**What are mixing zones?**
- Part of National Pollution Discharge Elimination System (NPDES) permits
- Water quality criteria must be met at the edge of the mixing zone
- Must not interfere with designated uses/human health
- Allows for initial dilution of point source wastewater discharges
- Compliance monitoring required for NPDES permit
- Often predicted with mixing zone models (e.g., CORMIX®)
- Spatial water quality data needed within mixing zone

**How does balloon remote sensing work?**
- Tethered helium balloon for low-altitude (< 161 m) deployment
- Aerial imaging at site scales
- Long-wavelength (7.5 to 13 µm) infrared (IR) and optical cameras
- Robotic pan/tilt camera mount
- Near real-time data transfer/camera control via Wi-Fi 802.11g wireless protocol
- ZoneView® application software controls platform, data acquisition and tagging
- Integrated imaging data provides spatial water quality information
- Additional platform sensors:
  - Digital compass - camera pitch, yaw, roll (x,y,z); bearing to true and magnetic north
  - Laser rangefinder - distance to target
  - Temperature/humidity sensor
  - Global Positioning System (GPS) - latitude/longitude/time

**How can infrared (IR) monitor mixing zone water quality?**
- Heat (temperature) is a Total Maximum Daily Load (TMDL) pollutant
- IR sensor measures surface temperature to +/- 0.08 ºC to within < 0.3 m resolution
- Many wastewater discharges are “warm”, i.e., T above ambient
- Temperature can be used as a tracer to monitor other constituents
- Aerial image data can be geo-referenced

**What are the advantages of remote sensing?**
- Less expensive than aircraft deployment
- Cost effective alternative to mixing zone dye studies
- Site scale mixing zone properties available in near-real time
- Mixing zone dilution data can be geo-referenced
- Easily deployable worldwide

**What are possible applications?**
- Power plant discharges/industrial discharges
- Publicly Owned Treatment Works (POTW)
- Thermal refugia/habitat assessment
- Groundwater recharge
- Fugitive Volatile Organic Compounds (VOC) emissions
- Mixing zone model calibration/validation

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