Towards Pathogen Accountability in Ontario's Rural Landscapes: An Action Opportunity

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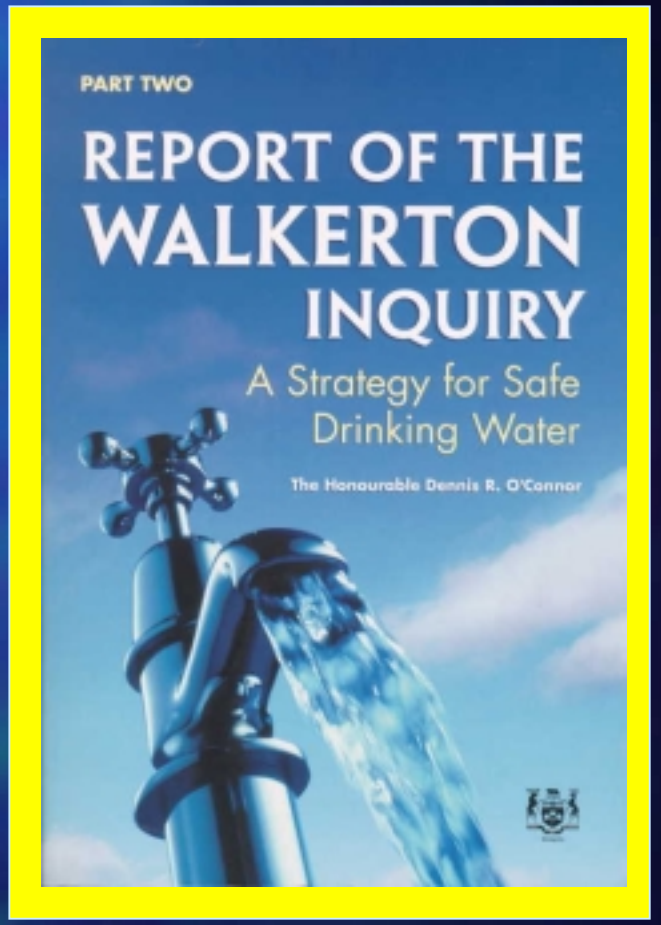
Ontario Pathogen Issues

- Reality of potential impacts of the water-borne pathogens from land-applied manure and biosolids on Ontario's drinking water resources were tragically realized in 2000 at Walkerton
- result = deaths and illnesses



Ontario Pathogen Issues

- Reality of potential impacts of multiple microbial contamination sources on Ontario's recreational water resources was demonstrated in 2003 at Lake Huron
- result = beach postings; loss of tourism; rural conflict; etc.

OMAF -MOE Pathogen Working Group

Philosophy:

- pro-active tools are available and can be developed for enhancing groundwater and surface water protection from pathogen impairments in Ontario's watersheds
  - Nutrient Management Plans (NMP's)
  - Environmental Farm Plans (EFP's)
  - Source Water Protection Plans (SWPP's)
  - Management Practice Options (MPO's = BMP's)

Microbial Impairment Sources in Rural Ontario Landscapes

Human:

- Septic Systems

Companion Animals and Wildlife:

- Resident and Migrating Populations

Agricultural:

- Manure on Barnyards/Feedlots
- Manure applied to cropland
- Manure in Pastures
- Biosolids applied to land

OMAF-MOE Pathogen Working Group

PWG "Terms of Reference":

- Provide Ontario residents with means to demonstrate appropriate awareness, accountability and due diligence for water-borne pathogen contamination risk mitigation in their activities

Towards Pathogen Accountability

Previous OMAF-sponsored efforts:

- MCLONE4 (M. Goss, U. of Guelph) portion for calculation of risk of bacteria leaching to groundwater
- Factors considered included:
  - **Groundwater table depth**
  - **Soil moisture status**
  - **Season factor (winter, spring, summer and fall)**
  - **Manure Type (liquid, slurry, solid)**
  - **Management Practice (surface applied, incorporated)**

Towards Pathogen Accountability

Our Initial Approach:

- Develop a "**Pathogen Index**" for NMP's
- However, significant quantitative scientific information is not available for pathogen:
  - fate
  - survival
  - transport
  - etc.
- term "Index" implies the use of quantitative results; it was dropped in favour of a "Checklist"

Towards Pathogen Accountability

Our Current/Continuing Approach:

- Continue to foster new research efforts to address needs for new knowledge and then incorporate these results into pragmatic field applications
- "Pathogen Accountability Checklist" - based on scientific concepts and known "high risk scenarios" rather than on a detailed quantitative microbial database

Pathogen Accountability Checklist

Scoping the Problem: the "**Checklist**"

- factors known to contribute to a pathogen problem in a water supply - groundwater or surface water
- focus first on the "highest risk" scenarios
- measurable/observable components
- keep it simple

Pathogen Accountability Checklist

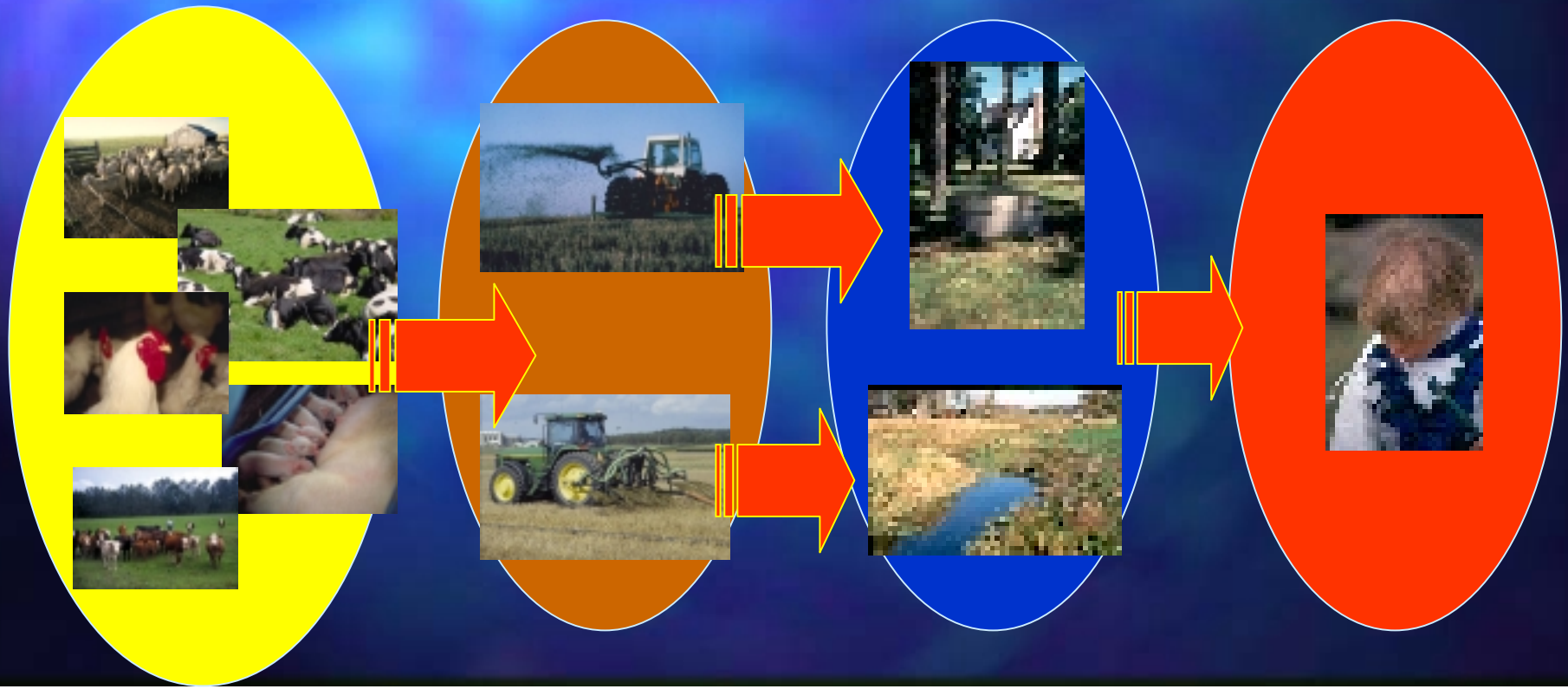
“Capturing” the Risk:

- likelihood of pathogen presence in the source
- survival of pathogens after environmental release
- contributions of weather; including extreme events
- potential for pathogen movement from the soil surface, through the profile and eventually to groundwater (or tile drain interception)
- proximity of “short-circuit” pathways for pathogen transport to groundwater or surface water bodies

Ontario Pathogen Issues: Livestock Agriculture

Pathogen Movement from Point A through Point B to Point C

Point A = Livestock **Point B = Landscape** **Point C = Humans**



Pathogen Accountability Checklist

Checklist Components

- **source materials** (fresh manure)
- **landscape factors** (soil texture and structure; depth to permeable bedrock; depth to groundwater)
- **climatic factors** (soil moisture and temperature status; 5-day weather forecast)
- **management factors** (tillage practices; timing of application, etc.)

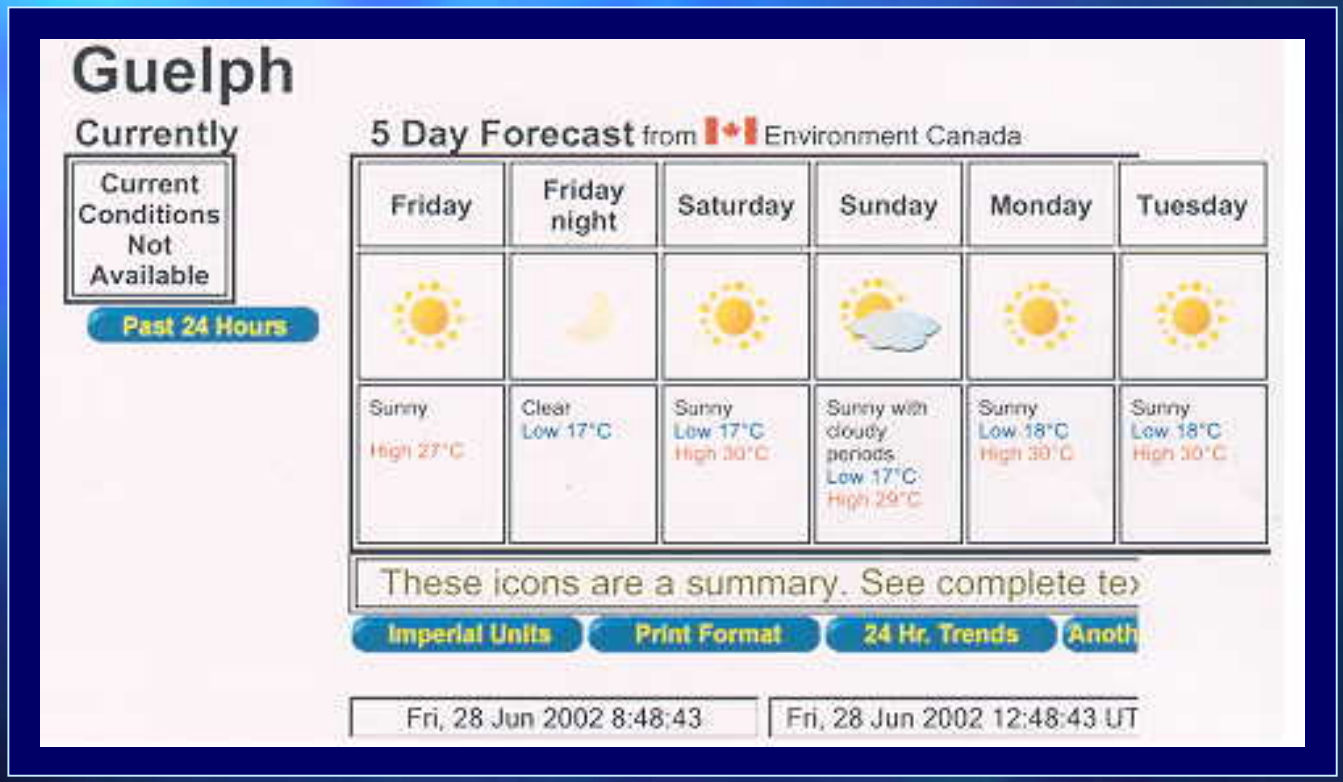
Pathogen Accountability Checklist

Climatic Factors: Climatic/Weather Conditions

- Soil moisture and temperature conditions prior to land application are critical to pathogen survival and transport.
- Extreme weather events with high intensity rainfall represent higher risk for water-borne pathogen mobility

Weather as a Factor

- Environment Canada 5-day Forecast



Text Forecast from Environment Canada

Waterloo-Wellington-Dufferin: *Issued 5.00 AM EDT Friday 28*

Today..Early morning fog patches otherwise sunny. High 27 exce
near the lake. Maximum UV index 7.7 or high.

Tonight..Clear. Low 17.

Saturday..Sunny. High 30.

Sunday..Sunny with cloudy periods. Low 17. High 29.

Monday..Sunny. Low 18. High 30.

Tuesday..Sunny. Low 18. High 30.

Normals for the period..Low 14. High 26.

Currently

Current Conditions Not Available

Past 24 Hours

5 Day Forecast from Environment Canada

Friday	Friday night	Saturday	Sunday	Monday	Tuesday
	Clear Low 17°C	Sunny Low 17°C High 30°C	Sunny with cloudy periods Low 17°C High 29°C	Sunny Low 18°C High 30°C	Sunny Low 18°C High 30°C

...is are a summary. See complete te...

Print Format | 24 Hr. Trends | Anoth...

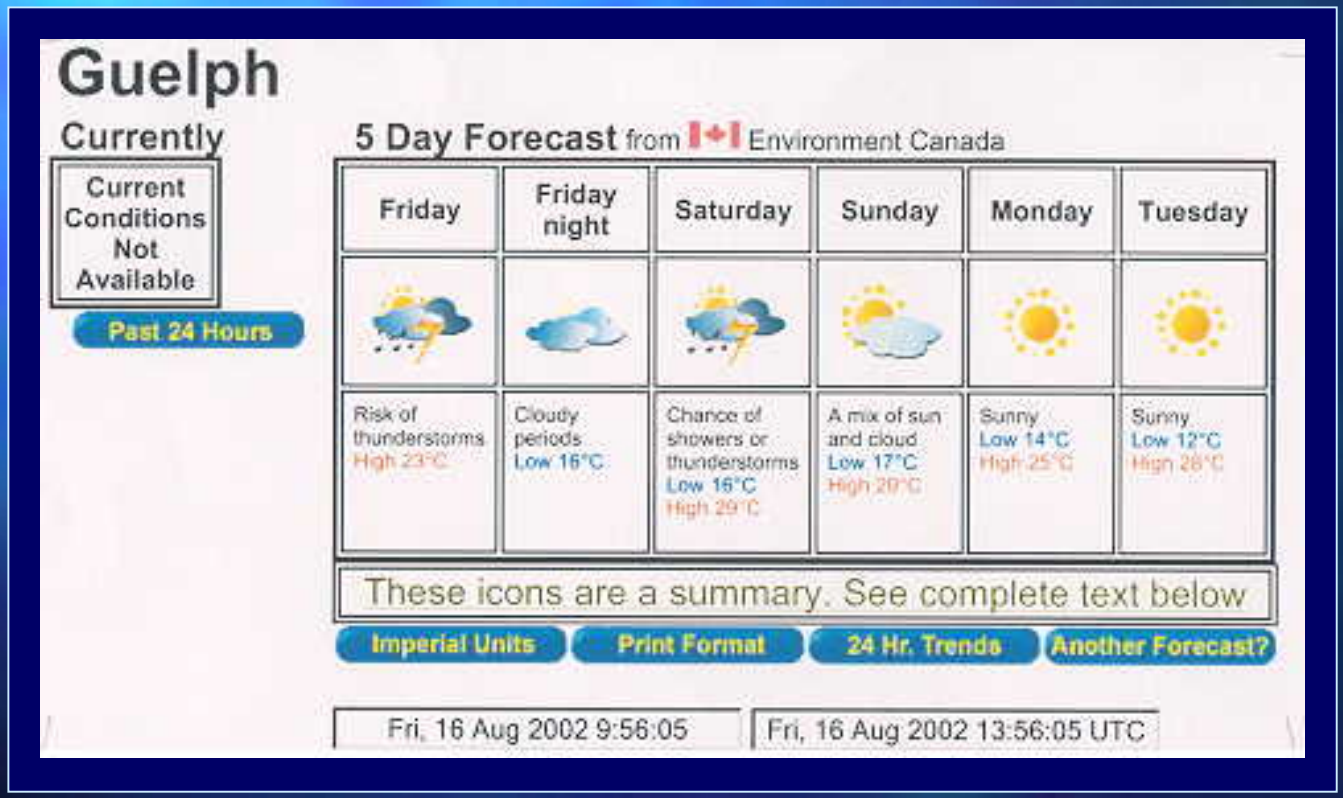
...28 Jun 2002 8:48:43 | Fri, 28 Jun 2002 12:48:43 UT

It's Spreading Time!

Unfavourable Conditions for Pathogen Survival

Weather as a Factor

- Environment Canada 5-day Forecast



Guelph

Currently

Current Conditions Not Available

Past 24 Hours

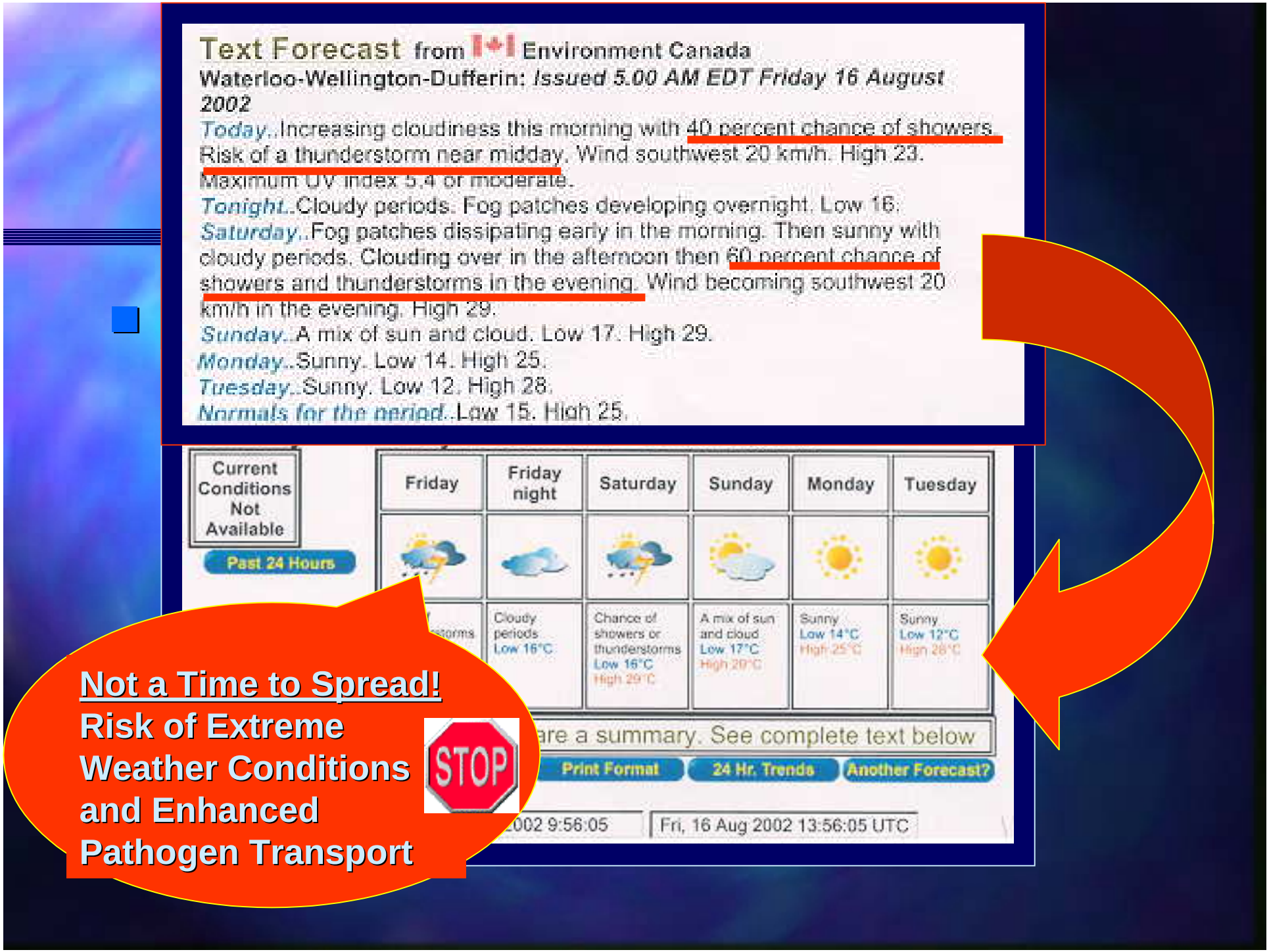
5 Day Forecast from Environment Canada

Friday	Friday night	Saturday	Sunday	Monday	Tuesday
Risk of thunderstorms High 23°C	Cloudy periods Low 16°C	Chance of showers or thunderstorms Low 16°C High 29°C	A mix of sun and cloud Low 17°C High 29°C	Sunny Low 14°C High 25°C	Sunny Low 12°C High 26°C

These icons are a summary. See complete text below

Imperial Units | Print Format | 24 Hr. Trends | Another Forecast?

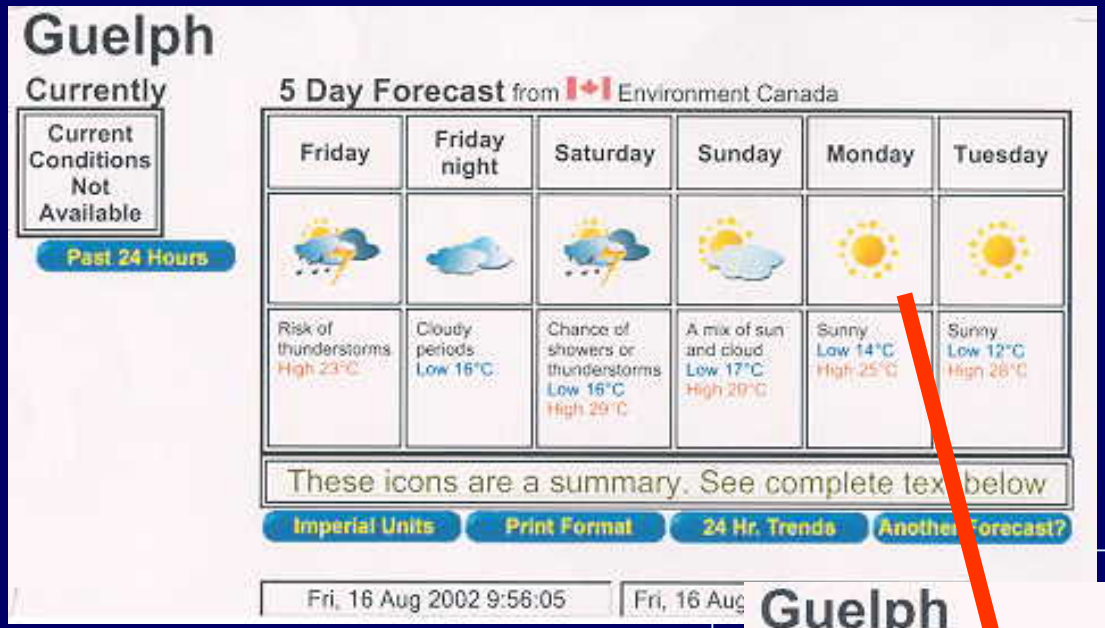
Fri, 16 Aug 2002 9:56:05 | Fri, 16 Aug 2002 13:56:05 UTC

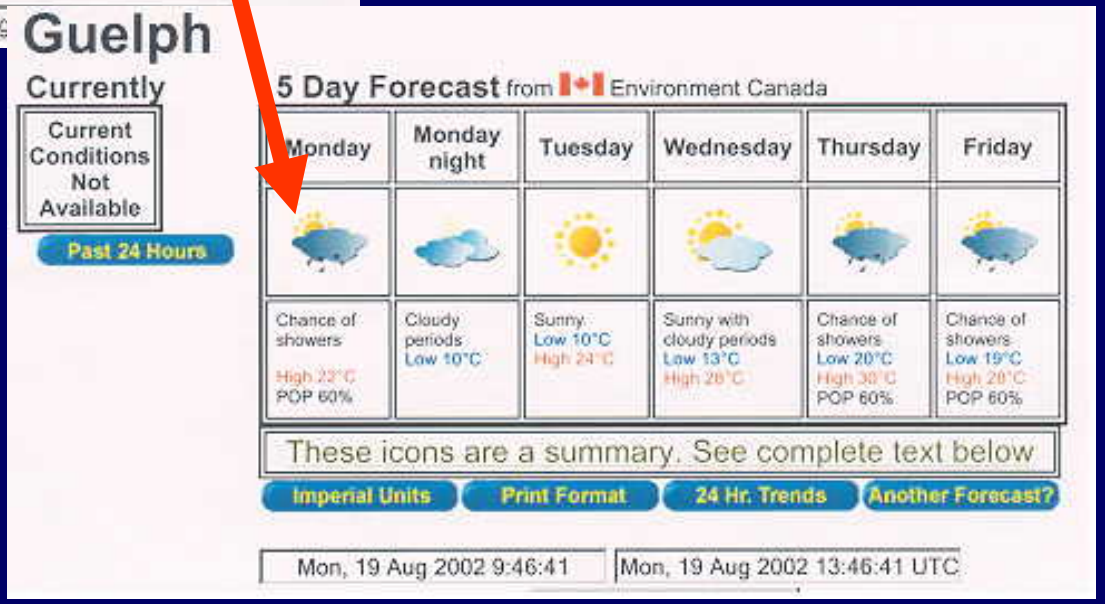

Text Forecast from Environment Canada
Waterloo-Wellington-Dufferin: Issued 5.00 AM EDT Friday 16 August 2002
Today..Increasing cloudiness this morning with 40 percent chance of showers. Risk of a thunderstorm near midday. Wind southwest 20 km/h. High 23. Maximum UV index 5.4 or moderate.
Tonight..Cloudy periods. Fog patches developing overnight. Low 16.
Saturday..Fog patches dissipating early in the morning. Then sunny with cloudy periods. Clouding over in the afternoon then 60 percent chance of showers and thunderstorms in the evening. Wind becoming southwest 20 km/h in the evening. High 29.
Sunday..A mix of sun and cloud. Low 17. High 29.
Monday..Sunny. Low 14. High 25.
Tuesday..Sunny. Low 12. High 28.
Normals for the period..Low 15. High 25.
Current Conditions Not Available
Past 24 Hours
Friday
Friday night
Saturday
Sunday
Monday
Tuesday
Cloudy periods Low 16°C
Chance of showers or thunderstorms Low 16°C High 29°C
A mix of sun and cloud Low 17°C High 29°C
Sunny Low 14°C High 25°C
Sunny Low 12°C High 28°C
are a summary. See complete text below
Print Format
24 Hr. Trends
Another Forecast?
Fri, 16 Aug 2002 13:56:05 UTC
Not a Time to Spread!
Risk of Extreme Weather Conditions and Enhanced Pathogen Transport
STOP

Weather as a Factor

- Weather Changes
  - must START land application on a "Sunny", DRY day

- Soil Moisture Changes
  - time since last rain is important





Discussion: Applications to Huron County

Invitation for Critical Review:

- Discussion of PAC's for Key Sources
  - Table Groups discuss the 4 Pac's
  - Provide comments
  - Present points
- Strategies for Stakeholder Uptake

Pathogen Accountability Checklist

PAC-Cropland - Draft

- **Review "Considerations" areas**
- **discuss/identify high risk scenarios**
- **think about "beta testing" in the field**

#	Risk Factor	X if risk factor exists
1.	**Manure Age Considerations:** - "fresh"; pathogen loads represent "host animal" loads with no time for population "die off" in storage - significant exposure to "fresh" manure where re-inoculation of the entire storage is highly likely	
2.	**Weather Considerations:** - Cool temperatures (increases survival likelihood); manure is incorporated into "cool" soil. - High probability of rainfall forecast; during or shortly after manure application.	
3.	**Soil Moisture Considerations:** - Transport enhanced under near-saturated conditions in sands and under drier, cracked conditions in clay soils - Liquid loading > 0.5 inch/application.	
4.	**Soil Texture, Structure and Tillage Considerations:** - Soil texture (risk relates to soil moisture status); wet sands and dry, cracked clay soils - Soil Structure (preferential flow pathways for pathogen transport); macropores present in abundance - Soil tillage; No-till or minimal tillage practice enhances macropore development and "by-pass flow" risk	
5.	**Landscape Considerations:** - Shallow water table < 0.9 m from surface; or - Shallow bedrock <1.5 m from surface.	
	Total number of X's	

Pathogen Accountability Checklist

PAC- Pasture - Draft

- **Review "Considerations" areas**
- **discuss / identify high risk scenarios**
- **think about "beta testing" in the field**

#	Risk Factor	X if risk factor exists
1.	**Livestock Access to Surface Water Considerations:** - Livestock with direct access to surface water bodies with stream network outlets; microbial loads can be readily mobilized to impair water sources. - Stream crossings also give opportunities for microbial impairments	
2.	**Manure/Livestock Density Considerations:** - Higher densities of livestock produce more manure per unit of pasture land area; the total microbial load on the pasture increases as well	
3.	**Pasture Landscape Considerations:** - Slope of pasture land; run-off is generated more quickly on steep slopes following rain/snowmelt events; microbial loads from manure dropped on these steeper slopes can be mobilized in the run-off waters - Shallow water table < 0.9 m from surface; or - Shallow bedrock <1.5 m from surface.	
4.	**Seasonal/Weather Considerations:** - Microbial transport is enhanced under near-saturated conditions in sands and also under drier, cracked conditions in clay soils when high intensity rainfall occurs - Cool temperatures and wet conditions (increase microbial survival likelihood in manure); pasturing livestock near streams at these times increases microbial impairment risk. - High probability of rainfall is forecast; during or shortly after livestock are moved across a stream. - Microbes can survive freezing; livestock pastured on steeper sloping land with snow cover; manure with its microbial load can move to waterways during melt.	
5.	**Other Considerations:**	
	Total number of X's	

Pathogen Accountability Checklist

PAC-Yards - Draft

- **Review "Considerations" areas**
- **discuss / identify high risk scenarios**
- **think about "beta testing" in the field**

#	Risk Factor	X if risk factor exists
1.	**Livestock Water Access Considerations:** - Livestock with direct access to stream network outlets; microbial loads can be readily mobilized to impair water sources.	
2.	**Manure/Livestock Density Considerations:** - Higher densities of livestock produce more manure per unit of yard/feedlot area; the total microbial load on the yard/feedlot increases as well	
3.	**Yard Landscape Considerations:** - Slope of yard/feedlot; run-off is generated more quickly on steep slopes following rain events; microbial loads from manure piled up on steeper slopes can be mobilized in the run-off waters - No runoff containment; perimeter berms, etc, - Channels leading from yard to streams; not grassed - Shallow water table < 0.9 m from surface; or - Shallow bedrock <1.5 m from surface.	
4.	**Seasonal/Weather Considerations:** - Microbial transport is enhanced under near-saturated conditions in sands and also under drier, cracked conditions in clay soils when high intensity rainfall occurs - High probability of rainfall is forecast; during or shortly after barnyard/feedlot manure clean-out; piling manure from barnyards on steep slopes near streams at these times increases microbial impairment risk - Microbes can survive freezing; for livestock yards with steeper sloping land and significant snow cover, manure with its microbial load can move to waterways during melt.	
5.	**Other Considerations:**	
	Total number of X's	

Pathogen Accountability Checklist

PAC-Septic - Draft

- **Review "Considerations" areas**
- **discuss / identify high risk scenarios**
- **think about "beta testing" in the field**

#	Risk Factor	X if risk factor exists
1.	**Septic System Considerations:** - No knowledge of where the septic system is; its age or maintenance schedule - Older systems were not designed and built to current standards; higher risk that microbial loads will be mobilized to impair water sources. - System does not meet current standards - Observed "wet spots" and vegetation changes on or near septic system	
2.	**Septic Use and Density Considerations:** - Greater septic system use produces more microbial load; System was not design/built for current level of use - Higher densities of septic systems per unit land area give correspondingly higher total microbial loads in such regions	
3.	**Landscape Considerations:** - Proximity of septic system to water sources; wells and surface water bodies; the closer they are – shorter the travel paths for microbes - Shallow water table < 0.9 m from surface; or - Shallow bedrock <1.5 m from surface.	
4.	**Seasonal/Weather Considerations:** - Microbial transport is enhanced under near-saturated conditions in sands and also under drier, cracked conditions in clay soils when high intensity rainfall occurs - Observed ponding of water on or near septic system during extreme weather events – high intensity rainfall	
5.	**Other Considerations:**	
	Total number of X's	

Discussion: Applications to Huron County

Invitation for Critical Review:

- Discussion of PAC's for Key Sources
  - Table Groups discuss the 4 Pac's
  - Provide comments
  - Present points
- Strategies for Stakeholder Uptake