PHMSA Risk Model Work Group:

Liquid Operator Consequence Overview and Discussion

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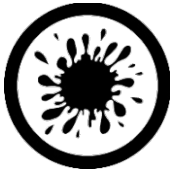
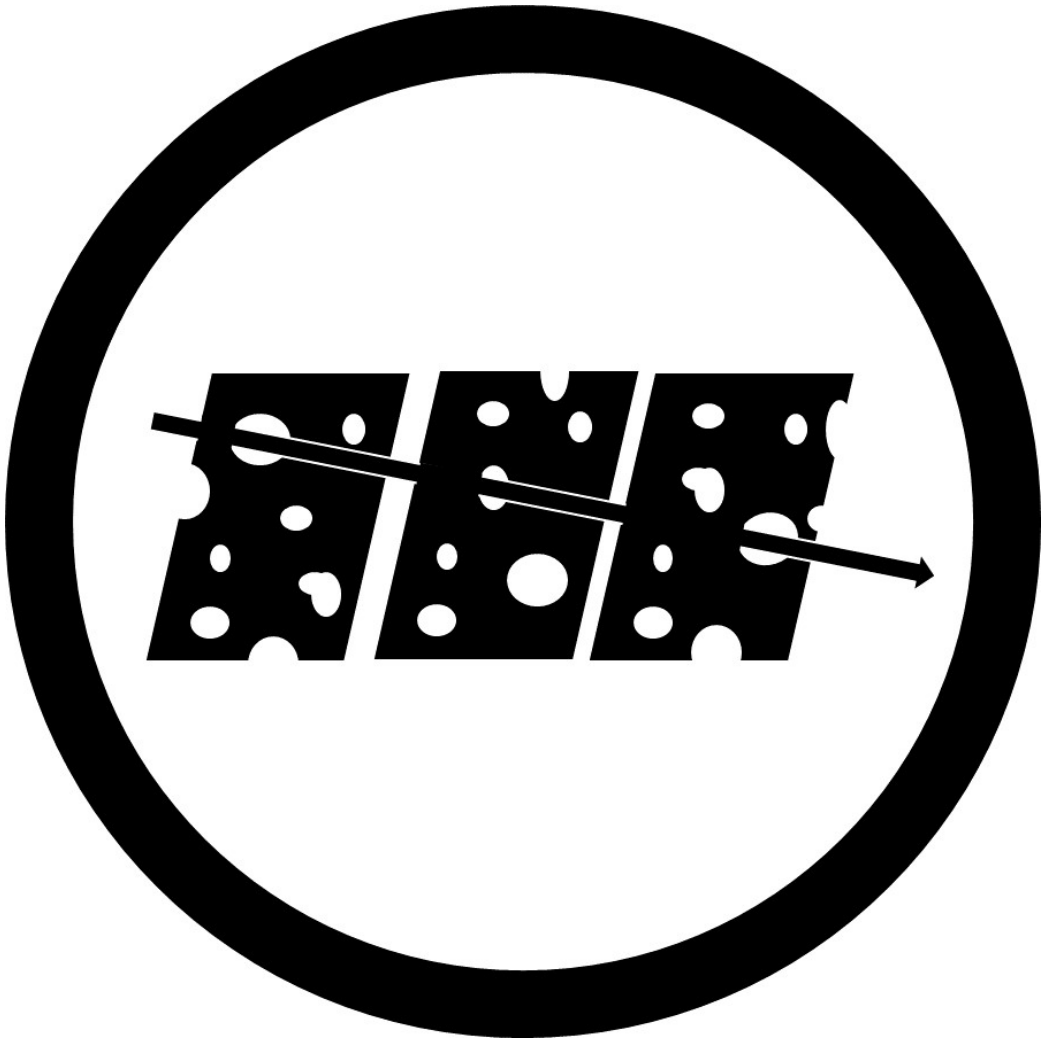
Agenda

- What is Risk?
- Consequence - Overview
- Consequence - Detail
- Use of Consequence

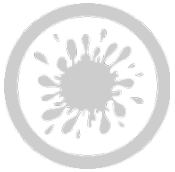



What is Risk?



What is Risk? – Definitions may vary…

- "Risk" can mean many things depending on who is speaking about it and in what context
- Fluidity of definition
- Some common uses –
  - Health and safety
  - Financial
  - Security (physical and cyber)
  - **Integrity**

What is Risk? – What it means to us.

- Meaningful Risk Analysis always involves two components:

$$Risk = Probability * \boldsymbol{Consequence}$$

- For the Integrity Management Program
  - Loss of product containment due to material (integrity) failure
    - From Facilities
    - From Tanks
    - From Pipelines – Focus of today's discussion
- Quick Risk Analysis Analogy – Crossing the street, crossing the creek
  - Note the role that consequence truly plays

What is Risk? – What it means to us

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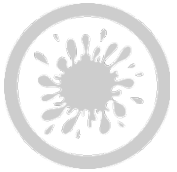
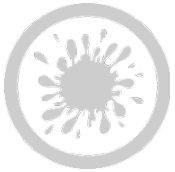
What is Risk? – Why do we care?

- Proper Risk Analysis can help with decision making
  - Provides an objective measurement of which option is “best”
    - Anchor subjective judgements to an objective number
    - Check Emotion
  - Models are not necessarily predictive or preventative on their own
  - Resources, however vast, are ALWAYS limited
  - So we must ALWAYS prioritize


What is Risk? – Discussion on Model Types

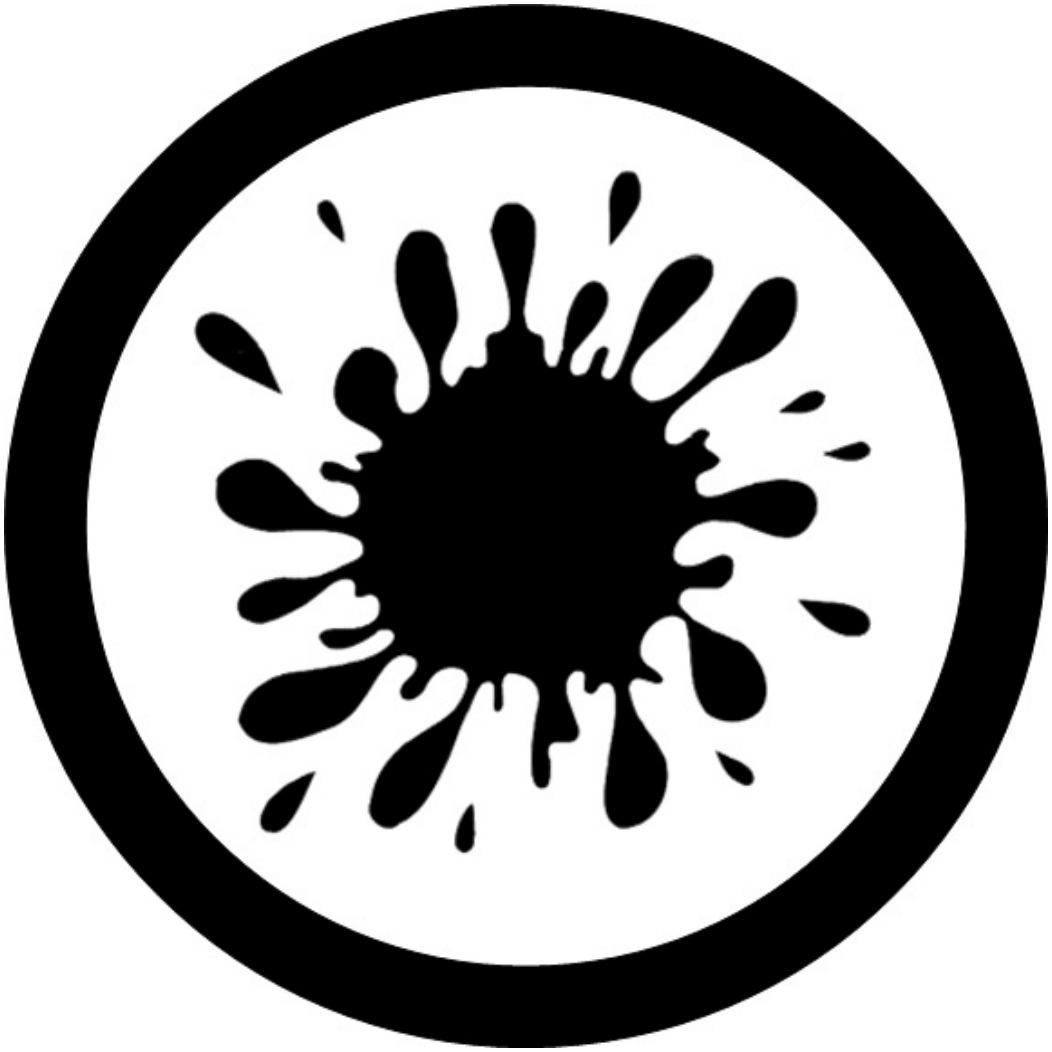
- Non – Models
  - Swiss Cheese - Not a model, an analogy
  - Bowtie – Not a model, an algorithm diagram
  - Grids – Not models, but can be useful in decision making



- Disputed terms for Relative/Index
  - Primary difference from fully quantitative is use of units
  - Dynamic Segmentation
  - Assigns Values to Variables and Aggregates them in an algorithm

- Fully Quantitative (Terms further disputed)
  - Dynamic Segmentation
  - Full use of units
  - Assigns probabilities in terms of expected incidents/year
  - Assigns consequence in $/incident

Consequence – High Level Overview



High Level Overview – Basics

- Spill Modeling
  - Use surrounding terrain (Digital Elevation Model – DEM)
  - Incorporate surrounding hydrographic data
  - Make conservative assumptions for release volume
  - Make conservative assumptions about release rates

- Receptors
  - Overlay plume models on geographic datasets which represent increased consequence factors if they were to be affected by the modeled spill
  - Primarily, HCA data
  - This recycles HCA analysis as consequence modeling for risk – is this appropriate?

<u>Discussion on industry practices, not necessarily what any one operator does within their own model…</u>

High Level Overview – Conservative Assumptions

- Spill Volume Calculations

  - HCA modeling requires assumption of very large leak flow rates
  - 10% - 100% of full line flow
  - Leads to large volumes because of very conservative undetected and shut-down times
  - Assumes 100% drain up of line
  - **This calculation most accurately represents the volume *available* to spill, rather than a realistic estimate as to what may spill even during a worst case scenario**

High Level Overview – Conservative Assumptions

- Spill Plume Modeling
  - Origin of spill above grade
  - Infiltration and Evaporation Assumptions
  - Consistent, Accurate, and Precise DEM and Hydrographic Data
  - Disregard for structures which impede or redirect flow (culverts, sewers, buildings, etc.)
  - Stream Velocity
  - Emergency Response/Spill mitigation generally neglected

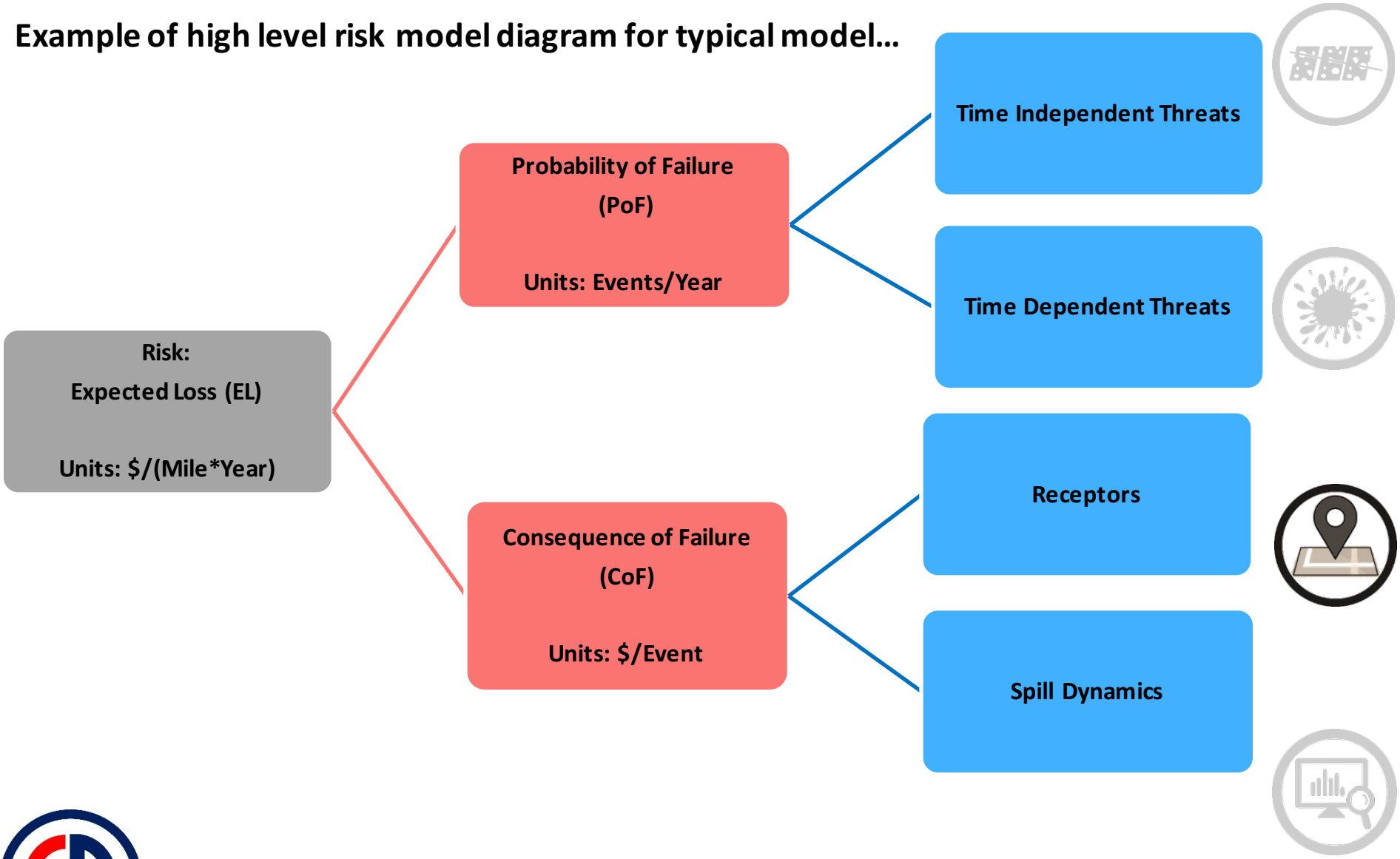
High Level Overview – Conservative Assumptions

- Receptors
  - Receptor Datasets (HCA) are either too general, or inappropriately granular for risk analysis
  - Generally are not conducive to defendable financial impact analysis (there is some reluctance on the part of industry to take this approach)
  - This could be a good place for guidance, as a generally accepted industry wide approach to consequence would help address some reluctance on the part of operators
  - May not ever place monetary value to human life – many agree this is best

Consequence – Details Overview

Details Overview – Advocated Model Diagram

Example of high level risk model diagram for typical model…



Details Overview – Plume Modeling

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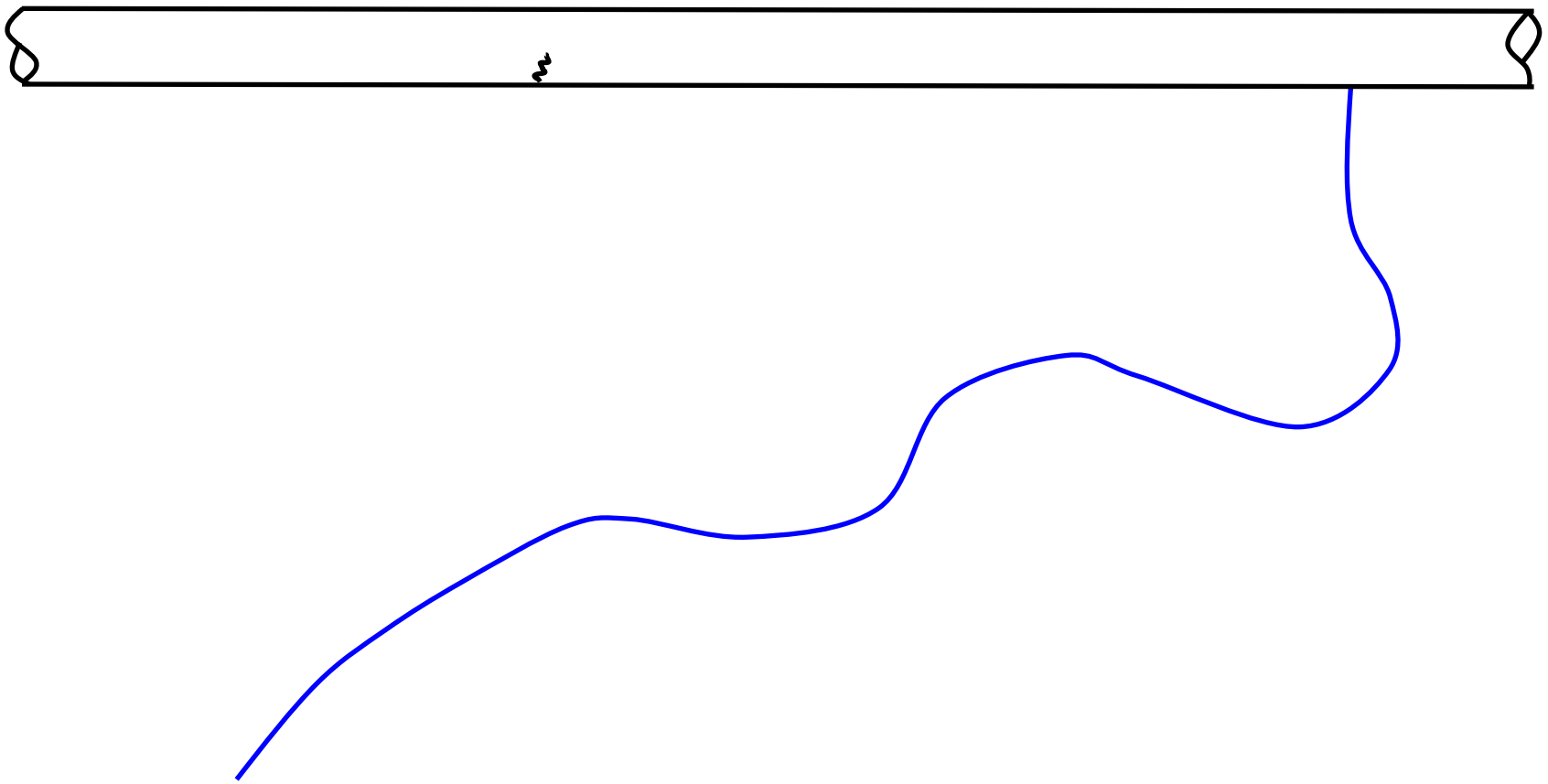

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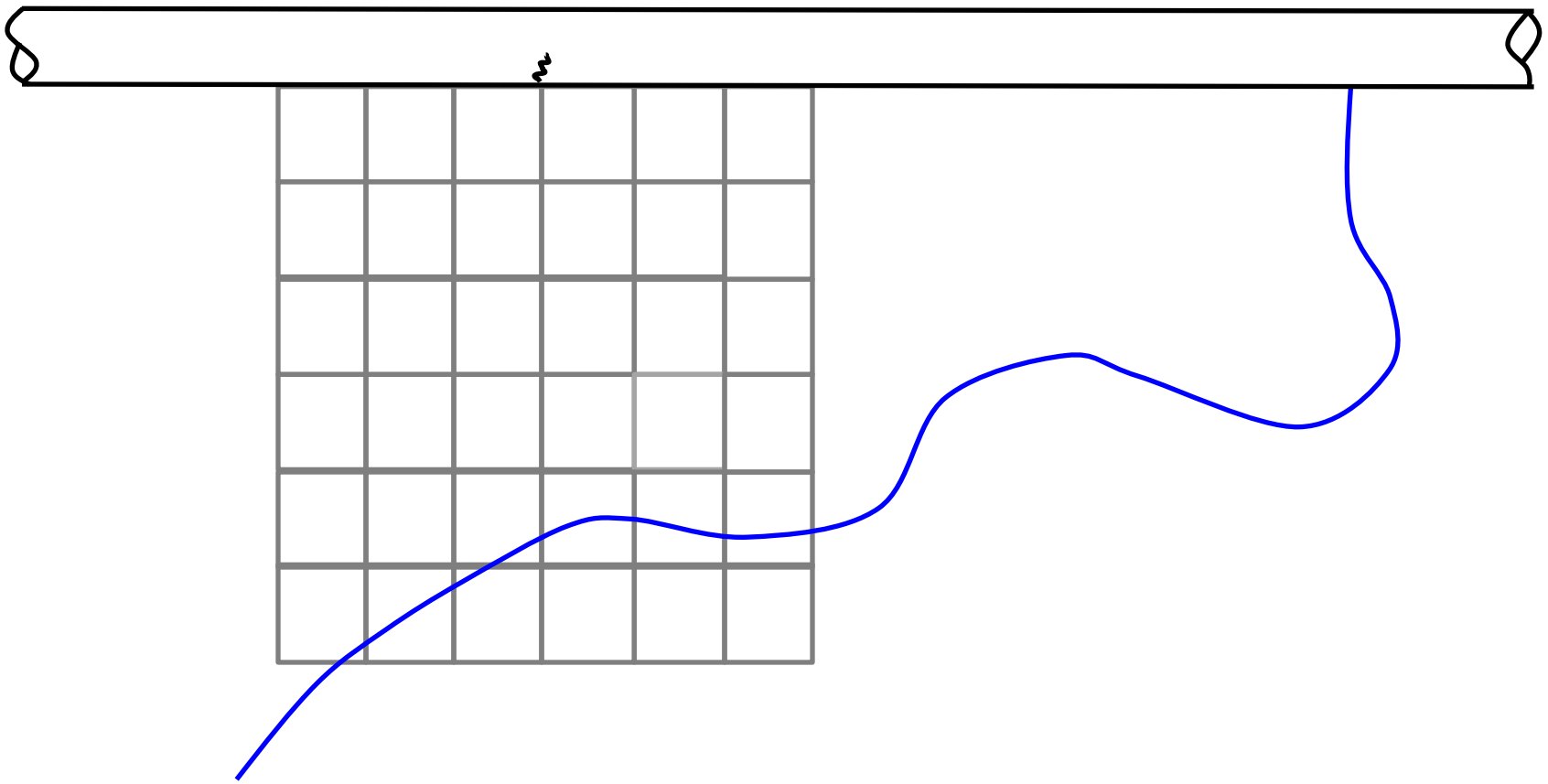

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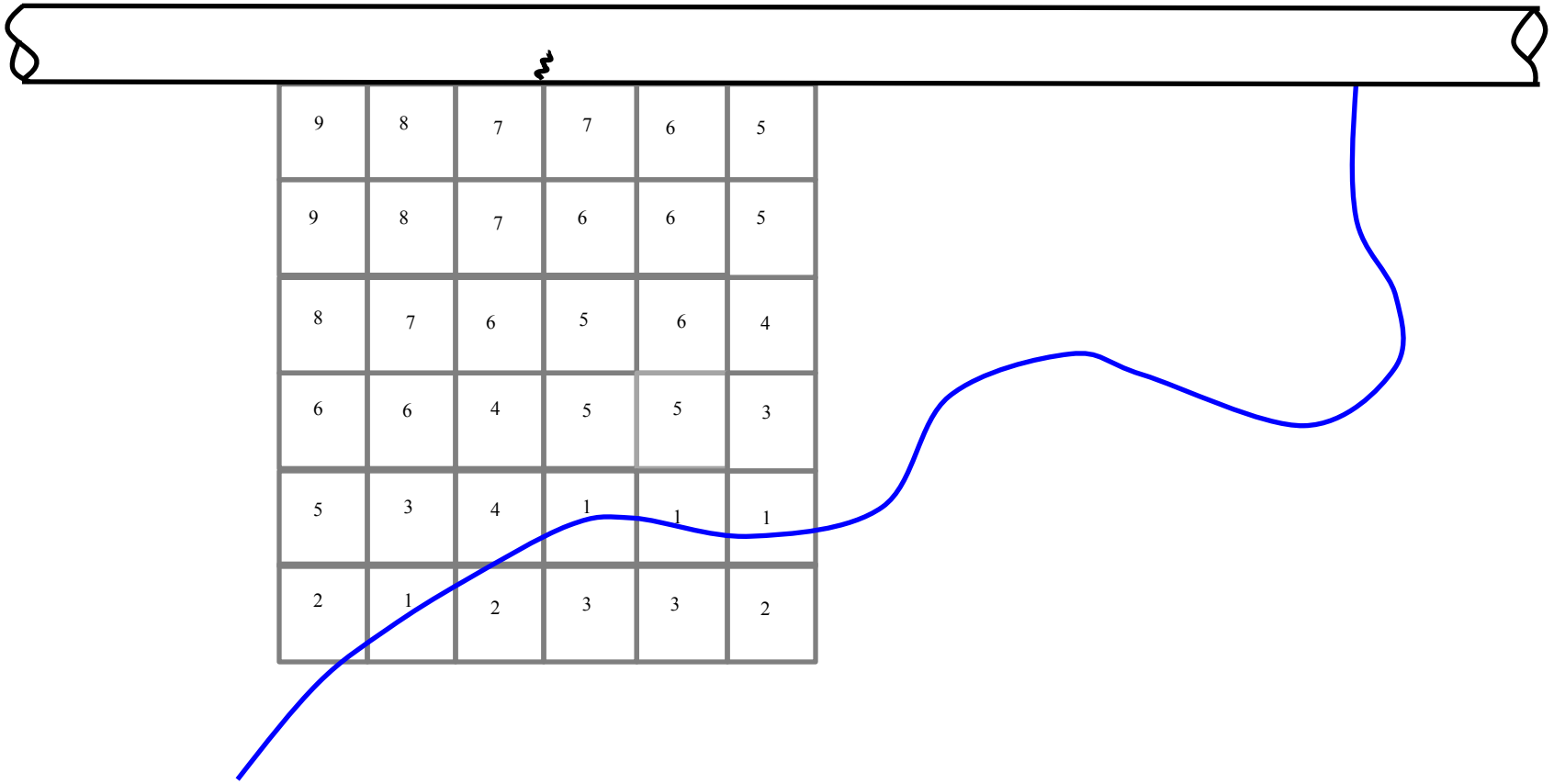

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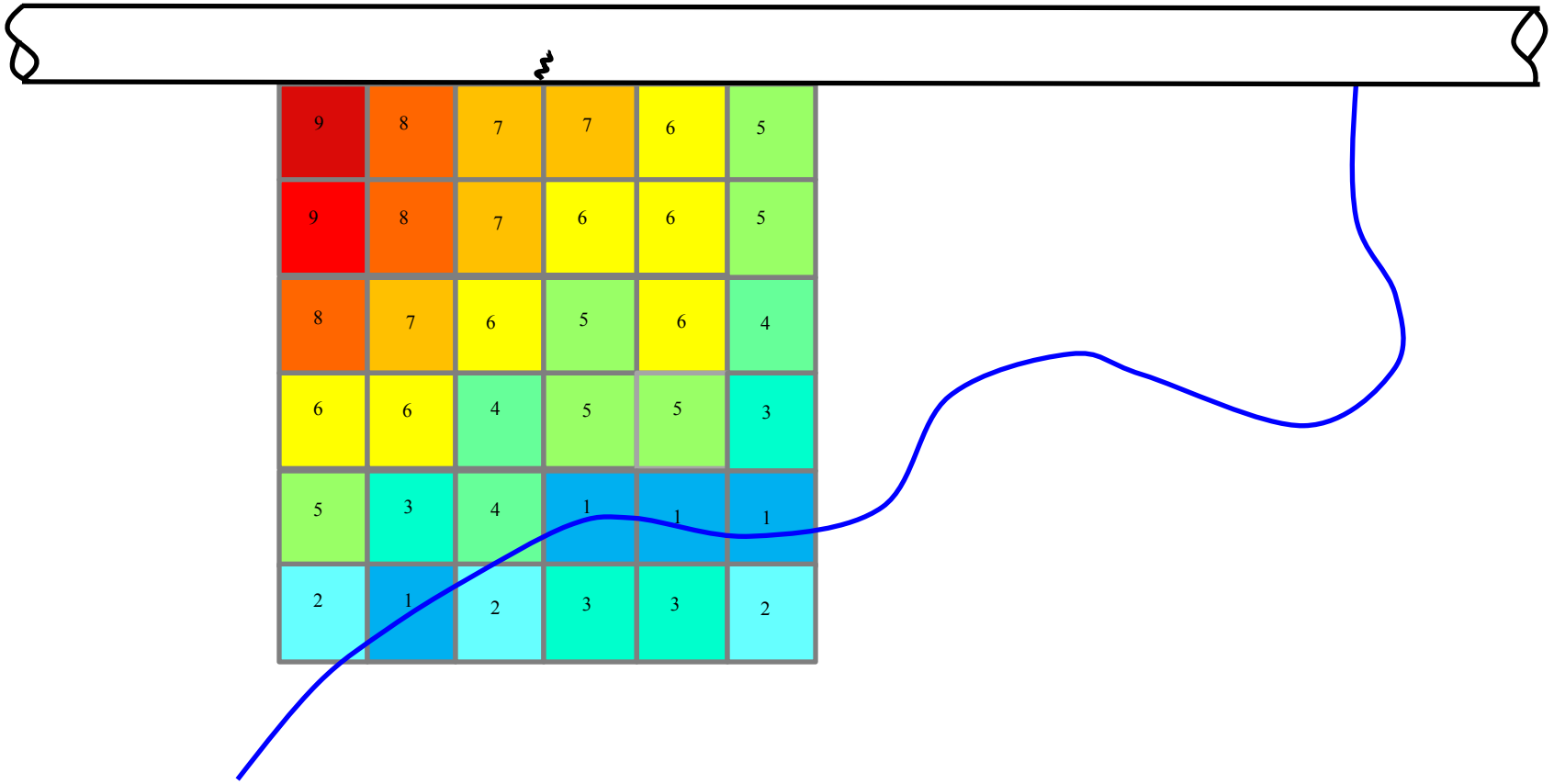

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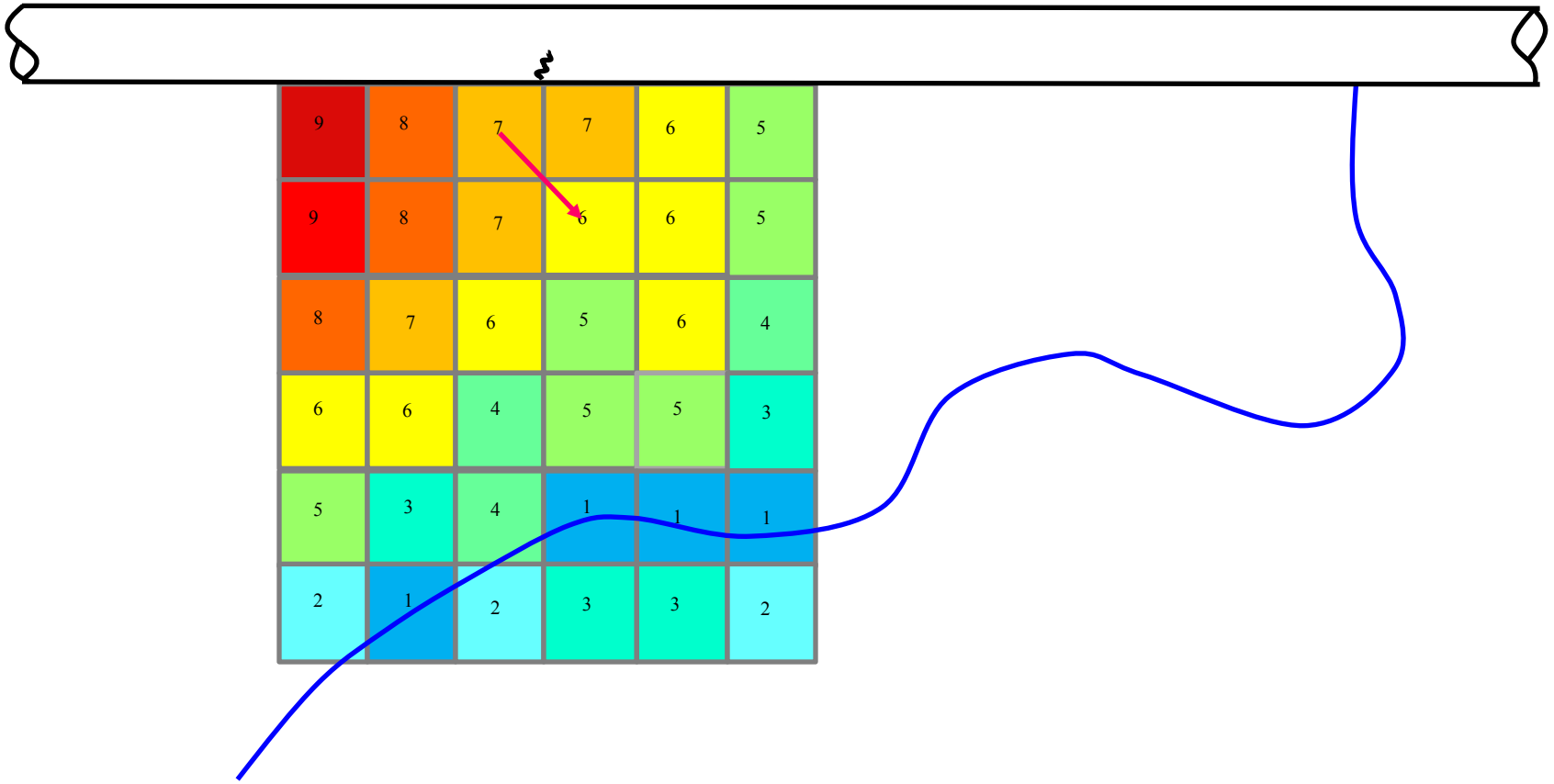

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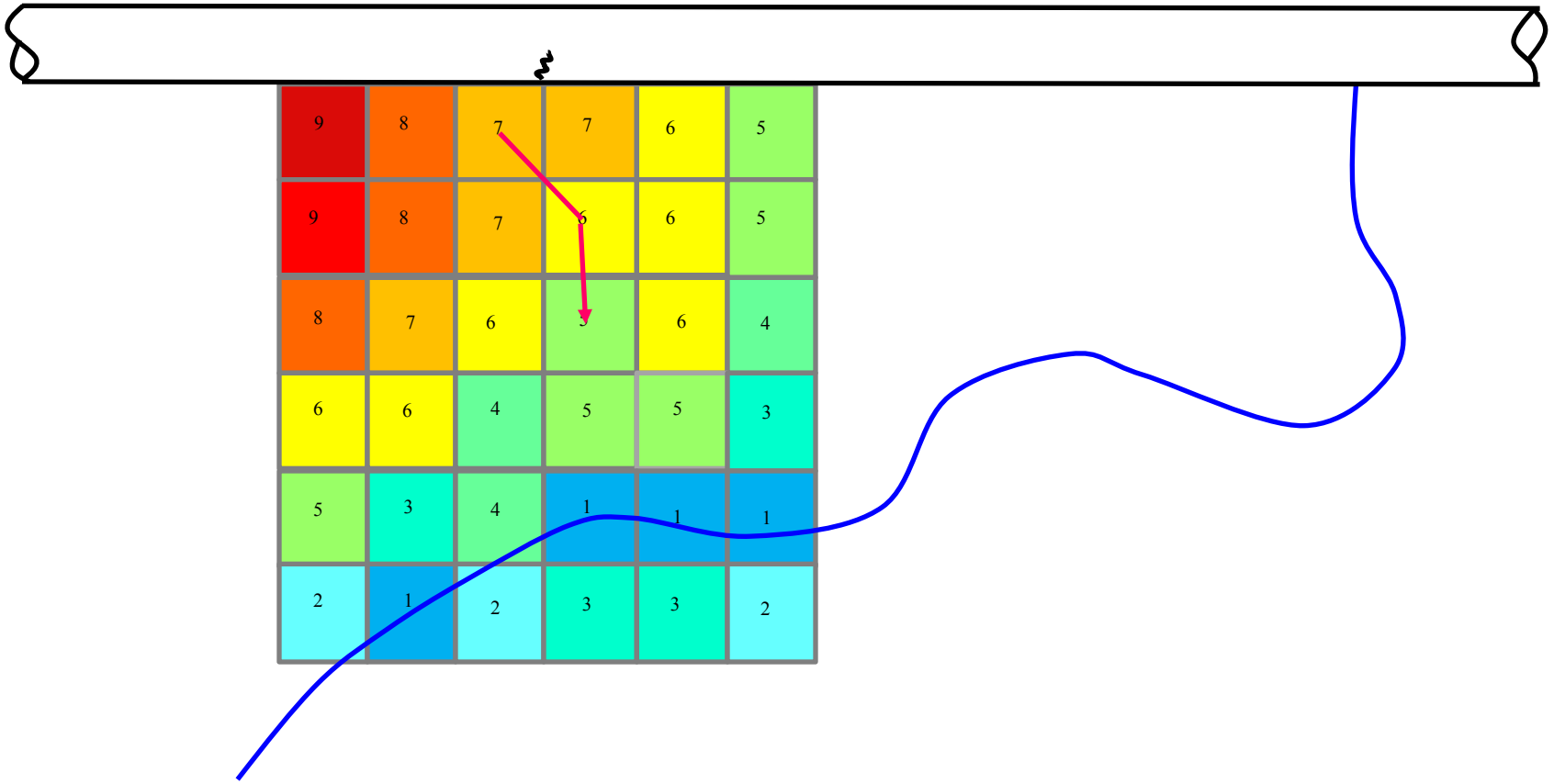

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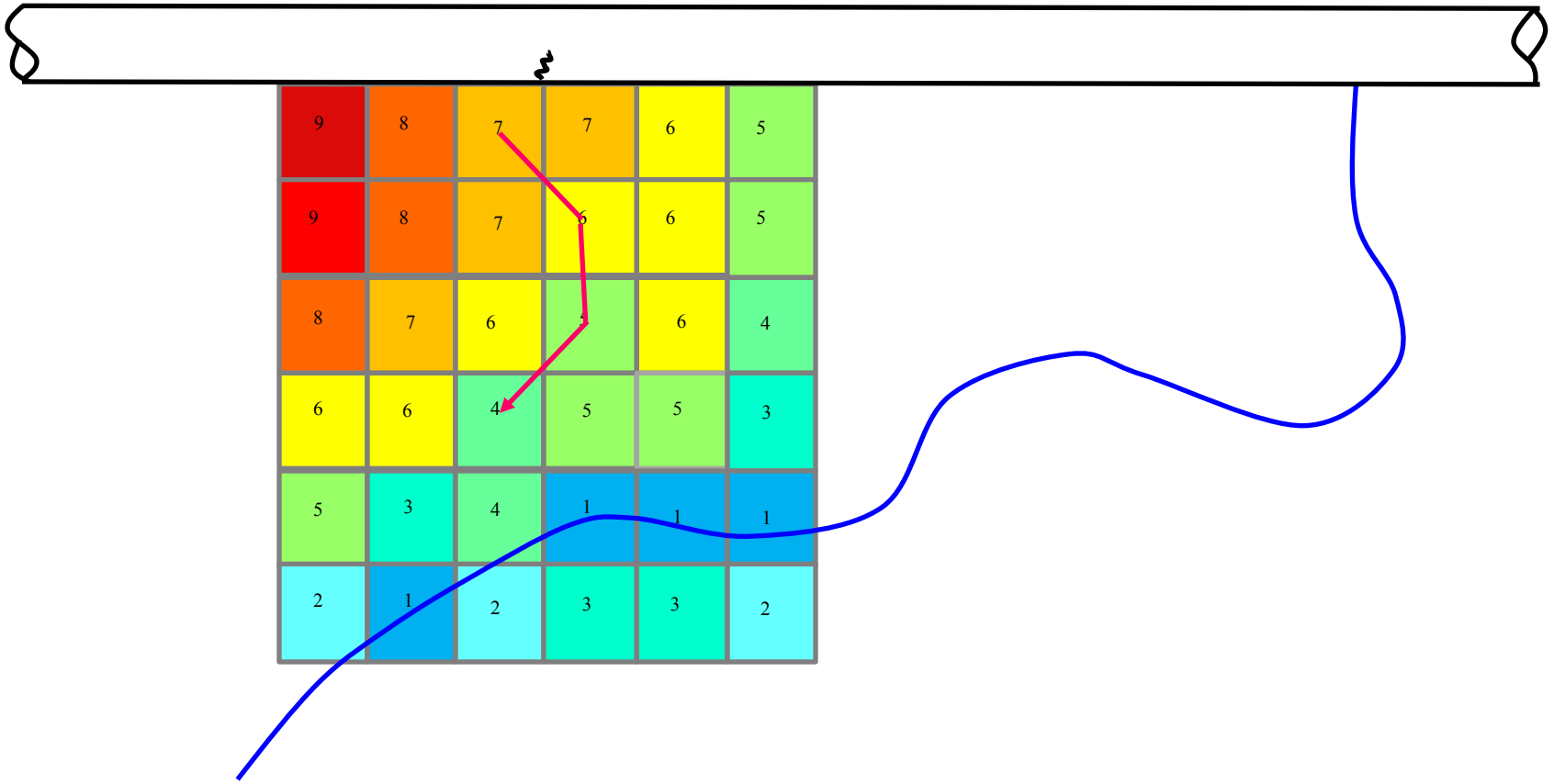

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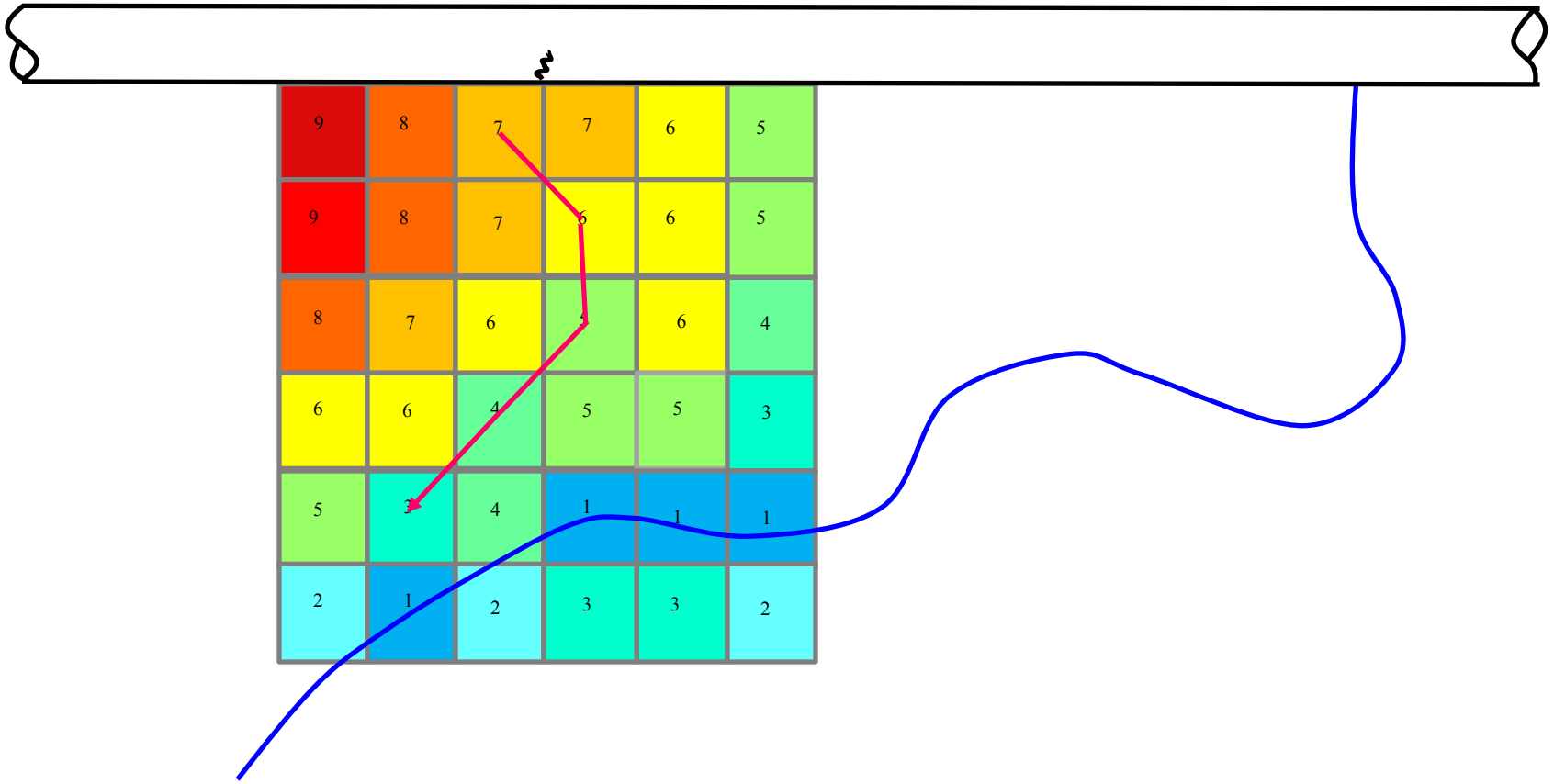

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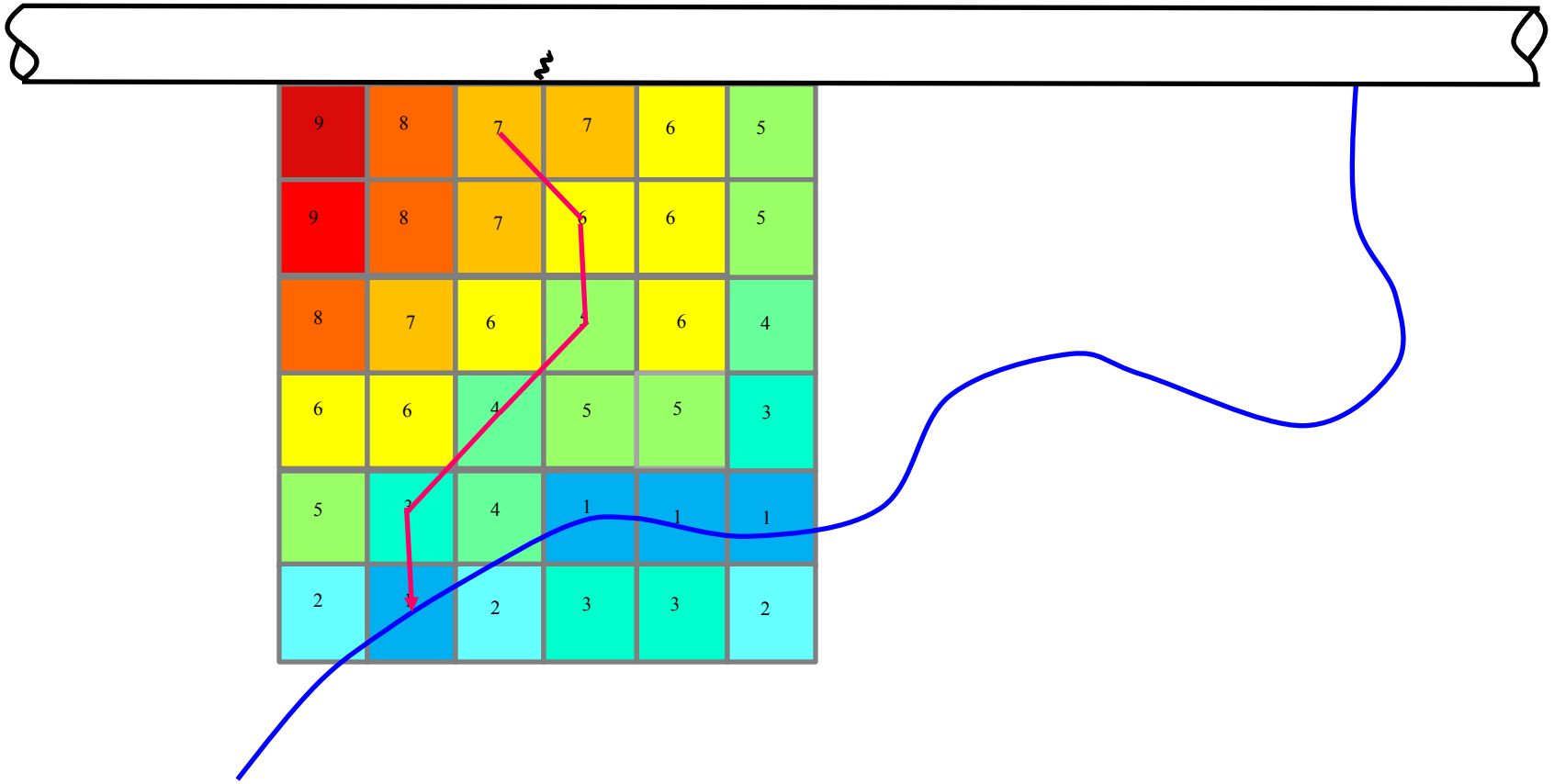

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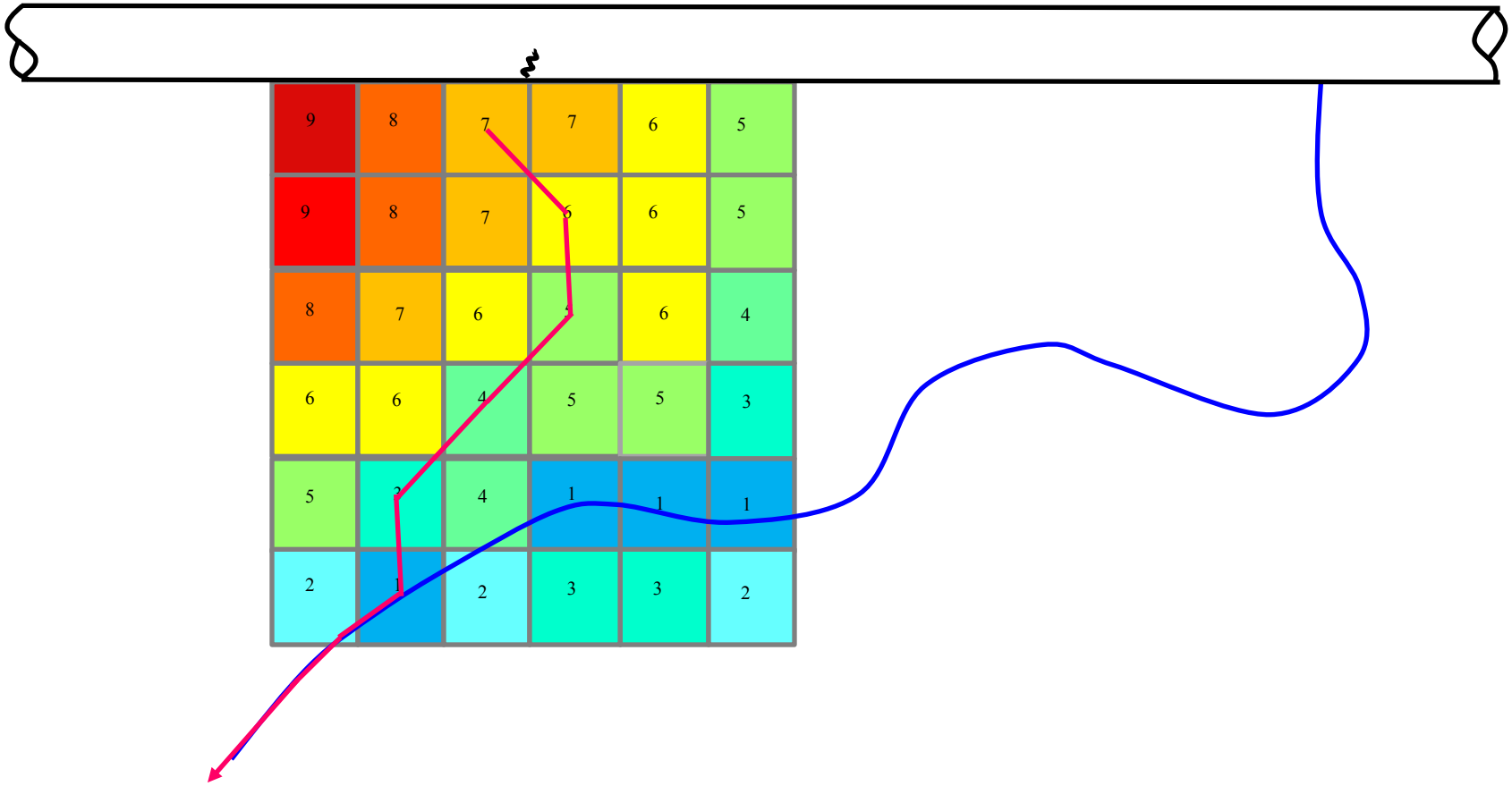

Details Overview – Receptors

- NPMS Data

  - Drinking Water –

    - The surface water intake for Community Water Systems and Non-Transient Non-Community Water Systems that do not have an Adequate Alternative Drinking Water Source

    - The Source Water Protection Area for Community Water Systems and Non-Transient Non-Community Water Systems that obtain their water supply from a Class I or Class IIA aquifer and do not have an Adequate Alternative Drinking Water Sources, if available.

    - If the Source Water Protection Area is not available, the Wellhead Protection Area (WHPA) becomes the USA

    - The aquifer recharge area for sole source aquifers that are karst in nature.

Details Overview – Receptors

- NPMS Data
  - Navigable Waterway –
    - The commercially navigable waterway data is derived from the Bureau of Transportation Statistics National Waterways Network database (BTS National Waterways Network), excluding all non-commercial routes designated as no-traffic, non-navigable, and/or for special vessels such as fishing, power, and recreational boats.

Details Overview – Receptors

- NPMS Data
  - Ecological USA –
    - Areas containing critically imperiled species or ecological communities
    - Multi-species assemblages where three or more different candidate resources co-occur
    - Migratory water bird concentration areas identified as Ramsar Sites or Western Hemisphere Shorebird Reserve Network sites designated as Hemispheric, International, and Endangered Species Reserves
    - Areas containing candidate species or ecological community occurrences that are identified as excellent quality or good quality
    - Areas species and ecological communities that are aquatic or aquatic-dependent, or are terrestrial with a limited range

Details Overview – Receptors

- NPMS Data
  - High Population Areas –
    - The High Population Areas (HPA) data is derived from the U.S. Census Bureau's TIGER Urban Areas data layer, which was downloaded from the Census website.
    - Within the Urban Areas data layer, features defined as Urbanized Areas were extracted to become the "High Population Areas" data layer. Urbanized Clusters within Census Urban Areas data layer were not included in the High Population Areas data layer.

Details Overview – Receptors

- NPMS Data

  - Other Population Areas –

    - The Other Populated Areas (OPA) data is derived from the U.S. Census Bureau's TIGER Designated Places (CDP)/Incorporated Places data layer, which was downloaded from the Census website.

    - Census Urbanized Areas (High Population Areas) were erased from the CDP/Incorporated Places data layer. The resultant data layer represents the "Other Populated Areas" data layer. Other Populated Areas are all CDP/Incorporated Places that lie outside of the boundaries of Census Urbanized Areas.

Details Overview – Receptors

- Discussion of HCA appropriateness in consequence modeling

  - HCA Could Affect Segments are a regulatory designation. These segments are not necessarily indicative that a potential failure located within these segments will actually affect areas of large populations of people, drinking water, or sensitive ecology.

  - What this designation means is that if a series of contributing factors are all present during a failure (worst case), the pipeline or piece of equipment in question has a volume of product available to leak which if not captured, stopped, or immediately mitigated could affect an area of high population, drinking water, navigable waterway, or ecologically sensitive area.

  - Sometimes the failed section runs through these areas directly, but often it does not. The area which may be affected may in fact be very far away from the actual pipeline itself and is often not affected at all. This designation exists to determine which sections of pipe are subject to certain regulations

Use of Consequence in Risk

What Should We Do? – The Results

- **Probability**
  - Probability can be thought of the same way flood zones are described
  - They reflect an expected failure rate averaged **over time**
  - Example – a 100 year flood event does not necessarily happen every 100 years
  - Not Predictive!

Threat	Probability (failures/mile/year)	Cost of Failure ($/failure)	Expected Loss ($/year)
Third Party Mechanical	1×10^{-x}	$ -	$ -
External Corrosion	1×10^{-x}	$ -	$ -
Internal Corrosion	1×10^{-x}	$ -	$ -
SCC	1×10^{-x}	$ -	$ -
Fatigue	1×10^{-x}	$ -	$ -
Incorrect Operations	1×10^{-x}	$ -	$ -
Natural Force	1×10^{-x}	$ -	$ -

What Should We Do? – The Results

- **Consequence**
  - Will look at multiple spill scenarios (volumes) from different failure modes based on historical data.
  - This prevents assuming a worst case scenario for every spill probability across all threats.
  - Allows for a more thorough (and realistic) consequence analysis.
  - Will use multiple receptors to evaluate consequence, not just HCA data.

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Natural Force	1×10^{-x}	$ -	$ -

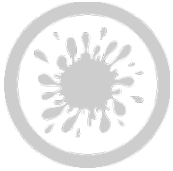
What Should We Do? – The Results

- **More Thorough Modeling**

  - More thorough does not need to be more technically advanced (but may be)

  - Recognize most spills are far less than worst case – Identify distribution

  - Look at monetary impact
    - All spills have terrible and expensive consequence
    - The goal of modeling is to differentiate areas of risk for the purposes of prioritization of mitigation activities
    - Publicly available structure, parcel, and land use data combined with cost estimates for response, purchase, and mitigation estimates



Questions and Discussion…

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