

Some Short-term Characteristics of Leachate Quality in the Methanogenic Phase

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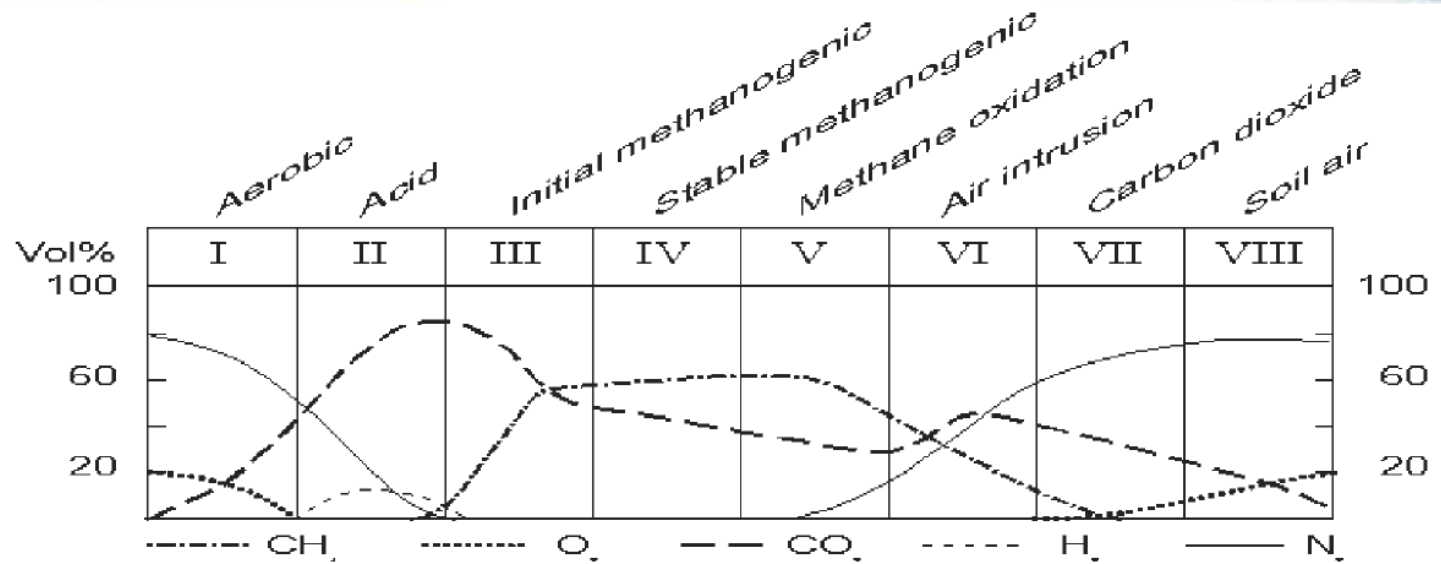
Bolton Landing, New York

May 22, 2019

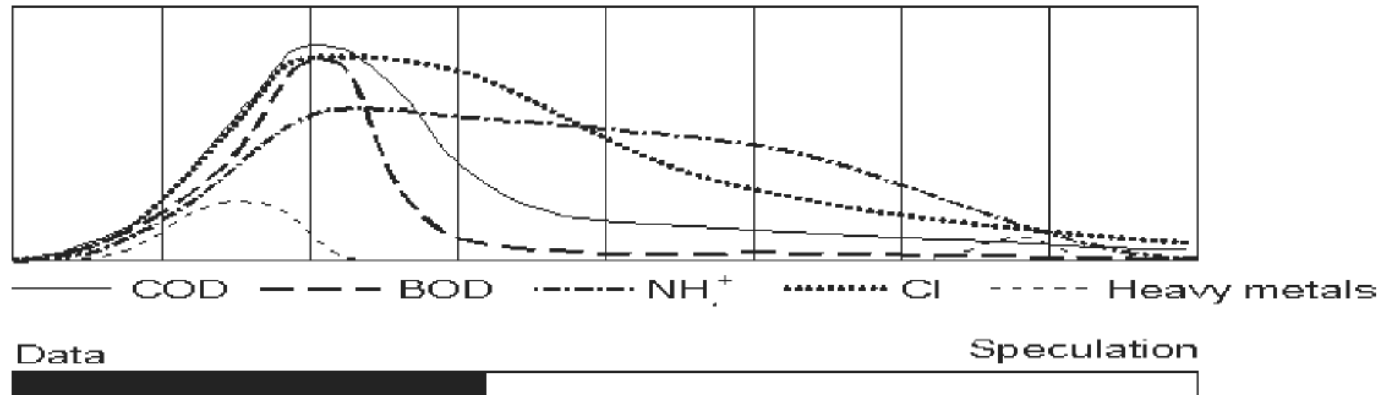


Leachate Evolution Phases

Landfill Gas

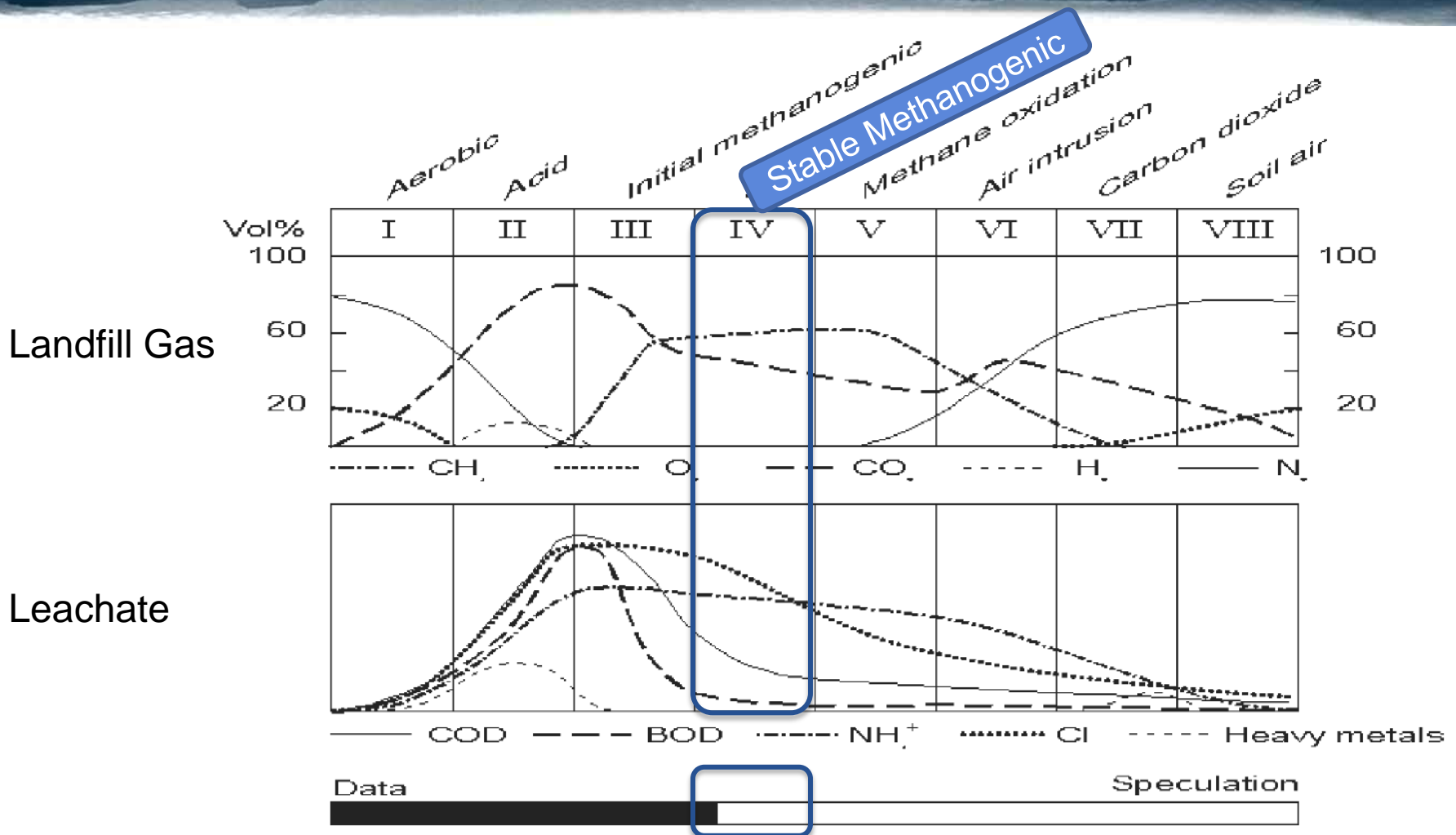


Leachate



Source: Kjeldsen P et al., Present and Long-term Composition of MSW Landfill Leachate: A Review, Crit Rev in Env Science and Tech, 32(4):297-336 (2002)

From Science to Engineering ...



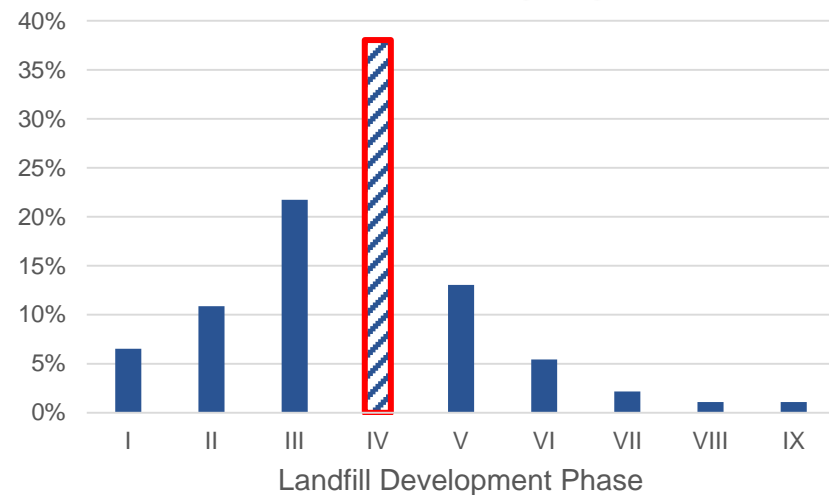
Source: Kjeldsen P et al., Present and Long-term Composition of MSW Landfill Leachate: A Review, Crit Rev in Env Science and Tech, 32(4):297-336 (2002)

Subtitle D-compliant Landfills

Phase IV: Methanogenic Phase

- COD: mostly recalcitrant compounds
- Maximum methane production rate
- Gradual leachate pH increase
- Declining BOD/COD ratio
- **Stable ammonia content**

US Landfill Inventory by Phases



Model vs. Reality

Landfill Model

- Idealized representation of complex behavior
- Focuses on distinct phases
- Integrates and abstracts data
- **Makes long-term testable prediction**



Landfill Reality

- Infrequent, inconsistent, incomplete data
- Data collection and analysis is expensive
- Statistical description vs. model validation
- **Needs to inform day-to-day decision making**

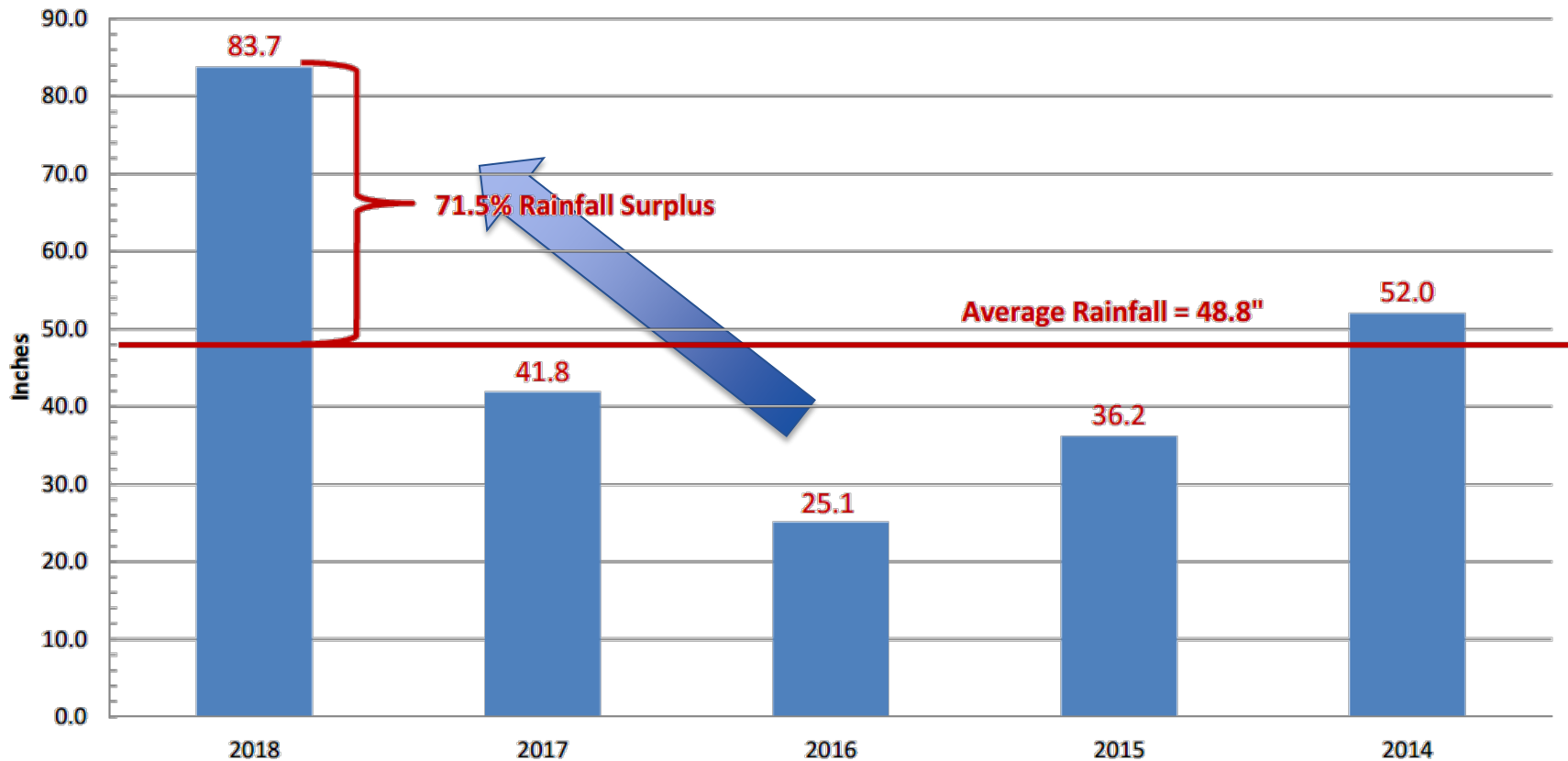
Limited Data Availability

- Sampling for permit compliance
 - Limited sampling frequency
 - Objectives of analytical panel
- Cost for sampling, lab work, and data analysis
- Marginal value of additional data
- Leachate volume is generally the only reliably available daily data
- Single sampling point, even for complex sites

Complex Interactions

- Waste composition, decomposition processes
- Wide range of waste age within single landfill cell
 - Staged construction of waste body
 - Landfill Expansion: lateral and/or overflow
- Stormwater management, e.g., rain covers
- Final cover installation
- Seasonal variation, extreme weather events
- Year-over-year variation, long-term climate trends

Example: Annual Precipitation Totals

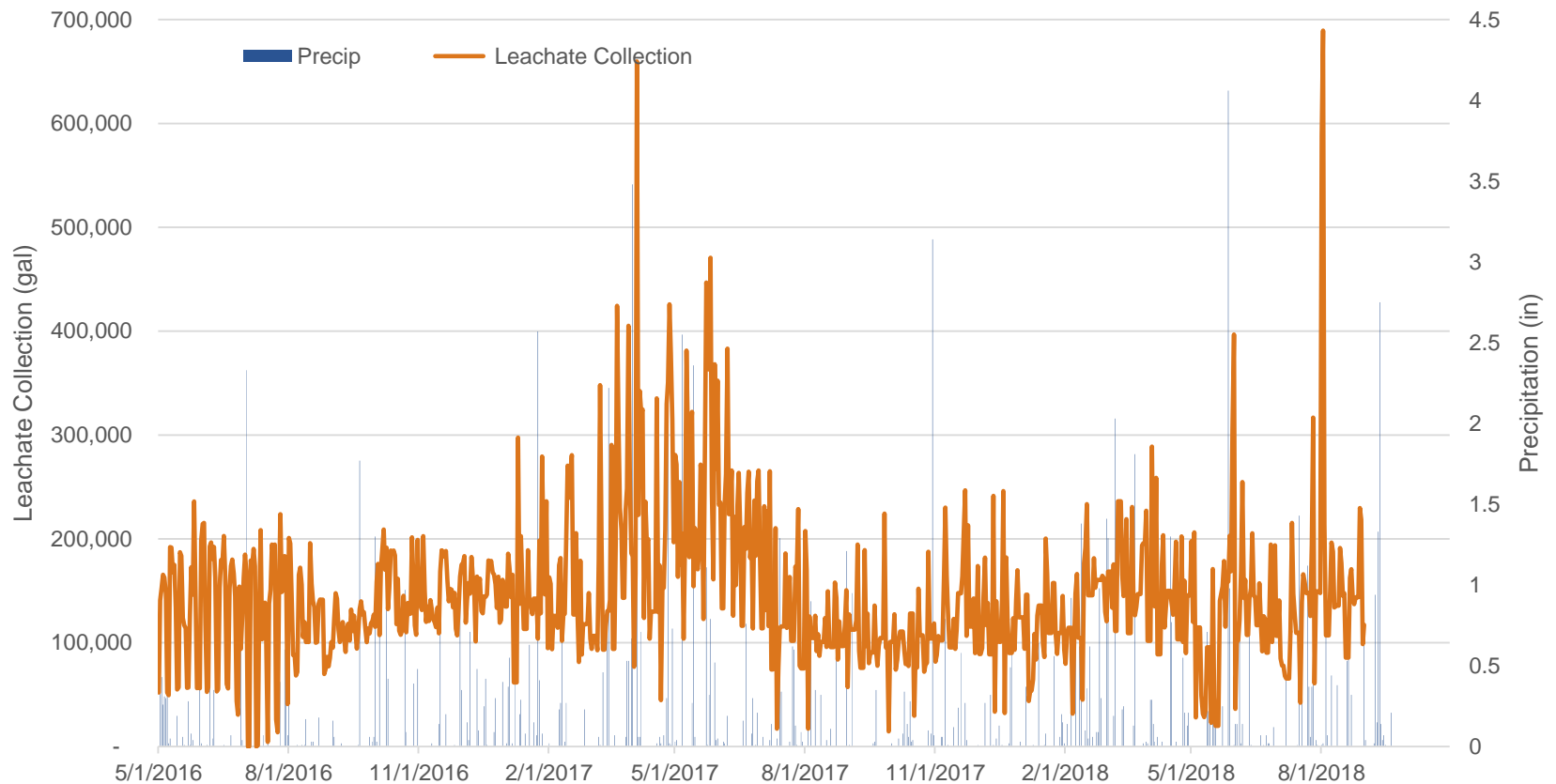


Available Database

- Daily precipitation, including snow
- Combined daily leachate collection from 3 landfills:
 - 90 acre closed and capped landfill – soil cap
 - 95 acre closed and capped landfill – geomembrane cover
 - 100 acre active landfill
- Daily Total Kjeldahl Nitrogen (TKN):

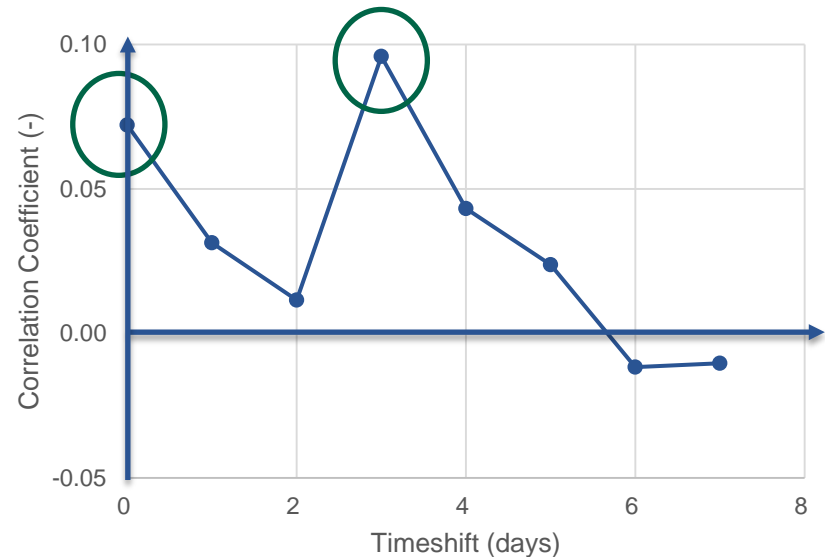
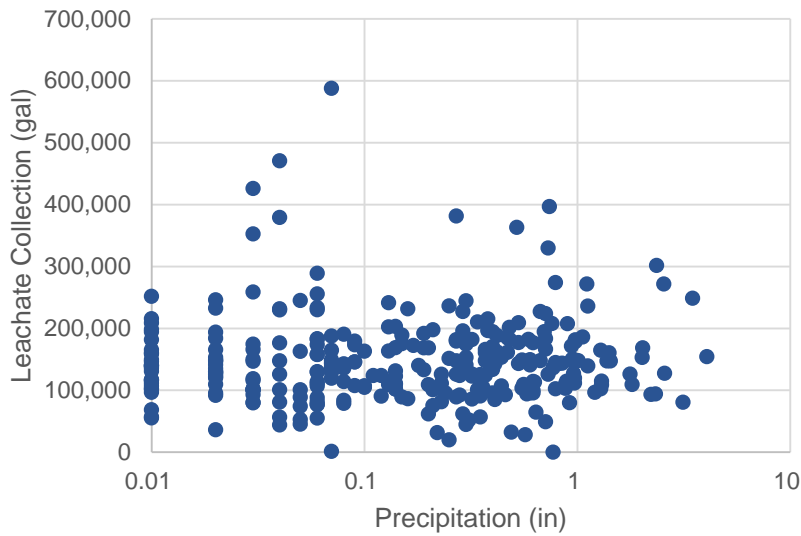
$$\begin{aligned} TKN &= \text{Organic Nitrogen} + \text{Ammonia} + \text{Ammonium} \\ &= \text{orgN} + \text{NH}_3 + \text{NH}_4 \end{aligned}$$

Precipitation vs. Leachate Collection

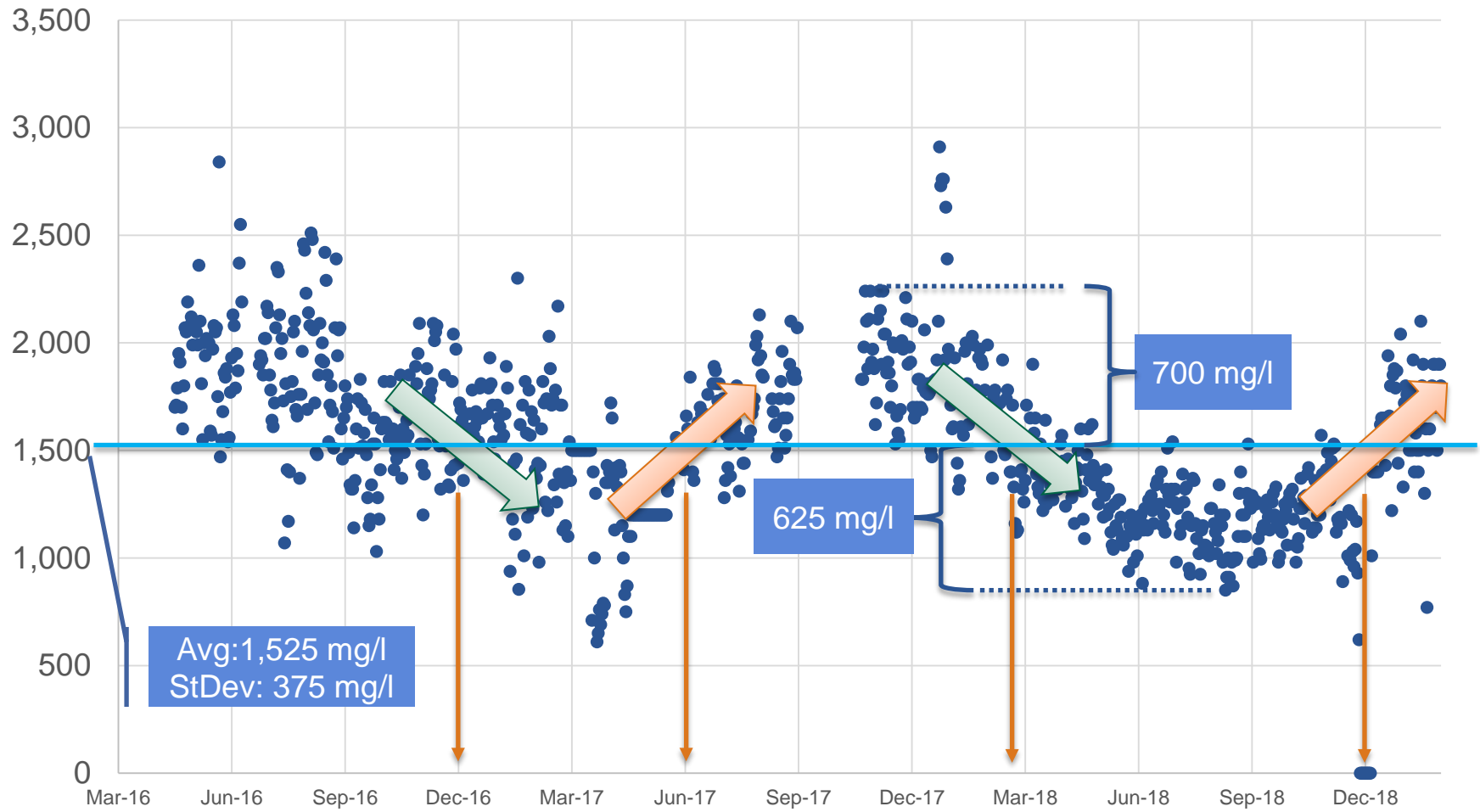


Hydraulic Residence Time, Estimate

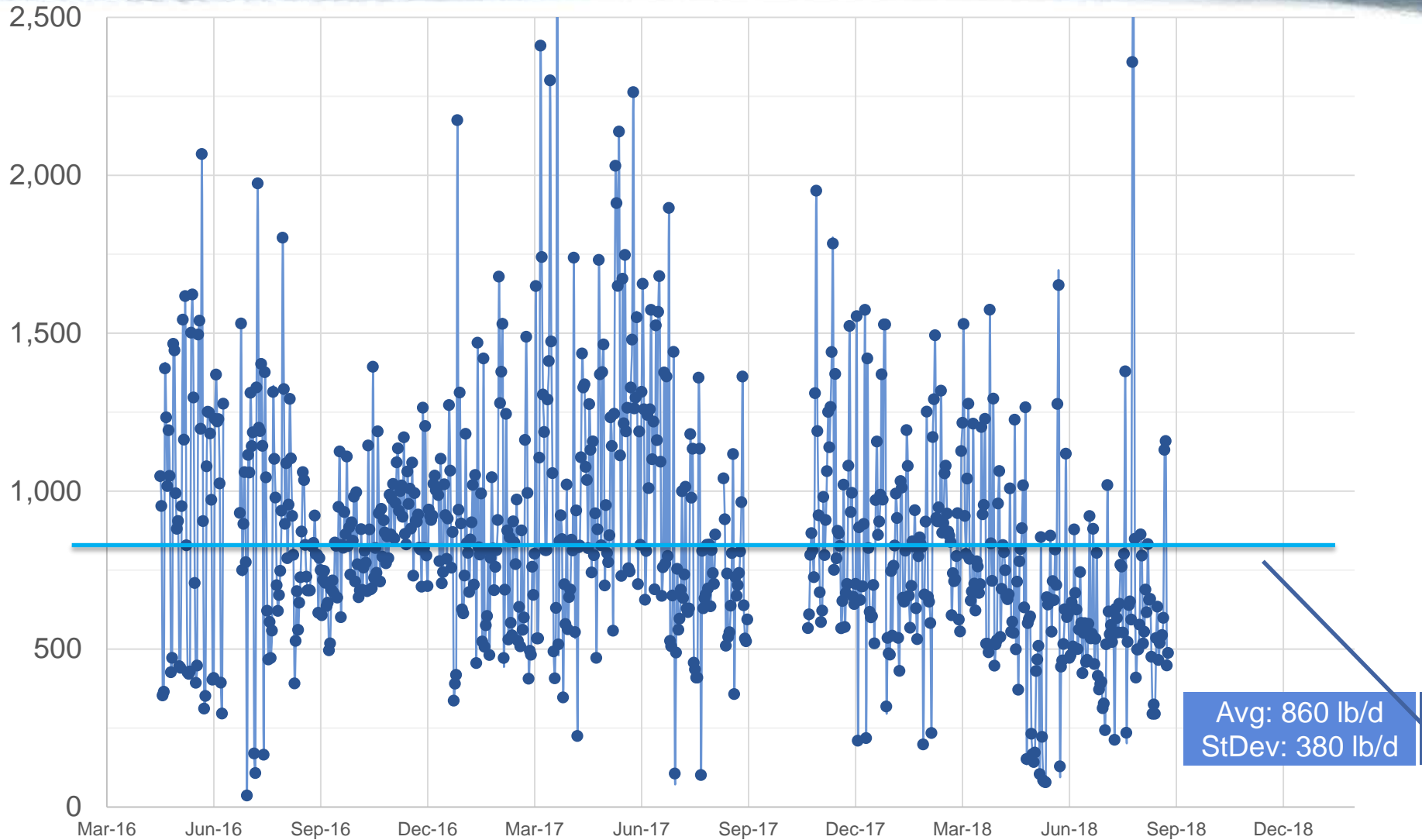
- Time between rainfall event and increase in leachate collection
- Plot Precipitation (log) vs Leachate Collection
- Offset Leachate Collection relative to Rainfall event
- Determine Correlation Coefficient, R



Daily TKN Concentration (mg/l)

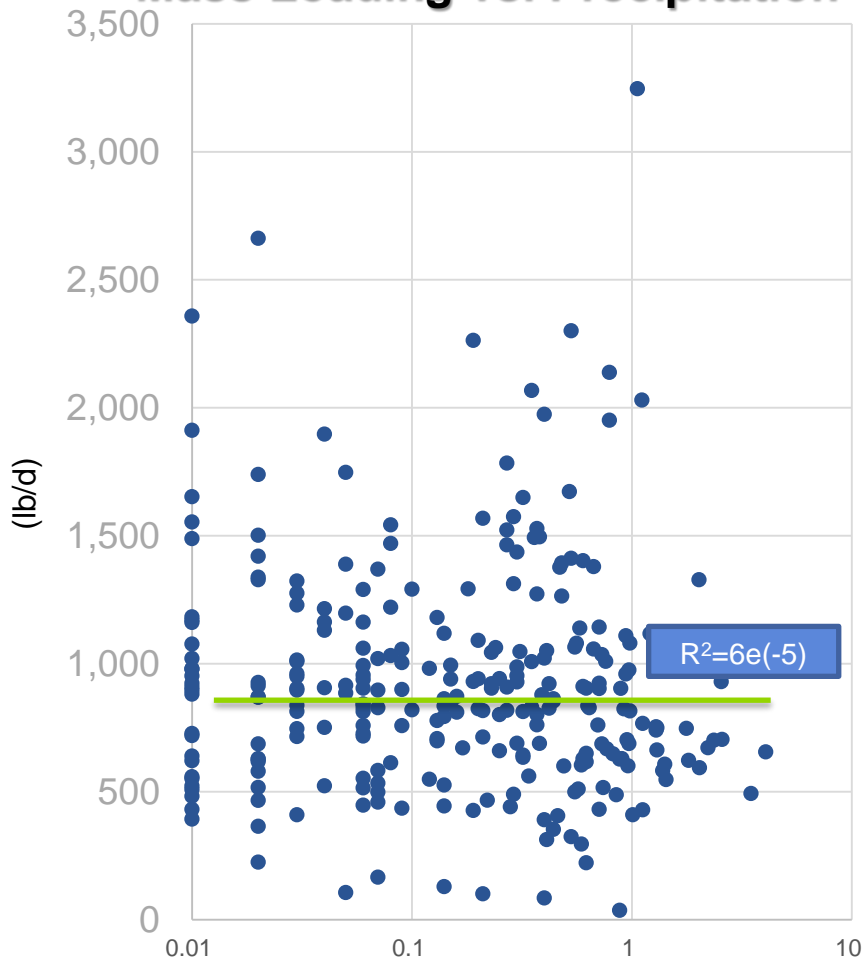


Daily TKN Mass Loading (lb/d)

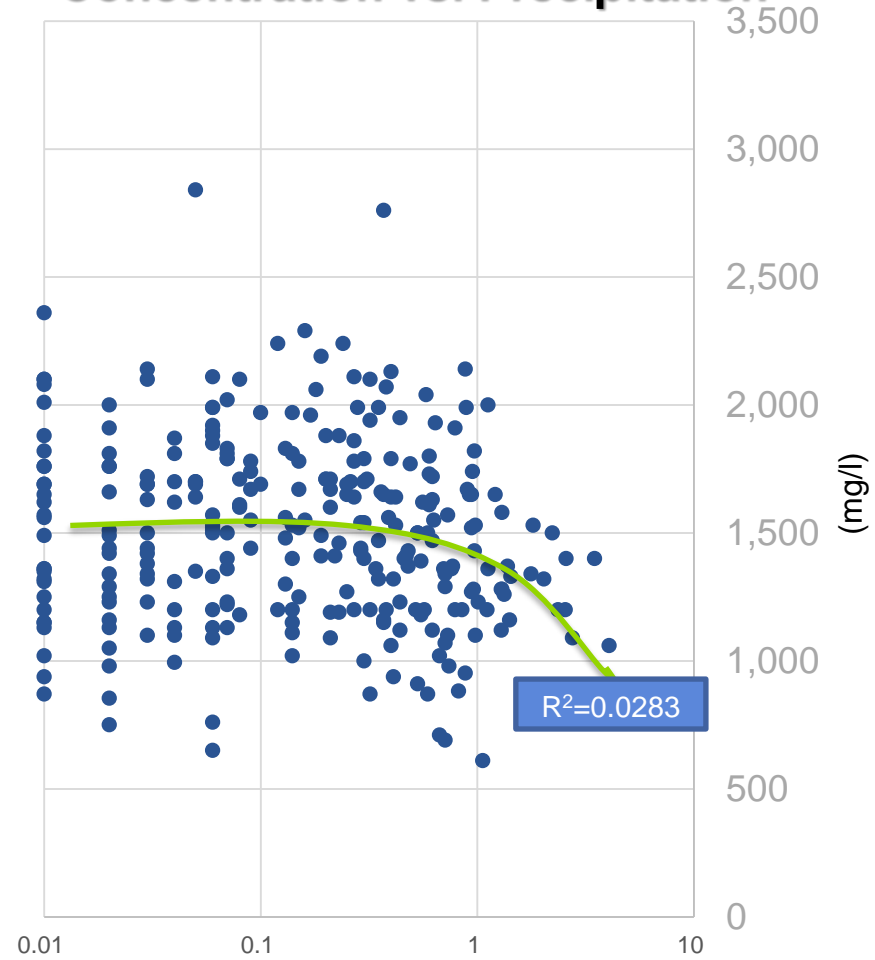


Precipitation: The Independent Variable

Mass Loading vs. Precipitation



Concentration vs. Precipitation



Important Conclusions

Mass Loading

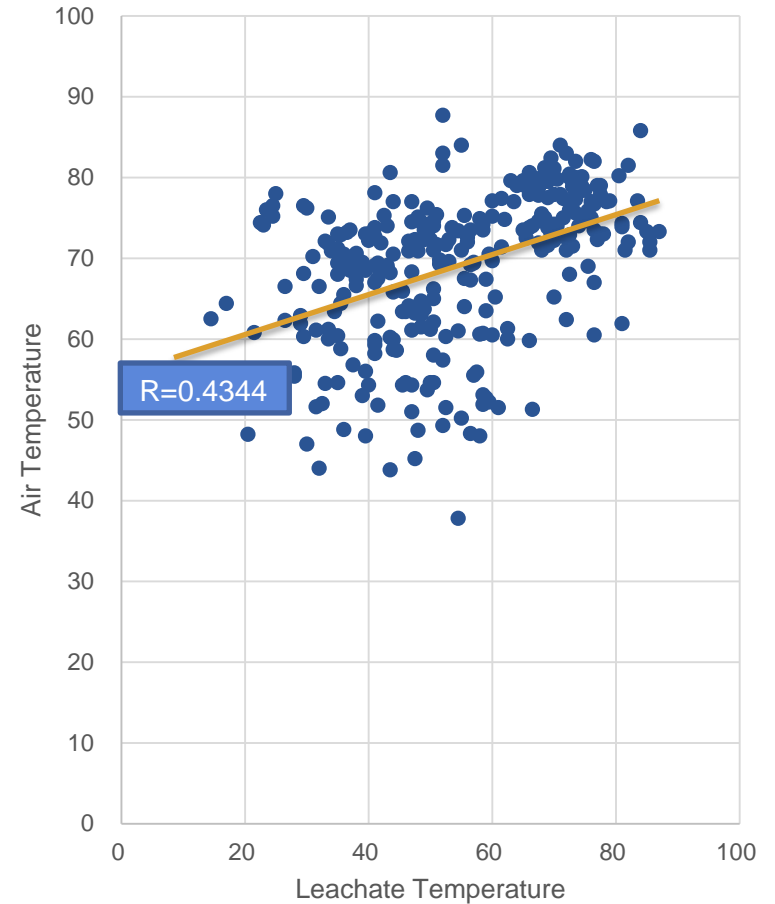
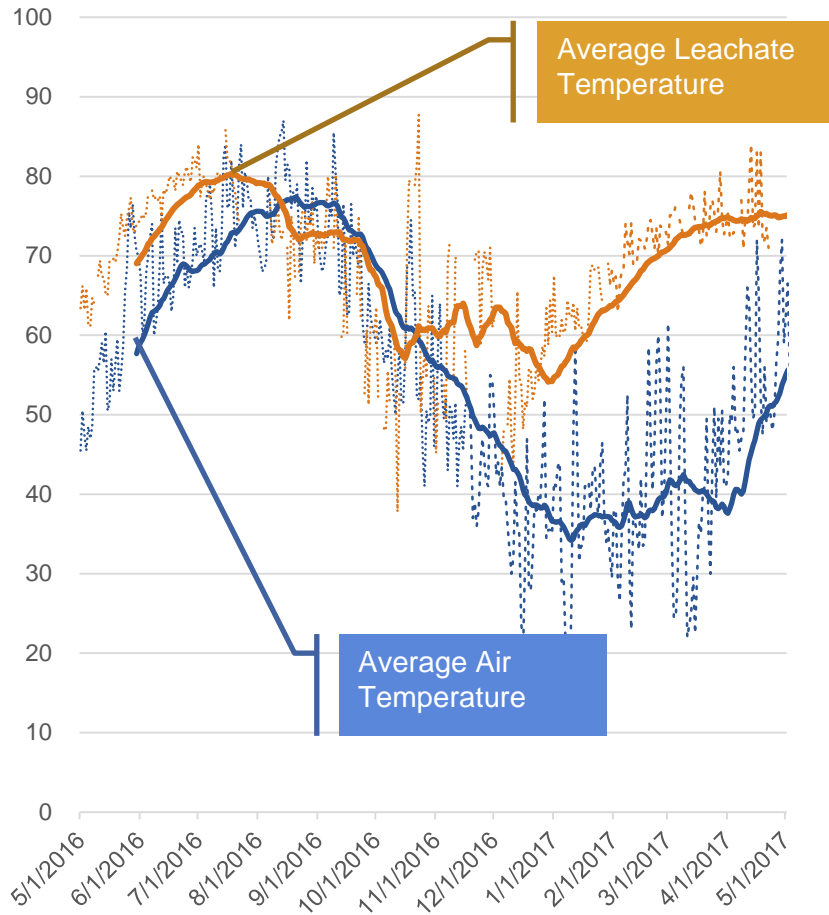
- Unaffected by rainfall
- No flushing
- Constant release

**Zero-order
Release Kinetics**

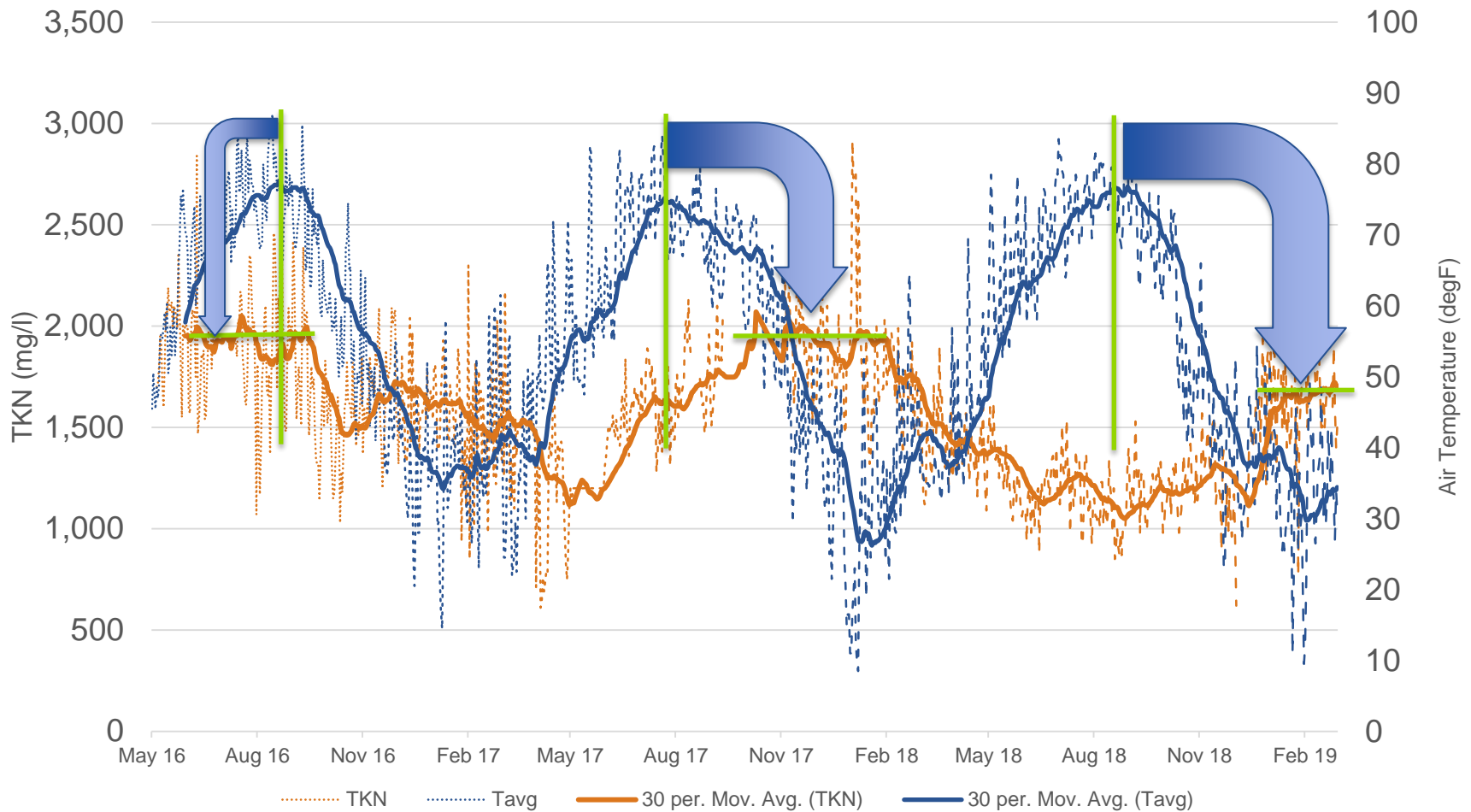
Concentration

- No correlation for small rainfalls ($P < 1$ inch)
- Dilution for larger rainfall events
- TKN not readily available for release, i.e., other processes are rate-limiting

Air & Leachate Temperatures

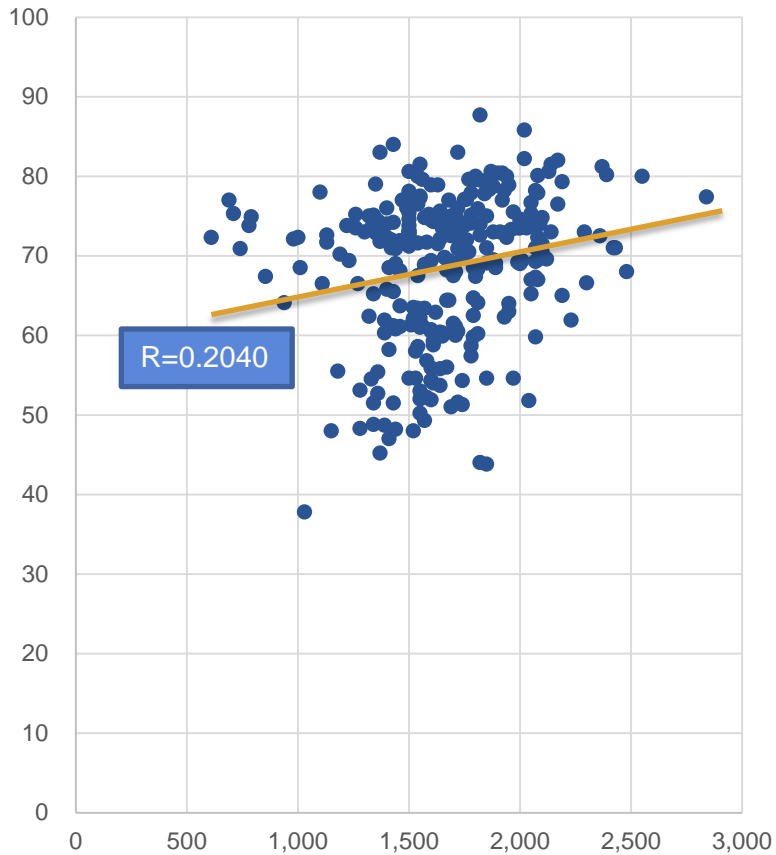


Temperature-TKN Relation

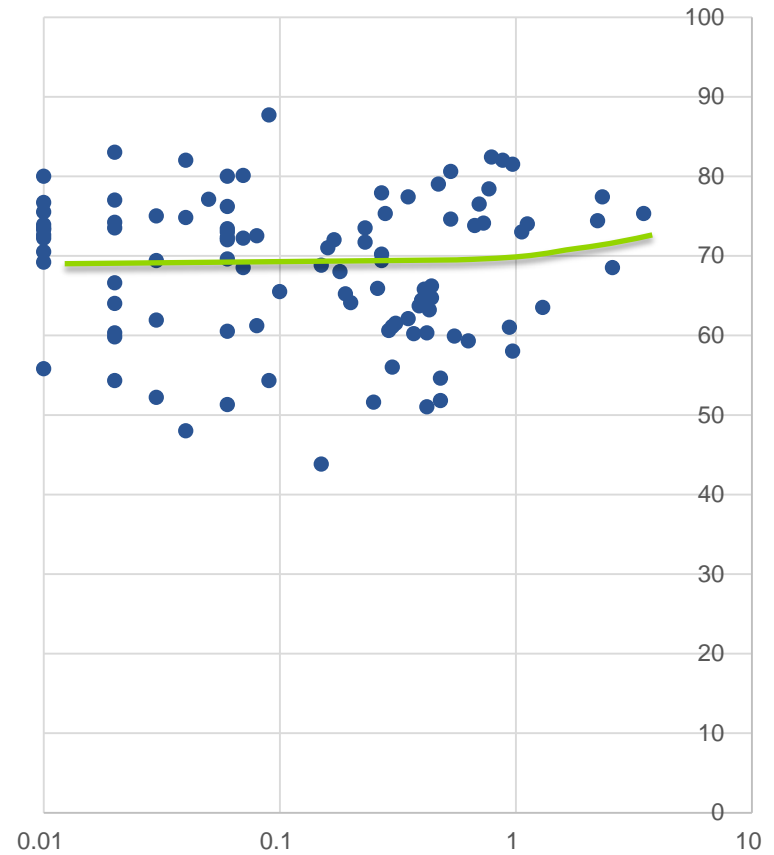


Temperature Correlations

TKN vs. T_{air}



$T_{leachate}$ vs. Precipitation

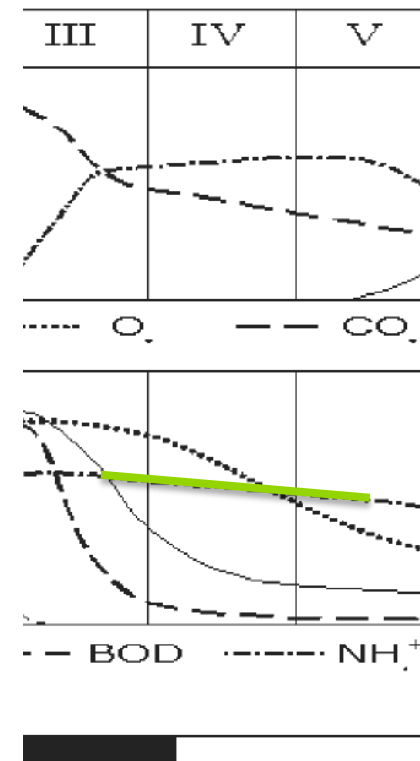


Some Conclusions

- TKN more strongly correlated to air than to leachate temperature
- Leachate temperature unaffected by low rainfall amounts ($P < 1$ inch)
- Leachate temperature **increases** for rainfall > 1 inch
- Temperature increase (2 - 3°F) is small, very minor effect on TKN concentration

- **Control infiltration - relative low cost and effort to minimize leachate generation**

- Operational storage more relevant than treatment reserves
- Field observations consistent with Landfill Model for Phase IV w/r/t N release
- Temperature exhibits a non-constant phase shift
- TKN is positively correlated with temperature



Questions? Comment?

Thank you!

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