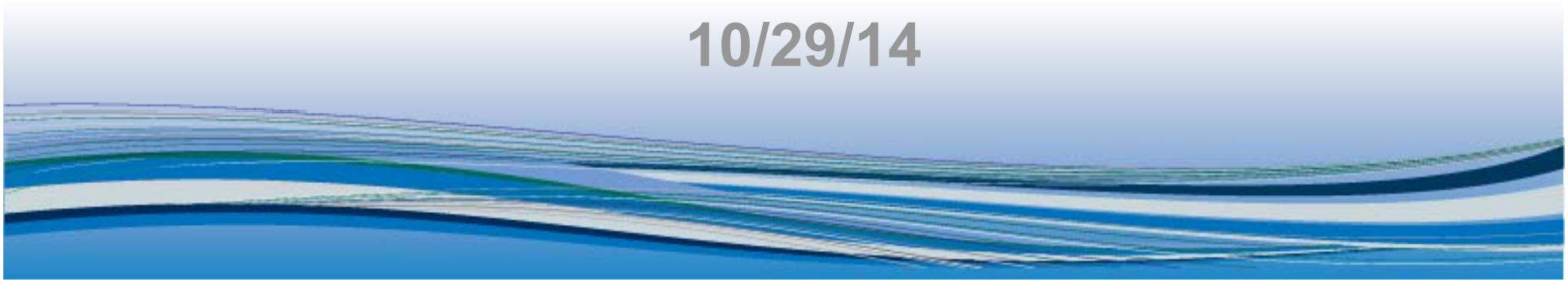
DPR Water Quality and Human Health

DPR Research Needs Workshop

with SWRCB Staff and Stakeholders

10/29/14



Defining DPR

- **DPR – Direct Potable Reuse includes both**
  - **Direct introduction of highly purified recycled water (FAT treated – MF/RO/AOP) into drinking water systems and**
  - **Introduction of highly purified recycled water into raw water supplies prior to conventional drinking water treatment but without significant retention in an aquifer or reservoir**

DPR Water Quality and Human Health Risks

- **Microbial risk (mostly acute)**
  - Pathogenic
    - Virus
    - Protozoa
    - Bacteria

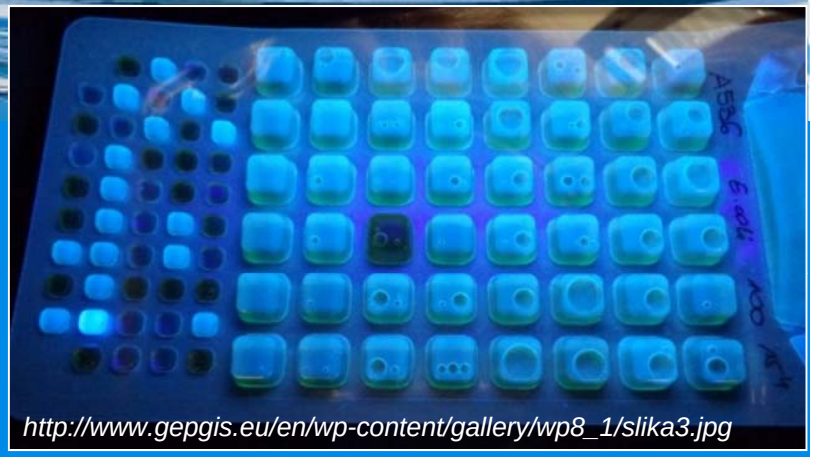

Epstein-Barr Virus
http://www.wallcg.com/cellular-virus-high-definition-high-135696/

- **Chemical risk (mostly chronic)**
  - Natural and synthetic compounds
  - Regulated and Unregulated

PROP. 65 WARNING
The State of California contains one or more chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

- **Microbial and chemical risks exist with both conventional drinking water and DPR sources but differ in degree of source vulnerability**

Controlling Microbial Risks


http://www.gepgis.eu/en/wp-content/gallery/wp8_1/slika3.jpg

- Cannot test for all pathogens
- Rely on indicator bacteria
- Rely on multiple barrier treatment
- Rely on surrogate measures of treatment performance
- DPR must achieve required log removals from raw sewage
  - Virus = 12 log (CA DDW)
  - Giardia & Crypto = 10 log (CA DDW)
  - Bacteria = 9 log (WRRF 11-02)
- Will need to assure virtually fail-safe treatment for microbial hazards via redundant barriers and real time monitoring

How DPR pathogen risk differs from conventional water sources

- Source waters (sewage) carry higher pathogen load
- Additional treatment barriers needed to assure microbial risk reduced to acceptable levels
- Need on-line continuous monitoring to detect treatment failure
- Supplemental/redundant barriers can be alternative to fail-safe monitoring (i.e., providing extra log removals)
- In addition to treatment monitoring and performance verification, is additional microbial testing (> coliform) needed for DPR?

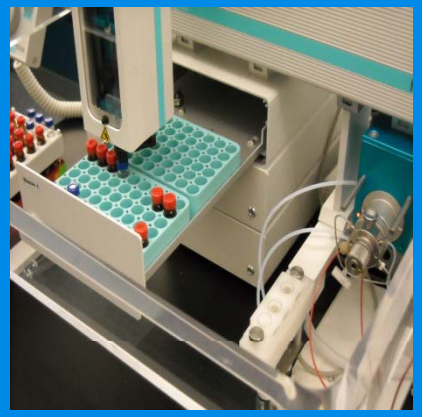
http://www.shimmick.com/upload_resources/project_images/display/1319664193 59.jpg

Microbial testing methods

- Conventional drinking water and recycled water systems rely on coliform testing – can take days for results
- Molecular methods (PCR-based) available today:
  - Can be done more quickly,
  - Can test for selected indicators or pathogens
  - Can test for microbial community structure
  - Cannot test for all pathogens
  - Difficult to determine infectivity and concentration

http://users.ugent.be/~avierstr/principles/pcrsteps.gif

Controlling Chemical Risks



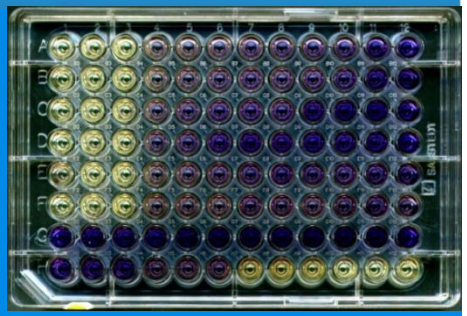
- Cannot test for all chemicals – list is huge and growing
- Test for chemicals with MCLs, NLs or in UCMR
- Rely on multiple barriers to chemicals
- Source control to reduce load of hazardous chemicals
- Secondary treatment to reduce biodegradable compounds
- RO to remove most chemicals, especially >200 daltons
- UV/AOP to photolyze and oxidize organic compounds
- Rely on surrogate measures to verify treatment performance (ΔTOC, ΔEC, UV power, etc) at Critical Control Points (CCPs)

How DPR chemical risk differs from conventional water sources

- For MCL contaminants – very little difference other than NO_2/NO_3
- Most conventional sources receive no treatment for removal of chemicals – more protected sources
- DPR sources more likely to carry unregulated contaminants (PPCPs and other CECs)
- DPR sources will require FAT treatment (MF/RO/AOP) to remove/destroy chemicals
- Use online monitoring of surrogates (at CCPs) and periodic indicator testing to verify chemical removal processes
- Are additional measures needed to examine risk of unregulated and mixtures of chemicals?

Assessing chemical risks

http://publiclab.org/sites/default/files/1471-2180-4-25-2-l.jpeg



- Conventional chemical risk assessment by testing compound by compound - occurrence and toxicity
- Bioanalytical tools provide a screening alternative to individual chemical testing – still in infancy
- Can assess only selected types of biological responses with in-vitro bioassays
- Can test for effects of unknown chemicals and mixtures
- Will require specialized training and certification in use of multiple in-vitro bioassays
- Will require advanced chemical analyses to attempt identification of chemicals or mixtures responsible for bioassay response
- Will require special knowledge of relationship between bioassay response and human health risk

Questions for DPR: microbial risk

- Is DPR microbial risk sufficiently different to require use of additional microbial tools?
- Or do conventional multiple barrier and surrogate/indicator monitoring provide adequate protection for microbial risk?
- Can additional log removal requirements and on-line treatment verification measures assure microbial safety?
- Can the risk of false positives be adequately mitigated?
- How would molecular methods be used and interpreted?

Questions for DPR: chemical risk

- Are chemical risks with DPR fundamentally different than conventional sources?
- Can additional chemical removal/destruction processes provide adequate protection against unknown chemical contamination?
- Can surrogate measures provide adequate evidence of removal of chemical risks?
- Which bioanalytical tools are ready to be used for screening DPR or other vulnerable water supply sources?
- Should bioanalytical tools be benchmarked against conventional water supplies?
- How would bioanalytical tools be used and results interpreted?

General DPR Questions

- Should DPR be subdivided into more than one category?
- Should different approaches be developed for water quality and health protection with “Direct” DPR vs. raw water supplementation DPR?