Additions to RUSLE2 Users Guide
Guidelines for Use of Factors
May 2005

1. Dates used in Management Templates for Crop Management Zones:

These dates are based on long term averages across the entire CMZ. For purposes of consistency in using the program, these planting and harvesting dates are to be the **same** for the entire management zone. These dates have been set and the templates for each crop have been developed. Field offices are to use the single crop templates that have been developed for their zone to build rotations, or use the multi-year rotations that have already been developed for each zone. As was discussed in the initial training, these dates are set for each zone and are **NOT to be changed** except on vary rare occasions. Consult with the State Agronomist before making any changes.

2. Guidelines for Estimating Soil Erosion with Terraces Using RUSLE2

7/7/04 gaw

If Terraces Already Exist

1. Select a slope length and steepness down to the first terrace, or the terrace interval.
2. Select a contouring row grade from the drop-down choice list for *Contouring*.
3. Select a terrace at the bottom of the slope from the drop-down choice list for *Diversion/terrace, sediment basin*

NOTE: If terraces already exist on the RUSLE2 slope, we need to take credit for remote deposition that occurs in the terrace channel outlet. Therefore, we must place the terrace at the bottom of the RUSLE2 slope as instructed above. If the grade of the outlet channel is sufficiently flat, RUSLE2 gives partial credit for this deposition, and the RUSLE2 erosion rate and sediment delivery values will be reduced.

If Terraces Are Being Planned But Are Not Installed

1. Select a slope length from the point where runoff begins to the point where deposition occurs or to a concentrated flow channel. Since terraces do not yet exist, measure the entire RUSLE2 slope.
2. Select a contouring row grade from the drop-down choice list for *Contouring*.
3. Select a terrace system for the RUSLE2 slope. From the drop-down choice list for *Diversion/terrace, sediment basin*, choose a system of one or more terraces and an appropriate channel grade that best matches the system planned.

3. Rock Cover - Guidelines for Estimating Rock Cover in the Field

Introduction: The RUSLE2 computer program has an input box on the Profile screen for *"Rock cover, %"*. This document offers guidelines for making estimates in the field for the percent cover from rock, rock fragments, or coarse fragments. Coarse fragments on the soil surface effect the Cover and Management factor in RUSLE2. Rock cover does not effect the Soil Erodibility factor.

Caution - Use Good Judgement: Research data shows that the presence of rock cover can significantly reduce soil erosion, and the RUSLE2 model accounts for this effect. However, users should be cautioned to exercise good judgement when developing conservation planning alternatives

that reflect the presence of surface rock fragments. For example, a rock cover entry in RUSLE2 that reduces soil loss to acceptable levels should be re-considered if the hillslope shows clear evidence of severe, active erosion.

In Minnesota, we have not determined any soils or locations where rock cover is a significant concern or should be measured. If this changes in the future, the following information will apply:

Minimum Size Requirement: Count rock fragments that are larger than 10-mm (0.3937 in, or 2/5 in). On undisturbed land in the western U.S., count rock fragments that are larger than 5-mm (0.19685 in, or 1/5 in). Professional judgement is needed when rocks are flat or light in weight. The defining criteria are whether it is easily moved by runoff during a storm event. *(See footnote at bottom)*

Most Erosive Period: The estimate of rock cover should represent the range in rock cover over the 3 or 4 month period that is most erosive. "Most erosive" should include consideration of both the period of highest rainfall erosivity and the vulnerable management period. Since field measurements cannot always be made during this period, additional guidelines may need to be issued by the state.

Measuring Rock Cover: Whenever possible, measure rock cover using the line-transect method.

Rock Cover on Entire "L": The percent rock cover should be based on the entire eroding hillslope profile, or "'L". We are evaluating soil loss on the entire RUSLE2 hillslope profile. Avoid overestimating the rock cover based on a segment of the slope that contains the largest percent of rock cover.

Represent Field or Portion Thereof: Adjust the rock cover estimate to represent the field or portion of the field represented by the hillslope profile if rock cover is significantly more or less on the representative hillslope compared to the rest of the field.

Ignore Overlap with Residue: When measuring or estimating rock cover, ignore any overlap with residue cover**.** Count the surface rock cover even if it lies above or below residue. RUSLE2 takes into account the overlap of different types of ground cover. For example, if rock cover is 15% and corn stalks provide 40% cover, the total cover considered by RUSLE2 is 49%. RUSLE2 properly takes into account the nonlinear mathematics of the combination of rock cover and crop residue.

FOOTNOTE on Minimum Size Requirement: States should develop practical field measurement guides for minimum size requirements of rock fragments. Field users should be encouraged to use (or should be given) a practical tool for use in measuring the 10-mm or 5-mm size. This could be a drill bit, stove bolt, plastic ruler or a paper scaled-drawing. For the 10-mm size, the minimum size rock should be slightly larger than a 3/8-in drill bit, or slightly smaller than a ½-in drill bit; and for the 5-mm size, the minimum rock size should compare with the ¼-in drill bit. Where rock fragments are flat, a conversion should be developed at the state level, since the 10-mm and 5-mm size in these requirements are meant to apply to a more rounded or blocky shape. Dimensions for flat rock measurement should take into account comparable weight of blocky or rounded rock vs. flat rock, keeping in mind the ability of the flat rock to remain in place and reduce runoff during a storm event.

4. Contouring: The program gives you choices of two types of contouring: relative row grade and absolute row grade. Relative row grade is the ratio of the row grade to the land slope. For example, if your land slope (which you entered in step 3) was 6%, a relative row grade of 1% (from the drop down menu under contouring) would represent 1% of 6, or a row grade of 0.06%. This approach gives the same relative benefit to row grade regardless of land slope steepness. However it can be confusing.

Absolute row grade is easier to understand, and it is recommended to use this choice most of the time. This is the actual grade of the contour line that you laid out, or the actual grade of the row.

There is a help menu available for all of the options in step 5, and it is accessed by highlighting the option (for example, highlight the word "contouring") and right clicking. A window will pop up with "help" as the first choice.

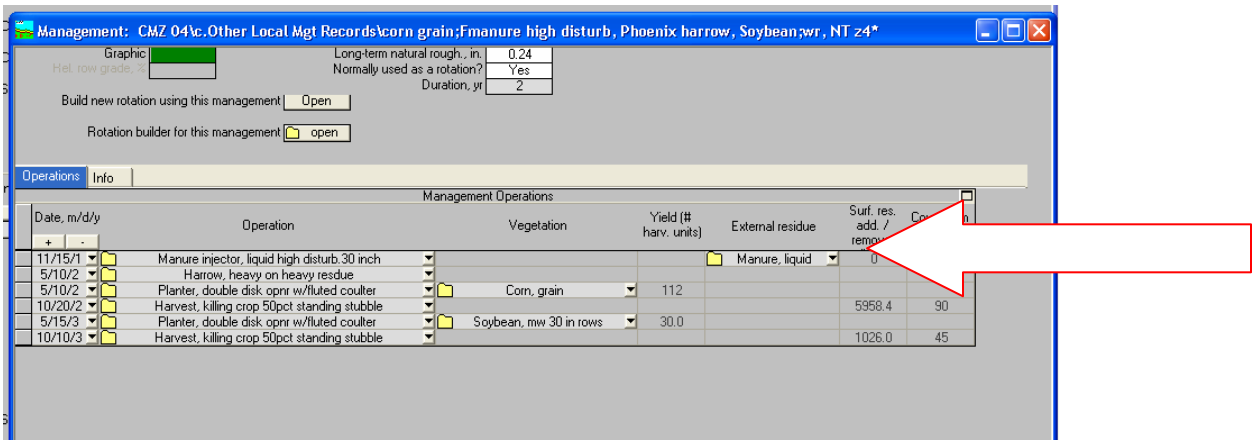
5. Filter Strips: Only use this factor if the filter strip occurs on the "L" you have described in Step 3 – on the slope that you are using to figure the soil erosion. Do not make any entry for this factor if the filter strip is along the ditch or creek farther on in the field, and not on the slope you are modeling. More information about filter strips is available from the help menu explained above.

6. Subsurface Drainage: this button currently is not working. It is intended to be tied to the hydrologic class of the soils, and be available for soils where there is more than one hydrologic class, depending on if the soils is drained or not. This is planned to be used at some point in the future.

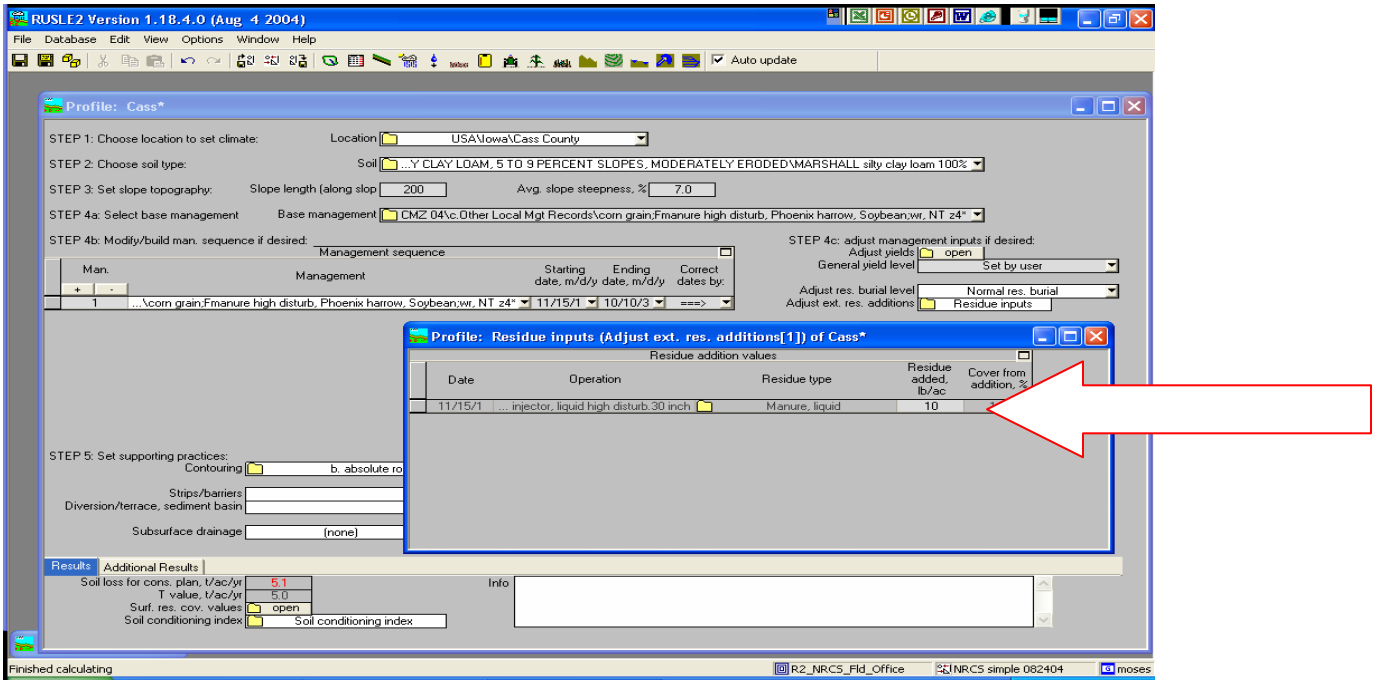
7. Additions of Manure: Guidelines for Calculating Manure Dry Weight and Effectiveness

How to incorporate manure into Crop Management File

When manure is applied to fields **regularly** on a **consistent** basis, it can be included in the management file (crop rotation). If manure is not applied regularly or is applied to only a part of a field, then just ignore the manure application when doing RUSLE2 calculations. To add a manure application to a management file, you start by adding an operation. When you select the manure operation in RUSLE2, a dialog box titled "external residue" will appear to the right of the operation that requires you to include the type of manure that you are applying.



You will then need to enter the amount of additional cover in **dry weight** in the next box, titled "Surf res. add / removed".



RUSLE2 requires that inputs for the amount of manure added to a field be entered as mass/ac dry weight. A method to convert the fresh or wet weights of manure to dry weight is shown below.

Laboratory data should be used in lieu of these conversion methods where available. Moisture content estimates are also available in the Ag Waste Handbook for various manure classes.

There are some new RUSLE2 manure residue effectiveness guidelines for **liquid, slurry, semi-solid and poultry** manure types that only **50%** of the dry weight for these wet manure types should be used. Liquid, slurry, semi-solid, and poultry manure types are not as affective in retarding the erosion process as solid manures. RUSLE 2 users should enter only half of the dry weight computed for these manure types. Use 100 % of dry weight calculated for solid manure and solid manure plus bedding.

Equations to Convert to Pounds Dry Weight

(A) For liquids and slurries
(gallons of liquid or slurry applied/ac) X (8.34 lbs/gal) (% solids as a decimal) = lbs dry matter

Sample calculations:
(10,000 gal liquid/ac) X (8.34 lbs/gal) X (0.02) = 1668 lbs/ac dry matter
RUSLE2 Conversion: 1668 lbs/ac dry matter X .5 = 834 lbs/ac

(B) For semi-solids
(lbs semi-solid applied/ac) X (% semi-solids as a decimal) = lbs dry matter

Sample calculations:
(8000 lbs semi-solid/ac) X (0.15) = 1200 lbs/ac dry matter
RUSLE2 Conversion: 1200 lbs/ac dry matter X .5 = 600 lbs/ac

(C) For solids
(lbs solid or semi-solid applied/ac) X (% solids or semi-solids as a decimal) = lbs dry matter

Sample calculation:
(8000 lbs solid/ac) X (0.25) = 2000 lbs/ac dry matter

Recommendations for Types of Manure in RUSLE2 Database:

"Manure, liquid" (beef, dairy or swine from confinement, holding ponds and municipal sewage): use Equation A,
"Manure, Slurry" (includes beef, swine and dairy settling basins): Use Equation A
"Manure, semi-solid" (beef, swine, dairy manure from open lots and buildings): Use Equation B.
"Manure, poultry": Use Equation B.
"Manure, moderate bedding":(loafing sheds, farrowing stalls or other facilities): Use Equation C.
"Manure, solid, sig. bedding" (horse, sheep packs including straw and shredded newspaper): Use Equation C.

Summary of % Moisture Content Manure
Agricultural Waste Management Field Handbook.

Species		% Moisture Content	% Solid Content
Dairy			
	Milk House	99.72%	0.28%
	Milk House + Parlor	99.4%	0.6%
	Milk House + Parlor + Holding area	99.7%	0.3%
Beef			
	Unsurfaced lot	45.0%	55.0%
	Surfaced lot - High forage	53.3%	46.7%
	Surfaced lot – High energy	52.1%	47.9%
	Feedlot runoff pond – Sludge	82.8%	17.2%
	Feedlot runoff pond – Supernatant	99.7%	0.3%
Swine			
	Storage tank under slats		
	Farrow	96.5%	3.5%
	Nursery	96.0%	3.0%
	Grow/Finish	91.0%	9.0%
	Breeding/gestation	97.0%	3.0%
	Feedlot runoff water	98.5%	1.5%
	Feedlot settling basin sludge	88.8%	11.2%
Poultry			
	Litter		
	Layer high-rise	50.0%	50%
	Broiler	24.0%	76%
	Turkey	34.0%	66%
	Broiler breeder	34.0%	66%
	Duck	11.2%	88.8%
Veal	As Excreted	97.5%	2.5%
Sheep	As Excreted	75.0%	25%
Horse	As Excreted	78.0%	22.%

8. **Estimating Soil Erosion with Ridges** and **Beds**

With Additional Notes on Sediment Delivery and Plastic Mulch 7/16/04 gaw

Ridges and Beds, Defined for Purpose of RUSLE2 Applications

For the purpose of RUSLE2 application, ridges are a series of reoccurring ridges and furrows left by tillage implements such as chisel plows, hippers and disk hillers. The top of these ridges are not flat for any appreciable length. Beds, for the purpose of RUSLE2 application, differ from ridges in that the raised areas (top of the beds) are commonly several feet across the top, and must be at least one foot wide across.

Representing Beds Using RUSLE2

RUSLE2 does not calculate soil loss in the furrows of these beds. Therefore, the topographic inputs must represent the flow path across the bed, then down the side of the bed to the furrow.

This implies that either 1) RUSLE2 provides reasonably good erosion and sediment yield results when minimal erosion occurs in furrows because of high residue cover in the furrows or low furrow grades; or 2) the furrow carries excessive runoff and experiences excessive erosion, a process more closely resembling concentrated flow erosion, a process that RUSLE2 does not currently model.

When Beds are Generally Up-Down the Hillslope:
Represent the cross-section from the middle of one bed to the middle of the next bed. The RUSLE2 output represents runoff and erosion from the middle of the bed to the furrow. Typically, water does not run along the top of the bed for any appreciable length, and instead will run off the side and into the furrow. In the table below, the top of one bed is represented with a 1% grade and 2-ft length, and the sideslope of that bed is represented with a 50% grade and 1-ft length. The adjacent bed across the furrow is represented with similar, but negative values.

SEGMENT	STEEPNESS (%)	LENGTH (ft)
1	1	2
2	50	1
3	-50	1
4	-1	2

When Beds are On or Near the Contour:
Represent the flow path across a bed and down the bed's sideslope to the furrow. An example is illustrated in the table below in which runoff across the top of the bed is represented with a 2% grade and a 4-ft length; and runoff down the bed's sideslope to the furrow is represented with a 50% grade and 1-ft length.

SEGMENT	STEEPNESS (%)	LENGTH (ft)
1	2	4
2	50	1

Representing Ridges Using RUSLE2

Represent the topography up-and-down the hillslope in the path the runoff would follow if the soil surface were flat (as if ridges were not present). If the ridges are on contour/near contour, select the row grade from the drop-down menu for *Contouring*.

NOTE: *The science in RUSLE2, in most instances, is adequate to represent ridge-furrow systems because it is based on research data on ridge-furrow systems with a "normal spacing." But RUSLE2 does not adequately represent "abnormally" wide beds, and the subsequent wider spacing of furrows because runoff comes from a larger area on the bed and flow concentrates in the furrow.*

A Ridge factor built into RUSLE2 "enhances" erosion when ridges are up-down but "diminishes" it with contouring.

Sediment Delivery in Furrows

RUSLE2 will model sediment deposition in the furrow resulting from low channel grade, but not deposition resulting from increased roughness such as from high residue in the furrow. Currently we have no way of modeling the channel shape and roughness, and the effects of different residue levels in the furrow compared to the ridge or bed.

In eroding landscapes, furrow grades are often too steep for deposited sediment to remain in the furrows. Therefore the sediment delivery value is the same as the soil loss value. However, if the furrow grade is sufficiently flat (often associated with low runoff and/or residue in the furrow), sediment delivery to the end of the furrow will be less than the soil loss value.

Plastic Mulch on Beds and Ridges

Select the Plastic Mulch Application Operation that best represents the percent cover provided by the plastic mulch to the field. So, the estimate of percent cover must include the furrow areas as well as the beds or ridges.

9. Average Planting Dates: The question was asked about the average dates for planting corn and soybeans that are used in the program. These dates are intended to be the average date (averaged over a period of years) that 50 to 75% of the crop is planted. The reference being used is the Minnesota Agricultural Statistics. This information is available on the web at http://www.nass.usda.gov/mn/annbulls.htm . The average date (1999 – 2003) that 75% of the corn in Minnesota is planted is May 13th. The average date for 50% of the corn planted is May 3rd. In RUSLE2, we are using May 10 as the average corn planting date for CMZ1 and May 5 for CMZ 4. We have found that your soil loss answers will not change very much at all unless you change the dates by at least two – three weeks. Based on the information from Ag Statistics, there is not currently a reason to change the average dates that the program is using. If any of the DCs have references with vastly different average dates, send those references to Robin Martinek, State Agronomist to be checked out. For soybeans, the average date (1999 – 2003) that 75% of the soybeans in Minnesota are planted is May 28th. The average date for 50% of the soybeans planted is May 19. We are using May 25 as the date in CMZ 1 and May 15 in CMZ 4. Again, those dates seem to be in line with the Ag Statistics. If someone has other references, please send them to Robin Martinek. In checking with the agronomists in several other states, the dates in their ag statistics books were similar.

10. Addition of Disk Chisel (DMI) To Database: Concerning the addition of another implement to the databace, (the DMI or disk chisel), Dave Lightle (the national program manager for RUSLE2) was asked about the need to do that. Here is the essence of what he said:
We are probably splitting hairs when it comes to the chisel plows vs. Chisel disks. These machines can either have the front gang from a heavy tandem disk in front of the chisel shanks or a set of straight coulters or a number of variations of that. Usually they are set to cut and size the residue so it will flow through the chisel shanks without plugging. The various chisel plows currently in the database represent all of these variations. If I built another record for the disk chisel, it would probably have the same numbers as the chisel plows but just a different name. We can't be more specific because of all the other variables related to age of the residue, moisture content of the soils, depth of operation, speed, etc. " Dave suggests that one way to model these implements is to just

choose the chisel plow and then adjust the residue burial, make it bury a little more or less that the chisel plow, depending on what the machine actually is doing. This can be done in the profile screen in step 4c "adjust residue burial level". If we use two implements he says the program may overaccount for the effect of the additional disk. "If the gang is straight coulters or concave disks set straight that just cut the residue, I would ignore it. If the disk blades are concave and the blades or gangs are angled and aggressive then use the light finishing disk ahead of the chisel. If there are two disk gangs ahead of the chisels and they are aggressive then use either the secondary tandem disk or the primary tandem disk depending on judgment."

"The effect of the single gang of disks on the front of the chisel isn't nearly as severe as using the tandem disk itself. I don't have a single disk gang in the database and even the light finishing disk is probably more aggressive than the single disk gang on the front of the disk chisel. That would bury another 55% of corn type surface residue, where as, if they use the residue adjustment they can vary it just a little which is closer to the truth."

"If I created new combination operations the values will be somewhere in between probably. But once we start down that road then people will want every variation imaginable when the results are not that different."

"Having said that, there may be some very aggressive disk chisels on the market that have two disk gangs in front of the chisels. If that is the case then they could use a primary tandem disk operation in addition to the chisel in the RUSLE2 management. To display the impact you could enter them on two successive days."

Remember, this is a model for Conservation Planning where we compare predicted results for one system to that of an alternative, with the purpose of assisting the producer make informed decisions. It is a model and as such approximates the actual results that one may achieve on the ground under the conditions of the day.

11. Printing

Profile: When you are doing a soil loss calculation and are in the Profile screen, go to the Toolbar, to *File*. Click on *File*, go to the bottom of the drop-down box, to the *Print to MS Word Template* choice. You will get a box that says *"Which Report template would you like to use?"* All of the choices are for Profiles – they will just display different amounts of information. The fourth one down, *"NRCS RUSLE2 profile Record with SCI product"* is usually the most useful one for a field office or a producer. Click on your choice for the template you want to print. This will open up a Word document on your screen. This is an actual MS Word file, so you can add or edit information just like you could in any word document. If you want to print this out, you do that just like you do in word – hit the "*File – Print"* button on the toolbar. If you want to save this document, you can hit "*File – Save As"*, choose the place where you want to save it (on your hard drive, in the producers case file in toolkit, etc.), and save.

Worksheet: The procedure for printing the worksheet, when you are in the Worksheet screen, is the same as described above. When you go to *"File, Print to MS Word Template"* you will still get the box that says "*Which Report template would you like to use?"* This time you will have a choice of three templates. They will each display different amounts of information. When you click on one of these choices, it will open up a word document on your screen. Just as described above, you can

enter and edit information in this document, print out a hard copy, and save it on y our hard drive in whatever location you want to.

Plan: The procedure for printing from the Plan screen is the same as above. This time you will have four choices of templates to print.

12. Organic Soils (Glenn Weesies)

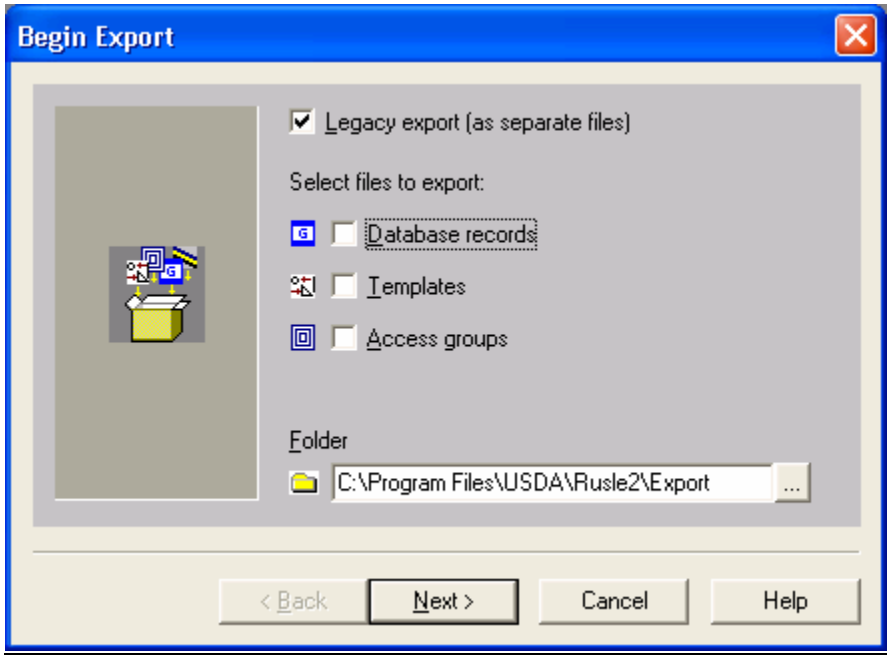
Some RUSLE2 users with CSP watersheds need to obtain an SCI for organic soils. We have no K values for mucks in the database (because these soils do not have a K value, and we do not do water erosion calculations on these soil types) so the specific map units cannot be used in the model.

Either choose a mineral soil from the same field and use that soil for your calculation, or use the "sand" texture from the Generic Soils folder in the RUSLE2 database for organic soil map units when calculating SCI. These map units typically have a "muck" texture and are classified as Histosols.

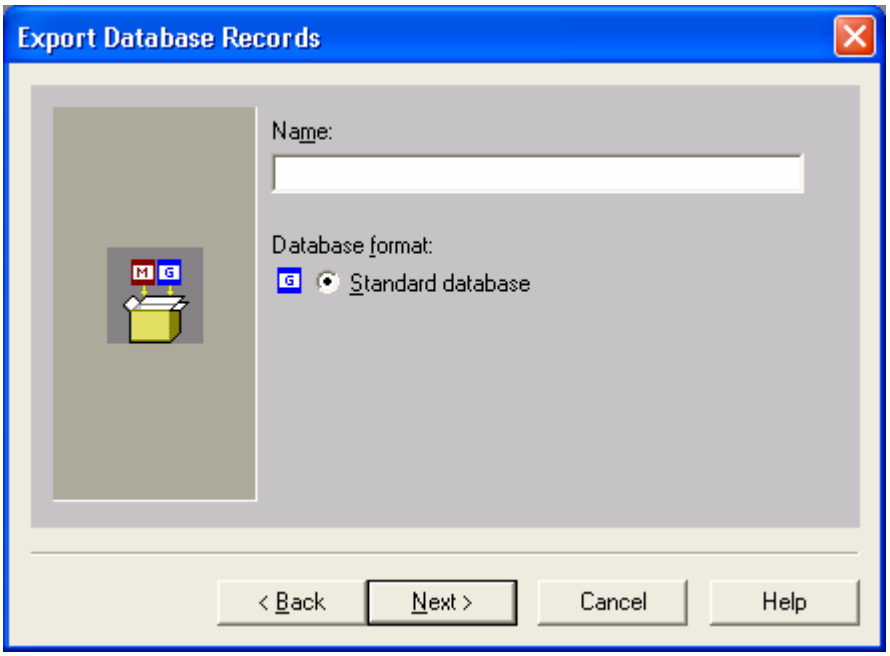
NOTE: This is not to suggest that the K value for sand is a suitable value for the K in organic soils. This just allows users to calculate an SCI rating without the influence of erosion. There is no research to support a K value for organic soils when they occur on hillslopes. So, our position remains – we cannot use RUSLE2 to predict erosion on organic soils.

13. To Export files from Rusle 2 to the Export file on your C drive

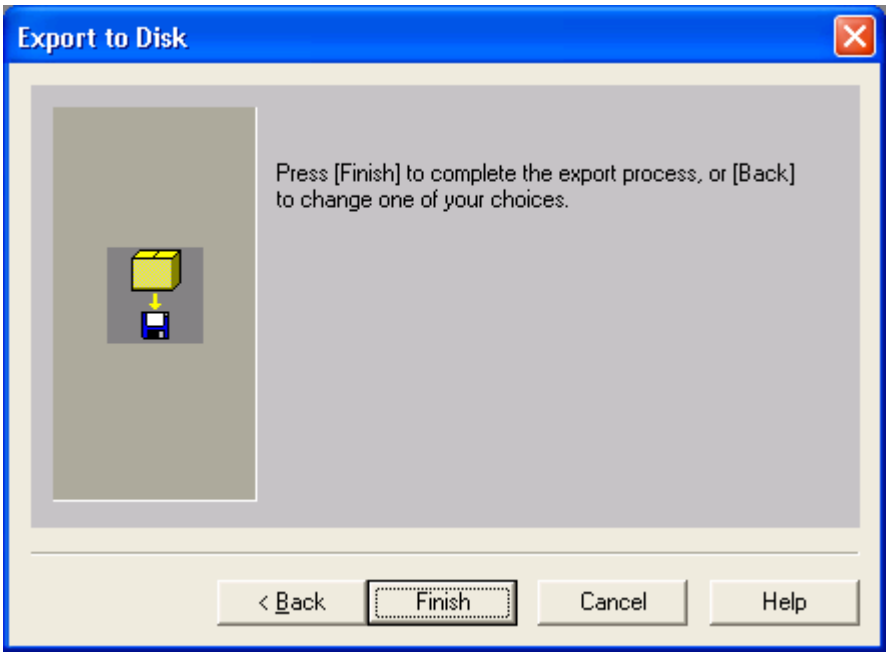
Open the Rusle2 program. Close the profile, so you have a blank screen. On the toolbar, click on "Database". Then click on "Export with templates, access". You will get the following screen:



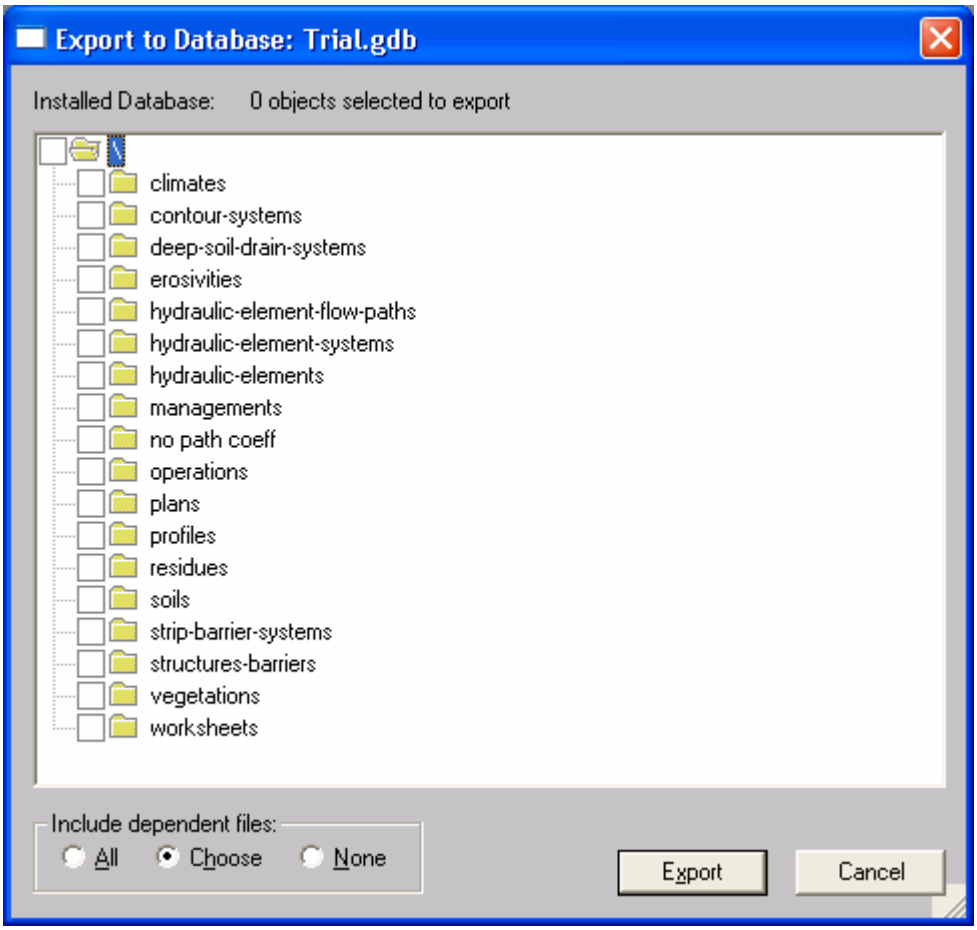
Check the top box, "Legacy export", and also the box that says "Database records". The exported files will go to the folder listed in the box: C:\Program Files\USDA\Rusle2\Export. Click on "Next".



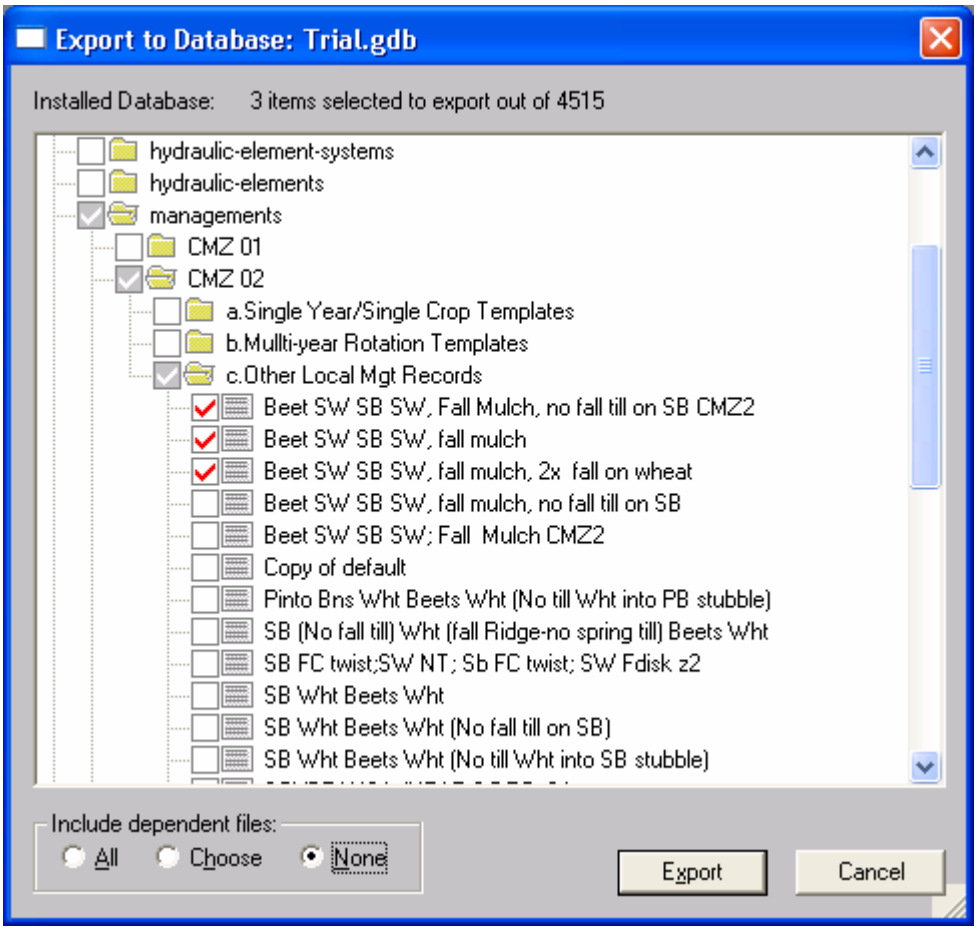
In the box under “Name”, type a name for the files you are exporting, so you will remember it when you go to use these files later. Click “Next”.



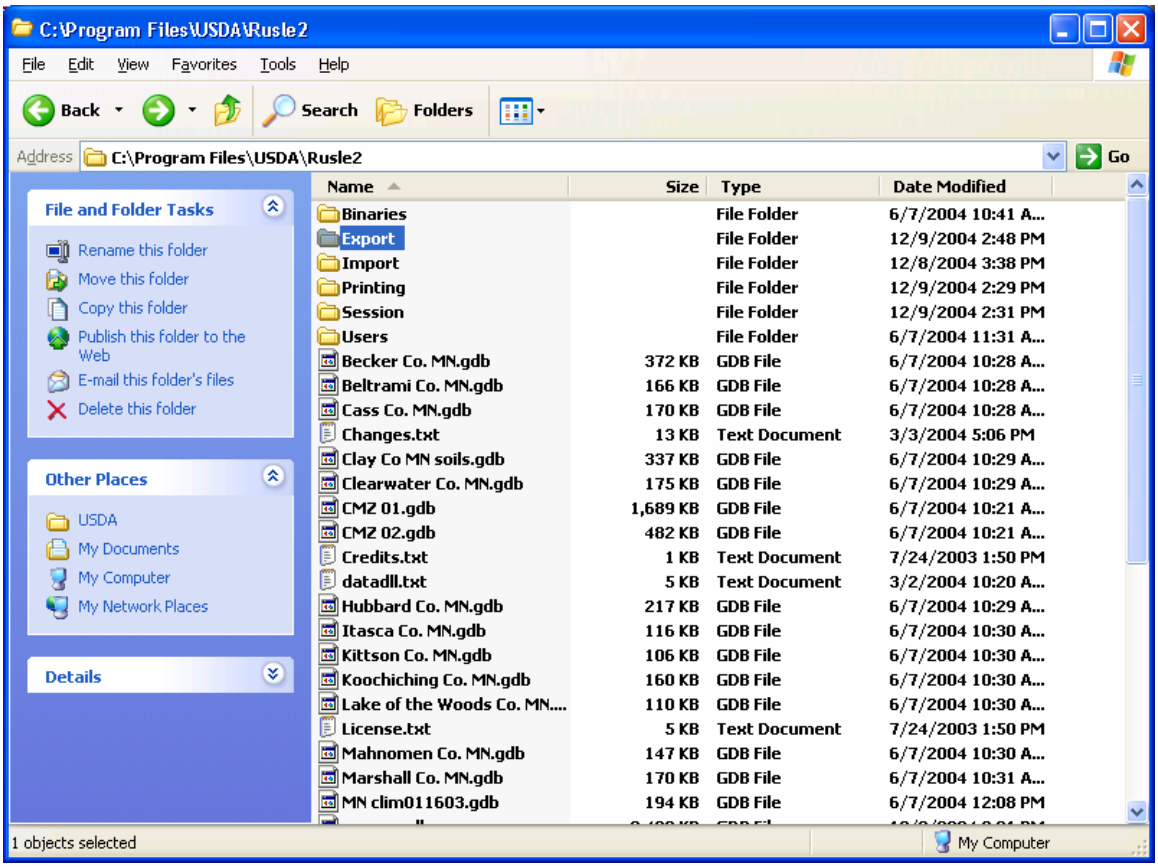
Click on “Finish”.



That will take you to this screen. You will have to make a check mark next to the database where you have records that you want to export.



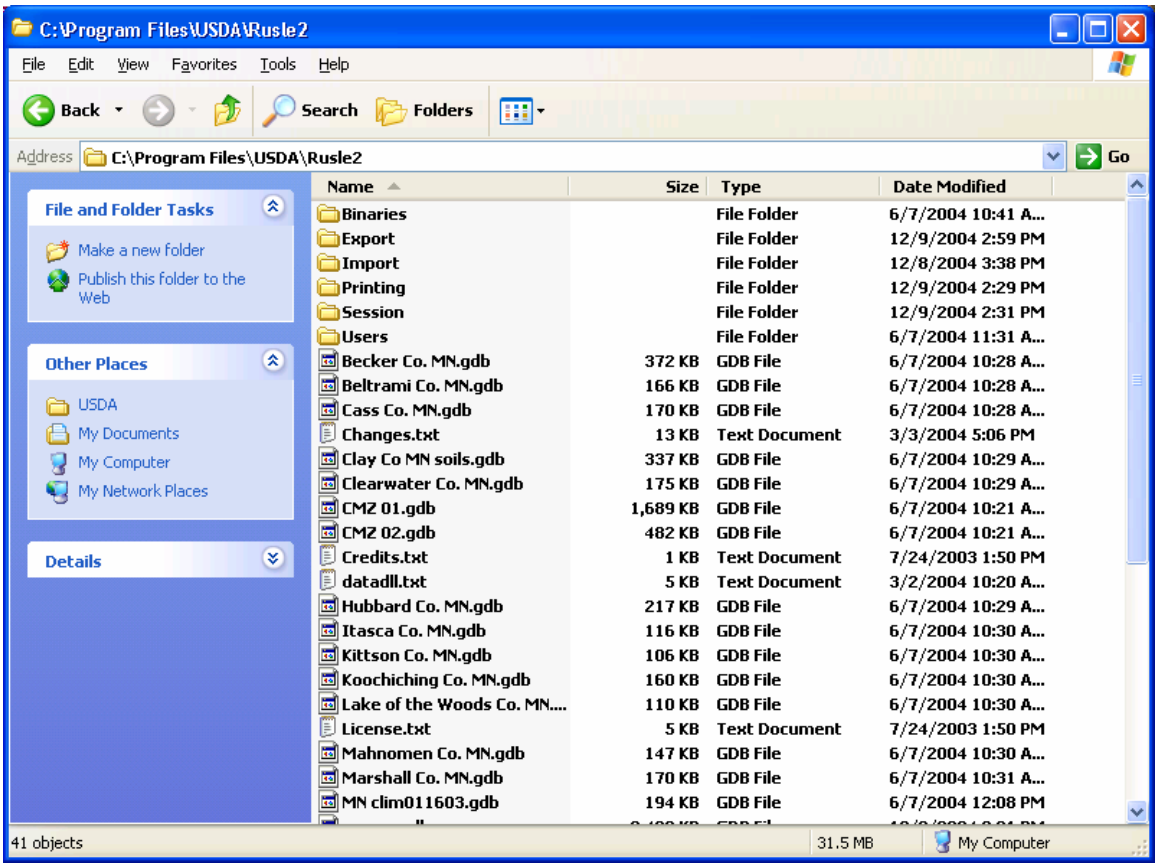
Make sure you choose “none” on the box that says “include dependent files”. Click Export, and the program will send these files to the “Export” file in Rusle2, on your C drive.



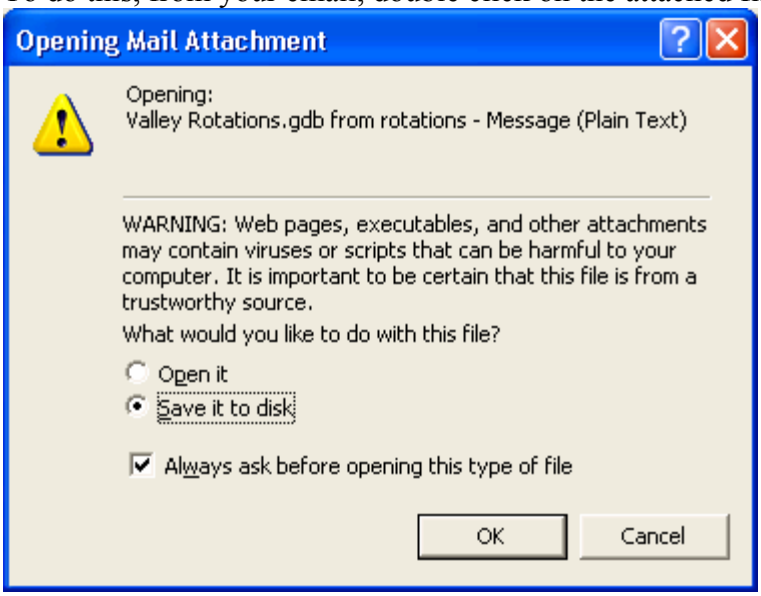
Now, if you want to send these files to someone, you can go to your email, and use the "attach file" button, and attach the exported file from this folder (above) to your email.

14. To Import Files from an email into RUSLE2

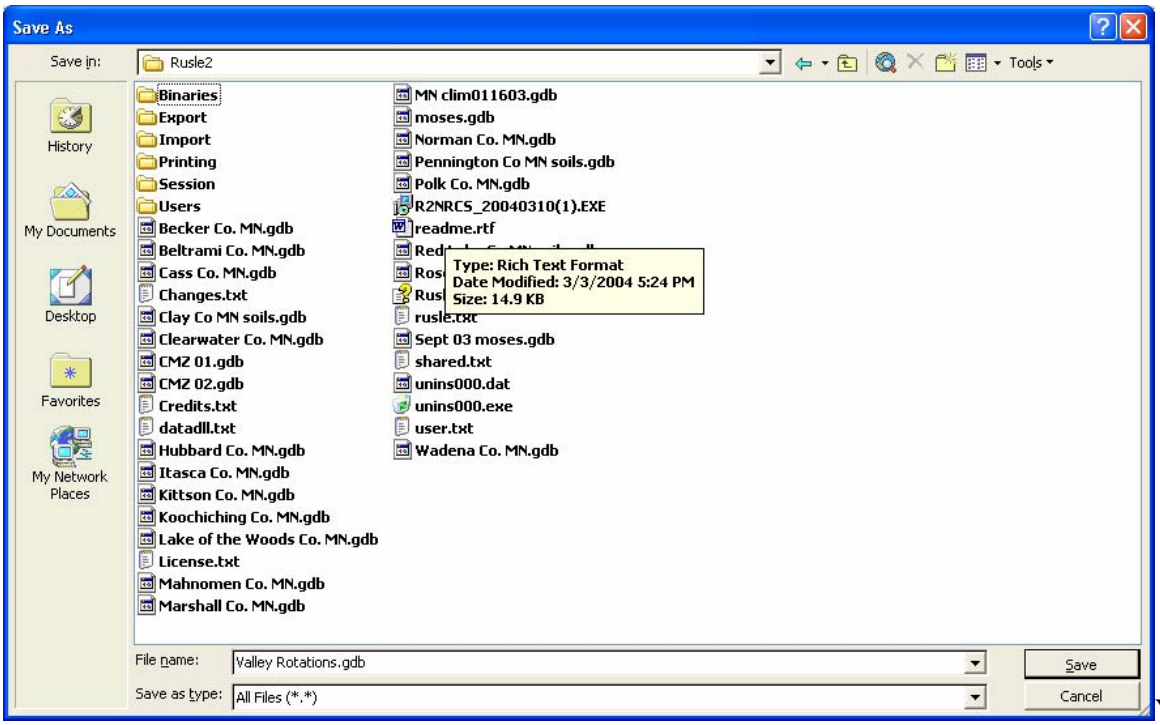
You will get a file, attached to an email. It will be a "xxx.gdb" file. The first thing you need to do is save the file FROM your email INTO a file on your C drive on your computer. You want to save it into the C\Program Files\USDA\Rusle2\Import file.



To do this, from your email, double click on the attached file that you want to save.



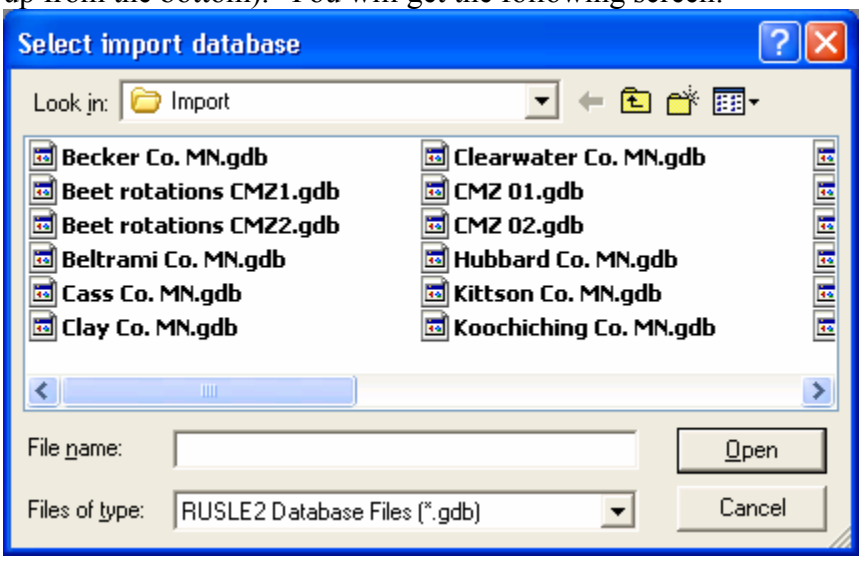
You will get this choice box. Click “Save it to disk”, and click “ok”.



You will get this box that says "Save As". In the "save in" window on the top, navigate to where you want to save this file – "C\Program Files\USDA\Rusle2\Import" file. Click "save", and the file will be saved in this file. Now close this window.

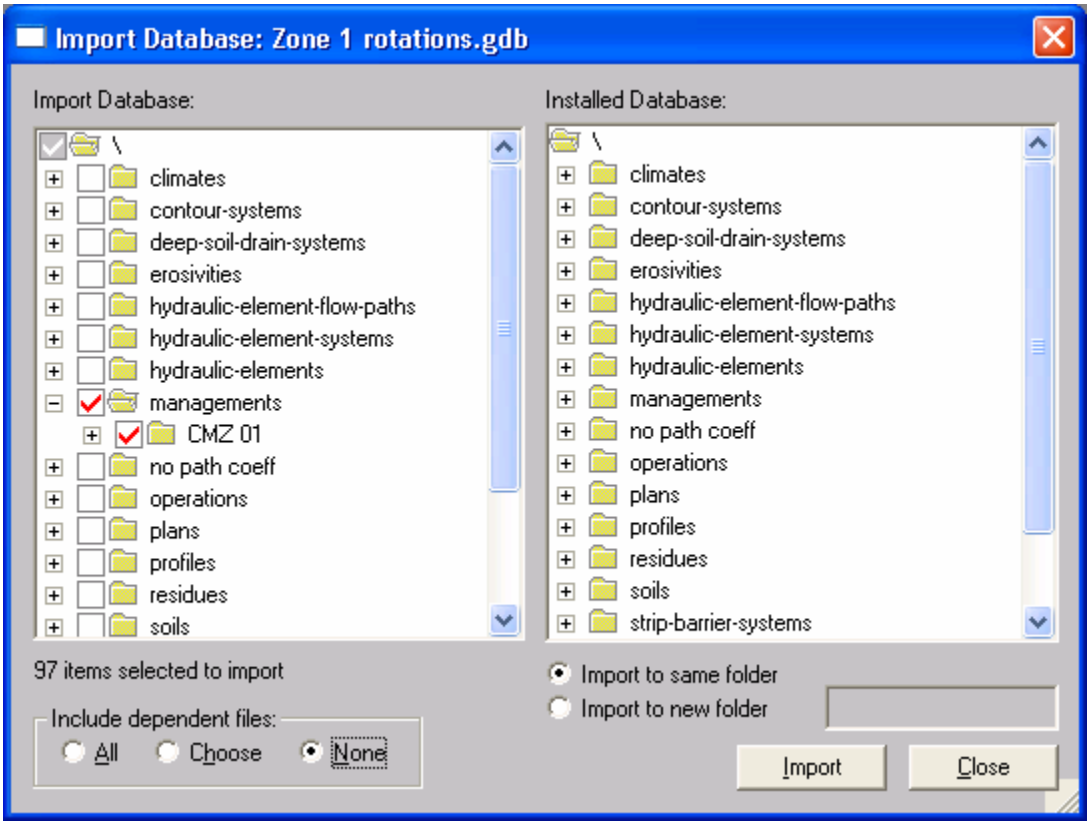
Next Step:

Open the RUSLE2 program. Close the profile, so you have a blank, gray screen. On the toolbar, click on "Database". Then click on "Import RUSLE2 database"(below the second line, third choice up from the bottom). You will get the following screen:



You will be in the "Import" folder, the same place that you just saved the file from your email. Find that file in this folder, highlight it, and click "Open".

You will get this screen:



On the left side of the window, find the word managements. Click on the + button next to managements. You will see CMZ1. Click the box next to this – a red check mark will appear. On the bottom left side of the window, under "Include dependent files", choose NONE. Click on "import", and the program will import these files into the program. When the import has been completed, you will get a message that says "import done". Click ok, and you are done.