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Structured Hazard Assessment Committee Process for Flooding (SHAC-F)

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Rajiv Prasad,[1] Kevin Coppersmith,[2] Philip Meyer[1], and Victor Gonzalez[3]

[1]Pacific Northwest National Laboratory
[2]Coppersmith Consulting, Inc.
[3]USACE ERDC Coastal and Hydraulics Laboratory

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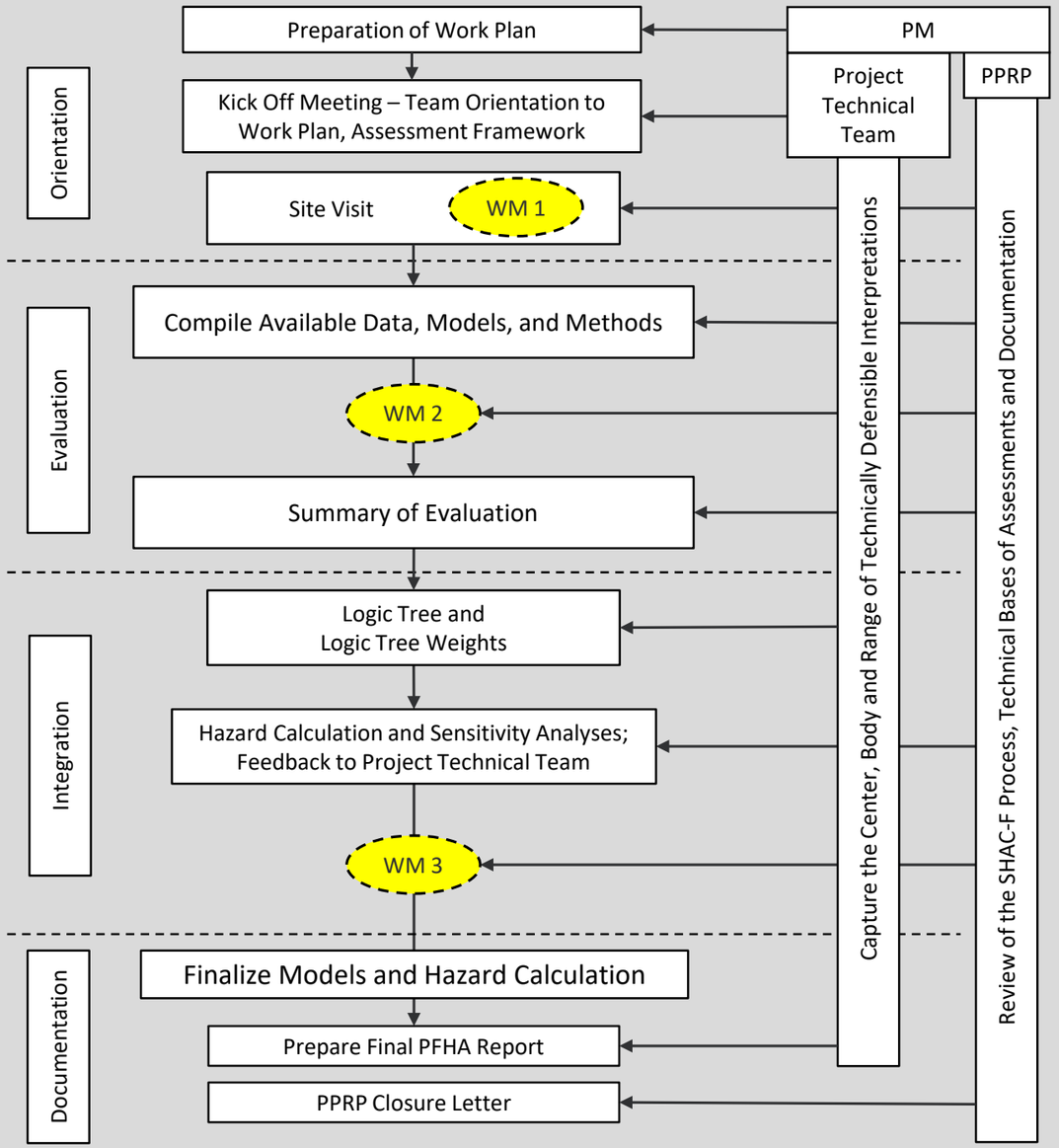

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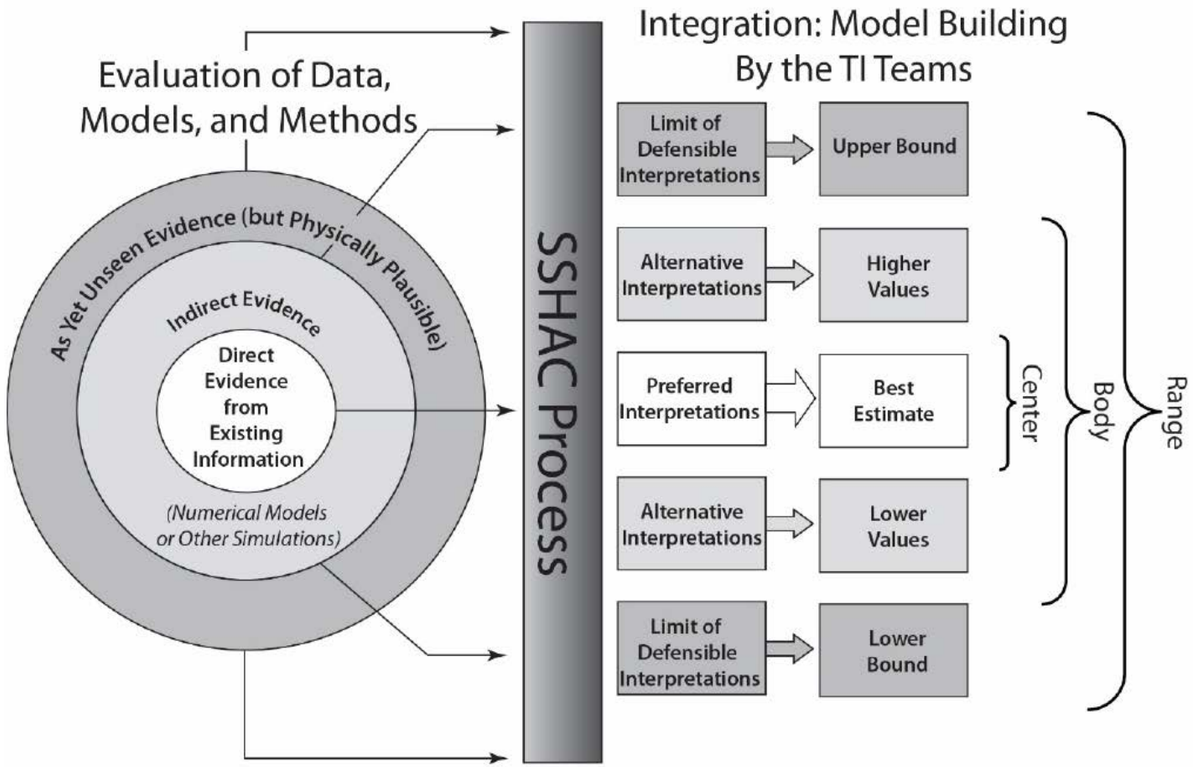
Motivation

- Flood frequency analysis (FFA) is well established
  - Suitable for at-site estimation of distribution of flood discharge or flood volumes
  - Bulletin 17B, 17C; Asquith et al. 2017
- NRC flood reviews need estimation of dynamic flood parameters and associated effects at very low exceedance probabilities
  - Complete flood hydrographs – temporal flood characteristics
  - Hydrostatic and hydrodynamic loadings – spatial flood characteristics
  - Inundation map – spatial flood characteristics
  - Inundation duration – temporal and spatial flood characteristics
- FFA needs to be supplemented with conceptual flood models
  - Watershed models, site-scale models
  - Introduction of additional uncertainties – epistemic and aleatory
- A structured process to account for all uncertainties is needed
  - Structured Hazard Assessment Committee Process for Flooding (SHAC-F)

SHAC-F Goals

- The fundamental goal of a SHAC-F process is to properly carry out and completely document the activities of evaluation and integration, defined as:
  - Evaluation: The consideration of the complete set of data, models, and methods proposed by the larger technical community that are relevant to flood hazard analysis.
  - Integration: Representing the center, body, and range of technically defensible interpretations in light of the evaluation process (i.e., informed by the assessment of existing data, models, and methods).



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SHAC-F Features

- Five essential features provide regulatory confidence – that a hazard assessment has followed a sufficiently rigorous and transparent process that can be efficiently reviewed by the regulatory agency:
  1. **Clearly defined roles** for all participants, including the responsibilities and attributes associated with each role.
  2. **Objective evaluation** of all available data, models, and methods that could be relevant to the characterization of the hazard at the site. This will often include additional new data collected specifically for the hazard assessment. This process includes identifying the limits of the existing data, gaps in the existing data, and the resolution and uncertainties in the available data.
  3. **Integration** of the outcome of the evaluation process into models that reflect both the best estimate of each element of the hazard input with the current state of knowledge and the associated uncertainty. This distribution is referred to as the center, body, and range of technically defensible interpretations. This will generally involve the construction of hazard input models … that address both aleatory variability and epistemic uncertainties.
  4. **Documentation** of the study with sufficient detail to allow reproduction of the hazard analyses. The documentation must identify all the data, models, and methods considered in the evaluation, and justify in detail the technical interpretations that support the hazard input models.
  5. **Independent participatory peer review** is required to confirm that the evaluation considered relevant data, models, and methods, and that the evaluation was conducted objectively and without bias. The peer review is conducted following a “participatory” or continual process throughout the entire project.

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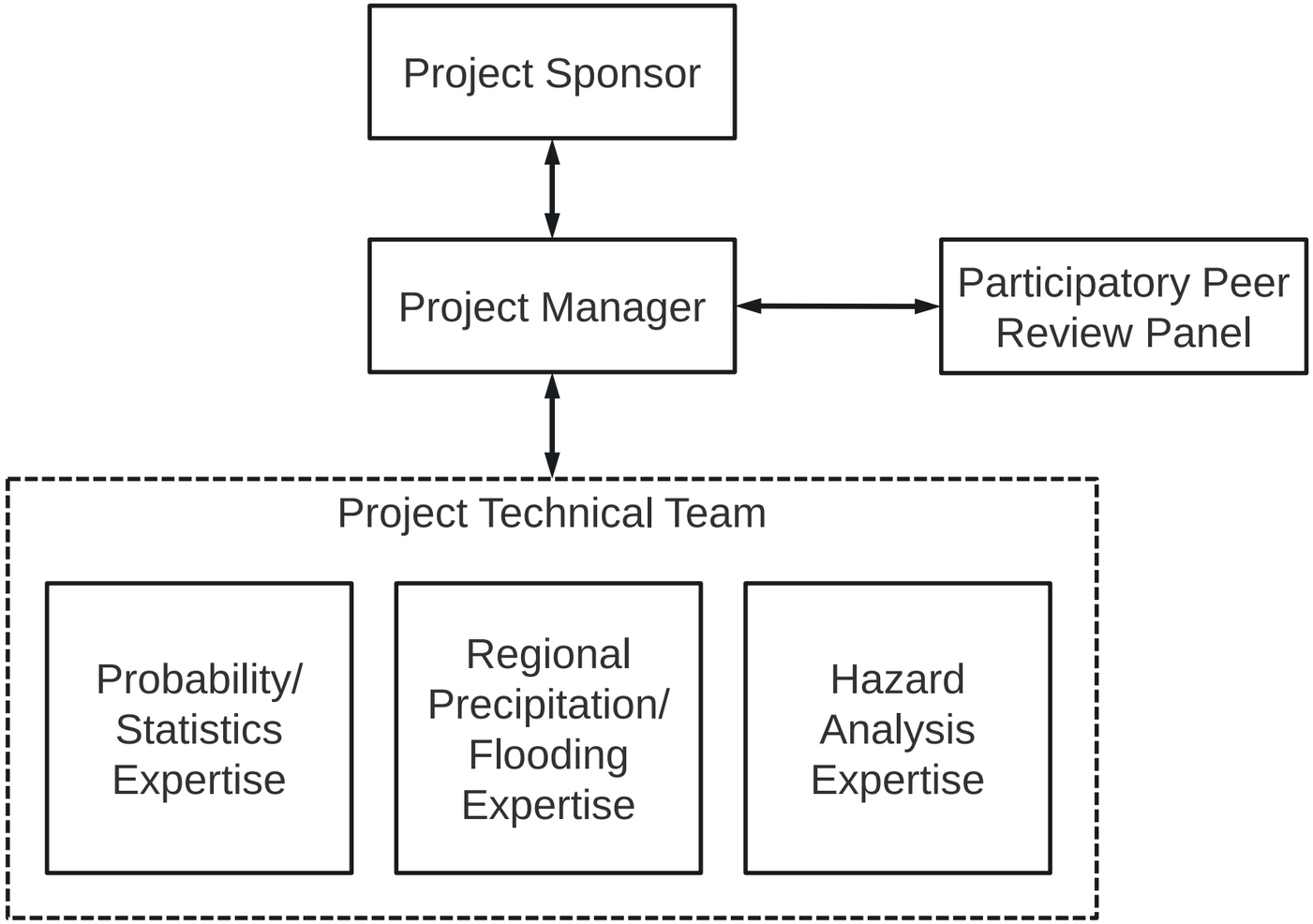
SHAC-F

- Three levels
- Levels address purposes of various NRC flood reviews
- Project teams and level of effort commensurate with complexity of reviews
- Data and methods commensurate with complexity of reviews
- Probabilistic flood assessment
- Incorporation of aleatory and epistemic uncertainties
- All three levels result in estimation of a family of flood hazard curves

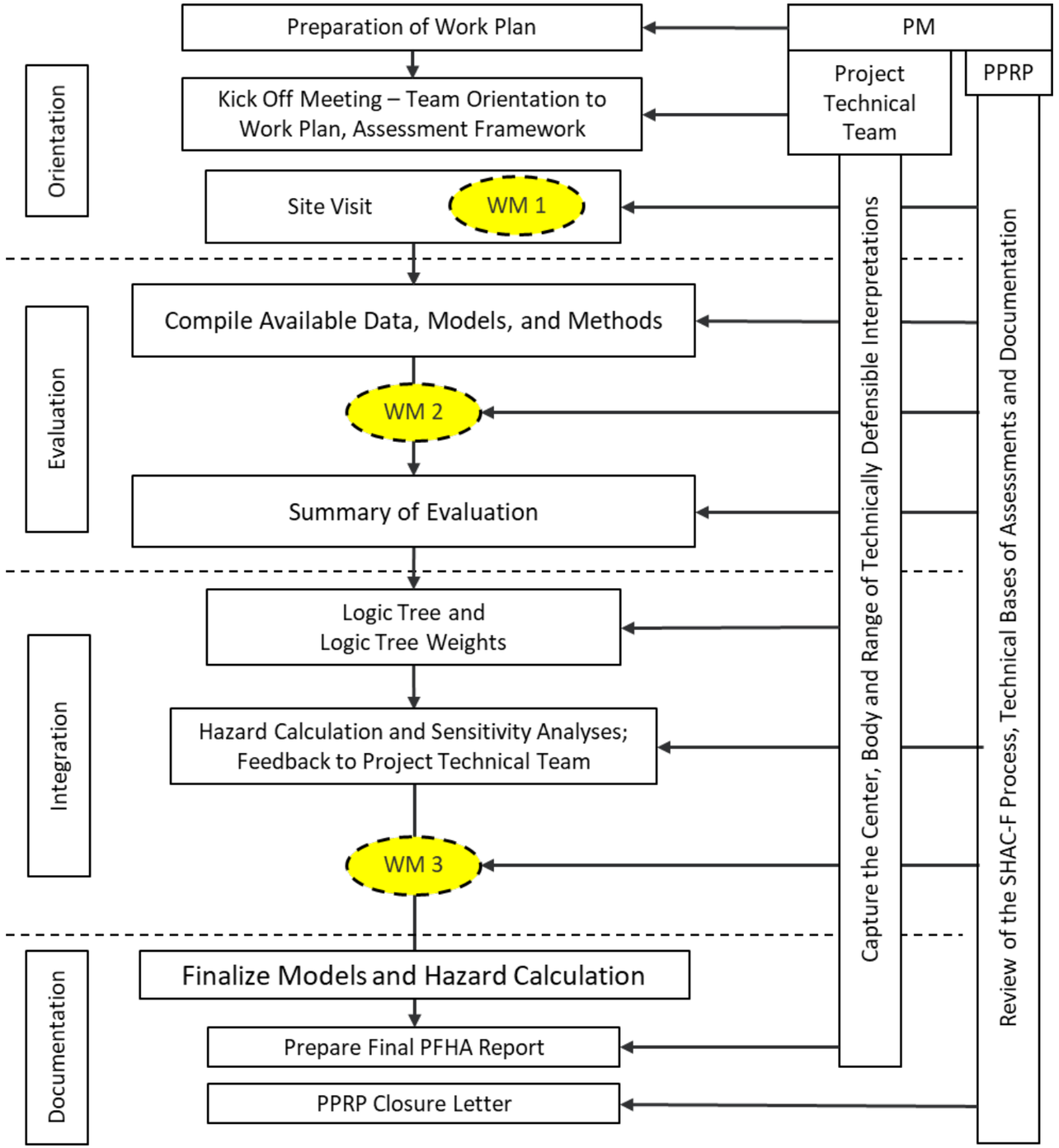
Level 1 SHAC-F Study

- Purpose: screening
  - Example: Significance Determination Process (SDP)
- Expected assessment results: family of flood hazard curves
  - Example: discharge and/or water surface elevation hazards plus associated effects for a LIP or riverine flood relevant to the system being analyzed in SDP
- Data
  - Readily-accessible data relevant to the chosen flood hazard assessment approach
  - Example: existing streamflow data, stage-discharge relationships
- Models and methods
  - Statistical models—at-site and/or regional precipitation and/or flood-frequency analyses to drive simplified hydrologic/hydraulic process simulation models
  - Example: FFA (see Asquith et al. 2017) to drive at-site hydraulic stage estimation
- Sources of uncertainty
  - Aleatory: precipitation/streamflow; Epistemic: measurement, statistical models, parameters

Level 1 SHAC-F Study – Project Team Structure



Level 1 SHAC-F Study: Workflow

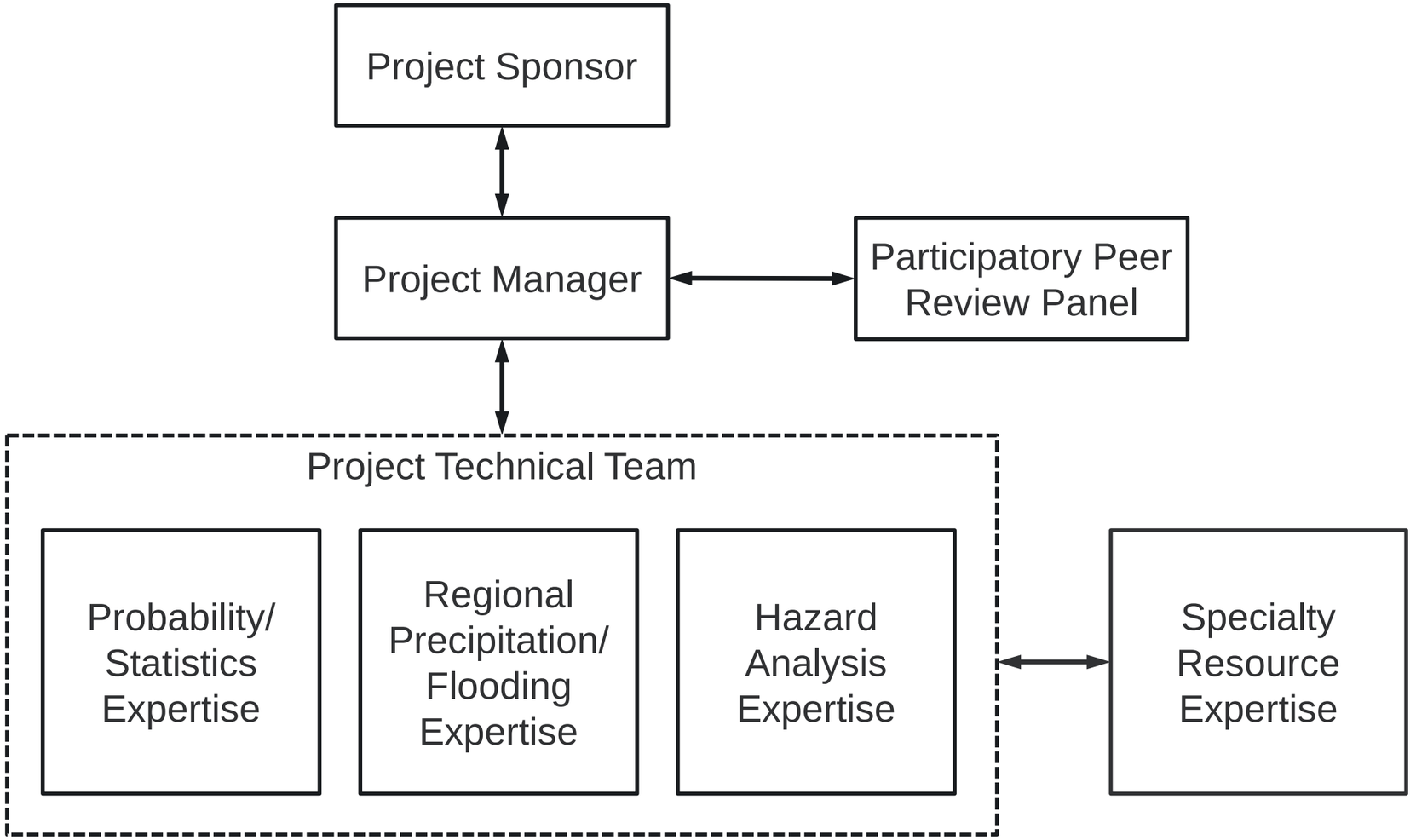


WM: Working Meeting

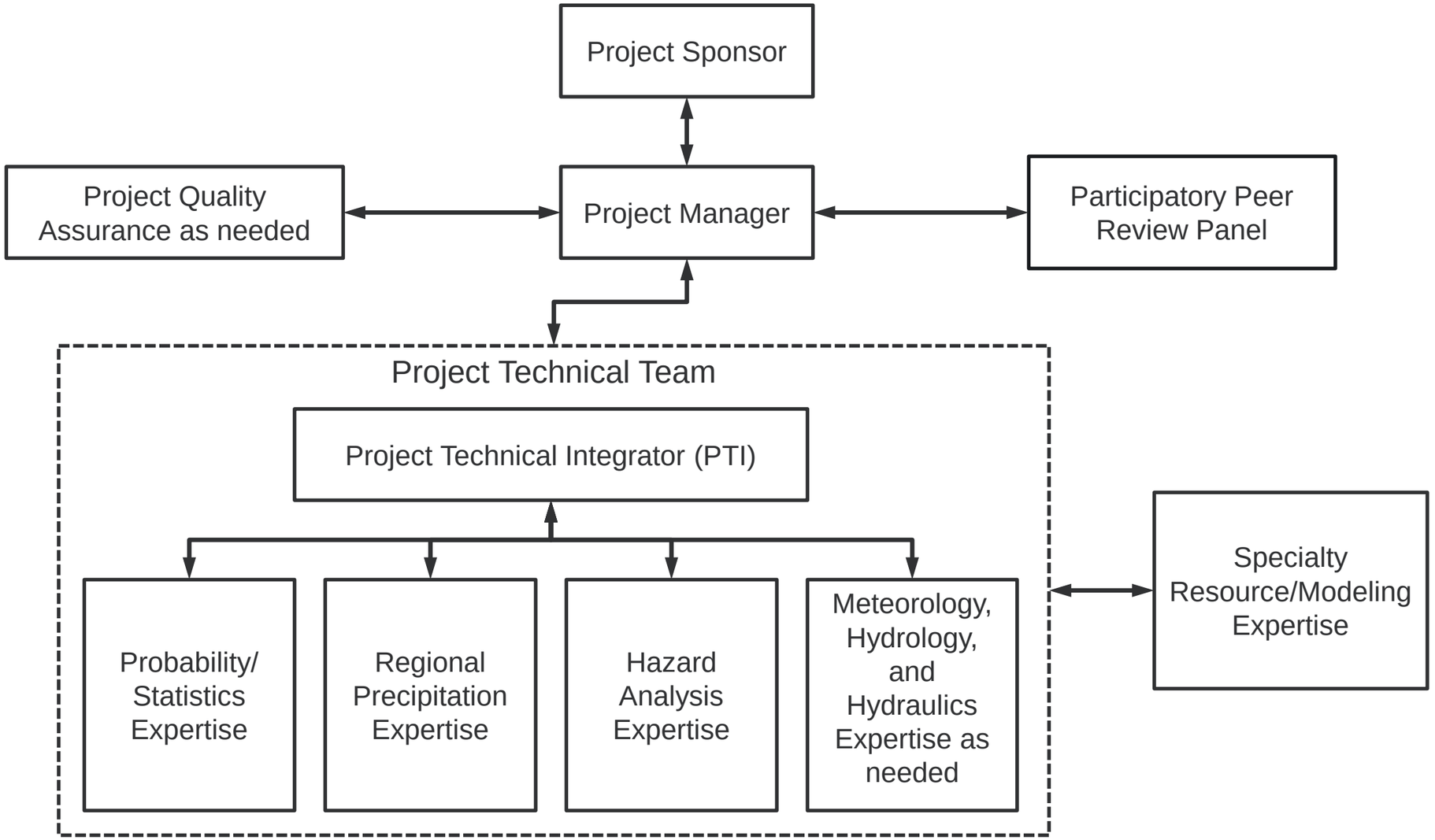
Level 2 SHAC-F Study

- Purpose: updating existing analyses or refining screening analyses
  - Example: support corrective actions, update or refine an existing Level 3 study, support License Amendment Requests, refine a Level 1 study
- Expected assessment results: family of flood hazard curves
  - Example: family of hazard curves plus associated effects for multiple systems/locations of interest for corrective actions or permitting/licensing
- Data
  - More extensive effort to assemble existing data, contact resource experts
  - Example: historical, non-public, reanalysis, available paleoflood, and synthetic data
- Models and methods
  - Statistical models, process-simulation models with spatial variations, consider nonstationarities
  - Example: frequency analysis incorporating additional data (see Asquith et al. 2017) to drive a watershed model
- Sources of uncertainty
  - Aleatory: streamflow, precipitation, initial conditions; Epistemic: discharge/precipitation/initial conditions measurement, alternative statistical/conceptual models, statistical/watershed model parameters

Level 2 SHAC-F Study – Project Team Structure for Refinement of a Level 1 Study

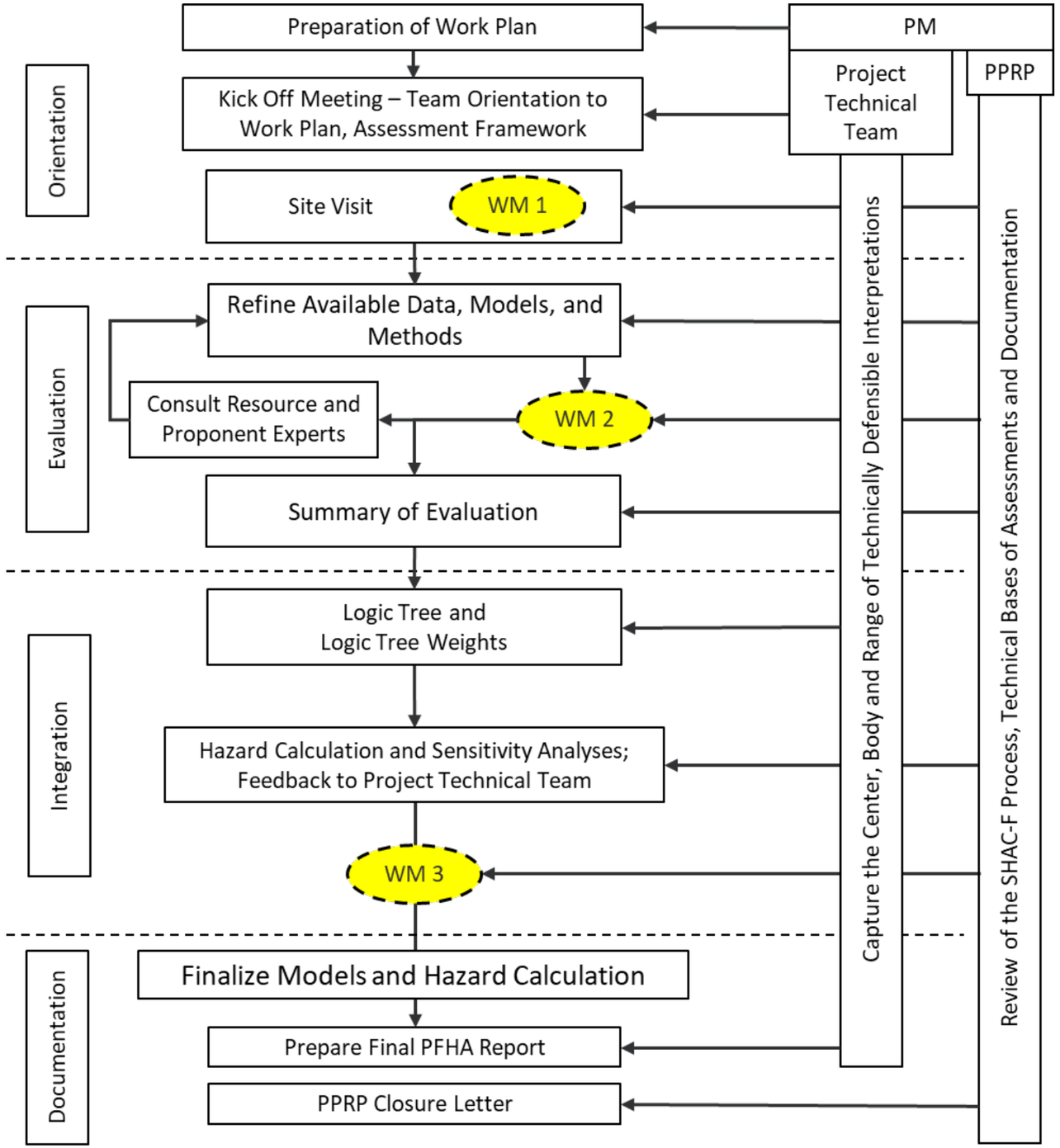


Level 2 SHAC-F Study – Project Team Structure for Update or Refinement of a Level 3 Study



PPRP: Participatory Peer Review Panel

Level 2 SHAC-F Study: Workflow

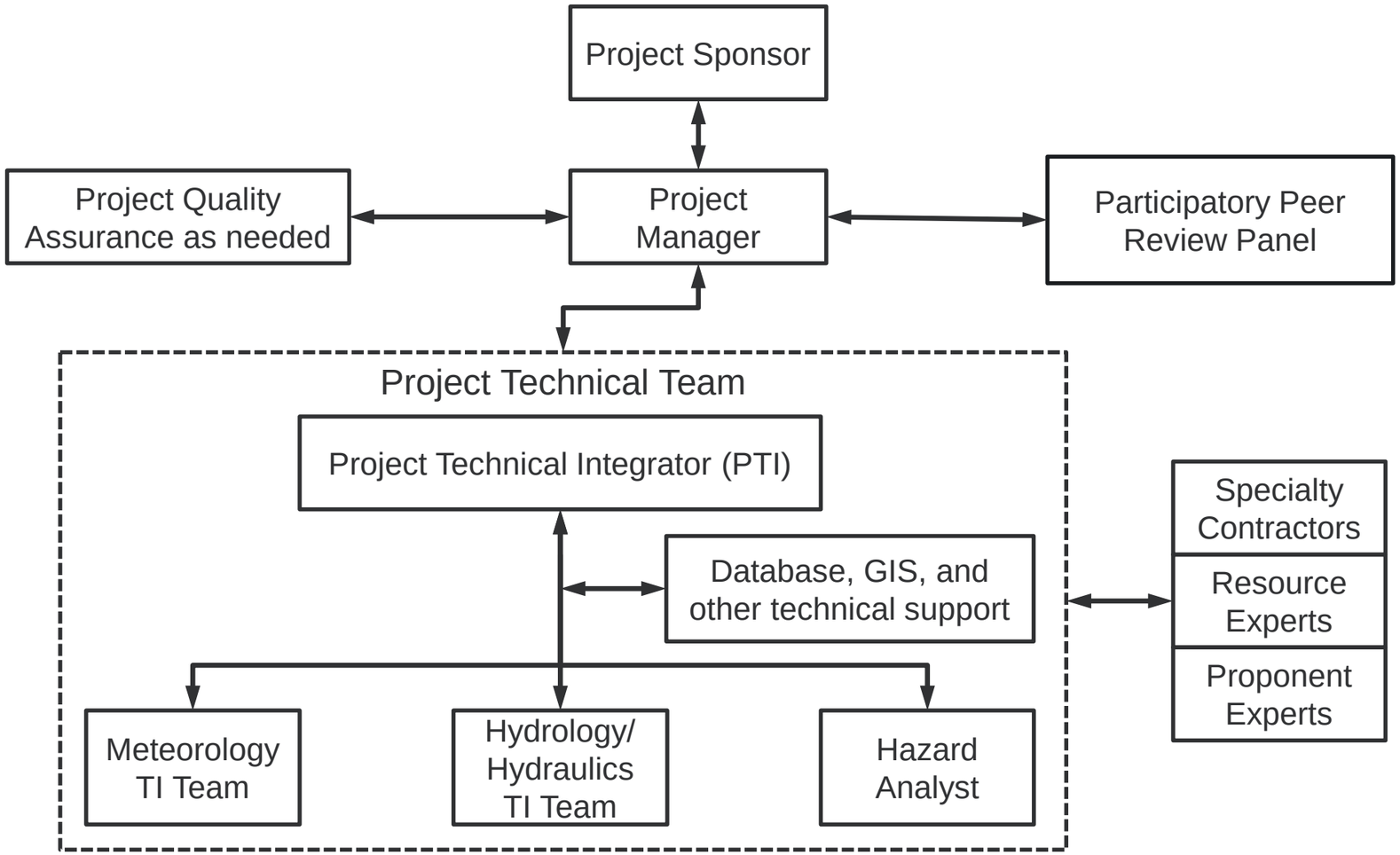


WM: Working Meeting

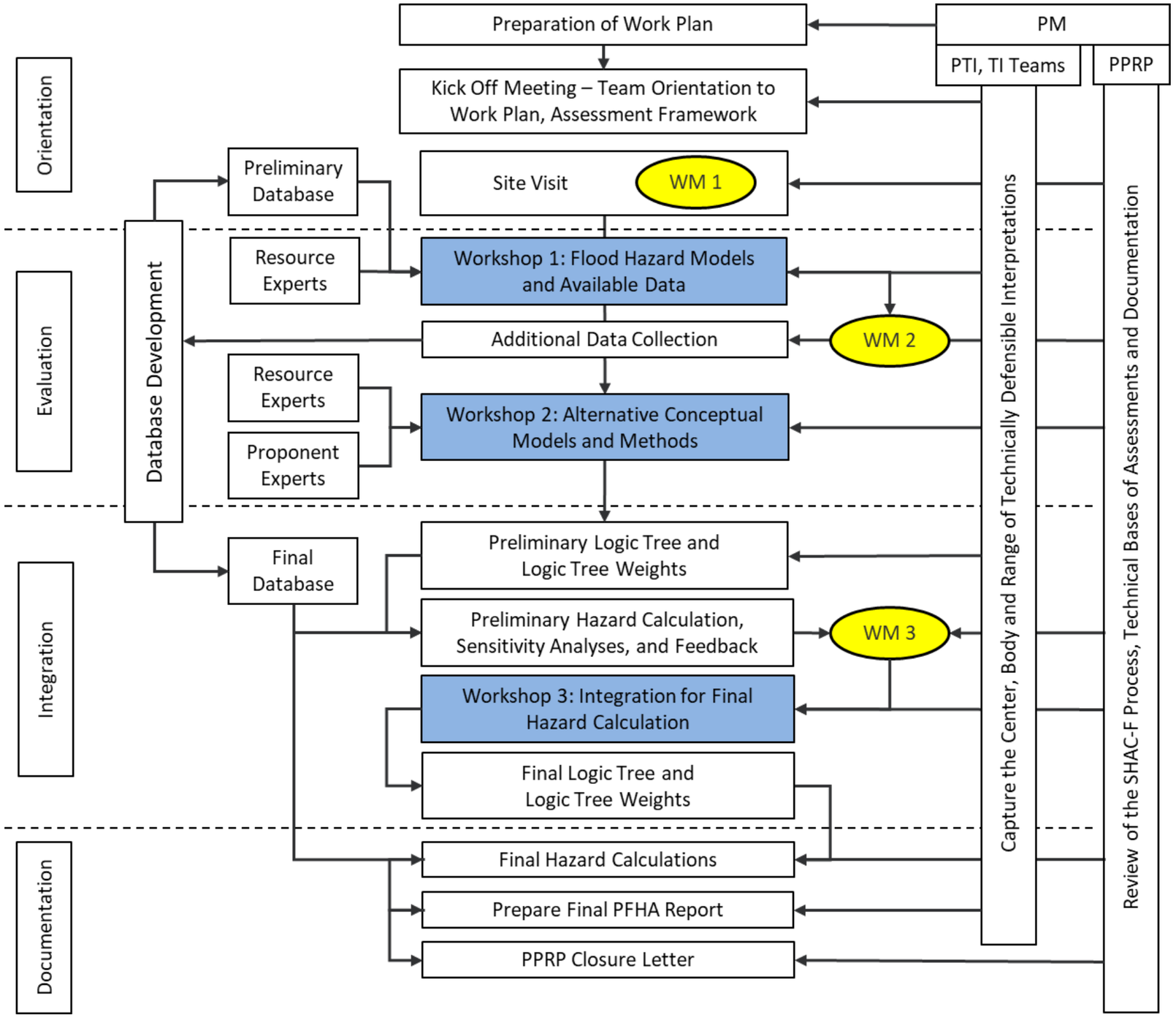
Level 3 SHAC-F Study

- Purpose: supporting design and/or providing inputs to a PRA
  - Example: support Combined License Application, support License Amendment Requests
- Expected assessment results: family of flood hazard curves
  - Example: family of hazard curves plus associated effects for site-wide hazards
- Data
  - Consider collecting new data
  - Example: paleoflood data, LiDAR surveys, remote sensing LULC data, bathymetric surveys
- Models and methods
  - Statistical and process-simulation models with spatiotemporal resolution to support PRA; consider nonstationarities
  - Example: FFA incorporating paleoflood data, site-specific watershed models driven with frequency inputs
- Sources of uncertainty
  - Aleatory: streamflow, precipitation, initial, and boundary conditions; Epistemic: discharge/precipitation/initial/boundary conditions measurement, alternative statistical models, statistical/watershed model parameters, alternative process representations in watershed models

Level 3 SHAC-F Study – Project Team Structure



Level 3 SHAC-F Study: Workflow



WM: Working Meeting

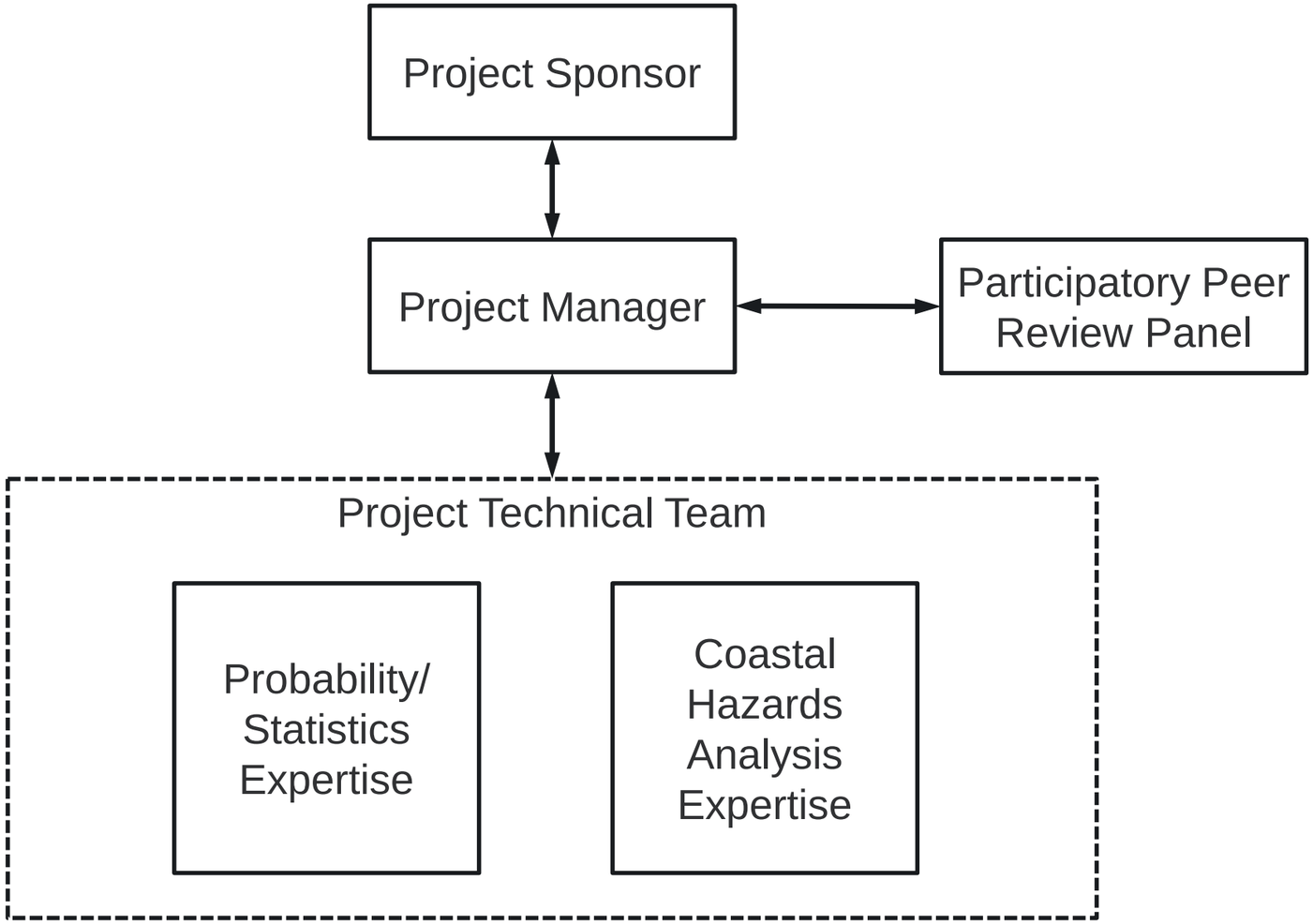
SHAC-F for Coastal Flooding

- USACE Coastal and Hydraulics Laboratory and PNNL
- Series of conference calls starting Fall 2019
- Three Levels of coastal flooding SHAC-F studies
- Workshop scheduled for first week of March 2020

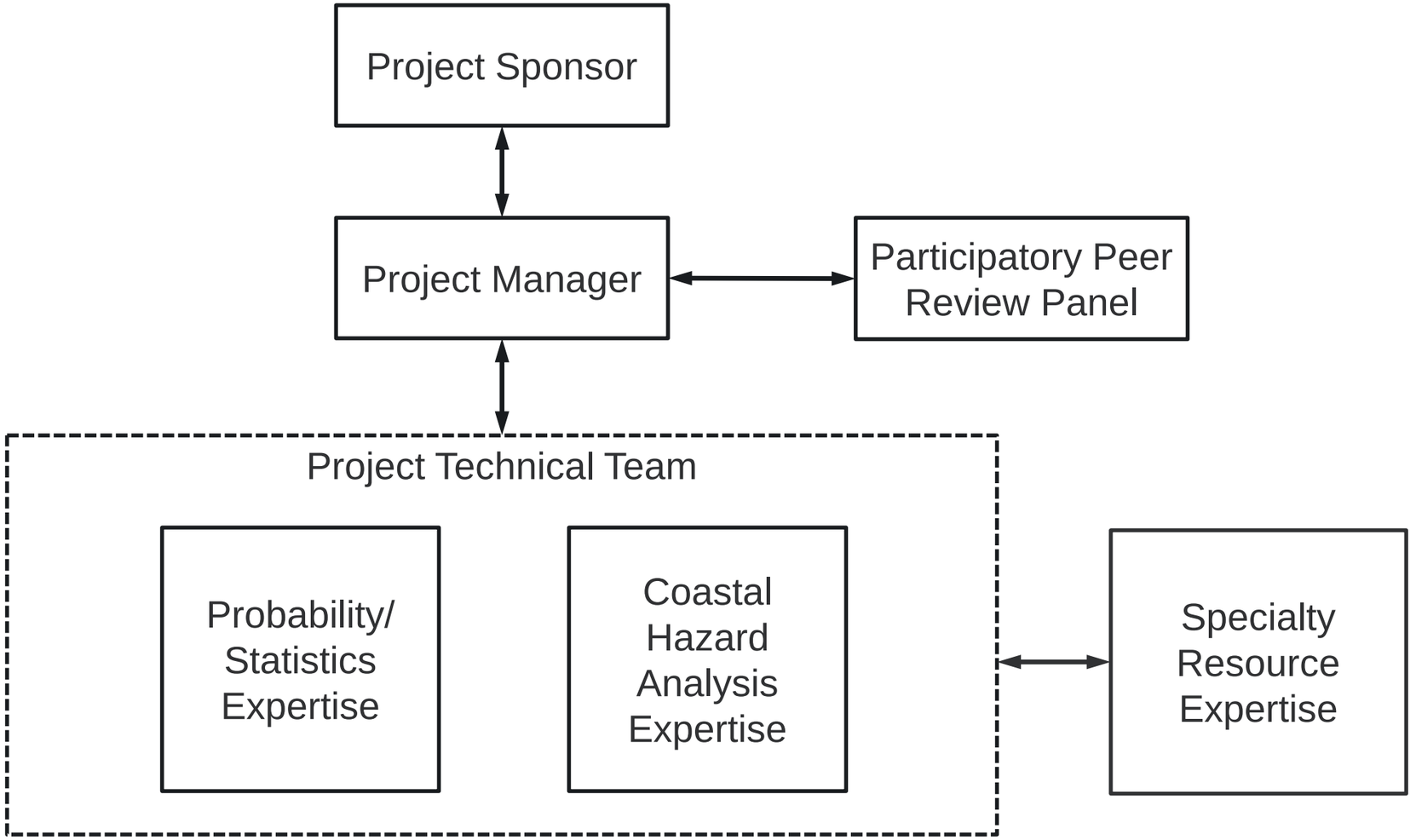
Summary of Coastal SHAC-F Levels

Coastal Floods	SHAC-F Level 1	SHAC-F Level 2	SHAC-F Level 3
Purpose	Screening	Updating existing analyses or refining screening analyses	Supporting design and/or providing input to PRA
Expected Assessment Results	Limited family of water level and wave climate hazard curves.	Family of hazard curves	More complex family of hazard curves
Data	• Readily accessible data: e.g. Existing JPM data Gauge data.	• More extensive effort to find and assemble existing data: Historical data (HURDAT), reanalysis data (EBTRK). Previous JPM study data.	Extensive effort to find and assemble existing data: Topobathy data for new grid development or significant upgrade of existing grid.
Models and Methods	Extreme value analysis Response based approach: Monte Carlo TC sampling of existing JPM storm responses.	JPM • Storm recurrence rate models • Defining marginal distributions of TC parameters • Re-computing synthetic storm set probability weights. • JPM hazard curve integration Storm subsampling Incorporation of extratropical analysis in hazard. Limited grid modifications.	Full JPM • Synthetic storm track development. • Development of wind and pressure fields. • Validation of historical TCs • Computation of TC probability masses and generation of synthetic storm sets. • Statistical plus simulation • Soft coupling of process-simulation models
Principal Sources of aleatory variability	Water level (surge), wave data, and tides, TC frequency.	Water level (surge), wave data, and tides, TC frequency.	Water level (surge), wave data, and tides, TC frequency. Tides, SLC.
Principal sources of epistemic uncertainty	Measurement uncertainty in historical storm data, sampling variability, alternative statistical models, parameter uncertainty.	Measurement uncertainty in historical storm data, alternative data sources and statistical models and methods, parameter uncertainty in simulation model parameters, hydrodynamic modeling errors.	Measurement uncertainty in historical storm data, alternative statistical models, parameter uncertainty in simulation model parameters, alternative process representations in simulation models

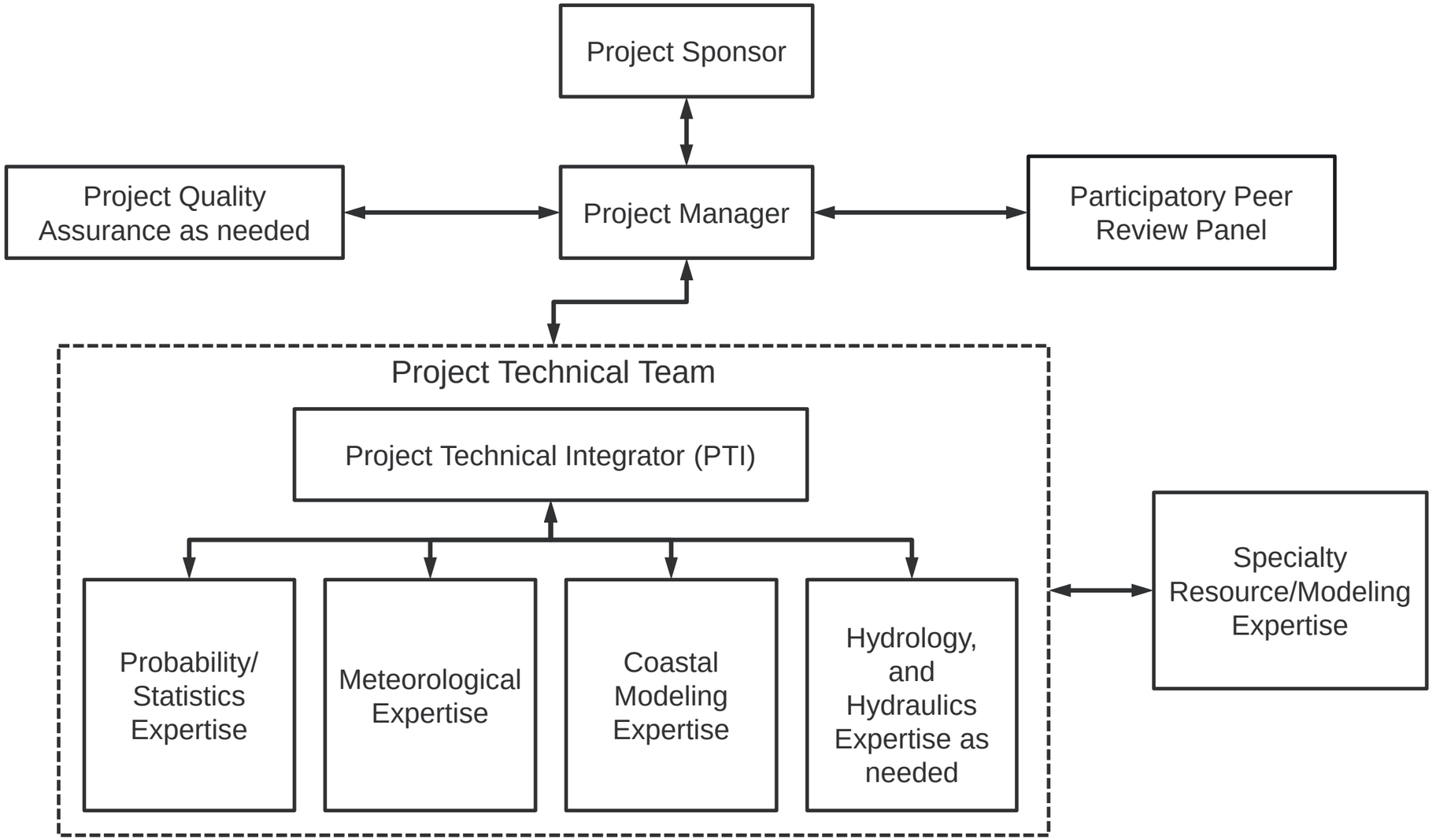
Level 1 SHAC-F Study – Project Team Structure



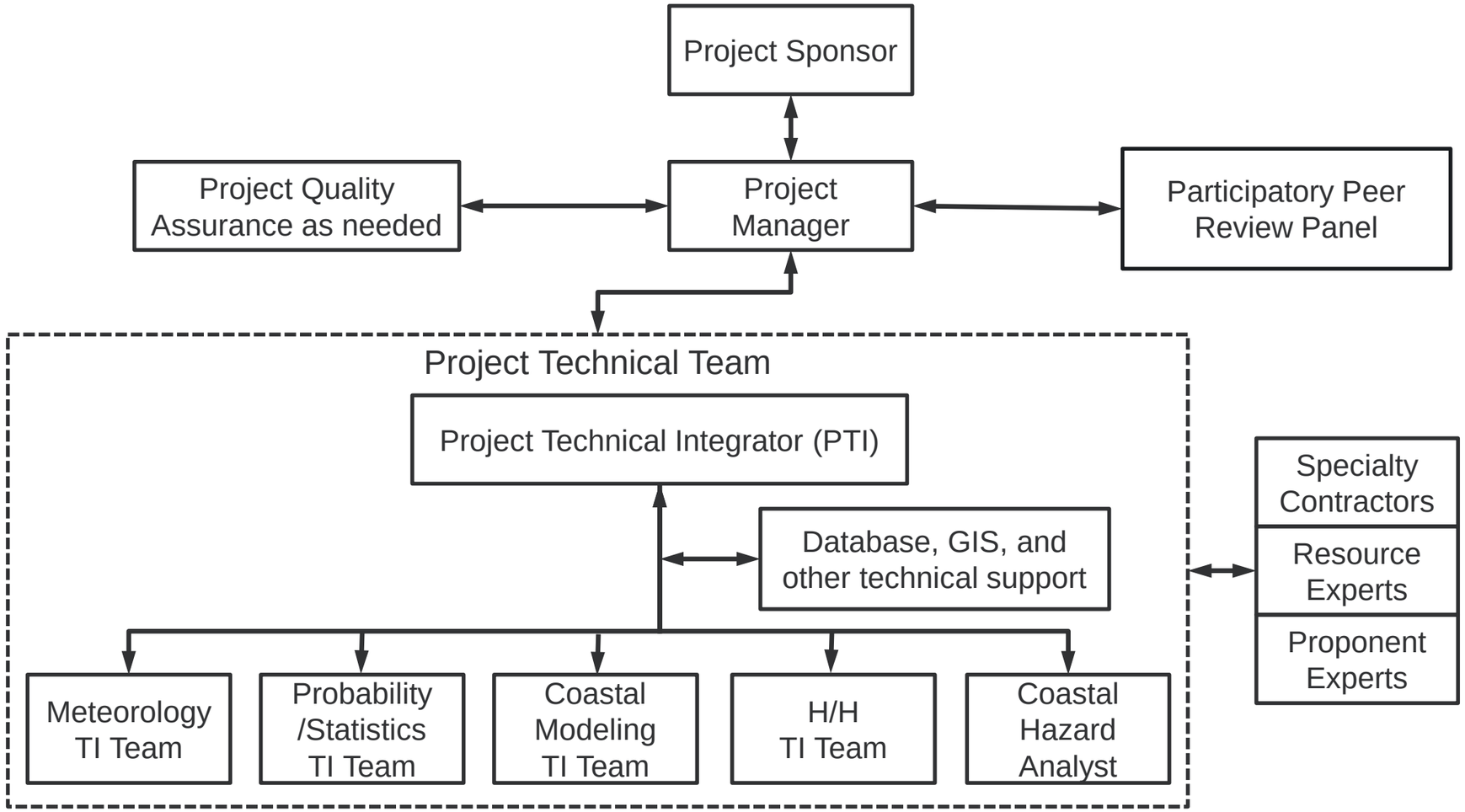
Level 2 SHAC-F Study – Project Team Structure for Refinement of a Level 1 Study



Level 2 SHAC-F Study – Project Team Structure for Update of a Level 3 Study



Level 3 SHAC-F Study – Project Team Structure



Conclusions

- SHAC-F is tailored after the Senior Seismic Hazard Assessment Committee (SSHAC) process
  - Three levels address purposes of various NRC flood reviews
  - Project teams and levels of effort commensurate with complexity of reviews
- SHAC-F does not require specific models or methods to be used
- SHAC-F does require probabilistic flood assessment with incorporation of aleatory and epistemic uncertainties in estimation of a family of flood hazard curves
- SHAC-F does require documentation with sufficient detail to allow review, reproduction, and update to a PFHA

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Thank you