# FECAL SLUDGE SENSORS

Black D, Burke B, Isquith-Dicker L, Slyker J


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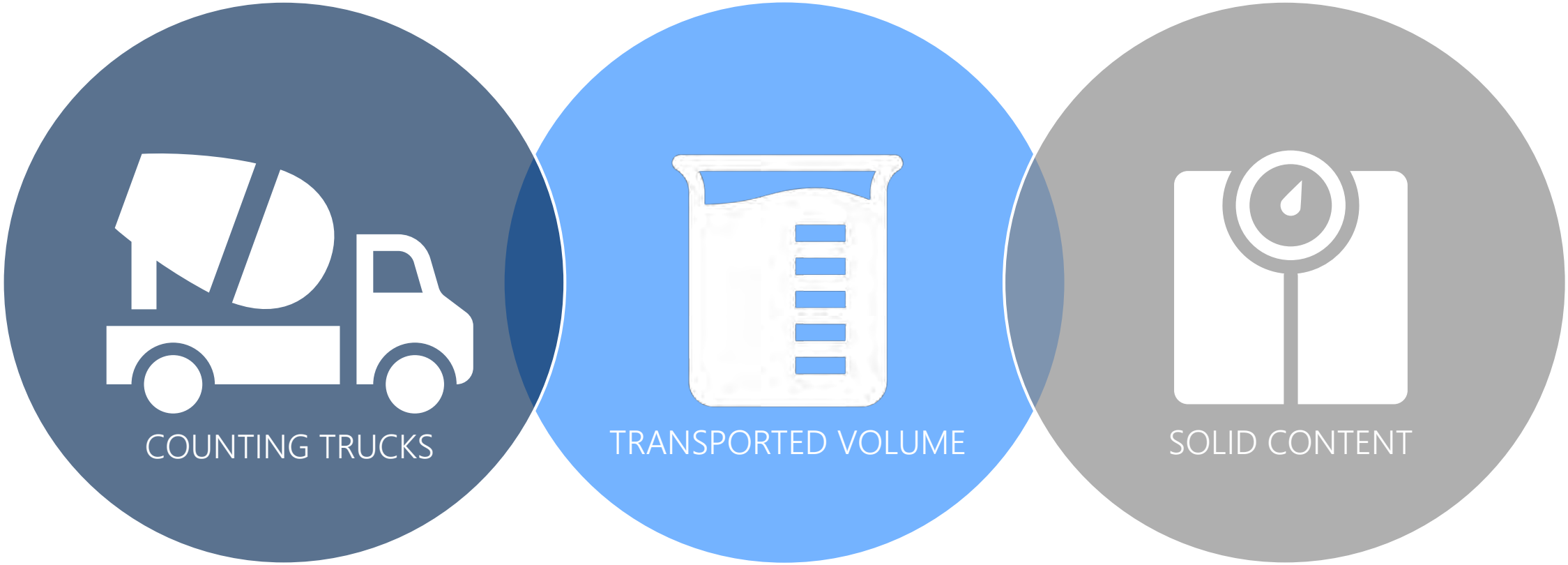
STRATEGIC ANALYSIS,
RESEARCH & TRAINING CENTER

Photo reference: (1)

# PRESENTATION OVERVIEW

1. Project objectives & methodology
2. Applicable technologies & sensors
3. Interview takeaways & conclusions

# OPERATIONAL GOALS




## WHY

Quantify Targets 6.1 and 6.2 of the Sustainable Development Goals

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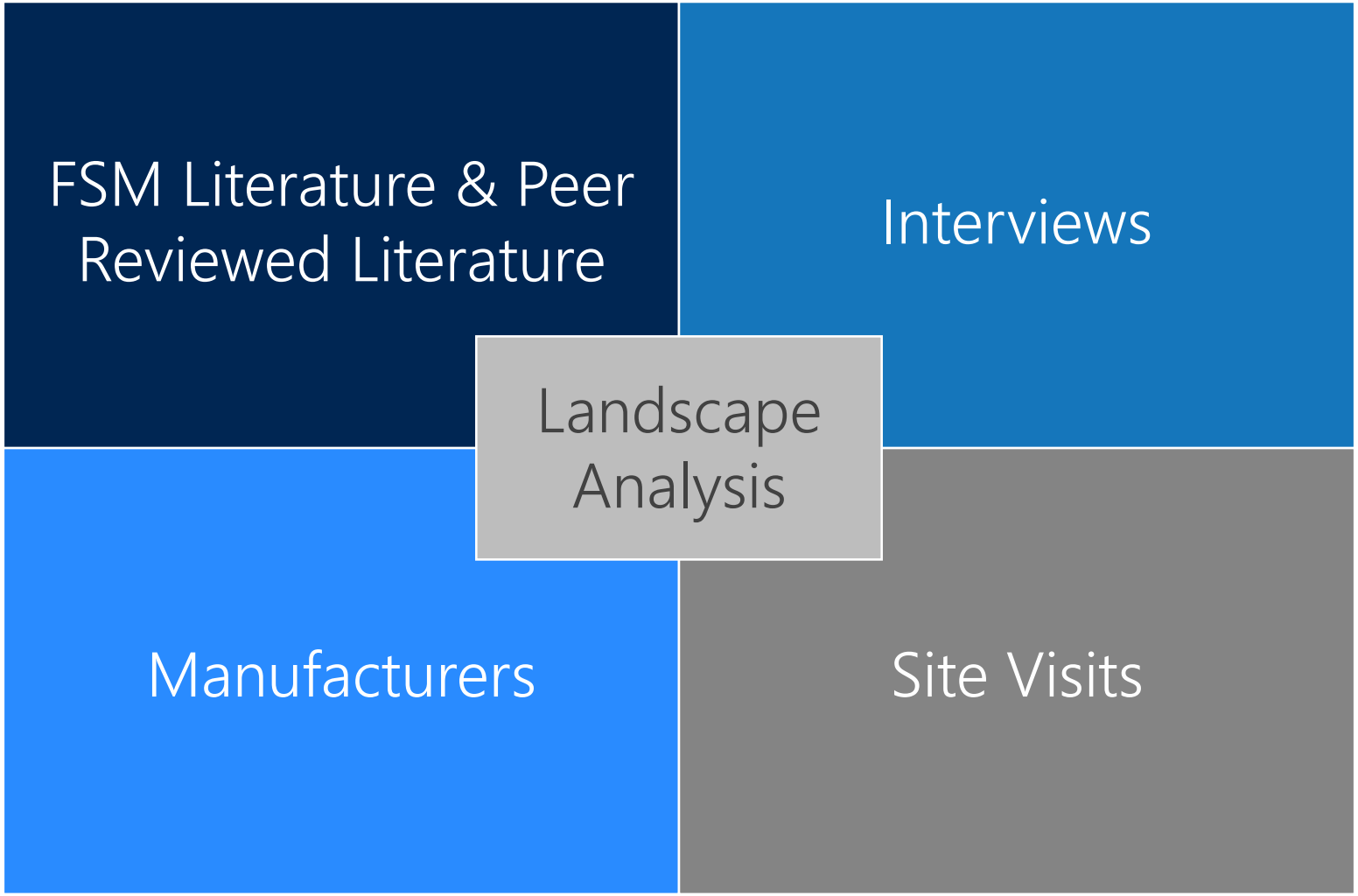
# METHODOLOGY



# TECHNOLOGIES AND SENSORS

- Counting trucks
- Measuring volume
- Measuring solid content

| Level of appropriateness for LMIC | |
|---|---|
| | Appropriate for most |
| | Appropriate for some |
| | Inappropriate |

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# CRITERIA FOR TECHNOLOGY & SENSORS TABLE

| Applicable to FSM | Maintenance | Longevity | Automation | Cost | Availability in LMIC |
|---|---|---|---|---|---|
| Will it work in FS? | Frequency of maintenance<br><br>Maintenance requirements | Length of time | Type of output<br><br>Data management software | Upfront cost, if applicable<br><br>Focus on basic hardware<br><br>$ <$500<br>$$ $500 - $1000<br>$$$ >$1000 | Distribution details<br><br>Manufacturing details |

# TECHNOLOGY & SENSORS TABLE

| Level of appropriateness for LMIC |
|---|
| Appropriate for most |
| Appropriate for some |
| Inappropriate |

| | | Applicable to FSM | Maintenance | Longevity | Automation | Cost | Availability in LMIC |
|---|---|---|---|---|---|---|---|
| Counting trucks | RFID | | | | | | |
| | GPS | | | | | | |
| | Mobile apps | | | | | | |
| Measuring volume | Float sensor | | | | | | |
| | Flow meter | | | | | | |
| | Laser level | | | | | | |
| | Ultrasonic | | | | | | |
| | Dual Tech | | | | | | |
| Measuring solid content | Sludge Judge | | | | | | |
| | SMUG | | | | | | |
| | Penetrometer | | | | | | |

# TECHNOLOGIES AND SENSORS

- Counting trucks
  - RFID
  - GPS
  - Mobile applications
- Measuring volume
- Measuring solid content

# COUNTING TRUCKS

RFID

Use of radio waves to transmit between reader and tag (affixed to truck)

Installed at plant

GPS

Tracker attached to truck or inside vehicle

Utilize software for reporting

MOBILE APP

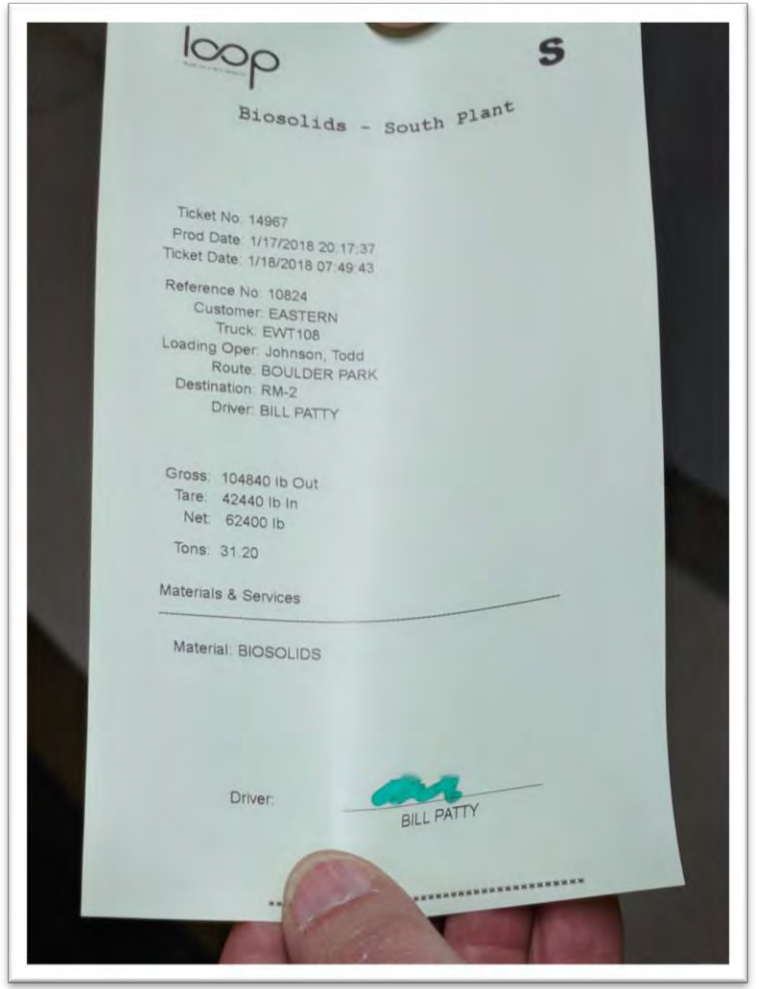
Can integrate GPS data, customer information, and driver information

Photo reference: (2)

# TECHNOLOGIES AND SENSORS

- Counting trucks
  - RFID
  - GPS
  - Mobile applications
- Measuring volume
- Measuring solid content

# APPLICATION OF RFID


Transport truck at South Treatment Plant, Renton WA using RFID Reader

| Level of appropriateness for LMIC |
| --- |
| Appropriate for most |
| Appropriate for some |
| Inappropriate |

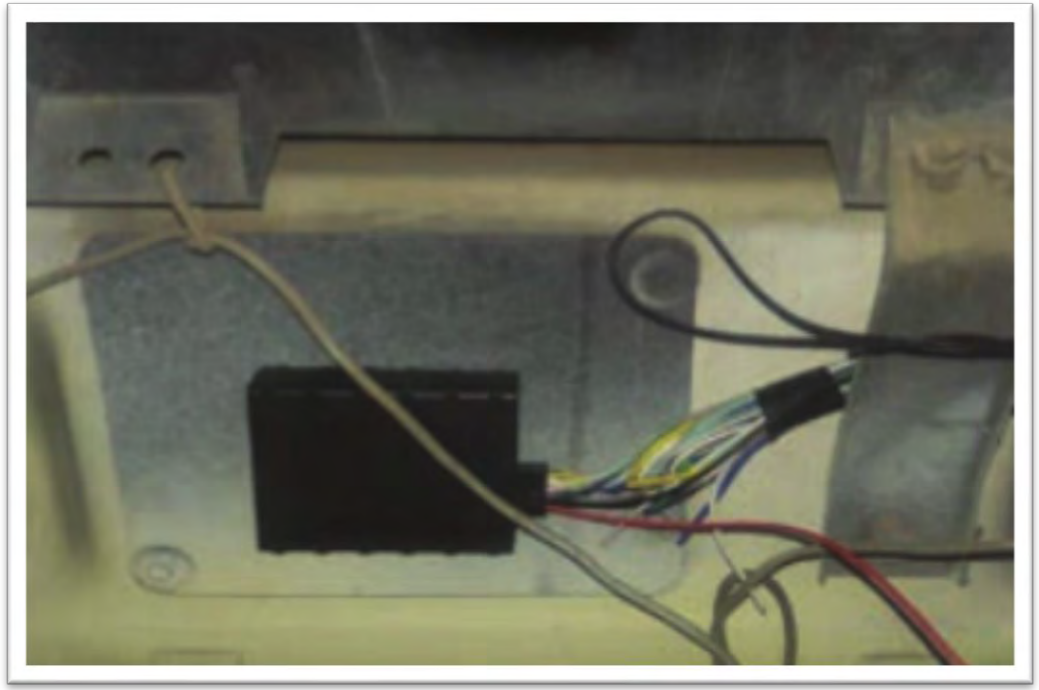
# COUNTING TRUCKS: RFID

- **Applicable to FSM**
  - Automated entry and exit
  - Truck assigned
  - Lack of flexibility
- **Maintenance**
  - Active: 2 – 3 years
  - Passive: No maintenance
- **Longevity**
  - Active: 3-5 years
  - Passive: Lifetime
- **Automation**
  - Data storage
  - Integration with software produces report output
- **Cost**
  - Infrastructure: $$
  - Tags: $
  - Active tags require replacement
- **Availability in LMIC**
  - Manufactured globally
  - Distributed globally

# TECHNOLOGIES AND SENSORS

- Counting trucks
  - RFID
  - GPS
  - Mobile applications
- Measuring volume
- Measuring solid content

# APPLICATION OF GPS



GPS tracker installed inside vehicle

Photo reference: (3)

| Level of appropriateness for LMIC |
| --- |
| Appropriate for most |
| Appropriate for some |
| Inappropriate |

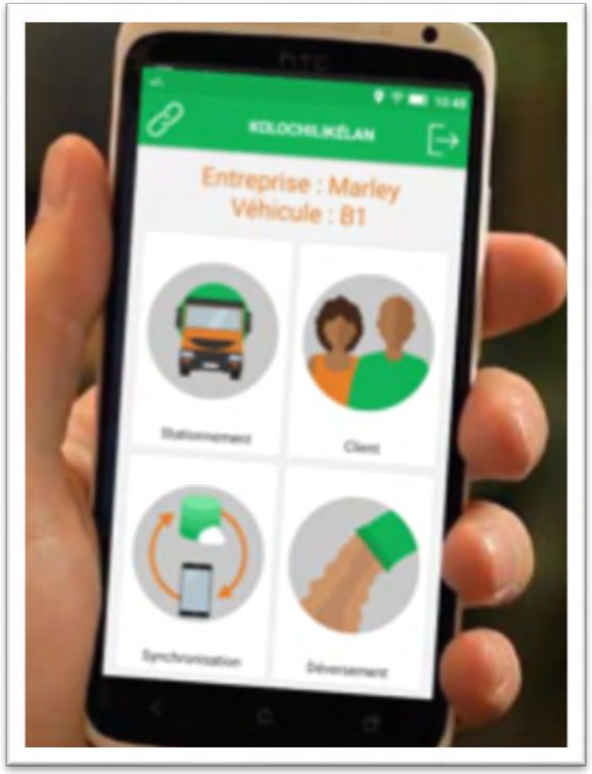
# COUNTING TRUCKS: GPS

- **Applicable to FSM**
  - Utilized for fleet management
  - Requires agreement from drivers
- **Maintenance**
  - Initial installation and activation
  - Provide alerts for vehicle maintenance
  - Service provider support
- **Longevity**
  - Rechargeable
  - 7+ years of continuous use
- **Automation**
  - Reports and alerts are integrated
- **Cost**
  - Initial hardware: $
  - Monthly fee: $
- **Availability in LMIC**
  - Manufactured globally
  - Distributed globally

# TECHNOLOGIES AND SENSORS

- Counting trucks
  - RFID
  - GPS
  - Mobile applications
- Measuring volume
- Measuring solid content

# APPLICATION OF MOBILE APPS





Mobile application by the Practica Foundation for FSM for vacuum trucks with tracking

Photo reference: (4)

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# COUNTING TRUCKS: MOBILE APPS

| Level of appropriateness for LMIC |
| --- |
| Appropriate for most |
| Appropriate for some |
| Inappropriate |

## Applicable to FSM

- 10+ apps
- Open source
- Wide access to phones

## Maintenance

- App support varies by developer
- Minimal updates following development

## Longevity

- Infinite, dependent on platform

## Automation

- Data storage within app
- Real time data collection

## Cost

- Initial build: $$$
- Dependent on internal capacity
- Maintenance: $

## Availability in LMIC

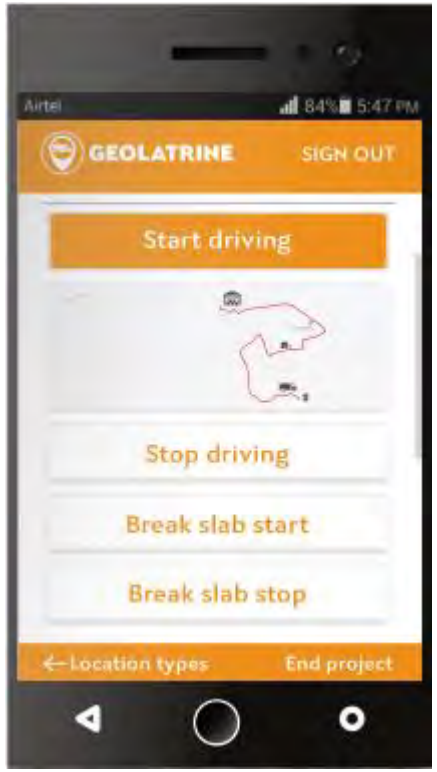
- Developers in LMIC

# RECOMMENDED FSS FOR COUNTING TRUCKS

| | | Applicable to FSM | Maintenance | Longevity | Automation | Cost | Availability in LMIC |
|---|---|---|---|---|---|---|---|
| Counting trucks | RFID | | | | | | |
| | GPS | | | | | | |
| | Mobile apps | | | | | | |

# CASE STUDY FOR COUNTING TRUCKS

## MOBILE APP




GeoLatrine for FSM Logistics Tracking and Workflow Optimization

- Implemented by Pit Vidura in Mombasa, Kenya
- Emptied pit latrines using double vacuum emptying system for hard-to-reach pits
- Aimed to incentivize manual pit desludgers to safely deposit FS through workflow tracking
- Identified inefficiency in use of barrels for sludge transport and identified high-traffic routes

Photo reference: (5)

# TECHNOLOGIES AND SENSORS

- Counting trucks
- Measuring volume
  - Float sensor
  - Electromagnetic flow meter
  - Laser level
  - Ultrasonic sensor
  - Dual tech
- Measuring solid content

# MEASURING VOLUME

**FLOAT**

*Contact*

Floats & switches

**FLOW METER**

*Contact*

Electromagnetic

**LASER**

*Non-contact*

Laser projection

**ULTRASONIC**

*Non-contact*

Sound pulse

**DUAL TECH**

*Both*

Probes & Ultrasonic

Photo references: (2, 6-10)

# TECHNOLOGIES AND SENSORS

- Counting trucks
- Measuring volume
  - Float sensor
  - Electromagnetic flow meter
  - Laser level
  - Ultrasonic sensor
  - Dual tech
- Measuring solid content

# APPLICATION OF FLOAT SENSOR

Failed float from West Point Treatment Plant

Photo reference: (11)

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| Level of appropriateness for LMIC |
| --- |
| Appropriate for most |
| Appropriate for some |
| Inappropriate |

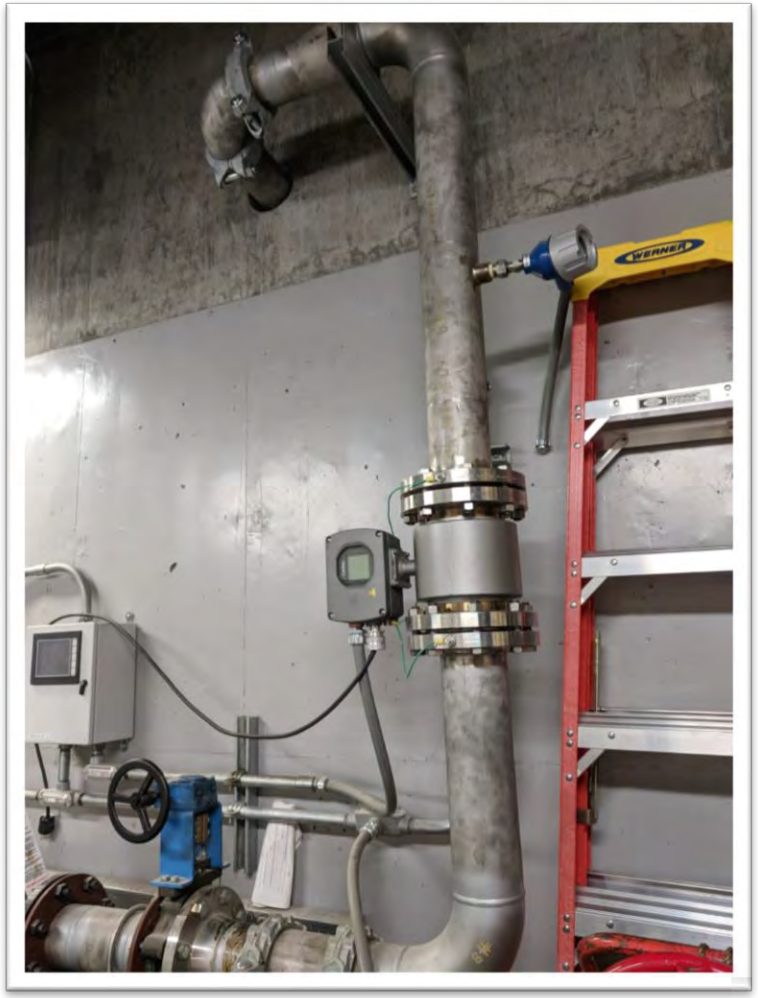
# VOLUME: FLOAT SENSOR

- **Applicable to FSM**
  - Vulnerability with moving parts
  - Lack of flexibility in placement
- **Maintenance**
  - Daily cleaning
- **Longevity**
  - 15+ years
  - More rapid deterioration with FS
- **Automation**
  - Discrete data
  - Visual display only
- **Cost**
  - Capital: $
  - Frequent replacement
- **Availability in LMIC**
  - Distributed globally

# TECHNOLOGIES AND SENSORS

- Counting trucks
- Measuring volume
  - Float
  - Electromagnetic flow meter
  - Laser level
  - Ultrasonic sensor
  - Dual tech
- Measuring solid content

# APPLICATION OF ELECTROMAGNETIC FLOW METER




Flow meter at UW Power Plant

Flow meter installation

Photo references (12)

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| Level of appropriateness for LMIC |
| --- |
| Appropriate for most |
| Appropriate for some |
| Inappropriate |

# VOLUME: ELECTROMAGNETIC FLOW METER

- **Applicable to FSM**
  - Only used for pipes, application theoretical
- **Maintenance**
  - Annual cleaning
- **Longevity**
  - 15+ years
- **Automation**
  - Continuous data
  - Must be connected to PLC
- **Cost**
  - Capital: $$
  - Maintenance of PLC
- **Availability in LMIC**
  - U.S. based companies

# TECHNOLOGIES AND SENSORS

- Counting trucks
- Measuring volume
  - Float sensor
  - Electromagnetic flow meter
  - Laser level
  - Ultrasonic sensor
  - Dual tech
- Measuring solid content

# APPLICATION OF LASER LEVEL

Laser sensors in a municipal well

Laser sensors in a wastewater facility

Photo references: (13-14)

# VOLUME: LASER LEVEL

| Level of appropriateness for LMIC |
| --- |
| Appropriate for most |
| Appropriate for some |
| Inappropriate |

- **Applicable to FSM**
  - Non-contact
  - Lack of versatility in placement
  - Potential issues with foam and turbidity
- **Maintenance**
  - Daily monitoring
- **Longevity**
  - 15+ years
- **Automation**
  - Continuous data
  - Must be connected to PLC
- **Cost**
  - Capital: $$$
  - Maintaining PLC
- **Availability in LMIC**
  - U.S. based companies

# TECHNOLOGIES AND SENSORS

- Counting trucks
- Measuring volume
  - Float sensor
  - Electromagnetic flow meter
  - Laser level
  - Ultrasonic sensor
  - Dual tech
- Measuring solid content

# APPLICATION OF ULTRASONIC SENSOR

Ultrasonic sensor at a reservoir

Ultrasonic at UW Power Plant

Photo reference: (15)

| Level of appropriateness for LMIC |
| --- |
| Appropriate for most |
| Appropriate for some |
| Inappropriate |

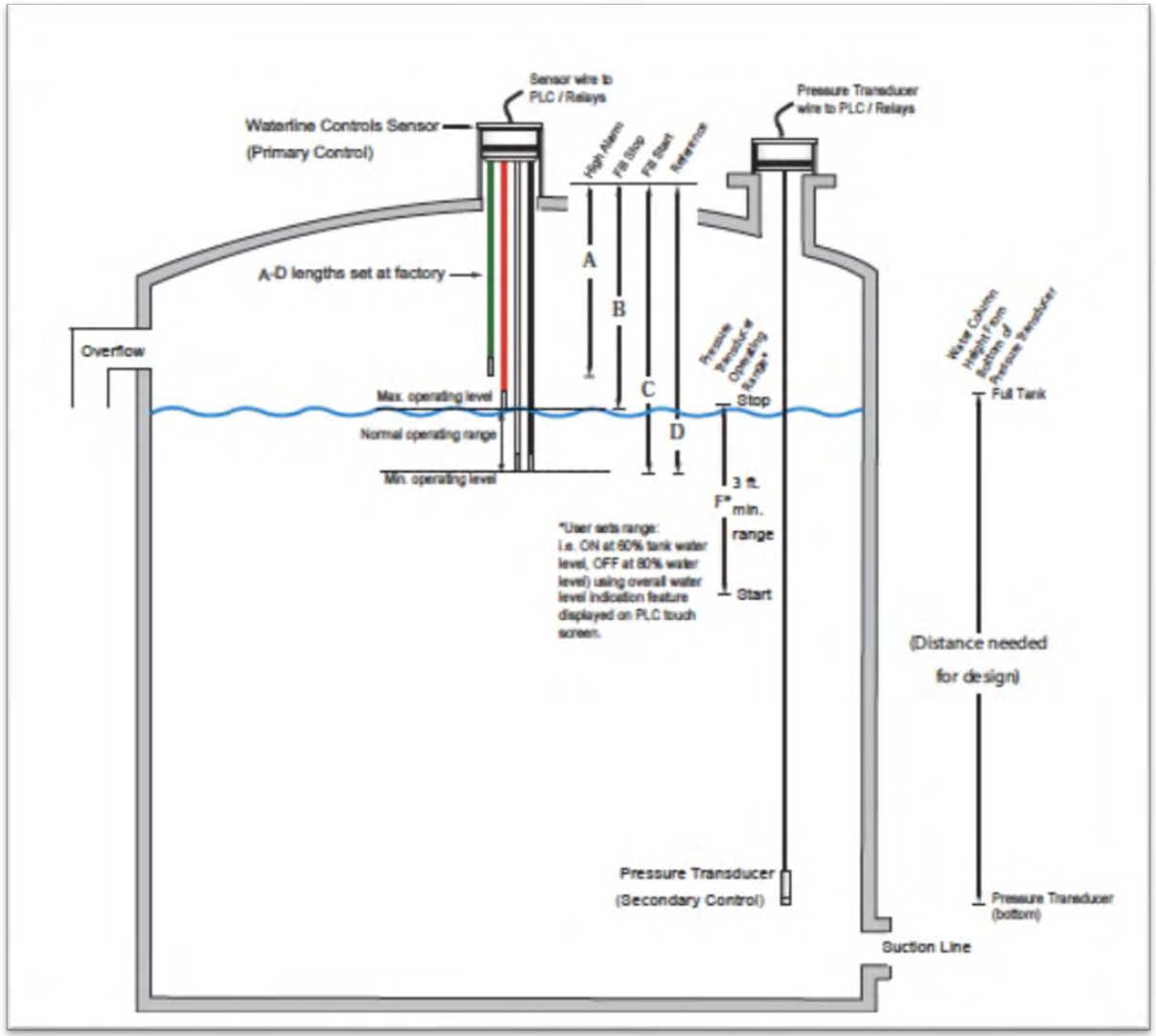
# VOLUME: ULTRASONIC SENSOR

- **Applicable to FSM**
  - Non-contact
  - High versatility in placement
  - Potential issues with foam and turbidity
- **Maintenance**
  - Mostly "set and forget"
- **Longevity**
  - 15+ years
- **Automation**
  - Continuous data
  - Must be connected to PLC
- **Cost**
  - Capital: $$
  - Maintaining PLC
- **Availability in LMIC**
  - Distributed globally

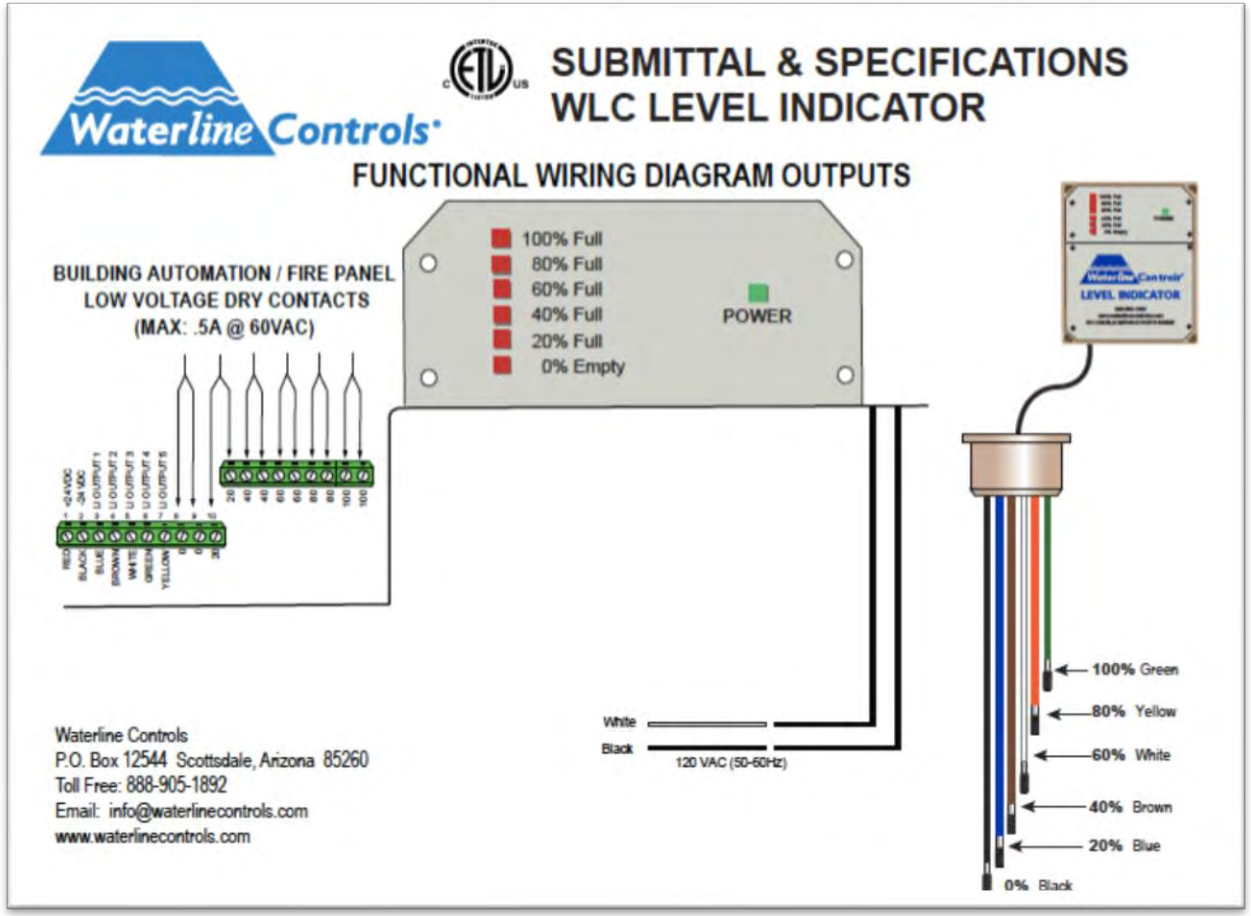
# TECHNOLOGIES AND SENSORS

- Counting trucks
- Measuring volume
  - Float sensor
  - Electromagnetic flow meter
  - Laser level
  - Ultrasonic sensor
  - Dual tech
- Measuring solid content

# APPLICATION OF DUAL TECH




Placement of dual technology




Wiring diagram and data display

Photo reference: (16)

# VOLUME: DUAL TECH

| Level of appropriateness for LMIC |
| --- |
| Appropriate for most |
| Appropriate for some |
| Inappropriate |

- **Applicable to FSM**
  - Failsafe with legacy sensor
  - High versatility in placement
- **Maintenance**
  - Mostly "set and forget"
- **Longevity**
  - 15+ years
- **Automation**
  - Continuous data
  - Must be connected to PLC
- **Cost**
  - Capital: $$
  - Maintaining PLC
- **Availability in LMIC**
  - U.S. based company

# RECOMMENDED FSS FOR MEASURING VOLUME

| | | Applicable to FSM | Maintenance | Longevity | Automation | Cost | Availability in LMIC |
|---|---|---|---|---|---|---|---|
| Measuring volume | Float sensor | | | | | | |
| | Flow meter | | | | | | |
| | Laser level | | | | | | |
| | Ultrasonic | | | | | | |
| | Dual Tech | | | | | | |

# CASE STUDY FOR MEASURING VOLUME

## ULTRASONIC SENSOR


Disposal by TNUSSP

- Implemented by TNUSSP in Trichy, India
- Gathered volume and composition estimates to inform construction of fecal sludge treatment plant
- Piloted 5 technologies on 30 onsite systems to determine feasibility and accuracy
- Determined that a combination of ultrasonic and laser sensors may work well for this application (pending final report)

Photo reference: (17)

# TECHNOLOGIES AND SENSORS

Identified technologies

- Counting trucks
- Measuring volume
- Measuring solid content
  - Sludge Judge
  - Scum measuring utility gauge (SMUG)
  - Penetrometer

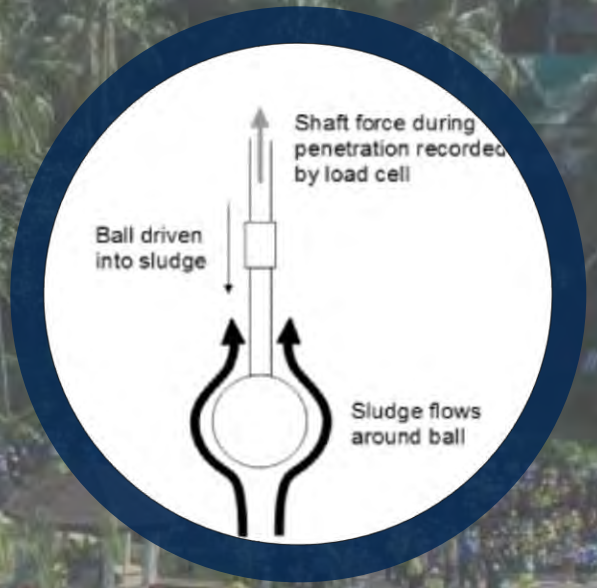
# MEASURING SOLID CONTENT

SLUDGE JUDGE

Tube with ball valve to sample sludge

SCUM MEASURING UTILTY GAUGE (SMUG)

Measures scum level




PENETROMETER

Measures in-situ strength and density

Photo references: (2, 18-20)

# TECHNOLOGIES AND SENSORS

- Counting trucks
- Measuring volume
- Measuring solid content
  - Sludge Judge
  - Scum measuring utility gauge (SMUG)
  - Penetrometer

# APPLICATION OF SLUDGE JUDGE

Man sampling septic tank with Sludge Judge

Photo reference: (21)

| Level of appropriateness for LMIC |
| --- |
| Appropriate for most |
| Appropriate for some |
| Inappropriate |

# SOLID CONTENT: SLUDGE JUDGE

- **Applicable to FSM**
  - Works in TSS <5%
- **Maintenance**
  - Clean after each use
- **Longevity**
  - 1 year
- **Automation**
  - Visual inspection
- **Cost**
  - Capital: $
  - Frequent replacement required
- **Availability in LMIC**
  - Globally distributed

# TECHNOLOGIES AND SENSORS

- Counting trucks
- Measuring volume
- Measuring solid content
  - Sludge Judge
  - Scum measuring utility gauge (SMUG)
  - Penetrometer

# APPLICATION OF SMUG

A man is using the SMUG to measure scum

Photo reference: (21)

# SOLID CONTENT: SMUG

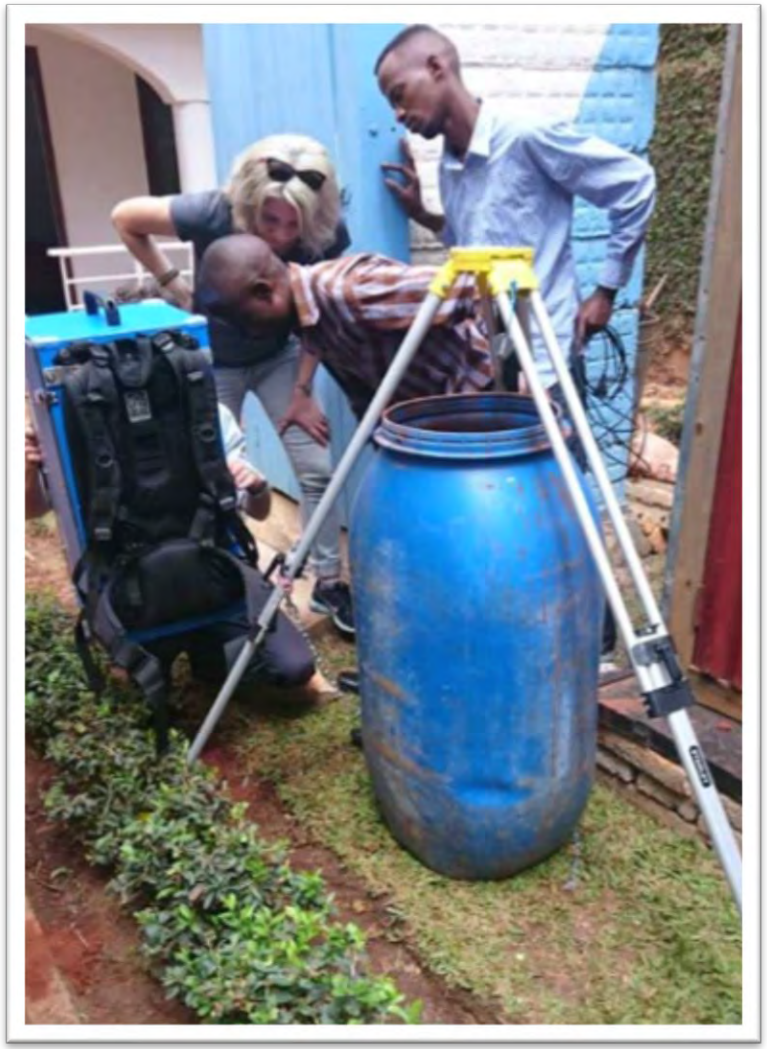
| Level of appropriateness for LMIC |
| --- |
| Appropriate for most |
| Appropriate for some |
| Inappropriate |

- **Applicable to FSM**
  - Used for septic tanks
  - Not used in moving trucks
- **Maintenance**
  - Clean after each use
- **Longevity**
  - 5+ years
- **Automation**
  - Visual inspection
  - Difficult to standardize results
- **Cost**
  - Capital: $
- **Availability in LMIC**
  - Globally distributed

# TECHNOLOGIES AND SENSORS

- Counting trucks
- Measuring volume
- Measuring solid content
  - Sludge Judge
  - Scum measuring utility gauge (SMUG)
  - Penetrometer

# APPLICATION OF PENETROMETER



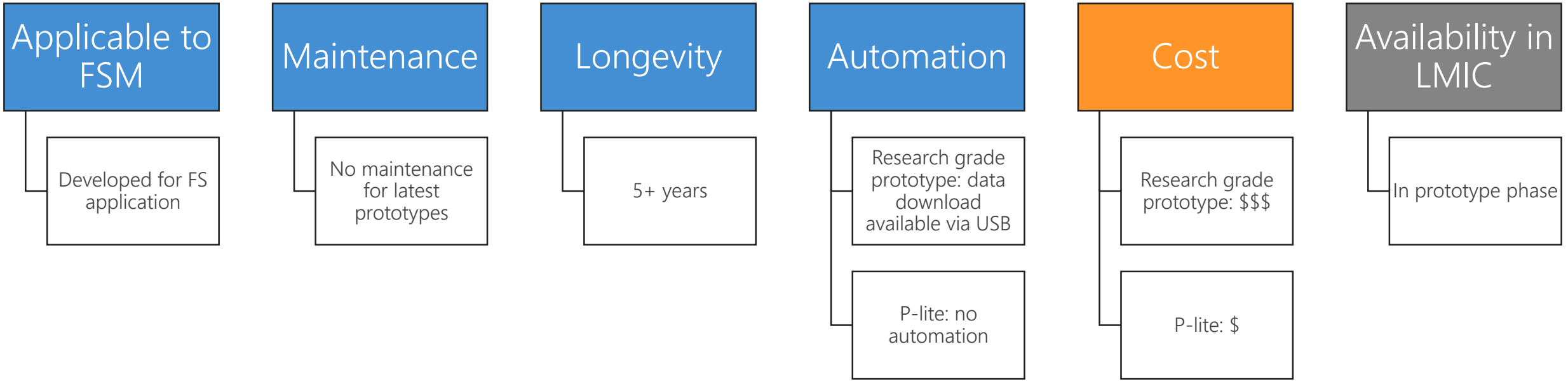
Workshop participants learning about the penetrometer

Man using penetrometer on a pit latrine

Photo reference: (22)

| Level of appropriateness for LMIC |
| --- |
| Appropriate for most |
| Appropriate for some |
| Inappropriate |

# SOLID CONTENT: PENETROMETER

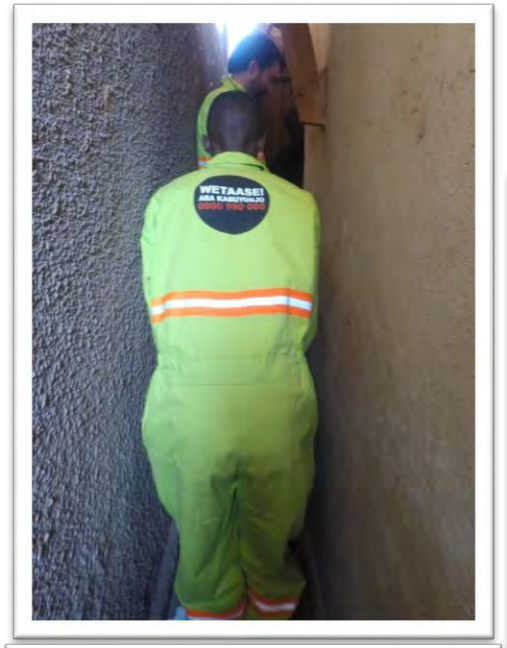


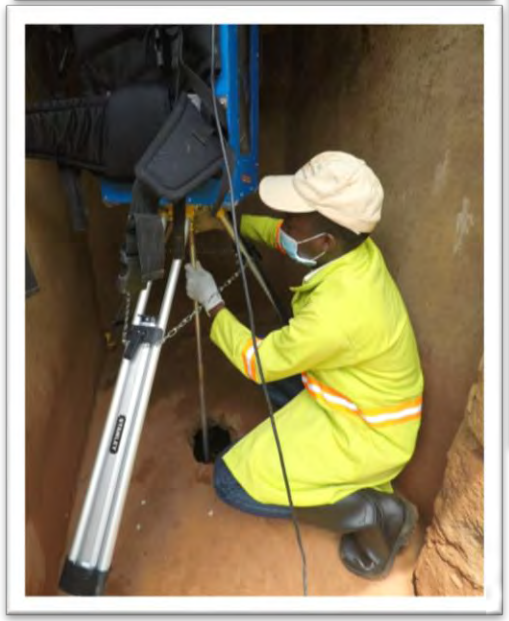
# RECOMMENDED FSS FOR MEASURING SOLID CONTENT

| Measuring solid content | Applicable to FSM | Maintenance | Longevity | Automation | Cost | Availability in LMIC |
|---|---|---|---|---|---|---|
| Sludge Judge | | | | | | |
| SMUG | | | | | | |
| Penetrometer | | | | | | |

# CASE STUDY FOR SOLID CONTENT

## PENETROMETER LITE (P-LITE)





Photos taken during pilot in Lusaka

- Pilot carried out by Partners in Development in Lusaka, Zambia
- P-lite used to test pit latrine fecal sludge strength
- Tested using P-lite in the field and a potential data automation option
- Found P-lite easy to use with the potential to be cost effective as it only took 3 minutes to test a pit. Information can help inform removal strategy

Photo reference: (22)

# INTERVIEW TAKEAWAYS & CONCLUSIONS

# INTERVIEWS CONDUCTED

JANUARY 2018 – APRIL 2018

**25** Number of formal interviews

**3** Number of site visits

**18** Number of manufacturers contacted

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# INTERVIEW SYNTHESIS

## MAIN TAKEAWAYS

1. Operators motivations for measurements do not align with SDG metrics
2. GPS and mobile apps can support efficiency
3. No ideal method to measure volume or solids

# INTERVIEW SYNTHESIS

## HOW DO STAKEHOLDERS IMPACT SELECTION OF TECH?

### Operators

Focus on technologies to maintain dignity for desludging workers

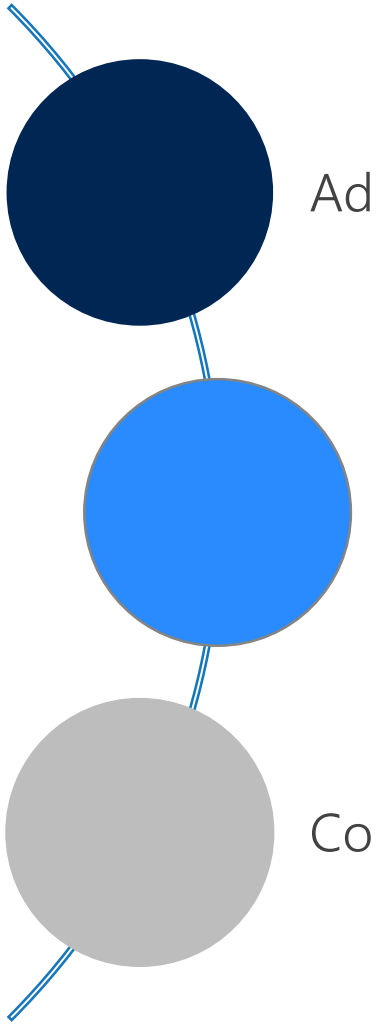
### Households

Balance facilitating efficiencies and transparency without increasing cost

### Manufacturers

Incentivize development of technologies with broad market potential

# CONCLUDING REMARKS



Adopt an off-the-shelf technology with assistance from clever personnel

Tracking: Mobile app

Volume: Ultrasonic sensor

Solid composition: P-Lite

Consider stakeholder motivations when selecting technologies

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# APPENDIX

- Counting trucks
- Measuring volume
- Measuring solid content

# COUNTING TRUCKS

- Near field communication (NFC)

**How this technology works:** Radio technology that allows data transfer over limited range of distance. When tag is activated, then it communicates with phone and completes pre-programmed command

**Requirements and cost:** Does not require internet connection or power ($)

**What makes this a good fit for FSM:** Inexpensive and can provide communication between customers and/or truck drivers

**Disadvantages:** Significant infrastructure requirements/cost

**Case study:** X-Runner

- Lima, Peru
- NFC tag on each toilet
- NFC tag provides updates on waste or payment





Reference: (1)

# COUNTING TRUCKS

- Sweet Sense Smart Sensors

**How this technology works:** Suite of remote-monitoring sensors that utilize a communication platform to provide continuous feedback. Can be hooked up to electrical motors, water tanks, flow meters

**Requirements and costs:** Hardware and monthly data services cost. ($$)

**What makes this a good fit for FSM:** Low power and real-time connectivity enable constant tracking

**Disadvantage**: Cost

**Case study:** Sweet Sense Kenya

- Captures number of individuals that use toilet and is calibrated to estimate when the toilet needs to be emptied




Reference: (2, 3)

# COUNTING TRUCKS

- Vehicle loop detection


Single Channel Traffic Detector microprocessor, which is utilized primarily for traffic control

**How this technology works:** Vehicle detectors built into roads that detect small changes in magnetic field established by coil of wire (inductive loop)

**Requirements and cost:** Card, Card or box detector, server software for data collection and report generation, software. Single loop detector is inexpensive, but infrastructure requirements require initial investment. ($)

**What makes this a good fit for FSM:** Available in battery or plug options; automated. Cost-effective.

**Disadvantages:** Significant infrastructure requirements/cost

Reference: (4)

# COUNTING TRUCKS

- RFID Case Study

**Location:** National University of Malaysia

**Background:** Goal to improve bus timeliness, monitoring and management of bus transportation. Buses were outfitted with black box that contained RFID reader, GPS, and GPRS. Bus stations were outfitted with RFID tags.

**Result**: Utilization of RFID, GPS, GPRS, and GIS for intelligent bus monitoring. Data are saved to a website and transmitted to end-user with GIS interface. Improved driver punctuality, monitoring of bus movements, and more efficient bus circulation


**Figure 5.** Black box installed in the bus with the communication technologies.

Reference: (5)

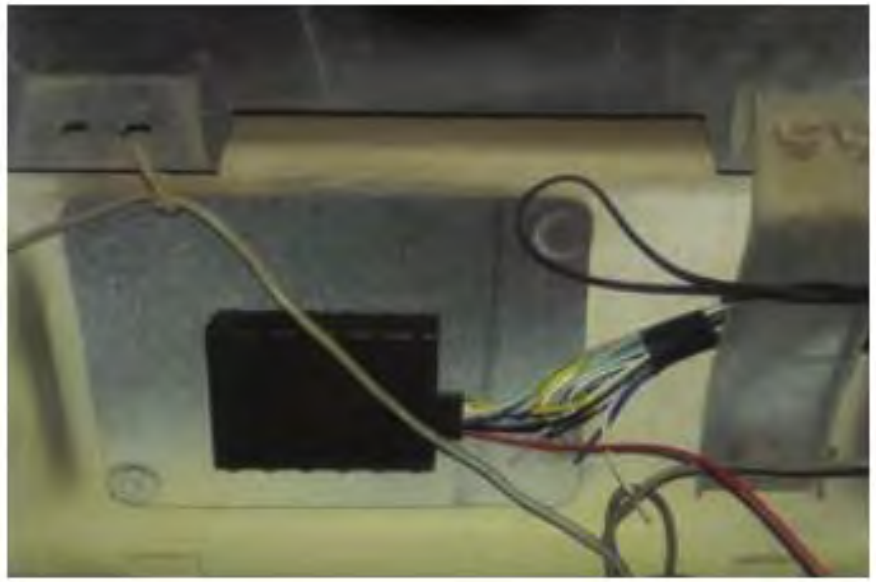
# COUNTING TRUCKS

- GPS Case Study

**Location:** Warangal, India

**Background:** 1st city in India to implement FSM regulations. The population was approximately 600,000 in 2011, with approximately 77% of houses having access to onsite sanitation. Desludging was not being conducted periodically and was solely conducted by private operators. Manual desludging was practiced in areas that were inaccessible by trucks. New regulations in 2016 required desludging operators to be licensed and vehicles to meet standards and be fitted with GPS.

**Results:** GPS data are being analyzed and the city is planning to utilize Geographic Information System (GIS) tools to further coordinate scheduled desludging.

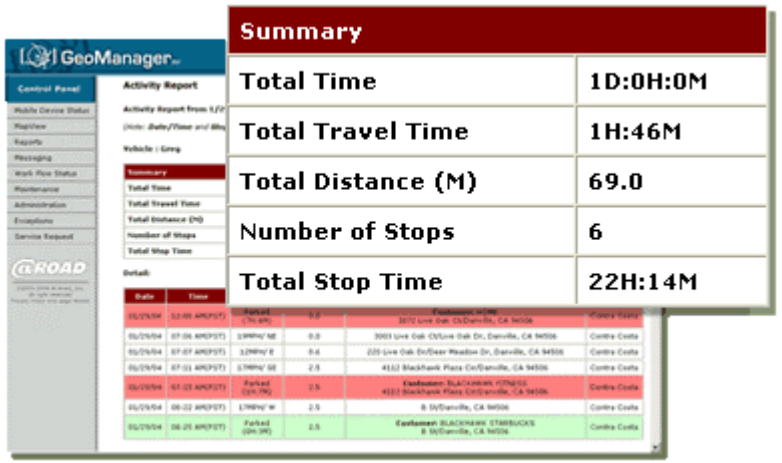


*GPS tracker inside a vehicle*

Reference: (6)

# COUNTING TRUCKS

- GPS Case Study




**Location:** JAS Trucking, based in Chicago, Illinois

**Background:** 120 drivers were dispatched by 7 dispatchers and when order is received the transfer of load information by phone took ~5 minutes per call and was prone to errors. Utilized @Road Geomanager Pocket Edition via Nextel phones to transmit customer information and map drivers' paths and locations.

**Results:** Time management was improved by automating transfer of driver/customer information

Reference: (7)

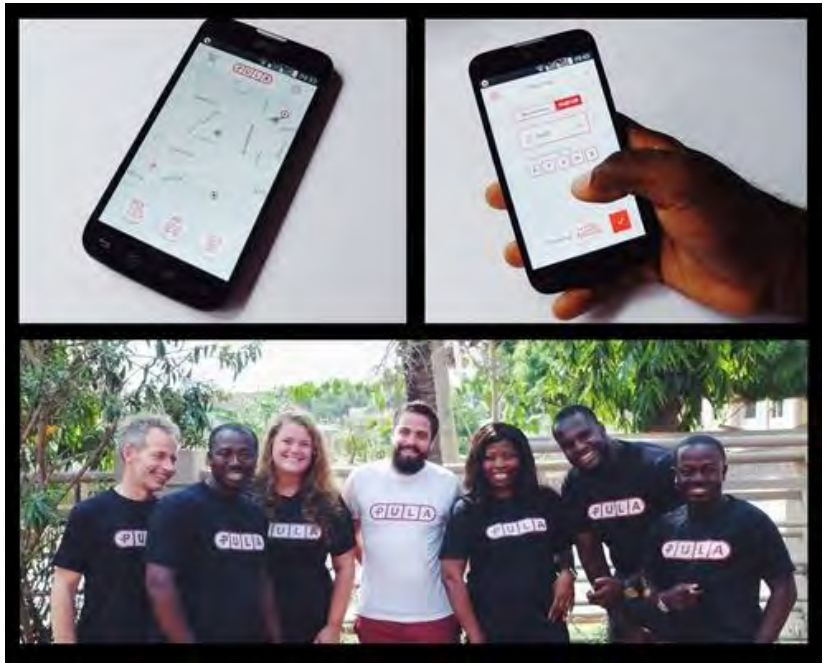
# COUNTING TRUCKS

- Mobile app Case Study

**Location:** Mozambique & Zambia

**Background:** Aqua for All and partner organizations are developing PULA, an app to improve efficiency of FSM for private operators. Goals include improving data collected and increasing operator profits.

**Result:** Project started in September 2017 and recently conducted a design sprint of the application with participation of vacuum truck owners, drivers, the Zambia Environmental Management Agency, and the Lusaka Water & Sewerage Company company. Minimally viable product characteristics identified included truck tracking and customer management.




PULA App and Aqua for All team



Reference: (8)

# COUNTING TRUCKS

- Mobile App Case Study

**Developers:** Dimagi

**Location:** Tanzania

**Background:** Developed CommCare application to assist with logistics and supply chain management for essential medicines.

**Result:** A CommCare open source application, ILS Gateway, allowed healthcare workers to send SMS to notify of stock levels for commodity tracking. ILS Gateway served as a way trace health commodities and prevent stock outs. The pilot program's success led to implementation of the platform to be expanded from 6 to 22 commodities. Currently being used on a national scale, at over 4,600 Tanzanian facilities.




Reference: (9)

# MEASURING VOLUME

- Oval Gear Flow Meter

**How this technology works:** Meter displaces the fluid to calculate volume.

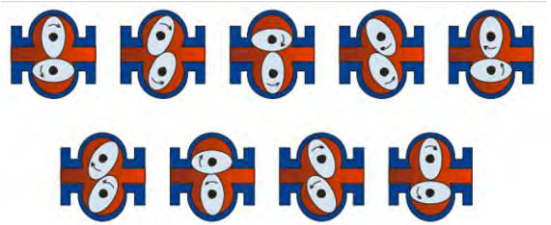
**Requirements & Cost:** Installed inside pipe; requires regular maintenance for moving parts. Large variation in cost from 60 dollars to thousands of dollars per meter.

**What makes this a good fit for FSM:** Positive displacement meters are the only flowmeters that directly measure volume; good for low flow, high viscosity fluids; pulsing flow is measured accurately.

**Other considerations:** Meter gears can snag on solid items in the FS, such as tampons, diapers, etc., which can block flow.

Kobold DON Series Oval Gear Flowmeter measures viscous liquids

Oval gear flowmeter operating principle



Reference: (10 - 12)

# MEASURING VOLUME

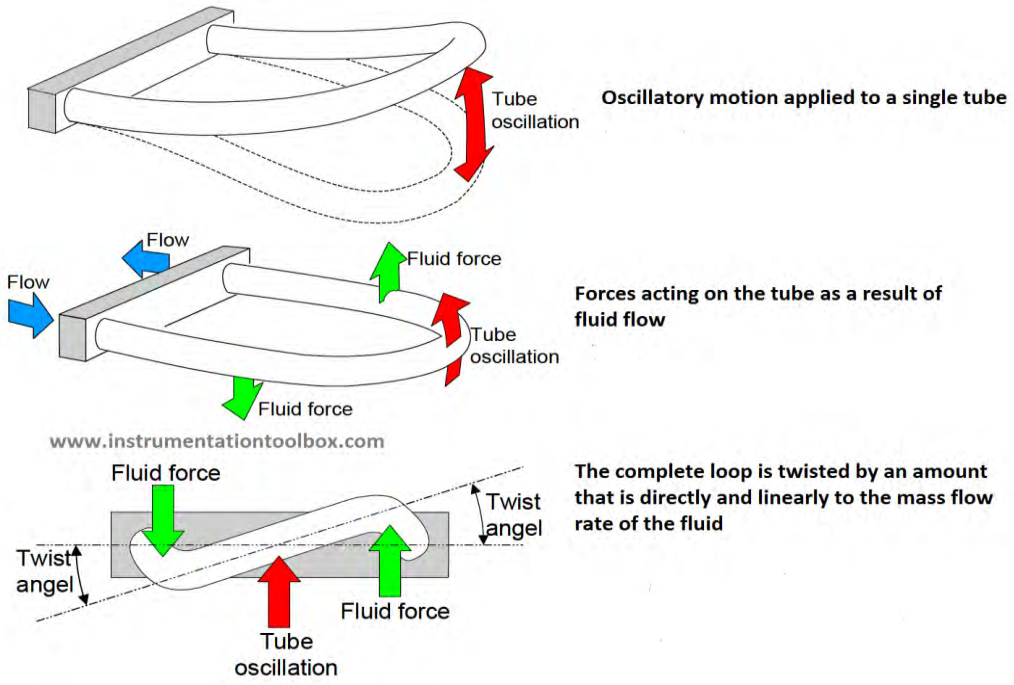
- Coriolis Mass Flow Meters

**How this technology works:** meter calculates mass flow rate by measuring force from acceleration caused by mass moving toward/away from center of rotation.

**Requirements & cost:** insert meter into a section of the pipe; expensive compared to other flowmeters

**What makes this a good fit for FSM:** low maintenance requirements, reliable.

**Disadvantages:** expensive; meter measures mass flow, so need to know density to accurately calculate volume; low flow rates can decrease accuracy.






Reference: (13, 14)

# MEASURING VOLUME

- Liquid levels: Alternative technologies

**Radar:** Requires advanced communication, fluid dielectric constant can present challenges

**Pressure:** Used primarily for "clean" fluids

**Capacitance:** Fluid dielectric constant can present challenges

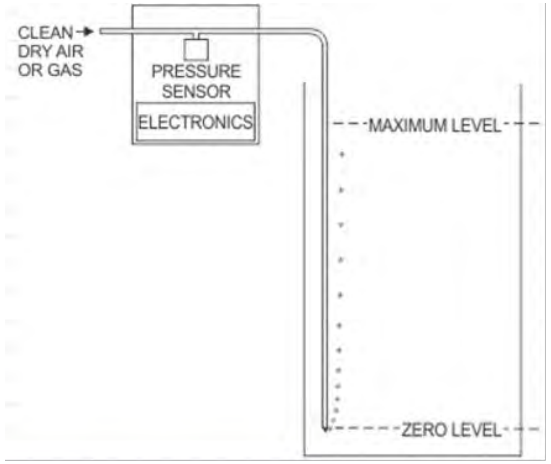
**Infrared:** Used primarily for anaerobic digesters

**Bubblers:** Requires multiple pieces of equipment

**Conductance:** Not enough information about use with viscous liquids

**Weight/load cells:** Must be mounted, expensive

**Sight glasses:** Not good for highly viscous liquids



*Bubbler*

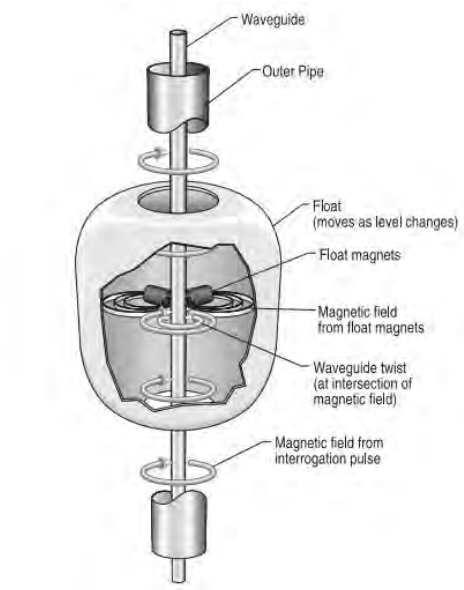

*Load cells*



Reference: (15, 16)

# MEASURING VOLUME

- Mechanical/magnetic floats Case Study




Components of a magnetostrictive level sensor

**Location:** (Undisclosed) pharmaceutical company, California

**Background:** The company needed a way to measure volumes of water solutions and buffers in portable tanks for quality control and data management. Many of their solutions had high salinity and a high level of foam; two conditions which lead to unreliable reads using both radar and ultrasonic sensors.

**Result:** They installed a MTS Sensors' MR M-series level and received reads with high degree of accuracy despite changes in temperature, pressure, and the use of caustic solutions used in the sanitation process.

Reference: (17)

# MEASURING VOLUME

- Flow Meter Case Study


Typical lift station in NSW

**Location:** New South Wales (NSW), Australia

**Background:** Utilized for monitoring sewage volumes in lift stations. Previously full bore magnetic flowmeters were used to monitor volumes but this was too costly and difficult to manage. Now, they have shifted to using a FloPro meter.

**Result:** Savings in the meter costs and installation. Meter can measure volume of discharge; cost efficient alternative to a magnetic flowmeter.

Reference: (18)

# MEASURING VOLUME

- Electromagnetic Flow Meter Case Study

**Location:** Ashley Valley Water & Sewer Improvement District (AVWSID), Vernal, Utah

**Background:** Team at AVWSID needed to track water use. If the plant exceeds their water allocation they have to purchase water for a higher rate, which results in many negative consequences both for operational costs and customer fees.

**Result:** Team installed magnetic flow meters to calculate the flow of water entering the plant. The team reports that the magnetic flow meter is accurate and reliable. In addition, installation of the new meters was simple and had minimal effects on operation.

Use of electromagnetic flow meter to track water use in a rural area for allocation and conservation purposes.

Reference: (19)

# MEASURING VOLUME

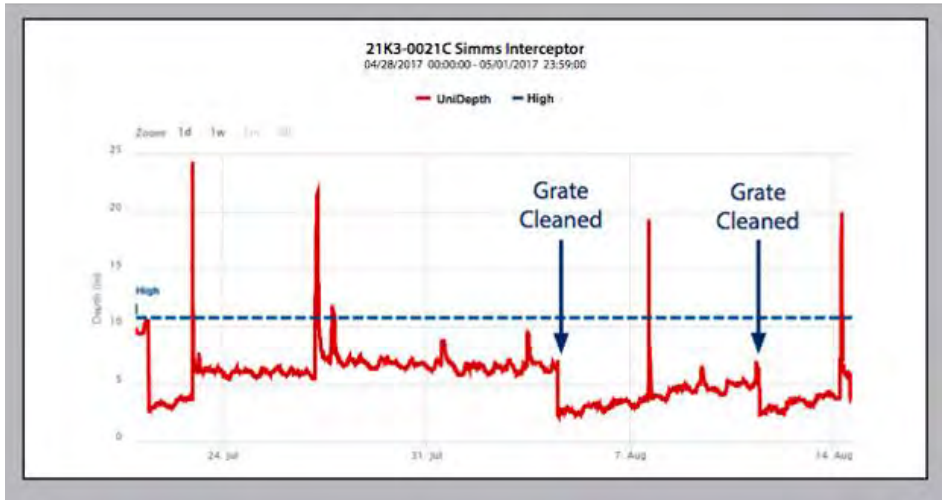
- Ultrasonic Sensor Case Study

**Location:** Metropolitan St. Louis Sewer District, St. Louis, Missouri

**Background:** Many parts of the system date back to the 1850s and have dry-weather diversions (or "interceptors") that become clogged and can lead to overflows. Previously, crews had to visit the Simms Interceptor and similar locations 2-3 times per week for monitoring.

**Result:** A single ADS Echo level sensor was installed below the manhole frame allowing for real-time data on the status of the interceptor via web-hosted software and text and email alarms. Field inspections were reduced by 67% and sensor facilitates targeted "on demand" cleaning leading to increased safety as well as time and cost savings.

Simms Interceptor Structure
St. Louis, MO (MH 21K3-0021C)




Sensor output data



Reference: (20)

# MEASURING VOLUME

- Transmission Ultrasonic Flow Meter Case Study

**Location:** Tritton Copper Mine, New South Wales

**Background:** Team at Tritton Copper Mine needed to measure the flow rate of slurry that included cement, tailings and water. As there are challenges with measuring slurry, the team decided to use ultrasonic flow meters but adapted the meters with customized solutions so that they were applicable for a thick slurry liquid.

**Result:** Team selected and implemented clamp-on ultrasonic flow meters, as this minimized disruption to the system, that had larger than standard ultrasonic transducers. The large transducers emit strong enough signals to travel to through the slurry and pipe walls to result in a measure.


Use of flow rate meter to measure slurry of cement, tailings, and water

Reference: (21)

# MEASURING VOLUME

- Laser Sensor Case Study

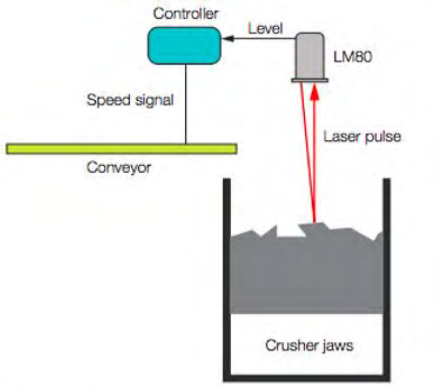



Fig. 4: The controller regulates conveyor speed based on the ore level signal from the ABB LM80 laser level gauge

Integration of sensor to operational machinery

Placement of the sensor

**Location:** Vale's Totten Mine, Ontario, Canada

**Background:** A recently opened copper and nickel mine was looking for solutions for receiving the optimal amount of ore in the crusher jaws. They selected a ABB LM80 laser level to measure the ore in the crusher and avoid issues with overloading and jams.

**Result:** The laser level works well and has eliminated the need for a manual intervention at the crusher increasing worker safety. It functions so efficiently that Vale purchased two additional laser sensors.

Reference: (22)

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