Companion Document
Chapter NR 151: Determining Direct Runoff from Feedlots to Waters of the State

Developed by WI Land+Water Technical Committee
September 2023

Intent of Document

This document was developed as a companion document to supplement the Wisconsin Department of Natural Resources (DNR) Bureau of Watershed Management Program Guidance *Chapter NR 151 Implementation Series: Determining Direct Runoff from Feedlots to Waters of the State*. Further referred to in this document as "DNR Guidance." This document does not contain any mandatory requirements except where governing statutes or administrative rules are referenced and is only intended as a tool to help County conservation staff consider what may be useful in determining when a direct runoff from a livestock operation to waters of the state has occurred. This document attempts to provide items to consider when assessing direct runoff from feedlots to surface water and direct conduits to groundwater.

Preparing for a Site Visit

Doing some work up front before conducting a site visit will make the actual site visit much more productive. Follow the local authority for accessing the property. Communicate with the farm owner to schedule the site visit and describe what the site visit will include. Some resources to use while preparing for a site visit include the following:

A. *Use mapping tools.* Such tools include geographical information system (GIS) mapping or web-based mapping applications such as the DNR's Surface Water Data Viewer or SnapMaps.
    1. Determine flow paths and the distance to water bodies, ground slopes, and other factors that may be relevant to the review. Some of this information will be confirmed later during the site visit but having an idea ahead of time makes for a more comprehensive site visit. Water bodies include those listed in the waters of the state definition. Consider special designations of water bodies (trout stream, impaired, etc.) and identify watershed.
    2. Review SnapMaps 590 and NR 243 Restriction Maps to look for mapped hazard features such as karst features and sensitive areas within the runoff flow path.

B. *Look at soils information.* The NRCS Web Soil Survey can provide some helpful information about the soils and landscape around the waste source as well as the predicted flow path between the source and receiving waters. Features such as soil types, infiltration rates, and depth to groundwater and bedrock can be helpful in determining potential discharge routes. Additionally, SnapPlus identifies restrictive and prohibitive soils (https://snapplus.wisc.edu/planning/soil-details/). It should be noted such information is typically for planning purposes only and an on-site soils investigation may still be needed.

C. *Look at past years aerial photography*. Identify trends of animal numbers, size of the farm, and potential frequency of direct runoff and/or significant discharge issues from historical aerial

imagery. This can be accomplished with GIS mapping or mapping applications such as Google Earth or State Cartographer's Office – University of Wisconsin-Madison.

D. *Time your site review.* It is best to view feedlot facilities when vegetation is dormant and streams are flowing. When possible, spring and fall are the best seasons for site visits. If site visits are done outside of the optimum times, a follow-up visit may be scheduled if a determination cannot be made at the time of the visit. If a follow-up visit is not possible, rely on best professional judgment.

E. *Watch the weather.* A discharge may be more observable immediately following a rain event capable of producing runoff from the production site.

F. *Request and review engineering plans.* Often animal lots have engineered practices such as sediment basins, vegetated treatment areas (VTAs), or other practices to mitigate pollutant loading to waters of the state. If there is knowledge of the presence of this type of practice, the owner or government staff (County conservation, WI Department of Agriculture, Trade and Consumer Protection (DATCP) conservation engineering, or NRCS) may have copies of engineering plans which can then be evaluated to see if they comply with appropriate NRCS Standards. If the information is private, you may need to request from the owner the release of engineering plans and information related to the facility. Do your research by talking to partners to determine what has been done on the farm previously. This information will also help you when talking with the landowner as your knowledge will show that you understand their farm.

G. *Review of existing water quality data, if available*. Although reviewing this data likely will not provide site-specific information, it can help identify if there is a known problem in the region or the watershed. Knowledge of this information can help identify site-specific issues during the evaluation, and facilitate a discussion with the landowner.
    1. Surface Water Integrated Monitoring System (SWIMS) database. This resource provides chemical, physical and biological data.
    2. USGS maps can help determine groundwater flow direction. Contact the USGS office to access this information.
    3. UW-Stevens Point Well Water Quality Viewer. This is an educational tool only. The information offered through this tool can help you understand groundwater resources based upon voluntarily submitted well water samples.
    4. WI Geologic Natural History Survey's Historic Well Construction Reports. This website compiles historical well construction information.
    5. DNR Well Inventory. This site has links to well construction and geology information.
    6. Contact your regional DNR water quality biologist.
    7. DNR Surface Water Data Viewer. This resource can help determine the watershed, special designations for waterbodies (trout stream, impaired, etc.), and the presence and type of wetlands.

Conducting the Site Visit

A site visit is an important part of the process for determining direct runoff from feedlots to waters of the state. Below are the components that may make this step more effective and valuable.

A. *Engage in conversation with the landowner.* Having open communication with the landowner allows for a better understanding of the current management, past management, and any history about the facility or specific structure being evaluated. Discuss with landowner future plans for the farm – expansion, retiring from dairy, transition to next generation. Ask about concerns and how they think things are going.

B. *Collect adequate data.* Be prepared to walk the site and gather your own information based upon the facilities you are evaluating for the basis of the site visit. Conversation with the landowner is often critical to gathering proper and comprehensive data. Take photographs of your observations and document where photographs were taken to support your notes. If you are likely to use a model (see Appendix C) later in the post-visit analysis, then keep this model in mind as you collect data to make sure you are gathering information for all the inputs you will need to run the model (see Appendices A & B).

C. *Compare conservation practices to engineering plans.* If a copy of engineering plans for conservation practices was obtained as part of preparing for the site visit, check to see if the practices were constructed as planned and if they appear to be properly managed and maintained according to the operation and maintenance plan. For livestock facilities with a VTA, a visual check for a discharge leaving the VTA may be conducted to determine if a discharge to waters of the state is occurring. Refer to DNR Guidance section on "*Operations which can support Predicting Direct Runoff and its Significance*." Appendices A & B can be used as a checklist in the field to document conditions. If lot has practices present but no design was located refer to Appendices A & B to document onsite conditions for modeling or evaluation.

D. *Document site visit and conclusions.* Site visits can be documented with written notes and include maps, photographs, data collected in the field, or any other information that supports the compliance determination. See Appendices A & B.

Evaluation and Follow-up

A. Evaluate existing site to determine if feedlots are functioning to prevent direct runoff. Conservation practice standards, previous engineering designs, best professional judgement and consideration of the operation and maintenance can help support this determination.

B. *Evaluate the feedlot runoff flow path.* Use slope, erosion, downed vegetation, etc. to define flow path. Identify flow path on map. Consider including on map: aerial photography, contours, livestock facilities, conveyance channels, overland flow paths, all affected surface waters including intermittent and perennial receiving waters. Make sure to identify where flow leaves lot and extend investigation until it reaches an intermittent or perennial stream. Refer to DNR Guidance for "*Factors to Consider in Predicting Direct Runoff and its Significance*" and document vegetation. See Appendices A & B.

C. *Use of models.* Where appropriate, use models such as the Barnyard Evaluation Rating Tool (BERT), Annual Phosphorus Loss Estimator (APLE)-Lots, and Wisconsin Barnyard Runoff Model (BARNY) or others. See Appendix C.

D. *OPTIONAL:* Consult with DNR to determine if collection of a surface water sample is appropriate**.**

Making a Final Determination

A landowner complies with the prohibition under s. NR 151.08(4), Wis. Adm. Code if a feedlot has no runoff that can be predicted to discharge a significant amount of pollutants into surface waters or to a direct conduit to groundwater. Use documentation collected during a thorough feedlot evaluation, supplemented with supporting information collected before and after the site walkover to determine if the feedlot facility is compliant with this prohibition.

Discharges to surface water or direct conduits to groundwater can be established through observable conditions such as observation of manure flowing into a water source listed in the waters of the state definition. When a visible discharge is occurring, or has recently occurred, and is apparent during the site visit, documentation of the visible discharge may include photographs or water samples in addition to a written report describing the observations and would be considered direct runoff. Refer to DNR Guidance section on "*Operations which can support Predicting Direct Runoff and its Significance*."

For cases where an actual discharge or a visible discharge is not obvious, different guidelines are needed in circumstances of a "predicted discharge" to make a direct runoff determination. The evaluation of a predicted discharge may be based on several factors, including landscape characteristics and is assessed by identifying and evaluating the feedlot runoff flow path. Since a predicted discharge can be less obvious than a visual discharge, use of available tools and resources, that can include mapping and modeling (Appendix C), are needed to document and support a determination about the extent of the predicted discharge. Other factors to consider when making a final determination include:

A. The best management practice in place that may or may not meet design standard but could potentially prevent direct runoff.

B. Whether the timing of the feedlot facility evaluation is appropriate (i.e., after a rainfall or snowmelt event).

C. Use of appropriate modeling tools (see Appendix C), such as BARNY, BERT, or APLE-Lots for feedlot evaluations, or other appropriate phosphorus and/or nitrogen loading models to help guide or support the determination.

D. The documented results of the evaluation adequately quantify best professional judgment.

In situations where compliance is very difficult to determine, consult with a partnering agency, such as DNR, DATCP, NRCS, or another County conservation professional prior to making a final determination about a facility predicted to have direct runoff to waters of the state.

Communicating compliance: Once a compliance determination is made, that determination, and the reasoning behind it, should be clearly communicated to the landowner. The landowner is required to either achieve or maintain compliance based upon this determination. Requirements to comply with the results of the compliance determination are described in the implementation and enforcement procedures for livestock performance standards and prohibitions in s. NR 151.095, Wis. Adm. Code.

A. **Livestock facilities determined to be <u>non-compliant</u> with NR 151 performance standards and prohibitions, should be documented with a NR 151 non-compliance letter to the landowner**.

Consider communicating your investigation findings and discussing the site with your regional DNR Nonpoint Source (NPS) Coordinator for shared understanding of performance.

B. **Livestock facilities determined to be <u>compliant</u> with NR 151 performance standards and prohibitions, should also be documented with a NR 151 compliance letter to the landowner.** It is important to reinforce that the compliance determination is valid based on conditions at the time of the evaluation. Clearly communicate to the landowner that once compliance with existing performance standards and prohibitions in NR 151 is achieved, this compliance status must be maintained regardless of future financial assistance or change in ownership. Consider communicating a compliance determination with your regional DNR NPS Coordinator.

Considerations to Work Toward Compliance

The following items are considerations for the next step of assisting a landowner with potentially achieving compliance:

A. Inform the landowner that cost-share funds may or may not be available for compliance depending on feedlot facility status per s. NR 151.095, Wis. Admin. Code. Consider if the site was previously compliant and if the site was present prior to the NR 151 performance standard.

B. Control feedlot runoff through use of best management practices following applicable NRCS conservation practice standards for design and implementation. Best management practice examples for feedlots include roof gutters, clean water diversions, roofs, vegetated treatment areas, runoff containment, and/or settling basins.

C. Discuss with the owner cost share eligibility and options for achieving compliance. Consider low-cost alternatives or operational changes that reduce or eliminate the discharge such as:
    1. Graze cattle on nearby fields
    2. Improve management by collecting feedlot manure on a consistent basis and field applying in accordance with a nutrient management plan
    3. Move animals away from concentrated/channelized flow paths that lead to waters of the state
    4. Reduce the time animals are on the lot
    5. Reduce the number of animals on the lot
    6. Transition operation to a rotational (prescribed) grazing operation
    7. Relocate feedlot or reposition to be on contour
    8. Discontinue animal feeding on the lot…should selling the animals be considered?

D. Landowner may not want to work with you directly after a non-compliance determination has been made.
    1. Refer to other government agencies for technical assistance (NRCS, DATCP)
    2. Suggest they hire a private engineering firm
    3. Attempt to fix the noncompliance issue(s) themselves

Appendix A: Information to Document for Modeling

General Site Information

Landowner:		Completed by:	
Date:		Lot ID:	
Paved Lot Area:		Lot Surfacing Material	
Earth Lot Area:		Is there a designed settling basin?	

Animals on Lot

Number		Number	
Type		Type	
Weight		Weight	
% Time on Lot per day		Days on lot (monthly)	
Feed Type		Manure Consistency	
How often is lot cleaned?		How is lot cleaned?	

Tributary area

Area flowing into lot (excluding roof)		Roof area	
Cover Type			

Lot

Ground Cover Immediately Downstream of Lot		Is there evidence of erosion downstream of lot?	
Length of Vegetated Area		Does Runoff From Lot Sheet Flow Across a Vegetative Area?	
Slope of Vegetative Area		Width of Vegetated Area	
Are Manure Solids Leaving the Lot?			

Document Presence and Distance to the following

Type 1 Feature: Waterways defined as solid or dashed blue lines on a USGS 7.5" quad map and all wetlands not included in Type 2		Type 2 Feature: Ponds and lakes. Wetlands adjacent to ponds or lakes should be considered as part of the pond or lake	
Are Manure Solids leaving the lot? If so where are they going and how are they leaving (culvert, etc)?		Is facility in Good Operating Condition?	

Draw out the system including system components

Include flow spreaders, reception tanks, waste transfer pipes, waste transfer channels and VTA

Note conditiion of each component (erosion, burned vegetation, evidence of feed/manure debris)

Appendix B: Feedlot Review Checklist

Map and take photographs of each item below. Include clear, concise statements of fact in site notes. Remember your information could be used as evidence in a compliance case.

Feedlot

- Surfacing material type and condition
- How was it constructed? (rebar in concrete, thickness, etc.)
- When was it constructed?
- Amount of manure stacked on lot
- Walls, curbs, gutters, outlet pipes, etc. – look closely, they may be obscured with manure

Contributing Areas

- Vegetation in tributary areas
- Concentrated flow or sheet flow

Flow Disrupters – document in detail the presence of things that may deter the flow of pollutants

- Vegetative buffers (type of vegetation, % cover, width, length, note any erosion)
- Impoundments (document width, length, depth, what is causing impoundment)

Downstream of Lot

- Condition of downstream edge of surfaced lot – if gully, document type
- How does runoff leave the lot (designed sediment basin, slotted wall, off downstream edge)?
- Is there a defined channel/concentrated flow channel continuing from the downstream edge of the lot?
- If any pipes are observed document inlet and try to locate outlet. If able to locate the outlet, inspect the outlet pipe. Is there evidence of sustained flows, manure solids, burned vegetation, ponding, etc.?
- Direct conduits to groundwater
    - Wells
    - Sinkholes
    - Swallets
    - Fractured bedrock at the surface
    - Mine shafts
    - Non-metallic mines
    - Tile inlets discharging to groundwater
    - Quarries
    - Depressional groundwater recharge areas over shallow fractured bedrock
- Document if any of the following are observed, what and where
    - Manure solids
    - Stressed or burned vegetation
    - Slime, foam or sheen on downstream waters
    - Dead fish downstream
    - Animal waste smell downstream
    - Foam in downstream water, mixing zones
    - Discolored sediment/substrate
    - Erosion
    - Discolored water downstream

Consider including on map: aerial photography, contours, livestock facilities, conveyance channels, overland flow paths, pipes, surface inlets, wells, all affected surface waters, etc.

Suggest documenting photograph number, date & time taken, location, photographer, and a brief yet detailed description of each photograph.

Keep in mind the *Factors to Consider in Predicting Direct Runoff and its Significance* from the DNR Guidance:

(a) Volume and frequency of the runoff from the feedlot
(b) Location of the source of the runoff from a feedlot relative to receiving waters
(c) Means of direct runoff conveyance from a feedlot to waters of the state
(d) Slope, vegetation, rainfall, and other factors affecting the likelihood or frequency of runoff to waters of the state
(e) Available evidence of runoff from the feedlot to a surface water of the state or to a conduit to groundwater as defined under s. NR 151.002(11m)
(f) Whether the runoff from the feedlot is to a site that is defined as a site susceptible to groundwater contamination under s. NR 151.015(18)
(g) Other factors relevant to the impact of the discharge on water quality standards of the receiving water or to groundwater standards.

Appendix C: Models

1. **Wisconsin Barnyard Runoff Model (BARNY)**
   https://efotg.sc.egov.usda.gov/#/state/WI/documents/section=1&folder=65015

   BARNY, or the Wisconsin Barnyard Runoff Model, is an inventory and analysis tool that is used to assess the water quality impacts of barnyards or feedlots. It is a modified version of the USDA-ARS Feedlot Runoff Model which was originally intended as a ranking tool and was developed by the USDA-Agricultural Research Service (ARS) in 1982. The current version of BARNY is available as an Excel spreadsheet downloaded from the Wisconsin NRCS Field Office Technical Guide website (link above). It was originally available as a DOS program but is no longer used in that format.

   The model is based upon an analysis of a long-term rainfall series to derive annual loads of phosphorus. For each event, the runoff volume from the lot and tributary area is calculated by the SCS runoff curve number method. The model estimates the pollutant loads at the edge of a barnyard based on the amount of manure on the lot, and the volume of runoff associated with the event. The BARNY phosphorus loading at the edge of lot is based on using a constant concentration of phosphorus of 85 mg/L. The estimates at the end of the buffer are approximate and are based upon an average of a very wide range of measured concentrations along the vegetated buffer from the original USDA-ARS study and therefore cannot be assumed to represent actual measured phosphorus concentrations.

   The BARNY spreadsheet is fairly self-explanatory to use, but there are several parameters within BARNY which must be characterized with care. It is recommended that staff receive training on how to properly use BARNY. One parameter which is easily misused is the lot usage (heavy, medium, light). The spreadsheet does not offer guidance on how to select this. The BERT spreadsheet instructions tab does offer guidance for this (see below).

Lot use (concrete)	Lot use (100% earth)
< 200 sq ft / AU is heavy use	< 600 sq ft / AU is heavy use
200 - 400 sq ft / AU is medium use	600 - 1200 sq ft / AU is medium use
> 400 is light	> 1200 is light

   Another parameter easily misused is the buffer length. The buffer downstream from the animal lot provides runoff treatment by filtration and infiltration of the discharge as it moves as “overland” flow over a vegetated surface. The original USDA-ARS study does not state overland flow is “sheet” flow, but sheet flow is needed for the buffer to function properly. The “buffer” within the BARNY model is definitely not for channelized or even concentrated flow. Concentrated flow paths through cropped fields or grassed areas would not constitute a “buffer.” The “buffer” is more like a NRCS Conservation Practice Standard 635 - Vegetated Treatment Area (VTA) and should be graded to have even, shallow flow distributed across the full width. BARNY does not have a buffer width parameter so it does not check to see if shallow flow is maintained. The BERT spreadsheet does have a width parameter and issues a warning if a 2-inch flow depth is exceeded. It is recommended to check the buffer flow depth with the BERT spreadsheet. BARNY has the option to model two buffers so it can represent situations where there are changes in slope or vegetative cover. The requirement to have even, shallow flow applies to both buffers.

As stated above, BARNY is an inventory and analysis tool using that utilizes the Buffer Process method. The Buffer Process has BARNY phosphorus discharge goals but also requires that the VTA/buffer area be at least 150% of the contributing animal lot area if the lot is paved and 100% if it is an earthen lot. The spreadsheet will calculate this required VTA/buffer area, but it is easy to overlook if one is just focused on achieving a given phosphorus loading result.

2. **Barnyard Evaluation Rating Tool Model (BERT)**
https://efotg.sc.egov.usda.gov/#/state/WI/documents/section=1&folder=65016

The Barnyard Evaluation Rating Tool (BERT) Excel spreadsheet is used to rate concentrated livestock areas, and can be downloaded from the Wisconsin NRCS Engineering website (link above). The BERT rating is a guide in deciding if a barnyard system is a resource concern, and is not to be used as a design tool for practices. Site specific conditions are critical when determining if a system is a resource concern or not.

BERT is very similar to the BARNY model, and was also developed from the USDA-ARS feedlot runoff model (Young et al. 1982), except BERT does not estimate pounds of phosphorus discharged, rather it provides a one number rating that is used to determine if the barnyard/feedlot is a resource concern or not. The BERT rating is based on a single rainfall event, rather than many small storms, as is the case with BARNY. The rating is based on the inputs and phosphorus delivered downstream of the concentrated livestock area or buffer. BERT reduces complex interactions of lot size, existence of a designed settling basin, percent time on the lot, management on the lot (scraping interval), animal numbers, animal type, weight of the animals, runoff across or on the lot, and buffering process.

Some other differences with BERT compared to BARNY is that BERT calculates whether the lot use is heavy, medium, or light based on the user inputs of percent time on the lot and whether or not the lot is scraped every 7 days or less. As mentioned above, BARNY has the user make the call on their own, which can lead to inconsistencies when using the BARNY model. BERT also analyzes the flow depth over the vegetated area and lets the user know if the depth of flow exceeds two inches. This can be an important factor for determining the effectiveness of the vegetated area. BARNY does not take into account flow depth. The other item that BERT takes into consideration is the distance from the lot or buffer to waters of the state identified in the model as Type 1 and Type 2 features (Type 1 features includes waterways defined as solid or dashed blue lines on a USGS 7.5" Quad Map, and all wetlands not included in Type 2. Type 2 features include navigable ponds, lakes, and wetlands adjacent to navigable ponds or lakes).

3. **Annual Phosphorus Loss Estimator for Wisconsin Cattle Lots (APLE-Lots WI)**
https://aplelots.wisc.edu/

APLE-Lots WI uses the same equations as the APLE-Lots spreadsheet created by Peter Vadas (2014, found at APLE Lots : USDA ARS) with some modification. The primary differences are that APLE-Lots WI uses county-specific precipitation event distributions based on weather records (rather than annual rainfall averages), calculates frozen soil runoff on earthen lots with a modified curve number method to account for reduced infiltration, and allows animals present on the lot to vary by season. Another difference is that APLE-Lots WI uses equations from the WI P Index to estimate the earthen lot soil contributions to runoff dissolved and sediment P.

The goal of the model is to estimate average annual P and sediment loss from feed lots. APLE-Lots WI is intended to be user-friendly and does not require extensive input data to operate. All data are input directly into the user interface (See APLE-Lots User Notes and Quick Guide). Lot information is entered into a GIS-system where lot boundaries and contributing areas can be drawn over aerial photos and soil maps. The model also supports tabular input via a no-map feature. User-input data include:

- The area of the lot (sq. ft.).
- Location of the lot (county is required).
- The number and type of cattle on the lot, including beef cattle and calves, dairy lactating and dry cows, and dairy heifers and calves and hours per day they are on the lot (animals on the lot can vary by month).
- The number of days between lot cleanouts (scraping) for paved lots.
- The surface type (paved or earthen) and the % vegetative cover for earthen lots.
- Area and surface type (or curve number) of areas contributing flow to the lot.
- The volume of a functional sedimentation basin (if present).
- The existence of any run-on flow diversions and percent of flow diverted.
- Soil test P (Bray P) and organic matter (%) for earthen lots (optional).

One of the most notable differences between APLE-Lots WI versus BARNY and BERT is that there is no option for modeling a vegetated area downstream of the feedlot. However, APLE-Lots WI uses more complex inputs and calculations than BARNY or BERT, and can be assumed to provide a more accurate edge-of-lot phosphorus value. APLE-Lots WI also incorporates relevant restriction map layers from SnapMaps to make it easier for Wisconsin planners.

Sources for above information:

- *APLE-Lots WI Technical Documentation*
- *Monitoring Sediment and Phosphorus Loads in Runoff from Dairy Feedlot/Exercise Lots to Facilitate Model Parameterization*

Summary

BARNY vs. BERT vs. APLE-Lots

BARNY	BERT	APLE-Lots
Phosphorus ❑ Estimates average annual P loss (lbs.) ❑ At edge-of-lot AND ❑ End of vegetated area	Phosphorus ❑ Resource concern rating tool (NO P loss) ❑ At edge-of-lot AND ❑ End of vegetated area	Phosphorus ❑ Estimates average annual P loss (lbs.) ❑ At edge-of-lot ❑ NO vegetated area option
Precipitation ❑ Annual rainfall from 1990 Green Bay data, and adjusted for other areas	Precipitation ❑ Single rainfall event	Precipitation ❑ County-specific distributions based on weather records
Data (input/output): ❑ Uses constant conc. of P (85 mg/L) ❑ Some outputs credible, some questionable	Data (input/output): ❑ Inputs: Very similar to BARNY ❑ Inputs: Allows for additional considerations ❑ Outputs: Pollution potential	Data (input/output): ❑ More complex inputs ❑ More complex calculations ❑ More accurate results