.44E-04	5.65E-04	2.36E-05	3.74E-04	6.45E-06	1.08E-03	8.31E-04	3.15E-04	5.30E-06
1992	5.57E-04	3.63E-05	1.76E-03	2.19E-04	1.88E-03	5.96E-06	6.94E-04	1.71E-05	4.38E-04	5.89E-05	1.07E-03	1.67E-04
1993	1.28E-04	1.94E-06	1.09E-04	5.80E-07	3.19E-03	1.30E-04	2.32E-04	3.86E-06	1.66E-04	5.88E-06	3.92E-04	7.04E-06
1994	8.21E-05	7.08E-07	1.19E-03	2.57E-04	5.27E-03	1.82E-04	4.24E-04	1.42E-05	3.62E-04	8.25E-05	8.00E-04	4.59E-05
Total	6.21E-03	4.07E-04	1.99E-02	3.06E-03	4.05E-02	1.44E-03	1.16E-02	9.55E-04	1.02E-02	3.96E-03	1.46E-02	1.35E-03

Appendix H – SWASH 20 -Year Mass Totals from Field (Koc = 10000)

	Weiherbach,Ger-R1_WC		Bologna, Italy – R3_WC		Roujan, France – R4_WC		Weiherbach,Ger-R1_PO		Porto, Portugal – R2_PO		Bologna, Italy – R3_PO	
Year	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha
1975	8.42E-06	9.56E-06	1.16E-05	2.34E-05	4.63E-05	6.05E-05	1.45E-04	4.17E-04	2.17E-05	1.75E-04	1.19E-04	2.29E-04
1976	5.03E-05	8.58E-05	1.17E-04	2.58E-04	6.85E-04	7.08E-04	1.73E-04	4.31E-04	8.14E-05	8.03E-04	1.10E-04	1.84E-04
1977	6.68E-05	2.19E-04	2.91E-04	1.41E-03	1.03E-03	9.86E-04	8.88E-05	1.56E-04	1.04E-04	6.93E-04	2.26E-04	9.19E-04
1978	3.55E-04	3.73E-04	2.22E-04	8.06E-04	4.41E-04	1.94E-04	5.65E-04	1.50E-03	8.96E-05	6.34E-04	1.72E-04	2.47E-04
1979	6.84E-05	1.58E-04	2.01E-04	9.73E-04	4.67E-04	5.28E-04	1.35E-04	2.91E-04	1.04E-04	5.83E-04	1.63E-04	4.09E-04
1980	7.39E-05	7.41E-05	1.60E-04	8.53E-04	2.57E-04	5.99E-04	1.50E-04	4.68E-04	4.02E-05	2.51E-04	1.01E-04	1.85E-04
1981	1.86E-04	1.68E-04	3.30E-05	7.84E-05	2.43E-04	1.15E-04	3.53E-04	9.03E-04	1.34E-04	1.87E-03	9.20E-05	1.92E-04
1982	2.01E-04	1.97E-04	1.32E-04	5.56E-04	5.27E-04	1.11E-03	2.78E-04	7.25E-04	7.63E-05	9.68E-04	1.08E-04	2.63E-04
1983	8.42E-05	6.09E-05	5.47E-05	8.79E-05	5.62E-04	8.62E-04	1.62E-04	3.02E-04	7.24E-05	4.60E-04	1.84E-04	5.44E-04
1984	9.74E-05	9.21E-05	1.34E-04	3.79E-04	8.12E-04	1.28E-03	1.36E-04	2.24E-04	1.20E-04	8.23E-04	1.39E-04	2.86E-04
1985	1.01E-04	3.12E-04	2.96E-05	5.88E-05	2.22E-04	8.94E-05	1.07E-04	1.85E-04	6.59E-05	5.18E-04	8.33E-05	1.75E-04
1986	1.96E-04	3.14E-04	2.15E-04	6.55E-04	5.08E-04	2.32E-04	2.43E-04	4.00E-04	8.04E-05	6.93E-04	1.52E-04	3.06E-04
1987	3.94E-05	2.77E-05	2.09E-04	8.02E-04	7.54E-04	3.81E-04	8.06E-05	1.53E-04	8.55E-05	5.01E-04	1.84E-04	4.51E-04
1988	1.00E-04	8.47E-05	5.26E-05	1.28E-04	5.24E-04	3.20E-04	1.41E-04	1.93E-04	5.19E-05	3.64E-04	1.09E-04	2.14E-04
1989	8.60E-05	2.08E-04	1.57E-04	3.21E-04	2.51E-04	2.11E-04	1.22E-04	2.34E-04	1.18E-04	1.71E-03	2.54E-04	5.38E-04
1990	5.52E-05	8.59E-05	2.74E-04	8.58E-04	1.38E-04	1.39E-04	1.25E-04	2.01E-04	4.86E-05	3.86E-04	3.60E-04	1.30E-03
1991	4.94E-05	8.97E-05	1.92E-04	1.02E-03	1.04E-04	1.11E-04	1.06E-04	2.18E-04	1.24E-04	2.00E-03	1.03E-04	1.72E-04
1992	9.78E-05	1.77E-04	2.51E-04	8.98E-04	6.62E-04	3.64E-04	1.70E-04	3.51E-04	5.59E-05	4.60E-04	2.47E-04	5.91E-04
1993	3.99E-05	5.05E-05	5.23E-05	5.73E-05	6.79E-04	1.03E-03	7.99E-05	1.42E-04	2.78E-05	2.06E-04	1.53E-04	2.01E-04
1994	2.23E-05	4.12E-05	1.70E-04	7.93E-04	1.01E-03	1.43E-03	9.87E-05	2.00E-04	5.20E-05	4.87E-04	1.99E-04	4.30E-04
Total	1.98E-03	2.83E-03	2.96E-03	1.10E-02	9.92E-03	1.08E-02	3.46E-03	7.70E-03	1.55E-03	1.46E-02	3.26E-03	7.84E-03

Appendix I - WISPE Crop Scenarios 26-year Maximum and 90th percentile PECs

Koc	WISPE Scenario	Field area, ha	Crop	Water-body	Max PEC in Water, ug/L	90th %ile Time-weighted Average PECs in Water, ug/L						
						Peak	1-day	4-day	21-day	60-day	90-day	Annual
10	Bjornebekk_WCereal_SW	0.02	Winter cereal	Pond	0.07250	0.06461	0.06451	0.06435	0.06342	0.06156	0.06028	0.04228
10	Syverud_WCereal_SW	0.04	Winter cereal	Pond	0.18000	0.16110	0.16080	0.16080	0.15820	0.15400	0.15070	0.10550
10	Heia_Wcereal_SW	0.024	Winter cereal	Pond	0.09900	0.08665	0.08652	0.08618	0.08468	0.08217	0.08042	0.05706
10	Bjornebekk_WCereal_SW	0.02	Winter cereal	Stream	1.80000	1.03900	0.52560	0.17290	0.03661	0.01281	0.00855	0.00211
10	Syverud_WCereal_SW	0.04	Winter cereal	Stream	3.57000	2.88300	1.45800	0.44130	0.08869	0.03120	0.02082	0.00513
10	Heia_Wcereal_SW	0.024	Winter cereal	Stream	2.16000	1.59200	0.80610	0.25150	0.05130	0.01801	0.01202	0.00296
10	Bjornebekk_Potatoes_SW	0.02	Potatoes	Pond	0.09640	0.06487	0.06477	0.06444	0.06278	0.05843	0.05529	0.04193
10	Syverud_Potatoes_SW	0.04	Potatoes	Pond	0.23100	0.13690	0.13690	0.13660	0.13430	0.12820	0.12340	0.09024
10	Bjornebekk_Potatoes_SW	0.02	Potatoes	Stream	2.49000	1.24700	0.63070	0.16050	0.03079	0.01078	0.00719	0.00177
10	Syverud_Potatoes_SW	0.04	Potatoes	Stream	5.35000	2.27800	1.15400	0.31170	0.06182	0.02176	0.01447	0.00357
1000	Bjornebekk_WCereal_SW	0.02	Winter cereal	Pond	0.04810	0.04084	0.04024	0.03872	0.03573	0.03197	0.02982	0.02132
1000	Syverud_WCereal_SW	0.04	Winter cereal	Pond	0.08480	0.07526	0.07455	0.07257	0.06735	0.06333	0.06128	0.04510
1000	Heia_Wcereal_SW	0.024	Winter cereal	Pond	0.04860	0.04185	0.04134	0.04007	0.03665	0.03379	0.03261	0.02345
1000	Bjornebekk_WCereal_SW	0.02	Winter cereal	Stream	0.39600	0.38730	0.19580	0.07746	0.02942	0.01196	0.00822	0.00237
1000	Syverud_WCereal_SW	0.04	Winter cereal	Stream	0.56800	0.55260	0.28050	0.12100	0.04456	0.02107	0.01482	0.00456
1000	Heia_Wcereal_SW	0.024	Winter cereal	Stream	0.35200	0.34280	0.17290	0.07316	0.02602	0.01231	0.00856	0.00256
1000	Bjornebekk_Potatoes_SW	0.02	Potatoes	Pond	0.04750	0.03183	0.03150	0.03051	0.02855	0.02692	0.02608	0.02180
1000	Syverud_Potatoes_SW	0.04	Potatoes	Pond	0.10100	0.07373	0.07324	0.07172	0.06708	0.06339	0.06124	0.05297
1000	Bjornebekk_Potatoes_SW	0.02	Potatoes	Stream	0.45400	0.36290	0.18330	0.05357	0.01681	0.00799	0.00591	0.00189
1000	Syverud_Potatoes_SW	0.04	Potatoes	Stream	0.84200	0.61010	0.31010	0.10010	0.03579	0.01701	0.01229	0.00442
10000	Bjornebekk_WCereal_SW	0.02	Winter cereal	Pond	0.01070	0.00858	0.00769	0.00641	0.00475	0.00430	0.00414	0.00320
10000	Syverud_WCereal_SW	0.04	Winter cereal	Pond	0.02700	0.02231	0.02035	0.01741	0.01392	0.01329	0.01264	0.01030
10000	Heia_Wcereal_SW	0.024	Winter cereal	Pond	0.00494	0.00367	0.00327	0.00276	0.00185	0.00171	0.00165	0.00120
10000	Bjornebekk_WCereal_SW	0.02	Winter cereal	Stream	0.14300	0.13780	0.06972	0.03266	0.01155	0.00596	0.00441	0.00170

Koc	WISPE Scenario	Field area, ha	Crop	Water-body	Max PEC in Water, ug/L	90th %ile Time-weighted Average PECs in Water, ug/L						
						Peak	1-day	4-day	21-day	60-day	90-day	Annual
10000	Syverud_WCereal_SW	0.04	Winter cereal	Stream	0.38300	0.32030	0.16330	0.07554	0.02872	0.01571	0.01182	0.00480
10000	Heia_Wcereal_SW	0.024	Winter cereal	Stream	0.07430	0.06750	0.03423	0.01397	0.00523	0.00251	0.00184	0.00078
10000	Bjornebekk_Potatoes_SW	0.02	Potatoes	Pond	0.01760	0.01387	0.01258	0.00981	0.00680	0.00584	0.00561	0.00461
10000	Syverud_Potatoes_SW	0.04	Potatoes	Pond	0.04430	0.03371	0.03031	0.02470	0.01792	0.01589	0.01536	0.01206
10000	Bjornebekk_Potatoes_SW	0.02	Potatoes	Stream	0.31100	0.28330	0.14330	0.04757	0.01665	0.00898	0.00703	0.00217
10000	Syverud_Potatoes_SW	0.04	Potatoes	Stream	0.75100	0.73280	0.37260	0.12460	0.04379	0.02376	0.01803	0.00547

Appendix J - SWASH Crop Scenarios run in SWASH - 1-year PECs

Koc	SWASH Scenario	Field area, ha	Crop	Water-body	Year	Global Max in Water, ug/L	Time-weighted Average PECs in Water, ug/L										
							1 day	2 days	3 days	4 days	7 days	14 days	21 days	28 days	42 days	50 days	100 days
10	WG -R1	0.45	W cereal	Pond	1978	0.01759	0.01747	0.01736	0.01727	0.01717	0.01690	0.01635	0.01584	0.01537	0.01458	0.01412	0.01147
10	WG-R1	1	W cereal	Stream	1978	0.80750	0.31960	0.15990	0.10660	0.07996	0.04570	0.02498	0.01665	0.01249	0.00867	0.00728	0.00364
10	BI – R3	1	W cereal	Stream	1980	7.23400	3.78300	2.37400	1.61300	1.21700	0.69560	0.34790	0.23210	0.17410	0.11610	0.09749	0.04875
10	RF–R4	1	W cereal	Stream	1979	6.73500	2.88700	1.44400	0.96270	0.73650	0.42220	0.21110	0.14070	0.10560	0.07037	0.05912	0.02956
10	WG-R1	0.45	Potatoes	Pond	1984	0.00727	0.00722	0.00717	0.00713	0.00708	0.00696	0.00675	0.00656	0.00633	0.00589	0.00565	0.00439
10	WG-R1	1	Potatoes	Stream	1984	1.31800	0.56840	0.28430	0.18960	0.14220	0.08126	0.04155	0.02770	0.02078	0.01385	0.01163	0.00582
10	PP–R2	1	Potatoes	Stream	1977	6.26600	1.64400	0.82240	0.71520	0.53650	0.30660	0.15330	0.10220	0.07666	0.05111	0.04293	0.02147
10	BI–R3	1	Potatoes	Stream	1980	8.71100	3.59200	2.31900	1.54700	1.16100	0.66350	0.34090	0.22730	0.17050	0.11370	0.09550	0.04776
1000	WG-1	0.45	W cereal	Pond	1978	0.06847	0.06749	0.06662	0.06584	0.06513	0.06330	0.05991	0.05716	0.05476	0.05339	0.05284	0.04516
1000	WG-R1	1	W cereal	Stream	1978	0.70970	0.28010	0.17340	0.15950	0.11980	0.06862	0.03437	0.02306	0.01744	0.01740	0.01463	0.01018
1000	BI – R3	1	W cereal	Stream	1980	0.87450	0.71400	0.58600	0.45510	0.41280	0.23990	0.12270	0.09723	0.07380	0.05643	0.04784	0.02637
1000	RF–R4	1	W cereal	Stream	1979	1.21000	0.83620	0.74370	0.64180	0.49040	0.35440	0.17770	0.11860	0.08905	0.05946	0.04999	0.02821
1000	WG-R1	0.45	Potatoes	Pond	1984	0.05526	0.05469	0.05416	0.05365	0.05317	0.05185	0.04914	0.04669	0.04510	0.04499	0.04393	0.03673
1000	WG-R1	1	Potatoes	Stream	1984	0.54330	0.28130	0.14090	0.09403	0.07058	0.06814	0.05072	0.03765	0.03388	0.02493	0.02411	0.01396
1000	PP–R2	1	Potatoes	Stream	1977	0.21320	0.12600	0.07901	0.06449	0.05639	0.05029	0.02982	0.02288	0.01717	0.01417	0.01372	0.00813
1000	BI–R3	1	Potatoes	Stream	1980	0.88000	0.43740	0.34760	0.23280	0.19980	0.11520	0.10790	0.08542	0.06710	0.05643	0.04750	0.02959
10000	WG-1	0.45	W cereal	Pond	1978	0.01406	0.01381	0.01358	0.01334	0.01312	0.01250	0.01126	0.01026	0.00945	0.00898	0.00882	0.00707
10000	WG-R1	1	W cereal	Stream	1978	0.08873	0.05114	0.03890	0.03463	0.02599	0.01488	0.00747	0.00499	0.00377	0.00331	0.00318	0.00194
10000	BI – R3	1	W cereal	Stream	1980	0.07897	0.07145	0.05640	0.04464	0.04159	0.02522	0.01424	0.01204	0.00960	0.00794	0.00701	0.00454
10000	RF–R4	1	W cereal	Stream	1979	0.12930	0.12930	0.12690	0.10300	0.07874	0.05259	0.02773	0.01998	0.01574	0.01085	0.00924	0.00574
10000	WG-R1	0.45	Potatoes	Pond	1984	0.01342	0.01327	0.01313	0.01298	0.01285	0.01246	0.01167	0.01138	0.01103	0.01019	0.00969	0.00952
10000	WG-R1	1	Potatoes	Stream	1984	0.07709	0.05423	0.02732	0.01825	0.01371	0.01047	0.00811	0.00601	0.00516	0.00435	0.00402	0.00265
10000	PP–R2	1	Potatoes	Stream	1977	0.01962	0.01576	0.01083	0.00823	0.00764	0.00666	0.00380	0.00299	0.00228	0.00183	0.00172	0.00125
10000	BI–R3	1	Potatoes	Stream	1980	0.08015	0.06171	0.03382	0.02268	0.02114	0.01224	0.01071	0.00877	0.00700	0.00637	0.00542	0.00404

WG = Weiherbach, Germany; BI = Bologna, Italy; RF = Roujan, France; PP = Porto, Portugal

Appendix K – SWASH Scenario PRZM/EXAMS 20 -Year Mass Totals from Field (Koc = 10)

	Weiherbach,Ger-R1_WC		Bologna, Italy – R3_WC		Roujan, France – R4_WC		Weiherbach,Ger-R1_PO		Porto, Portugal – R2_PO		Bologna, Italy – R3_PO	
Year	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha
1975	8.31E-06	1.07E-11	2.58E-05	8.61E-11	4.18E-06	3.62E-13	9.21E-09	1.06E-16	2.75E-04	1.45E-08	1.07E-05	2.22E-12
1976	3.52E-07	1.71E-13	9.86E-04	1.75E-07	6.59E-04	6.40E-08	1.79E-03	2.28E-07	5.72E-04	1.10E-07	1.54E-04	2.85E-09
1977	3.24E-05	7.85E-11	2.80E-03	1.06E-06	9.65E-04	1.94E-08	3.41E-07	4.69E-13	5.95E-04	4.63E-08	5.53E-03	4.16E-06
1978	3.62E-05	1.07E-10	9.69E-04	8.55E-08	1.56E-06	1.17E-10	8.72E-05	3.94E-10	1.51E-04	5.60E-08	4.20E-04	1.40E-08
1979	3.87E-04	6.48E-09	4.21E-03	5.98E-07	6.47E-04	3.91E-08	1.68E-04	3.45E-09	1.44E-03	2.31E-06	1.11E-03	3.09E-08
1980	1.67E-04	3.17E-08	3.43E-03	7.40E-07	1.70E-04	1.78E-09	1.10E-05	1.11E-11	4.55E-05	3.70E-09	2.34E-04	1.35E-08
1981	7.82E-09	4.47E-16	6.18E-06	4.51E-12	1.75E-04	9.41E-10	3.82E-03	2.08E-06	4.97E-04	1.41E-08	5.27E-05	6.67E-10
1982	1.10E-03	1.49E-07	4.64E-03	2.23E-06	2.35E-03	2.75E-07	9.55E-05	6.48E-10	2.04E-03	1.12E-04	2.95E-04	2.20E-08
1983	1.17E-04	4.50E-09	3.88E-05	1.32E-10	8.82E-03	1.05E-06	6.61E-05	4.75E-10	2.87E-06	9.09E-13	7.24E-04	7.03E-08
1984	1.13E-05	7.07E-11	2.47E-04	1.08E-08	1.98E-04	1.35E-09	1.52E-05	3.15E-11	1.81E-04	3.01E-08	1.47E-05	1.15E-10
1985	1.08E-03	2.46E-08	3.17E-04	8.56E-08	3.46E-06	1.31E-12	6.13E-05	1.82E-08	1.08E-04	1.13E-08	6.82E-06	1.17E-11
1986	6.92E-05	8.83E-10	9.34E-04	6.85E-08	1.56E-03	4.55E-08	1.08E-04	3.16E-09	1.58E-03	1.70E-06	1.75E-04	3.93E-08
1987	5.02E-05	1.44E-09	1.75E-03	3.54E-07	1.04E-03	4.82E-08	5.81E-05	2.78E-12	1.18E-05	9.06E-11	2.00E-05	1.78E-10
1988	5.47E-05	2.92E-10	1.36E-03	2.39E-07	8.28E-04	5.09E-08	1.58E-04	7.17E-09	1.95E-04	7.55E-08	1.64E-04	4.84E-08
1989	5.59E-05	2.85E-10	6.35E-06	8.09E-10	8.17E-04	8.56E-08	8.14E-06	5.04E-12	1.45E-03	7.88E-07	6.90E-04	1.71E-07
1990	1.01E-04	7.78E-10	1.73E-03	7.39E-08	3.77E-04	4.90E-09	2.58E-05	5.48E-12	3.60E-04	6.78E-08	2.64E-03	1.09E-06
1991	7.67E-06	2.01E-11	6.34E-04	4.08E-08	7.24E-04	6.78E-08	6.72E-05	1.83E-09	2.29E-03	4.12E-06	1.52E-04	7.77E-09
1992	2.91E-04	3.67E-09	6.05E-04	3.40E-08	1.58E-04	6.13E-09	8.70E-06	5.40E-10	2.05E-05	1.08E-10	3.17E-03	1.79E-06
1993	8.45E-05	3.25E-08	4.48E-06	3.82E-11	4.24E-03	4.75E-07	2.28E-05	2.28E-11	2.25E-07	1.11E-12	5.96E-04	6.82E-08
1994	9.96E-09	1.83E-16	2.00E-03	2.37E-07	1.93E-03	7.24E-08	3.60E-04	3.81E-08	5.37E-04	1.29E-07	5.84E-04	1.39E-07
Total	3.66E-03	2.57E-07	2.67E-02	6.04E-06	2.57E-02	2.31E-06	6.93E-03	2.38E-06	1.24E-02	1.22E-04	1.67E-02	7.67E-06

Appendix L – SWASH Scenario 20 -Year PRZM/EXAMS Mass Totals from Field (Koc = 1000)

	Weiherbach,Ger-R1_WC		Bologna, Italy – R3_WC		Roujan, France – R4_WC		Weiherbach,Ger-R1_PO		Porto, Portugal – R2_PO		Bologna, Italy – R3_PO	
Year	**RFLX, kg/ha**	**EFLX, kg/ha**	**RFLX, kg/ha**	**EFLX, kg/ha**	**RFLX, kg/ha**	**EFLX, kg/ha**	**RFLX, kg/ha**	**EFLX, kg/ha**	**RFLX, kg/ha**	**EFLX, kg/ha**	**RFLX, kg/ha**	**EFLX, kg/ha**
1975	7.72E-05	1.53E-06	8.41E-05	2.65E-06	1.93E-04	5.85E-07	6.62E-04	6.76E-06	1.89E-04	2.50E-05	4.32E-04	6.54E-06
1976	1.42E-04	9.17E-07	7.07E-04	6.97E-05	2.61E-03	3.14E-05	7.51E-04	1.13E-04	5.50E-04	1.59E-04	3.98E-04	8.43E-06
1977	3.06E-04	5.13E-05	2.24E-03	4.27E-04	3.82E-03	6.44E-05	2.36E-04	1.68E-06	5.51E-04	2.03E-04	1.42E-03	3.65E-04
1978	5.16E-04	3.66E-06	1.53E-03	2.17E-04	9.92E-04	3.07E-06	2.47E-03	1.78E-04	4.23E-04	1.86E-05	6.51E-04	2.46E-05
1979	3.72E-04	5.55E-05	1.57E-03	4.24E-04	2.08E-03	3.65E-05	4.69E-04	5.48E-05	6.11E-04	1.14E-04	7.27E-04	1.00E-04
1980	1.23E-04	2.12E-06	1.36E-03	3.45E-04	1.36E-03	8.78E-05	4.79E-04	6.04E-05	2.24E-04	2.25E-05	4.00E-04	2.79E-05
1981	3.13E-04	2.25E-06	1.06E-04	4.72E-07	8.96E-04	7.82E-06	1.31E-03	2.50E-04	1.10E-03	8.63E-04	3.77E-04	5.47E-06
1982	5.59E-04	2.17E-05	1.14E-03	2.51E-04	3.11E-03	2.74E-04	7.54E-04	1.37E-04	5.46E-04	4.12E-04	4.90E-04	2.52E-05
1983	1.37E-04	3.13E-06	1.89E-04	1.92E-06	3.65E-03	2.45E-04	4.84E-04	2.96E-05	4.18E-04	2.22E-05	1.01E-03	1.07E-04
1984	3.35E-04	4.44E-06	6.96E-04	6.96E-05	3.66E-03	1.62E-04	3.01E-04	4.14E-06	6.66E-04	1.56E-04	4.92E-04	1.06E-05
1985	5.64E-04	1.14E-04	2.01E-04	1.44E-05	5.91E-04	2.41E-06	2.91E-04	5.04E-06	3.42E-04	8.76E-05	3.86E-04	1.13E-05
1986	6.60E-04	3.48E-05	1.27E-03	1.63E-04	1.48E-03	2.80E-05	5.69E-04	3.10E-05	5.09E-04	1.38E-04	5.47E-04	3.13E-05
1987	7.23E-05	6.97E-07	1.42E-03	1.56E-04	1.91E-03	4.31E-05	2.08E-04	2.30E-05	4.33E-04	1.99E-05	9.98E-04	2.76E-05
1988	4.47E-04	8.04E-06	2.43E-04	4.47E-05	9.22E-04	5.79E-05	1.90E-04	5.07E-06	3.26E-04	5.26E-05	4.09E-04	4.74E-06
1989	5.30E-04	5.40E-05	6.13E-04	2.44E-06	1.34E-03	2.15E-05	3.52E-04	7.27E-06	9.18E-04	6.41E-04	1.20E-03	7.91E-05
1990	1.90E-04	9.28E-06	1.93E-03	2.53E-04	8.07E-04	2.71E-05	3.60E-04	7.13E-06	3.03E-04	6.49E-05	2.12E-03	2.91E-04
1991	9.98E-05	1.49E-06	1.54E-03	1.45E-04	5.65E-04	2.38E-05	3.74E-04	6.45E-06	1.08E-03	8.35E-04	3.15E-04	5.33E-06
1992	5.57E-04	3.63E-05	1.77E-03	2.21E-04	1.88E-03	5.99E-06	6.94E-04	1.72E-05	4.38E-04	5.93E-05	1.07E-03	1.68E-04
1993	1.28E-04	1.94E-06	1.09E-04	5.84E-07	3.19E-03	1.31E-04	2.32E-04	3.86E-06	1.66E-04	5.91E-06	3.92E-04	7.08E-06
1994	8.21E-05	7.09E-07	1.19E-03	2.59E-04	5.27E-03	1.83E-04	4.24E-04	1.43E-05	3.62E-04	8.30E-05	8.00E-04	4.62E-05
Total	6.21E-03	4.07E-04	1.99E-02	3.07E-03	4.03E-02	1.44E-03	1.16E-02	9.56E-04	1.02E-02	3.98E-03	1.46E-02	1.35E-03

Appendix M – SWASH Scenario 20 -Year PRZM/EXAMS Mass Totals from Field (Koc = 10000)

	Weiherbach,Ger-R1_WC		Bologna, Italy – R3_WC		Roujan, France – R4_WC		Weiherbach,Ger-R1_PO		Porto, Portugal – R2_PO		Bologna, Italy – R3_PO	
Year	**RFLX, kg/ha**	**EFLX, kg/ha**	**RFLX, kg/ha**	**EFLX, kg/ha**	**RFLX, kg/ha**	**EFLX, kg/ha**	**RFLX, kg/ha**	**EFLX, kg/ha**	**RFLX, kg/ha**	**EFLX, kg/ha**	**RFLX, kg/ha**	**EFLX, kg/ha**
1975	8.42E-06	9.56E-06	**8.41E-06**	**1.02E-05**	3.14E-05	1.99E-05	1.45E-04	4.18E-04	2.17E-05	1.76E-04	1.19E-04	2.30E-04
1976	5.03E-05	8.58E-05	1.17E-04	2.59E-04	6.85E-04	7.12E-04	1.73E-04	4.31E-04	8.14E-05	8.06E-04	1.10E-04	1.85E-04
1977	6.68E-05	2.19E-04	2.91E-04	1.42E-03	1.03E-03	9.91E-04	8.88E-05	1.56E-04	1.04E-04	6.96E-04	2.26E-04	9.23E-04
1978	3.55E-04	3.73E-04	2.22E-04	8.10E-04	4.41E-04	1.95E-04	5.65E-04	1.50E-03	8.96E-05	6.35E-04	1.72E-04	2.49E-04
1979	6.85E-05	1.58E-04	2.01E-04	9.78E-04	4.67E-04	5.31E-04	1.35E-04	2.91E-04	1.04E-04	5.86E-04	1.63E-04	4.11E-04
1980	7.39E-05	7.41E-05	1.60E-04	8.57E-04	2.58E-04	6.02E-04	1.51E-04	4.68E-04	4.02E-05	2.52E-04	1.01E-04	1.86E-04
1981	1.86E-04	1.68E-04	3.30E-05	7.88E-05	2.43E-04	1.16E-04	3.53E-04	9.03E-04	1.34E-04	1.88E-03	9.20E-05	1.93E-04
1982	2.01E-04	1.97E-04	1.32E-04	5.59E-04	5.27E-04	1.12E-03	2.78E-04	7.25E-04	7.63E-05	9.72E-04	1.08E-04	2.64E-04
1983	8.42E-05	6.09E-05	5.47E-05	8.83E-05	5.62E-04	8.66E-04	1.62E-04	3.02E-04	7.24E-05	4.62E-04	1.84E-04	5.47E-04
1984	9.74E-05	9.21E-05	1.34E-04	3.81E-04	8.12E-04	1.29E-03	1.36E-04	2.24E-04	1.20E-04	8.26E-04	1.39E-04	2.88E-04
1985	1.01E-04	3.12E-04	2.96E-05	5.91E-05	2.22E-04	8.98E-05	1.07E-04	1.85E-04	6.59E-05	5.20E-04	8.33E-05	1.76E-04
1986	1.96E-04	3.14E-04	2.15E-04	6.58E-04	5.08E-04	2.34E-04	2.43E-04	4.00E-04	8.04E-05	6.95E-04	1.52E-04	3.08E-04
1987	3.94E-05	2.77E-05	2.09E-04	8.06E-04	7.54E-04	3.83E-04	8.06E-05	1.53E-04	8.55E-05	5.02E-04	1.84E-04	4.53E-04
1988	1.00E-04	8.47E-05	5.26E-05	1.29E-04	5.24E-04	3.22E-04	1.42E-04	1.93E-04	5.19E-05	3.65E-04	1.09E-04	2.15E-04
1989	8.60E-05	2.08E-04	1.57E-04	3.23E-04	2.51E-04	2.12E-04	1.22E-04	2.34E-04	1.18E-04	1.71E-03	2.54E-04	5.40E-04
1990	5.52E-05	8.59E-05	2.74E-04	8.62E-04	1.38E-04	1.40E-04	1.25E-04	2.01E-04	4.86E-05	3.87E-04	3.60E-04	1.31E-03
1991	4.95E-05	8.97E-05	1.92E-04	1.02E-03	1.04E-04	1.12E-04	1.06E-04	2.18E-04	1.24E-04	2.01E-03	1.03E-04	1.73E-04
1992	9.78E-05	1.78E-04	2.51E-04	9.03E-04	6.62E-04	3.66E-04	1.70E-04	3.51E-04	5.59E-05	4.62E-04	2.47E-04	5.94E-04
1993	3.99E-05	5.05E-05	5.22E-05	5.75E-05	6.79E-04	1.04E-03	7.99E-05	1.43E-04	2.78E-05	2.07E-04	1.53E-04	2.03E-04
1994	2.23E-05	4.12E-05	1.70E-04	7.97E-04	1.01E-03	1.44E-03	9.87E-05	2.00E-04	5.20E-05	4.90E-04	1.99E-04	4.32E-04
Total	1.98E-03	2.83E-03	2.96E-03	1.11E-02	9.91E-03	1.08E-02	3.46E-03	7.70E-03	1.55E-03	1.46E-02	3.26E-03	7.88E-03

Appendix N— SWASH Crop Scenarios run with PRZM/EXAMS - 20-year simulation PECs

Koc	SWASH Scenario	Field area, ha	Crop	Water-body	Max Peak in Water, ug/L	90th Percentile Time-weighted Average PECs in Water, ug/L						
						Peak	1 day	4 days	21 days	60 days	90 day	Annual
10	WG -R1	0.45	W cereal	Pond	0.577	0.568	0.567	0.564	0.552	0.524	0.457	0.314
10	WG-R1	1	W cereal	Stream	36.700	31.980	16.170	4.269	0.823	0.288	0.192	0.047
10	BI – R3	1	W cereal	Stream	154.000	131.600	66.550	17.570	3.357	1.178	0.783	0.193
10	RF–R4	1	W cereal	Stream	294.000	127.900	64.720	17.290	3.287	1.156	0.768	0.189
10	WG-R1	0.45	Potatoes	Pond	1.930	0.890	0.889	0.886	0.871	0.846	0.825	0.583
10	WG-R1	1	Potatoes	Stream	110.000	43.040	21.750	7.001	1.334	0.467	0.312	0.077
10	PP–R2	1	Potatoes	Stream	65.200	52.640	26.670	8.027	1.676	0.587	0.391	0.096
10	BI–R3	1	Potatoes	Stream	176.000	95.620	48.300	13.280	2.537	0.888	0.592	0.146
1000	WG-1	0.45	W cereal	Pond	0.291	0.263	0.259	0.248	0.212	0.173	0.161	0.116
1000	WG-R1	1	W cereal	Stream	12.800	11.520	5.828	1.735	0.400	0.156	0.104	0.031
1000	BI – R3	1	W cereal	Stream	42.900	42.070	21.280	6.079	1.363	0.523	0.350	0.099
1000	RF–R4	1	W cereal	Stream	135.000	111.200	56.200	14.440	2.948	1.114	0.745	0.185
1000	WG-R1	0.45	Potatoes	Pond	1.100	0.543	0.534	0.513	0.431	0.377	0.352	0.255
1000	WG-R1	1	Potatoes	Stream	33.000	17.120	8.666	3.815	0.768	0.344	0.235	0.068
1000	PP–R2	1	Potatoes	Stream	32.300	21.180	10.780	2.967	1.034	0.429	0.292	0.078
1000	BI–R3	1	Potatoes	Stream	35.300	32.360	16.330	5.284	1.079	0.409	0.300	0.078
10000	WG-1	0.45	W cereal	Pond	0.179	0.077	0.068	0.049	0.028	0.022	0.020	0.015
10000	WG-R1	1	W cereal	Stream	7.320	4.472	2.265	0.661	0.189	0.077	0.064	0.021
10000	BI – R3	1	W cereal	Stream	18.600	17.140	8.676	2.556	0.644	0.261	0.177	0.047
10000	RF–R4	1	W cereal	Stream	33.400	27.630	13.970	3.952	1.045	0.476	0.318	0.090
10000	WG-R1	0.45	Potatoes	Pond	0.350	0.173	0.152	0.115	0.060	0.050	0.046	0.036
10000	WG-R1	1	Potatoes	Stream	13.600	7.229	3.659	1.602	0.374	0.191	0.134	0.050
10000	PP–R2	1	Potatoes	Stream	23.600	16.080	8.178	2.293	0.883	0.375	0.259	0.073
10000	BI–R3	1	Potatoes	Stream	14.200	12.730	6.424	2.013	0.475	0.196	0.146	0.044

WG = Weiherbach, Germany; BI = Bologna, Italy; RF = Roujan, France; PP = Porto, Portugal

Appendix O— SWASH Crop Scenarios run with PRZM/EXAMS - 1-year simulation PECs

Koc	SWASH Scenario	Field area, ha	Crop	Water-body	Max Date	Maximum Time-weighted Average PECs in Water, ug/L						
						Peak	1-day	4 days	21 days	60 days	90 days	Annual
10	WG -R1	0.45	W cereal	Pond	25-Oct-78	0.018	0.018	0.018	0.017	0.017	0.015	0.011
10	WG-R1	1	W cereal	Stream	25-Oct-78	1.170	0.593	0.150	0.029	0.010	0.007	0.002
10	BI – R3	1	W cereal	Stream	26-Nov-80	73.800	37.300	14.600	2.790	0.975	0.650	0.160
10	RF–R4	1	W cereal	Stream	22-Oct-79	20.700	10.400	2.720	0.526	0.184	0.123	0.030
10	WG-R1	0.45	Potatoes	Pond	7-May-84	0.007	0.007	0.007	0.007	0.007	0.006	0.003
10	WG-R1	1	Potatoes	Stream	7-May-84	0.488	0.247	0.062	0.012	0.004	0.003	0.001
10	PP–R2	1	Potatoes	Stream	14-Mar-78	3.630	1.840	0.643	0.123	0.043	0.029	0.007
10	BI–R3	1	Potatoes	Stream	15-Mar-80	3.990	2.020	0.847	0.190	0.066	0.044	0.011
1000	WG-1	0.45	W cereal	Pond	31-Dec-78	0.070	0.069	0.064	0.052	0.046	0.043	0.030
1000	WG-R1	1	W cereal	Stream	31-Dec-78	3.220	1.620	0.524	0.100	0.039	0.032	0.008
1000	BI – R3	1	W cereal	Stream	27-Nov-80	33.800	17.100	6.120	1.230	0.441	0.294	0.073
1000	RF–R4	1	W cereal	Stream	26-Oct-79	31.800	16.100	7.830	1.620	0.572	0.388	0.096
1000	WG-R1	0.45	Potatoes	Pond	30-May-84	0.052	0.051	0.048	0.043	0.038	0.037	0.026
1000	WG-R1	1	Potatoes	Stream	30-May-84	1.820	0.921	0.235	0.097	0.048	0.034	0.013
1000	PP–R2	1	Potatoes	Stream	29-Apr-78	1.840	0.927	0.278	0.113	0.046	0.038	0.011
1000	BI–R3	1	Potatoes	Stream	22-Mar-80	4.410	2.230	0.587	0.161	0.091	0.063	0.020
10000	WG-1	0.45	W cereal	Pond	31-Dec-78	0.019	0.016	0.008	0.004	0.003	0.003	0.002
10000	WG-R1	1	W cereal	Stream	31-Dec-78	1.060	0.537	0.167	0.032	0.012	0.010	0.002
10000	BI – R3	1	W cereal	Stream	27-Nov-80	13.300	6.750	2.340	0.552	0.212	0.141	0.035
10000	RF–R4	1	W cereal	Stream	26-Oct-79	8.950	4.520	2.330	0.533	0.229	0.160	0.039
10000	WG-R1	0.45	Potatoes	Pond	22-Nov-84	0.020	0.018	0.015	0.009	0.008	0.008	0.005
10000	WG-R1	1	Potatoes	Stream	22-Nov-84	1.040	0.527	0.175	0.045	0.021	0.021	0.011
10000	PP–R2	1	Potatoes	Stream	7-Dec-77	0.878	0.449	0.176	0.082	0.038	0.031	0.010
10000	BI–R3	1	Potatoes	Stream	22-Mar-80	1.400	0.708	0.194	0.055	0.031	0.023	0.012

WG = Weiherbach, Germany; BI = Bologna, Italy; RF = Roujan, France; PP = Porto, Portugal

Appendix P – SWASH Scenario 20 -Year Mass Totals from Field using Norway Weather (Koc = 10)

	Weiherbach,Ger-R1_WC		Bologna, Italy – R3_WC		Roujan, France – R4_WC		Weiherbach,Ger-R1_PO		Porto, Portugal – R2_PO		Bologna, Italy – R3_PO	
Year	**RFLX, kg/ha**	**EFLX, kg/ha**	**RFLX, kg/ha**	**EFLX, kg/ha**	**RFLX, kg/ha**	**EFLX, kg/ha**	**RFLX, kg/ha**	**EFLX, kg/ha**	**RFLX, kg/ha**	**EFLX, kg/ha**	**RFLX, kg/ha**	**EFLX, kg/ha**
1965	6.26E-06	1.54E-12	5.52E-06	2.74E-11	3.03E-09	1.02E-16	3.84E-15	2.52E-21	1.41E-13	1.43E-19	2.99E-14	1.40E-21
1966	1.04E-03	3.02E-07	3.94E-04	1.79E-08	3.11E-03	5.37E-05	3.49E-10	5.71E-18	3.62E-07	7.49E-08	1.53E-08	1.45E-15
1967	3.60E-05	4.51E-11	2.47E-03	2.08E-06	6.83E-07	9.61E-14	3.14E-04	1.25E-07	2.43E-05	1.34E-09	1.47E-05	4.97E-10
1968	1.17E-04	3.33E-09	3.30E-04	1.83E-07	4.29E-05	3.42E-10	1.92E-04	2.55E-08	1.36E-04	4.74E-08	8.13E-04	4.02E-07
1969	2.30E-04	1.74E-09	1.25E-03	9.68E-08	4.71E-04	7.03E-08	9.60E-05	3.79E-10	6.00E-05	1.60E-08	2.44E-03	4.92E-07
1970	7.84E-04	1.72E-07	2.53E-03	1.47E-06	1.07E-03	5.97E-08	8.63E-05	4.37E-06	1.37E-10	4.39E-17	1.14E-04	1.09E-08
1971	4.78E-04	7.96E-09	1.23E-03	4.99E-05	1.53E-05	3.64E-11	3.13E-07	1.26E-11	1.76E-04	2.09E-07	2.24E-03	9.61E-07
1972	8.53E-04	1.01E-07	1.35E-04	1.05E-08	4.15E-05	7.58E-10	3.48E-04	5.58E-08	2.33E-04	4.34E-08	3.26E-04	1.85E-06
1973	7.12E-04	3.07E-08	2.45E-05	1.51E-06	8.15E-05	5.65E-10	1.91E-04	6.07E-09	1.36E-04	1.29E-08	3.91E-04	9.46E-09
1974	2.58E-03	8.34E-07	5.49E-04	1.53E-08	2.20E-03	3.70E-07	1.37E-03	1.67E-06	1.31E-04	6.99E-08	1.28E-04	2.07E-09
1975	1.26E-03	8.48E-08	1.29E-03	8.35E-05	5.26E-04	3.16E-09	1.99E-03	1.53E-05	1.08E-04	1.54E-07	9.04E-04	4.80E-07
1976	9.12E-05	1.12E-09	2.81E-04	9.39E-06	7.04E-04	6.34E-08	1.73E-04	4.23E-08	5.81E-05	5.94E-09	8.17E-04	2.50E-08
1977	9.87E-04	2.61E-08	1.30E-03	5.63E-08	2.05E-04	7.35E-10	7.27E-04	1.88E-06	8.57E-04	1.18E-07	6.00E-03	2.37E-04
1978	9.05E-04	5.81E-08	8.34E-16	3.54E-22	4.31E-06	7.42E-10	4.01E-04	9.22E-09	5.73E-04	6.63E-07	2.21E-03	1.24E-06
1979	8.75E-07	9.22E-13	2.74E-04	9.59E-09	5.81E-10	1.29E-16	8.21E-07	1.68E-13	2.03E-04	9.18E-08	2.05E-03	3.10E-06
1980	1.30E-03	1.75E-07	1.42E-05	2.59E-11	7.76E-04	2.45E-08	2.82E-04	8.29E-08	4.52E-04	5.90E-07	2.65E-04	6.42E-09
1981	3.31E-03	6.53E-07	2.54E-03	2.43E-04	9.34E-04	1.42E-07	1.86E-05	1.09E-10	2.24E-04	2.18E-08	1.33E-06	1.54E-13
1982	1.40E-04	3.19E-08	5.84E-04	2.75E-07	3.88E-05	1.67E-09	6.79E-04	2.43E-08	7.31E-04	1.86E-06	1.15E-04	4.94E-09
1983	2.12E-05	1.02E-10	8.70E-05	7.90E-09	3.31E-06	2.85E-12	1.74E-05	1.63E-10	5.08E-09	7.45E-16	1.65E-07	4.66E-14
1984	1.37E-04	9.47E-09	9.81E-04	5.68E-07	5.88E-05	1.70E-09	4.66E-06	7.13E-13	4.28E-04	3.04E-07	1.62E-03	5.30E-07
Total	1.50E-02	2.49E-06	1.63E-02	3.92E-04	1.03E-02	5.44E-05	6.89E-03	2.36E-05	4.53E-03	4.28E-06	2.04E-02	2.46E-04

Appendix Q – SWASH Scenario 20 -Year Mass Totals from Field using Norway Weather (Koc = 1000)

	Weiherbach,Ger-R1_WC		Bologna, Italy – R3_WC		Roujan, France – R4_WC		Weiherbach,Ger-R1_PO		Porto, Portugal – R2_PO		Bologna, Italy – R3_PO	
Year	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha
1965	3.26E-04	8.85E-06	1.81E-04	4.40E-06	3.04E-04	9.82E-07	2.84E-04	7.37E-07	1.06E-04	8.84E-06	2.02E-04	3.09E-07
1966	8.20E-04	1.12E-04	3.59E-04	3.17E-05	1.52E-03	1.86E-04	5.98E-04	3.05E-06	2.36E-04	2.02E-05	4.57E-04	2.62E-06
1967	5.29E-04	6.96E-05	4.21E-04	1.03E-04	5.39E-04	1.67E-05	4.88E-04	2.98E-05	1.68E-04	8.16E-06	2.08E-04	1.83E-06
1968	1.11E-04	3.25E-06	1.08E-04	5.97E-06	5.02E-05	1.19E-06	3.07E-04	1.44E-05	1.56E-04	2.34E-05	3.95E-04	3.80E-05
1969	8.64E-04	1.46E-04	1.04E-03	1.85E-04	9.64E-04	3.97E-05	5.92E-04	5.02E-05	2.39E-04	3.59E-05	1.16E-03	2.56E-04
1970	2.84E-04	1.22E-05	4.40E-04	9.86E-05	9.42E-04	5.25E-05	4.56E-04	1.56E-05	2.37E-04	1.09E-05	2.55E-04	5.33E-06
1971	7.52E-04	1.29E-04	3.97E-04	1.31E-04	1.70E-04	1.50E-06	4.39E-04	4.23E-06	2.28E-04	1.53E-05	6.27E-04	9.42E-05
1972	6.43E-04	2.21E-05	1.32E-03	8.23E-05	4.06E-04	2.74E-06	3.48E-04	3.61E-05	2.15E-04	3.48E-05	3.69E-04	3.57E-05
1973	1.04E-03	1.12E-04	3.46E-05	2.28E-06	1.29E-03	3.31E-05	3.79E-04	1.17E-05	1.76E-04	2.47E-05	4.38E-04	5.46E-05
1974	6.17E-04	6.55E-05	4.13E-04	3.99E-05	6.85E-04	3.62E-05	4.86E-04	1.11E-04	2.17E-04	1.11E-05	3.69E-04	1.97E-05
1975	4.98E-04	1.30E-04	3.46E-04	2.00E-04	4.72E-04	5.94E-05	8.61E-04	1.96E-04	2.43E-04	8.60E-06	3.47E-04	2.46E-05
1976	7.31E-04	1.57E-05	4.70E-04	2.78E-05	4.51E-04	1.98E-05	2.48E-04	9.42E-06	2.54E-04	5.51E-05	1.29E-03	2.71E-04
1977	7.66E-04	3.45E-05	1.64E-03	3.22E-04	9.27E-04	1.27E-05	7.60E-04	7.24E-05	4.67E-04	5.42E-05	1.16E-03	7.12E-04
1978	2.76E-04	2.00E-05	9.10E-05	3.75E-08	2.67E-05	4.37E-08	6.90E-04	6.48E-05	4.02E-04	6.44E-05	1.12E-03	1.58E-04
1979	5.79E-04	4.04E-05	2.04E-04	3.56E-06	4.13E-04	5.53E-06	3.89E-04	4.51E-06	3.13E-04	1.02E-04	6.62E-04	1.18E-04
1980	7.13E-04	4.71E-05	4.64E-04	4.18E-06	6.61E-04	2.14E-05	4.09E-04	1.56E-05	2.62E-04	5.14E-05	2.90E-04	2.54E-05
1981	1.50E-03	3.54E-04	7.69E-04	5.33E-04	1.71E-03	6.76E-05	5.31E-04	3.75E-06	3.49E-04	1.14E-04	3.72E-04	2.00E-06
1982	1.05E-03	1.17E-04	8.25E-04	5.92E-05	1.12E-03	3.45E-05	7.51E-04	1.01E-04	2.57E-04	3.86E-05	2.73E-04	1.21E-05
1983	1.49E-04	1.61E-06	1.39E-04	2.47E-06	8.58E-05	2.47E-07	3.53E-04	1.35E-05	1.99E-04	9.62E-06	2.37E-04	9.71E-07
1984	8.24E-04	1.56E-05	8.92E-04	4.02E-05	5.75E-04	4.10E-06	6.93E-04	1.81E-05	4.73E-04	7.27E-05	1.64E-03	1.59E-04
Total	1.31E-02	1.46E-03	1.06E-02	1.88E-03	1.33E-02	5.96E-04	1.01E-02	7.75E-04	5.20E-03	7.64E-04	1.19E-02	1.99E-03

Appendix R – SWASH Scenario 20 -Year Mass Totals from Field using Norway Weather (Koc = 10000)

	Weiherbach,Ger-R1_WC		Bologna, Italy – R3_WC		Roujan, France – R4_WC		Weiherbach,Ger-R1_PO		Porto, Portugal – R2_PO		Bologna, Italy – R3_PO	
Year	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha	RFLX, kg/ha	EFLX, kg/ha
1965	3.67E-05	5.38E-05	1.99E-05	2.82E-05	5.34E-05	3.26E-05	7.41E-05	2.22E-04	1.38E-05	2.26E-04	6.65E-05	1.73E-04
1966	1.56E-04	4.37E-04	1.05E-04	2.08E-04	3.78E-04	5.07E-04	1.97E-04	3.77E-04	3.27E-05	3.31E-04	1.70E-04	3.08E-04
1967	1.40E-04	3.54E-04	1.26E-04	3.01E-04	1.90E-04	1.96E-04	1.89E-04	3.45E-04	2.99E-05	2.01E-04	1.42E-04	1.95E-04
1968	6.89E-05	6.01E-05	7.76E-05	9.50E-05	8.73E-05	1.34E-05	1.23E-04	1.72E-04	2.73E-05	1.86E-04	1.27E-04	2.08E-04
1969	2.07E-04	4.90E-04	2.21E-04	5.59E-04	2.62E-04	3.45E-04	2.82E-04	4.90E-04	4.71E-05	3.40E-04	3.09E-04	8.06E-04
1970	1.72E-04	1.27E-04	1.79E-04	2.43E-04	2.69E-04	2.02E-04	2.45E-04	2.97E-04	5.65E-05	3.17E-04	2.02E-04	1.87E-04
1971	2.10E-04	4.29E-04	2.06E-04	3.63E-04	1.75E-04	3.25E-05	2.35E-04	2.97E-04	5.03E-05	3.20E-04	2.36E-04	3.73E-04
1972	2.20E-04	1.77E-04	3.33E-04	8.47E-04	2.23E-04	5.75E-05	3.33E-04	3.86E-04	6.50E-05	4.60E-04	2.93E-04	2.94E-04
1973	2.40E-04	4.40E-04	1.07E-04	4.32E-05	3.01E-04	3.11E-04	2.17E-04	2.51E-04	3.94E-05	2.24E-04	1.90E-04	2.63E-04
1974	1.99E-04	2.47E-04	1.79E-04	2.68E-04	2.31E-04	1.24E-04	2.68E-04	4.57E-04	5.27E-05	3.15E-04	2.29E-04	2.54E-04
1975	2.25E-04	4.04E-04	2.21E-04	4.37E-04	2.36E-04	1.80E-04	3.08E-04	6.25E-04	6.22E-05	3.11E-04	2.14E-04	2.37E-04
1976	1.94E-04	2.47E-04	1.63E-04	1.95E-04	2.03E-04	1.05E-04	1.63E-04	1.61E-04	4.25E-05	2.01E-04	2.63E-04	8.82E-04
1977	3.94E-04	2.47E-04	4.82E-04	1.04E-03	4.63E-04	1.26E-04	5.36E-04	6.75E-04	1.21E-04	6.40E-04	5.24E-04	1.19E-03
1978	2.83E-04	2.01E-04	2.53E-04	1.29E-04	2.81E-04	2.46E-05	3.99E-04	4.56E-04	1.06E-04	5.54E-04	4.17E-04	7.40E-04
1979	1.77E-04	4.27E-04	1.20E-04	1.74E-04	1.97E-04	1.74E-04	1.99E-04	3.17E-04	5.84E-05	4.92E-04	2.04E-04	4.08E-04
1980	2.08E-04	2.09E-04	1.61E-04	1.14E-04	2.41E-04	1.14E-04	2.95E-04	3.58E-04	6.56E-05	4.86E-04	2.40E-04	2.51E-04
1981	3.24E-04	1.04E-03	2.60E-04	8.03E-04	4.24E-04	7.06E-04	2.96E-04	4.21E-04	6.85E-05	6.46E-04	2.45E-04	3.17E-04
1982	2.64E-04	6.79E-04	2.42E-04	5.09E-04	3.22E-04	4.60E-04	3.13E-04	8.45E-04	5.78E-05	4.83E-04	2.08E-04	2.49E-04
1983	1.24E-04	9.04E-05	1.24E-04	9.37E-05	1.29E-04	1.81E-05	1.96E-04	2.48E-04	4.27E-05	2.71E-04	1.60E-04	1.63E-04
1984	3.54E-04	3.76E-04	3.15E-04	3.65E-04	4.06E-04	1.28E-04	4.28E-04	6.39E-04	1.02E-04	7.36E-04	5.30E-04	1.19E-03
Total	4.20E-03	6.74E-03	3.89E-03	6.81E-03	5.07E-03	3.86E-03	5.30E-03	8.04E-03	1.14E-03	7.74E-03	4.97E-03	8.68E-03

Appendix S— SWASH Crop Scenarios run with PRZM/EXAMS and Norway Weather - 20-year simulation PECs

Koc	SWASH Scenario	Field area, ha	Crop	Water-body	Max Peak in Water, ug/L	90th Percentile Time-weighted Average PECs in Water, ug/L						
						Peak	1 day	4 days	21 days	60 days	90 day	Annual
10	WG -R1	0.45	W cereal	Pond	2.010	1.803	1.794	1.793	1.773	1.732	1.382	1.060
10	WG-R1	1	W cereal	Stream	88.000	79.330	40.140	10.450	1.995	0.698	0.465	0.115
10	BI – R3	1	W cereal	Stream	81.300	80.740	40.860	10.770	2.046	0.717	0.478	0.118
10	RF–R4	1	W cereal	Stream	76.400	68.450	34.650	8.879	1.698	0.593	0.396	0.098
10	WG-R1	0.45	Potatoes	Pond	1.340	0.758	0.757	0.753	0.734	0.690	0.671	0.543
10	WG-R1	1	Potatoes	Stream	45.600	42.020	21.200	5.534	1.058	0.371	0.247	0.061
10	PP–R2	1	Potatoes	Stream	25.400	23.230	11.710	2.970	0.582	0.204	0.136	0.033
10	BI–R3	1	Potatoes	Stream	122.000	71.790	36.290	10.310	1.964	0.687	0.458	0.113
1000	WG-1	0.45	W cereal	Pond	0.809	0.624	0.614	0.587	0.504	0.460	0.396	0.285
1000	WG-R1	1	W cereal	Stream	24.400	22.010	11.150	4.313	0.863	0.315	0.211	0.054
1000	BI – R3	1	W cereal	Stream	23.800	21.070	10.680	3.105	0.943	0.375	0.251	0.065
1000	RF–R4	1	W cereal	Stream	27.100	26.790	13.500	5.299	1.196	0.457	0.306	0.077
1000	WG-R1	0.45	Potatoes	Pond	0.421	0.354	0.350	0.341	0.299	0.252	0.239	0.178
1000	WG-R1	1	Potatoes	Stream	16.900	9.271	4.690	1.376	0.477	0.182	0.131	0.039
1000	PP–R2	1	Potatoes	Stream	6.870	5.158	2.608	0.872	0.179	0.070	0.051	0.024
1000	BI–R3	1	Potatoes	Stream	38.000	22.790	11.590	5.096	1.192	0.424	0.284	0.078
10000	WG-1	0.45	W cereal	Pond	0.286	0.202	0.177	0.129	0.071	0.060	0.050	0.037
10000	WG-R1	1	W cereal	Stream	12.100	9.379	4.763	1.677	0.410	0.186	0.125	0.038
10000	BI – R3	1	W cereal	Stream	13.200	10.010	5.108	1.862	0.553	0.247	0.168	0.046
10000	RF–R4	1	W cereal	Stream	11.100	9.335	4.726	1.664	0.466	0.215	0.146	0.038
10000	WG-R1	0.45	Potatoes	Pond	0.177	0.146	0.128	0.100	0.056	0.046	0.044	0.038
10000	WG-R1	1	Potatoes	Stream	9.260	7.356	3.731	1.180	0.324	0.145	0.102	0.047
10000	PP–R2	1	Potatoes	Stream	5.960	3.246	1.661	0.677	0.181	0.090	0.067	0.029
10000	BI–R3	1	Potatoes	Stream	17.600	12.520	6.325	2.350	0.668	0.273	0.189	0.068

WG = Weiherbach, Germany; BI = Bologna, Italy; RF = Roujan, France; PP = Porto, Portugal

WORLD INTEGRATED SYSTEM FOR PESTICIDE EXPOSURE (WISPE) FOR NORWAY

USER MANUAL

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Prepared by:

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WORLD INTEGRATED SYSTEM FOR PESTICIDE EXPOSURE (WISPE) for Norway

Introduction
The World Integrated System for Pesticide Exposure (WISPE) for Norway model was developed to improve upon the WISPE model that was developed in 2012 to evaluate the potential impact of crop protection chemicals on the environment throughout the world (Cheplick, et al., 2012). WISPE currently has been configured with scenarios containing crop, soil, and weather conditions for major agricultural areas in Canada, Colombia, Peru, the European Union (EU), Norway, the People's Republic of China, and the United States. This version is specific to Norway. The architecture of WISPE allows seamless executions of two environmental fate and transport models including Pesticide Root Zone Model (PRZM) and Exposure Analysis Modeling System (EXAMS) operating under the Windows environment. The WISPE model includes the climatic data, soil properties, and cropping data necessary to conduct the simulations. The user needs to supply information on the pesticide such as degradation rates and sorption parameters as well as application rates, timing and methods. The coding for the WISPE model is based on the previously developed model with groundwater and surface water shells with the coding was done by Waterborne Environmental, Inc.

The WISPE model uses three exposure models to evaluate the scenarios. winPRZM (version 4.74) is used to estimate runoff/erosion and associated chemical mass from a field (Carousel, *et al.*, 2005; FOCUS, 2003 Appendix K) and EXAMS (version 2.98.04) uses these runoff loading estimates to simulate concentration in a standard pond (Burns, 2004).

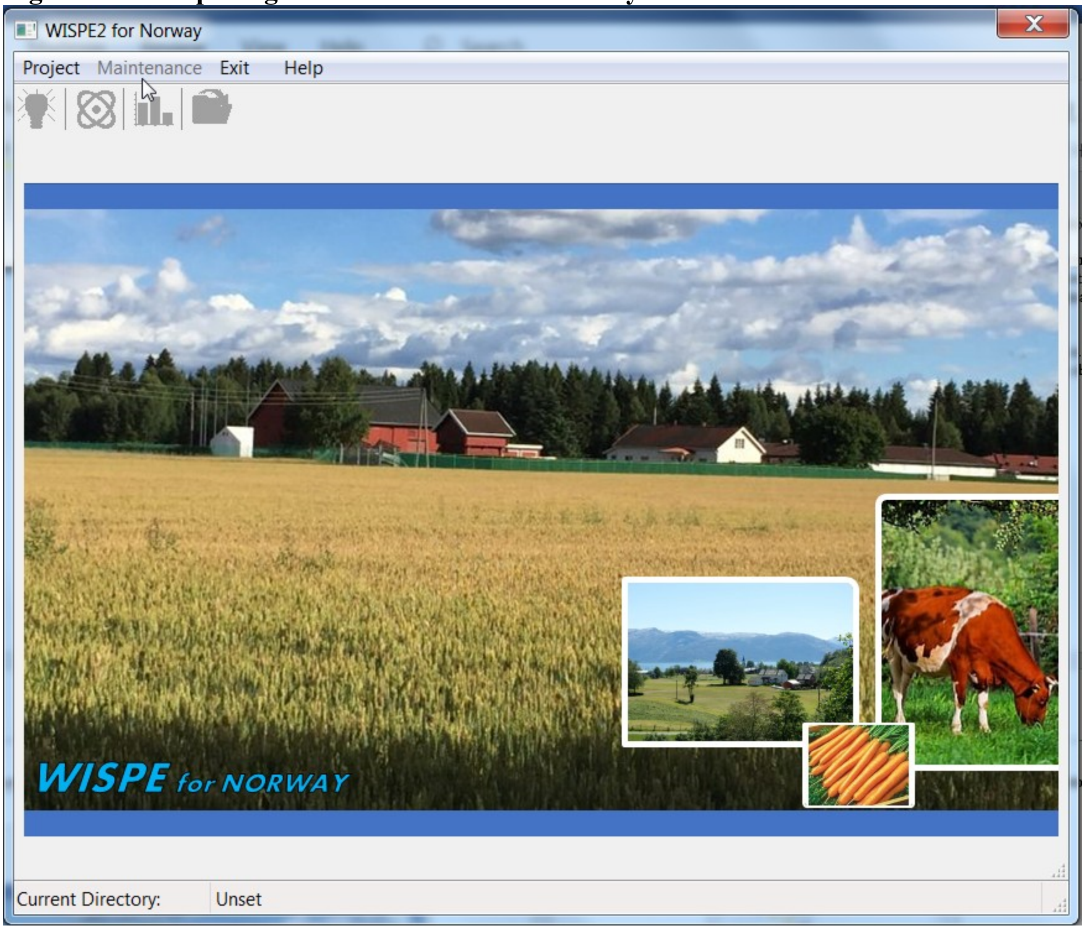
Hardware Requirements
The WISPE model runs on PCs under the Windows operating system (installation has been tested on Windows 7 and 10). Adobe Reader is required to read model user guides. Best used with window size 1920 x 1080.

Installation and Removal
Double click on the file nispe.exe and the setup program will begin and then all required files will be installed to C:\WISPE2 or other user-selected installation path.

WISPE can be removed using the standard Windows uninstall procedure, i.e., via "Settings – Control Panel – Add/Remove Programs", followed by deletion of the directory structure along with any remaining user-modified project or meteorological data files.

Starting the WISPE Model
WISPE can be started by double clicking on nispe.exe in the WISPE2 folder or by starting any shortcut "WISPE" to the executable. The starting screen shown in Figure 1 appears.

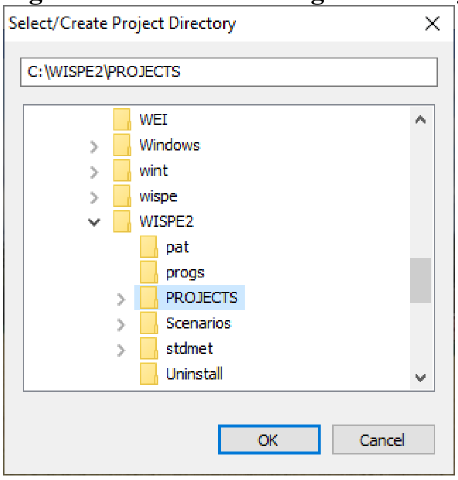
Figure 1. The opening screen of WISPE for Norway Tool



The first step in using WISPE is to select (or create) an active project directory. All relevant input/output data of a simulation run is saved in this directory. Therefore, WISPE requires full read/write permission for the specified directory.

The directory is set by clicking on "Project" on the top left corner of the opening screen. Then the "Select/Create Project Directory" box appears as shown in Figure 2.

Figure 2. Box for creating or selecting a project directory



The initial project directory display is always the default project folder ...\WISPE2\PROJECTS. However, directories can be located in other locations on hard disks or network drives using WISPE itself, Windows Explorer, or other tools. Long filenames are supported.

To select an existing directory, use the scroll bar to move to the desired drive\directory (if it is not already visible in the selection window), and then double-click on it. The selected folder (the terms "drive\directory" and "folder" are equivalent) will then replace the "...\WISPE2\PROJECTS" text initially displayed (see Figure 2). Pressing the "OK" button at this time will set the selected drive\directory to be the current project directory. To create a new project directory, type a "\" followed by the new project directory name on the path line in Figure 2. For example, typing "\newchem1" at the end of the folder selection window creates a new project directory called "...\WISPE2\projects\newchem1." Only one subdirectory can be created in a single step: entering, for example, "\newchem1\app1", is not supported. To create dependent subdirectories (i.e., folders within folders), first create \newchem1, press the "OK" button, then reselect "Select/Create Project Directory" and enter "\app1." This will create the "...\WISPE2\projects\newchem1\app1" projects directory.

A different project directory should be chosen for each set of simulations. Each simulation scenario can be re-run or re-analysed at a later time. However, note that if the simulation scenario is re-run, the earlier results will not be preserved. If the user wants to make changes, the user should go back to the start, make changes and rerun the scenarios.

During the creation of a simulation, a Master Project File (MPF) is created which contains all of the information necessary to characterize the simulation. This is stored in the project directory with the name master.fpj. Sharing of the MPF is a good way to transfer information about a specific scenario between different users and computers when trying to resolve difficulties or unusual results.

After the user has specified an active project directory, WISPE directly checks if a MPF is existing in this directory. If none is found, the opening screen is displayed, but this time displaying the selected project directory.

Creating Input Files

After a project directory has been selected, click on the “Lightbulb” icon button  (just below the “Project” button). The screen shown in Figure 3 should now appear. The user has the option to choose the simulation type for surface water (SW) or groundwater (GW) simulations. The “FOCUS Hybrid SW (WinPRZM-EXAMS)” scenarios are crop scenarios run with winPRZM linked to EXAMS. If the user selects the surface water scenarios, the user has a choice of Norwegian SW, Standard FOCUS SW, or User Defined SW. There are two User Defined SW scenarios to use as templates for creating new SW scenarios. The “FOCUS GW (winPRZM)” scenarios are scenarios simulated with winPRZM (Figure 4). The user can select Norwegian GW, Standard FOCUS GW, or User Defined GW scenarios. The user cannot run surface water and groundwater scenario at the same time.

Figure 3. Scenario screen (Norwegian surface water scenarios)

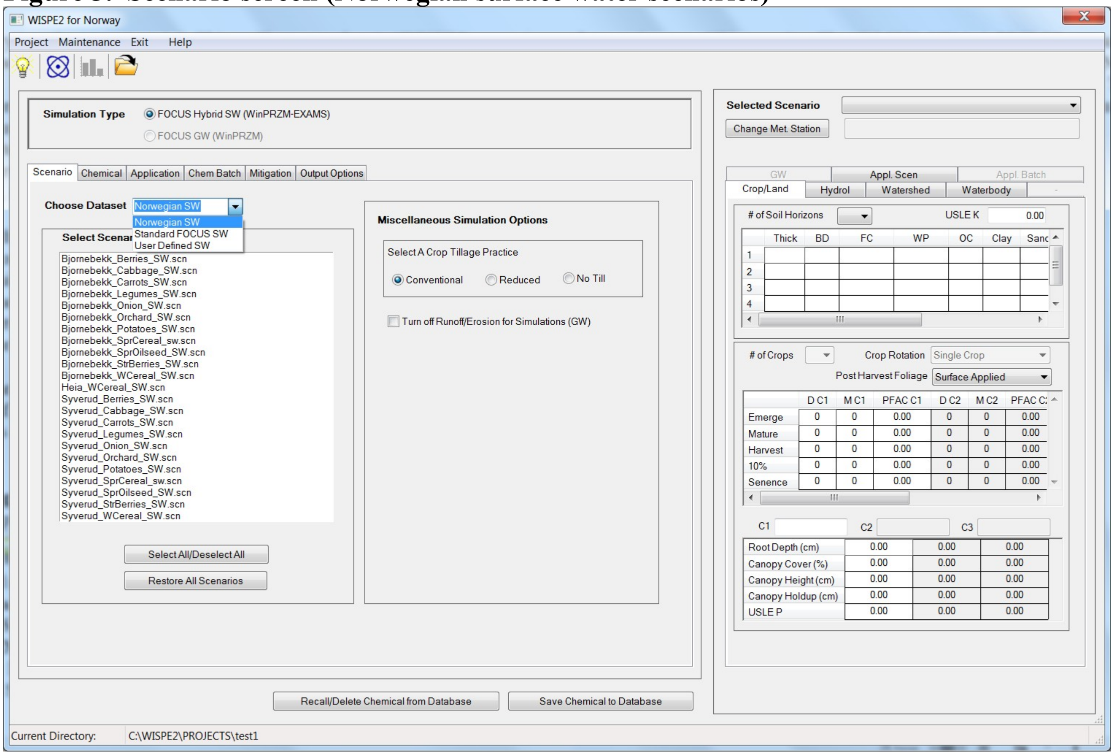
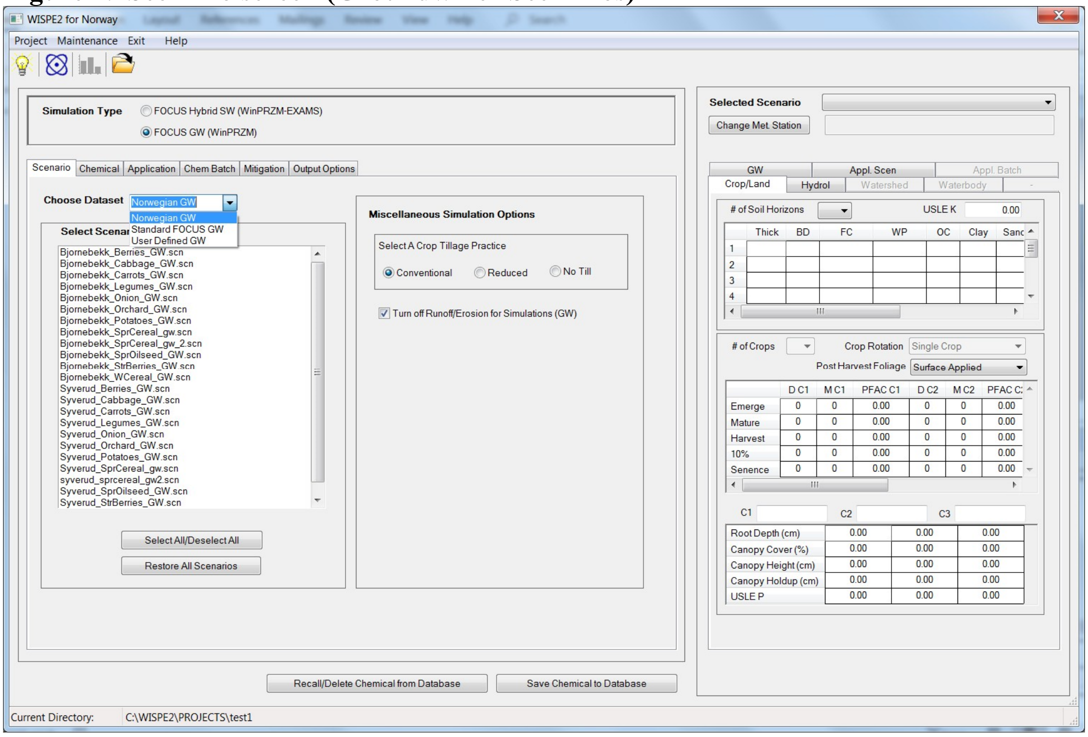
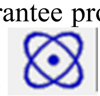


Figure 4. Scenario screen (Groundwater Scenarios)



The creation of input parameters for a set of simulations is a three-step process:

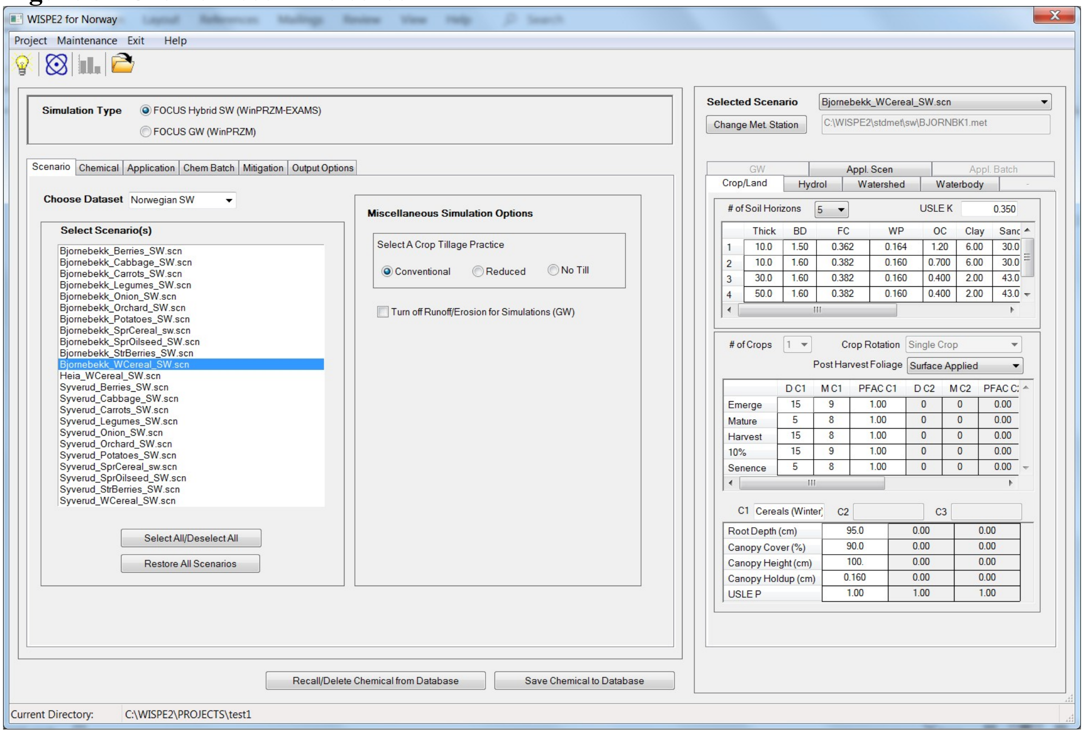
1. Scenario: Select one or more of the predefined scenarios
2. Chemical: Define the physical-chemical and environmental fate pesticide properties needed for winPRZM and EXAMS
3. Application: Choose method, rate(s), drift. The user has the option to select application date(s) or use PAT to determine the application dates.

All three of these data creation steps should initially be completed in the suggested order (Scenario, Chemical, Application) to guarantee proper creation of the input file set. After the completion of the three steps, the user hits the  button to write the inputs and run the models.

Scenario

To begin scenario definition, click on the "Scenario" menu item. The Create a Scenario screen then appears (Figure 5). If the simulation type is "FOCUS Hybrid SW (WinPRZM-EXAMS)", the user can select scenarios from Norwegian SW, Standard FOCUS scenarios SW, or User Defined SW to run surface water scenarios. If the simulation type selected is "FOCUS GW (WinPRZM)" then the user can select groundwater scenarios from Norwegian GW, Standard FOCUS scenarios GW, or User Defined GW. One, several, or all of the scenarios can then be selected for inclusion in the simulation for the simulation type and category that has been selected. If the user wants to run all the scenarios, the user can click on the "Select All/Deselect All" button. If a user has recalled a previous project, only the scenarios from that previous project will appear. If the user that has recalled a previous project wants to add more scenarios then the user can click on the "Restore All Scenarios" button.

Figure 5. Create a scenario screen



The information about the selected scenario is on the right side of the screen Figure 5. The Crop/Land tab shows the soil horizon data (eg., bulk density, field capacity, etc.), crop data (e.g., emergence date, harvest date, root depth, etc.). The hydrology tab, "Hydrol" shows the erosion data, irrigation data, etc. The Watershed tab has the waterbody and watershed information such as waterbody type, field area and waterbody area, etc. The Waterbody tab has the water column and benthic parameters (e.g., suspended sediment, organic carbon, etc.).

Table 1. Norwegian scenario weather and crop information

Crop	Surface Water Scenario	Groundwater Scenario	Weather Station	Emergence	Harvest
Berries	Bjornebekk_Berries_SW.scn	Bjornebekk_Berries_GW.scn	Bjornbk1.met	23-Apr.	15-Aug.
Cabbage	Bjornebekk_Cabbage_SW.scn	Bjornebekk_Cabbage_GW.scn	Bjornbk1.met	30-May.	15-Sept.
Carrots	Bjornebekk_Carrots_SW.scn	Bjornebekk_Carrots_GW.scn	Bjornbk1.met	25-May	5-Oct.
Legumes	Bjornebekk_Legumes_SW.scn	Bjornebekk_Legumes_GW.scn	Bjornbk1.met	10-May	20-Aug.
Onion	Bjornebekk_Onion_SW.scn	Bjornebekk_Onion_GW.scn	Bjornbk1.met	17-May	28-Aug.
Orchard	Bjornebekk_Orchard_SW.scn	Bjornebekk_Orchard_GW.scn	Bjornbk1.met	23-Apr.	18-Sept.
Potatoes	Bjornebekk_Potatoes_SW.scn	Bjornebekk_Potatoes_GW.scn	Bjornbk1.met	10-June	20-Sept.
Spring Cereal	Bjornebekk_SprCeeral_SW.scn	Bjornebekk_SprCeeral_GW.scn	Bjornbk1.met	3-May	28-Sept.
Spring Oilseed	Bjornebekk_SprOilseed_SW.scn	Bjornebekk_SprOilseed_GW.scn	Bjornbk1.met	10-May.	4-Sept.
Strawberries	Bjornebekk_StrBerries_SW.scn	Bjornebekk_StrBerries_GW.scn	Bjornbk1.met	23-Apr.	8-July
Winter Cereal	Bjornebekk_WCereal_SW.scn	Bjornebekk_WCereal_GW.scn	Bjornbk1.met	15-Sept.	15-Aug.
Winter Cereal	Heia_WCereal_SW.scn	Heia_WCereal_GW.scn	Syverud1.met	15-Sept.	15-Aug.
Berries	Syverud_Berries_SW.scn	Syverud_Berries_GW.scn	Syverud1.met	23-Apr.	15-Aug.
Cabbage	Syverud_Cabbage_SW.scn	Syverud_Cabbage_GW.scn	Syverud1.met	30-May.	15-Sept.

Crop	Surface Water Scenario	Groundwater Scenario	Weather Station	Emergence	Harvest
Carrots	Syverud_Carrots_SW.scn	Syverud_Carrots_GW.scn	Syverud1.met	25-May	5-Oct.
Legumes	Syverud_Legumes_SW.scn	Syverud_Legumes_GW.scn	Syverud1.met	10-May	20-Aug.
Onion	Syverud_Onion_SW.scn	Syverud_Onion_GW.scn	Syverud1.met	17-May	28-Aug.
Orchard	Syverud_Orchard_SW.scn	Syverud_Orchard_GW.scn	Syverud1.met	23-Apr.	18-Sept.
Potatoes	Syverud_Potatoes_SW.scn	Syverud_Potatoes_GW.scn	Syverud1.met	10-June	20-Sept.
Spring Cereal	Syverud_SprCeeral_SW.scn	Syverud_SprCeeral_GW.scn	Syverud1.met	3-May	28-Sept.
Spring Oilseed	Syverud_SprOilseed_SW.scn	Syverud_SprOilseed_GW.scn	Syverud1.met	10-May.	4-Sept.
Strawberries	Syverud_StrBerries_SW.scn	Syverud_StrBerries_GW.scn	Syverud1.met	23-Apr.	8-July
Winter Cereal	Syverud_WCereal_SW.scn	Syverud_WCereal_GW.scn	Syverud1.met	15-Sept.	15-Aug.

This screen also allows the user to change from the default conventional tillage practice to a “higher tier” tillage of reduced or no till. Conventional tillage assumes that less than 30 percent of the ground cover is left on the field. This option produces the most runoff and erosion. If reduced till is selected, the curve numbers are reduced by 5%. Reduced tillage leaves approximately 30 percent or more ground cover (SETAC, 2013). If the no till option is selected, the curve numbers are reduced by 10%. No till leaves about 50 percent or more ground cover because the soil surface is left undisturbed from harvest to planting (SETAC, 2013). The tillage options are used in the surface water scenarios and only used for groundwater simulations if the “Turn off Runoff/Erosion for Simulations (GW)” is not checked. The default for groundwater simulations is to have the “Turn off Runoff/Erosion for Simulations (GW)” box checked.

Chemical

The input screen for chemical environmental fate parameters (Figure 6) includes data entry fields for the following compound properties: molecular weight, solubility, koc/kd, vapor pressure, aerobic soil degradation half-life (applied equally to dissolved and sorbed phases), water column and benthic aquatic metabolism half-life, aqueous photolysis, and if foliar processes are being modelled, foliar half-life. The user can input a Henry’s K constant or have the model estimate the Henry K. If the Henry K is left blank, then it is input as zero in the PRZM input file (no volatilization). The air diffusion coefficient and enthalapy of vaporization are parameters used for volatilization. The user can either input the sorption coefficient as Koc or as Kd. There is also an option to use the Freundlich Exponent (1/n). The default when the Freundlich Exponent box is checked “on” is to use a value of 0.9 if that value is not known.

The user can check if the half-life is adjusted by temperature (default = box checked). If the box is checked, the user can input the Q10 factor. In accordance with the scientific opinion of EFSA on the Q10 value (EFSA, 2007) a default Q10 of 2.58 should be used. The degradation is adjusted in the soil (PRZM) or the waterbody (EXAMS) based on the soil or water temperature (t_{act}) and a reference temperature (t_{ref}) (usually 20ºC for soil and 25ºC in EXAMS). See equation below.

$$\text{Adjusted } DT_{50} = DT_{50} * Q10^{[(tact-tref)/10]}$$

Two metabolites can be simulated. The user can select the pathway:

- parent to metabolite 1,
- parent to metabolite 1 to metabolite 2,
- parent to metabolite 1 and parent to metabolite 2.

The user will need to fill in the metabolite environmental fate information. Also, if metabolites are simulated, then the molar formation:decline ratio in fractions need to be filled in to indicate the degradation process that forms the metabolite. These data cells are grayed out if only the parent is simulated.

All of the scenarios assume that foliar washoff is set to a default value of 0.5 and plant uptake factor is set at default value of 0.5 (FOCUS, 2003).

The user has the option to select “WinPRZM Specific” parameters (Figure 6). The first set of options pertain to DFOP parameters. The default is “Off”, the box is NOT checked. If the box is checked, then a new chemical screen will come up for the user to fill in data for the fast and slow phases for the soil half-life which are outline inFigure 7. The user puts in the fraction next to the DFOP checked on box to define the fraction of the application in the DFOP fast phase.

The second set of options pertain to aged sorption. The default is “Off”. Otherwise, the user can choose between using PEARL or PRZM defined values for fraction in equilibrium. These values (FEQ, Kdes, S2 Non-Eq, and t1/2 Sorb) are used for modelling non-equilibrium sorption. Guidance for incorporating non-equilibrium sorption in simulations is provided in Section 7.1.6 of FOCUS (2009).

For the third set, the user has the option of using the moisture adjusted soil half-life. The options are Abs (reference soil moisture entered in absolute terms), Rel (FC) (reference soil moisture entered relative to field capacity), or Off (don’t adjust half-life with moisture) The default is “Abs” the absolute option for moisture adjusted soil half-life. The default for the moisture correction exponent “M. Exponent” is 0.7 and the default “M. Content” is 100 (FOCUS, 2003 and 2010).

The default is set to simulate evapotranspiration (ET) using crop coefficients (box checked “ON”). “On” is based on FAO 56 crop coefficients (FAO, 1998). The ET crop coefficients are associated with the scenario cropping dates (emergence, maturation, harvest, 10% and senence) and PFAC C1 values (crop coefficients) shown in the right panel under “Crop/Land” cropping dates.

Figure 6. Input screen for chemical parameters

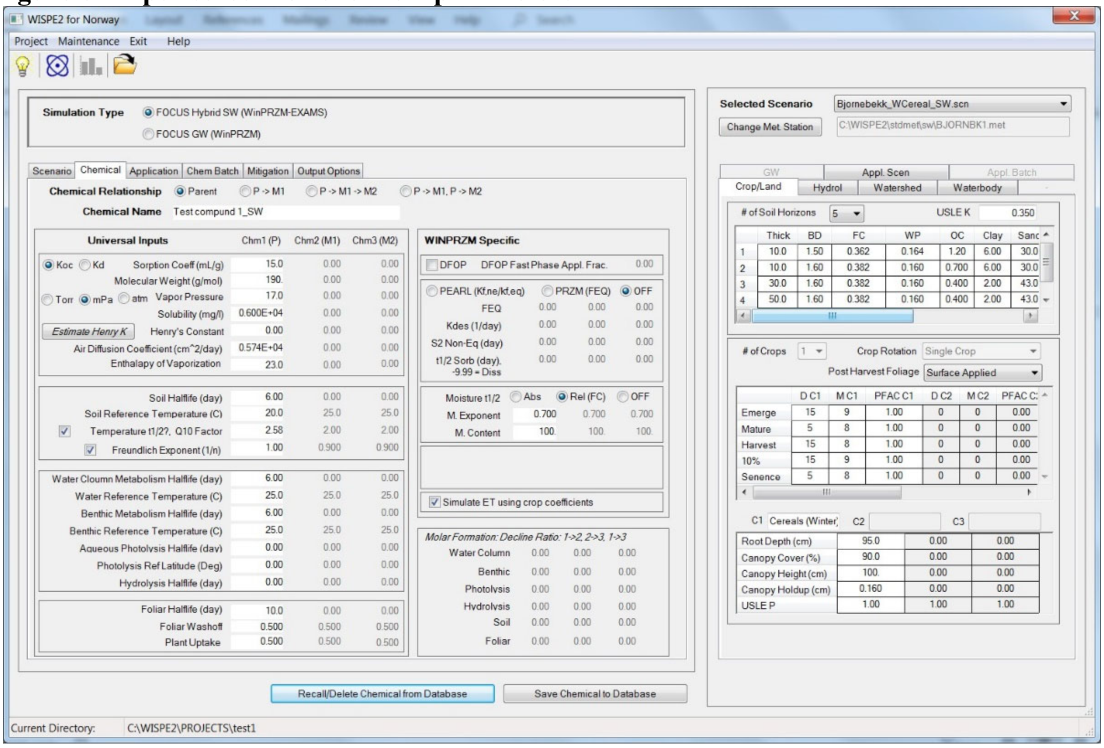
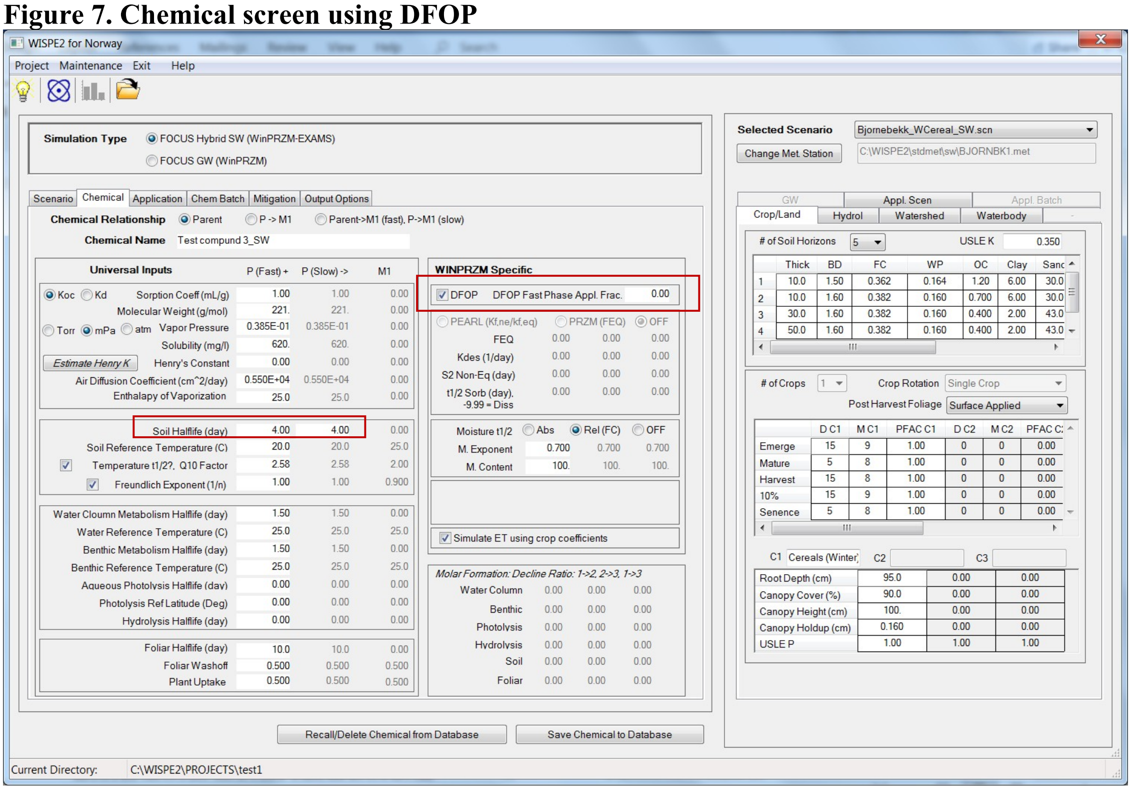


Figure 7. Chemical screen using DFOP



After the user has filled out the chemical screen, the user has the option to save the chemical for future use by hitting the "Save Chemical to Database" button. Then when the user makes a future run, the user can click on the "Recall/Delete Chemical from Database" button.

Environmental Fate Endpoints
Soil half-life: Enter the aerobic soil metabolism half-life in days. The geometric mean of the various soil half-lives is used when four or more values are available (3 values for a transformation product). If data are stable, enter zero (0) or leave blank.

Koc: Enter a Koc (mL/g) value for partitioning. The arithmetic mean of the Koc values should be used. If the cell is left blank, the Koc is set to zero (0). When Kf or Kfoc is input, the 1/n values should be supplied by the user.

Water column metabolism half-life: Enter an aerobic aquatic metabolic half-life in days from the total system of water-sediment studies. The geometric mean of the various water-sediment total system half-lives is used when two or more values are available. If stable, enter zero (0) or leave blank.

Benthic metabolism half-life: Enter an anaerobic aquatic metabolic half-life in days from the total system of water-sediment studies. The geometric mean of the various water-sediment total system half-lives is used when two or more values are available. If stable, enter zero (0) or leave blank.

Solubility: Enter the solubility in mg/L (ppm). The dissolved pesticide concentrations in a water body cannot exceed the solubility of the chemical.
Aquatic hydrolysis DT50: Enter the pH 7 hydrolysis half-life in days. This is an optional value. If the chemical is stable, enter zero (0) or leave this cell blank.

Aquatic photolysis DT50: Enter the aquatic photolysis half-life in days. This is an optional value. The effective photolysis half-life will be 124 times longer than the one entered in the program due to light attenuation in the pond. If the chemical is stable to aqueous photolysis, enter zero (0) or leave blank.

Application
The input screen for application parameters (Figure 8) contains data entry fields for the number of applications, application timing, application rate, depth of incorporation, and chemical application method. The same values can be applied to all selected scenarios ("Copy Application Data to All Selected Scenarios" button) or specific values can be entered for each scenario ("Copy Application Data to Currently Selected Scenarios" button). The selected scenario is shown in the upper right corner. The user can check the "AppScen" tab on the right to see if the application has been copied to the scenario.

For surface water, pesticide application dates can either be set using PAT or explicit date (by calendar date). If PAT is selected, then the user needs to also input the application date range which is relative to emergence and the pre-harvest interval. PAT determines the application dates for each year. This feature facilitates rapid configuration of application scenarios for multiple scenarios. For example, when the pesticide is intended for application 7 days pre-emergence, the user can enter -7 days relative to emergence and the correct application date will be calculated from the cropping information imbedded in the crop scenario file. The user can input a pre-harvest interval by filling in the days prior to harvest in which no application should occur. If applications can be made up to the harvest date, then this value can be 0. In Figure 8, the user has indicated a post-emergence application 30 days after crop emergence with a pre-harvest interval of -14 days prior to harvest.

The user should fill in all the application data (number of applications, interval, rate, application method, drift, efficiency) before running PAT. The application rate should be entered as kg/ha. The drift and efficiency are fractions. The user has the option to run PAT for all selected scenarios or run PAT for each individually selected scenario. Figure 8 shows the Appl Scen (right panel) filled in after running PAT. PAT is only used for surface water scenarios. Figure 9 shows the application screen if PAT is not run and absolute dates are used. PRZM will run the same application dates for every year if absolute dates are selected.

For multiple applications, the user can select the interval between applications in “Uniform Application Interval”. Typically, this value is the minimum allowed between application on the label. The default value for “Application occur every” is 1 year. However, the user has the option to change this value if PAT is not run. It’s easier if the user fills out the first row of application information (rate, method, efficiency, drift, etc.) then selects the number of applications because then the rows will be automatically filled with the information from the first row. Adding the application interval will automatically fill in the correct timing between the applications on the rows.

PAT is only available for surface water. For groundwater, the user can put in absolute dates or can put in dates relative to emergence. Figure 10 shows the application screen and Appl Scen filled out as applications relative to emergence date.

For PRZM, the user has 9 different Chemical Application Methods (CAM) that are selected under “App. Method”:
CAM 1 – Below crop
CAM 2 – Above crop, foliar fraction intercepted as a straight-line function of crop development
CAM 3 – Above crop, foliar fraction intercepted exponentially as the crop develops
CAM 4 – Uniform below crop, user defined depth
CAM 5 – Below crop, increasing with depth
CAM 6 - Below crop, decreasing with depth
CAM 7 – T-band
CAM 8 – At depth
CAM 12 – Set crop interception

Further descriptions of the CAM options are described below.
CAM = 1 should be used for surface applied chemicals. To account for surface roughness, a linearly decreasing distribution of chemical in soil to a depth of 4 cm is used.
CAM = 2 results in linear applications to foliage based on crop canopy. Non-intercepted chemical is applied the same as CAM=1. Washed-off chemical is uniformly distributed to a depth of 2 cm.
CAM = 3 results in nonlinear applications to foliage using exponential filtration. All else is the same as CAM=2.
CAM = 4 is used for uniform incorporation into the soil to a depth specified by the user.
CAM = 5 results in linearly increasing incorporation to a user defined depth.
CAM = 6 results in linearly decreasing incorporation to a user defined depth.
CAM = 7 approximates T-Band application to a user defined incorporation depth. Variable DRFT should be used to define the fraction of chemical to be applied in the top 2 cm. The remainder of the chemical will be uniformly incorporated between 2 cm and the user defined depth.
CAM = 8 incorporates chemical directly to the depth specified by the user.
CAM = 12 results in applications to foliage based on user defined crop interception. Non-intercepted chemical is applied the same as CAM=1. Washed-off chemical is uniformly distributed to a depth of 2 cm.

Drift and efficiencies are entered as fractions. Efficiency for aerial is 0.95 (95 percent) and 0.99 (99 percent) for ground spray or airblast. The user can input their own drift and efficiency if they do not want to use the drift tool. For example, no drift is assumed for granular applications so the user can use 0.00 for drift and 1.00 (100 percent) for efficiency.

If the user recalls a previous project, the saved application information from the previous runs is shown on the right-side bar when clicking on the "Appl Scen" tab. This previous application data will be used for the new runs. However, the user can click on the "Make this the currently displayed application date" on the right-side bar to copy the application data to the main application screen. If the user wants all new application data, the user can change all the application values in the main application screen and hit the "Copy Application Data to All Selected Scenarios" or "Copy Application Data to Currently Selected Scenarios".

Figure 8. Application screen and Appl Scen tab after running PAT for surface water scenarios

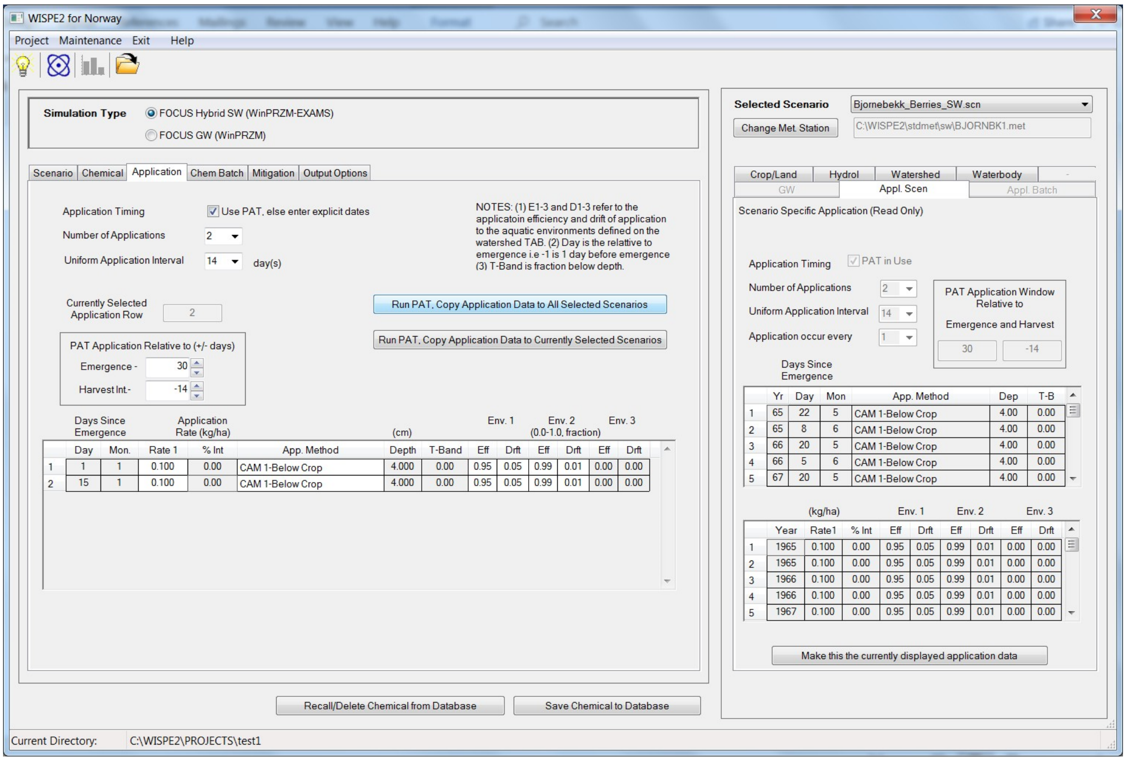


Figure 9. Application screen and Appl Scen tab for absolute dates for surface water scenarios

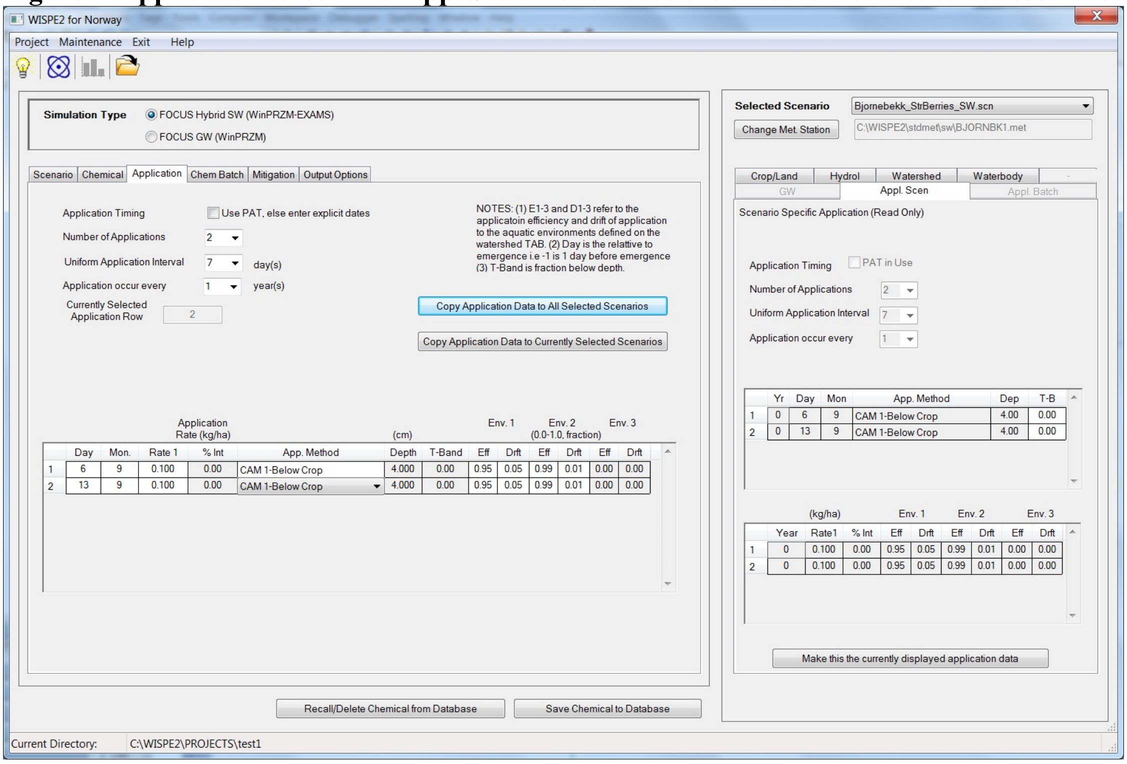
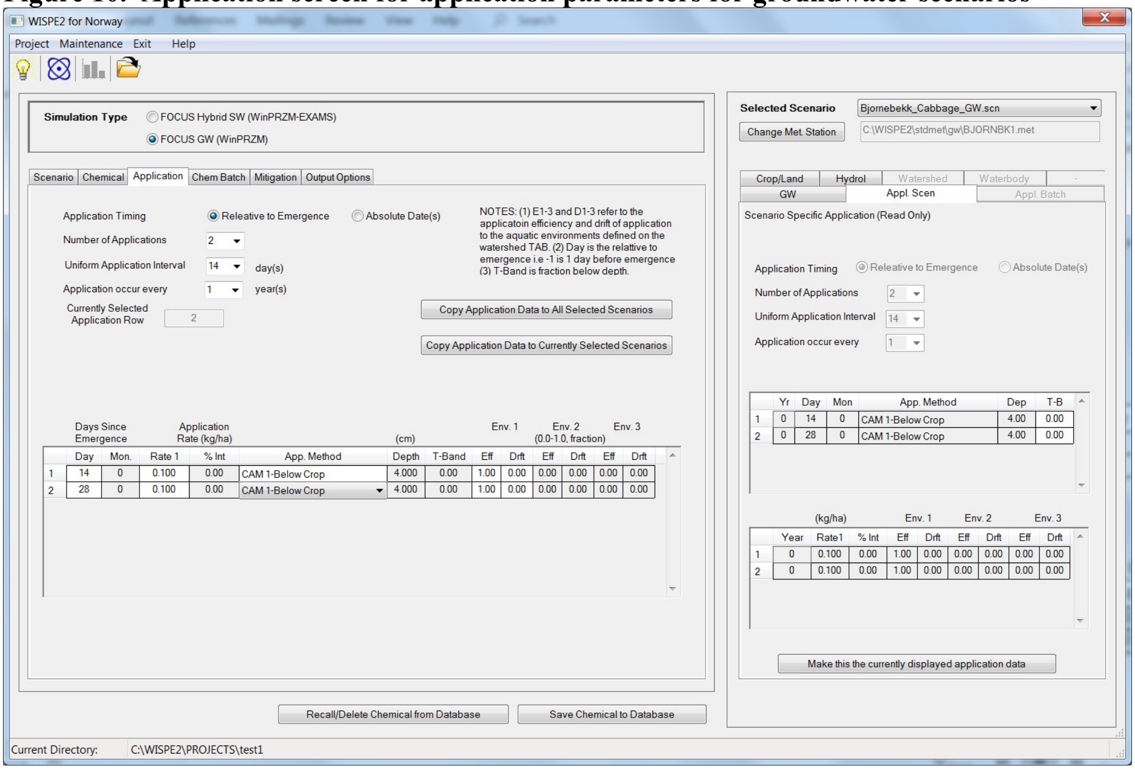


Figure 10. Application screen for application parameters for groundwater scenarios



Batch Runs

The user can simulate batch (sensitivity) runs using this tab.

Figure 11 shows the screen if the batch runs is not used – Number of Simulations set to zero (0). Batch runs will be run if the Number is Simulations is greater than zero (1 to 999 runs). The user has the option to change 33 chemical properties which includes parent, metabolites and transformation. The user can see the columns listed on the screen (highlighted in rectangle). To use the batch runs, it's easiest for the user to first indicate 1 number of simulations (Figure 12). This will fill in the current chemical data for the scenario(s). The user can select which chemical property or properties to change with the beginning row and ending row, minimum value, maximum value and increment. For example, if the user wanted to change the sorption by 1000 starting with 15 up to 3015, the user would have the begin row =1, end row =4, min. value =15, max. value = 3015, increment = 1000. The user changes the number of simulations to 4, then the user hits the "Update range deg. Values" button and the table is filled in (Figure 13). The user can add more changes to the simulations by selecting the chemical property and adding row information (begin, end, min. value, max. value, increment) and changing the number of simulations then hitting "Update range Deg. Values" to add the rows with chemical data changes for sensitivity runs.

In the future, the user will be able to simulate application batch runs.

Figure 11. Batch runs screen

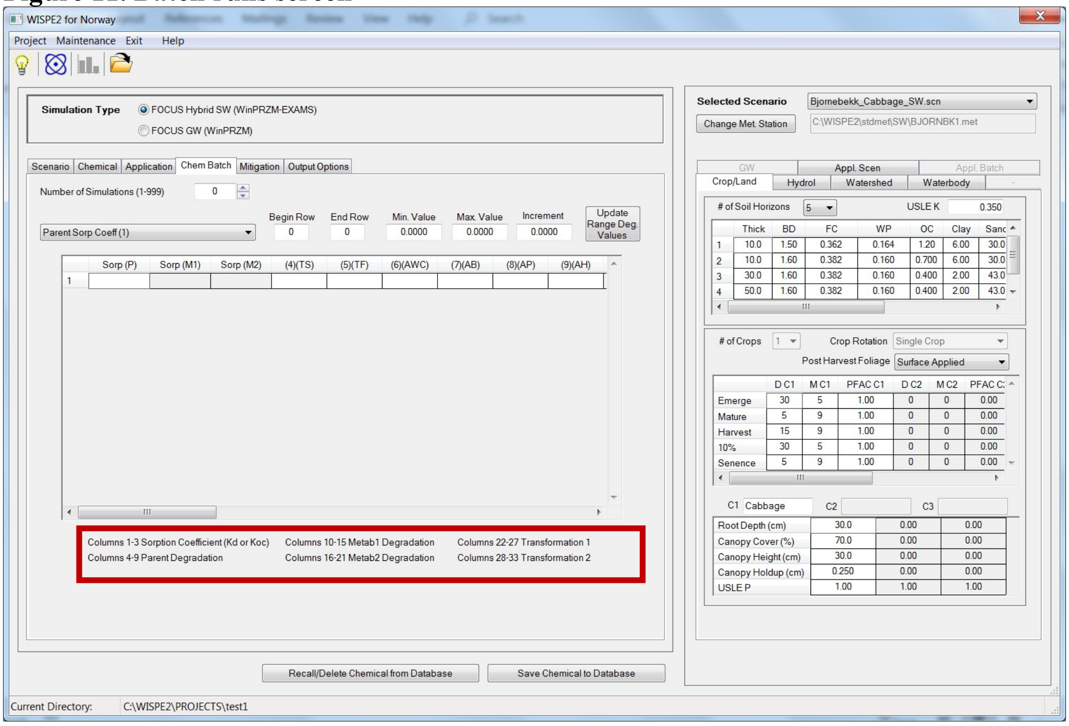


Figure 12. Batch runs screen with one simulation (current chemical)

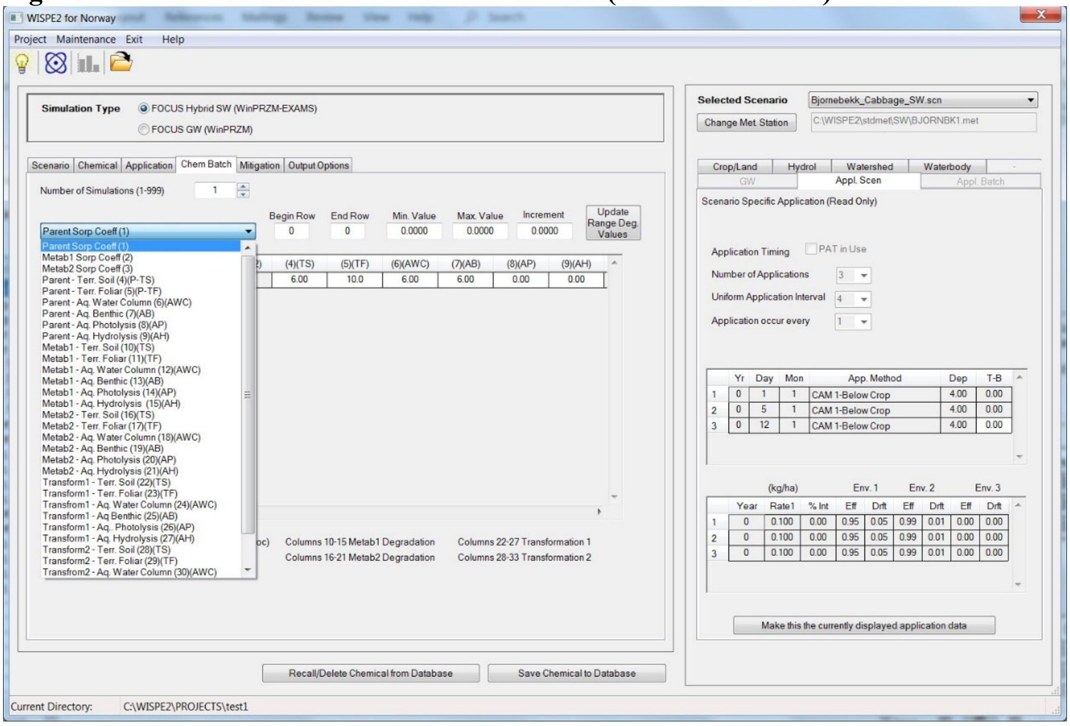
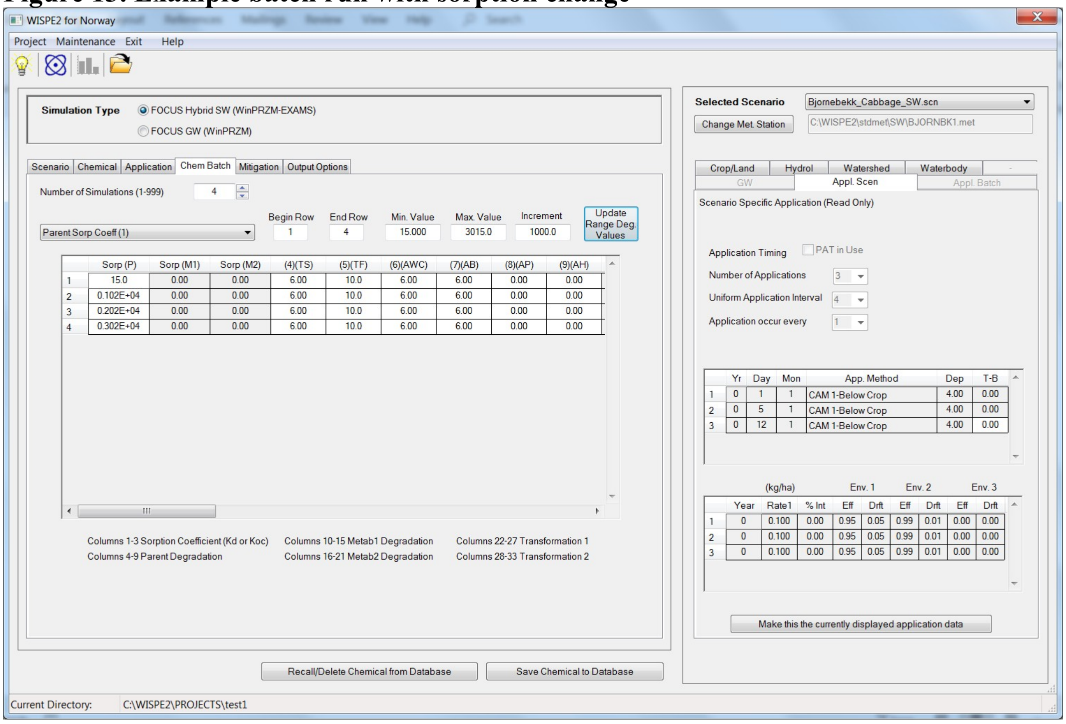


Figure 13. Example batch run with sorption change



Mitigation

The user has the option to add a vegetative filter strip (VFS) mitigation. Figure 14 shows the screen when the user hits the mitigation tab. If the user clicks on the “Mitigate Runoff/Erosion Using Vegetative Filter Strip” button, then “Method 1 – Uniform Reduction” option appears (Figure 15) which allows the user to select the size of the VFS. If the VFS is less than 5 m, then there isn’t any reduction in the runoff/erosion mass from the field (PRZM runs). If a 5 to 10-m VFS is selected then the runoff/erosion mass is reduced by 40% and reduced by 65% if a 10 to 20-m VFS is selected (SETAC, 2013). A runoff/erosion mass reduction of 80% is simulated if the VFS is greater than 20 m (SETAC, 2013). In the future, other methods of reduction through a VFS will be simulated but are not available at this time.

Figure 14. Mitigation screen

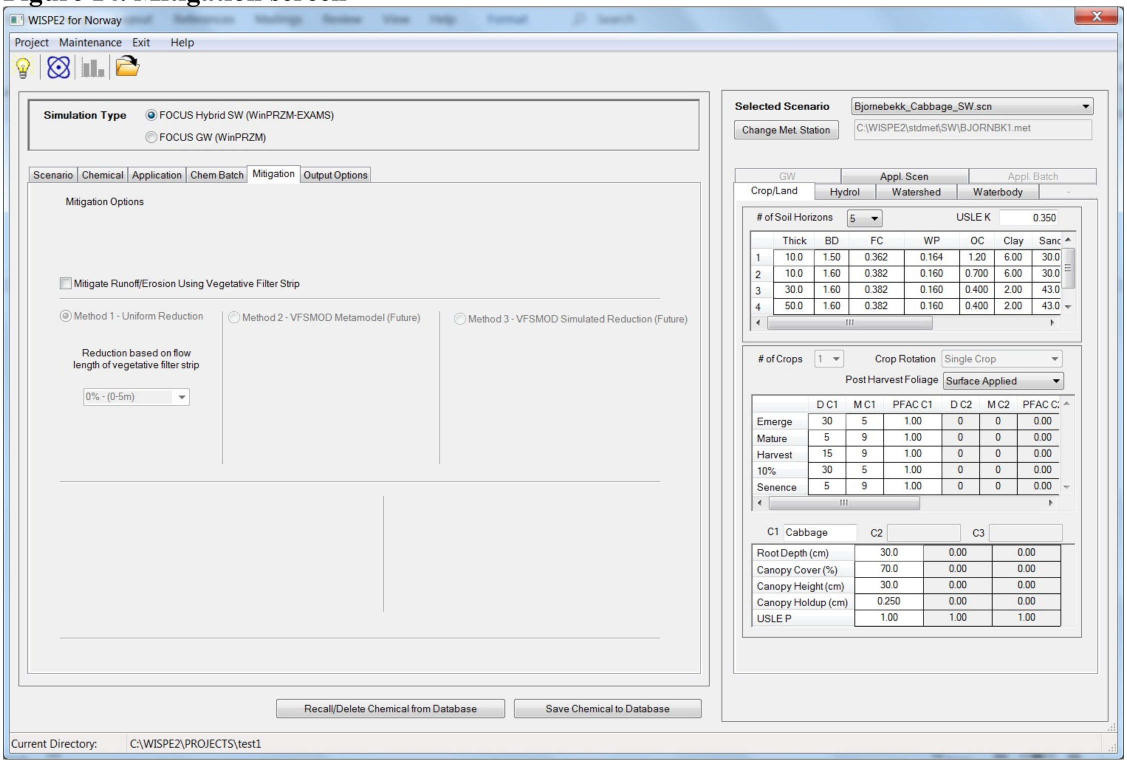
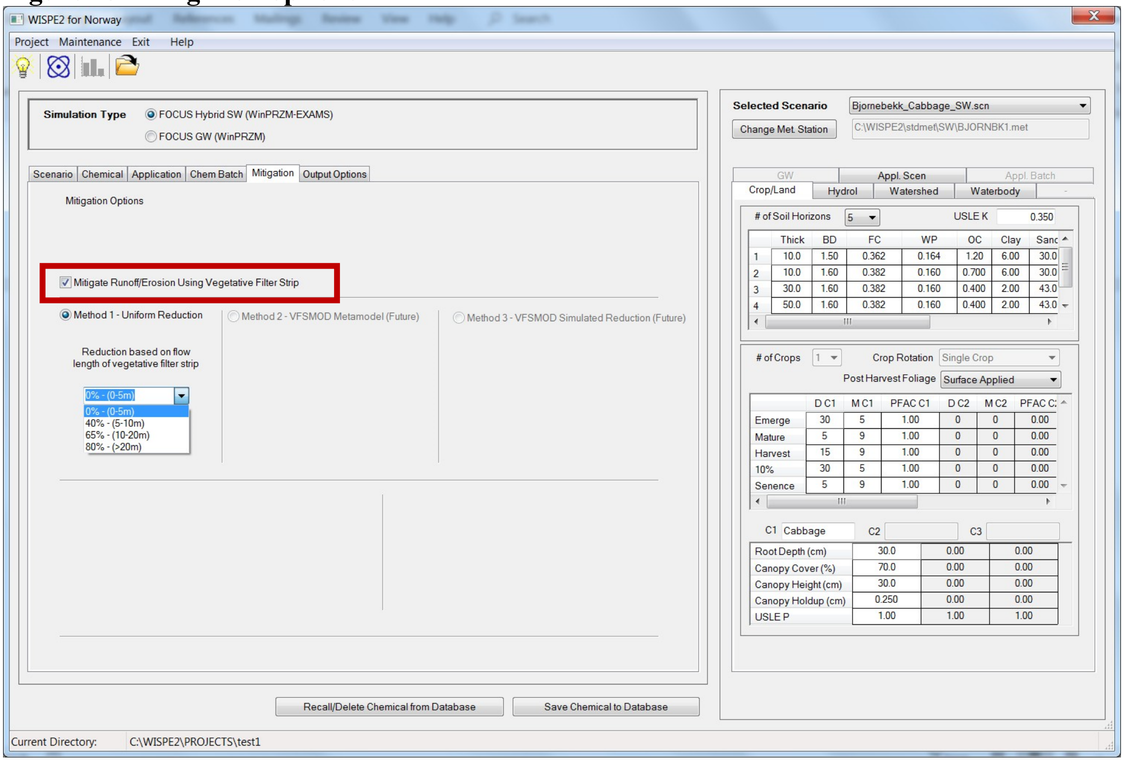


Figure 15. Mitigation options

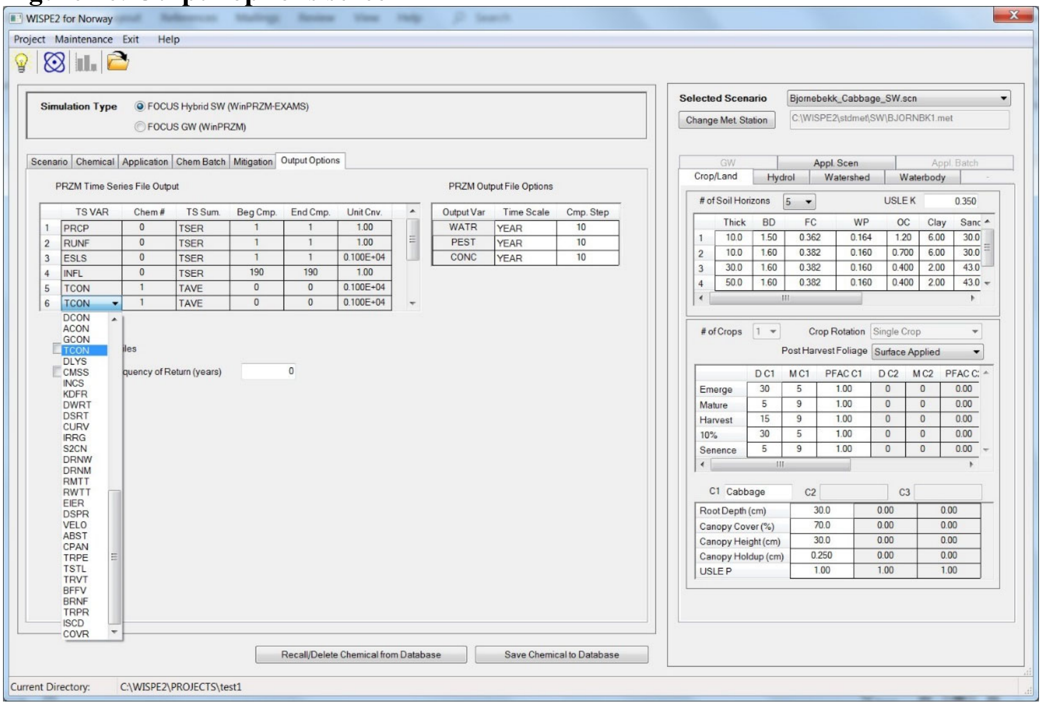


Output Options

The output is currently locked down to the default PRZM output files. In the future, the user has the option to change any of the Time Series Variables (TS Var) as shown in Figure 16 The user can also change the Time Series Summary (TS Sum.) of the output to TSER (daily), TCUM (cumulative), TAVE (daily average over multiple compartments), or TSUM (daily sum over multiple compartments). If using TAVE or TSUM, the user must provide a beginning soil compartment (Beg Cmp.) and ending soil compartment (End Cmp.). Unit conversions (Unit Cnv.) can be changed by the user. The user can specify the output time step for the .out file (year, month, day) and compartment step (default = 10). Output descriptions can be found in the PRZM manual (Carousel, et al., 2005).

In the future, the user can check if HED files are needed and add additional frequency of return (years).

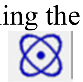
Figure 16. Output options screen



Screen on the right

As previously mentioned, the screens to the right show the parameters that are associated with the scenario. The "Crop/Land" tab shows the soil properties and cropping properties. The "Hydrol" tab shows the USLE c-factors and curve numbers used in winPRZM. It also shows if there is irrigation for winPRZM scenarios. The "Watershed" tab shows information about the watershed such as field area and waterbody data (area, depth). The "waterbody" tab gives more information about the waterbody such as suspended sediment, benthic bulk density and benthic organic carbon. The "Appl Scen" tab is filled in after the Application screen is filled out for each scenario and the user hits the "Copy Application Data" button. The "Appl. Batch" tab is not available at this time. It is for future use to fill out if the user sets up application batch runs.

Writing and Running the Input Files

After the input screens have been filled in. The final step of writing the input files and running the models is started by clicking the button on the upper left of the screen next to the lightbulb. 

The information necessary to run winPRZM-EXAMS is contained in several input data files:

winPRZM

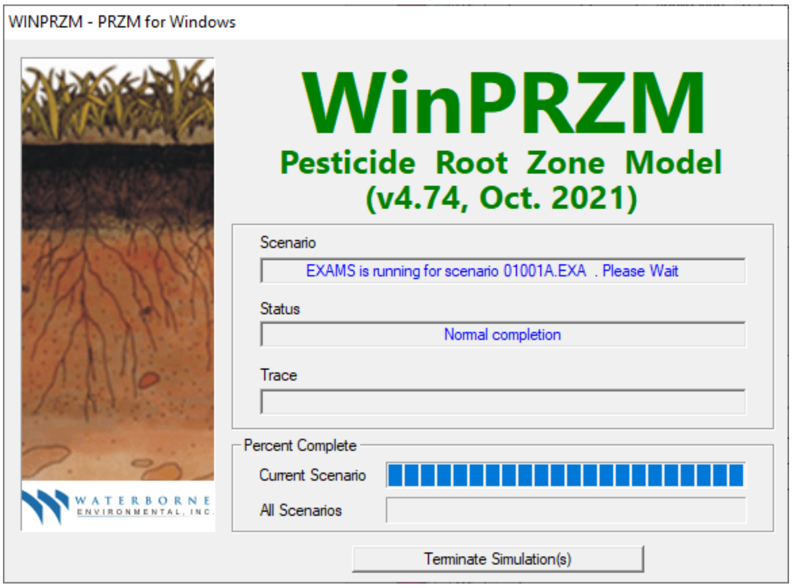
- annotated parameter file incorporating the scenario definition, *.inp
- climate file providing the weather data used, *.met

EXAMS

- parameter file including the scenario selection, *.exa
- water body (pond) environment file, *.exv

Each standard scenario is assigned a unique name that identifies the location and crop. Figure 17 shows the window that appears when the models are running.

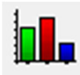
Figure 17. Window during the running of the winPRZM-EXAMS



After a completed simulation run, the relevant scenario output data is provided in three winPRZM ASCII files (*.hyd, *.cnc, *.msb, *.zts, and *.out) and three EXAMS ASCII files (*.xms, *.yms, and *.zms). These files are analyzed automatically by WISPE to generate tables and graphics of the results. The output generator can also export results for each simulated scenario in an ASCII file with an extension of ".txt." These files are created in the current project directory. These files can be used for further data analysis.

winPRZM Output
- *.out = summary of winPRZM output. Contains all winPRZM output
- *.cnc = mean annual soil concentration at depths of 1 meter from the soil surface and at the bottom of the soil column
- *.hyd = annual hydrology summary (total precipitation, runoff, erosion, and evapotranspiration)
- *.msb = annual chemical mass balance at depths of 1 meter from the soil surface and at the bottom of the soil column (total application, runoff flux, decay flux, erosion flux, mass remaining in soil column, etc.)
- *.zts = winPRZM times series outputs for closer analysis (using other software)

EXAMS Output
- *.xms = EXAMS standard tabular report file
- *.yms = EXAMS EcoRisk output file containing "instantaneous" and mean 24-hour, 96-hour, 21-day, 60-day, 90-day, and annual average aquatic concentrations of parent and transformation product chemicals
- *.zms = EXAMS EcoTox output files (daily concentrations of parent and product chemicals)

Output Generator
Start the output generator by selecting the “histogram graph” icon on the opening screen (upper left corner, third icon from left). 

Surface water
Clicking the “histogram graph” icon results in the screen shown in Figure 18 appearing for surface water scenarios. Graphical output of the annual maximum predicted environmental concentrations PECs in chronological order are shown in the screen for the current scenario selected with the buttons on the left top of the screen. The user can choose to look at Environment 1 (Standard Pond) or Environment 2 (Standard Stream) by checking the radio button. The screen also shows the 90^{th} percentile (upper 10^{th} percentile) PECs for exposure duration time weighted averages in the bottom of the screen for the current selected scenario and environment. The 10^{th} percentile annual maximum PECs for 1-day, 4-day, 21-day, 60-day, 90-day, 365-day, and all years are shown for the water phase. Pore water and sediment 10^{th} percentile annual maximum PECs for 1-day and 21-day time-weighted average are also provided. The relative percent of runoff, erosion, and drift over the entire period is shown.

Additionally, the user can see the “Relative Transport (%)” on the output screen. This provides the modeler with information on the estimated transport contribution of the mass load into the waterbody from either runoff, erosion, or drift. The fraction of applied transported from the field to the waterbody via runoff or drift is also shown.

Clicking on the “90^{th} Percentile Multi-scenario” button on the top left of the screen (under the current scenario), results in the screen shown in Figure 19 appearing. Graphical output of the 90^{th} percentile annual maximum water PECs in scenario run order are displayed. The run order is shown below with scenario listed with the 90^{th} percentile annual maximum PECs for water and pore water in ppb for each exposure duration.

The project folder contains the output of each simulation. For surface water, a text file (*.txt) for each scenario is created that contains the annual maximum PECs and the 90^{th} (upper 10^{th}) percentile PECs for water and pore water. If only one scenario is run with one chemical, then the files would be named “01001A_parent.txt” and “01001B_parent.txt” for the pond environment and stream environment, respectively. The first two numbers of the file names change as additional scenarios are run (e.g, if two scenarios are simulated, then files “02001A_parent.txt” and “02001B_parent.txt” will also be saved in the project folder). Figure 20 shows the data from the .txt file which is shown in the graphs. The data in these .txt files are presented in the graphs as stacked bars of exposure duration concentrations. As previously mentioned, a file “eec10.txt” is created that has the summary of the 90^{th} percentile PECs for each scenario.

The user has the option to view the pore water graphs. Figure 21 shows graphically the annual maximum PECs in the pore water for the current scenario in chronological order. Figure 22 shows a graph of the 90^{th} (upper 10^{th}) percentile PECs for all the scenarios.

To leave the Output Graphics, the user can click on the “OK” button.

Figure 18. Screen showing a graph of the maximum annual PECs in the water phase for a surface water scenario

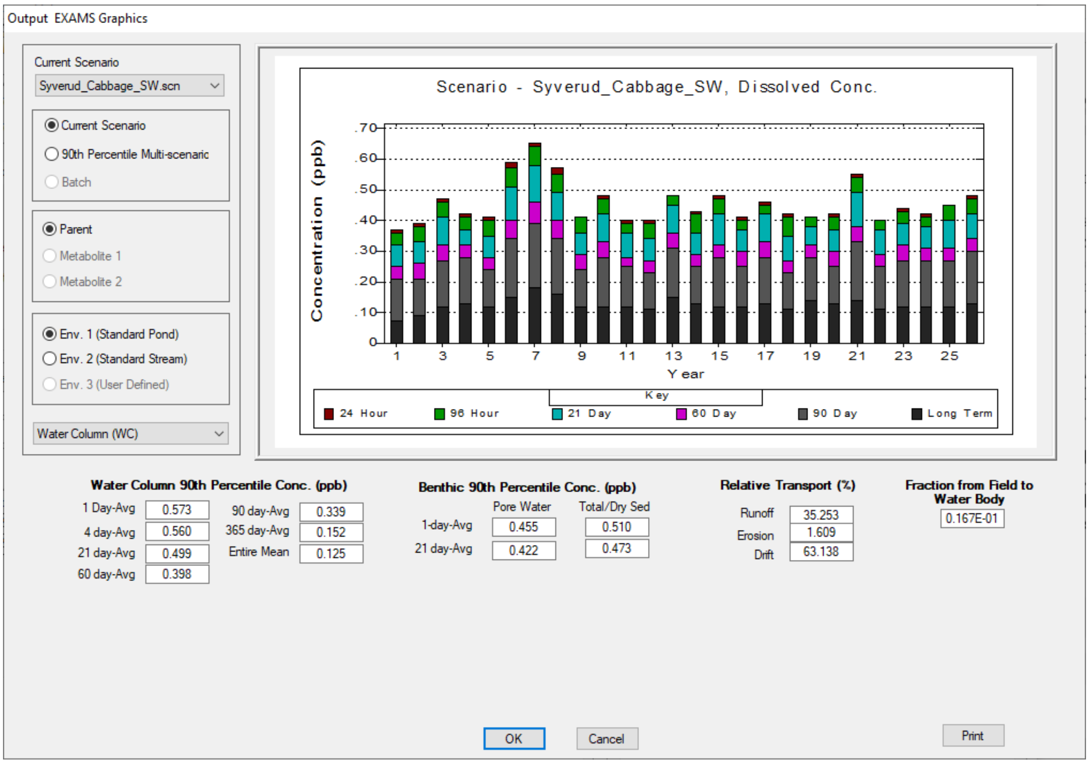
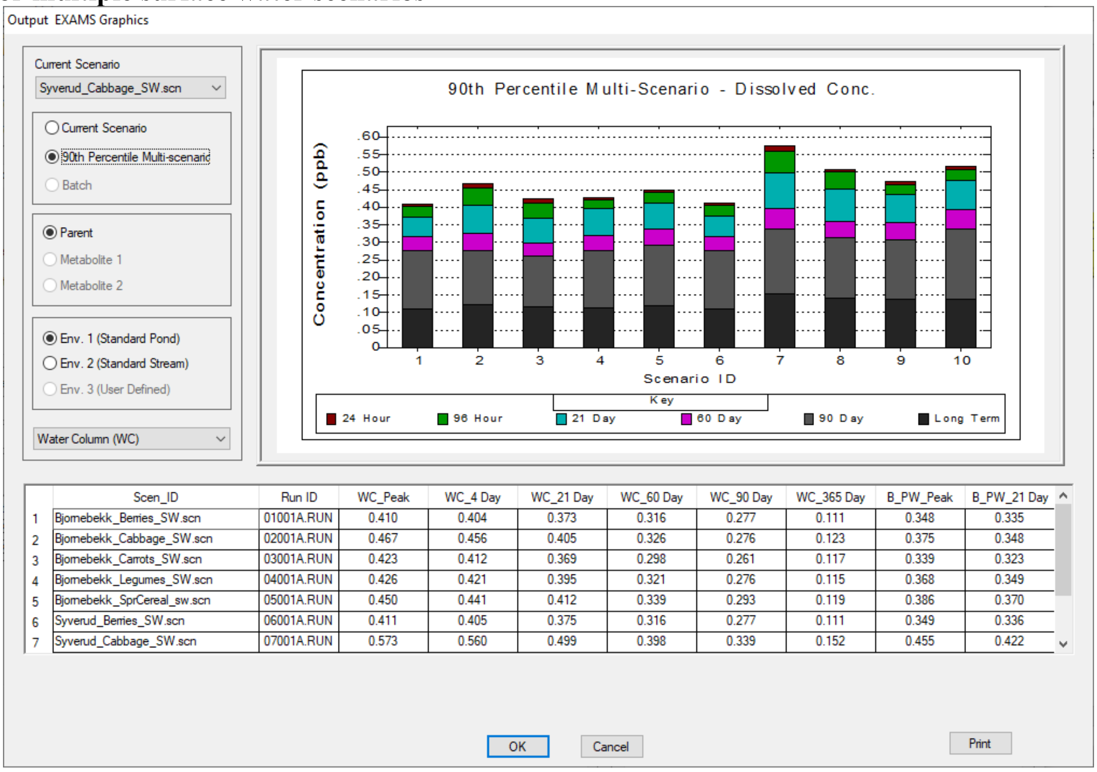


Figure 19. Screen showing a table and graph of the 90th percentile PECs in the water phase for multiple surface water scenarios



	Scen_ID	Run ID	WC_Peak	WC_4 Day	WC_21 Day	WC_60 Day	WC_90 Day	WC_365 Day	B_PW_Peak	B_PW_21 Day
1	Bjornebekk_Berries_SW.scn	01001A.RUN	0.410	0.404	0.373	0.316	0.277	0.111	0.348	0.335
2	Bjornebekk_Cabbage_SW.scn	02001A.RUN	0.467	0.456	0.405	0.326	0.276	0.123	0.375	0.348
3	Bjornebekk_Carrots_SW.scn	03001A.RUN	0.423	0.412	0.369	0.298	0.261	0.117	0.339	0.323
4	Bjornebekk_Legumes_SW.scn	04001A.RUN	0.426	0.421	0.395	0.321	0.276	0.115	0.368	0.349
5	Bjornebekk_SprCereal_sw.scn	05001A.RUN	0.450	0.441	0.412	0.339	0.293	0.119	0.386	0.370
6	Syverud_Berries_SW.scn	06001A.RUN	0.411	0.405	0.375	0.316	0.277	0.111	0.349	0.336
7	Syverud_Cabbage_SW.scn	07001A.RUN	0.573	0.560	0.499	0.398	0.339	0.152	0.455	0.422

Figure 20. Exposure output .txt file for pond environment (scenario ID =7 in this example)

```
 Water Model Output (EXAMS)

 *******************************************
 Performed on:

Peak 1-in-10.0      (ppb) =      0.5780E+00
Chronic 1-in-10.0   (ppb) =      0.1523E+00
Simulation Avg      (ppb) =      0.1254E+00
4-d avg 1-in-10.0   (ppb) =      0.5598E+00
21-d avg 1-in-10.0  (ppb) =      0.4987E+00
60-d avg 1-in-10.0  (ppb) =      0.3975E+00
90-d avg 1-in-10.0  (ppb) =      0.3389E+00
1-d avg 1-in-10.0   (ppb) =      0.5734E+00
Benthic Pore Water Peak 1-in-10.0     (ppb) =      0.4551E+00
Benthic Pore Water 21-d avg 1-in-10.0 (ppb) =      0.4223E+00
Benthic Conversion Factor             (ppb) =
Benthic Mass Fraction in Pore Water   (ppb) =

YEAR   1-day      4-day      21-day     60-day     90-day     Yearly Avg Benthic Pk  Benthic 21-day
 1    0.37E+00   0.36E+00   0.32E+00   0.25E+00   0.21E+00   0.73E-01   0.29E+00   0.27E+00
 2    0.39E+00   0.38E+00   0.33E+00   0.26E+00   0.21E+00   0.92E-01   0.30E+00   0.28E+00
 3    0.47E+00   0.46E+00   0.41E+00   0.32E+00   0.27E+00   0.12E+00   0.37E+00   0.34E+00
 4    0.42E+00   0.41E+00   0.37E+00   0.32E+00   0.28E+00   0.13E+00   0.33E+00   0.32E+00
 5    0.41E+00   0.40E+00   0.35E+00   0.28E+00   0.24E+00   0.12E+00   0.32E+00   0.30E+00
 6    0.59E+00   0.57E+00   0.51E+00   0.40E+00   0.34E+00   0.15E+00   0.45E+00   0.43E+00
 7    0.65E+00   0.64E+00   0.58E+00   0.46E+00   0.39E+00   0.18E+00   0.54E+00   0.50E+00
 8    0.57E+00   0.55E+00   0.49E+00   0.40E+00   0.34E+00   0.16E+00   0.46E+00   0.42E+00
 9    0.41E+00   0.41E+00   0.36E+00   0.29E+00   0.24E+00   0.12E+00   0.33E+00   0.31E+00
10    0.48E+00   0.47E+00   0.42E+00   0.33E+00   0.28E+00   0.12E+00   0.38E+00   0.36E+00
11    0.40E+00   0.39E+00   0.36E+00   0.28E+00   0.25E+00   0.12E+00   0.32E+00   0.31E+00
12    0.40E+00   0.39E+00   0.34E+00   0.27E+00   0.23E+00   0.11E+00   0.30E+00   0.28E+00
13    0.48E+00   0.48E+00   0.45E+00   0.36E+00   0.31E+00   0.15E+00   0.42E+00   0.40E+00
14    0.43E+00   0.42E+00   0.36E+00   0.29E+00   0.25E+00   0.13E+00   0.32E+00   0.30E+00
15    0.48E+00   0.47E+00   0.42E+00   0.32E+00   0.28E+00   0.12E+00   0.38E+00   0.35E+00
16    0.41E+00   0.40E+00   0.37E+00   0.30E+00   0.25E+00   0.12E+00   0.32E+00   0.31E+00
17    0.46E+00   0.45E+00   0.42E+00   0.33E+00   0.28E+00   0.13E+00   0.39E+00   0.37E+00
18    0.42E+00   0.41E+00   0.35E+00   0.27E+00   0.23E+00   0.11E+00   0.31E+00   0.29E+00
19    0.41E+00   0.41E+00   0.38E+00   0.32E+00   0.28E+00   0.14E+00   0.35E+00   0.33E+00
20    0.42E+00   0.41E+00   0.37E+00   0.30E+00   0.25E+00   0.13E+00   0.33E+00   0.32E+00
21    0.55E+00   0.54E+00   0.49E+00   0.38E+00   0.33E+00   0.14E+00   0.45E+00   0.42E+00
22    0.40E+00   0.40E+00   0.37E+00   0.29E+00   0.25E+00   0.11E+00   0.34E+00   0.32E+00
23    0.44E+00   0.43E+00   0.39E+00   0.32E+00   0.27E+00   0.12E+00   0.36E+00   0.33E+00
24    0.42E+00   0.41E+00   0.38E+00   0.31E+00   0.27E+00   0.12E+00   0.35E+00   0.33E+00
25    0.45E+00   0.45E+00   0.40E+00   0.31E+00   0.27E+00   0.12E+00   0.37E+00   0.34E+00
26    0.48E+00   0.47E+00   0.42E+00   0.34E+00   0.30E+00   0.13E+00   0.39E+00   0.37E+00
```

Figure 21. Screen showing a graph of the maximum annual PECs in the pore water phase for a surface water scenario

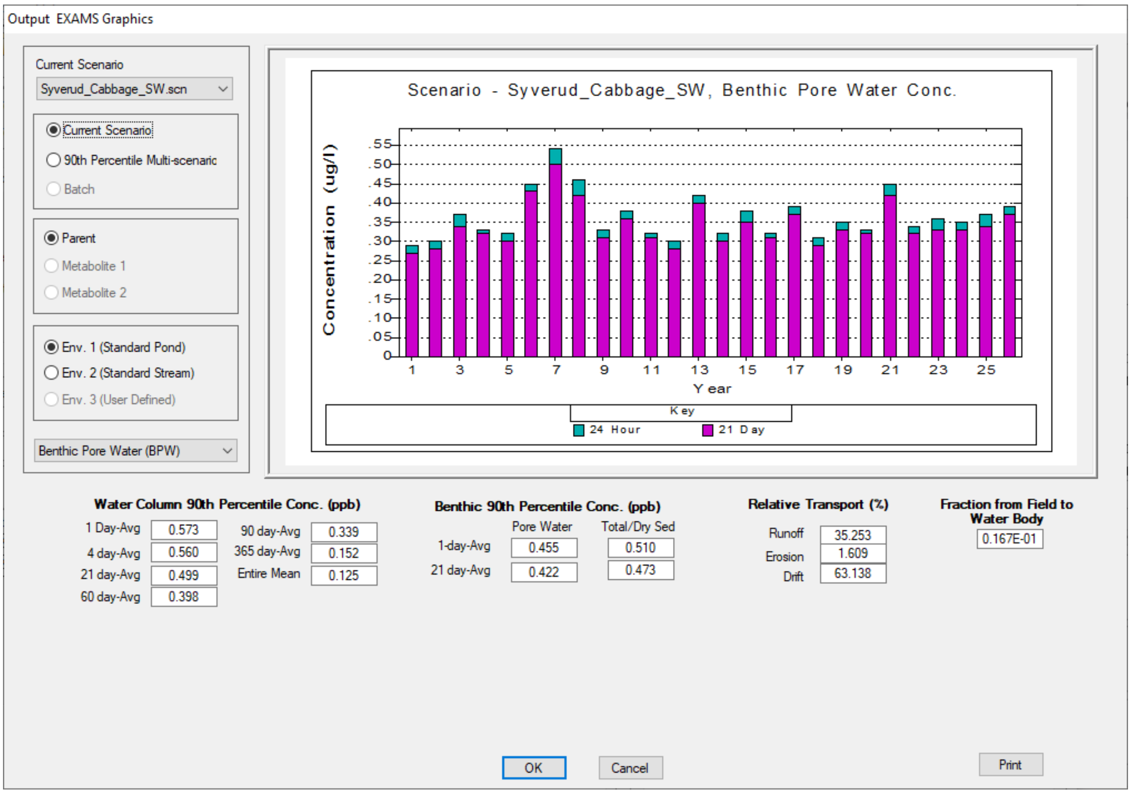
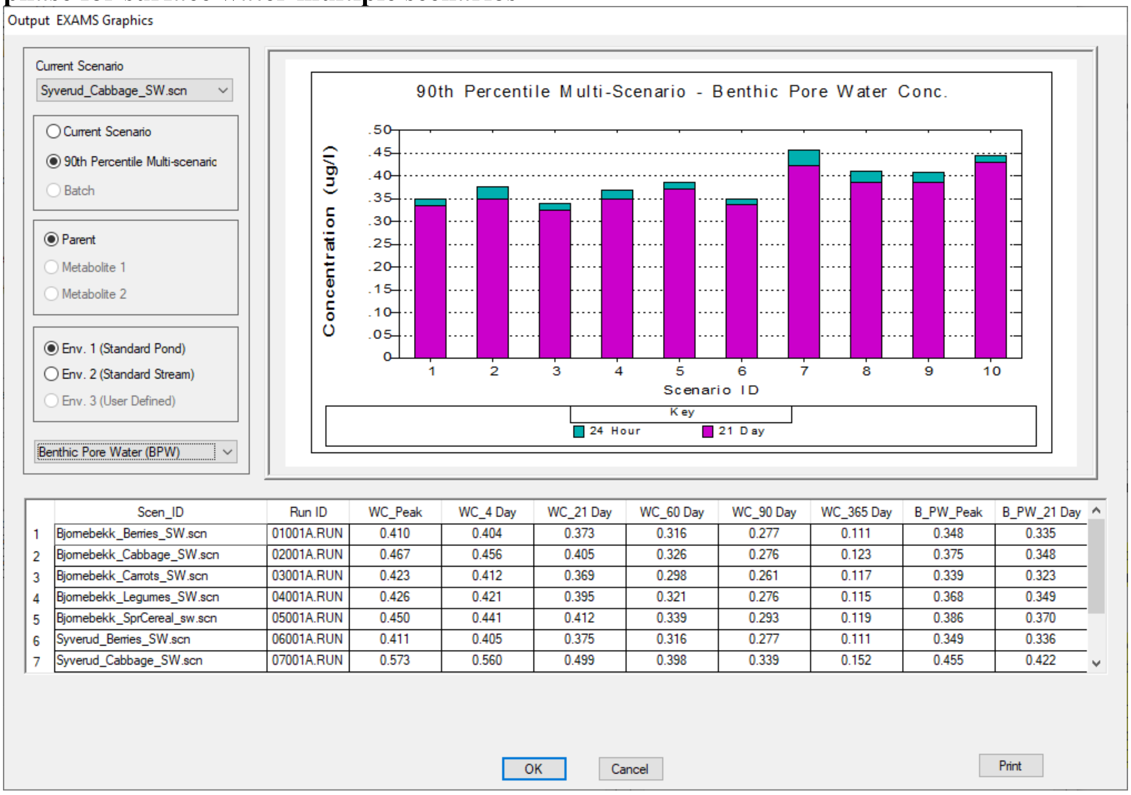


Figure 22. Screen showing a table and graph of the 90th percentile PECs in the pore water phase for surface water multiple scenarios



	Scen_ID	Run ID	WC_Peak	WC_4 Day	WC_21 Day	WC_60 Day	WC_90 Day	WC_365 Day	B_PW_Peak	B_PW_21 Day
1	Bjornebekk_Berries_SW.scn	01001A.RUN	0.410	0.404	0.373	0.316	0.277	0.111	0.348	0.335
2	Bjornebekk_Cabbage_SW.scn	02001A.RUN	0.467	0.456	0.405	0.326	0.276	0.123	0.375	0.348
3	Bjornebekk_Carrots_SW.scn	03001A.RUN	0.423	0.412	0.369	0.298	0.261	0.117	0.339	0.323
4	Bjornebekk_Legumes_SW.scn	04001A.RUN	0.426	0.421	0.395	0.321	0.276	0.115	0.368	0.349
5	Bjornebekk_SprCereal_sw.scn	05001A.RUN	0.450	0.441	0.412	0.339	0.293	0.119	0.386	0.370
6	Syverud_Berries_SW.scn	06001A.RUN	0.411	0.405	0.375	0.316	0.277	0.111	0.349	0.336
7	Syverud_Cabbage_SW.scn	07001A.RUN	0.573	0.560	0.499	0.398	0.339	0.152	0.455	0.422

Additionally, the user can select to look at the PRZM mass balance and hydrology summary for each scenario. The radio button for the current scenario needs to be checked before looking at these graphs. The user can see the mass balance of the pesticide in the field for each year at the bottom of the soil core (Figure 23). Figure 24 shows the hydrology in the field for each year. The top graph displays the precipitation plus irrigation. The bottom graph shows the amount of water in leachate, evapotranspiration (ET), or runoff from the field.

Figure 23. PRZM mass balance graph for current scenario

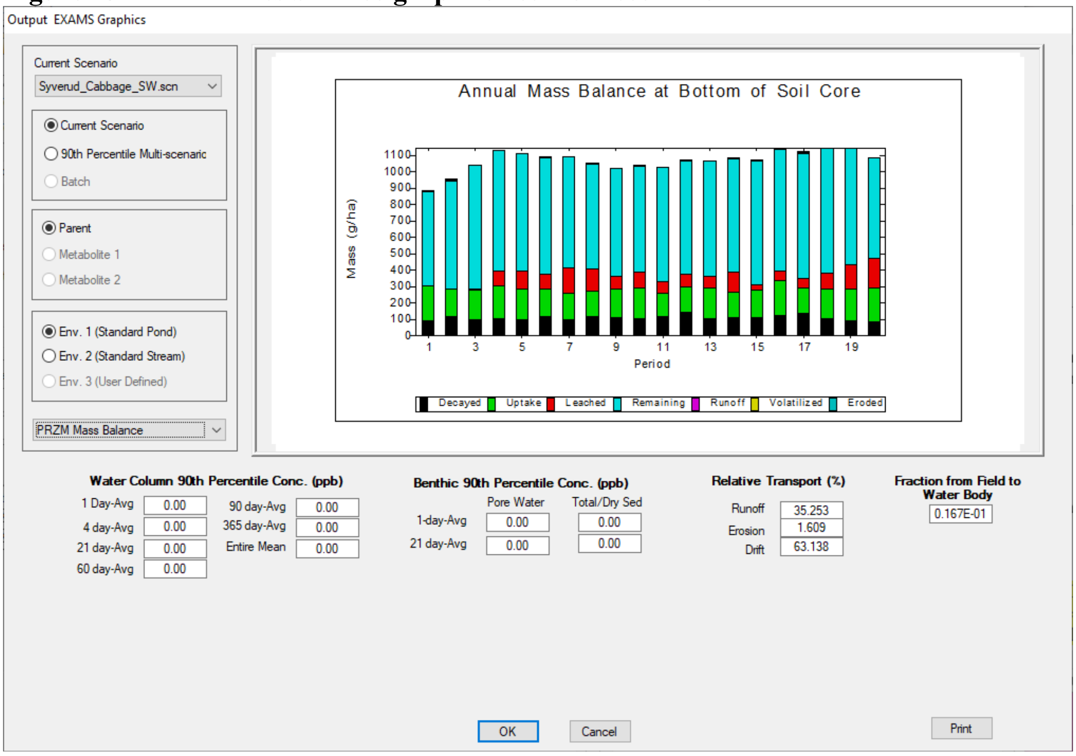
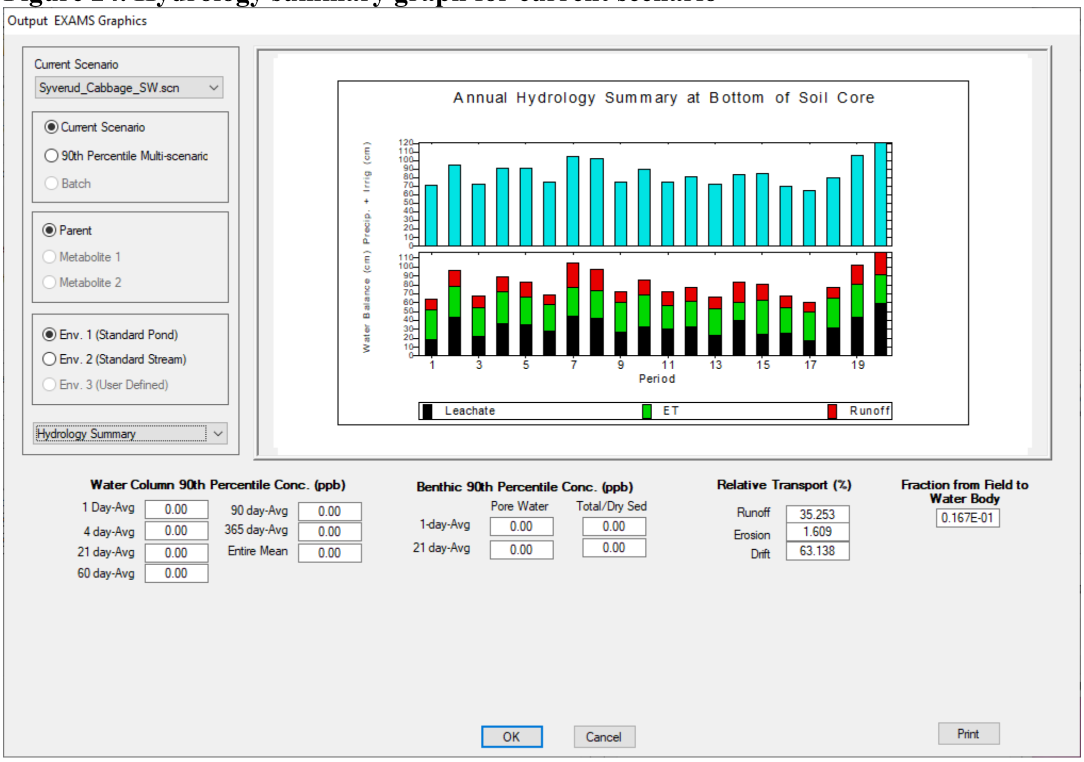


Figure 24. Hydrology summary graph for current scenario



Groundwater

For the groundwater scenarios, only 20 years of the 26-year runs are analysed since it is assumed that there are six "warm up" years. The user can select the current scenario to look at the annual concentrations that have leached below 1 m (Figure 25) or to the bottom of the soil core (Figure 26). The left side of the bottom of the screen shows the "Summary of Leaching Concentration" in µg/L for the 1-m depth and the bottom of the core. The 80th percentile concentration, minimum annual concentration, and maximum annual concentration are shown along with the year associated with that value. In the example figure, the 80th percentile concentration at 1-m depth is 11 µg/L which is closest to the time period 4. The maximum at 1-m depth occurred on time period 16 and the minimum concentration was in time period 8. These data are further analysed in the summary on the right on the bottom of the screen. For example, for the 80th percentile year (time period 4), the amount of pesticide that decayed was 976 g/ha, 54.5 g/ha leached, 2.43 g/ha volatilized, and 20.4 g/ha mass is remaining. The amount of water infiltrated was 49.7 cm that year. The analysis of mass and hydrology is also shown for the year that had the minimum concentration and the year that had the maximum concentration. The 1-m depth and Bottom of Core are both shown in the summary of results.

The mass balance masses are also shown graphically as stacked bars for each year if the user selects the mass balance button (Figure 27). The annual hydrology is shown in Figure 28 with the precipitation plus irrigation on the top graph and the leachate, evapotranspiration and runoff as stacked bars on the lower graph.

Figure 29 shows the 80th percentile concentrations for all the groundwater scenarios that were simulated in one graph. The x-axis is the ID of the scenario and the y-axis is the 80th percentile concentration.

Figure 25. Annual maximum groundwater concentrations leached below 1 m

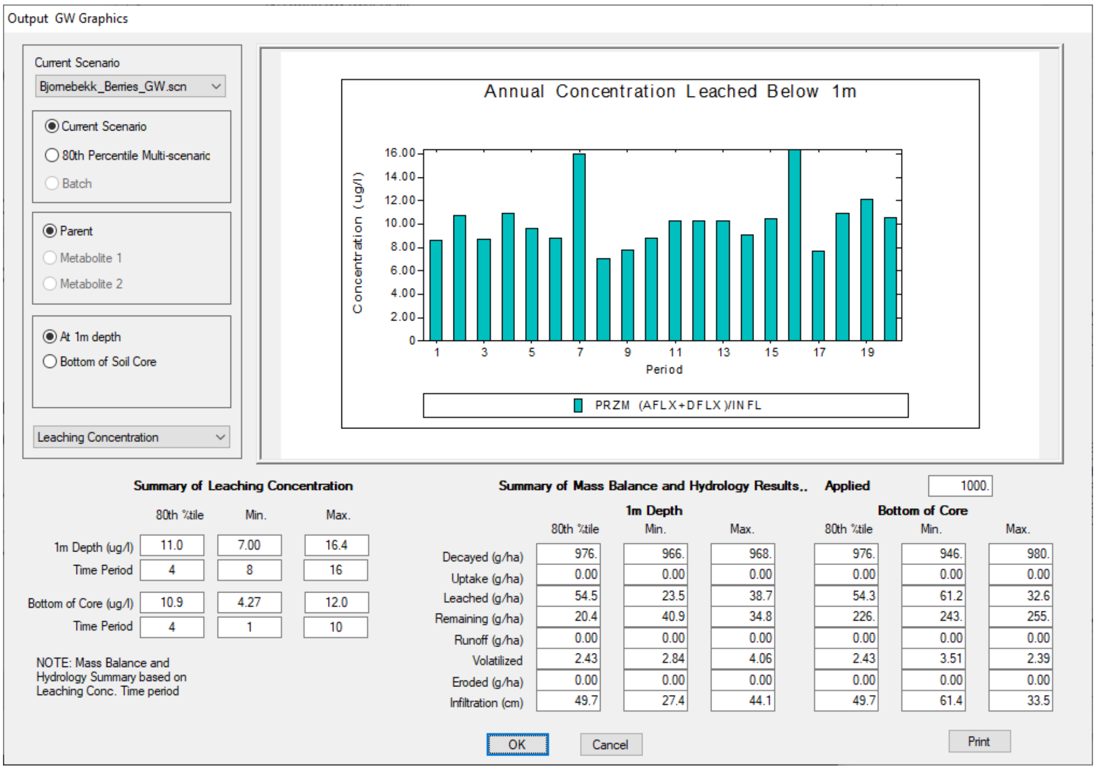


Figure 26. Annual maximum groundwater concentrations leached at bottom of the soil core

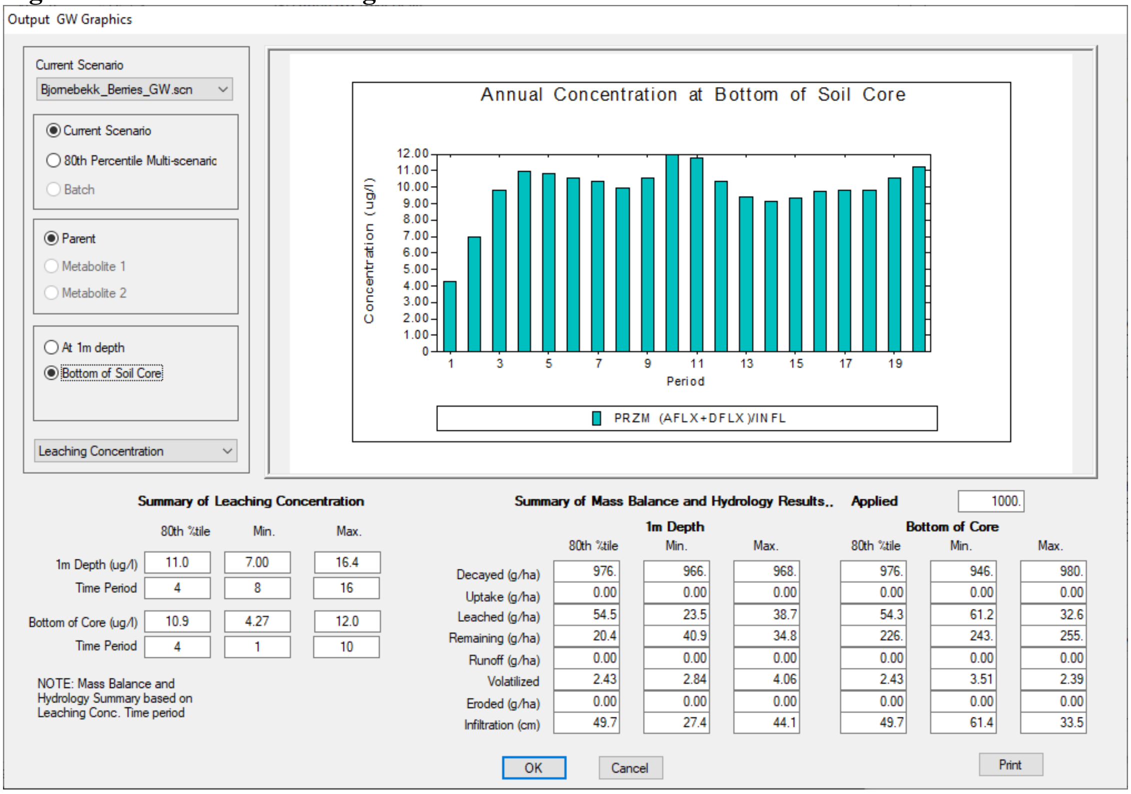


Figure 27. Groundwater annual mass balance summary at bottom of the soil core

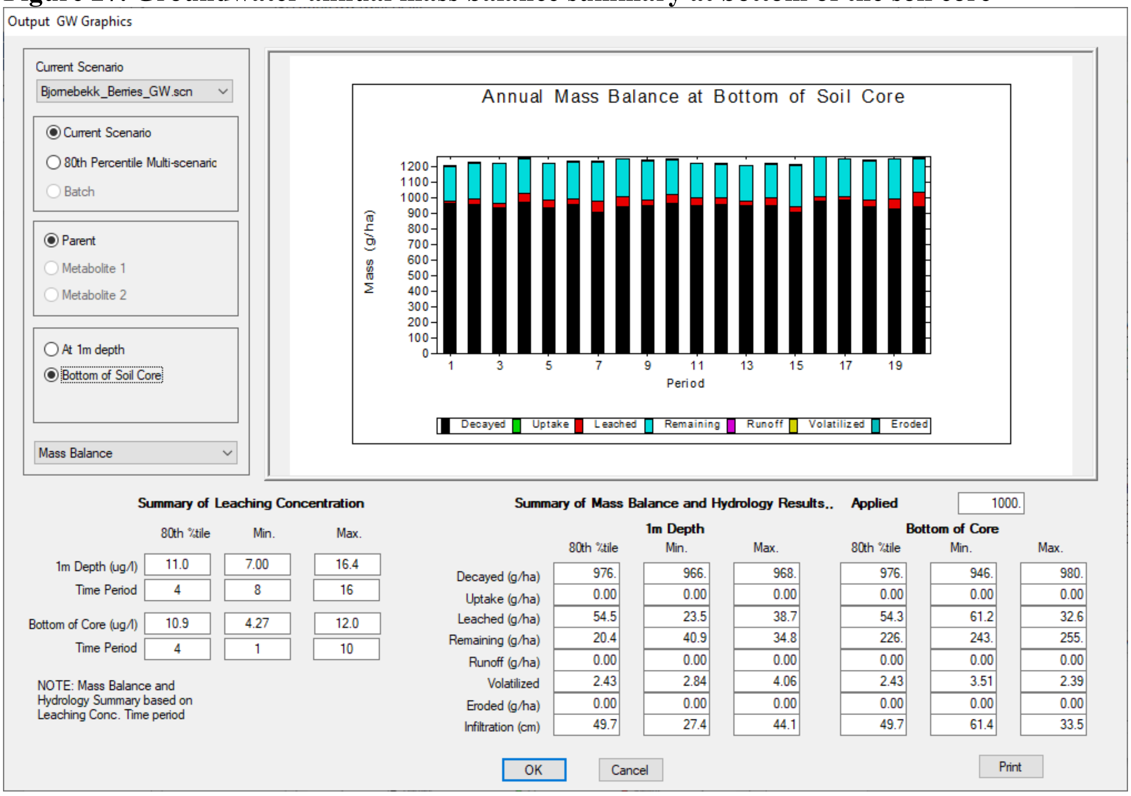


Figure 28. Groundwater hydrology summary at bottom of the soil core

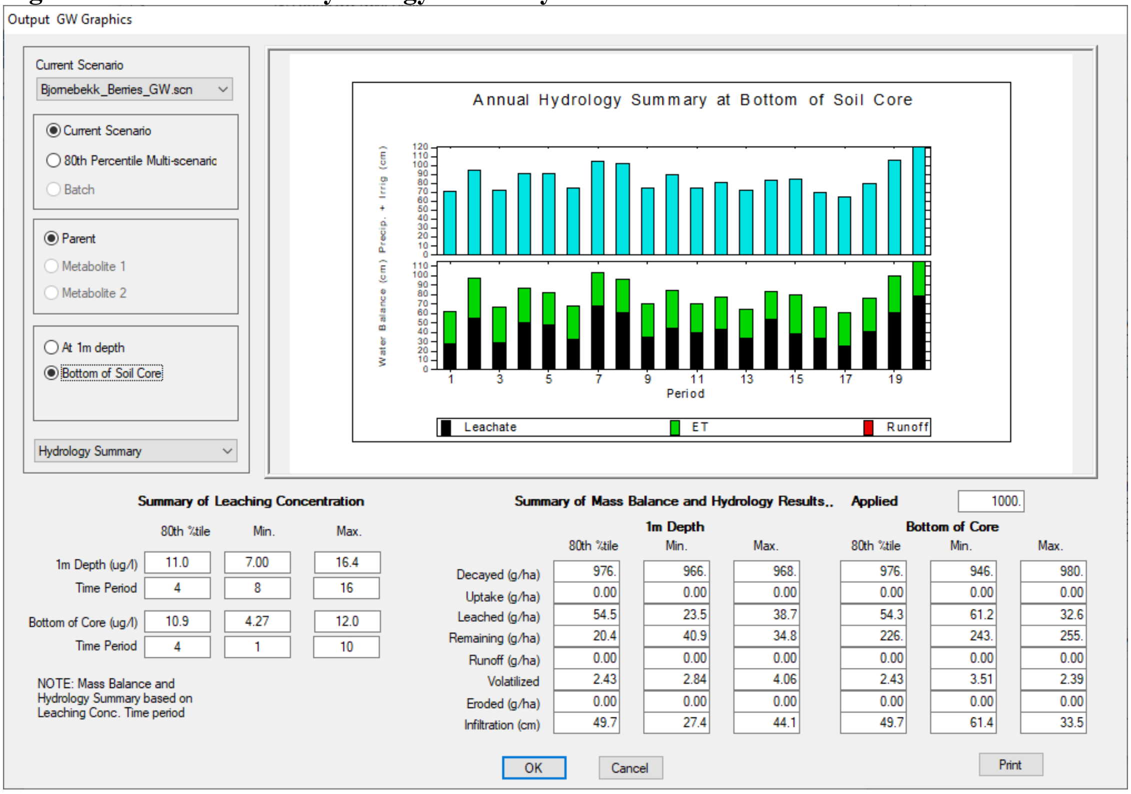
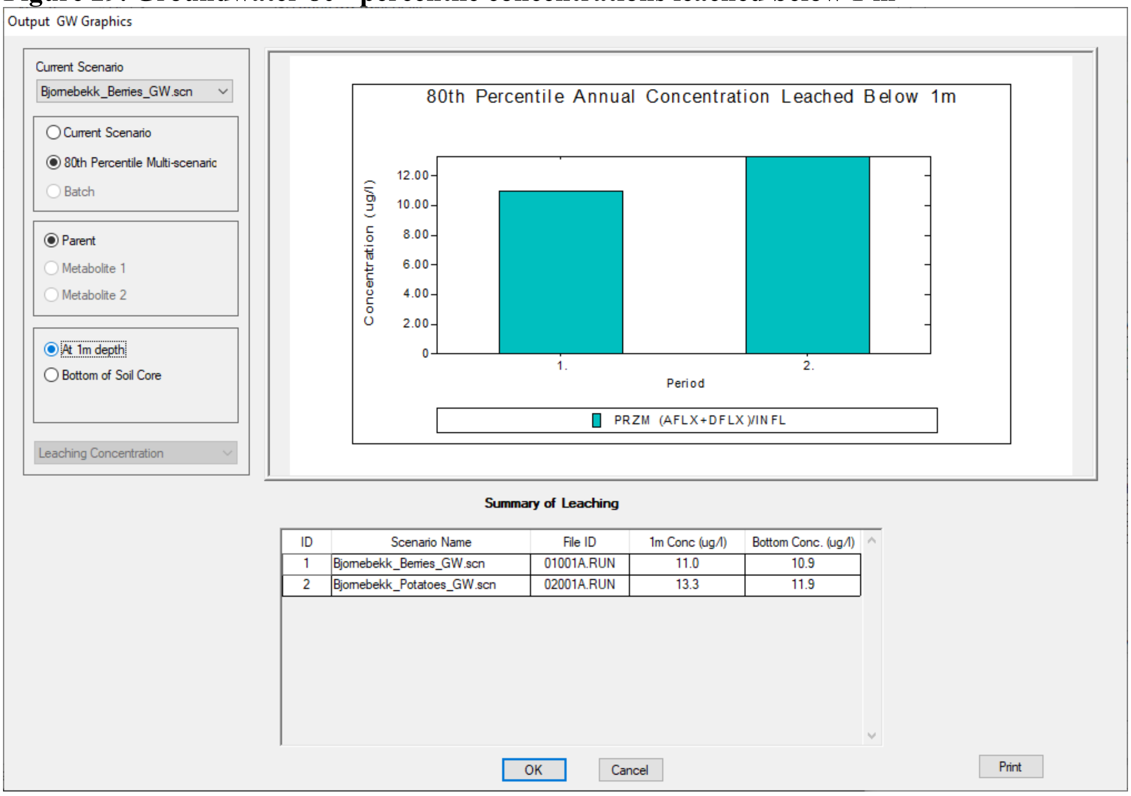


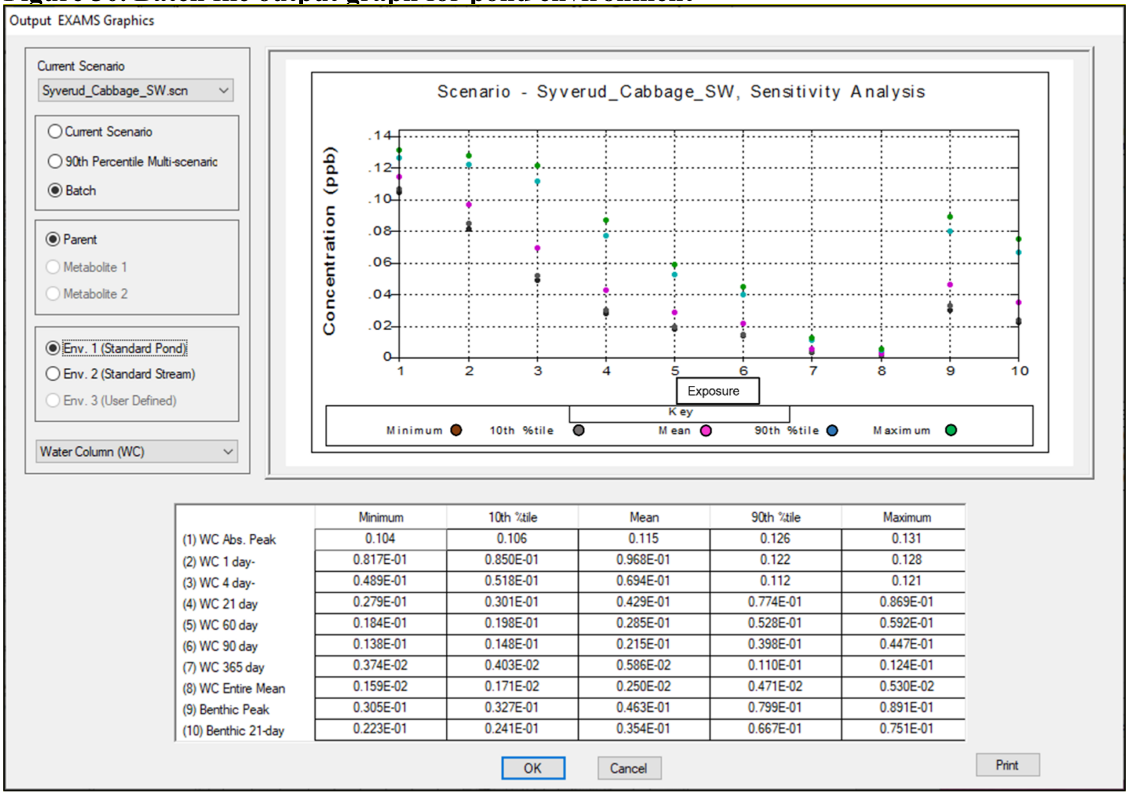
Figure 29. Groundwater 80th percentile concentrations leached below 1 m



Batch run
If the user has simulated a batch, the batch radio button will be available for the user to click on to see the batch output. In the example figure below (Figure 30), the ten exposure duration concentrations are plotted on the X-axis:
1 = Water Column (WC) absolute peak exposure concentration
2 = Water Column (WC) 1-day exposure concentration
3 = Water Column (WC) 4-day exposure concentration
4 = Water Column (WC) 21-day exposure concentration
5 = Water Column (WC) 60-day exposure concentration
6 = Water Column (WC) 90-day exposure concentration
7 = Water Column (WC) 365-day (annual) exposure concentration
8 = Water Column (WC) entire simulation mean exposure concentration
9 = Benthic 1-day exposure concentration
10 = Benthic 21-day exposure concentration

The y-axis shows the minimum, 10th percentile, mean, 90th percentile, and maximum concentrations for each of the exposure durations. The user can see the sensitivity in acute and chronic concentrations with changing sorption or degradation values in the pond and stream environments for each scenario that was simulated.

Figure 30. Batch file output graph for pond environment

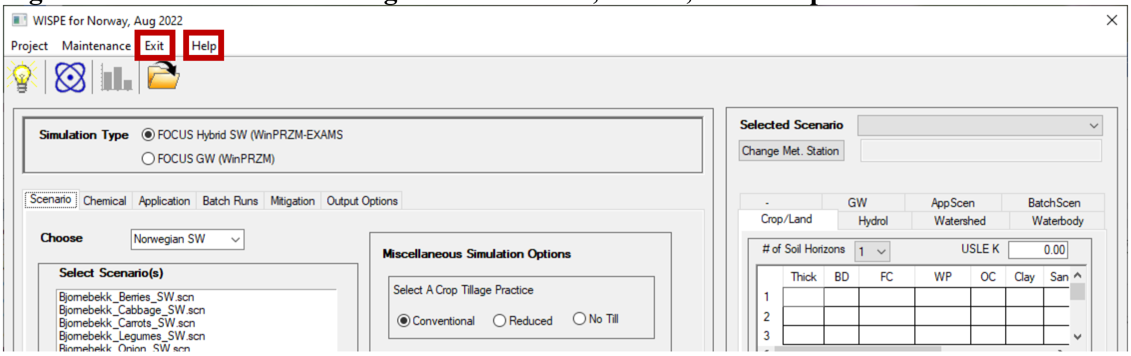


	Minimum	10th %tile	Mean	90th %tile	Maximum
(1) WC Abs. Peak	0.104	0.106	0.115	0.126	0.131
(2) WC 1 day-	0.817E-01	0.850E-01	0.968E-01	0.122	0.128
(3) WC 4 day-	0.489E-01	0.518E-01	0.694E-01	0.112	0.121
(4) WC 21 day	0.279E-01	0.301E-01	0.429E-01	0.774E-01	0.869E-01
(5) WC 60 day	0.184E-01	0.198E-01	0.285E-01	0.528E-01	0.592E-01
(6) WC 90 day	0.138E-01	0.148E-01	0.215E-01	0.398E-01	0.447E-01
(7) WC 365 day	0.374E-02	0.403E-02	0.586E-02	0.110E-01	0.124E-01
(8) WC Entire Mean	0.159E-02	0.171E-02	0.250E-02	0.471E-02	0.530E-02
(9) Benthic Peak	0.305E-01	0.327E-01	0.463E-01	0.799E-01	0.891E-01
(10) Benthic 21-day	0.223E-01	0.241E-01	0.354E-01	0.667E-01	0.751E-01

Exit and Help

To leave the WISPE tool completely, the user can click on the “Exit” button up the top left part of the screen (Figure 31). The “Help” button will bring up user manuals.

Figure 31. Main screen showing “Maintenance”, “Exit”, and “Help”



User Defined Scenarios within WISPE

WISPE reads .scn files with defined scenario inputs for PRZM and EXAMS. The Norwegian scenarios were developed for the original WISPE for Bjørnebekk and Syverud for major crops grown in Norway. The description of the Norwegian scenarios with the development of the scenarios and the sources of input parameters is documented in “National Scenarios – Norway, Development of WISPE for Surface- and Groundwater Modelling of Pesticides in Major Crops” (Bolli, et. al, 2013). The crops include berries, cabbage, carrots, legumes, onions, orchard, potatoes, spring cereals, spring oilseed strawberries, and winter cereal. For the Norwegian surface water scenarios, two waterbodies are defined (pond and stream).

WISPE provides the user with a list Norwegian or FOCUS surface water or groundwater scenarios to run (Figure 3). However, the user also has the choice to select a scenario then change parameters in the panel on the right then save the scenario with a new name and description. Later the user will have the new scenario listed under the “User Defined SW” or “User Defined GW” options.

For example, the Bjornebekk_Berries_SW.scn scenario was selected but the user wanted to use a different weather file. Figure 32 shows that the user changed the weather file to R1NOIRR.met. The user can also make their own weather file and save it in the stdmet folder. After switching the weather file, the user can hit the maintenance tab on the top row and the maintenance screen will appear (Figure 33). The user can input a filename for the scenario along with a description of the scenario. Once the user hits “Save to user directory”, this scenario will then be saved under “User Defined SW” scenarios to be able to use in the future (Figure 34). The user can also delete “User Defined” scenarios on the maintenance tab. As shown in the figure, only specified administrators will have the password which will allow them the ability to save and delete scenarios.

Figure 32. Example changing weather station

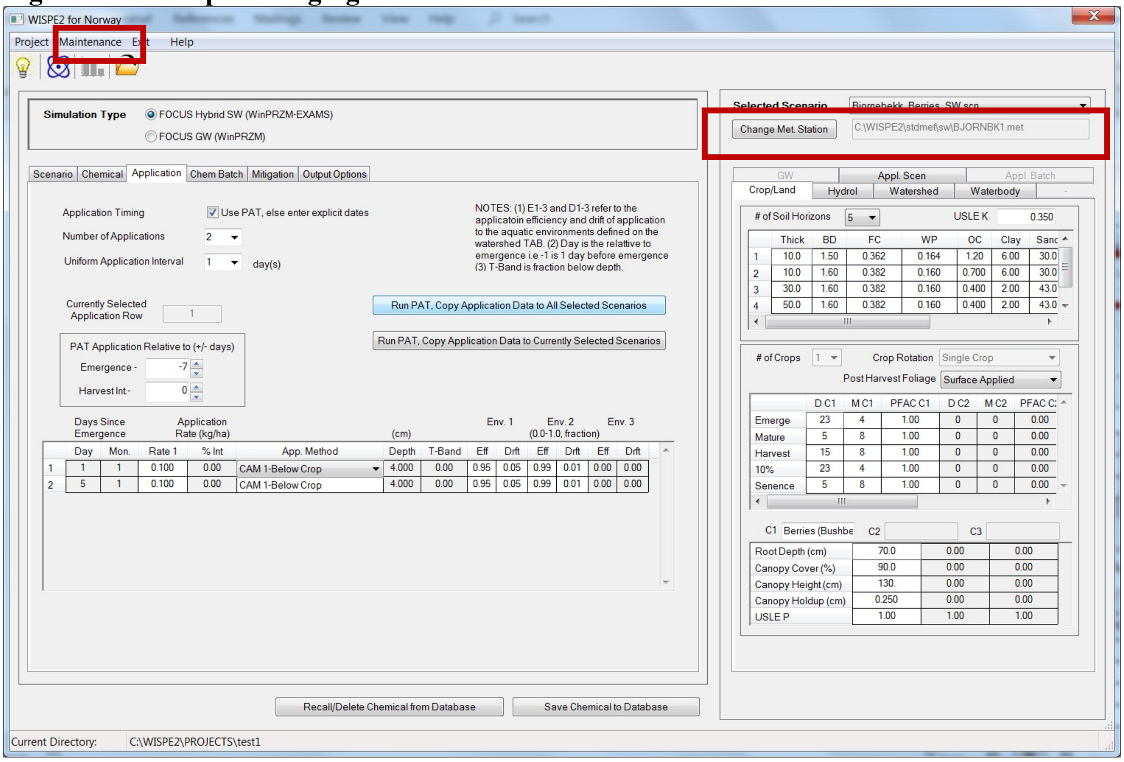


Figure 33. Maintenance tab and saving user defined scenario

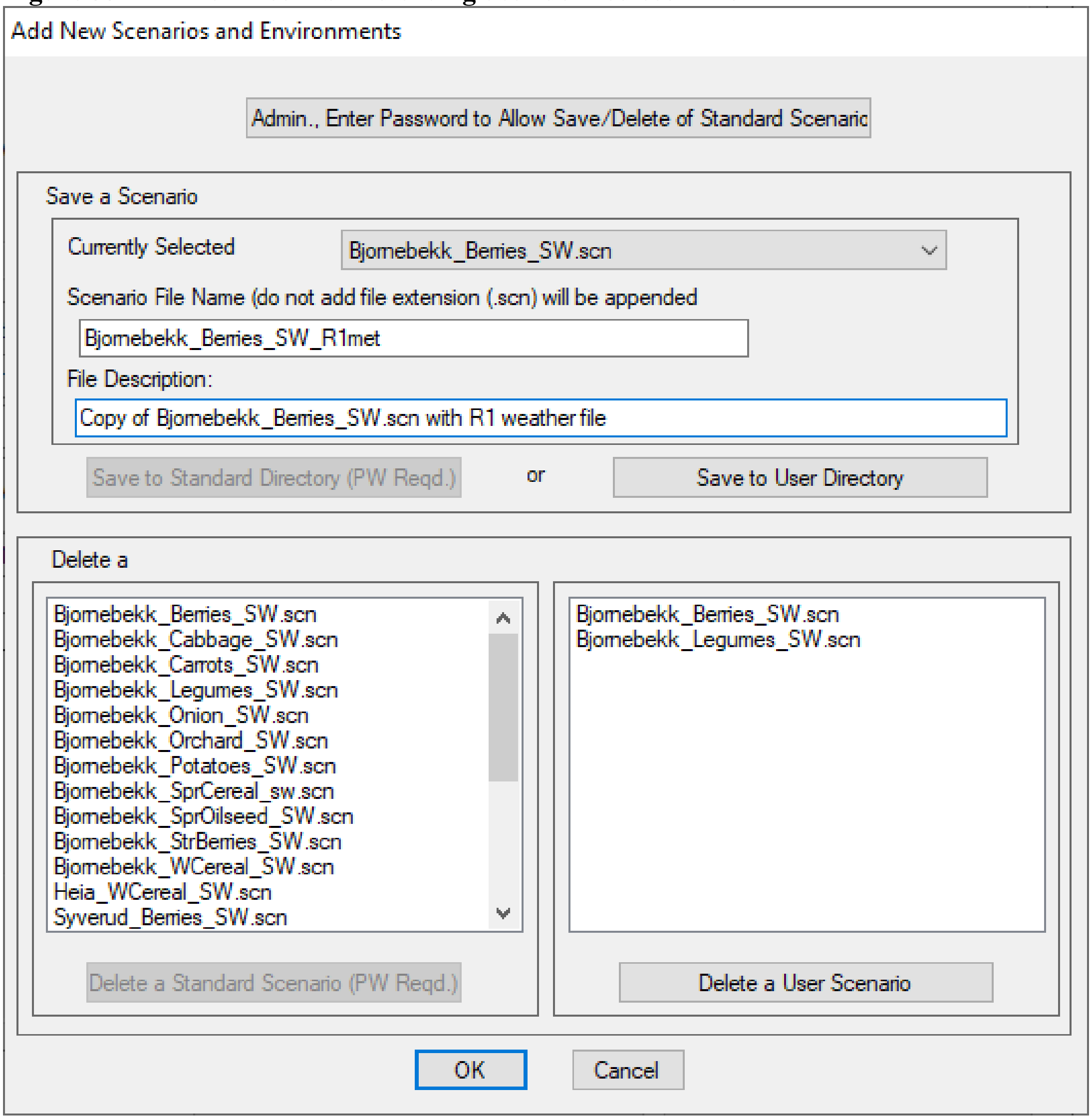
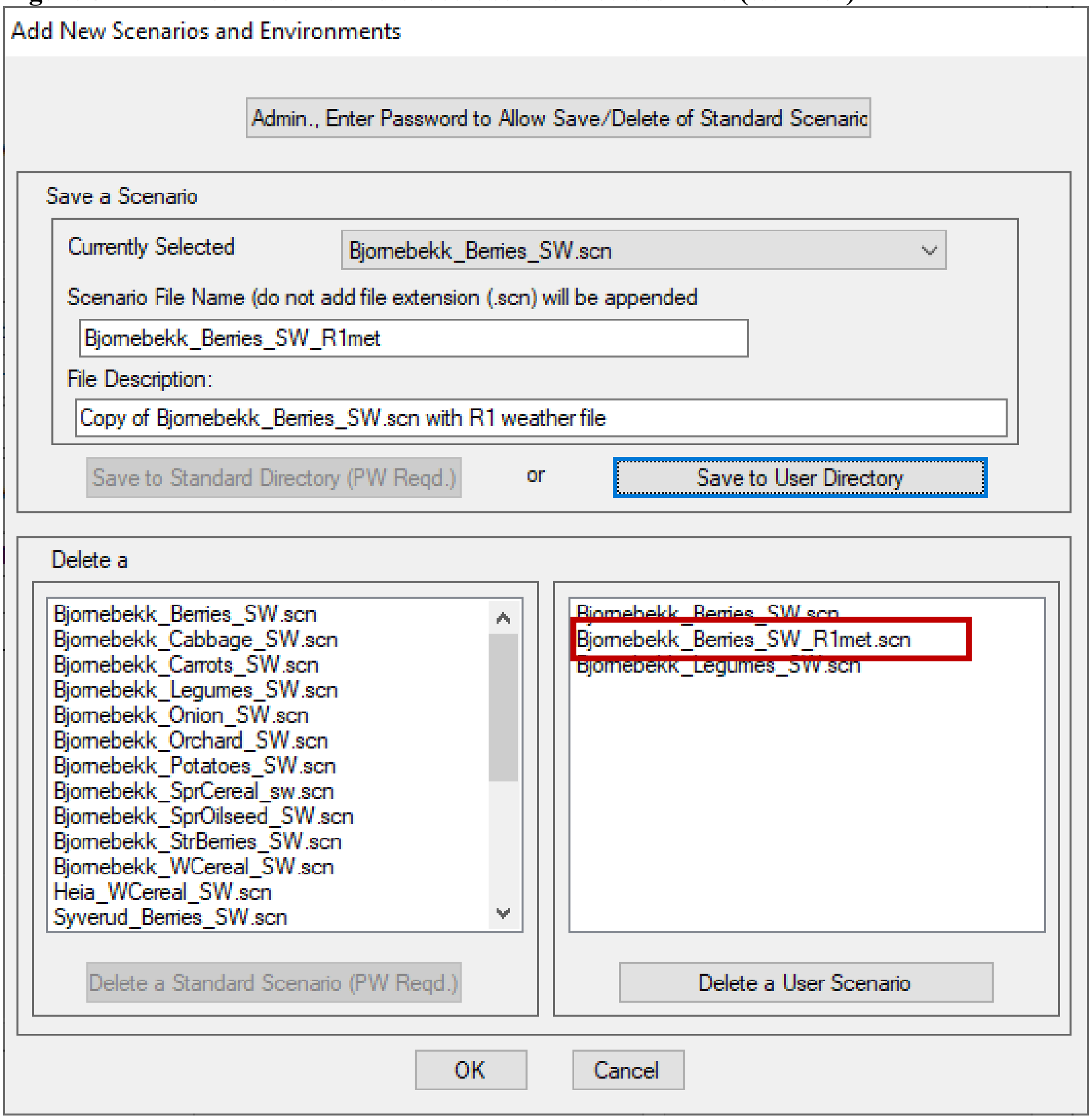


Figure 34. Maintenance tab and saved user defined scenario (weather)



For another example, the Bjornebekk_Berries_SW.scn scenario was selected but the user wanted to use a 3% organic carbon in the top layer. Figure 35 shows that the user changed the organic carbon in the Crop/Land tab on the right panel for the top layer. After changing the soil property, the user hit the maintenance tab and saved the new file (Figure 36).

Figure 35. Organic carbon changed in the top soil layer

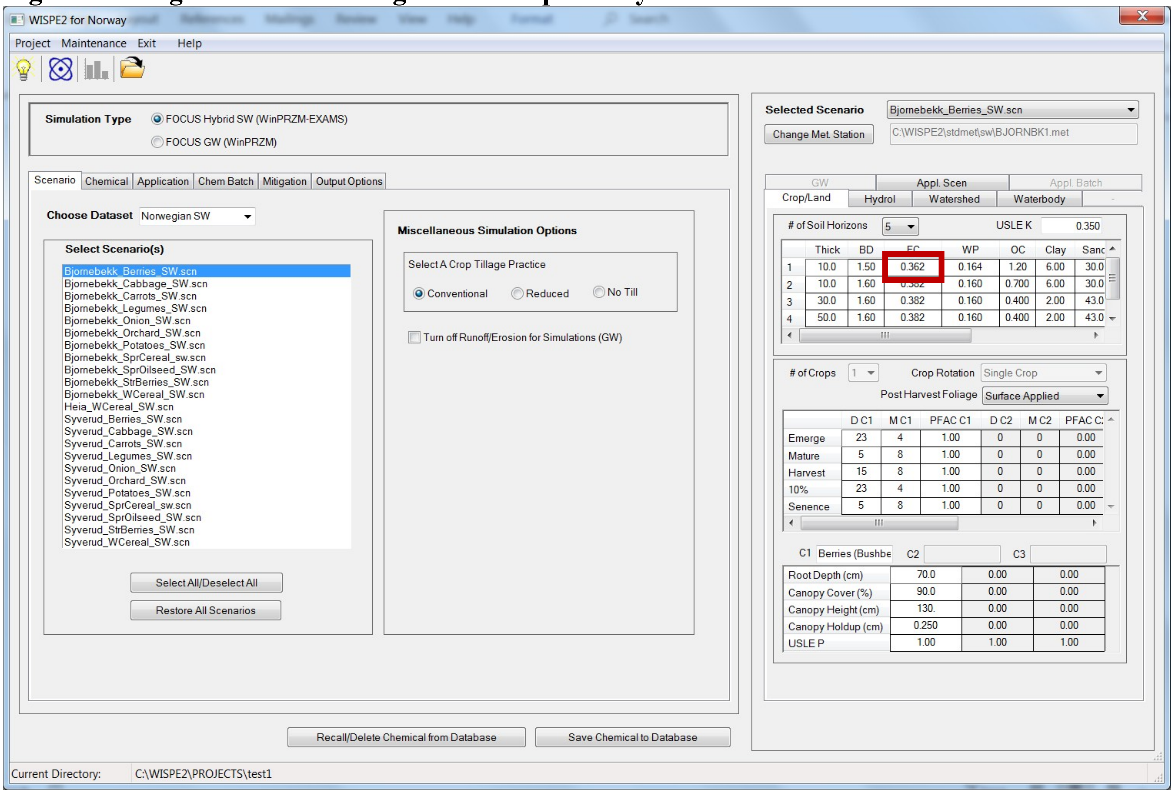
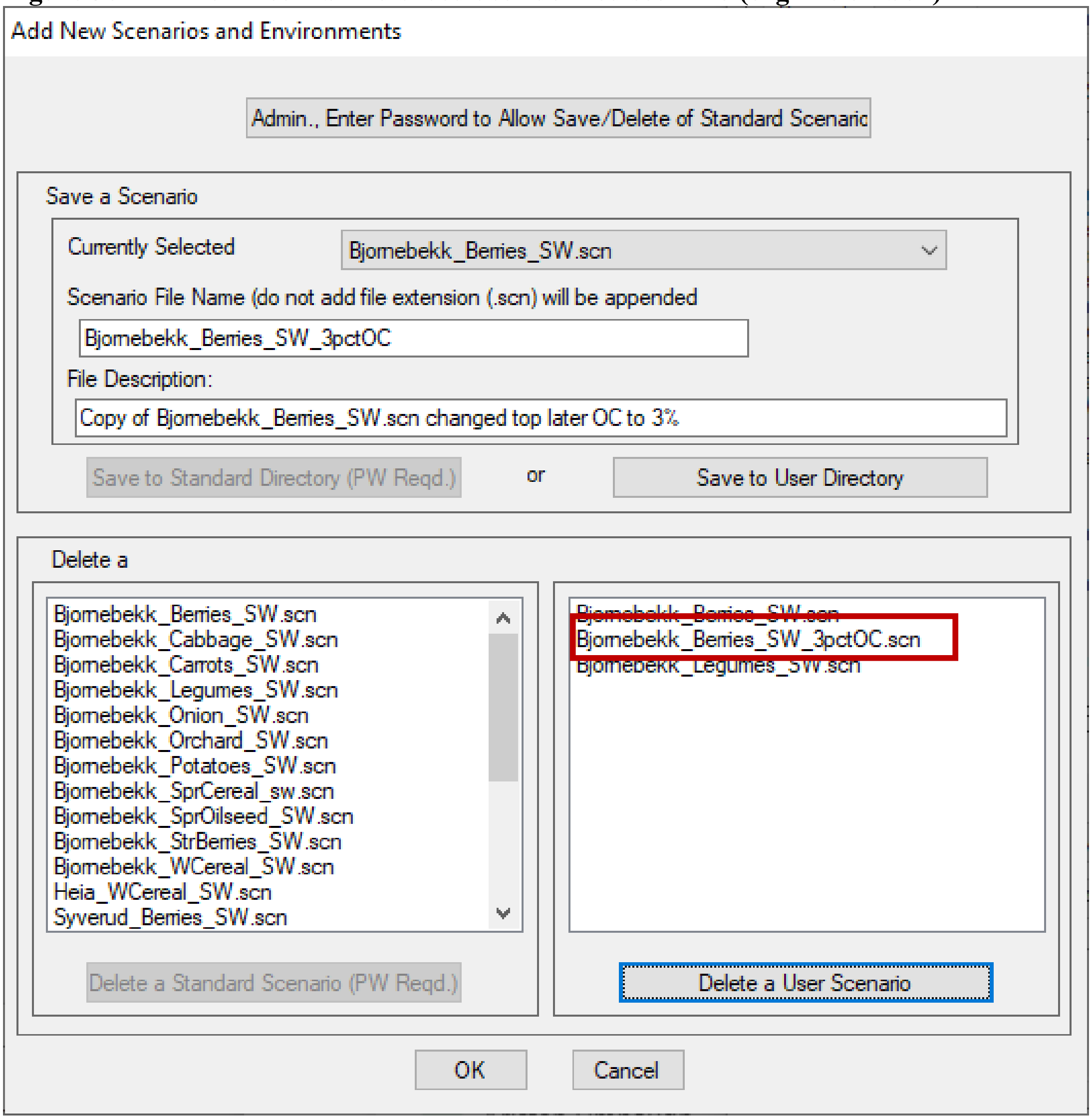


Figure 36. Maintenance tab and saved user defined scenario (organic carbon)



Scenario (.scn) file

When a user creates a new surface water scenario in WISPE, a new file is created in D3_sw folder under scenarios. The scenarios associated with WISPE are .scn files. An example of the .scn file for surface water is shown below. Appendix 1 describes the input records for the .scn file that WISPE uses to make the PRZM and EXAMS input files. The inputs are described in the appendix by lines in the scenario (.scn) file that is read by the WISPE modeling tool. For the PRZM inputs, the .scn file lists the record number for the PRZM input file. The user can look up the record number in the PRZM user manual for the inputs associated with that record and more of a description of the input parameter (Carousel, et al, 2005). The .scn file is formatted so the user should be careful to use the same columns and integer or real numbers as shown in the example. The example shows a surface water .scn file. The groundwater scenarios do not have the lines that start with "!". That is data used for the waterbody environments.

Example format of Bjornebekk_Potatoes_SW.scn

```
PRZM INPUTS.XLS - PRZM Data Inputs for Various Crop Scenarios
65 90 C:\WISPE2\stdmet\BJORNBK1.met

PRZM      Variable
Record #  Name      Value       Parameter Source                     Comments
         1TITLE                 Title of input file
         2HTITLE                Short description of file

         3PFAC             1.   Pan factor (dimensionless)
          SFAC           0.20   Snowmelt factor (cm/C)
          IPEIND            0   Pan factor
          ANETD           10.   Min. depth from which evaporation is
          INICRP            1   Flag for iAlways should be 1
          ISCOND            1   Surface condition of initial crop if INICRP = 1; 1 = fallow,
                                2 = cropping, 3 = residue

         6ERFLAG            4   Flag to calculate erosion; 0 = none, 2 = MUSLE, 3 = MUST, 4 =
                               MUSS; note that a value of 1 is meaningless; MUSS selected by
                               EPA and industry as most appropriate.

         7Only needed if ERFLAG = 2,3, or 4 (Record 6)
          AFIELD        .0178  .0178  .0178
          HL                5      5      5
          USLELS         0.15   0.15   0.15
          USLEP           1.0    1.0    1.0
          SLP            13.0   13.0   13.0
          USLEK          0.35   Universal soil loss equation (K) of soil erodability
          IREG              3   Location of NRCS 24-hour hyetograph/Soil Conservation Service
                                rainfall distribution region

         8NDC               1   Number of different crops in simulation (1 to 5)
Potatoes
         9(repeat this record NDC times)
          ICNCN             1   Crop number
          CINTCP         0.15   Maximum interception storage of crop (cm)
          AMXDR            60   Maximum rooting depth of crop (cm)
          COVMAX           80   Maximum areal coverage of canopy (%)
          ICNAH             1   Surface condition of crop after harvest date (see Record 11);
                                1 = fallow, 2 = cropping, 3 = residue
          CN (x3)           0   Runoff curve numbers of antecedent moisture condition for
                               fallow, cropping, and residue (three values); note that runoff
                               and leaching are very sensitive to these factors.
                            0
                            0
          WFMAX             0   Maximum dry weight of crop at full canopy (kg/m2), required
                               if CAM = 3 (Record 16) else set to 0.0
          HTMAX            50   Maximum canopy height (cm) at maturation date (Record 11)
Conventional Tillage
          RECORD9A        1       5
          RECORD9B  0101 1006 1009 2009 1910
          RECORD9C  .900 .900 .200 .500 1.00
          RECORD9D  .017 .017 .017 .017 .017
          RECORD9E    91   91   89   89   91
Reduced Tillage
          RECORD9A        1       5
          RECORD9B  0101 1006 1009 2009 1910
          RECORD9C  .900 .900 .200 .500 1.00
          RECORD9D  .017 .017 .017 .017 .017
          RECORD9E    86   86   84   84   86
No Till
          RECORD9A        1       5
          RECORD9B  0101 1006 1009 2009 1910
          RECORD9C  .900 .900 .200 .500 1.00
          RECORD9D  .017 .017 .017 .017 .017
          RECORD9E    82   82   80   80   82

        10NCPDS            26   Number of Based on new weather station data.

        11(Repeat this record NCPDS times)
```

```
Potatoes
          EMD                10  Integer day of crop emergence
          EMM                 6  Integer month of crop emergence
          IYREM              65  Integer year of crop emergence
          MAD                10  Integer day of crop maturation
          MAM                 9  Integer month of crop maturation
          IYRMAT             65  Integer year of crop maturation
          HAD                20  Integer day of crop harvest
          HAM                 9  Integer month of crop harvest
          IYRHAR             65  Integer year of crop harvest
          P10D               10  Integer day of crop emergence
          P10M                6  Integer month of crop emergence
          IYP10              65  Integer year of crop emergence
          P60D               10  Integer day of crop maturation
          P60M                9  Integer month of crop maturation
          IYRP60             65  Integer year of crop maturation
          KCINIT            1.0  Initial Crop growth stage
          KCMID             1.0  Crop development stage
          KCLATE            1.0  Late season growth stage
          KCMAX             1.0  Maximum growth stage
          REW               1.0  Stage 1 Evapotranspiration (mm)
          INCROP              1  Crop number associated with NDC (Record 8)

        19STITLE  Brief description of soil properties

        20CORED             500  Total depth of soil core (cm); must be sum of all horizon
                                 thicknesses in Record 33 and at least as deep as the root
                                 depth in Record 9
          BDFLAG              0  Bulk densi
          THFLAG              0  Field capa
          KDFLAG              0  Soil adsorSubmission studies
          HSWZT               0  Drainage femail from Sid Abel (99 03 10)
          MOC                 0  Method of email from Sid Abel (99 03 10)
          IRFLAG              0  Irrigation
          ITFLAG              1  Soil tempe
          IDFLAG              1  Thermal conductivity and heat capacity flag; 1 = yes, 0 = no.
          BIOFLG              0  Biodegradaemail from Sid Abel (99 03 10)
          DSPFLG              1  Dispersion flag for FOCUS GW modeling (1=GW, 0=SW)

        31ALBEDO+          0.60 0.60 0.30 0.30 0.18 0.10 0.10 0.10 0.10 0.15 0.18 0.60 0.96
2

        32BBT               4.1  3.8  3.4  3.8  7.8  8.4  9.9  10.6  9.2  8.9  7.4  6.3

         IRTYPE               0  Irrigation type, under canopy=4
         RATEAP            0.00  Max rate at which irrigation is applied (cm/hr)
         PCDEPL            0.00  fraction of water capacity at which irrigation is applied
         FLEACH             0.0  Leaching factor as a fraction of irrigation water depth

        33NHORIZ              5  Number of horizons

Horizon 1:
        34(Repeat Records 34, 36, and 37 for each horizon)
          HORIZN              1  Horizon number
          THKNS              10  Thickness of horizon (cm)
          BD              1.500  Bulk density if BDFLAG = 0 or mineral density if BDFLAG = 1
                                 (Record 20) (g/cm3)
          THETO           0.362  Initial soil water content in horizon (cm3/cm3); if site-
                                 specific value not known, use field capacity
          AD              0.000  Soil drainage parameter if HSWZT = 1 (Record 20), else set to
                                 0.0 (day-1); note that the # of compartments (= DPN/THKNS) is
                                 needed to determine AD
          DISPL           2.500  Pesticide(s) hydrodynamic solute dispersion coefficient for
                                 each NCHEM; should be set to zero unless field data are
                                 available for calibration
          ADL             0.000  Lateral soil drainage parameter if HSWZT = 1 (Record 20)
                                 (should be set to zero)
          DEGF            1.000  Degradation Factor

        37DPN             0.100  Thickness of compartments in horizon (cm)
          THEFC           0.362  Field capacity in horizon (cm3/cm3)
```

```
         THEWP          0.164  Wilting point in horizon (cm3/cm3)
         OC              1.20  Organic carbon in horizon (%)

       38SPT             5.00  Initial Soil Temperature (C)
         SAND            6.00  Sand Content
         CLAY           30.00  Clay Content

Horizon 2:
       34(Repeat Records 34, 36, and 37 for each horizon)
         HORIZN             2  Horizon number
         THKNS             10  Thickness of horizon (cm)
         BD             1.600  Bulk density if BDFLAG = 0 or mineral density if BDFLAG = 1
                               (Record 20) (g/cm3)
         THETO          0.382  Initial soil water content in horizon (cm3/cm3); if site-
                               specific value not known, use field capacity
         AD             0.000  Soil drainage parameter if HSWZT = 1 (Record 20), else set to
                               0.0 (day-1); note that the # of compartments (= DPN/THKNS) is
                               needed to determine AD
         DISPL          5.000  Pesticide(s) hydrodynamic solute dispersion coefficient for
                               each NCHEM; should be set to zero unless field data are
                               available for calibration
         ADL            0.000  Lateral soil drainage parameter if HSWZT = 1 (Record 20)
                               (should be set to zero)
         DEGF           1.000  Degradation Factor

       37DPN            5.000  Thickness of compartments in horizon (cm)
         THEFC          0.382  Field capacity in horizon (cm3/cm3)
         THEWP          0.160  Wilting point in horizon (cm3/cm3)
         OC              0.70  Organic carbon in horizon (%)

       38SPT             5.00  Initial Soil Temperature (C)
         SAND            6.00  Sand Content
         CLAY           30.00  Clay Content

Horizon 3:
       34(Repeat Records 34, 36, and 37 for each horizon)
         HORIZN             3  Horizon number
         THKNS             30  Thickness of horizon (cm)
         BD             1.600  Bulk density if BDFLAG = 0 or mineral density if BDFLAG = 1
                               (Record 20) (g/cm3)
         THETO          0.382  Initial soil water content in horizon (cm3/cm3); if site-
specific value not known, use field capacity
         AD             0.000  Soil drainage parameter if HSWZT = 1 (Record 20), else set to
                               0.0 (day-1); note that the # of compartments (= DPN/THKNS) is
                               needed to determine AD
         DISPL          5.000  Pesticide(s) hydrodynamic solute dispersion coefficient for
                               each NCHEM; should be set to zero unless field data are
                               available for calibration
         ADL            0.000  Lateral soil drainage parameter if HSWZT = 1 (Record 20)
                               (should be set to zero)
         DEGF           0.200  Degradation Factor

       37DPN            5.000  Thickness of compartments in horizon (cm)
         THEFC          0.382  Field capacity in horizon (cm3/cm3)
         THEWP          0.160  Wilting point in horizon (cm3/cm3)
         OC              0.40  Organic carbon in horizon (%)

       38SPT             5.00  Initial Soil Temperature (C)
         SAND            2.00  Sand Content
         CLAY           43.00  Clay Content

Horizon 4:
       34(Repeat Records 34, 36, and 37 for each horizon)
         HORIZN             4  Horizon number
         THKNS             50  Thickness of horizon (cm)
         BD             1.600  Bulk density if BDFLAG = 0 or mineral density if BDFLAG = 1
                               (Record 20) (g/cm3)
         THETO          0.382  Initial soil water content in horizon (cm3/cm3); if site-
                               specific value not known, use field capacity
```

```
          AD              0.000  Soil drainage parameter if HSWZT = 1 (Record 20), else set to
                                 0.0 (day-1); note that the # of compartments (= DPN/THKNS) is
                                 needed to determine AD
          DISPL           5.000  Pesticide(s) hydrodynamic solute dispersion coefficient for
                                 each NCHEM; should be set to zero unless field data are
                                 available for calibration
          ADL             0.000  Lateral soil drainage parameter if HSWZT = 1 (Record 20)
                                 (should be set to zero)
          DEGF            0.200  Degradation Factor

        37DPN             5.000  Thickness of compartments in horizon (cm)
          THEFC           0.382  Field capacity in horizon (cm3/cm3)
          THEWP           0.160  Wilting point in horizon (cm3/cm3)
          OC               0.40  Organic carbon in horizon (%)

        38SPT              5.00  Initial Soil Temperature (C)
          SAND             2.00  Sand Content
          CLAY            43.00  Clay Content

Horizon 5:
        34(Repeat Records 34, 36, and 37 for each horizon)
          HORIZN              5  Horizon number
          THKNS             400  Thickness of horizon (cm)
          BD              1.600  Bulk density if BDFLAG = 0 or mineral density if BDFLAG = 1
                                 (Record 20) (g/cm3)
          THETO           0.382  Initial soil water content in horizon (cm3/cm3); if site-
                                 specific value not known, use field capacity
          AD              0.000  Soil drainage parameter if HSWZT = 1 (Record 20), else set to
                                 0.0 (day-1); note that the # of compartments (= DPN/THKNS) is
                                 needed to determine AD
          DISPL           5.000  Pesticide(s) hydrodynamic solute dispersion coefficient for
                                 each NCHEM; should be set to zero unless field data are
                                 available for calibration
          ADL             0.000  Lateral soil drainage parameter if HSWZT = 1 (Record 20)
                                 (should be set to zero)
          DEGF            0.000  Degradation Factor

        37DPN             5.000  Thickness of compartments in horizon (cm)
          THEFC           0.382  Field capacity in horizon (cm3/cm3)
          THEWP           0.160  Wilting point in horizon (cm3/cm3)
          OC               0.40  Organic carbon in horizon (%)

        38SPT              5.00  Initial Soil Temperature (C)
          SAND             2.00  Sand Content
          CLAY            43.00  Clay Content

        40ILP                 0  Flag for initial pesticide(s) levels before simulation start
                                 date; 1 = yes, 0 = no
          CFLAG               0  Conversion flag for initial pesticide(s) levels; 0 = mg/kg, 1
                                 = kg/ha, blank if ILP = 0
!
!       1       1       6        Watershed Data
!   900.0    100.     0.0        Waterbody Area (by Env)
!     1.0     0.3     0.0        Waterbody Depth (by Env)
!     1.0     0.3     0.0        Waterbody Max. Depth (by Env)
!     1.0     1.0     0.0        Crop Area Fraction
!       4       4       4        Flow/Volume Option
!      0.     5.6      0.        Flow/Volume value
!       0       0       0        Scen Specific Drift Option
! 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
! 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
! 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
!
!       0                        burial
!   3.e-5                        user mass transfer coefficient
!     0.5                        prben
!    0.05                        benthic depth
!    0.50                        benthic porosity
```

```
!    0.80                       benthic bulk density
!    0.05                       benthic foc
!     5.0                       benthic doc
!   0.006                       benthic biomass
!    1.19                       wc dfac
!    15.0                       wc ss
!   0.005                       wc chlorophyll
!    0.05                       wc foc
!     5.0                       wc doc
!     0.4                       wc biomass
```

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APPENDIX 1 – Example scenario (.scn) file, single crop, surface water

Example format of Bjornebekk_Potatoes_SW.scn

```
Line 1   PRZM INPUTS.XLS - PRZM Data Inputs for Various Crop Scenarios
Line 2   65 90 C:\WISPE2\stdmet\BJORNBK1.met
Line 3
Line 4   PRZM      Variable
Line 5   Record #  Name      Value       Parameter Source                     Comments
Line 6           1TITLE                  Title of input file
Line 7           2HTITLE                 Short description of file
Line 8
Line 9           3PFAC             1.    Pan factor (dimensionless)
Line 10           SFAC           0.20    Snowmelt factor (cm/C)
Line 11           IPEIND            0    Pan factor
Line 12           ANETD           10.    Min. depth from which evaporation is
Line 13           INICRP            1    Flag for iAlways should be 1
Line 14           ISCOND            1    Surface condition of initial crop if INICRP = 1; 1 = fallow, 2 = cropping, 3 = residue
Line 15
Line 16          6ERFLAG            4    Flag to calculate erosion; 0 = none, 2 = MUSLE, 3 = MUST, 4 = MUSS; note that a value of 1 is
                                          meaningless; MUSS selected by EPA and industry as most appropriate.
Line 17
Line 18          7Only needed if ERFLAG = 2,3, or 4 (Record 6)
Line 19           AFIELD        .0178  .0178  .0178
Line 20           HL                5      5      5
Line 21           USLELS         0.15   0.15   0.15
Line 22           USLEP           1.0    1.0    1.0
Line 23           SLP            13.0   13.0   13.0
Line 24           USLEK          0.35  Universal soil loss equation (K) of soil erodability
Line 25           IREG              3  Location of NRCS 24-hour hyetograph/Soil Conservation Service rainfall distribution region
Line 26
Line 27          8NDC               1  Number of different crops in simulation (1 to 5)
Line 28  Potatoes
Line 29          9(repeat this record NDC times)
Line 30           ICNCN             1  Crop number
Line 31           CINTCP         0.15  Maximum interception storage of crop (cm)
Line 32           AMXDR            60  Maximum rooting depth of crop (cm)
Line 33           COVMAX           80  Maximum areal coverage of canopy (%)
Line 34           ICNAH             1  Surface condition of crop after harvest date (see Record 11); 1 = fallow, 2 = cropping, 3 =
residue
Line 35           CN (x3)           0  Runoff curve numbers of antecedent moisture condition for fallow, cropping, and residue
                                        (three values); note that runoff and leaching are very sensitive to these factors.
Line 36                             0
Line 37                             0
Line 38           WFMAX             0  Maximum dry weight of crop at full canopy (kg/m2), required if CAM = 3 (Record 16) else 0.0
Line 39           HTMAX            50  Maximum canopy height (cm) at maturation date (Record 11)
Line 40  Conventional Tillage
Line 41           RECORD9A        1       5
Line 42           RECORD9B  0101 1006 1009 2009 1910
Line 43           RECORD9C  .900 .900 .200 .500 1.00
Line 44           RECORD9D  .017 .017 .017 .017 .017
Line 45           RECORD9E    91   91   89   89   91
```

```
Line 46  Reduced Tillage
Line 47           RECORD9A         1       5
Line 48           RECORD9B  0101 1006 1009 2009 1910
Line 49           RECORD9C  .900 .900 .200 .500 1.00
Line 50           RECORD9D  .017 .017 .017 .017 .017
Line 51           RECORD9E    86   86   84   84   86
Line 52  No Till
Line 53           RECORD9A         1       5
Line 54           RECORD9B  0101 1006 1009 2009 1910
Line 55           RECORD9C  .900 .900 .200 .500 1.00
Line 56           RECORD9D  .017 .017 .017 .017 .017
Line 57           RECORD9E    82   82   80   80   82
Line 58
Line 59         10NCPDS             26  Number of Based on new weather station data.
Line 60
Line 61         11(Repeat this record NCPDS times)
Line 62  Potatoes
Line 63           EMD               10  Integer day of crop emergence
Line 64           EMM                6  Integer month of crop emergence
Line 65           IYREM             65  Integer year of crop emergence
Line 66           MAD               10  Integer day of crop maturation
Line 67           MAM                9  Integer month of crop maturation
Line 68           IYRMAT            65  Integer year of crop maturation
Line 69           HAD               20  Integer day of crop harvest
Line 70           HAM                9  Integer month of crop harvest
Line 71           IYRHAR            65  Integer year of crop harvest
Line 72           P10D              10  Integer day of crop emergence
Line 73           P10M               6  Integer month of crop emergence
Line 74           IYP10             65  Integer year of crop emergence
Line 75           P60D              10  Integer day of crop maturation
Line 76           P60M               9  Integer month of crop maturation
Line 77           IYRP60            65  Integer year of crop maturation
Line 78           KCINIT           1.0  Initial Crop growth stage associated with emergence date for growth
Line 79           KCMID            1.0  Crop development stage associated with maturation date for growth
Line 80           KCLATE           1.0  Late season growth stage associated with P60 date for growth
Line 81           KCMAX            1.0  Maximum growth stage associated with harvest date for growth
Line 82           REW              1.0  Stage 1 Evapotranspiration (mm)
Line 83           INCROP             1  Crop number associated with NDC (Record 8)
Line 84
Line 85         19STITLE  Brief description of soil properties
Line 86
Line 87         20CORED            500  Total depth of soil core (cm); must be sum of all horizon thicknesses in Record 33 and at
                                         least as deep as the root depth in Record 9
Line 88           BDFLAG             0  Bulk densi
Line 89           THFLAG             0  Field capa
Line 90           KDFLAG             0  Soil adsorSubmission studies
Line 91           HSWZT              0  Drainage femail from Sid Abel (99 03 10)
Line 92           MOC                0  Method of email from Sid Abel (99 03 10)
Line 93           IRFLAG             0  Irrigation
```

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Line 94           ITFLAG            1  Soil tempe
Line 95           IDFLAG            1  Thermal conductivity and heat capacity flag; 1 = yes, 0 = no.
Line 96           BIOFLG            0  Biodegradaemail from Sid Abel (99 03 10)
Line 97           DSPFLG            1  Dispersion flag for FOCUS GW modeling
Line 98
Line 99         31ALBEDO+         0.60 0.60 0.30 0.30 0.18 0.10 0.10 0.10 0.10 0.15 0.18 0.60 0.96    2
Line 100
Line 101        32BBT              4.1  3.8  3.4  3.8  7.8  8.4  9.9  10.6  9.2  8.9  7.4  6.3
Line 102
Line 103         IRTYPE              0  Irrigation type, under canopy=4
Line 104         RATEAP           0.00  Max rate at which irrigation is applied (cm/hr)
Line 105         PCDEPL           0.00  fraction of water capacity at which irrigation is applied
Line 106         FLEACH            0.0  Leaching factor as a fraction of irrigation water depth
Line 107
Line 108        33NHORIZ             5  Number of horizons
Line 109
Line 110 Horizon 1:
Line 111        34(Repeat Records 34, 36, and 37 for each horizon)
Line 112          HORIZN             1  Horizon number
Line 113          THKNS             10  Thickness of horizon (cm)
Line 114          BD             1.500  Bulk density if BDFLAG = 0 or mineral density if BDFLAG = 1 (Record 20) (g/cm3)
Line 115          THETO          0.362  Initial soil water content in horizon (cm3/cm3); if site-specific value not known, use field
                                         capacity (fc)
Line 116          AD             0.000  Soil drainage parameter if HSWZT = 1 (Record 20), else set to 0.0 (day-1); note that the # of
                                         compartments (= DPN/THKNS) is needed to determine AD
Line 117          DISPL          2.500  Pesticide(s) hydrodynamic solute dispersion coefficient for each NCHEM; should be set to zero
                                         unless field data are available for calibration
Line 118          ADL            0.000  Lateral soil drainage parameter if HSWZT = 1 (Record 20) (should be set to zero)
Line 119          DEGF           1.000  Degradation Factor
Line 120
Line 121        37DPN            0.100  Thickness of compartments in horizon (cm)
Line 122          THEFC          0.362  Field capacity in horizon (cm3/cm3)
Line 123          THEWP          0.164  Wilting point in horizon (cm3/cm3)
Line 124          OC              1.20  Organic carbon in horizon (%)
Line 125
Line 126        38SPT             5.00  Initial Soil Temperature (C)
Line 127          SAND            6.00  Sand Content
Line 128          CLAY           30.00  Clay Content
Line 129
Line 130 Horizon 2:
Line 131        34(Repeat Records 34, 36, and 37 for each horizon)
Line 132          HORIZN             2  Horizon number
Line 133          THKNS             10  Thickness of horizon (cm)
Line 134          BD             1.600  Bulk density if BDFLAG = 0 or mineral density if BDFLAG = 1 (Record 20) (g/cm3)
Line 135          THETO          0.382  Initial soil water content in horizon (cm3/cm3); if site-specific value not known, use fc
Line 136          AD             0.000  Soil drainage parameter if HSWZT = 1 (Record 20), else set to 0.0 (day-1); note that the # of
                                         compartments (= DPN/THKNS) is needed to determine AD
Line 137          DISPL          5.000  Pesticide(s) hydrodynamic solute dispersion coefficient for each NCHEM; should be set to zero
                                         unless field data are available for calibration
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Line 138          ADL             0.000  Lateral soil drainage parameter if HSWZT = 1 (Record 20) (should be set to zero)
Line 139          DEGF            1.000  Degradation Factor
Line 140
Line 141        37DPN             5.000  Thickness of compartments in horizon (cm)
Line 142          THEFC           0.382  Field capacity in horizon (cm3/cm3)
Line 143          THEWP           0.160  Wilting point in horizon (cm3/cm3)
Line 144          OC               0.70  Organic carbon in horizon (%)
Line 145
Line 146        38SPT              5.00  Initial Soil Temperature (C)
Line 147          SAND             6.00  Sand Content
Line 148          CLAY            30.00  Clay Content
Line 149
Line 150 Horizon 3:
Line 151        34(Repeat Records 34, 36, and 37 for each horizon)
Line 152          HORIZN              3  Horizon number
Line 153          THKNS              30  Thickness of horizon (cm)
Line 154          BD              1.600  Bulk density if BDFLAG = 0 or mineral density if BDFLAG = 1 (Record 20) (g/cm3)
Line 155          THETO           0.382  Initial soil water content in horizon (cm3/cm3); if site-specific value not known, use fc
Line 156          AD              0.000  Soil drainage parameter if HSWZT = 1 (Record 20), else set to 0.0 (day-1); note that the # of
                                          compartments (= DPN/THKNS) is needed to determine AD
Line 157          DISPL           5.000  Pesticide(s) hydrodynamic solute dispersion coefficient for each NCHEM; should be set to zero
                                          unless field data are available for calibration
Line 158          ADL             0.000  Lateral soil drainage parameter if HSWZT = 1 (Record 20) (should be set to zero)
Line 159          DEGF            0.200  Degradation Factor
Line 160
Line 161        37DPN             5.000  Thickness of compartments in horizon (cm)
Line 162          THEFC           0.382  Field capacity in horizon (cm3/cm3)
Line 163          THEWP           0.160  Wilting point in horizon (cm3/cm3)
Line 164          OC               0.40  Organic carbon in horizon (%)
Line 165
Line 166        38SPT              5.00  Initial Soil Temperature (C)
Line 167          SAND             2.00  Sand Content
Line 168          CLAY            43.00  Clay Content
Line 169
Line 170 Horizon 4:
Line 171        34(Repeat Records 34, 36, and 37 for each horizon)
Line 172          HORIZN              4  Horizon number
Line 173          THKNS              50  Thickness of horizon (cm)
Line 174          BD              1.600  Bulk density if BDFLAG = 0 or mineral density if BDFLAG = 1 (Record 20) (g/cm3)
Line 175          THETO           0.382  Initial soil water content in horizon (cm3/cm3); if site-specific value not known, use fc
Line 176          AD              0.000  Soil drainage parameter if HSWZT = 1 (Record 20), else set to 0.0 (day-1); note that the # of
                                          compartments (= DPN/THKNS) is needed to determine AD
Line 177          DISPL           5.000  Pesticide(s) hydrodynamic solute dispersion coefficient for each NCHEM; should be set to zero
                                          unless field data are available for calibration
Line 178          ADL             0.000  Lateral soil drainage parameter if HSWZT = 1 (Record 20) (should be set to zero)
Line 179          DEGF            0.200  Degradation Factor
Line 180
Line 181        37DPN             5.000  Thickness of compartments in horizon (cm)
Line 182          THEFC           0.382  Field capacity in horizon (cm3/cm3)
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Line 183           THEWP          0.160  Wilting point in horizon (cm3/cm3)
Line 184           OC              0.40  Organic carbon in horizon (%)
Line 185
Line 186         38SPT             5.00  Initial Soil Temperature (C)
Line 187           SAND            2.00  Sand Content
Line 188           CLAY           43.00  Clay Content
Line 189
Line 190 Horizon 5:
Line 191         34(Repeat Records 34, 36, and 37 for each horizon)
Line 192           HORIZN             5  Horizon number
Line 193           THKNS            400  Thickness of horizon (cm)
Line 194           BD             1.600  Bulk density if BDFLAG = 0 or mineral density if BDFLAG = 1 (Record 20) (g/cm3)
Line 195           THETO          0.382  Initial soil water content in horizon (cm3/cm3); if site-specific value not known, use fc
Line 196           AD             0.000  Soil drainage parameter if HSWZT = 1 (Record 20), else set to 0.0 (day-1); note that the # of
                                          compartments (= DPN/THKNS) is needed to determine AD
Line 197           DISPL          5.000  Pesticide(s) hydrodynamic solute dispersion coefficient for each NCHEM; should be set to zero
                                          unless field data are available for calibration
Line 198           ADL            0.000  Lateral soil drainage parameter if HSWZT = 1 (Record 20) (should be set to zero)
Line 199           DEGF           0.000  Degradation Factor
Line 200
Line 201         37DPN            5.000  Thickness of compartments in horizon (cm)
Line 202           THEFC          0.382  Field capacity in horizon (cm3/cm3)
Line 203           THEWP          0.160  Wilting point in horizon (cm3/cm3)
Line 204           OC              0.40  Organic carbon in horizon (%)
Line 205
Line 206         38SPT             5.00  Initial Soil Temperature (C)
Line 207           SAND            2.00  Sand Content
Line 208           CLAY           43.00  Clay Content
Line 209
Line 210         40ILP                0  Flag for initial pesticide(s) levels before simulation start date; 1 = yes, 0 = no
Line 211           CFLAG              0  Conversion flag for initial pesticide(s) levels; 0 = mg/kg, 1 = kg/ha, blank if ILP = 0
Line 212 !
Line 213 !       1       1       6       Watershed Data
Line 214 !   900.0    100.     0.0       Waterbody Area (by Env)
Line 215 !     1.0     0.3     0.0       Waterbody Depth (by Env)
Line 216 !     1.0     0.3     0.0       Waterbody Max. Depth (by Env)
Line 217 !     1.0     1.0     0.0       Crop Area Fraction
Line 218 !       4       4       4       Flow/Volume Option
Line 219 !      0.     5.6      0.       Flow/Volume value
Line 220 !       0       0       0       Scen Specific Drift Option
Line 221 ! 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
          0.00 0.00
Line 222 ! 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
          0.00 0.00
Line 223 ! 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
          0.00 0.00
Line 224 !
Line 225 !       0                       burial
Line 226 !   3.e-5                       user mass transfer coefficient
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Line 227 !     0.5                        prben
Line 228 !    0.05                        benthic depth
Line 229 !    0.50                        benthic porosity
Line 230 !    0.80                        benthic bulk density
Line 231 !    0.05                        benthic foc
Line 232 !     5.0                        benthic doc
Line 233 !   0.006                        benthic biomass
Line 234 !    1.19                        wc dfac
Line 235 !    15.0                        wc ss
Line 236 !   0.005                        wc chlorophyll
Line 237 !    0.05                        wc foc
Line 238 !     5.0                        wc doc
Line 239 !     0.4                        wc biomass
```

Scenario guide by line for one crop, surface water scenario

Line 1 Title
Line 2 Beginning year of weather (2 digits), Ending year of weather file (2 digits), Path and weather filename
Line 3 Beginning year of irrigation file (2 digits), Path and irrigation filename
Line 4 Header for record and variable
Line 5 Header for record and variable
Line 6 Record 1 Label for simulation title
Line 7 Record 2 Short description of the file
Line 8 Blank line
Lines 9 – 14 Record 3 variables
Line 15 Blank line
Line 16 Record 6 Erosion flag
Line 17 Blank line
Line 18 Record 7 Title (Only use lines 7 to 25 if ERFLAG=2,3, or 4 in line 16)
Line 19 Field size 1, field size 2, field size 3
Line 20 Hydaulic length associated with field 1, field 2, field 3
Line 21 USLELS factor associated with field 1, field 2, field 3
Line 22 USLEP factor associated with field 1, field 2, field 3
Line 23 Slope associated with field 1, field 2, field 3
Line 24 USLEK factor
Line 25 IREG
Line 26 Blank line
Line 27 Record 8 Number of crops
Line 28 Type of crop
Line 29 Record 9 Header
Lines 30 – 39 Record 9 variables, lines 35 to 37 can remain zero if erosion is simulated (ERFLAG=2,3, or 4 in line 16). If ERFLAG=0, fill in curve numbers
Line 40 Header for Conventional Tillage
Line 41 Record 9A Crop number and number of USLEC factors
Line 42 Record 9B Dates (day, month) for the USLEC factors
Line 43 Record 9C USLEC factors for each date
Line 44 Record 9D Manning's N for each date
Line 45 Record 9E Curve number for each date
Line 46 Header for Reduced Tillage
Line 47 Record 9A Crop number and number of USLEC factors
Line 48 Record 9B Dates (day, month) for the USLEC factors
Line 49 Record 9C USLEC factors for each date
Line 50 Record 9D Manning's N for each date
Line 51 Record 9E Curve number for each date (Typically 5% less than conventional tillage)
Line 52 Header for No Till
Line 53 Record 9A Crop number and number of USLEC factors
Line 54 Record 9B Dates (day, month) for the USLEC factors
Line 55 Record 9C USLEC factors for each date
Line 56 Record 9D Manning's N for each date
Line 57 Record 9E Curve number for each date (Typically 10% less than conventional tillage)
NOTE Lines 28 to 57 are repeated for the number of crops (NDC value)
Line 58 Blank line
Line 59 Record 10 This is the number of years that are being run. If it's a double crop then this value is doubled.
Line 60 Blank line
Lines 61 Record 11 Header
NOTE: Lines 62 to 83 are repeated for the number of crops
Line 62 Crop Type

Line 63 – 71 Record 11 Cropping variables (emergence, maturation, harvest dates)
Line 72 P10D – 10% crop growth day
Line 73 P10M – 10% crop growth month
Line 74 IYP10 - 10% crop growth year
Line 75 P60D – 60% crop growth (typically set to crop 10 days before harvest)
Line 76 P60M – 60% crop growth (typically set to crop month of 10 days before harvest)
Line 77 IYRP60- 60% crop growth (typically set to crop harvest year)
Line 78 KCINT – Initial crop growth stage crop coefficient (FAO, 1998) Default = 1.0
Line 79 KCMID– Mid crop growth stage (FAO, 1998) Default = 1.0
Line 80 KCLATE– Late crop development stage (FAO, 1998) Default = 1.0
Line 81 KCMAX– Maximum crop growth stage (FAO, 1998) Default = 1.0
Line 82 REW – Stage 1 evapotranspiration, Default = 1.0
Line 83 INCROP – Crop number associated with NDC (Record 8)
Line 84 Blank line
Line 85 Record 19 Title of soil properties
Line 86 Blank line
Lines 87 – 96 Record 20 Soil core depth and flags
Line 97 DSPFLG – Dispersion flag for FOCUS GW modeling (0 = SW, 1 = GW)
Line 98 Blank line
Line 99 Record 31 Monthly albedo, reflectivity and wind height
Line 100 Blank line
Line 101 Record 32 Monthly BBT values
Line 102 Blank line
Lines 103 – 106 Record 27 Irrigation values
Line 107 Blank line
Line 108 Record 33 Number of soil horizons
Line 109 Blank line
Line 110 Title for horizon number
Line 111 Record 34 header
Lines 112 – 118 Soils data
Line 119 Degradation factor (1.0 for all horizons in surface water scenarios, 1.0 for top horizon for groundwater scenarios then decreasing through the profile [0.5, 0.3, 0.0])
Line 120 Blank line
Lines 121 – 124 Record 37 Soil properties
Line 125 Blank line
Lines 126 - 128 Record 38 Soil properties
Line 129 Blank line
NOTE: Lines 110 to 129 are repeated for every soil horizon. This example has 5 horizons.
Lines 130 – 149 Horizon 2 soils properties
Lines 150 – 169 Horizon 3 soils properties
Lines 170 – 189 Horizon 4 soils properties
Lines 190 – 209 Horizon 5 soils properties
Lines 210 – 211 Record 40 Flags – Default = 0
NOTE: Lines 212 to 239 are not needed for a groundwater scenario
Line 212 Blank line
Line 213 Flags for watershed data for up to 3 environments, 1=waterbody, 6=no waterbody
Line 214 Waterbody area for each environment
Line 215 Waterbody depth for each environment
Line 216 Waterbody maximum depth for each environment
Line 217 Watershed crop area fraction for each environment
Line 218 Waterbody flow/volume option for each environment
Line 219 Waterbody flow value for each environment
Line 220 Drift option for each environment
Line 221 Not used
Line 222 Not used

Line 223 Not used
Line 224 Blank line
Lines 225 – 239 Waterbody water column and benthic water quality parameters

NIBIO
NORSK INSTITUTT FOR BIOØKONOMI

Norsk institutt for bioøkonomi (NIBIO) ble opprettet 1. juli 2015 som en fusjon av Bioforsk, Norsk institutt for landbruksøkonomisk forskning (NILF) og Norsk institutt for skog og landskap.

Bioøkonomi baserer seg på utnyttelse og forvaltning av biologiske ressurser fra jord og hav, fremfor en fossil økonomi som er basert på kull, olje og gass. NIBIO skal være nasjonalt ledende for utvikling av kunnskap om bioøkonomi.

Gjennom forskning og kunnskapsproduksjon skal instituttet bidra til matsikkerhet, bærekraftig ressursforvaltning, innovasjon og verdiskaping innenfor verdikjedene for mat, skog og andre biobaserte næringer. Instituttet skal levere forskning, forvaltningsstøtte og kunnskap til anvendelse i nasjonal beredskap, forvaltning, næringsliv og samfunnet for øvrig.

NIBIO er eid av Landbruks- og matdepartementet som et forvaltningsorgan med særskilte fullmakter og eget styre. Hovedkontoret er på Ås. Instituttet har flere regionale enheter.

Forsidefoto: Ragnar Våga Pedersen

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