Evaluating Risks in a Source Water Protection Area - Modernized Methodologies

Aaron Colson
City of Dayton, Department of Water
Division of Environmental Management
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Water Laboratory Analyst Workshop
Operator Training Committee of Ohio, Inc.

Outline

* City of Dayton Source Water Protection Area
* Recent Updates to the City of Dayton Source Water Protection Program
* US EPA's Priority Setting Approach (PSA) for Managing Groundwater Contamination Sources in Wellhead (Source Water) Protection Areas
* Modernizing PSA Methodology
* Conclusions

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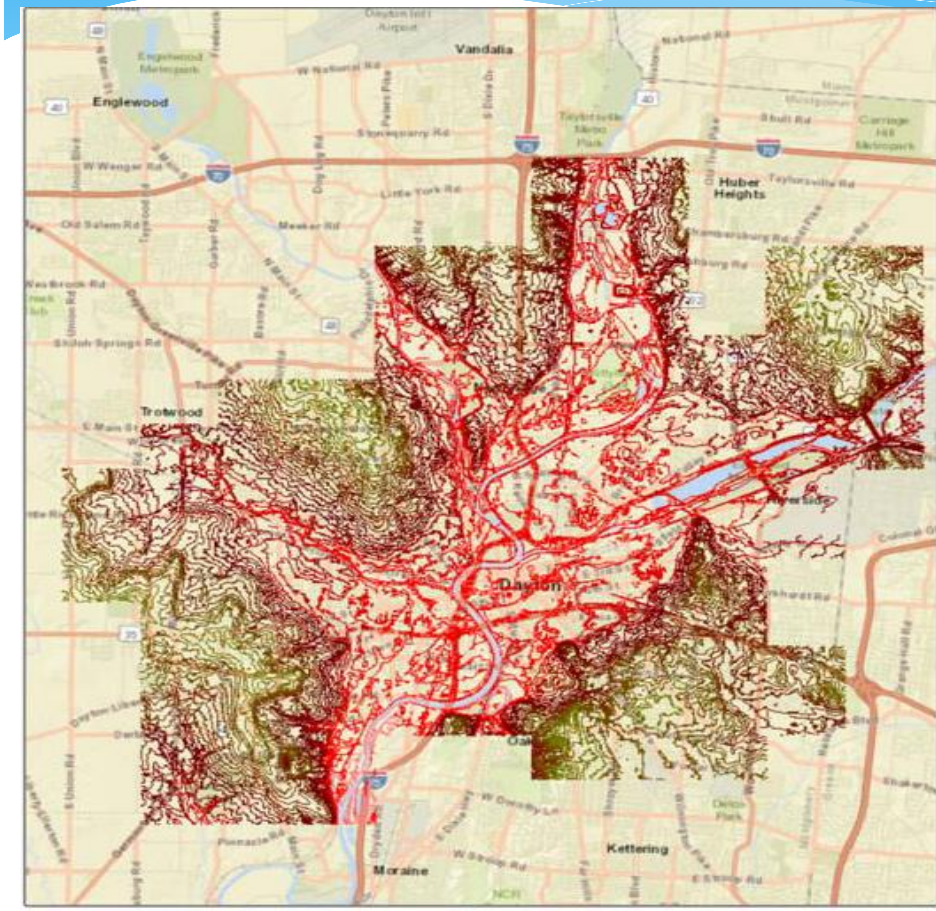
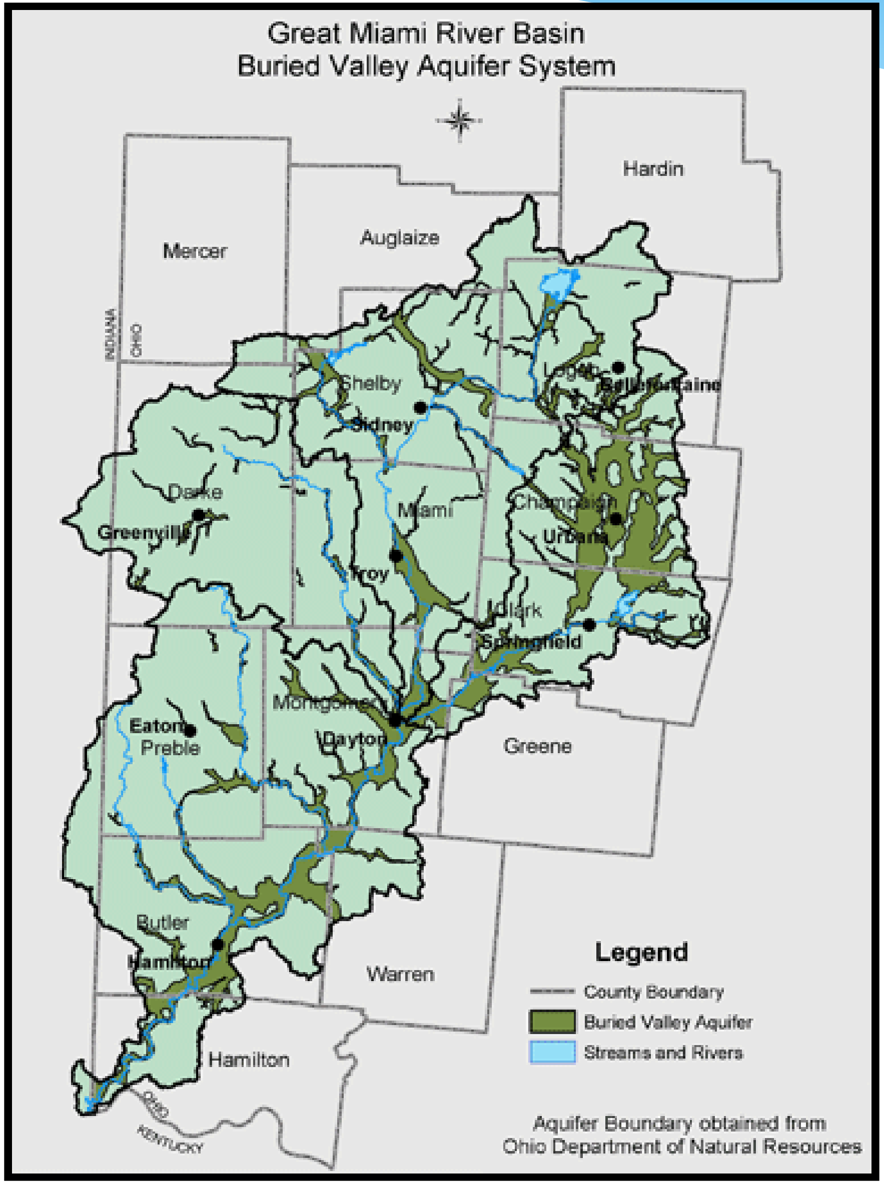
City of Dayton, Ohio

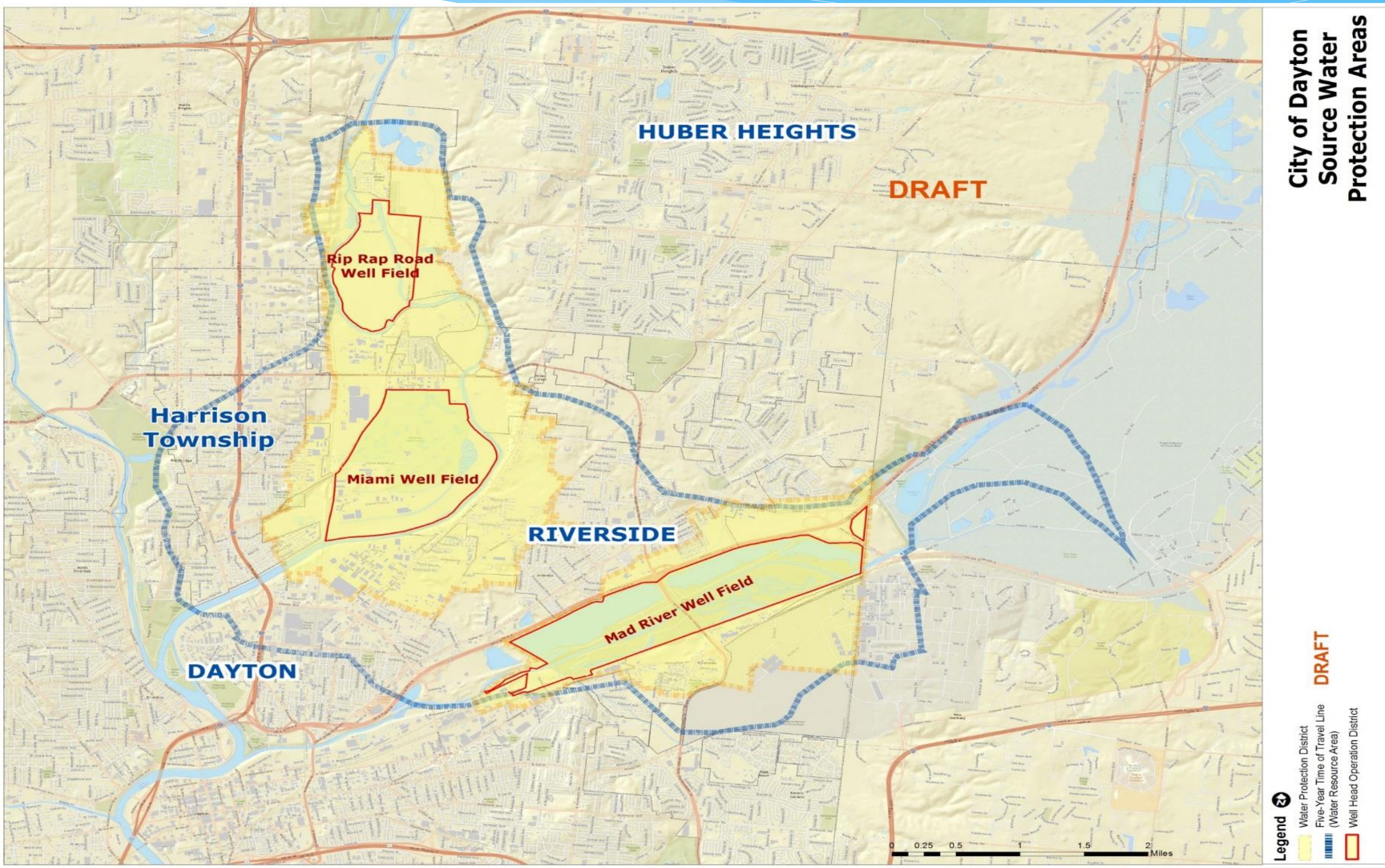


Great Miami Buried Valley Aquifer



- Sustainable Asset
- Phenomenal Recharge
- Sole Source Aquifer
- ~1.5 Trillion Gallons
- Principal Water Source For 1.6 Million People
- Dayton Water provides drinking water to more than 400,000 customers
- Producing 60 MGD

Wellfields and Source Water Protection Area



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Reasons for Updating SWPP

- Timeframe 25+ years; water usage decrease and the need to model the 5 year Time Of Travel (TOT) boundary
- Time for a re-evaluation of the Source Water Protection Program
- A need was identified to reconnect with the businesses that are operating in the 1 year TOT and begin to understand businesses operating in the 5 year TOT

Reasons for Updating SWPP Cont.

- The new delineation and the risks posed within the 5 year TOT
- Large number of businesses and the need for a quantitative risk ranking system
- End goal of the risk ranking system is to prioritize limited SWPP funding for the highest risks

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Priority Setting Approach (PSA)

- What is the PSA?
  - Method developed by the US EPA in the early 1990s
  - Risk screening tool to enable assessment of risks posed by potential sources of contaminants
  - Scores and ranks risk posed by sources of contaminants
  - Based on conventional risk assessment
    - Risk = Likelihood x Severity
    - R = L x S

Priority Setting Approach
R = L + S

* Risk (R) = Likelihood of well contamination (L) + Severity (S)

* Likelihood in the above equation is a factor of two components: The likelihood of a release (spill) from a source (L_1), and likelihood that the release impacts drinking water production wells (L_2)
* $L = (L_1) + (L_2)$

  * $L_{1,}$ score of the Likelihood of a release at the source, is based on duration of material storage, material throughput, storage area design, and site best management practices

  * L_2 score of likelihood of a release impacting drinking water, depends on planning period (10, 25, 50, 100 years), contaminant mobility in soil and groundwater, depth to groundwater, aquifer thickness, velocity of groundwater, pumping rates, and distance to nearest drinking water production well

Priority Setting Approach

* Risk (R) = Likelihood of well contamination (L) + Severity (S)
* Likelihood of Well Contamination (L)
  * L = Likelihood of release at source (L_1) + Likelihood that the contaminant released will reach the well (L_2)
  * $L = (L_1) + (L_2)$
    * L_1 is a function of engineering failure of source type (drum, tank, landfill, etc.), design characteristics (secondary containment), material throughput, and operating status (e. g. age)
    * L_2 = Time of travel through unsaturated zone (L_U) + Time of travel through the saturated zone (L_S)
    * $L_2 = L_U + L_S$
      * L_U is a function of depth to aquifer, hydraulic conductivity in the unsaturated zone, and contaminant mobility
      * L_S is a function of the distance from the well, groundwater velocity, and contaminant mobility

Priority Setting Approach
R = L + S

- S reflects the potential health hazard from drinking water from a well that has been contaminated.
- S = Quantity Released (Q) + Attenuation due to transport (A) through buried valley aquifer deposits + Toxicity of the contaminant (T)
- S = Q+A+T

Priority Setting Approach
R = L + S

- S = Q+A+T

- Q, score of quantity of contaminant released , is determined from the potential volume released and chemical concentration.

- A, attenuation score, is calculated based on hydraulic conductivity, type of soil or aquifer material such as silt, sand, or gravel, groundwater velocity, distance from production well, and chemical persistence.

- T, toxicity score, is calculated based on critical concentrations from the Safe Drinking Water Act Maximum Contaminant Levels (MCLs) or oral reference doses from the US EPA Integrated Risk Information System or other toxicological information sources.

Priority Setting Approach
$R = L + S$

- Severity (S) = Q + A + T
  - Quantity (Q) is the expected mass of Release
  - Quantity (Q) = expected volume released X the contaminant concentration
    - Volume score is a function of facility type and size
    - Volume is in $\log_{10}(m^3/yr.)$ of release
    - Concentration is in $\log_{10}(kg/m^3)$

Priority Setting Approach
R = L + S

- Severity (S) = Q + A + T
- Attenuation (A) in $\log_{10}$((mg/l)/(kg/yr.)) reflects the dilution and decay of the contaminant due to transport; the higher the score the less the dilution and/or decay expected
  - Attenuation is the sum of two attenuation scores A_U and A_S
    - A_U is the unsaturated zone attenuation and is a function of hydraulic conductivity, contaminant persistence and mobility, and depth to aquifer
    - A_S is the saturated zone attenuation and is a function of groundwater velocity, contaminant persistence and mobility, type of saturated zone material (silt, sand, gravel, karst) and distance from well.

Priority Setting Approach
R = L + S

- Severity (S) = Q + A + T
- Toxicity of a Contaminant (T)
- T is based on critical dose for each contaminant
  - Dose –response relationships can be found on Integrated Risk Information System (IRIS) and other similar databases
  - The PSA defines the critical dose
    - Oral reference dose (RfD) for non-carcinogens
    - Dose corresponding to 1 in 100,000 excess lifetime risk for carcinogens
  - RfD is converted to a drinking water equivalent critical concentration in mg/l
- T is defined as the inverse log of the critical concentration

Priority Setting Approach

R = L + S

		Likelihood				
		1	2	3	4	5
Severity	1	1	2	3	4	5
	2	2	4	6	8	10
	3	3	6	9	12	15
	4	4	8	12	16	20
	5	5	10	15	20	25

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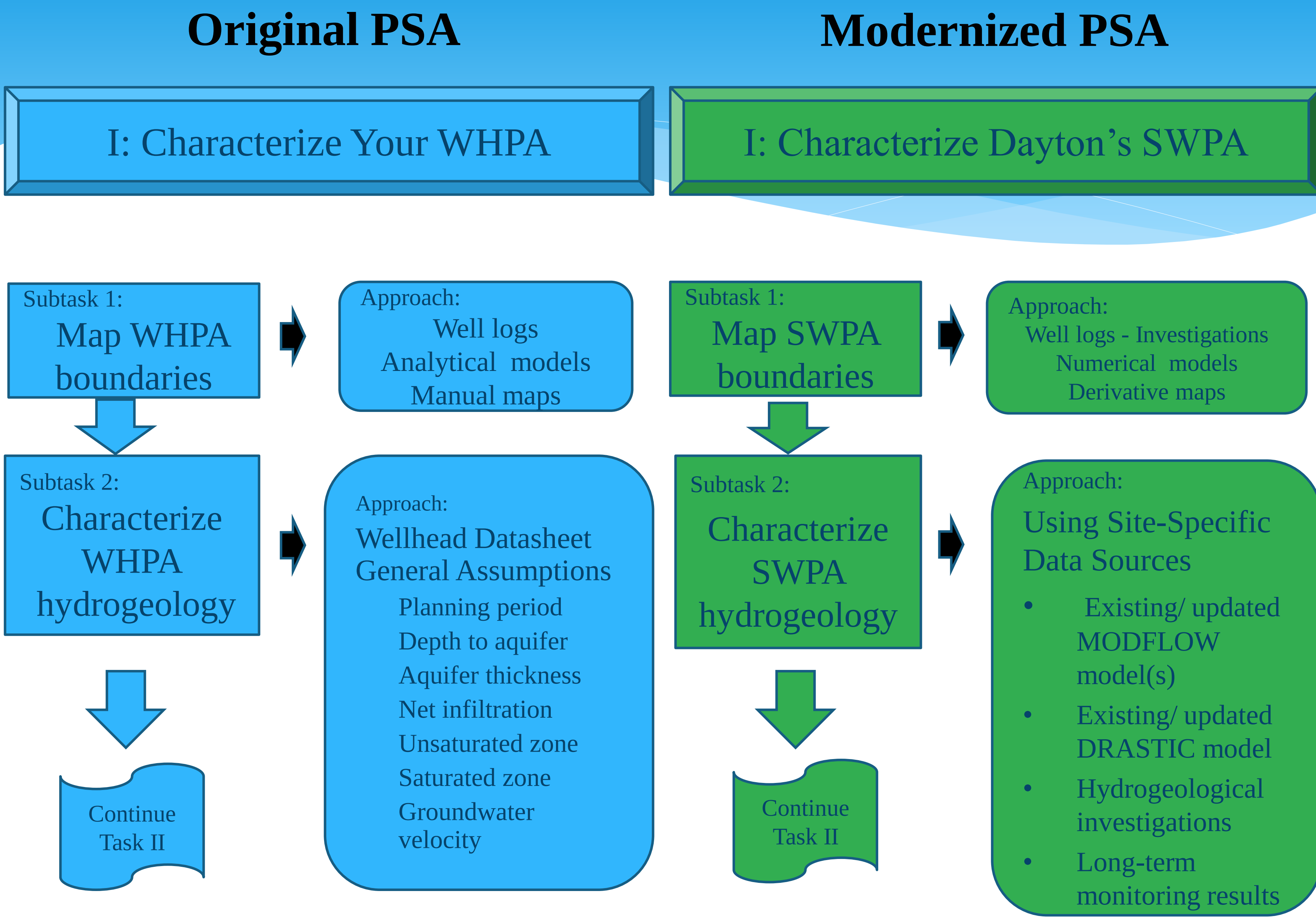
Modernization of the PSA

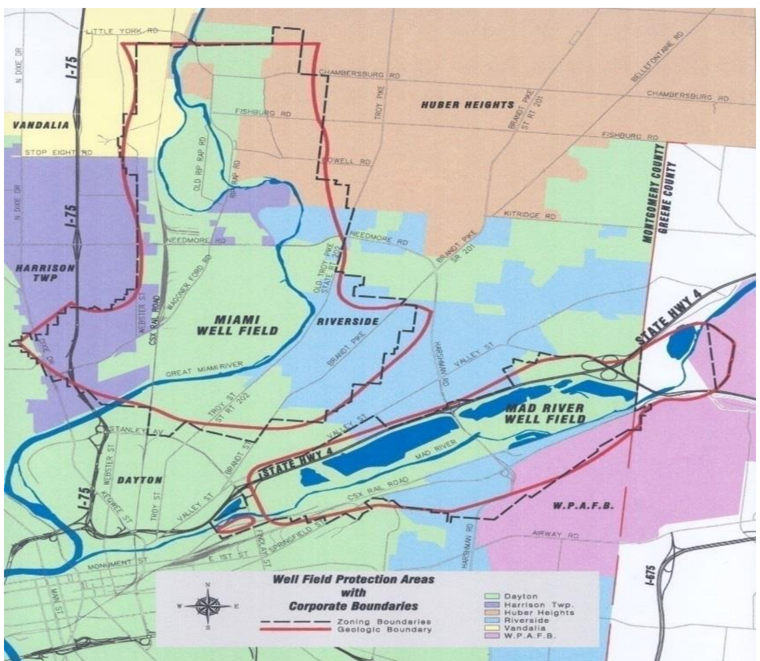
- Why the PSA method required modernization for use by the City of Dayton?
  - Over 25 years of SWPA- specific information available
  - Incorporation of results from numerous hydrogeologic investigations
  - Standardization of potential contaminant's environmental characteristics and how they persist in the subsurface
  - Inclusion of new contaminants of concern in the PSA evaluation process
  - Needed to implement PSA calculations in a computer model format to permit quick and standardized assessments

Overview of the Priority Setting Approach

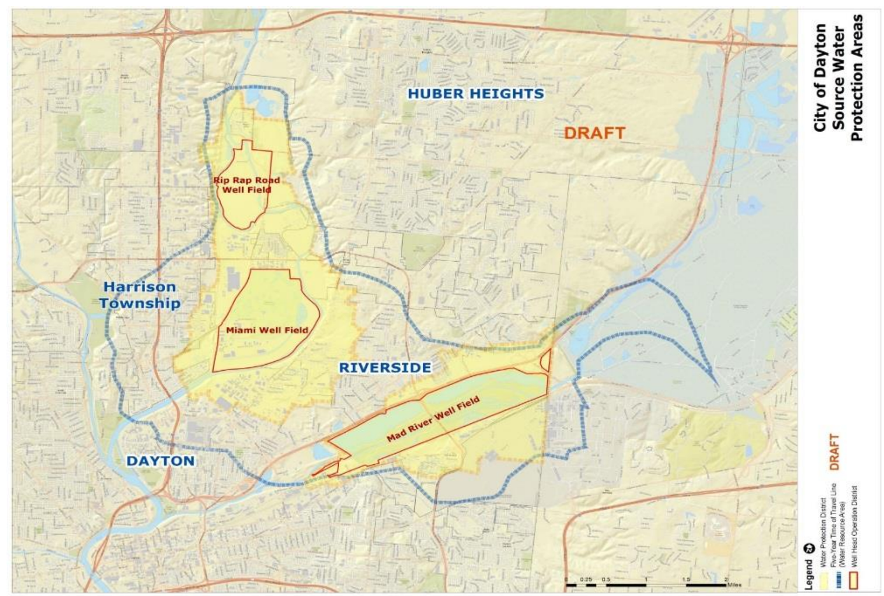


Previously Defined WHPA vs Current SWPA Delineation

Dayton WHPA (circa 1988)



Current Dayton SWPA

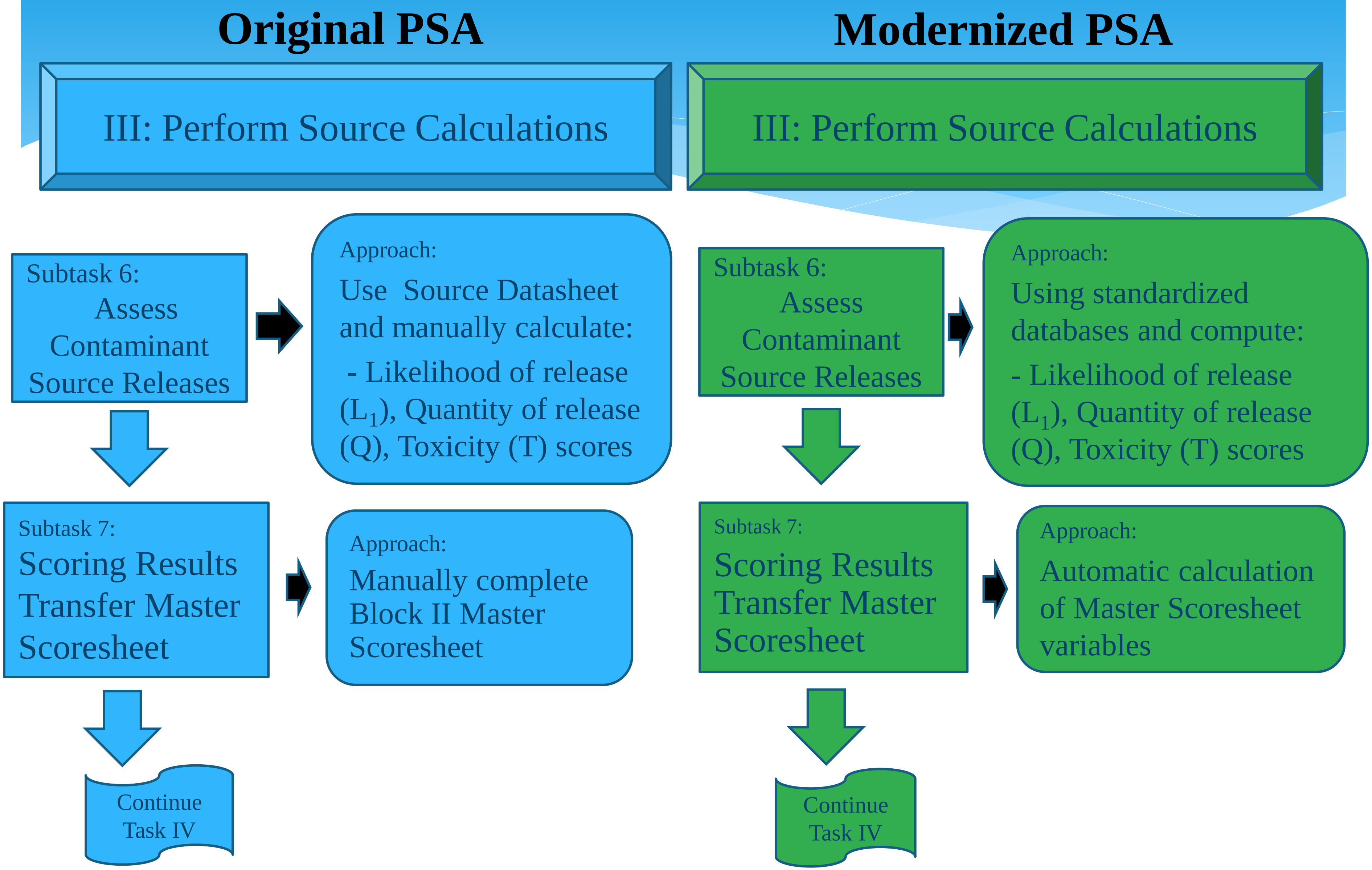


Original PSA		**Modernized PSA**	
II: Potential Sources of Well Contamination		II: Potential Sources of Well Contamination	
Subtask 3: Identify & Locate All Sources	Approach: Surveys; Field studies; Manual maps	Subtask 3: Identify & Locate All Sources	Approach: Site inventories (historical & new); Existing databases
Subtask 4: List all sources by category & name	Approach: Manually complete Block I Master Scoresheet	Subtask 4: List all sources by category & name	Approach: Develop standardized category & name database
Subtask 5: Contaminant source characterization	Approach: Source Datasheet; General Assumptions; Non-standard inputs estimated based on source type	Subtask 5: Contaminant source characterization	Approach: Develop standardized database for potential contamination for all sources
Continue Task III		Continue Task III	

Example Potential Sources of Contamination in the Dayton SWPA

- Container Storage and Material Transfer
- Storage Piles
- Tanks
- Overland Material Transport
- Landfills
- Shallow (Class V) Dry Wells
- Agrichemical Applications
- Pipelines

Overview of the Priority Setting Approach



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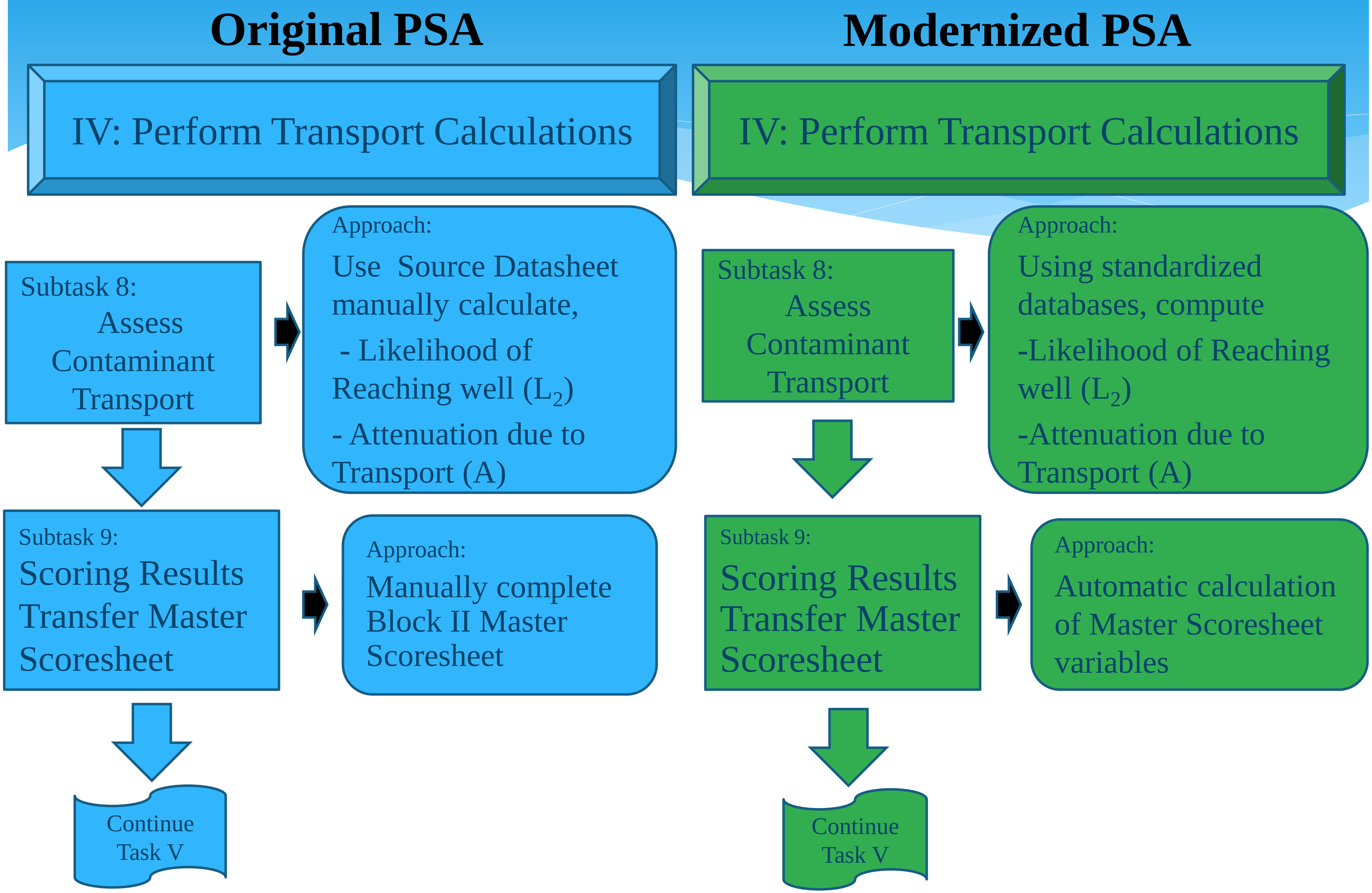

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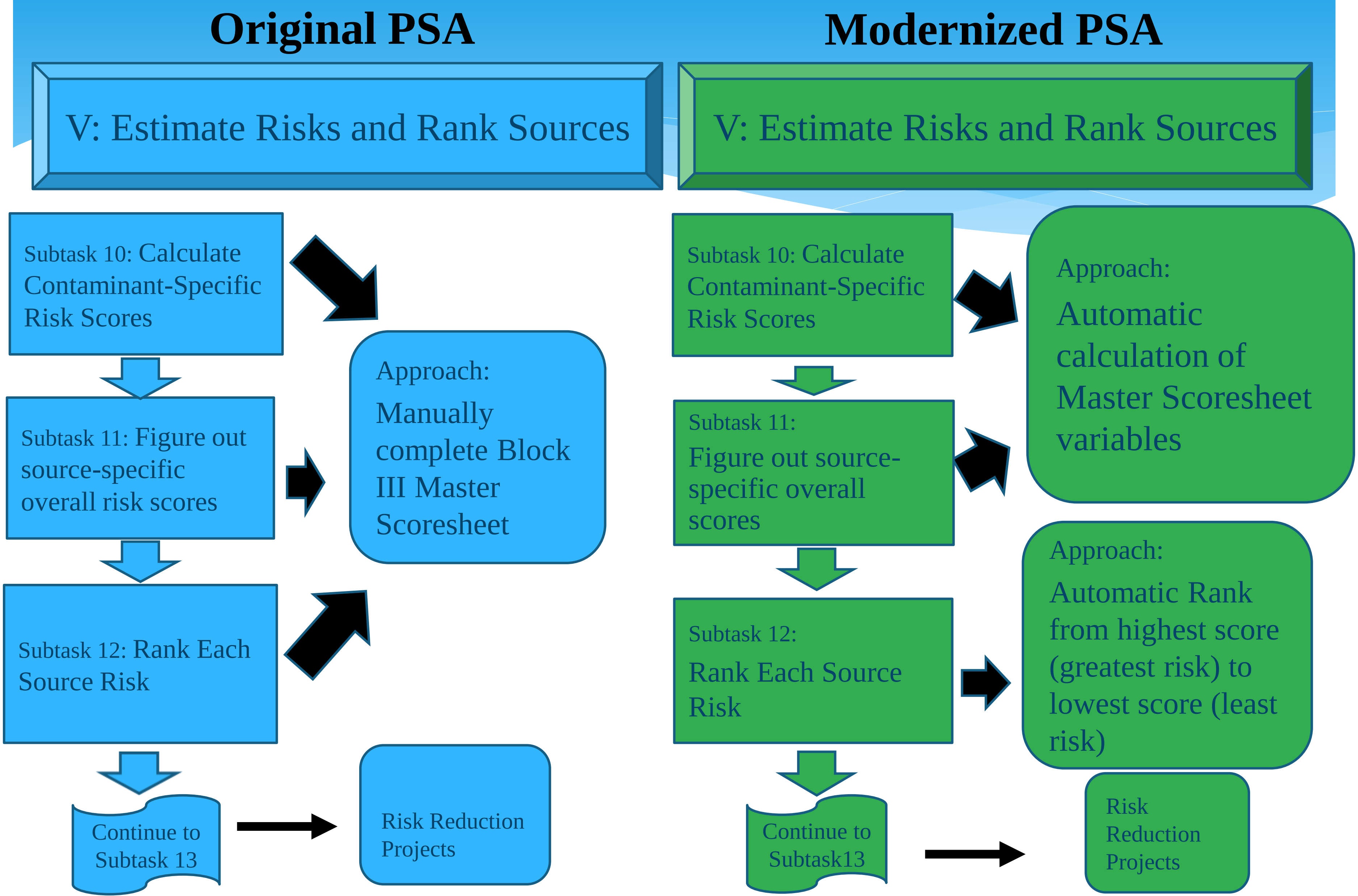

Original PSA

Subtask 13: Risk Reduction Projects

Approach:

More Regulatory With Some Incentives including purchasing chemical rights

Modernized PSA

Subtask 13: Risk Reduction Projects

Approach:

- More incentive focus and target greatest risks
- Developing Drinking Water Protection Partnerships
- Social media to create awareness plus promoting the business
- Offering more useful incentives such as use of consultant and funding for engineering controls
- Purchasing chemical rights

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Conclusions In Dayton's SWPA

- Many business operations may not pose a great risk to groundwater
- Many businesses already practice BMP further protecting groundwater
- Some businesses do pose significant risks
    - Large quantities of toxic and persistent chemicals with high mobility in soil and groundwater
    - Not so common anymore but chlorinated ethenes used as degreasers, or in dry cleaning
    - Emerging contaminants of concerns such as PFAS

Conclusions In Dayton's SWPA

* Modernization of the Priority Setting Approach (PSA) algorithm provides an effective tool for Source Water Protection Programs
* The PSA provides objective ranking of risks to drinking water resources between businesses and other sources operating and located within the SWPA
* The PSA can be updated with data from emerging contaminants of concern

Conclusions In Dayton's SWPA

Based on risk screening, locate monitoring equipment/ wells in areas of greatest risk

Prioritization of limited resources to address greatest risks

Thank You!

* City of Dayton Dept. of Water
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* Terran Corp.
  * Brent Huntsman and others
* OTCO, Inc.

DAYTON

MULTI-JURISDICTIONAL SOURCE WATER PROTECTION

amec foster wheeler

TERRAN

OTCO, Inc.