Mosquitoes in My Infrastructure!

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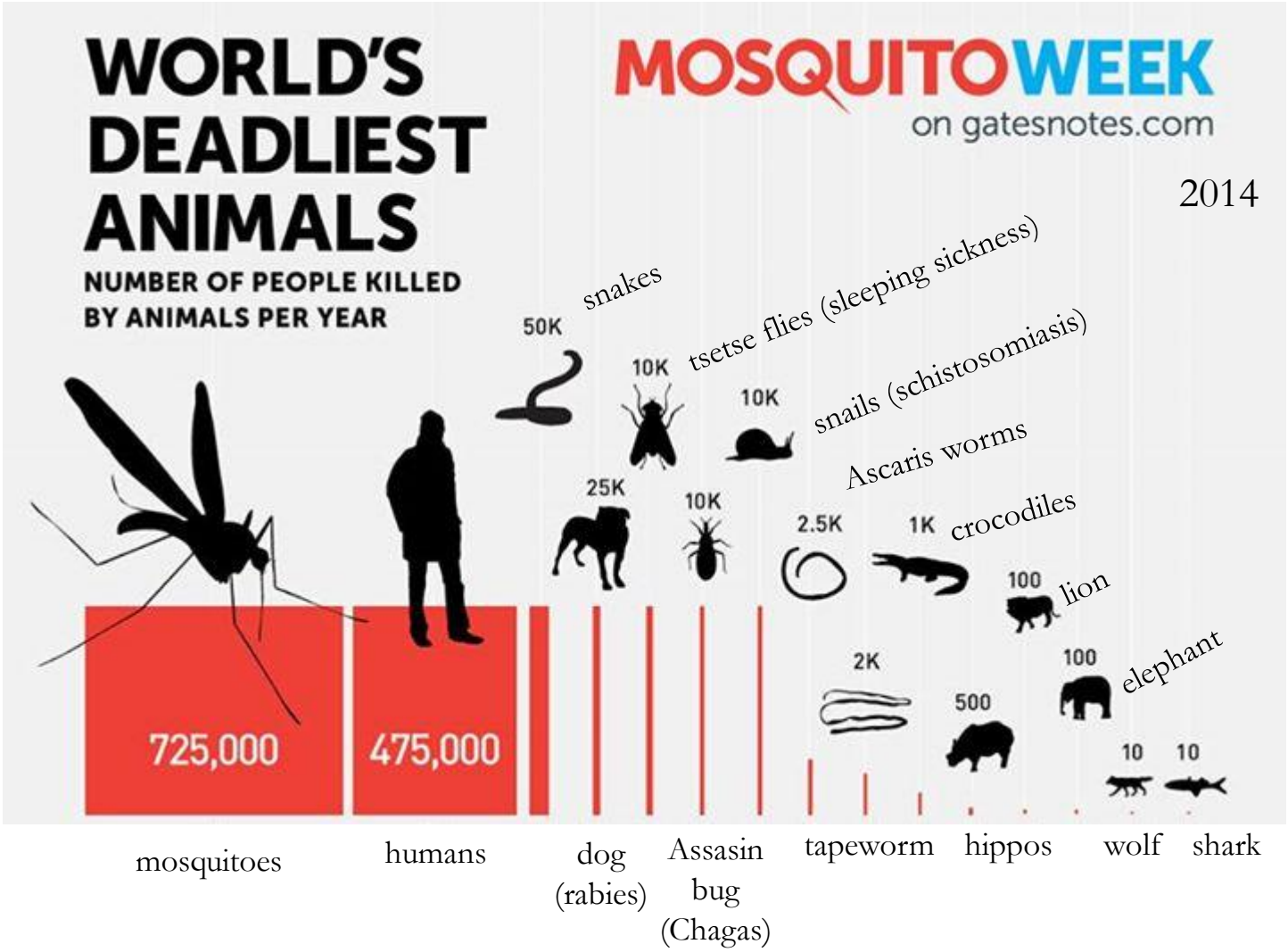
Plan for presentation

- Why should you care about mosquitoes?
- Mosquitoes in stormwater & flood infrastructure
  - How we manage them
- Zika virus

Why should you care about mosquitoes?

- **Annoyance**
  - Can affect property values
- **Reduce disease burden and associated costs**
  - West Nile Virus, dog heartworm
- **Prevent the spread of new and exotic diseases**
  - Malaria
  - Dengue, Chikungunya
  - Zika

gatesnotes THE BLOG OF BILL GATES



Source: http://www.gatesnotes.com/Health/Most-Lethal-Animal-Mosquito-Week

In the United States today....

- Hundreds of special agencies devoted to mosquito control

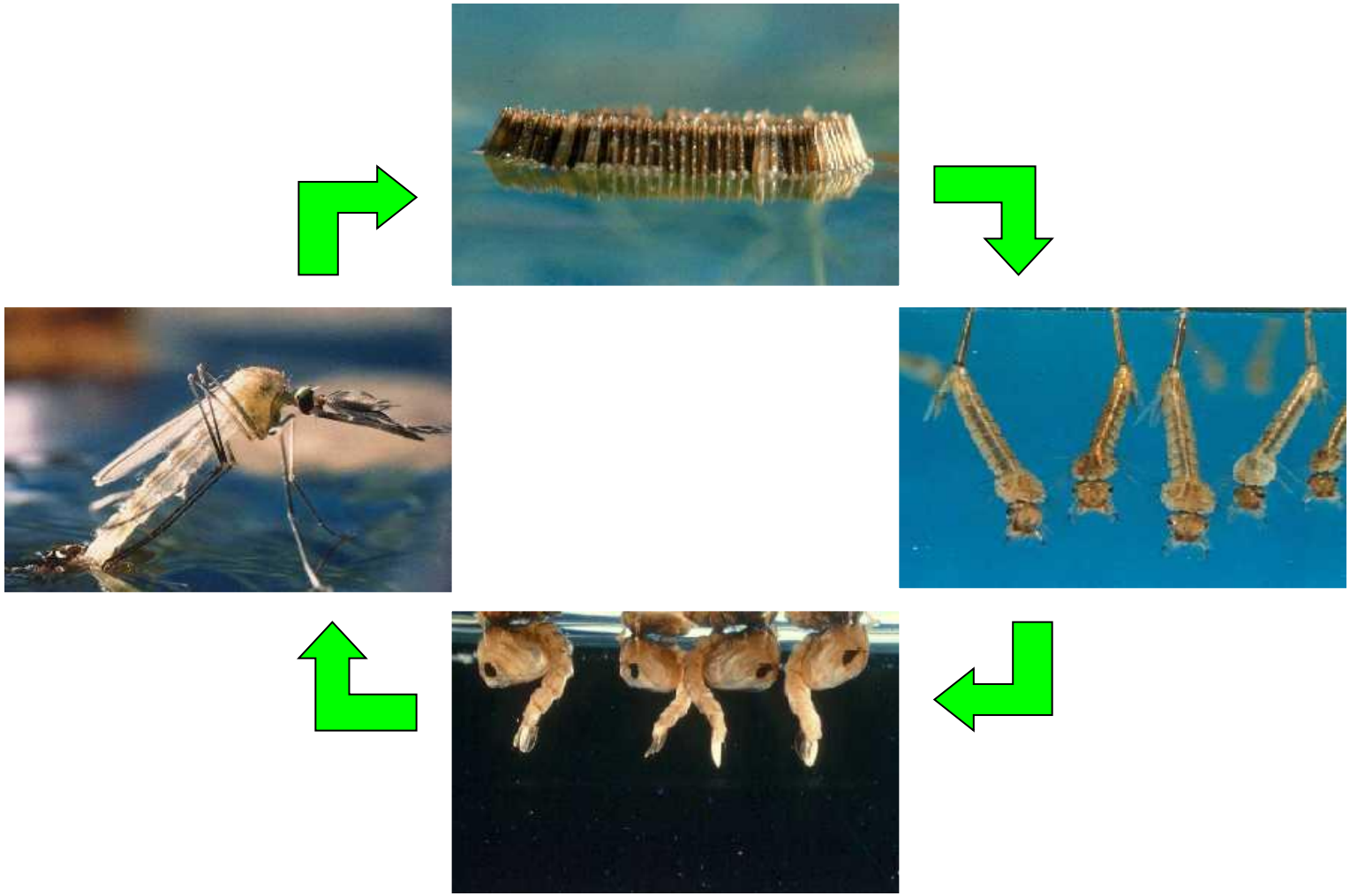
- Mandated by **local health and safety codes**
  - Many instituted over a century ago

Mosquito Control In Illinois

- Illinois Code
  - "**Mosquito Abatement District Act**"

- Special agencies formed in 1927 to fight malaria (in south) and nuisance mosquitoes (in north)

Mosquito life cycle dependent on stagnant water



Best way to get of mosquitoes

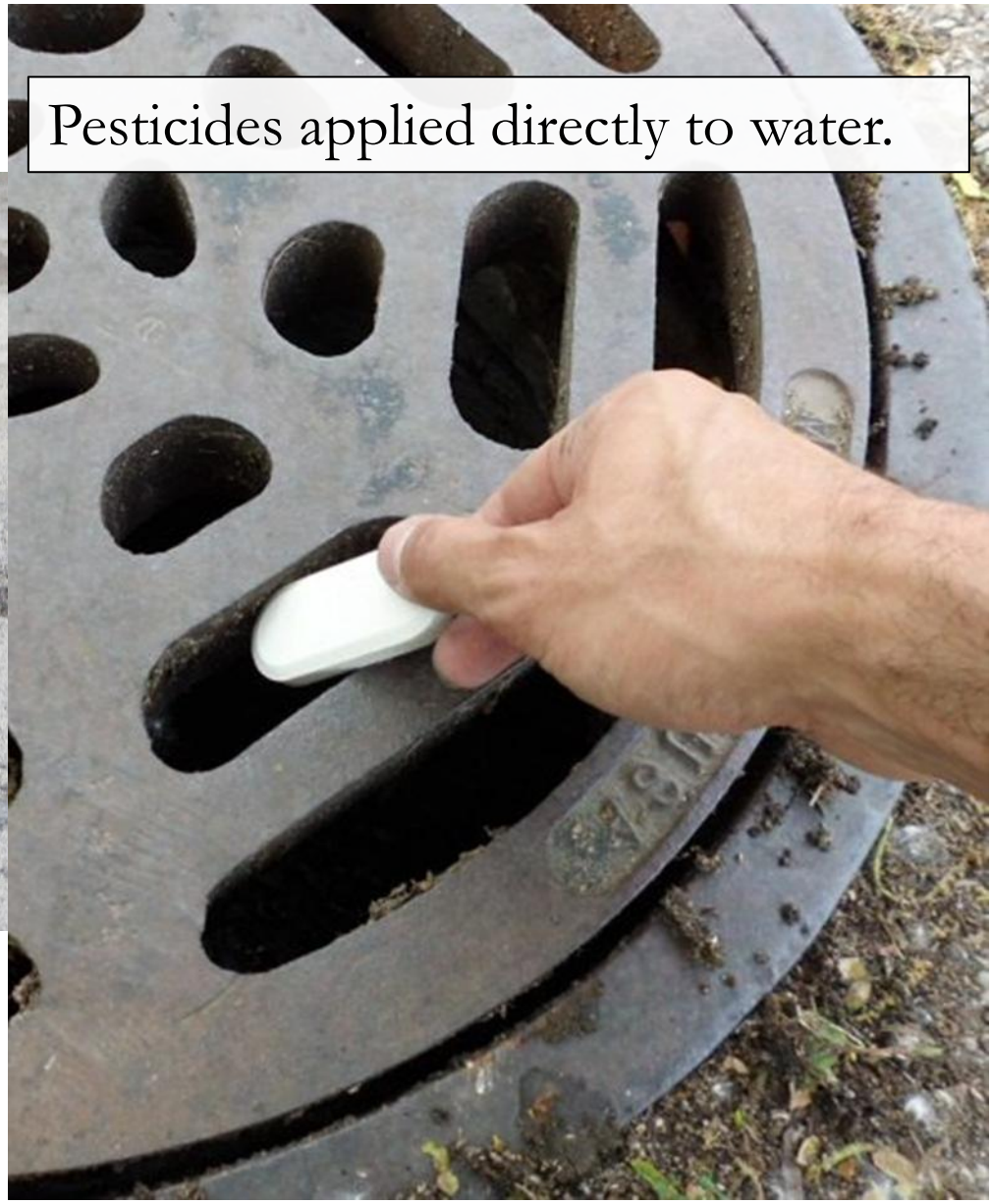
Remove standing water

- Most cost-effective
- Permanent
- Most environmentally-friendly

When it is impossible to remove standing water…

Larvicides

Pesticides that utilize components of bacteria or insect hormones and target **mosquito larvae** and **pupae**



Pesticides applied directly to water.

Adulticides

Target: adult, biting mosquitoes

Last resort effort

- High #s of mosquitoes
- Mosquitoes with virus
- Human cases

Mosquito Pesticide Regulations

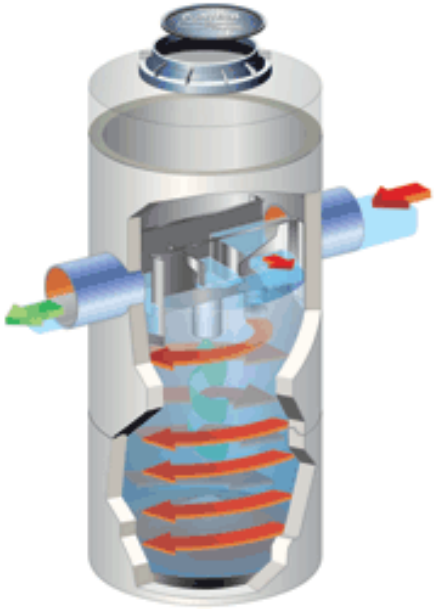
- "Doubly regulated" by EPA
  - Regulated by FIFRA (Federal Insecticide, Fungicide and Rodenticide Act) since early 1900s.
  - Since 2012 Agencies must apply for NPDES permits (EPA) and keep them updated

The connection between public infrastructure & mosquitoes

Flood and Water Quality Infrastructure

Flood Control

BATs + BMPs + Green Infrastructure, etc.



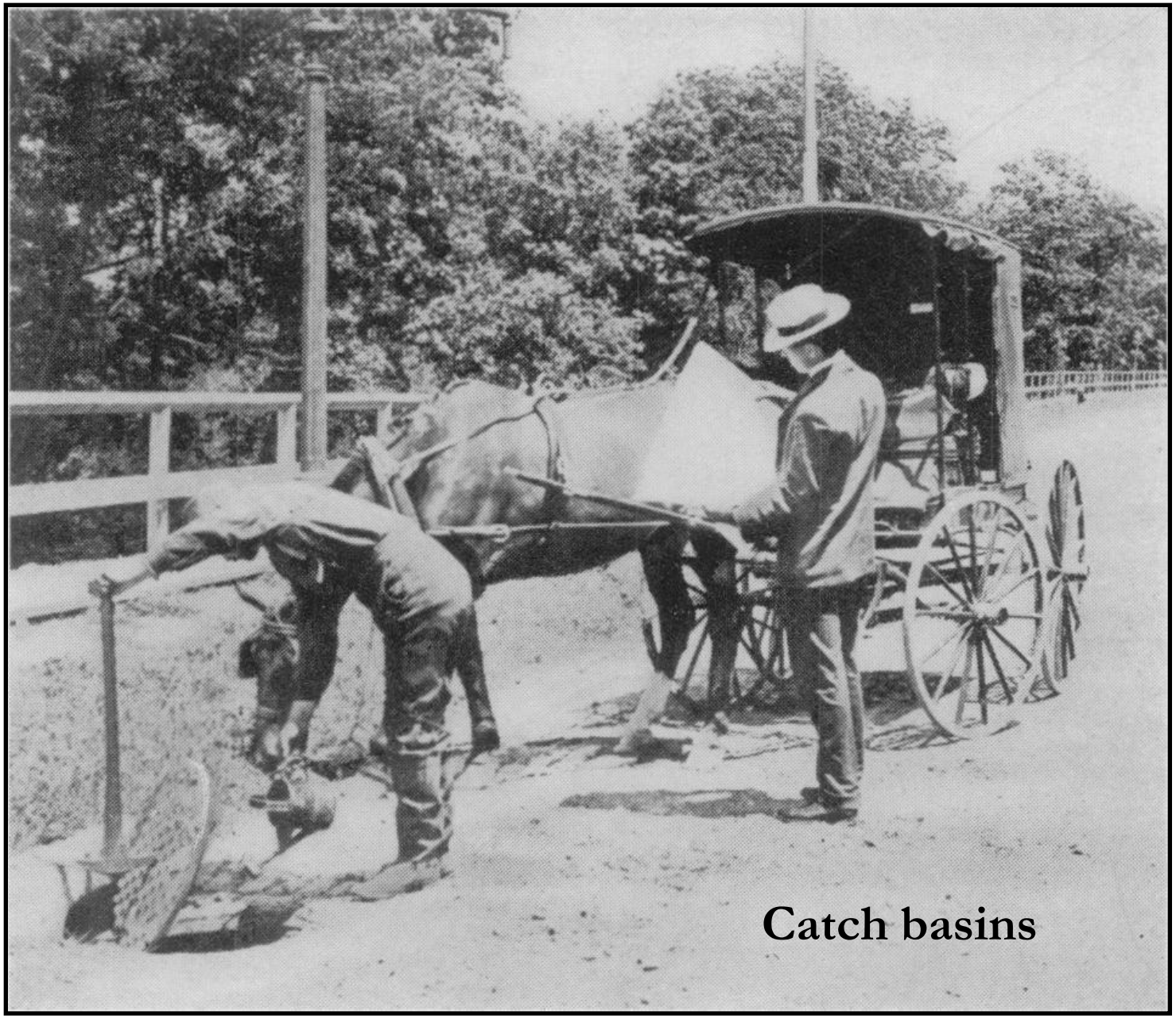
Common structural characteristic:

Standing water!

Over a century of studies

Mosquitoes found throughout flood and stormwater (public) infrastructure

- Flood Control Channels
- Storm drains
- Catch basins
- Rain barrels, cisterns
- Detention and/or retention basins
- Grass swales
- Stormwater treatment wetlands/ponds
- Infiltration basins/trenches
- Belowground proprietary systems
- Bioretention systems
- Sand filters

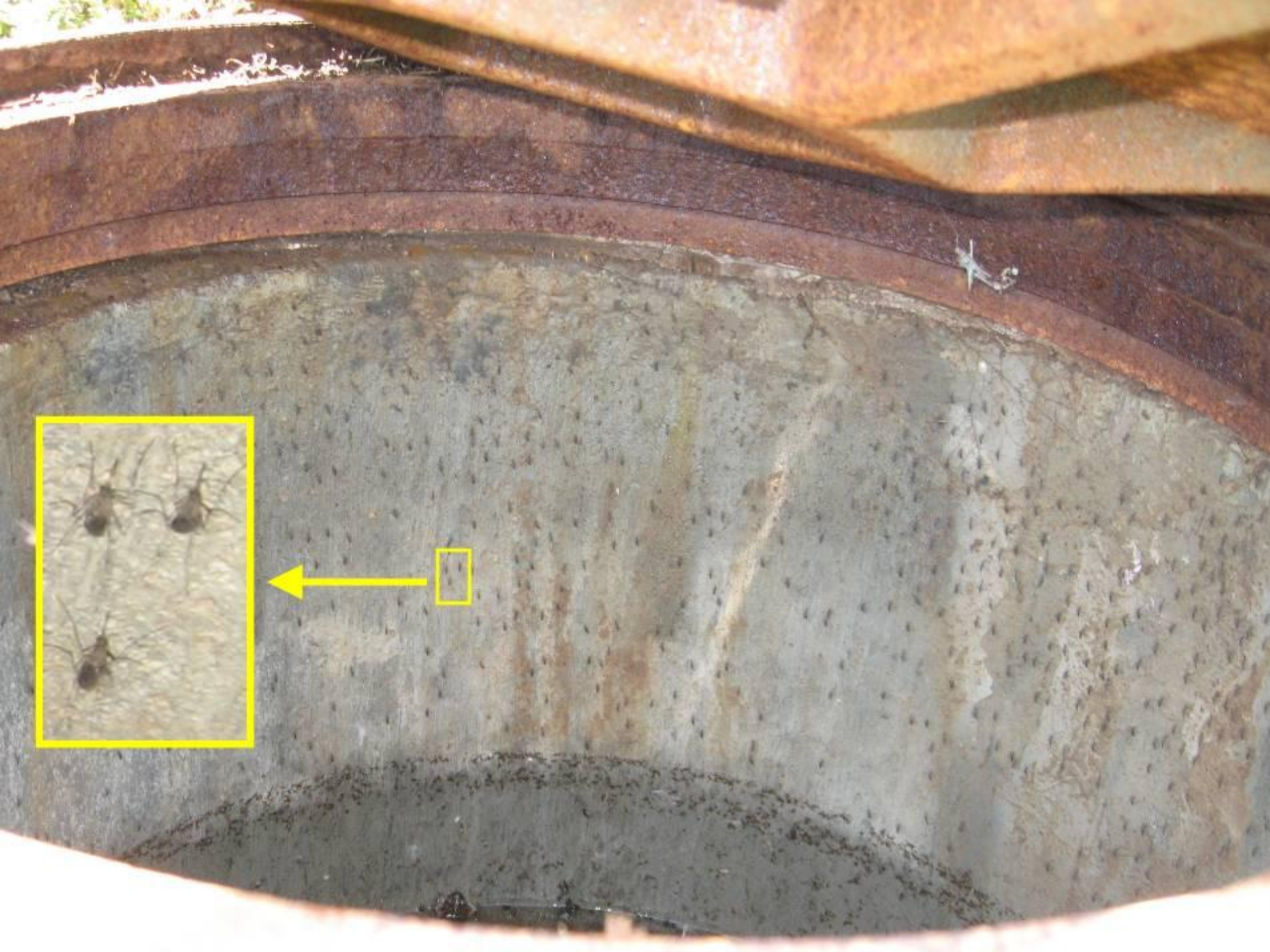


Abatement of the Mosquito Nuisance in Brookline H. Lincoln Chase, J. Albert C. Nyhen J Mass Assoc Boards Health. **1903** January; 12(4): 190–203.

Habitats Associated With Design


Retention Basin

Habitats Created by Design



Lessons learned

- West Nile Virus mosquitoes most commonly found in public infrastructure.

- In Illinois, *Culex pipiens*
  - Primary transmitter of WNV
  - Does well in polluted waters

Culex pipiens

West Nile virus

St. Louis Encephalitis

Harbison et al. 2010

Lessons learned.

- There is growing evidence that public infrastructure is the **predominant source** of mosquitoes species that can transmit West Nile virus.

Stockwell et al. 2006; Allen and Shellito 2008; Metzger et al. 2011, 2012

Lots of sources in Chicago Area

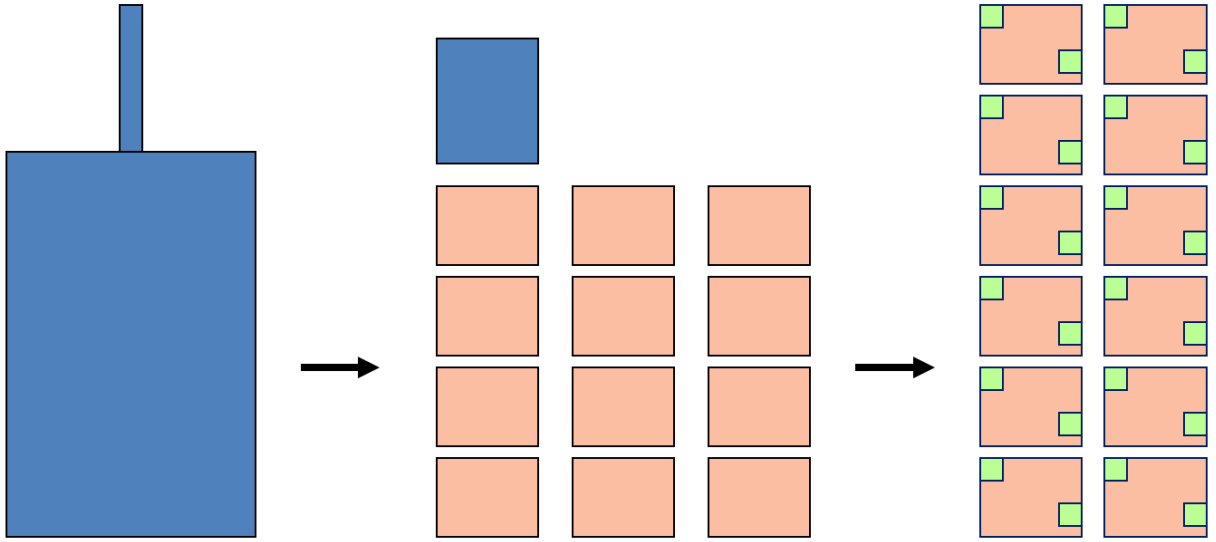
To reduce WNV mosquitoes each year:

- local mosquito programs will spend over $1 million on pesticide applications to just **catch basins** alone
  - approximately 600,000 catch basins treated

Lessons learned

- Increasing amount the amount of structures <u>increases</u> the number of mosquito sources near humans

Flood and stormwater transition

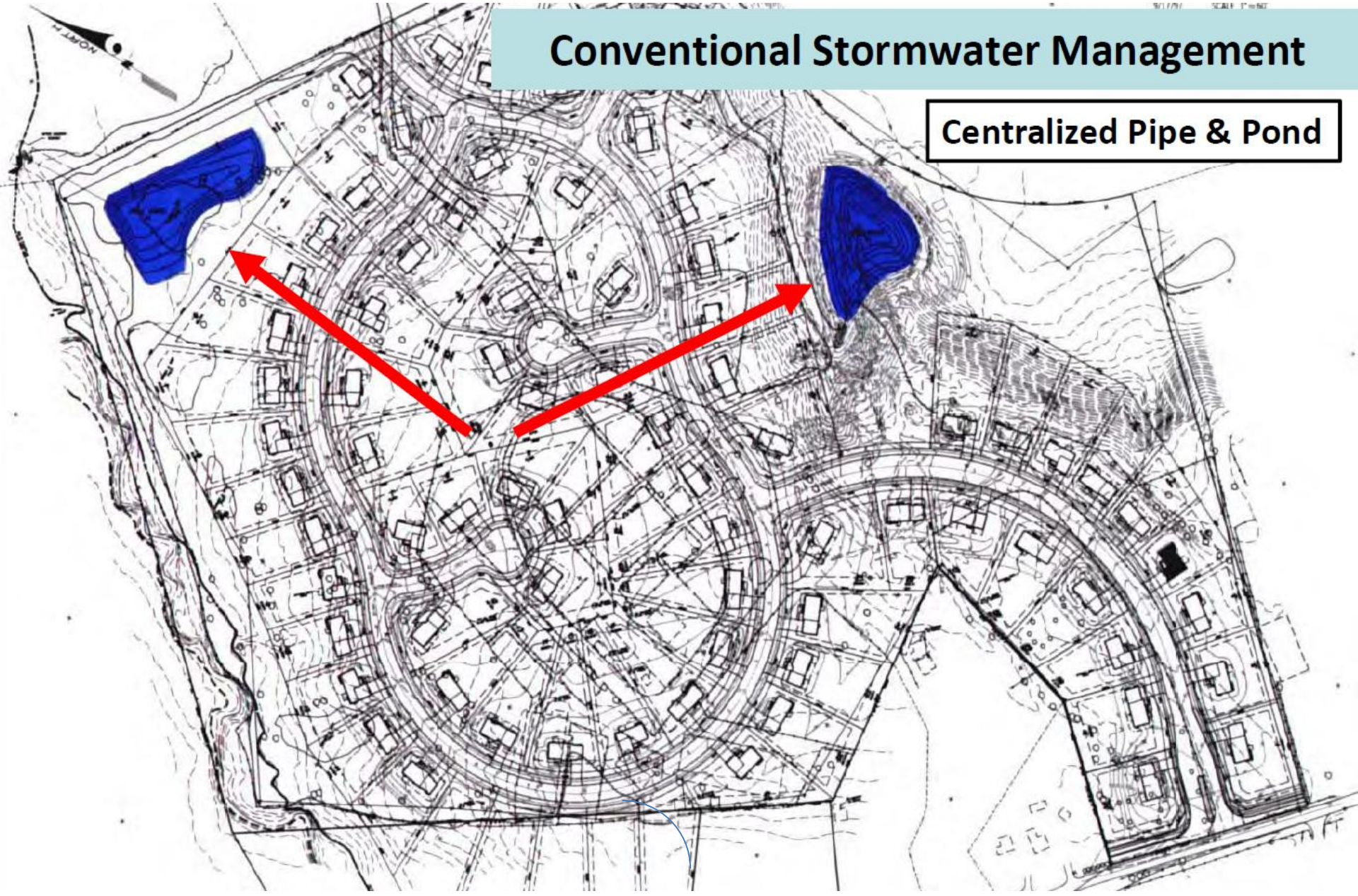


End of Pipe
Regional Approach

Specific Plan/ Housing
Development Scale

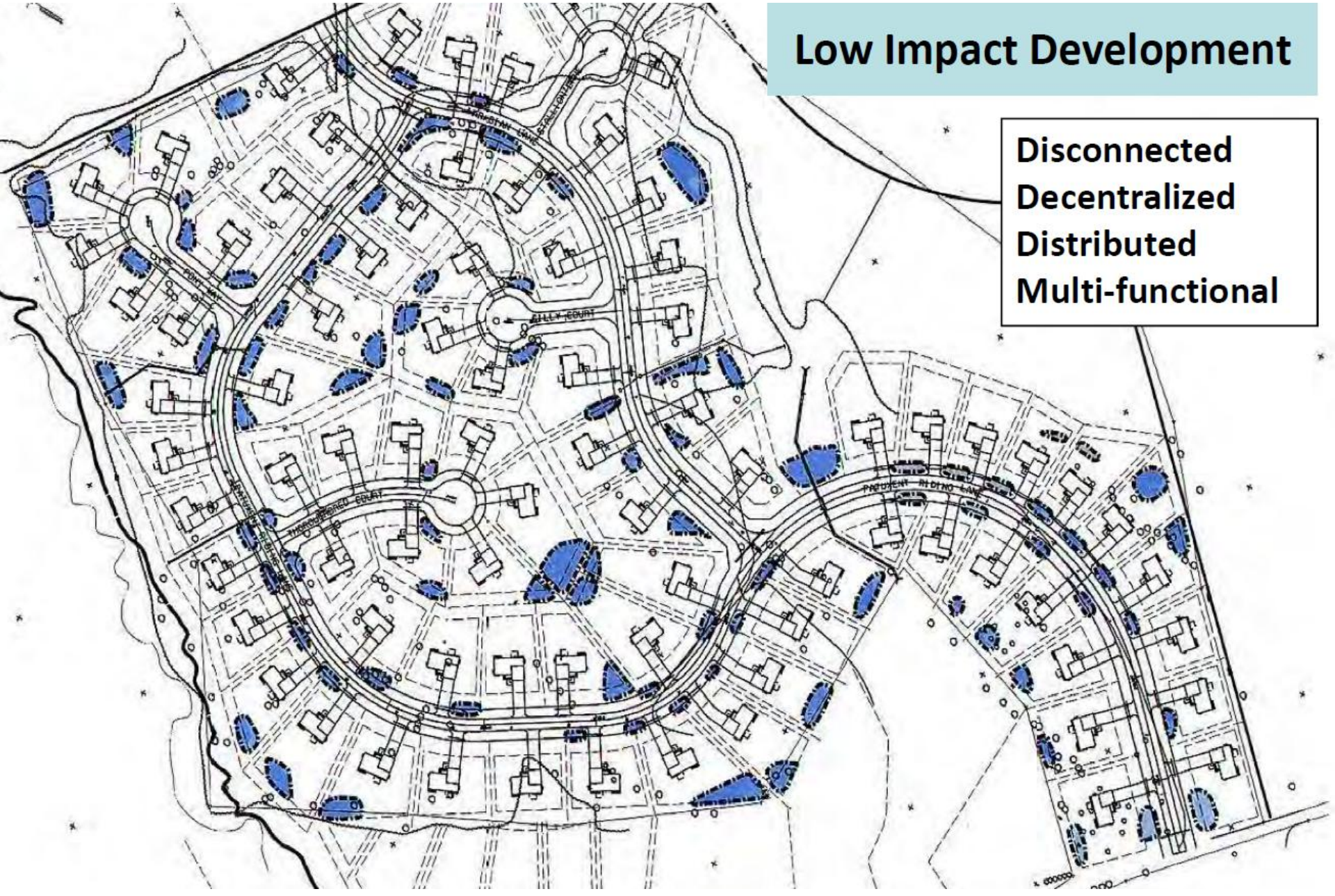
Parcel Scale

Conventional Stormwater Management

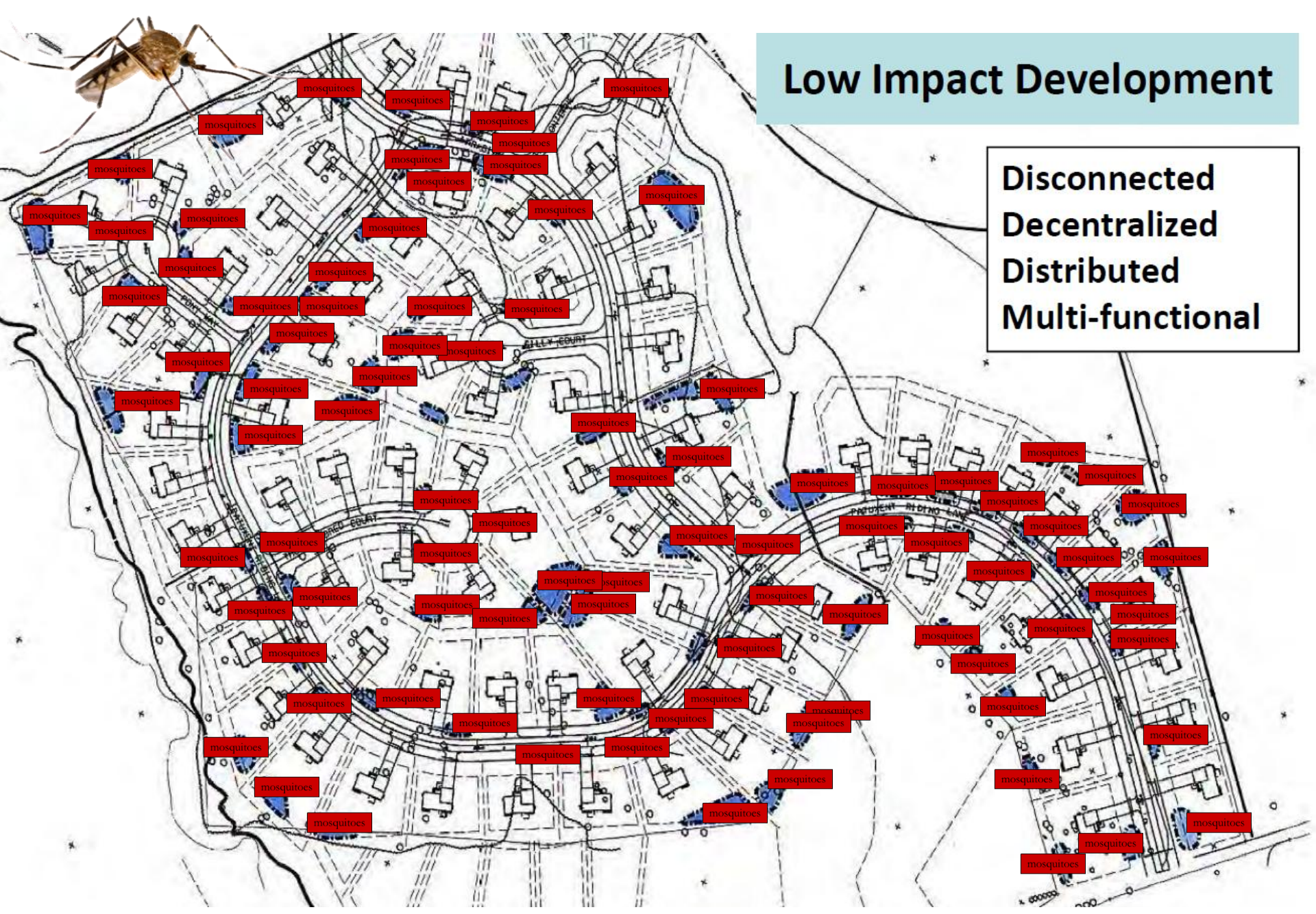


Horsley Witten Group 2012

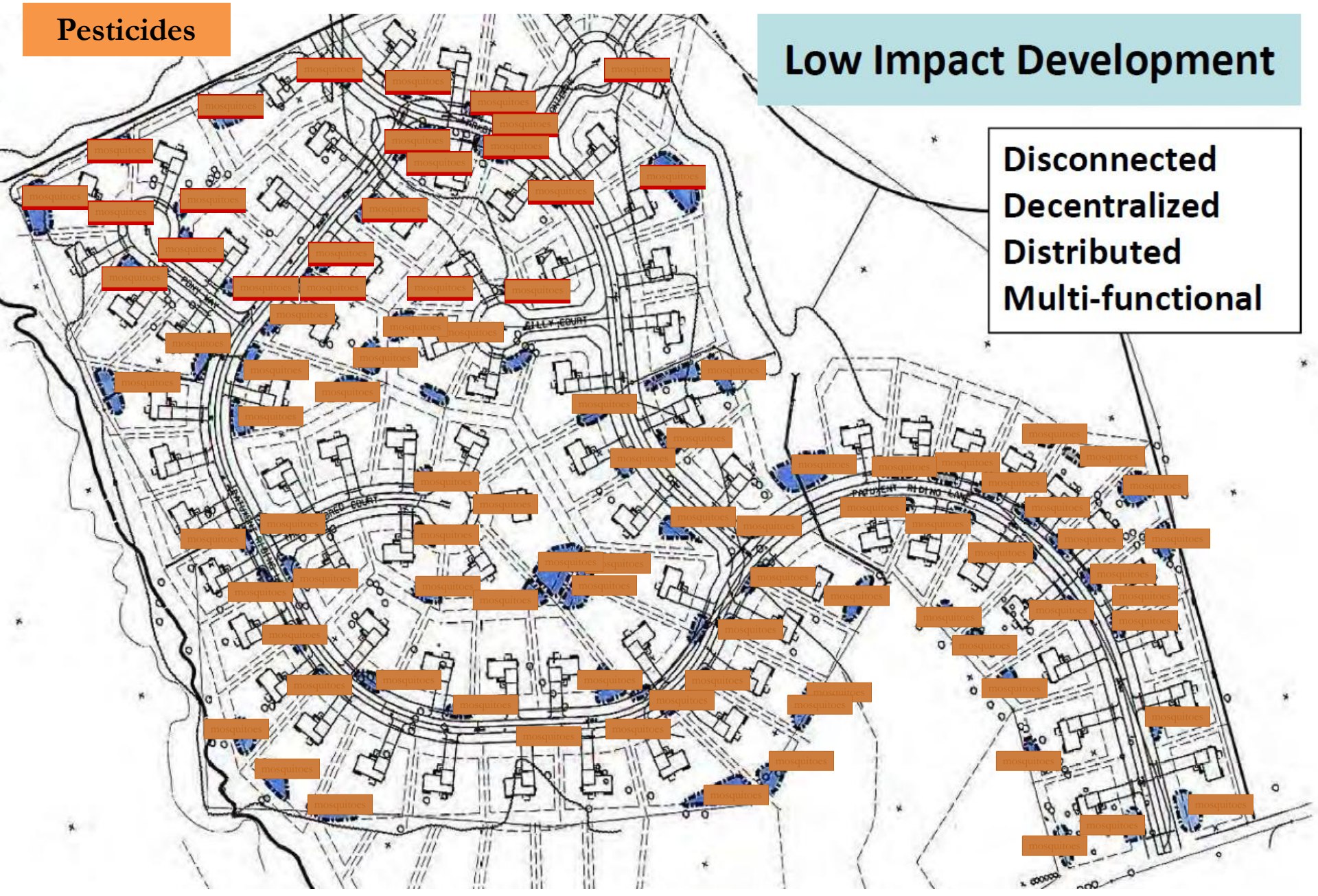
Low Impact Development



Horsley Witten Group 2012



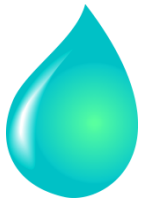
Horsley Witten Group 2012



Horsley Witten Group 2012

Ethical Inconsistencies in Our Water Management?

Flood and Stormwater Management

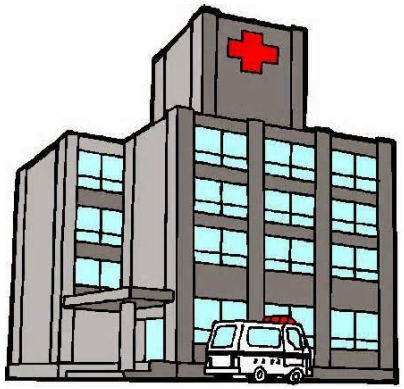


Infrastructure used to:

protect our waters from pollution

protect our property

protect our health



But what happens in times when there aren't major storm events?

Example: Total Maximum Daily Loads

Limits amounts of pollutants going in our waters

Structures designed to reduce pollutants:

- TSS, TDS
- Dissolved Oxygen
- Phosphorous, Chlorides
- Salt
- Fecal coliform, etc.

http://www.epa.illinois.gov/

Health risk of TMDL Pollutants?

How many kill people or at least make people clinically ill?

- Fecal coliform (E.coli)
  - but also found in other sources, e.g. Chipotle
- Total Suspended Solids?
- Sedimentation/Siltation?
- Sludge, Phosphorous
- Dissolved oxygen, pH, etc.?

Health Risk of Mosquitoes

From 2002 to 2015 in Illinois:

- 2,200 reported West Nile Virus cases
  - 1,371 neuroinvasive cases
    - serious, long lasting or permanent effects
      - » Tremors, seizures, paralysis, headache, coma, etc.
- 138 WNV deaths

http://www.cdc.gov/westnile/

If there is a constituent in your structures' waters that can **kill** people or **permanently disable** them…

Why not more actively plan to reduce that public health risk?

Moving forward…

We already can design structures to:

- Minimize mosquitoes (particularly WNV species)

&

- Reduce the need for pesticides

Good design – no standing water, water drains completely

- Maintained properly
- Drains in <96 hrs

Good design even though has permanent water

Alternative to loose rock rip-rap

Metzger et al. 2008

Removal of debris ?

Dig out old rip-rap and replace or reposition rip-rap using front loader or similar vehicle

EXPENSIVE

Deere.co

Remove debris with a hand shovel

INEXPENSIVE

Linear Radial GSRD inlet

Belowground infrastructure

Structural modifications

Harbison et al. 2009, 2010
Metzger et al. 2012

Manhole inserts

Can reduce mosquito access

~ 60% entry

~ 50% exit

Harbison et al. 2009, 2010b
Metzger et al. 2012

Fewer pickholes =
↓ mosquito access/detection

Okay

Better

8 holes

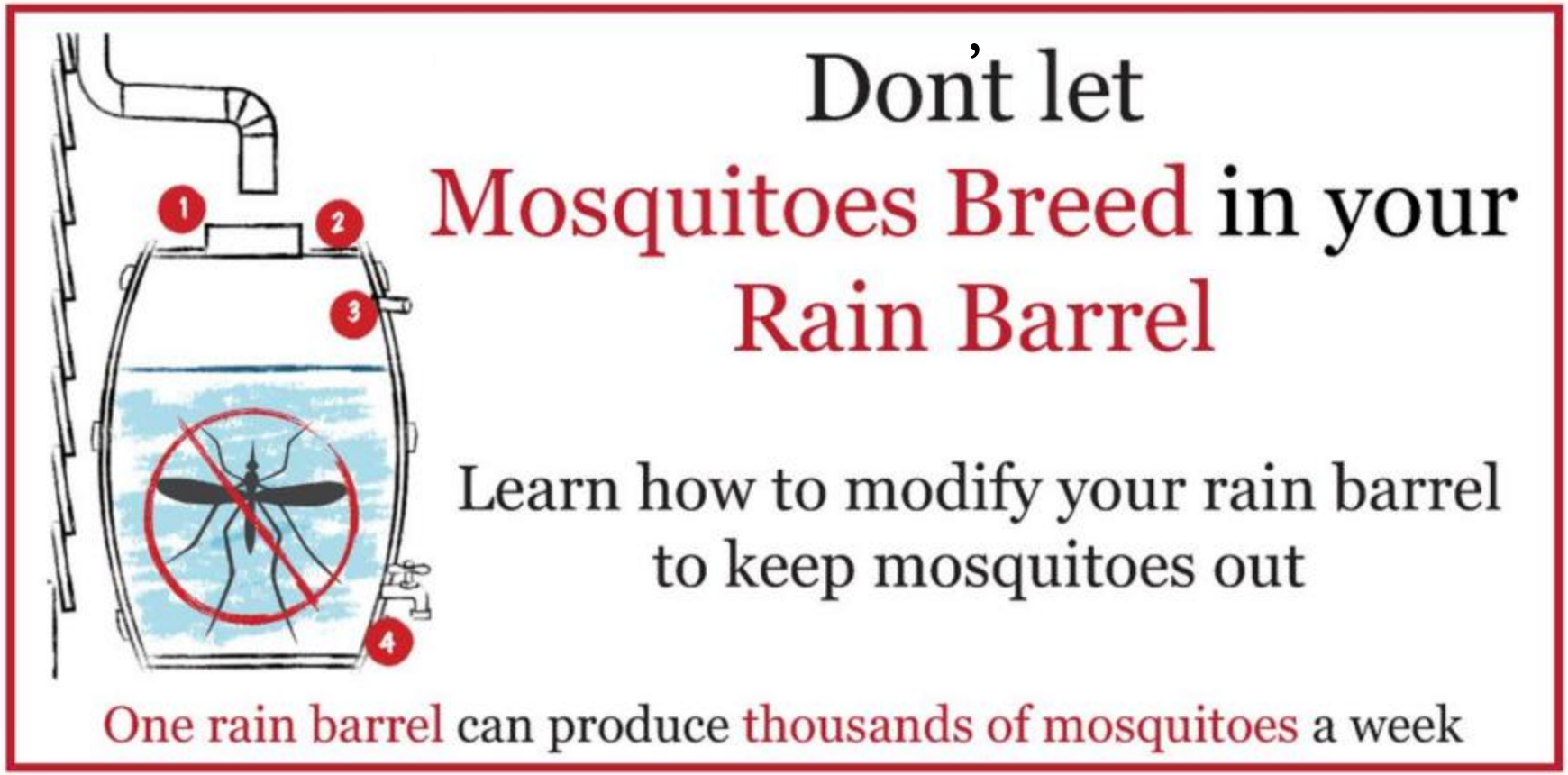
6 holes

2 holes

1 hole

Harbison et al. 2009, 2010

Reduce promotion of Rain Barrels



http://www.sgvmosquito.org/newsevents_articles_details.php?aid=101

Culex pipiens . . . . . (rain barrel or house mosquito).

WNV Species

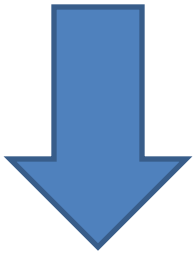


TABLE SHOWING VARIOUS SPECIES OF MOSQUITOES FOUND IN DISTRICT.

Culex pipiens	(rain barrel or house mosquito). Predominant species throughout territory after July 1st.
Ædes sylvestris	(fresh water swamp mosquito). Predominant species during early summer, decreasing in number as season advanced.
Ædes sollicitans	(white-banded salt marsh mosquito). Taken in territory surrounding Pennsylvania Salt Works.
Anopheles punctipennis . . .	(malarial mosquito). Found in relatively small numbers and scattered breeding places throughout territory. Believed to carry malaria.
Anopheles quadrimaculatus	(malarial mosquito). Found in relatively small numbers and scattered breeding places throughout territory. Known to carry malaria.

MOSQUITO ERADICATION IN SOUTHEASTERN PENNSYLVANIA

B. Franklin Royer, C. A. Emerson, Jr. , Am J Public Health (N Y) **1919** May; 9(5): 327–332.

RBs are common mosquito sites

- Harbor disease mosquito species
  - *Cx. pipiens* – WNV
  - *Aedes aegypti* – Dengue, CHIK, Zika

- Difficult to monitor and treat
  - mosquito control staff must enter private property

- Requires property owners be "good stewards" of their barrels

Zika, Mosquitoes, & Illinois

Zika linked to more birth defects than just microcephaly

Governments shouldn't wait for scientific proof to take action, WHO says

By Arielle Duhaime-Ross on March 8, 2016 03:21 pm Email @ArielleDRoss

(Photo by Mario Tama/Getty Images)

Theverge.com

Information still evolving…

Zika virus

- Generally a rare and mild clinical disease
  - 1 in 5 infected develop symptoms within about 12 days after infectious bite.
  - Mild symptoms lasts 4 to 7days.
    - fever, sometime rash, joint pain, or "red-eyes"
    - muscle pain and headache.
    - full recovery
  - Deaths rare

http://www.cdc.gov/zika/symptoms/index.html

Mosquito species of Zika

Most attention on:

- *Aedes aegypti*
  - Tropical & Subtropical
  - Much less associated with West Nile Virus

Genus:

Aedes

Dengue
Chikungunya
Zika

Why the spread of Zika in United States may be "minimal"

- The disease is limited by the range of the mosquito species (*Aedes aegypti*) that can transmit it.

As of March 2015

Approximate distribution of *Aedes aegypti* in the United States*

As of March 2015

Approximate distribution of *Aedes albopictus* in the United States*

Possible Zika species

Zika mosquitoes in IL

- **Rare to absent** in most of the state
  - Cannot survive freezing temps

- Presently, Zika threat a concern in **tropical to subtropical** areas
  - Similarly to sporadic dengue cases in Florida, South Texas, Hawaii
  - Locally transmitted cases are unlikely for the Upper Midwest (5 travel cases currently)

IDPH memo to Local HDs, Feb 16, 2016

Apparent low risk for Zika doesn't mean "no mosquito problem" in Illinois

No high-fives yet…

Illinois already has a deadly mosquito disease

West Nile Virus in Illinois for 2015

- 72 cases, 44 neuroinvasive cases
  - 7 deaths

- Vaccine in the works for Zika
  - No human vaccine for WNV

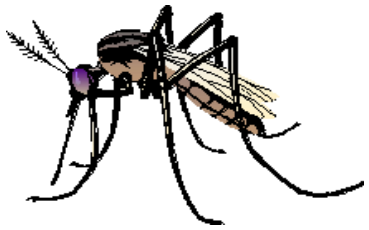
http://www.cdc.gov/westnile

Plan to partner…

…so let's "partner in planning".

Water managers & Engineers

Protect public health & our waters



Mosquito Disease Prevention and Control

2016 Annual Conference

"Partners in Planning"

WHAT THE ENGINEER CAN AND SHOULD DO TOWARD PREVENTION OF MALARIA AND MOSQUITO NUISANCES

J. A. LePrince 1924

Chairman, Committee on Engineering of the National Malaria Committee, Memphis, Tennessee

Read before the Sanitary Engineering Section of the American Public Health Association at the Fifty-third Annual Meeting at Detroit, Michigan, October 20, 1924.

PROMINENT engineering journals recently commented on the memoirs of Ronald Ross, the pioneer in malaria elimination, but omitted mentioning the fact that much of the future success to be achieved along this line, as well as the methods to be followed, must be devised or created by engineers.

Ross did not stress the point, although it is true, that due to engineering practice as now carried on, the engineer is frequently responsible for the creation of mosquito pest nuisances as well as the spread of malaria, or as an American malaria field worker remarked, "How long will it be before our engineers stop building malaria in, instead of building it out?"

but did not accomplish one cent's worth of results toward yellow fever control or elimination.

During the recent epidemic of dengue fever that swept through our southern states from the Atlantic Ocean to Texas, no reference was made by our public press, engineering publications, or engineering societies, to the fact that our street storm water catch basins, present by hundreds in many cities and towns, are sources of millions of the mosquitoes involved in mosquito-borne disease. Yet, without question, a well selected committee of our American sanitary engineering associations could devise an economical modification for the catch basins now in use, so they would become self-draining

Thanks for listening!

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