



DRAFT

**TOTAL MAXIMUM DAILY LOAD ANALYSIS
FOR
BUCKEYE BROOK AND TRIBUTARIES TO WARWICK POND**

**Benthic-Macroinvertebrate, Cadmium, Copper, Iron,
Dissolved Oxygen Impairments**

January 9, 2018

Overview of Presentation

- Background
- Study Overview
- Monitoring Data
- Pollution Sources
- Required Pollutant Reductions
- Pollution Abatement Measures



RI's Water Quality Management Framework

- RIDEM charged with implementing the federal **Clean Water Act** in RI
- **CWA Goals** are to restore and maintain the chemical, physical, and biological integrity of the nation's waters to support:
 - The protection and propagation of fish, shellfish, and wildlife, and
 - Recreation in (swimming) and on the water (boating, fishing).
- **Among the efforts undertaken by RIDEM to realize CWA goals:**
 - Assessment of state's waters and identification of Impaired Waters (303(d) List)
 - Development of water quality restoration studies, formally known as Total Maximum Daily Loads (TMDL) for impaired waters



What is a TMDL?

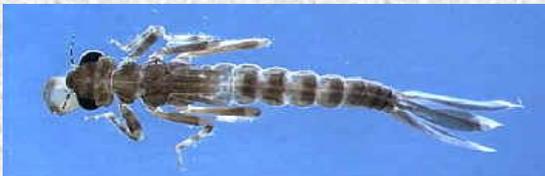
- **Total Maximum Daily Load (TMDL) = Water Quality Restoration Study**
- These studies are water body and pollutant specific and specify the amount of a pollutant that a waterbody can receive and still meet water quality standards.
- A **TMDL** is the sum of the **allowable loads** of a single pollutant from all contributing point and nonpoint sources.
- The calculation must include a **Margin of Safety (MOS)** to account for uncertainty in the TMDL analysis.

Focus of Buckeye Brook TMDL

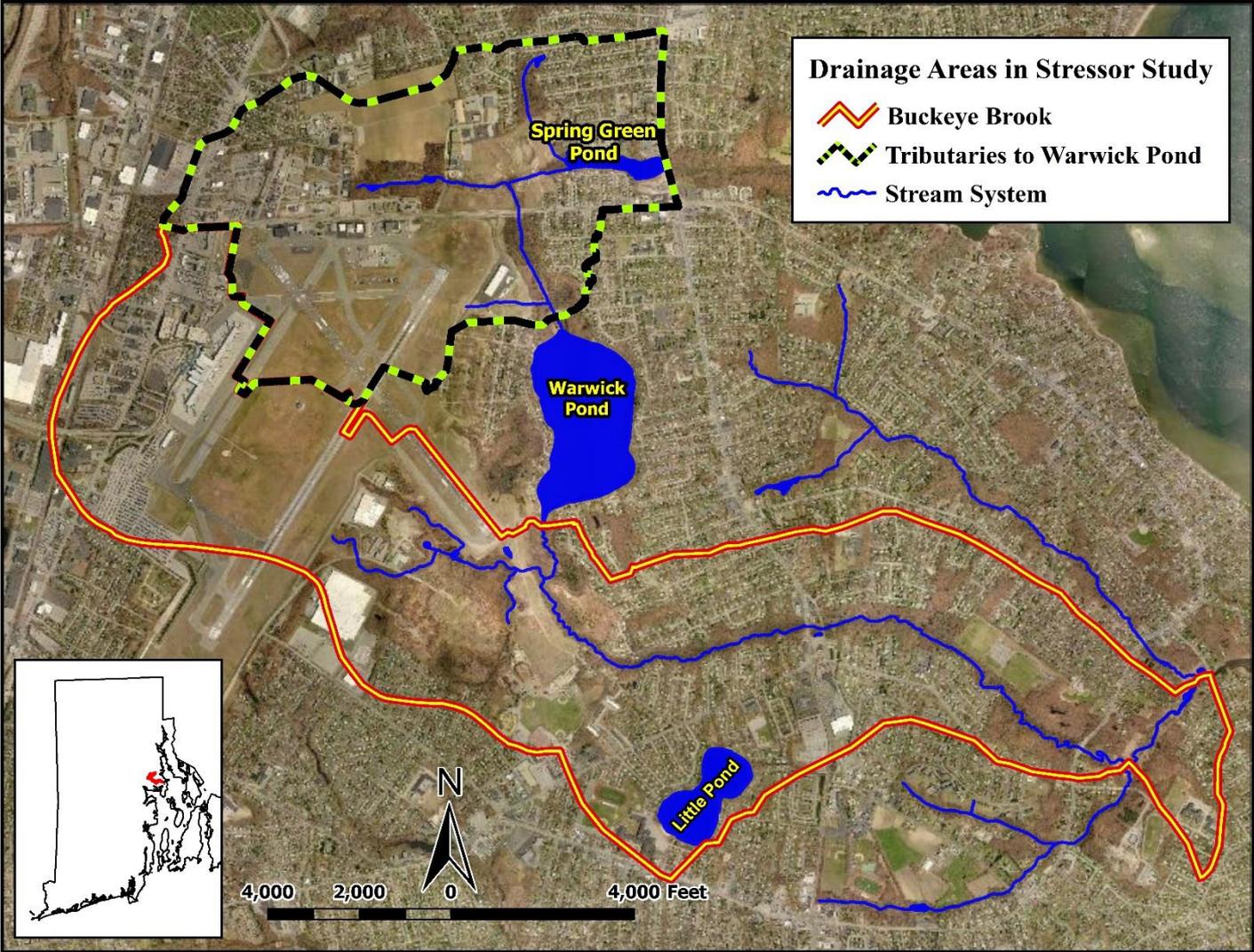
- TMDL addresses benthic macroinvertebrate, cadmium, copper, iron, and dissolved oxygen impairments in Buckeye Brook and Tributaries to Warwick Pond
- Focus of the TMDL is to address the stressors contributing to aquatic life impairments as indicated by the rivers' benthic macroinvertebrate communities

Why Macroinvertebrates?

- Macroinvertebrates are organisms that live in and on the bottom
- Because they are exposed to the cumulative effects of different stressors over their life cycle they make good indicators of water quality
- Macroinvertebrate data provide a more reliable reflection of a waterbody's ecological condition than do “snap shot” water chemistry measurements alone
- RIDEM uses biological and habitat monitoring data as core indicators for aquatic life use support in wadeable streams



Study Watersheds

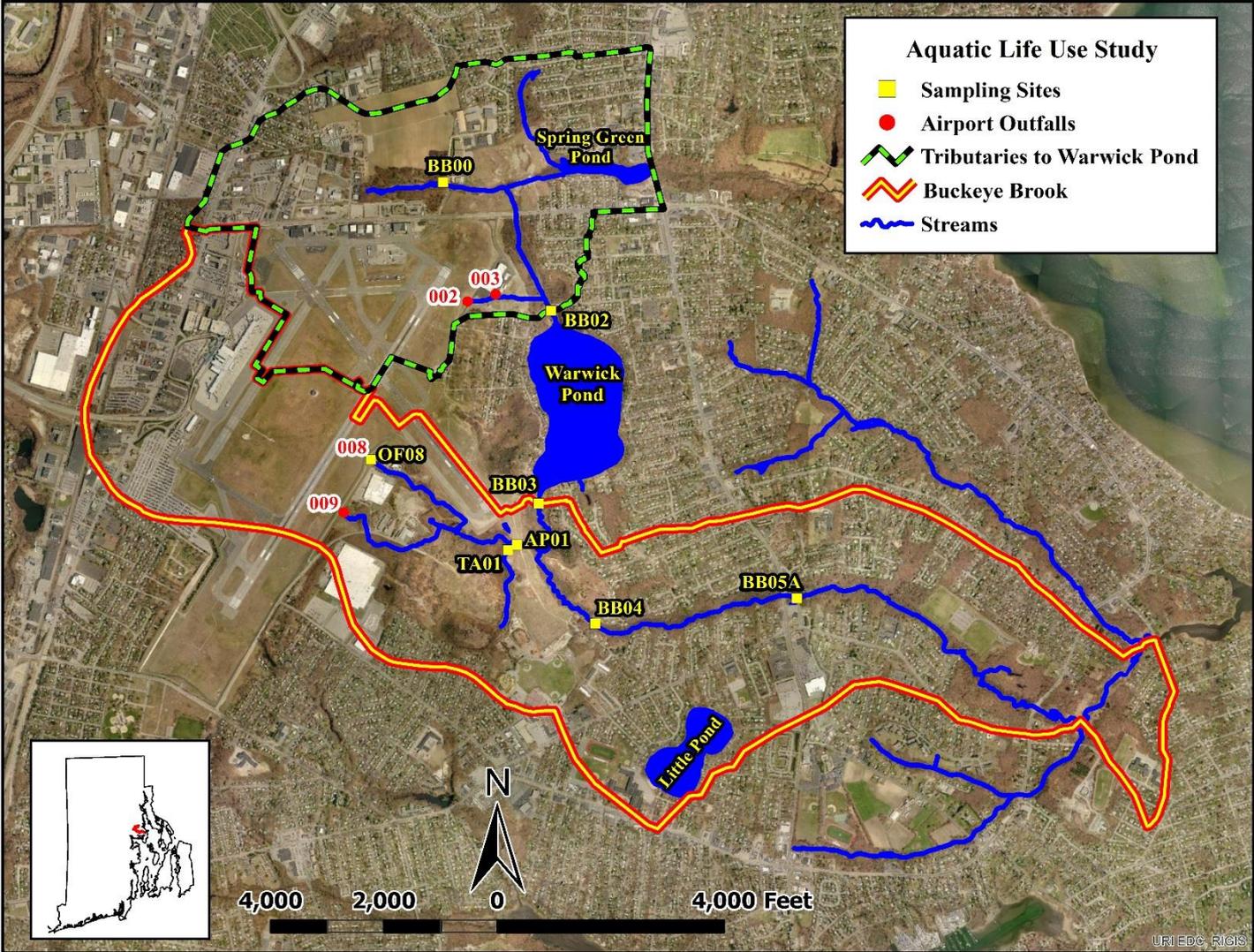




TMDL Study Approach

- To support development of the TMDL, DEM conducted a study designed to collect data to:
 - **Characterize the rivers' biological condition**
 - Benthic macroinvertebrates and algae (periphyton)
 - **Document water quality conditions**
 - Water chemistry and toxicity testing
 - **Assess potential pollution sources & stressors including:**
urban stormwater runoff, airport, and Truck-Away Landfill
- Results led to addition of **Iron, Copper, and Cadmium Impairments to 2014 303d list**

Sampling Stations



Sampling Stations in vicinity of airport and Truk-Away Landfill



Parameters

- **Field** – Dissolved Oxygen, Specific Conductance, Temperature
- **Nutrients** - Ammonia-N, Nitrate+Nitrite-N, Total Kjeldahl Nitrogen, and Total Phosphorus
- **Trace Metals** – Dissolved Arsenic, Copper, Cadmium, Lead, Manganese, Zinc, and Total Iron
- **Other** - Biological Oxygen Demand, Chloride, Hardness, pH, Propylene Glycol, Total Organic Carbon, Total Suspended Solids, Particulate Organic Matter
- **7 Day Chronic Toxicity Test**
 - *Ceriodaphnia dubia* (daphnid)
 - *Pimephales promelas* (fathead minnow)
- **Biological** - Habitat Assessment, Macroinvertebrate and Periphyton Sampling

Monitoring Surveys

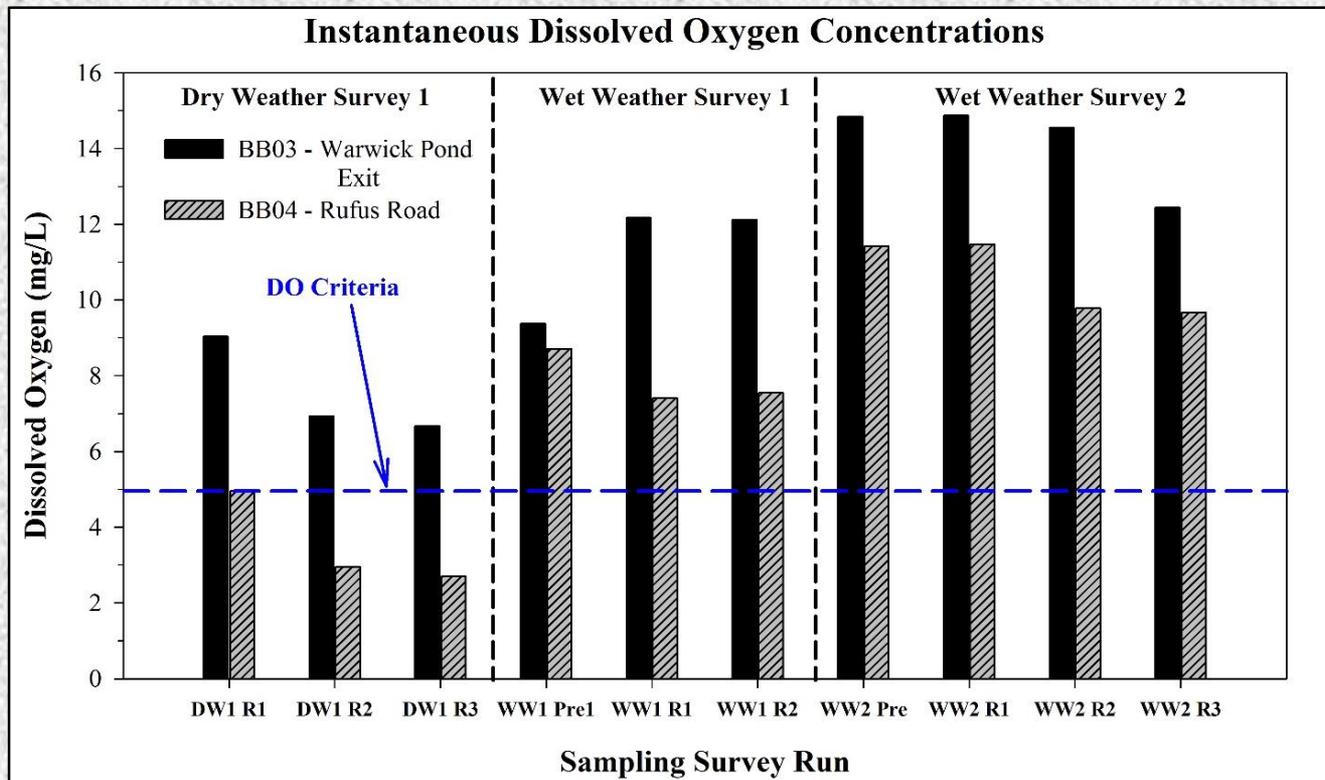
- **2 Dry Weather Surveys**
 - July 16-21, 2008
 - Chemistry and Toxicity Sampling
 - September 10, 2008
 - Chemistry and Biological Sampling
- **2 Wet Weather Surveys**
 - December 9-11, 2008 (Non-icing conditions)
 - Chemistry Sampling
 - February 1-8, 2011 (Icing conditions)
 - Chemistry and Toxicity Sampling

Results



Dissolved Oxygen Results

- **Dry Weather** – multiple stations below 5 mg/L DO criteria (BB00, BB04, and TA01)
- **Wet Weather** – one station below 5 mg/L criteria (TA01)
- **Significant Dissolved Oxygen Sag** between Buckeye Brook stations BB03 and BB04 in dry and wet weather surveys





Summary of Biological Survey

Stream Habitat

- Best habitat (considered sub-optimal) found upstream of airport (BB00), at outlet of Warwick Pond (BB03) and at furthest downstream station on Buckeye (BB05A)
- Poorest habitat (considered marginal) found downstream of Airport Outfall 008 (OF08) and Landfill (TA01)

Macroinvertebrate

- Moderate to severe impairment across most of watershed
 - Moderate impairment upstream of airport (BB00), furthest downstream stations on Tributary to Warwick Pond (BB02) and Buckeye Brook (BB05A)
 - Severe impairment downstream of airport & landfill – Stations BB04, AP01

Periphyton (algae growing attached to substrate)

- Taxa richness less than expected for small streams in this ecoregion.
- Relatively high # of taxa associated with instream disturbance

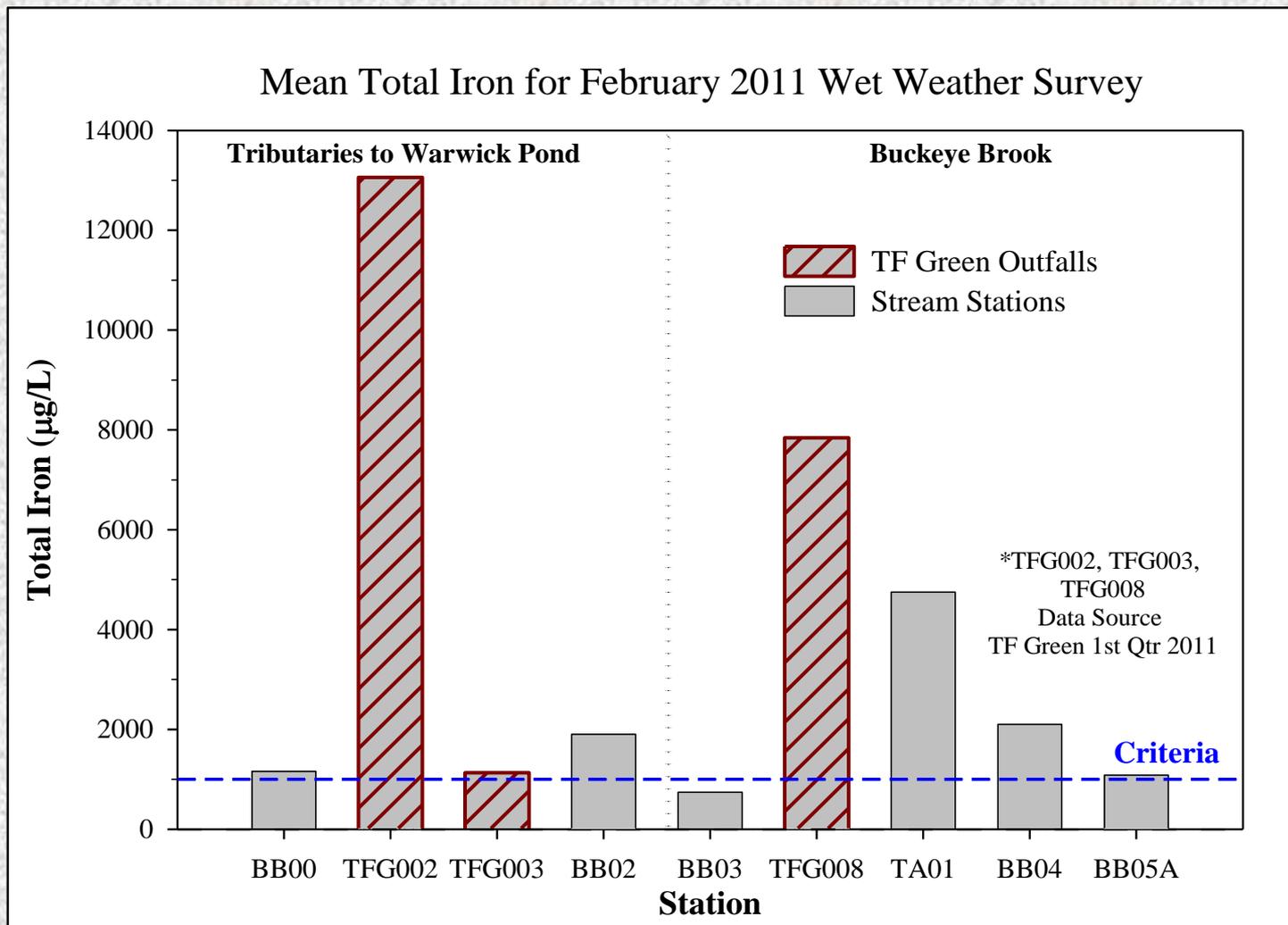
Summary of Trace Metal Results Acute and Chronic Exceedances

Station	Cadmium		Copper		Iron	
	Dry	Wet	Dry	Wet	Dry	Wet
Tributaries to Warwick Pond (RI0007024R-05)						
BB00	C	2C				C
BB02		2C		C		2C
Buckeye Brook (RI0007024R-01)						
BB03	C					C
TA01	C	C			C	2C
OF08	C	2C		2A, C	C	2C
AP01					C	
BB04	C				2C	2C
BB05A		C		A, C	2C	2C

A = Acute – One hour average concentration should not exceed criteria more than 1x /3 yrs

C = Chronic – Four day average concentration should not exceed criteria more than 1x/3 yrs

Mean Total Iron Concentrations



Summary of Toxicity Results

- **Dry Weather**
 - No statistically significant impacts on survivability or growth of either fathead minnow or daphnid
 - **Chronic toxic affect observed for daphnid's reproduction**
Statistically significant reduction in number of daphnid neonates produced at TA01 and OF08 (44% below control sample)
- **Wet Weather**
 - No significant impacts on Fathead minnow survival rate except at BB02 during de-icing condition due to physical impairment from filamentous floc.
 - Significant reduction in Fathead minnow biomass at BB02, BB04, OF08, and TA01 – due to filamentous floc
 - Daphnid survival rates not affected but reproduction data failed to meet test criteria.

Daphnid (Water Flea)



Fathead Minnow

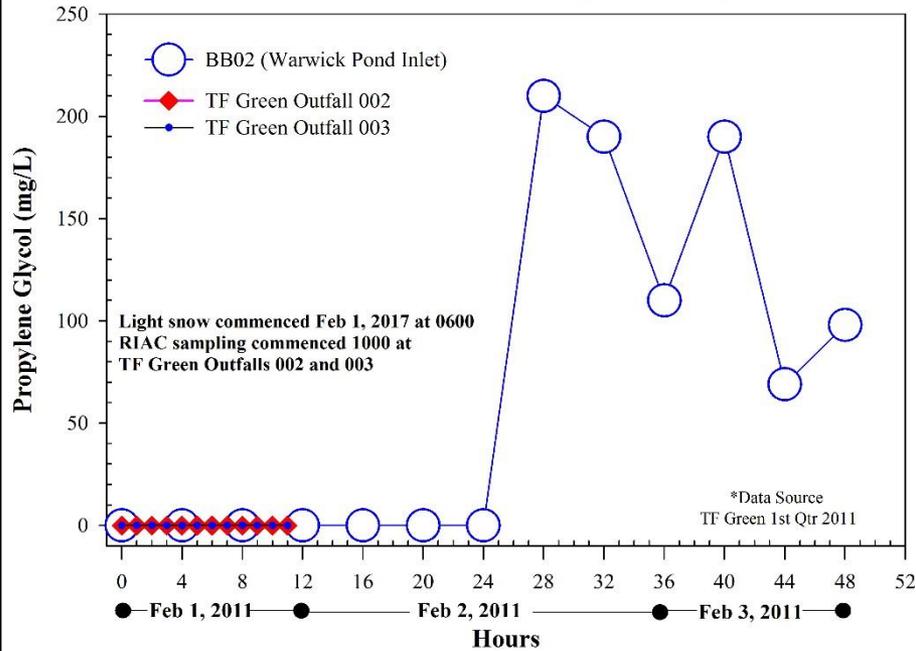




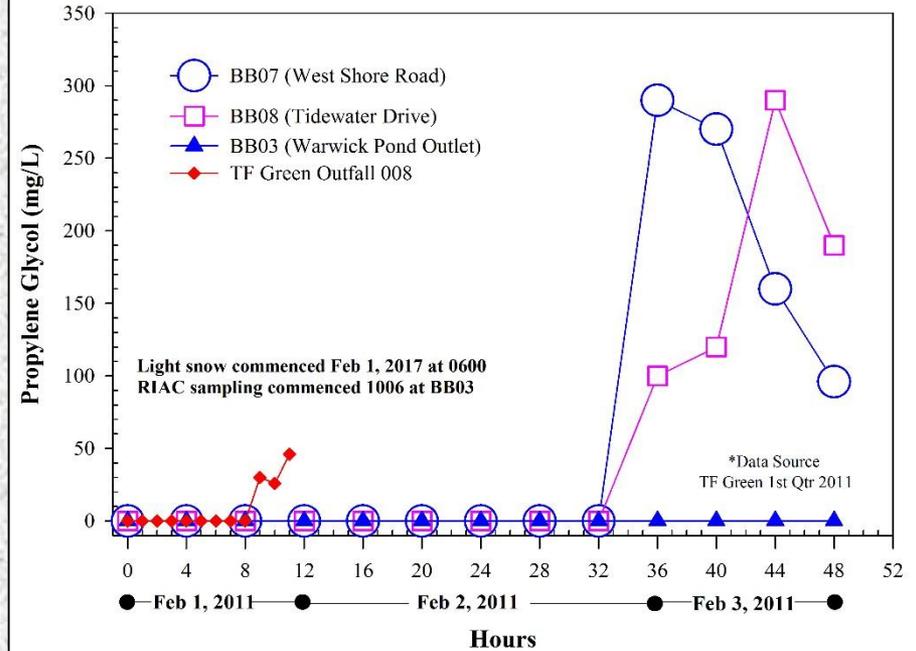
Propylene Glycol Results

- **Sampled during wet weather prior to construction of treatment and diversion facilities at airport**
- **Wet Weather 1 (Dec 9-11, 2008) – Non-icing conditions**
 - BB00, BB02, BB04, BB05A, OF08 -All non-detects
- **Wet Weather 2 (Feb 1-8, 2011) –Icing conditions**
 - Average Glycol Values
 - BB02 – 45 mg/L
 - OF08 – 79 mg/L
 - BB04 – 22 mg/L

RIAC Stations North of Warwick Pond for February 2011 Storm

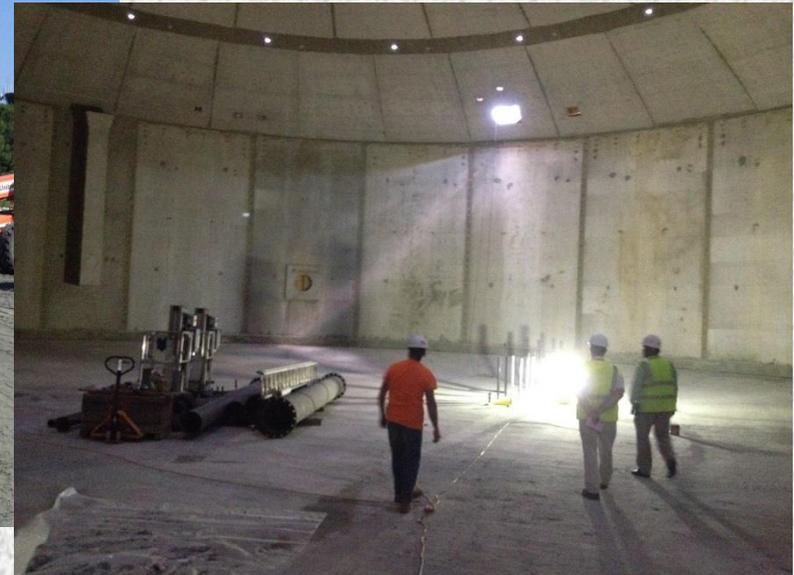


RIAC Buckeye Brook Watershed Stations for February 2011 Storm



TF Green Airport Propylene Glycol Storage Tanks

Construction completed October 2014





Winter Storm Stream Monitoring 2012-2017 during De-icing Operations at TF Green Airport

Before

After

January 17-19, 2012

Station	DO (mg/L)	DO Saturation (%)	COD (mg/L)	BOD ₅ (mg/L)	Propylene Glycol (mg/L)
BB02	10.7	84.3	35	12	9
BB03	10.9	85.1	24	4	<10
BB07	10.7	82.6	80	24	29
BB08	10.9	85.9	44	16	34

March 20-22, 2015

Station	DO (mg/L)	DO Saturation (%)	COD (mg/L)	BOD ₅ (mg/L)	Propylene Glycol (mg/L)
BB02	12.0	89.8	41	11	<10
BB03	11.6	84.9	18	<12	<10
BB04	11.1	84.0	16	<12	<10
BB07	11.6	87.1	17	<12	<10

January 21-23, 2013

Station	DO (mg/L)	DO Saturation (%)	COD (mg/L)	BOD ₅ (mg/L)	Propylene Glycol (mg/L)
BB02	10.1	72.6	29	16	12
BB03	10.7	76.2	19	9	8
BB04	9.8	71.7	114	27	26
BB07	10.8	77.5	28	15	15

January 23-25, 2016

Station	DO (mg/L)	DO Saturation (%)	COD (mg/L)	BOD ₅ (mg/L)	Propylene Glycol (mg/L)
BB02	11.3	82.8	7	<12	<10
BB03	13.1	91.3	13	<12	<10
BB04	11.3	86.3	26	<12	<10
BB07	11.8	92.5	13	<12	<10

February 13-15, 2014

Station	DO (mg/L)	DO Saturation (%)	COD (mg/L)	BOD ₅ (mg/L)	Propylene Glycol (mg/L)
BB02	10.8	82.9	91	40	2
BB03	10.9	83.4	126	52	1
BB04	10.6	85.6	73	28	5
BB07	10.6	88.9	120	32	18

February 1-3, 2017

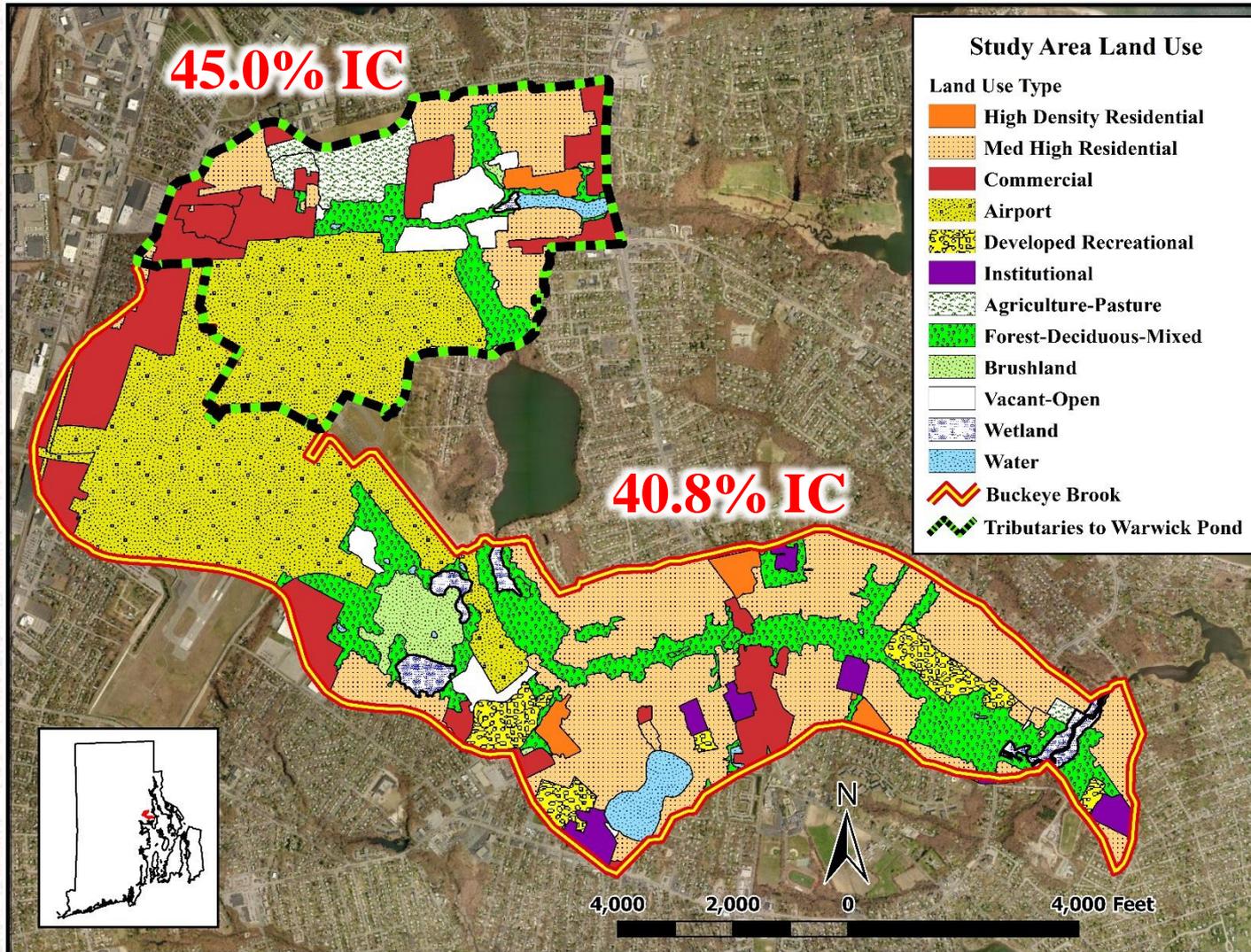
Station	DO (mg/L)	DO Saturation (%)	COD (mg/L)	BOD ₅ (mg/L)	Propylene Glycol (mg/L)
BB02	12.2	93.4	8	4	<10
BB03	12.7	99.7	1	1	<10
BB04	11.0	80.6	11	1	<10
BB07	12.7	92.5	10	<6	<10

Study Conclusions

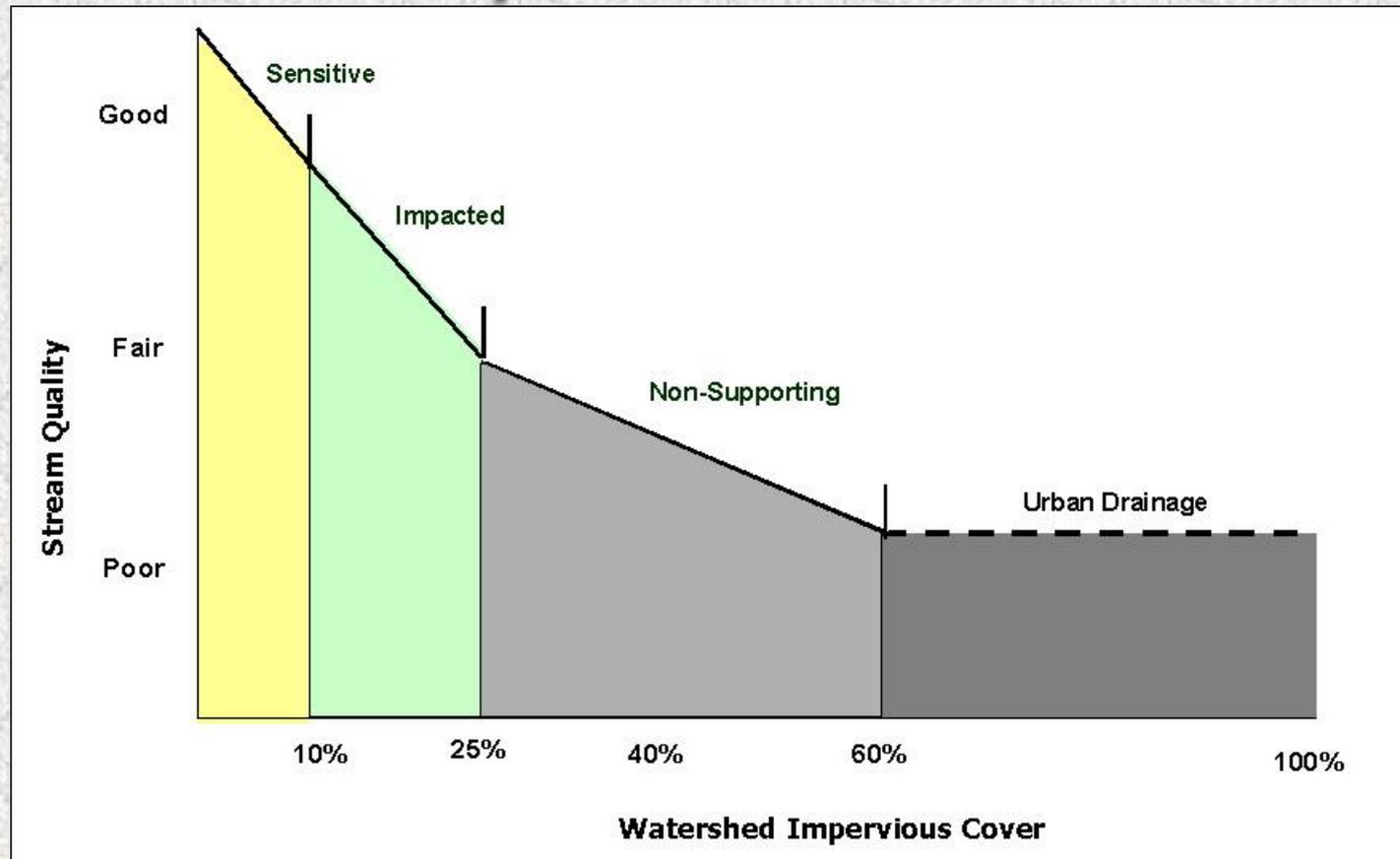
A combination of stressors is contributing to moderate to severe impairments of benthic macroinvertebrate community in Buckeye Brook and Tributaries to Warwick Pond:

- Impairments more **severe downstream of airport and landfill**
- Smothering of the streambed habitat by **iron fixing bacteria** found in tributaries originating from the airport and/or landfill;
- Iron contributing to observed dissolved oxygen sags in water
- Previously uncontrolled discharge of **propylene glycol** from airport
- Violations of ambient water quality criteria for **iron, copper, and cadmium in wet and/or dry weather**
- **Altered streamflow** (decreased groundwater recharge, lower base flows and increased runoff) and degraded habitat associated with highly impervious watersheds

Watershed Land Use



Impacts to Stream Quality as a function of Impervious Cover



Source: EPA/ENSR, 2005

Pollution Sources

Source	Location/ Explanation
Stormwater Runoff	Throughout these highly urbanized watersheds including T.F. Green Airport. Runoff from impervious areas such as parking lots, streets, roofs, and runoff contaminated with heavy metals (Cd, Cu, and Fe) among other pollutants.
Waste Sources	Waste sources include landfills including Truk Away Landfill.
Contaminated Groundwater	Potential sources of contaminants to groundwater can be historic in origin and originate in landfills, open areas of unsupervised dumping, construction operations, backfilled areas with contaminated soils.
Non-Stormwater Urban Runoff	Overland flows from various land use practices enter storm drains, which including lawn irrigation runoff, car washing, sidewalk washing and commercial pavement washing. These urban flows can contain metals among other pollutants.

TMDL Requirements Trace Metal Reductions

Dry Weather/ Low Flow Reductions

Station	Cadmium	Copper	Iron
Tributaries to Warwick Pond			
BB00	14.6%		
BB02			
Buckeye Brook			
BB03	53.2%		
TA01	30.9%		92.2%
OF08	14.6%		68.4%
AP01			70.1%
BB04	57.8%		56.7%
BB05A			37.5%

Wet Weather/High Flow Reductions

Station	Cadmium	Copper	Iron
Tributaries to Warwick Pond			
BB00	48.6%		44.7%
BB02	58.7%	18.7%	53.6%
Buckeye Brook			
BB03	11.0%		13.4%
TA01	34.8%		93.7%
OF08	63.7%	52.5%	71.9%
BB04			69.3%
BB05A	53.8%	18.6%	40.3%

Final reductions in **Red Bold Type**



Summary of Pollution Abatement Measures

- Continue operation of propylene glycol controls at TF Green Airport
- Mitigate elevated levels of iron and cadmium contained in groundwater discharged from TF Green Airport outfalls
- Properly close Truk-Away Landfill to mitigate contaminated leachate and runoff
- Manage urban stormwater watershed-wide to reduce runoff volumes and metals concentrations, and mitigate hydrologic and habitat alterations



Pollution Abatement City of Warwick and RIDOT

- Continue ongoing efforts to manage stormwater to prevent discharge of metals through pollution prevention and non-structural measures
 - Construction/Post Construction controls
 - Storm drain cleaning and street-sweeping
 - Public education
- Implement structural retrofits to drainage systems to reduce metals and stormwater runoff volumes
- Consistent with EPA and DEM consent decrees, stormwater must be managed such that impervious cover is eliminated or treated to act as if it were eliminated to reach a target impervious cover of 10%



Pollution Abatement RI Airport Corporation

- Continue to comply with 2012 Permit including operation of de-icing management system to collect, treat and divert propylene glycol
- Mitigate elevated levels of iron and cadmium found in groundwater that is collected and discharged via airport's stormwater outfalls
- Manage stormwater to reduce metals concentrations and runoff volumes consistent with requirements established for MS4 operators.
- RIDEM working on issuance of revised permit in 2018 to incorporate TMDL provisions including addition of in-stream metals sampling

Pollution Abatement Others

- **Truk-Away Landfill – RI Department of Administration**
 - Landfill has not been properly capped
 - Properly close landfill to prevent leachate and stormwater containing pollutants of concern
 - Effort has begun with core Potentially Responsible Parties to initiate site investigations and to set a schedule for permanently closing landfill
- **Jay Packaging (Industrial Stormwater Permit holder)**
 - Identify potential sources of pollutants of concern (metals)
 - Describe implementation practices they will use to reduce metals in stormwater and attenuate stormwater on-site
 - Implement enhanced good-housekeeping measures



The draft TMDL is available on the RIDEM website at:

<http://www.dem.ri.gov/programs/water/quality/restoration-studies/reports.php>

Written comments on draft Buckeye Brook TMDL may be submitted to:

Skip Viator

RIDEM/Office of Water Resources

235 Promenade Street

Providence, RI 02908-5767

skip.viator@dem.ri.gov

Comments due by February 9, 2018

That's All Folks!

Trace Metal Results

Cadmium (µg/L)				
Station	Dry Weather Values		Mean Wet Weather Values	
	7/16/08	9/10/08	12/9-11/08	2/1-8/11
Tributaries to Warwick Pond				
BB00	0.16	0.08	0.24	0.18
BB02	0.10	0.11	0.26	0.12
Buckeye Brook				
BB03	0.28	NS	0.15	<0.05
TA01	0.30	NS	0.25	0.09
OF08	0.16	NS	0.18	0.12
AP01	NS	<0.06	NS	NS
BB04	0.39	<0.06	0.11	0.10
BB05A	0.13	<0.06	0.30	0.08

Copper (µg/L)				
Station	Dry Weather Values		Mean Wet Weather Values	
	7/16/08	9/10/08	12/9-11/08	2/1-8/11
Tributaries to Warwick Pond				
BB00	1.82	2.10	2.02	1.80
BB02	3.53	1.19	2.20	2.75
Buckeye Brook				
BB03	2.35	NS	0.86	1.61
TA01	1.40	NS	1.63	1.40
OF08	0.67	NS	2.55	2.65
AP01	NS	1.08	NS	NS
BB04	5.73	1.24	1.00	1.76
BB05A	1.62	1.68	2.14	3.57

Total Iron (µg/L)				
Station	Dry Weather Values		Mean Wet Weather Values	
	7/16/08	9/10/08	12/9-11/08	2/1-8/11
Tributaries to Warwick Pond				
BB00	732	522	878	1,161
BB02	648	824	1,327	1,904
Buckeye Brook				
BB03	186	NS	358	740
TA01	11,586	NS	14,272	4,752
OF08	2,844	NS	2,703	2,694
AP01	NS	3,008	NS	NS
BB04	2,078	1,258	2,928	2,102
BB05A	1,347	1,439	1,509	1,083