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Optimizing Radiological Emergency Response: A Workflow Analysis

March 2025

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The research in this presentation was conducted with the U.S. Department of Homeland Security (DHS) Science and Technology Directorate (S&T) under contract 70RSAT23KPM000023. Any opinions contained herein are those of the author and do not necessarily reflect those of DHS S&T.

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Summary

With support from the Department of Homeland Security (DHS) Science and Technology Directorate (S&T) National Urban Security Technology Laboratory (NUSTL), Pacific Northwest National Laboratory (PNNL) was tasked with conducting research under the *FRMAC End States Analysis, Feedback, and Validation and Automation Research* project. This was a collaborative research project with Sandia National Laboratories, Lawrence Livermore National Laboratory, and the Remote Sensing Laboratory. A key element to this project is external federal, state, local, tribal, and territorial (FSLTT) stakeholder elicitation. The project team collected feedback from FSLTT external partners regarding current Federal Radiological Monitoring and Assessment Center (FRMAC) product uses. As part of this project, PNNL developed workflow diagrams for specific Department of Energy (DOE) Consequence Management (CM) process steps and products that external partners determined essential for a radiological or nuclear response. The project team then used workflow diagrams to identify pain points in product generation. The goal of this manual is to capture the project team's research for typical internal and external FRMAC workflow process steps with the aim of identifying potential areas for improvement or automation recommendations.

The term "end states" describes the delivery method, media, and manner in which FRMAC provides measurement and modeling interpretation information, usually presented in the form of a computer prediction that ranges in complexity. Throughout this report, specific processes and FRMAC products are explicitly called out rather than using the broader "end states" term.

The workflow diagrams are intended to provide a broad audience with key data needs, potential outputs, and process steps within specific DOE CM processes. This manual can be used to inform internal FRMAC partners as well as external FSLTT external partners. Selected workflow diagrams are based on stakeholder-identified pain points associated with FRMAC information sharing processes. Together, they describe product presentation methods, key data inputs, communication pathways, and timeliness of FRMAC written products.

The workflows fall into two broad categories: internal processes to FRMAC and external processes to FRMAC. The *internal workflows* come from three sources: 1) the generic workflow described in this report (Section 2.3, Workflow C), 2) the FRMAC Operations Manual Volume 1, and 3) descriptions of processes supplied by stakeholder feedback. The project team developed *external workflows* from collected stakeholder feedback, summarized in *Assessing and Enhancing Radiological Emergency Response Products: Insights from Stakeholder Feedback* (PNNL, 2025). The workflows include a description that describes current capabilities to support the common operating picture and applicable relevance to stakeholder feedback.

The workflows in this manual are intended to be used in combination with the other research results to develop targeted recommendations that are grounded in stakeholder needs and focused on DOE CM capability building for the future. Detailed recommendations can be found in *Recommendations to Improving Radiological Emergency Response Products and Processes* (PNNL, 2025).

Acronyms and Abbreviations

CBRN	chemical, biological, radiological, nuclear
CM	DOE's Consequence Management Program
CMHT	Consequence Management Home Team
COP	common operating picture
COSMOS	Consequence Management Operational System
DHS	Department of Homeland Security
DOE	Department of Energy
EOC	Emergency Operations Center
FRMAC	Federal Radiological Monitoring and Assessment Center
FSLTT	federal, state, local, tribal, territorial
IMAAC	Interagency Modeling and Atmospheric Assessment Center
IMS	information management systems
LLNL	Lawrence Livermore National Laboratory
NARAC	National Atmospheric Release Advisory Center
NEST	Nuclear Emergency Support Team
NUSTL	National Urban Security Technology Laboratory
PAG	Protective Action Guidelines
PNNL	Pacific Northwest National Laboratory
RFI	request for information
RSL	Remote Sensing Laboratory
S&T	Science and Technology
SiP	shelter in place
SME	subject matter expert
SNL	Sandia National Laboratories

Contents

1.0 Introduction

With support from the Department of Homeland Security (DHS) Science and Technology Directorate (S&T) National Urban Security Technology Laboratory (NUSTL), Pacific Northwest National Laboratory (PNNL) developed workflow diagrams that include product presentation methods, key data inputs, communication pathways, specific products (expected outcomes), and timeliness of products. The team developed these workflows from collected feedback from external federal, state, local, tribal, and territorial (FSLTT)[1] partners on Federal Radiological Monitoring and Assessment Center (FRMAC) products uses. Processes selected for this manual are guided by stakeholder-informed priorities during a radiological or nuclear emergency response.

1.1 Background

Workflow diagrams contained in this report fall in two categories: processes either external or internal to the FRMAC. *Internal workflows* are based on the generic workflow described in this report and in the FRMAC Operations Manual Volume 1,[2] which describes the internal process steps for responding to a request for information (RFI). These workflows highlight individual routes through the decision tree considered representative of expected actions taken by RFI responders based on different time periods or generic locations. *External workflows* are based on descriptions of processes supplied by stakeholder feedback and vetted through FRMAC subject matter experts (SMEs) during fiscal year (FY) 2024 and summarized in the FRMAC Analysis Report.[3] The project team includes SMEs from Sandia National Laboratories (SNL), Lawrence Livermore National Laboratory (LLNL), and the Remote Sensing Laboratory (RSL), who support the Department of Energy (DOE) Consequence Management (CM) program and are responsible for developing and distributing FRMAC data products.

Each workflow included in this manual contains a description with the following elements:

- relevance to stakeholder elicitation results
- process steps that support updating the common operating picture (COP)
- assumptions and limitations for typical workflow process steps.

These workflow descriptions leverage stakeholder- and SME-identified gaps to help support the development of recommendations to improve current FRMAC processes. To streamline the process, the project team determined it would be more efficient to consolidate similar data needs into a unified workflow rather than separate workflows for specific data products. This approach minimized redundancy and ensured internal and external stakeholders could easily access critical information.

[1] We were unable to connect with tribal or territorial external partners during this project timeline. Therefore, FSLTT is limited to federal, state, and local external partners.
[2] Federal Radiological Monitoring and Assessment Center. 2010. *FRMAC Operations Manual.* https://nnss.gov/wp-content/uploads/2023/04/FRMAC-Operations-Manual-2010.pdf.
[3] Sleiman, C., Napier, J., Ortega, S., Davis, B., Kernan, W., Cruz, J., Meagher, B., Cochran, L., Fleming, S., Sanchez, D., Alires, T. 2025. *Assessing and Enhancing Radiological Emergency Response Products: Insights from Stakeholder Feedback.* Pacific Northwest National Laboratory. PNNL-36130.

By examining combined external and internal information needs, the project team defined clear processing steps that aligned with the requirements of each workflow. The team then developed a comprehensive set of workflow diagrams to capture the most common processes and scenarios encountered during RFIs. The resulting list of workflow diagrams includes:

- Timeline of Products During a Response
- DOE CM RFI Submission Architecture
- Default RFI Process Template
- Default RFI – Characterization
- Default RFI – Verification
- Near-field RFI Initial
- Near-field RFI Subsequent
- Far-field RFI Initial
- Far-field RFI Subsequent
- Unique RFI Process – Evacuation and Shelter in Place
- Unique RFI Process – Isotopic Identification
- Product Distribution Process

1.2 Approach

During the response process, the pathways in RFI acceptance, generation of response, and delivery of recommendations generally align with the workflows described in this manual. The typical response process has three parts, where recommendations depend on factors such as time and the generalized location of the request, while RFI acceptance and recommendation delivery generally remain constant through the duration of an event.

At every stage (early, intermediate, and recovery phase) of the timeline, there will always be some form of RFI request (Section 2.2, Workflow B) and RFI delivery (Section 2.12, Workflow L). Section 2.3 through Section 2.11, Workflows D through K, detail the activities that facilitate the development of a response. These workflows follow the default RFI response process outlined in the FRMAC Operations Manual Volume 1, as illustrated in Section 2.3, Workflow C. They represent potential pathways during specific periods of the response life cycle.

In the final step of the process, all RFIs are submitted to Consequence Management Operational System (COSMOS) for prioritization, review, and approval by FRMAC leadership. CM teams internally submit RFIs into COSMOS, but external stakeholders can submit through an online RFI portal called the COSMOS Portal. Other avenues for RFI submission include Incident Objectives, FRMAC liaison officers, CMHT email, and the CMHT bridge line. Once an RFI is submitted, it is routed through established channels, often involving DOE CM teams for real-time data integration and analysis. The goal is to quickly collect and analyze the data necessary to support decision-making by FSLTT organizations, ensuring that protective actions are decided based on accurate and up-to-date information.

1.3 Definitions

Along with a general description, the workflow diagrams in this manual include:

- Workflow assumptions

- Potential limitations (on processes or specific products, informed by stakeholders or DOE CM SMEs)
- External information needs, when applicable
- FRMAC information needs, when applicable.

All workflows include an a*ssumptions* and *limitations* section. *Assumptions* are current expectations within the workflow either reported by stakeholders, reported by the FRMAC (DOE CM SMEs), or identified in the FRMAC Operations Manual.[1] *Limitations* are identified pain points where current practices or communication processes affect process step effectiveness.

Applicable workflows include *external information needs* and *FRMAC information needs*. *External information needs* are pieces of information needed by external partners to accomplish a task or serve as an RFI indicator. *FRMAC information needs* are the minimum requirements to respond to an RFI or identify further information to adequately respond.

[1] FRMAC Operations Manual reference: Federal Radiological Monitoring and Assessment Center. 2010. *FRMAC Operations Manual.* https://nnss.gov/wp-content/uploads/2023/04/FRMAC-Operations-Manual-2010.pdf.

2.0 Workflow Diagrams

2.1 Workflow A: Timeline of Products During a Response (*Internal)*

The method of responding to an RFI changes as a response progresses. This change is due to changes in available information, changes in area of interest for the specific RFI, and changes in types of information needed to generate an RFI response. This “workflow of workflows” identifies initial actions, generic near-field and far-field RFIs, and initial intermediate phase RFIs that can be reliably expected. RFIs after initial early phase response (transitioning to early intermediate phase) are less predictable and become targeted at site-specific issues. These frequently require a unique methodology for each RFI.

Workflow A represents the timeline of a data product response and its evolution as the incident progresses. It is intended to define four sets of workflows and begins with the default RFI process defined in the FRMAC Operations Manual Volume 1, which involves characterizing the incident (Workflow D). This step is followed by verification of initial assumptions (Workflow E). Jointly, Workflows D and E facilitate the development of initial public protection recommendations, which are then shared with all FSLTT participants. Following these default RFIs, workflow A response process for near-field and far-field locations diverges, primarily driven by the distinct nature of far-field date requirements:

Near-field RFIs primarily rely on data from handheld instruments or other collection methods that do not require extensive laboratory analysis for worker protection, releasing unimpacted areas, updating the COP, and determining shelter-in-place (SiP) or evacuation decisions. Far-field RFIs often require sample collection and laboratory analysis, leading to a more complex response process.

Workflow A recognizes but does not detail three additional workflows—near-field intermediate phase responses, far-field intermediate phase responses, and hypothetical questions of interest. These workflows pertain to the later stages of the incident when the response tempo has slowed, with the focus shifting to addressing site-specific questions. These questions are highly unique and do not lend themselves to predefined pathways. As such, attempting to recommend likely pathways through the default process for these scenarios was deemed unnecessary.

FRMAC can produce map-based products during a response. However, the available products and level of detail depends on when the RFI is received. The early, intermediate, and recovery phases can be broken into subphases based on available personnel and available data. The likely available data (mapping) products during each subphase are listed in Table 1.

During a response, FRMAC can produce supplementary information that does not always require generating a data product. The information produced is limited based on when the RFI is received. The early, intermediate, and recovery phases can be broken into sub phases based on available personnel and available data. The likely available technical information at each subphase is listed in Table 2. The information contained within Table 2 can be used to generate subsequent FRMAC actions or recommendations (i.e., directing data collection by routing mobile data collection through low deposition areas).

Workflow A Assumptions:

- Weather (NARAC can help) not having meteorological data will not stop the model run.
- Process outcomes (Tables 1 and 2) are not products specific to event types, but potential products that can be generated from the workflow.
- The workflows are generally applicable to any type of incident.

Workflow A limitations:

- The workflows are generic and must be implemented based on the initiating event.

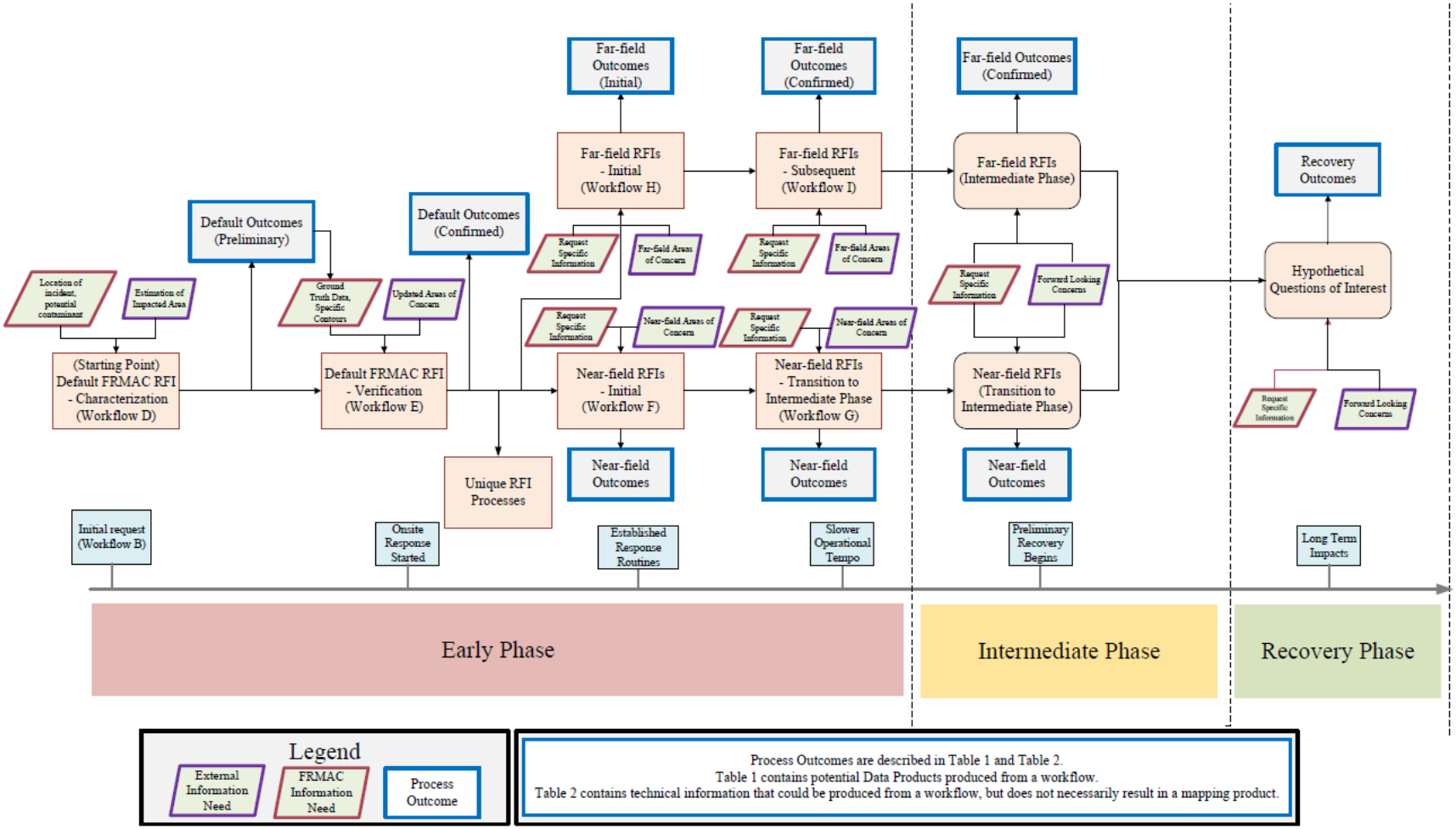


Figure 1. Workflow A: Timeline of Products During a Response

Table 1. Data Products (Mapping)

Characterization (Workflow D)	Verification (Workflow E)	Near-Field (Initial) (Workflow F)	Near-Field (Transition (Workflow G)	Far-Field (Initial) (Workflow H)	Far-Field (Subsequent) (Workflow I)
Early Phase TED	Early Phase TED	Early Phase TED		Worker Protection Dose Rate (Far Field)	
Early Phase Thyroid CDE	Early Phase Thyroid CDE	Early Phase Thyroid CDE		Areas of Agricultural Intervention	Areas of Agricultural Intervention
Early Phase Evac/SiP TED	Early Phase Evac/SiP TED	Early Phase Evac/SiP TED			Areas of Agricultural Release
Early Phase Thyroid CDE	Early Phase Thyroid CDE	Early Phase Thyroid CDE			
KI Administration	KI Administration				
Worker Protection Dose Rate at 12 Hours (Near Field)	Worker Protection Dose Rate at 12 Hours (Near Field)	Updated Worker Protection Dose Rate (Near Field)	Updated Worker Protection Dose Rate (Near Field)		
Worker Protection Dose Rate at 12 Hours (Far Field)	Worker Protection Dose Rate at 12 Hours (Far Field)			Worker Protection Dose Rate (Far Field)	Updated Worker Protection Dose Rate (Far Field)
Deposition at 12 Hours	Updated Deposition at 12 Hours				Updated Deposition
Initial COP	Updated COP	Updated COP	Updated COP	Updated COP	Updated COP
Prompt Effects	Updated Prompt Effects				
Prompt Thermal Effects	Updated Prompt Thermal Effects				
Prompt Effects on Heavy Structures	Updated Prompt Effects on Heavy Structures				
Prompt Effects on Light Structures	Updated Prompt Effects on Light Structures				
Early Fallout Casualties	Updated Early Fallout Casualties				

Table 2. Report/Technical Information (Non-Mapping Products)

Characterization (Workflow D)	Verification (Workflow E)	Near-Field (Initial) (Workflow F)	Near-Field (Transition (Workflow G)	Far-Field (Initial) (Workflow H)	Far-Field (Subsequent) (Workflow I)
Estimated Deposition	Estimated Deposition	Updated DRLs (Worker/Public)	Updated DRLs (Worker/Public)	DRLs (Crop/Meat/Milk/Water)	DRLs (Crop/Meat/Milk/Water)
Preliminary DRLs (Worker/Public)	Updated DRLs (Worker/Public)	Updated Worker Dose Estimates	Updated Worker Dose Estimates	Intervention Levels	Intervention Levels
Preliminary Worker Protection Values	Preliminary Worker Protection Values	Updated Worker Turnback Limits	Updated Worker Turnback Limits	Ingestion Dose (Food/Soil)	Ingestion Dose (Food/Soil)
Preliminary KI Recommendations	Updated KI Recommendations	Updated Public Dose Estimates	Updated Public Dose Estimates		Projected Contamination Levels (Crop/Meat/Milk)
Preliminary Public Dose Estimates	Public Dose Estimates		Recommendations for Releasable Areas		
Preliminary Worker Dose Estimates	Updated Worker Dose Estimates				
Worker Turnback Limits	Updated Worker Turnback Limits				
Likely Exposure Pathways	Likely Exposure Pathways				
		Isotopic Identification			
Sample Results and Locations	Sample Results and Locations	Sample Results and Locations	Sample Results and Locations	Sample Results and Locations	Sample Results and Locations

2.2 Workflow B: DOE CM RFI Submission Architecture

Workflow B outlines the current DOE CM RFI submission process as reported by external FSLTT partners and the FRMAC Operations Manual Volume 1. It involves several submission pathways to ensure the efficient collection and analysis of radiological data during emergencies, enabling coordinated monitoring and assessment support for state and local authorities.

The **purple arrow** pathway indicates all recognized access points for FSLTT partners to submit RFIs to DOE CM. The workflow also includes a **green arrow** pathway indicating the process for routing RFIs for review, prioritization, and approval resides with FRMAC leadership in the COSMOS. COSMOS provides a standardized approach through workflows on prioritizing and tracking received RFIs. It also connects the technical data used to address the RFIs, making it a useful tool for both RFI submission and response. All RFIs are expected to be entered into COSMOS for appropriate workflow assignment and prioritization.[1] Therefore, it is important to develop this workflow that captures current FRMAC processes and recognizes potential process limitations.

Workflow B Assumptions:

- Expected pathway for direct RFI submission is by the state EOC.
- Following the expected pathway from local EOC to state EOC for RFI submission can support the RFI refinement process.
- The Interagency Modeling and Atmospheric Assessment Center (IMAAC)[2] portal can be used for training purposes, but it has a warning of not to use it during a real event.
- COSMOS is the most effective pathway for submitting, tracking, and prioritizing RFIs.

Workflow B Limitations:

- COSMOS is new and unfamiliar to all levels of government. This may be due to underdeveloped standard operating procedures or informal implementation practices.
- Due to limited engagement with FRMAC, it is difficult to know through whom to submit RFIs.
- Exercises involving FRMAC are infrequent and impose artificiality that does not allow for effective practice using RFI submission pathways.
- Expected pathways for RFI submission are not formalized and therefore not standardized.
- It is assumed local EOCs directly filter RFIs through state EOCs, but this is not always the case with larger cities. Many communication pathways are siloed and impact communication between state organizations and the FRMAC (e.g., the incident commander does not communicate with state SMEs before asking for a product.

[1] FRMAC Operations Manual reference: FRMAC Operations Manual reference: Federal Radiological Monitoring and Assessment Center. 2010. *FRMAC Operations Manual.* https://nnss.gov/wp-content/uploads/2023/04/FRMAC-Operations-Manual-2010.pdf.

[2] IMAAC provides no-cost, expert support for incidents involving hazardous materials or chemical, biological, radiological, nuclear, or explosive agents. One of the primary opportunities to engage with IMAAC is with planning, training, and exercise support.

- Inconsistencies in procedures or informal instructions create confusion. Since there is not a singular pathway for state or local organizations to contact the FRMAC, some rely on a specific CM SME to submit RFIs.
- Many reported receiving an “FRMAC phone number” during an FRMAC training but were unclear on who they would reach or when they should call the number. The intent of this number is unclear and may be misinterpreted.
- There is no mechanism to “fast track” RFIs to the advisory team (A-Team) for support or tracking purposes.

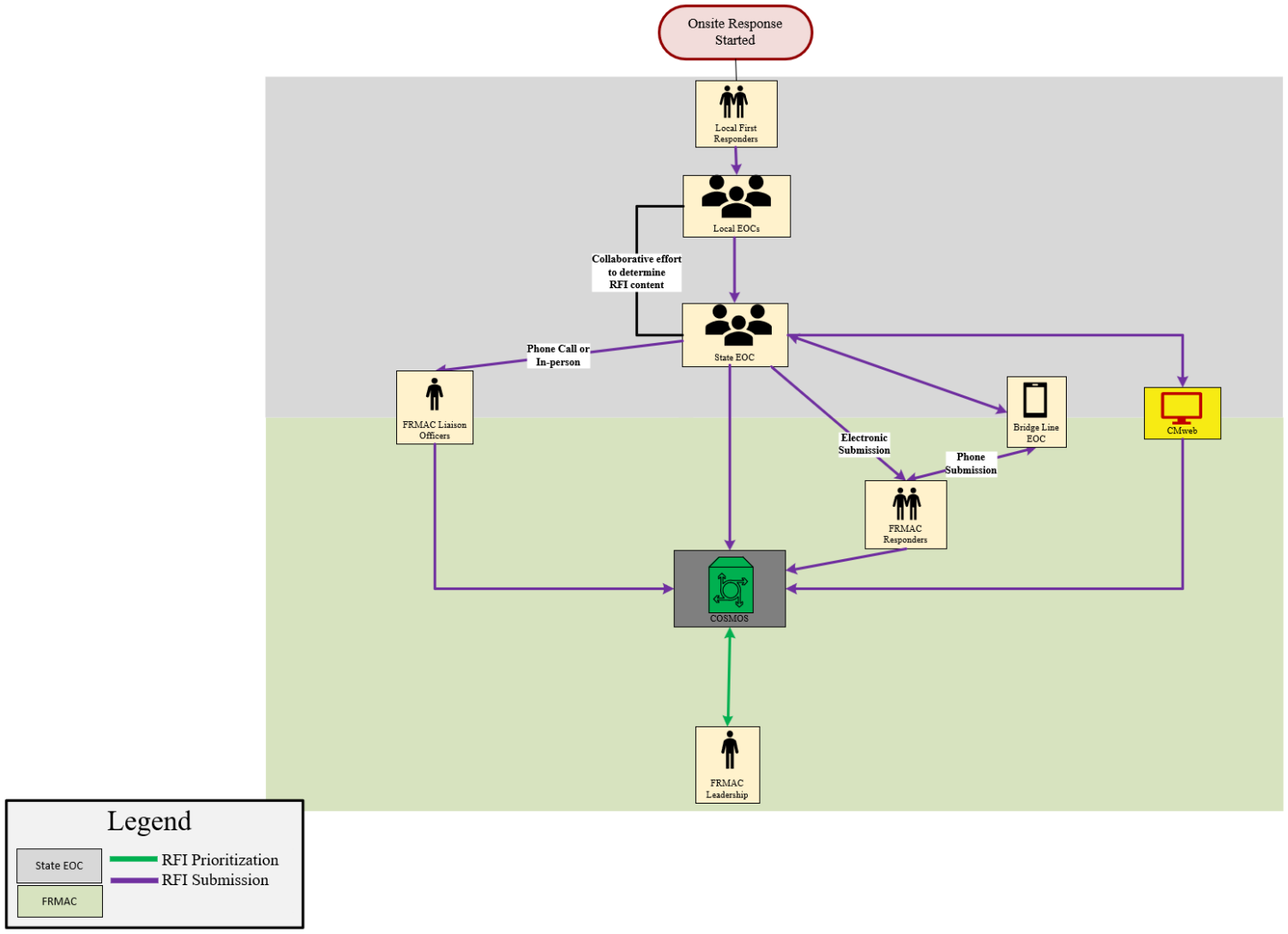


Figure 2. Workflow B: DOE CM RFI Submission Architecture

2.3 Workflow C: Default RFI Process Template

FRMAC Operations Manual Volume 1 defines the default RFI Process Template. This process identifies the generic process to responding to all RFIs. The current process is to modify the default process after review of all incoming RFIs. This process is included in this section for reference. The FRMAC Operations Manual Volume 1 has a complete description.

Workflow C is the basis for the remainder of this document. Sections 2.3 through 2.11, Workflows D through K, further refine it, based on expected actions at a specific time. It is an idealized process flow that can define an event response until the operational tempo slows to such an extent that automated workflows should not be required.

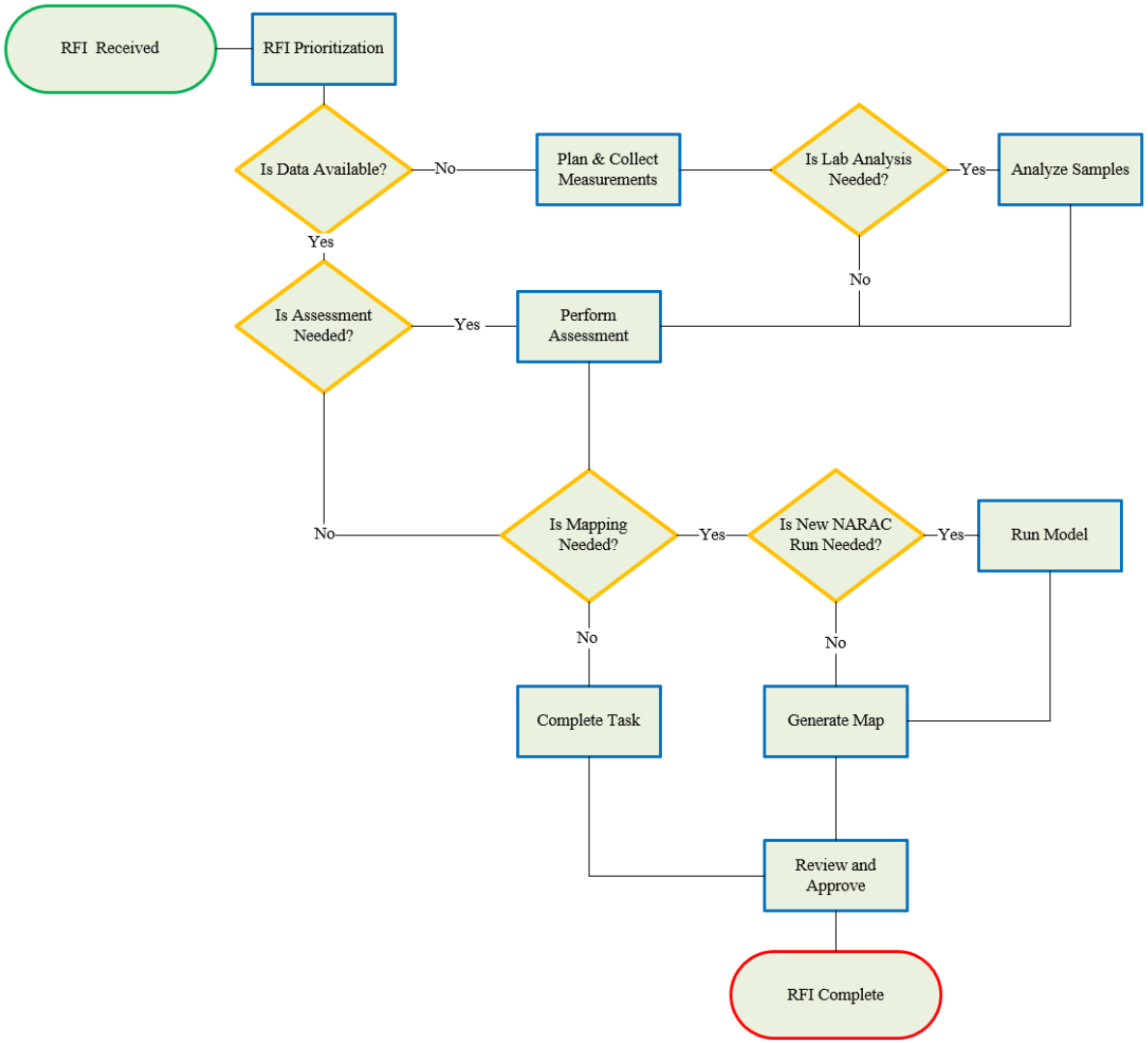


Figure 3. Workflow C: Default RFI Process Template

2.4 Workflow D: Default RFI Process – Characterization

Workflow D is the default FRMAC workflow initiated at the start of every response. It begins with preliminary available data to identify an initial set of potential data products. These products inform early safety recommendations and highlight additional FRMAC data needs for validating these initial recommendations. The process is designed to address stakeholder feedback seeking prompt recommendations. This workflow indicates a likely path for response to initial default FRMAC RFIs that occur at the beginning of every response. This internally focused workflow, and every subsequent workflow, highlights the information needs, actions (and inactions), and pathway for responding to an RFI.

External Information Needs:

- Estimation of impacted area (through prompt or delayed effects)

FRMAC Information Needs:

- Location of Incident
- Potential contaminant (Estimation of activity released & isotope[s])

Workflow D Assumptions:

- Only initial reports have occurred.
- There are no response teams on-site.
- No samples have been collected.
- Use of this workflow will initiate from the Default FRMAC RFIs stated in the FRMAC Operations Manual Volume 1.

Workflow D Limitation:

- This workflow is limited by information contained within initial incident reports,
- The results of this workflow are projections where no ground truth data has been collected.

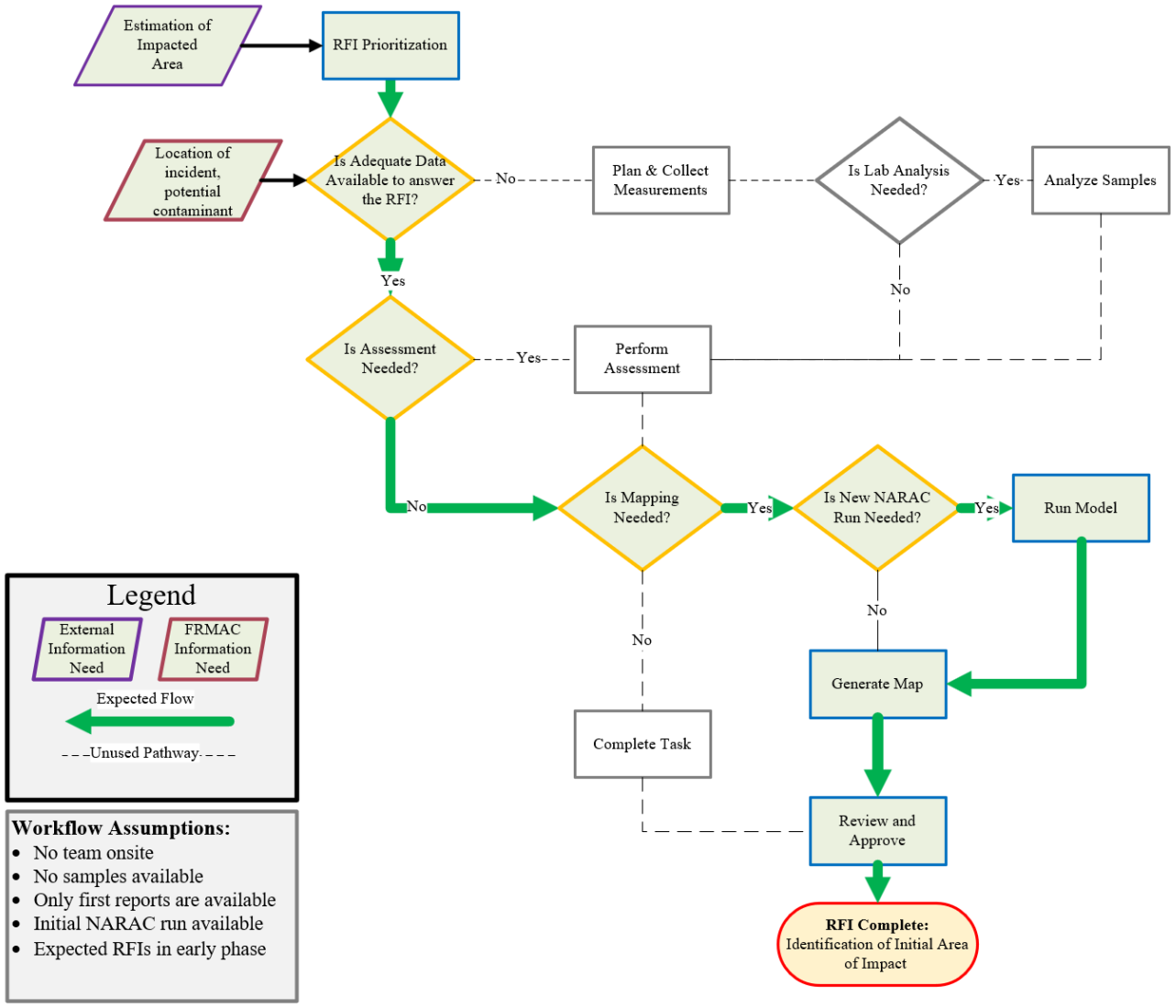


Figure 4. Workflow D: Default RFI Process – Characterization

2.5 Workflow E: Default RFI Process – Verification

This workflow is a confirmation of the default FRMAC workflow that occurs at the beginning of every response. It uses data collected and available to FRMAC to produce an initial array of data products. The workflow confirms or revises the assumptions used to generate initial recommendations, addressing stakeholder feedback by providing verified initial recommendations.

External Information Needs:

- Revision to initial recommendations and guidance generated through the use of Workflow D.

FRMAC Information Needs:

- Specific contours (specific boundaries or thresholds for visualization on FRMAC products)
- Ground truth data (collected by an on-site response team)

Workflow E Assumptions:

- A Radiological Assistance Program (RAP) or equivalent (i.e., Civil Support Team or state/local) team has arrived on-site and is in communication with FRMAC.
- Collected data is available for review by an assessment scientist.
- All collected data will undergo data quality review.

Workflow E Limitations:

- Workflow is limited by collected ground truth data. This is expected to be collected using mobile, airborne, or handheld survey meters by initial responders.

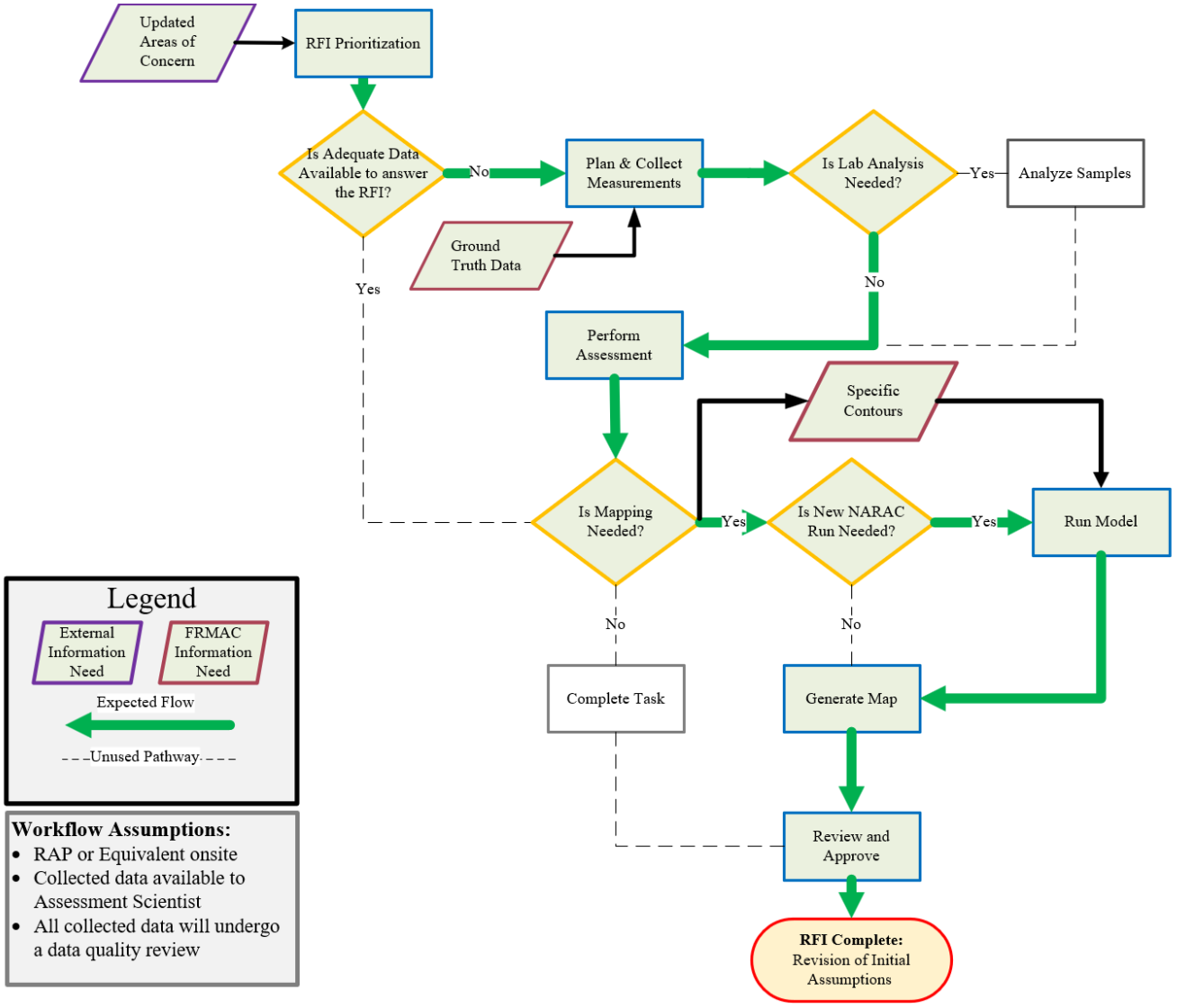


Figure 5. Workflow E: Default RFI Process – Verification

2.6 Workflow F: Near-Field RFI Initial

This workflow provides a generic process for responding to stakeholder RFIs after the verification phase of the default RFI process. These RFIs are expected to target areas local to the point of release that have larger amounts of data collected using basic handheld survey meters. Completion of the workflow will target specific recommendations for stakeholders or responders related to updating COP, lowering restrictions on unaffected areas, and revising SiP and evacuation decisions.

External Information Needs:

- Responder requests for site-specific concerns. These would be related to responder basing, actions, or personal protection guidance and monitoring.
- Specific information such as locations of interest that relate to the request.

FRMAC Information Needs:

- Specific contours (specific boundaries or thresholds for visualization on FRMAC products).
- Specific information such as GIS layers that can be integrated into RFI products or locations of concern specific to the requestor.

Workflow F Assumptions:

- Near-field areas are the focus of this RFI.
- No samples have been collected (handheld monitoring data is expected).
- Lab assessment is not required for handheld data.
- Data quality review will be performed for collected monitoring information.

Workflow F Limitations:

- This workflow is limited by data that does not require laboratory analysis. It is expected to only use assessed count rate or dose rate information to form the basis of any recommendations.

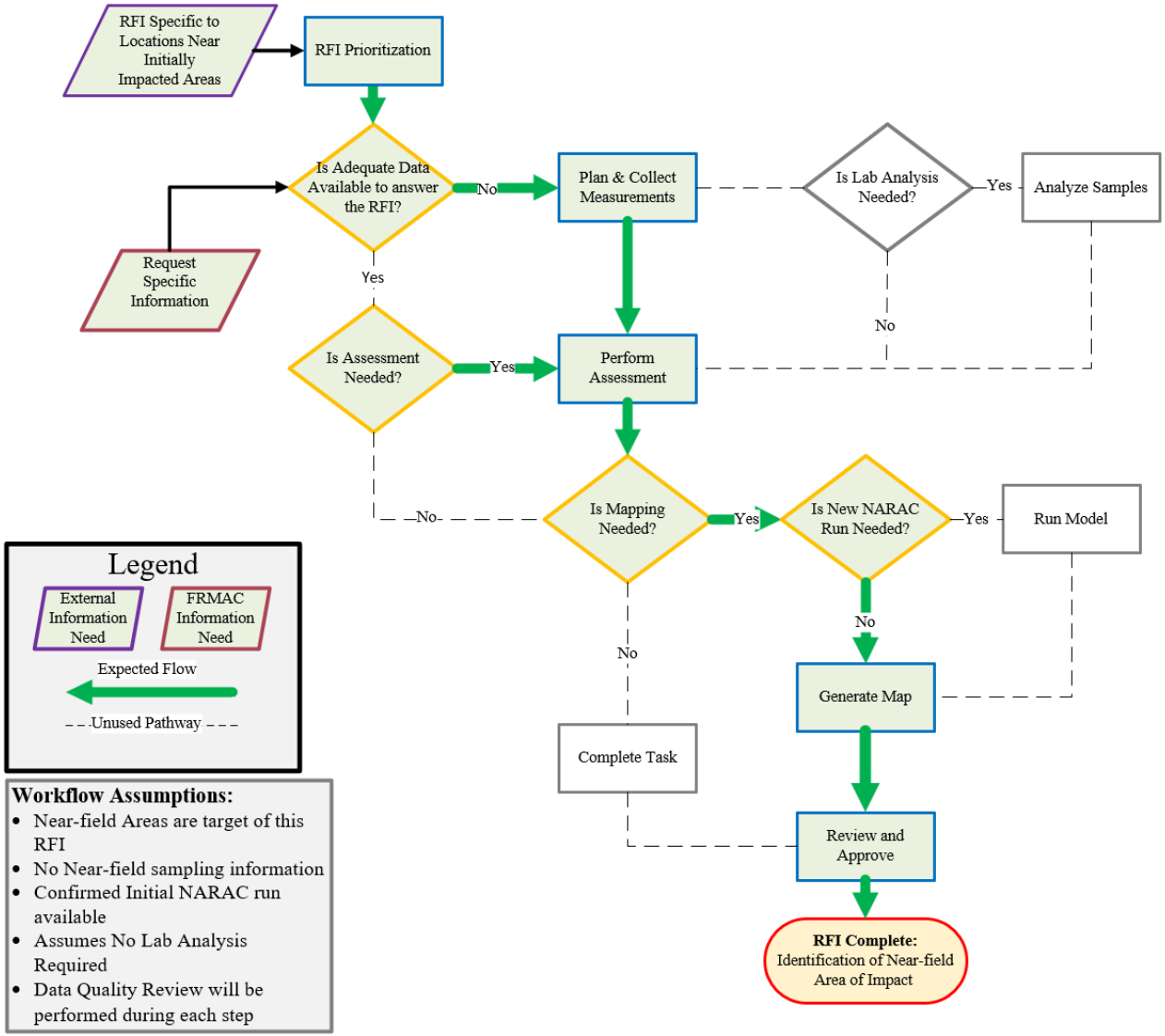


Figure 6. Workflow F: Near-Field RFI Initial

2.7 Workflow G: Near-Field RFI Subsequent (Transition to Intermediate Phase)

This workflow provides a generic process for responding to subsequent stakeholder RFIs that correspond to transitioning from the early to intermediate phase of a response. These RFIs are expected to occur at a slower operational tempo and have more data readily available for the generation of data products. Data products are expected to describe longer periods and focus on initial recovery processes and general long-term impacts to near-field areas.

External Information Needs:

- Local official requests for site-specific concerns, i.e. initial recovery actions or personal protection guidance and monitoring.

FRMAC Information Needs:

- Specific contours, i.e. request-specific boundaries or thresholds for visualization on FRMAC products.
- Specific information such as GIS layers that can be integrated into RFI products or locations of concern specific to the requestor.

Workflow G Assumptions:

- Near-field areas are the focus of this RFI.
- Near-field data has been collected (handheld monitoring data is expected).
- Lab assessment is not required for handheld data.
- Data quality review will be performed for collected monitoring information.

Workflow G Limitations:

- This workflow relies on existing collected data to generate new recommendations.

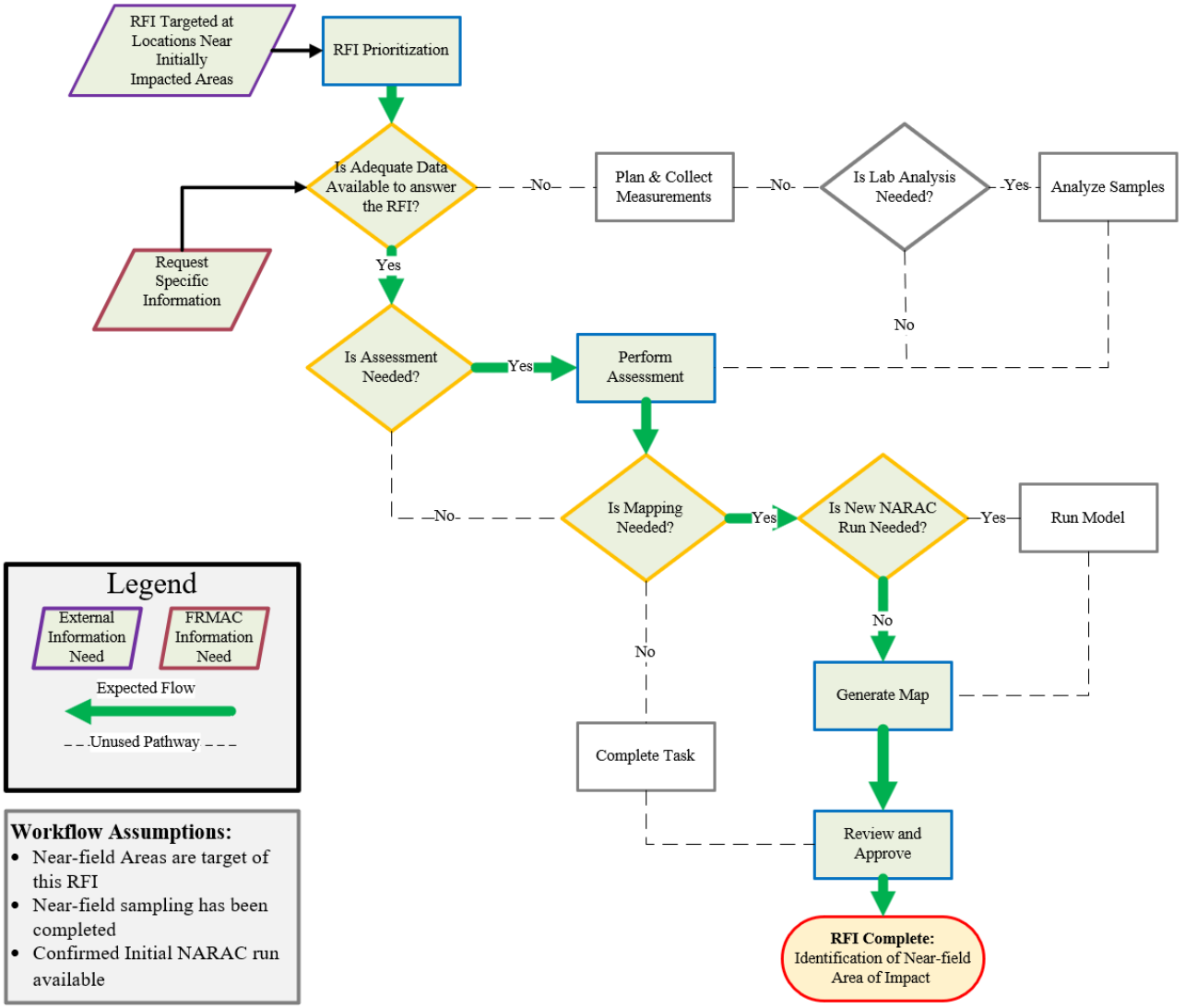


Figure 7. Workflow G: Near-Field RFI Subsequent (Transition to Intermediate Phase)

2.8 Workflow H: Far-Field RFI Initial

This workflow describes the process for responding to initial RFIs targeted at far-field locations affected by a release. Data products generated by these RFIs would focus on the identification of immediate actions targeting food and water-related ingestion pathways linked to dairy, pasture-raised farm animals, and leafy vegetables. Generated data products identify areas recommended for initial interdiction or embargo that may need further actions to lower any administrative restrictions enacted due to the event.

External Information Needs:

- Responder requests for far-field recommendations (specific to initial agricultural impacts, potential embargo, immediate protective actions, and future sampling).

FRMAC Information Needs:

- Request-specific information such as area in question and types of agriculture expected to be affected by a release.

Workflow H Assumptions:

- Incoming RFIs are targeted at far-field locations.
- No ground truth data has been collected at the locations in question.
- A validated NARAC run is available.
- Any collected samples will require laboratory analysis.

Workflow H Limitations:

- This workflow is limited to supplying recommendations focused on short-term agricultural impacts.

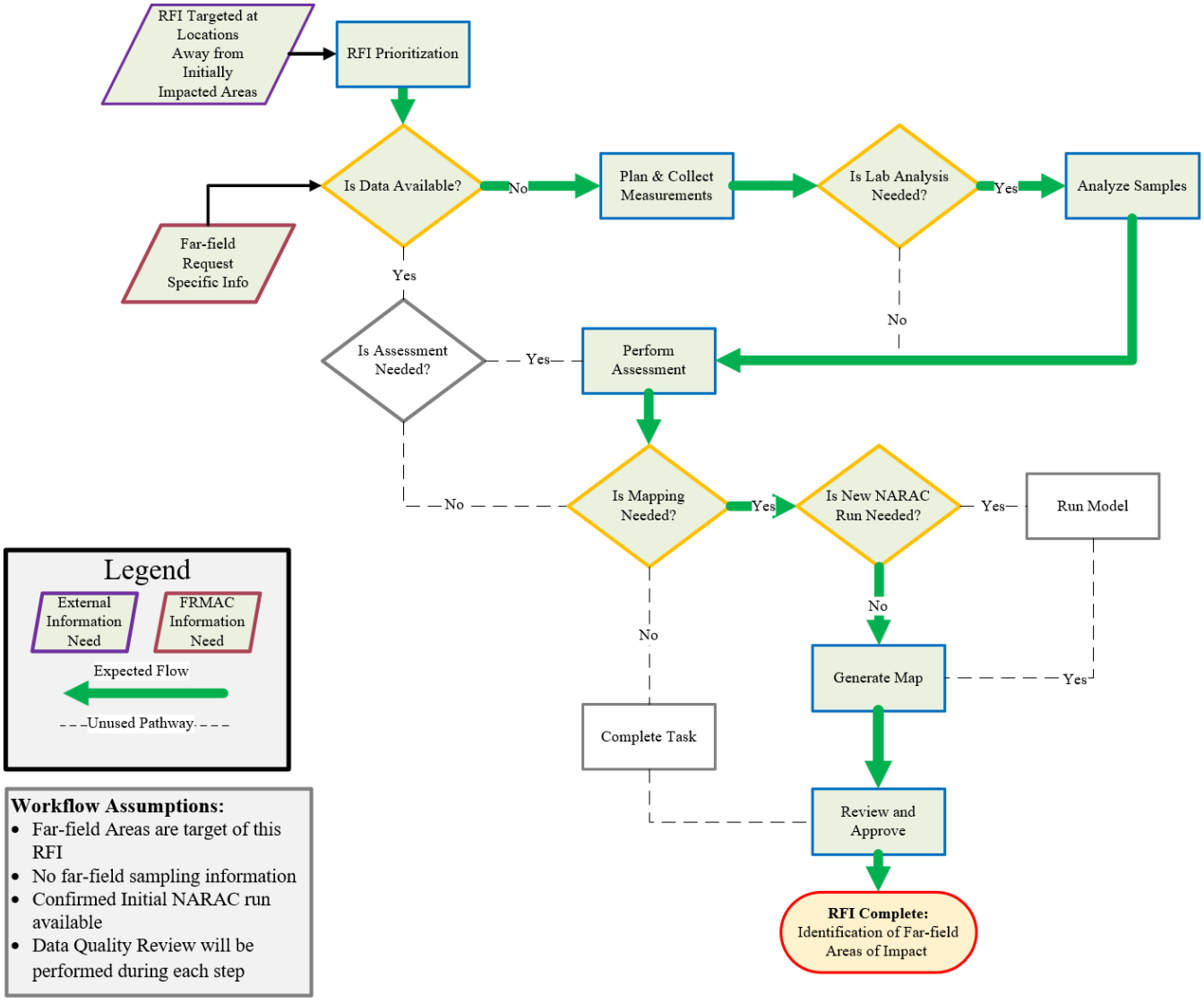


Figure 8. Workflow H: Far-Field RFI Initial

2.9 Workflow I: Far-Field RFI Subsequent

This workflow describes processes used to answer hypothetical questions related to economic areas of interest specific to far-field areas. This workflow is intended for use with existing data collected because of identified data needs during the initial far-field RFI response. The data products generated from this workflow address site-specific economic issues that can include specific crops, pasture animals, or fish and game found in the affected area. This addresses stakeholder feedback asking for data products that include location specific information be readily available.

External Information Needs:

- Responder requests for far-field recommendations (specific to initial agricultural impacts, release of embargo, and long-term protective actions).

FRMAC Information Needs:

- Request-specific information such as area in question and types of agriculture expected to be affected by a release.

Workflow I Assumptions:

- Incoming RFIs are targeted at far-field locations.
- Ground truth data has been collected at the locations in question.
- A validated NARAC run is available.
- Any collected samples have been analyzed and assessed.

Workflow I Limitations:

- This workflow is limited to supplying recommendations focused on mid- to long-term agricultural impacts.

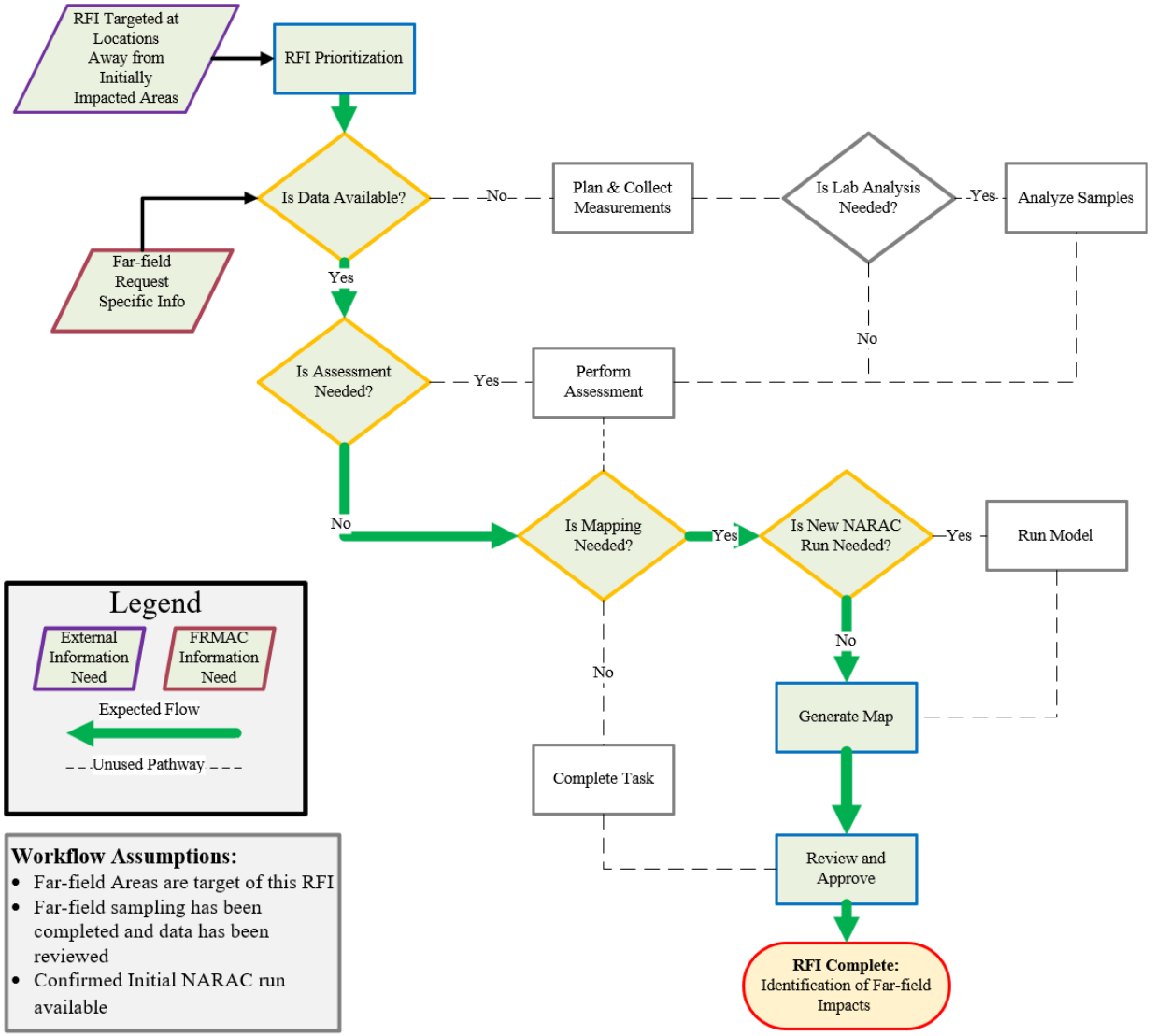


Figure 9. Workflow I: Far-Field RFI Subsequent

2.10 Workflow J: Unique RFI Process – Evacuation and Shelter-in-Place

This workflow focuses on recommendations for evacuation or SiP orders during the initial phases of a response. While similar to the default RFI Characterization process described earlier, it addresses data needs related to the identification of evacuation routes and community reception centers. These data products, based on preliminary incident assumptions, provide recommendations for evacuation or sheltering in place.

External Information Needs:

- Quickly identify locations that should either issue SiP or evacuation orders.

FRMAC Information Needs:

- The starting assumptions from Workflow D.

Workflow J Assumptions:

- This workflow assumes Workflow D has been completed.

Workflow J Limitations:

- This workflow is limited by information contained within initial incident reports.
- The results of this workflow are projections where no ground truth data has been collected.

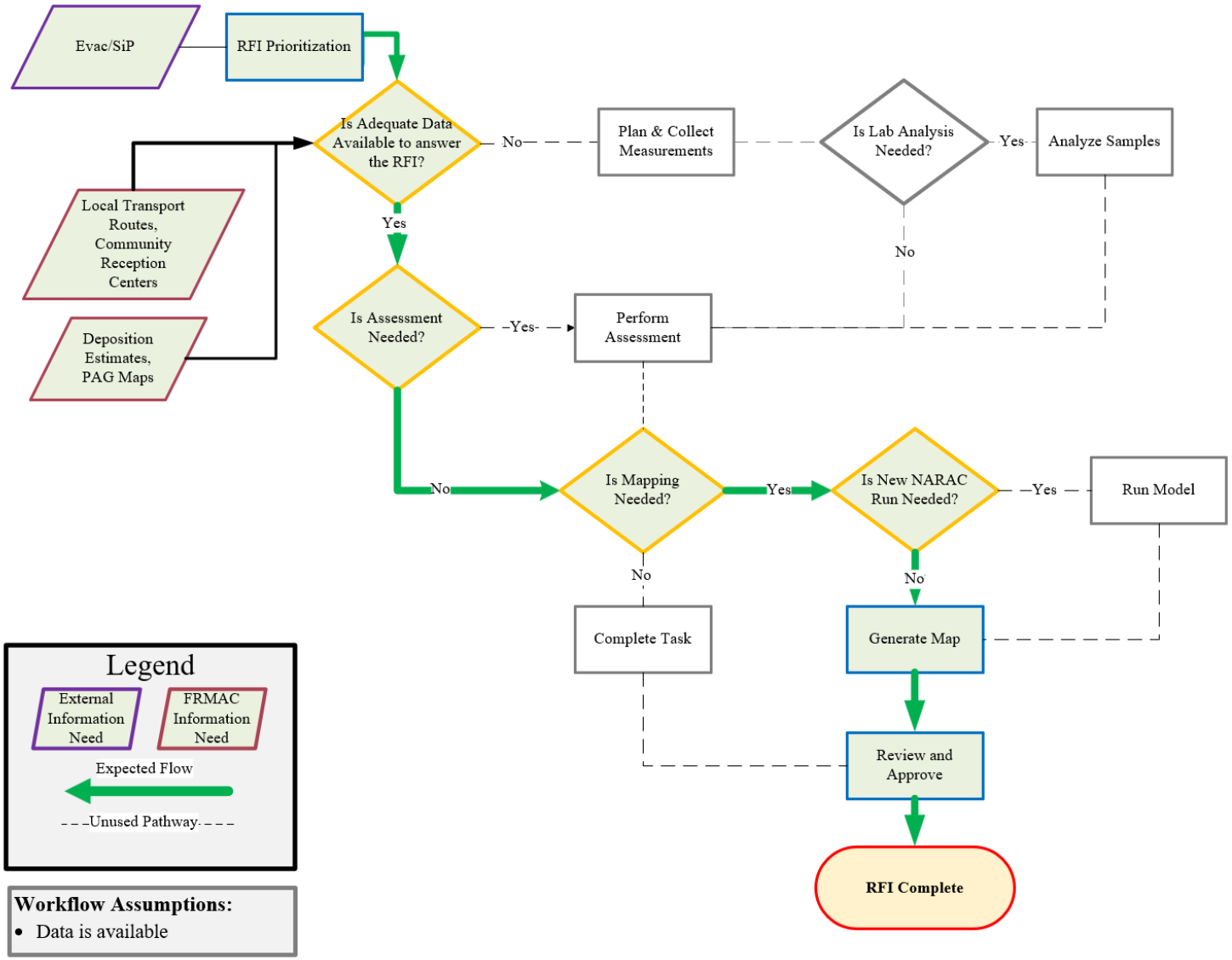


Figure 10. Workflow J: Unique RFI Process – Evacuation and Shelter-in-Place

2.11 Workflow K: Unique RFI Process – Isotopic Identification

This workflow is intended to be specific to isotopic identification in the early phase of the response. It addresses actions that would occur during initial response actions to verify or update assumptions about isotopes released during an incident. Completion of this workflow targets data needs internal to FRMAC to confirm starting assumptions. Confirmation allows FRMAC to refine recommendations and to provide technical information during a response.

FRMAC Information Needs:

- To better understand the hazard to provide more effective recommendations. This is driven by identified discrepancies between expected and actual results obtained during monitoring and sampling.

Workflow K Assumptions:

- Collected data does not match predicted results. This could be due to incorrect alpha/beta ratios, unexpected activities, or other factors identified during sample analysis.

Workflow K Limitations:

- This workflow is specific to updating the FRMAC body of knowledge about the contaminants released during the incident.

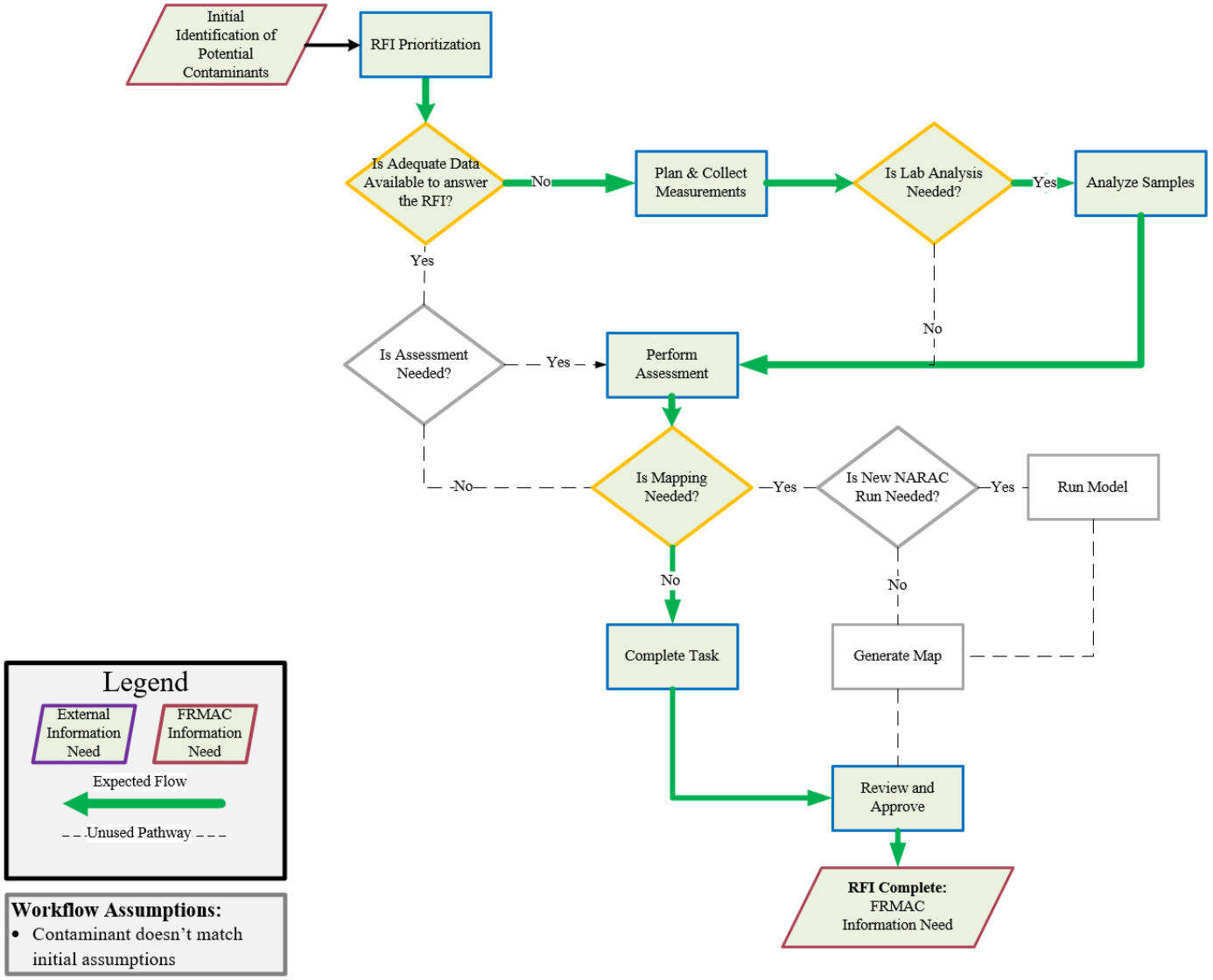


Figure 11. Workflow K: Unique RFI Process – Isotopic Identification

2.12 Workflow L: Product Distribution Process

Part of the process to update FRMAC data products includes integrating ground truth data to validate initial characterization (see section 2.5, Workflow D). Workflow L provides a visual representation of how data is collected from the field and how open-access platforms, FRMAC-specific platforms, and key agency roles interact during product distribution and updates. It was developed through the stakeholder engagement feedback and refined through DOE CM SME supports.

Workflow L begins at the end of Workflows D through K when specific expected outcomes have been approved and are ready for distribution. The **green arrow** pathway indicates the typical distribution pathway from FRMAC leadership approval to two expected information sharing platforms: CBRNResponder or to CMweb. However, uploaded products do not typically have the same technical information or are in the same format on these platforms. CBRNResponder has less restrictive access. Ultimately, state and local organizations may upload FRMAC products or translated elements into their jurisdiction's information management systems (IMS) to support public/responder safety and situational awareness.

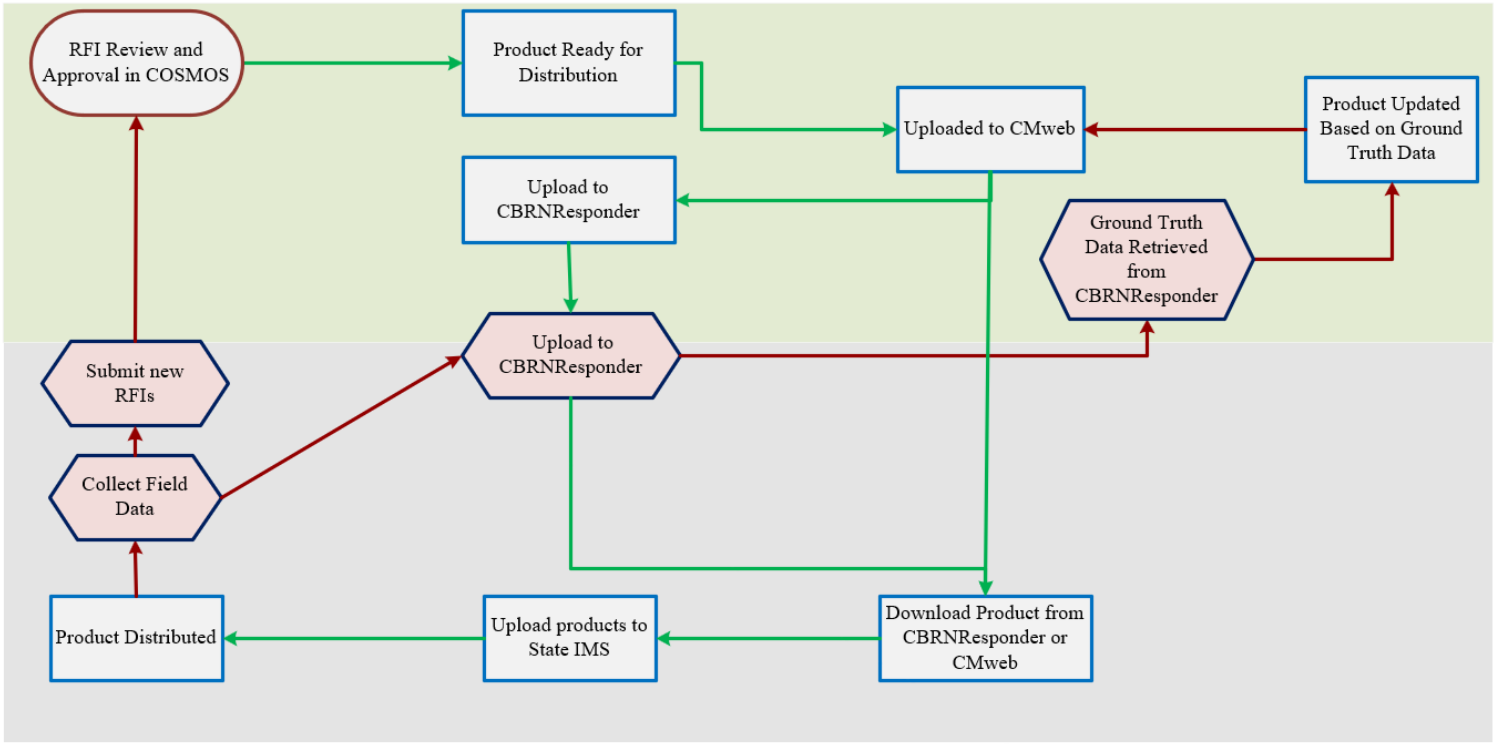
Both FRMAC personnel and external partnering organizations collect ground truth data to validate and update the COP. The **red arrow** pathway indicates data verification steps, which also contains two expected pathways. Pathway one can begin at the *product distribution* decision point where collected field data leads to the development of new or revised RFIs. Pathway two has the same origin as pathway one and branches to indicate ground truth data are uploaded to CBRNResponder. From there, the FRMAC retrieves ground truth data from CBRNResponder and uses it to update products, when appropriate. Pathway two ends with the updated product being uploaded to CMweb to follow the expected distribution pathways indicated with the green arrow.

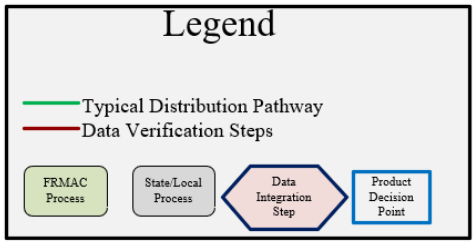
Workflow L Assumptions:

- The responding organization has access to and know how to use CMweb.
- Roles and responsibilities within communication platforms between FRMAC and external partners are established and well understood at all levels.

Workflow L Limitations:

- Accessibility challenges with CMweb can alter the expected pathway for product distribution and hinder FRMAC's ability to track who has been briefed on specific products.
- If there is a breakdown in the process between data collection and getting it to FRMAC, the COP can be compromised.
- Information sharing on CBRNResponder and CMweb is not the same.
- Product distribution practices do not adhere to an established pathway and can be different between government levels and jurisdictions.
- Established product distribution tracking processes are not established in the workflow.





Workflow Assumptions:

- Responding organizations have access to CMweb
- FRMAC communication platforms have established roles and responsibilities are established

Figure 12. Workflow L: Product Distribution Process

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