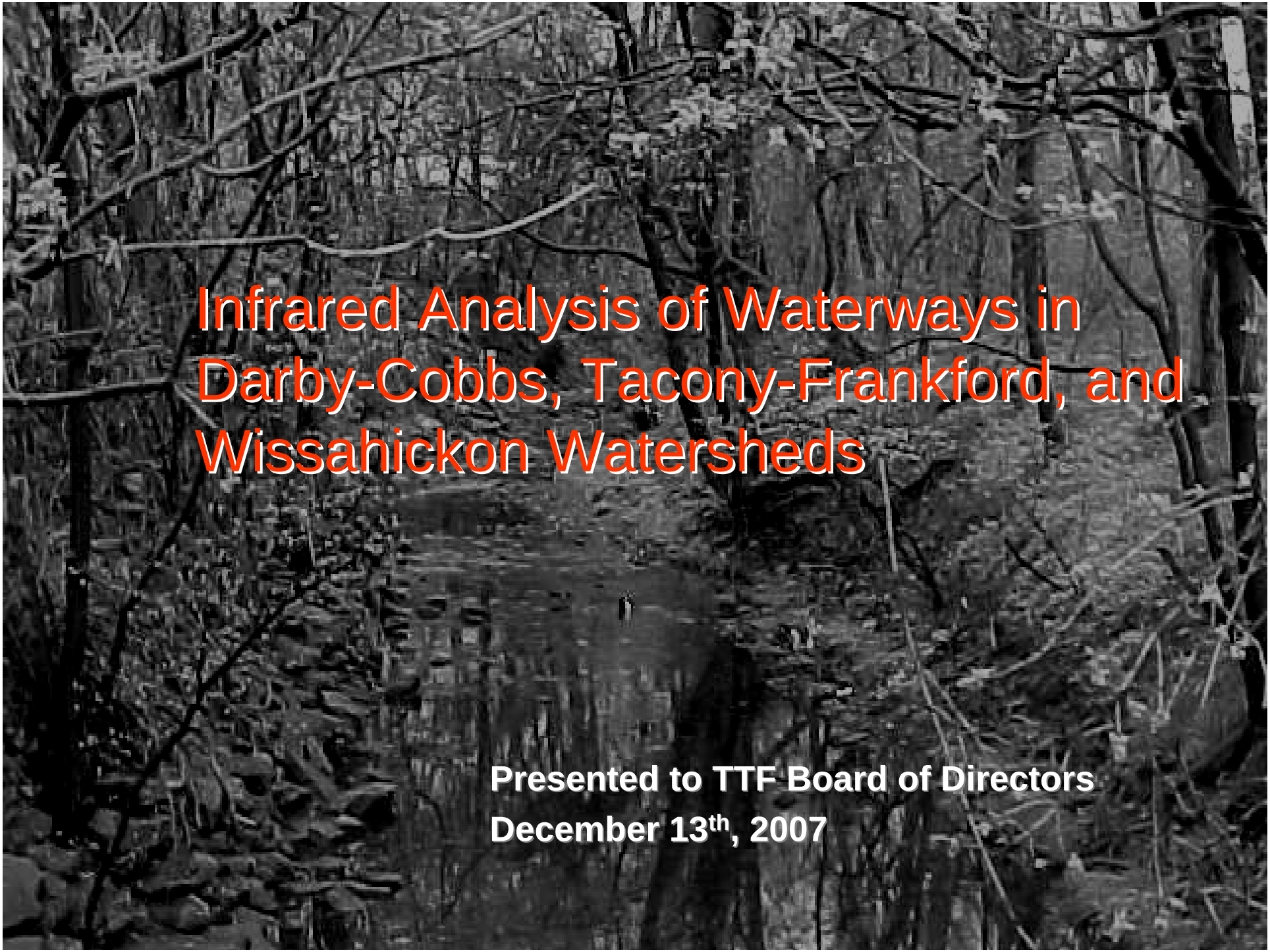


Infrared Analysis of Waterways in Darby-Cobbs, Tacony-Frankford, and Wissahickon Watersheds

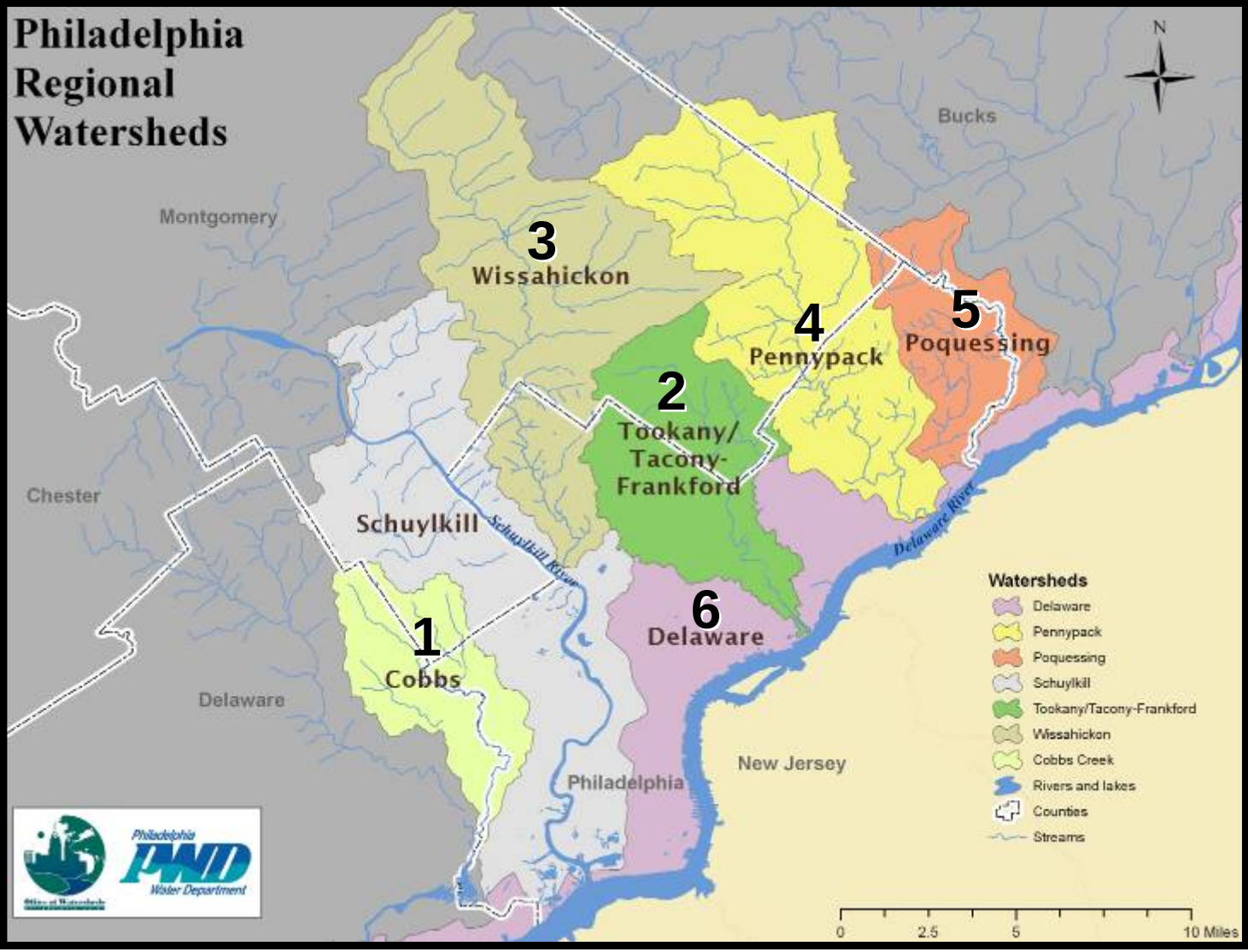
Presented to TTF Board of Directors

December 13th, 2007

Philadelphia Water Department – Office of Watersheds

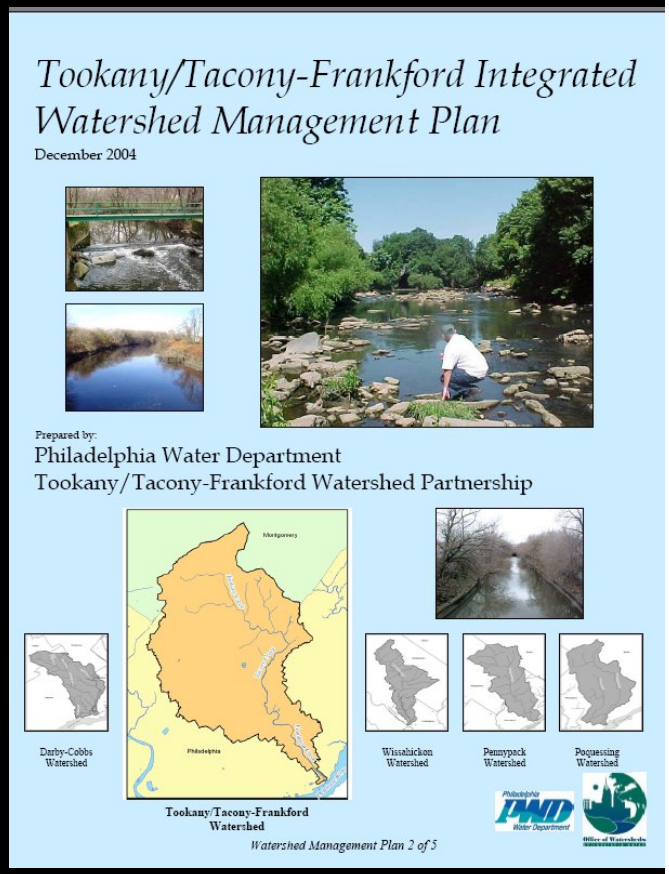
- Established in 1999 – the Philadelphia Water Department (PWD) Office of Watersheds (OOW) has been leading initiatives to preserve and enhance the health of the region's watersheds through:
  - Effective wastewater and stormwater management practices and implementation of watershed improvements and
  - Protection projects along the Schuylkill and Delaware rivers and it's tributaries.

PWD Watershed Management Program



PWD's Watershed Management Planning Program

- PWD has been initiating inter-governmental watershed partnerships since 1999 in an effort create and implement watershed-wide visions for ecological restoration and water quality improvement
  - Partnerships have been initiated in 6 watersheds
    - Cobbs (1999)
    - TTF (2000)
    - Pennypack – RCP (2003)
    - Poquessing – RCP (2004)
    - Wissahickon (2005)
    - Delaware River Direct – RCP (2007)
- 2005 – Tookany/Tacony-Frankford Integrated Watershed Management Plan (TTFIWMP) was completed
  - Available online at: www.phillyriverinfo.org

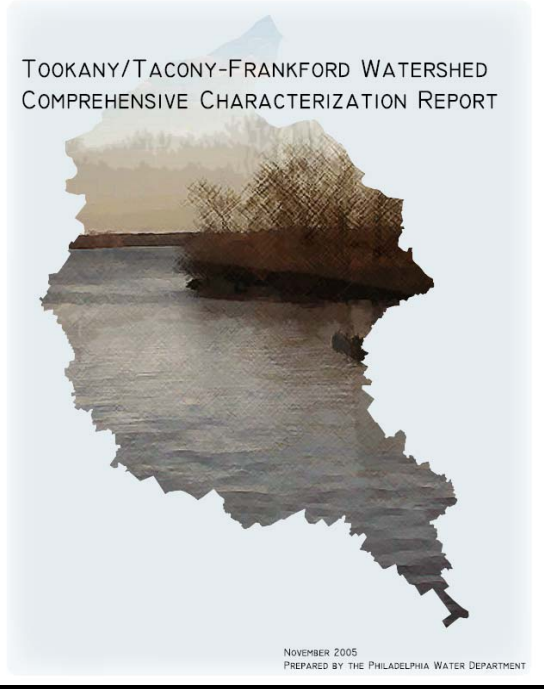


What is an Integrated Watershed Management Plan?

- The IWMP process is based on a carefully developed approach to meeting the challenges of watershed management in an ***urban*** setting
- IWMPs are designed to serve as "living documents" – with a purpose of integrating the whole host of ongoing regulatory and non-regulatory planning processes and initiatives.
  - MS4 – NPDES Phase II
  - Act 167
  - CSO
  - River Conservation Planning
  - Greenway/Open Space Preservation
- Planning process does not prescribe a formal implementation plan or schedule for the portion of the watershed outside of the City of Philadelphia.
  - Instead, based on identified water quality, quantity and ecological degradation issues within the watershed – a series of implementation options are identified and packaged together in a "*menu*" format

What kind of data is utilized to create an Integrated Watershed Management Plan?

- An IWMP is based on **scientific backbone**
  - Incorporates Physical, Chemical and Biological monitoring data collected watershed-wide by PWD (2002-2004)
    - Data used to identify existing issues – and sources when possible
      - Compiled into 2005 Tookany/Tacony-Frankford Comprehensive Characterization Report (available online at www.phillyriverinfo.org)
  - Additional data collected watershed-wide includes:
    - **Fluvial Geomorphology** – report online
    - **Infrastructure** – no report developed but data burned to disk given today
    - **Wetlands** – report online
    - **Aerial Infrared Thermography** – individualized CD developed for each municipality with stream segments within jurisdiction



Fluvial Geomorphology (FGM)

PURPOSE

- Document existing conditions within the watershed using Rosgen methodologies to measure channel geometry and stability parameters to determine stream classification.
- Comprehensive habitat survey completed for the watershed.
- Together, the measured geomorphologic channel survey and the habitat survey will provide the implementers of the IWMP with:
  - a baseline for evaluating effects of urbanization,
  - a land use and/or planning tool,
  - a rating method specific to the TTF watershed,
  - potential stream and habitat restoration sites, and
  - appropriate potential restoration strategies.

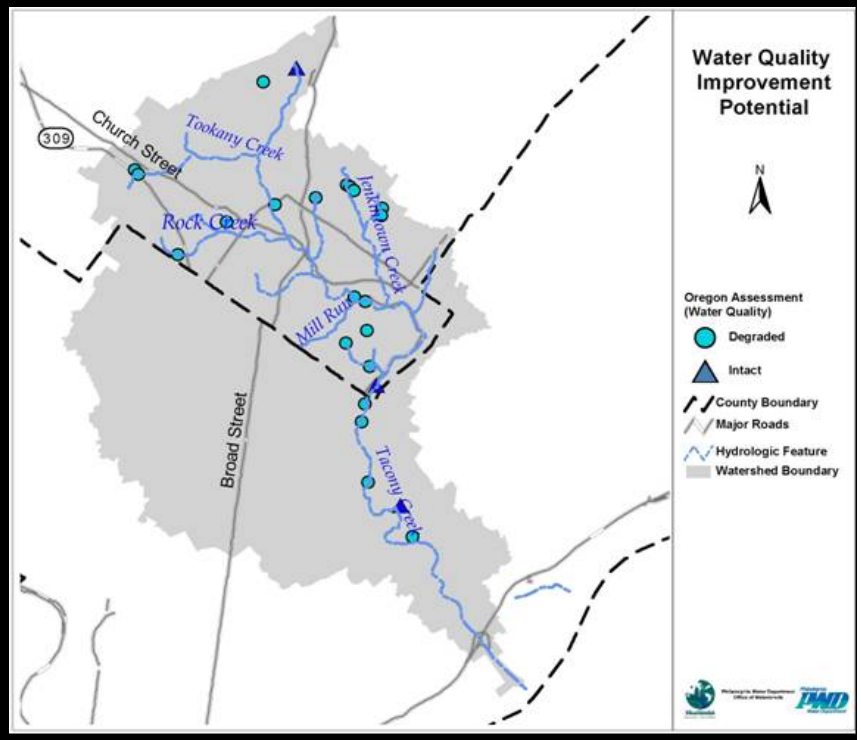
Infrastructure Assessment

- Watershed-wide inventory of streamside infrastructure including:
  - Stormwater and sanitary sewers
  - Outfalls
  - Pipes of any kind
  - Culverts
  - Abutments
  - Constrictions

- Work conducted by PWD staff in 2004
- Could be helpful to municipalities in meeting some NPDES Phase II requirements!

Wetlands Assessment

- **Purpose:** to assess existing wetlands, evaluate select stormwater outfalls, and identify potential wetland creation sites throughout the Cobbs Creek watershed.
- Included the entire Tookany/Tacony-Frankford Watershed in Montgomery and Philadelphia Counties.
- 79 observation sites were investigated for either the presence of wetlands or the potential for wetland creation.
  - All of the wetlands were located along one of the major waterways in TTF Watershed including tributaries
- Assessment conducted 2001-2003, Report completed 2006
  - Available at www.phillyriverinfo.org

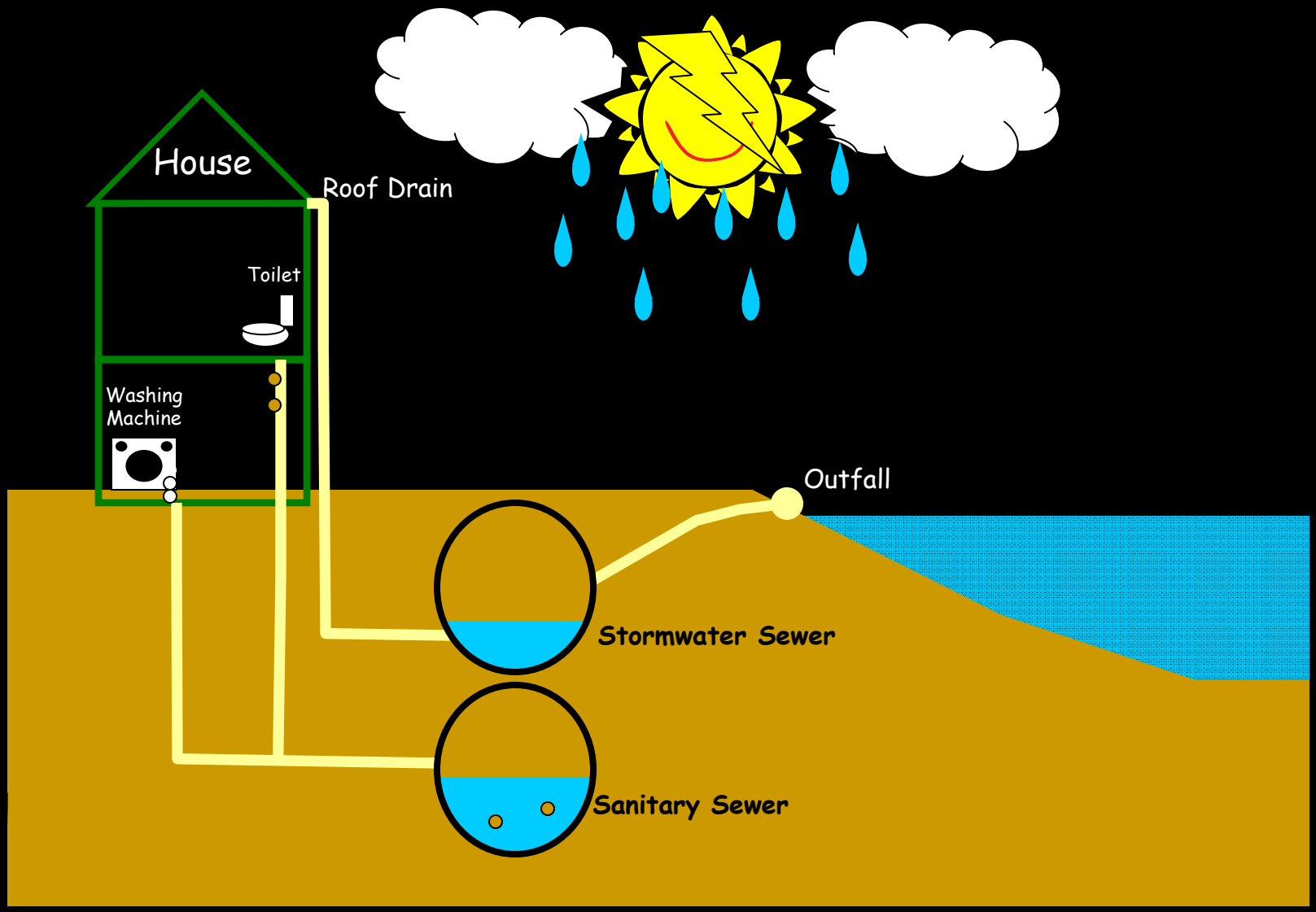


Aerial Infrared Thermography

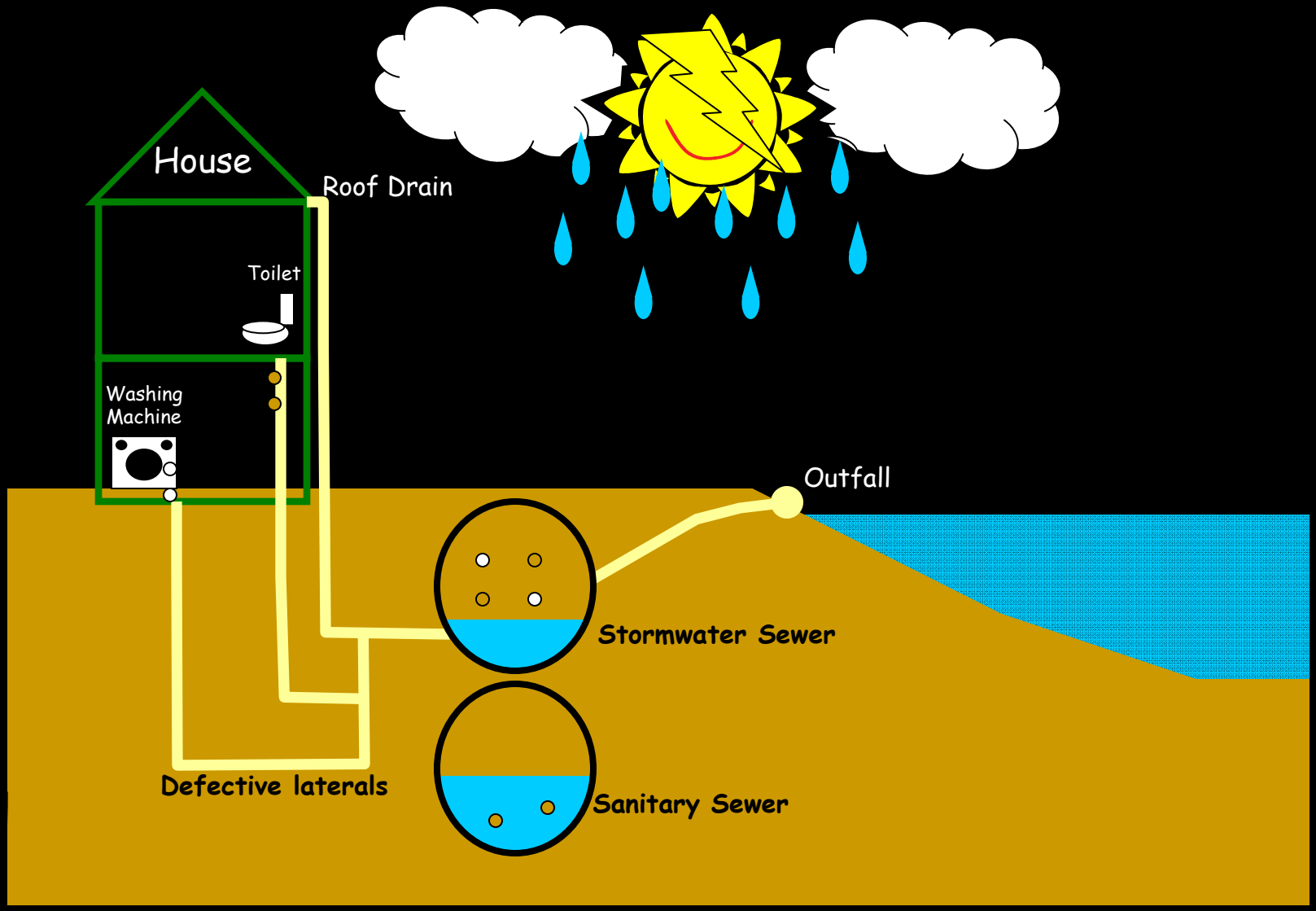
- Flyovers are conducted using infrared technology – which can indicate differences in temperatures
  - Conducted during the winter (“leaf-off” conditions) when waterways run at colder temperatures
  - Can identify “anomalies” indicative of liquid contamination of surface water
- Data produced through this initiative consists of gray-scale photo images whose varying shades represent differences in temperature
  - As a general rule, lighter colors designate warmer objects and darker colors indicate cooler ones.

Aerial Infrared Thermography

- Proven an economical and effective means of identifying thermal anomalies in large watersheds within relatively short timeframes.
  - As previously mentioned – technology can pinpoint potential environmental problems such as:
    - stormwater drain discharges,
    - illicit connections to stormwater drainage systems,
    - sanitary collections system failures/seepages,
    - illegal dumping to streams/rivers, and
    - other potential anomalies that may be contributing to the pollution of waterways
  - Could be a very useful tool for municipalities implementing NPDES Phase II regulations
    - Required to detect and abate sewer cross connections

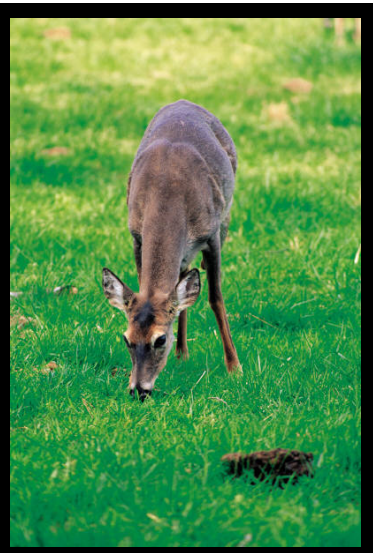


Separate Sewer System Connections



Cross Connections in a Separate Sewer System

Background



- The Fairmount Park Commission (FPC) used the infrared technology in the Fairmount Park System in 2004 for deer counting purposes.
- FPC saw what appeared to be thermal anomalies in/along Philadelphia creeks and shared the data with PWD.
- PWD decided this would be a useful technology to employ to identify leaking sewers and illicit discharges

Study Details

- **Purpose:** finding thermal anomalies indicative of liquid contamination of the surface water that may be caused by leaking sewer lines, ground water seeps, unidentified surface or subsurface outfalls in the form of pipes or drains, storm sewers and any other detectable source of liquid that may be of interest

- **Contractor:** Davis Aviation of Beryl, Ohio was contracted to conduct aerial infrared (IR) imaging and report the results for all hydrology and immediately adjacent areas in the following watersheds:
  - Wissahickon Creek (125 miles),
  - Cobbs Creek (17 miles)
  - Tookany/Tacony-Frankford Creek (31 miles)

- **Cost:** $19,839 ($115 per mile plus a ferry/deployment fee of $1324)

- **Timeline:** Flyovers performed in winter 2006/2006 with data delivered in Spring 2006

Project Location Overview

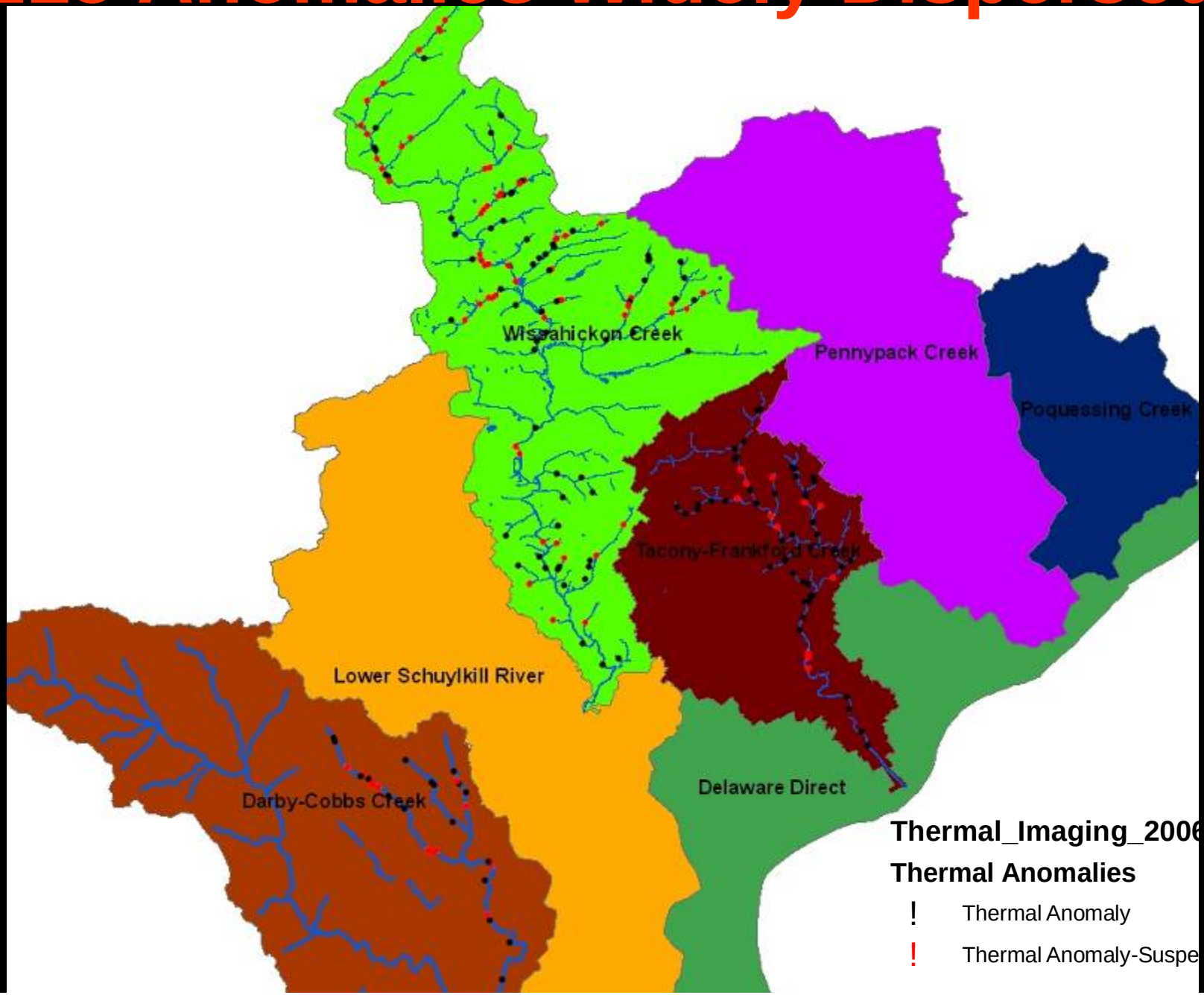
<u>3 Watersheds</u>

- Tacony-Frankford Creek Watershed
  - Stream miles - 31 miles total
    - 6 miles inside Philadelphia and 25 miles located outside of Philadelphia
- Wissahickon Creek Watershed
  - Stream miles - 125 miles total
    - 21 miles inside Philadelphia and 103 miles located outside of Philadelphia
- Cobbs Creek Watershed
  - Stream miles - 17 miles total
    - 10 miles inside Philadelphia and 7 miles located outside of Philadelphia

215 Anomalies Identified

- **Good news!**
  - **Of 215 anomalies identified – only 85 are suspected leaks**
    - **All data should be ground-truthed**
- **By County:**
  - **Delaware:** 17 anomalies identified
  - **Montgomery**: 160 anomalies identified
  - **Philadelphia**: 38 anomalies identified
- **By Watershed:**
  - **Cobbs**: 31 anomalies identified
  - **Tookany/Tacony-Frankford**: 58 anomalies identified
  - **Wissahickon**: 126 anomalies identified

215 Anomalies Widely Dispersed



IR Imaging Analysis

- Analysis based on comparing anomaly locations with infrastructure data collected watershed-wide
  - Anomalies located near manholes and sewer lines were deemed **suspected leaks**
    - Rational based on the fact that vicinity to the sewer line makes it more likely that the anomaly could be a sanitary sewer leak
  - Additionally, anomalies near roads, homes, and storm drains were categorized as **suspected leaks**
    - These anomalies are important to categorize because they possibly identify urban pollution, malfunctioning septic systems, illegal sanitary-sewer and stormdrain “cross-connections” or other illicit discharges

Codes for Characterization

These codes were applied to the thermal anomaly data to describe the assumed cause of the anomaly.

SD	Storm Water Drain
GS	Natural Ground Seep
MH	Manhole
TA	Thermal Anomaly
SLk	Sewer Leak
SL	Sewer Line

PWD Field Anomaly Investigations Details

- As a result of the assessment, PWD has tracked and inspected 43 anomalies that are contained within or in close proximity to City limits:
  - Anomalies within Philadelphia: 38
  - Anomalies inspected by PWD: 43
  - Suspected Sewage Discharges found: 7
  - Confirmed Sewage Leaks: 3 (All fixed by Phila Water Dept)
- PWD investigations were conducted during Fall 2006 and Spring 2007 – when ground vegetation and foliage was at a minimal, to ease the efforts of tracking the anomaly points (which are often located in heavily wooded areas along these waterways).
- In addition to aerial maps, PWD utilized a GPS enabled rugged tablet PC to pinpoint these suspected anomalies in the field.
  - Any consumer GPS systems can be used with an accuracy of 10ft with WAAS (Wide Area Augmentation System) Technology.

What will TTF Municipalities receive?

- For each municipality with portions of the Tookany/Tacony-Frankford Creek and its tributaries within its jurisdiction – an individualized “Aerial Infrared Thermography” presentation has been developed
  - Presentation is in PowerPoint format
  - Each presentation will contain the following
    - A basemap of the municipality with the stream highlighted and numbered anomaly points illustrated
    - A table with information about each anomaly point including
      - lat/long coordinates,
      - County
      - Watershed
      - Municipality
      - Potential source of anomaly
    - Two Individual maps for each anomaly
      - Basic map with streets
      - Zoomed in aerial photo of the location
      - Aerial Infrared Thermography Image of location

What's on the Municipal Data Disk?

- Each municipality will receive a disk with the following Geographic Information Systems (GIS) data layers:
  - TTF Watershed Delineation
  - TTF Municipal boundaries
  - TTF Creek Hydrology (including tributaries)
  - TTF Creek Streamside Infrastructure Data
  - Color Aerial Photography for TTF Watershed Area
  - Point file of locations with thermal anomalies

What if my municipality does not have access to GIS?

- We have provided a piece of free "shareware" GIS viewer software called "MapWindow" with each CD
  - Once downloaded – users can open the file titled "Mapwindow Project.mwprj" and a basemap will open illustrating all data layers on the disk.
- For information on this MapWindow software please visit: http://www.mapwindow.org
- For a MapWindow Tutorial please visit: http://www.mapwindow.org/tutorials/