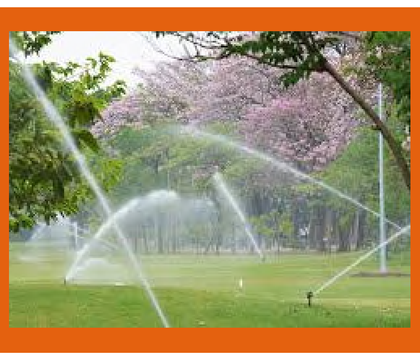


Modeling the Sustainable Re-Use of Treated Water Containing Active Pharmaceutical Ingredients

Virginia Houck, Norman Forsberg, Andy Newcombe (Arcadis)

Motivation

Irrigation using *treated* wastewater is becoming an important consideration

- For stressed or diminishing water supplies
- To reduce discharge directly to waterbodies
- To achieve zero discharge ambitions to meet sustainability goals

Can we model environmental impacts in a screening level approach?

Modeling Approach: Spray Irrigation Calculator

Simulates spray irrigation applied to established turf/grass, or other crops.

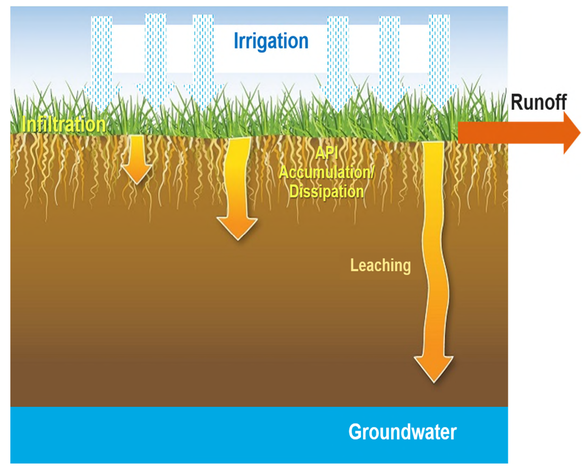
Uses the USEPA pesticide model Pesticide in Water Calculator (PWC) Pesticide Root Zone Model v.5 (PRZM5) module, with custom automated script generation.

Estimates Active Pharmaceutical Ingredient (API) residues in soil, runoff, and leachate to groundwater following irrigation with treated water, over a 10-year simulation period, to compare to environmental thresholds.

Optimizes irrigation rates or effluent concentrations to remain below user defined API protection goals in soil, groundwater, and runoff.

Customized inputs for soil and climate parameters, API irrigation practices, and environmental threshold values. User interface allows selection of generalized soil and climate inputs.

Output Summaries of results are automatically generated.



PWC estimates API accumulation and dissipation in soil, groundwater, and runoff after irrigation with treated water.

Conclusions

A screening-level MODELING APPROACH for re-use (irrigation) of treated water enables a facility to *estimate* potential API concentrations in soil, runoff, and groundwater.

A facility can then *optimize* either
- **volume of treated irrigation water applied, or**
- **the API concentration in the treated water,**

to reduce the risk of exceeding environmental thresholds and to meet sustainability goals.

Soil and Cropping

Based on existing USEPA PWC Scenarios
- **Soils: Generalized soil characteristics (sandy vs. silt loam soils)**
- **Crop: Default is turf/grass, although other crops can be simulated**

API Parameters

- **API Chemical Properties:** Soil adsorption (Kd) and degradation half-life
- **API Concentration in the treated water**
- **API Production Schedule** (if not all year)
- **Environmental Protection Goals**
  (e.g., Predicted No-Effect Concentration (PNEC)

PWC Model Inputs

Meteorological

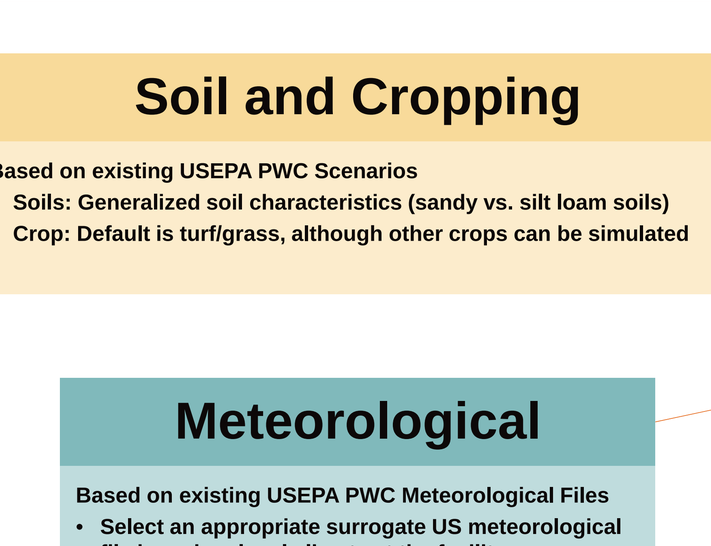
Based on existing USEPA PWC Meteorological Files
- **Select an appropriate surrogate US meteorological file based on local climate at the facility**

Irrigation Regime

Regime: As-needed OR regular interval
- Frequency of irrigation
- Water volume applied
- Area of land irrigated
- Yearly timeframe (e.g., summer only)

Example Results

Example Estimated Concentrations: Baseline



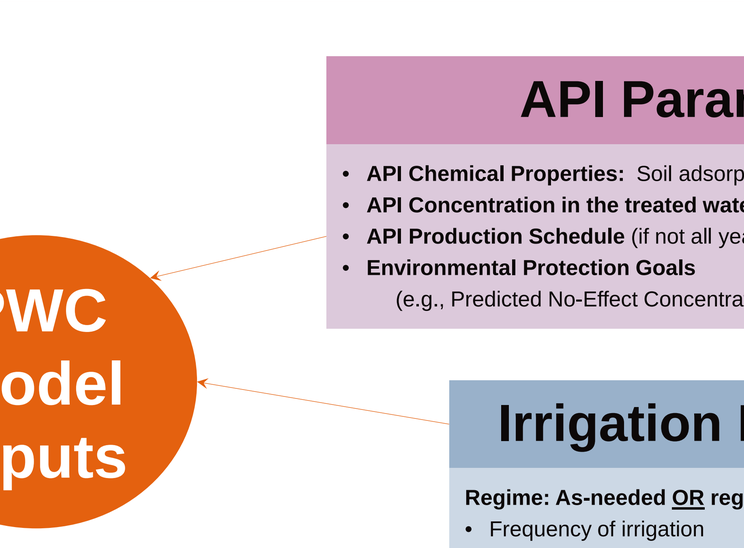
PWC estimates API concentrations in soil, pore-water leachate, and runoff after irrigation with treated water, over a period of ten years.

Estimated Concentrations exceed the threshold for soil

Optimization for soil

Optimize

Example Estimated Concentrations: Optimized



Reduce the irrigation volume or API concentration by 21%

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