

TRANSPORTATION RESEARCH BOARD

**Guide to Snow and Ice Performance
Measures: Key Findings &
Recommendations**

**Wednesday, May 15, 2019
2:00-3:30 PM ET**

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REGISTERED CONTINUING EDUCATION PROGRAM



Purpose

To discuss NCHRP [Research Report 889](#): Performance Measures in Snow and Ice Control Operations.

Learning Objectives

At the end of this webinar, you will be able to:

- Identify how to construct effective approaches to set up performance monitoring programs for snow and ice control activities
 - Determine what performance measures are best suited for their agency's operations and current capabilities
 - Describe ongoing snow and ice performance programs
- 



Guide for Performance Measures in Snow and Ice Control Operations

Webinar

May 15 2019

NCHRP 14-34

Prepared for the
National Cooperative
Research Program
(NCHRP)
Transportation
Research Board of the
National Academies

Snow and ice control operations in the US

- More than 70% of the US population resides in areas affected by snow and ice
- Over 425,000 injuries and 5,000 fatalities occur in adverse weather and/or roadway surface conditions annually¹
- Snow and ice control is complex due to climatic differences and varying agency responses
- Traveling public expectations are continuously changing
- Shrinking agency budgets, aging workforce, and evolving technologies require efficiencies in operations



¹From 2010 – 2014, https://www.aaafoundation.org/sites/default/files/weather_report_2016.pdf

Why measure snow and ice-control operations?

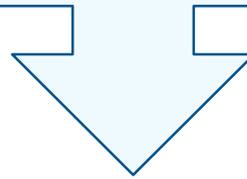
- Provides an assessment of current investments levels
- Demonstrates operational accomplishments under varying investment levels
- Delivers a clear explanation of operational trade-offs
- Offers the ability to predict future performance and optimize current practices
- Provides a clear connection between winter maintenance and other safety metrics
- Focuses on what matters most to the traveling public



Current challenges in measuring performance

Complexities Arise Due to Differences In:

- ✓ Seasons
- ✓ Regions
- ✓ Roadway Types
- ✓ Agency Types
- ✓ Customer Expectations
- ✓ Travel Patterns
- ✓ Funding Availability
- ✓ Available Strategies and Tactics



In response, guidance was developed to be broadly applicable to a wide variety of agency types

Opportunities for advancing current snow and ice-control performance measures

Greater ability to collect real-time maintenance field data

Growth in probe data availability

Greater linkages between transportation and weather community

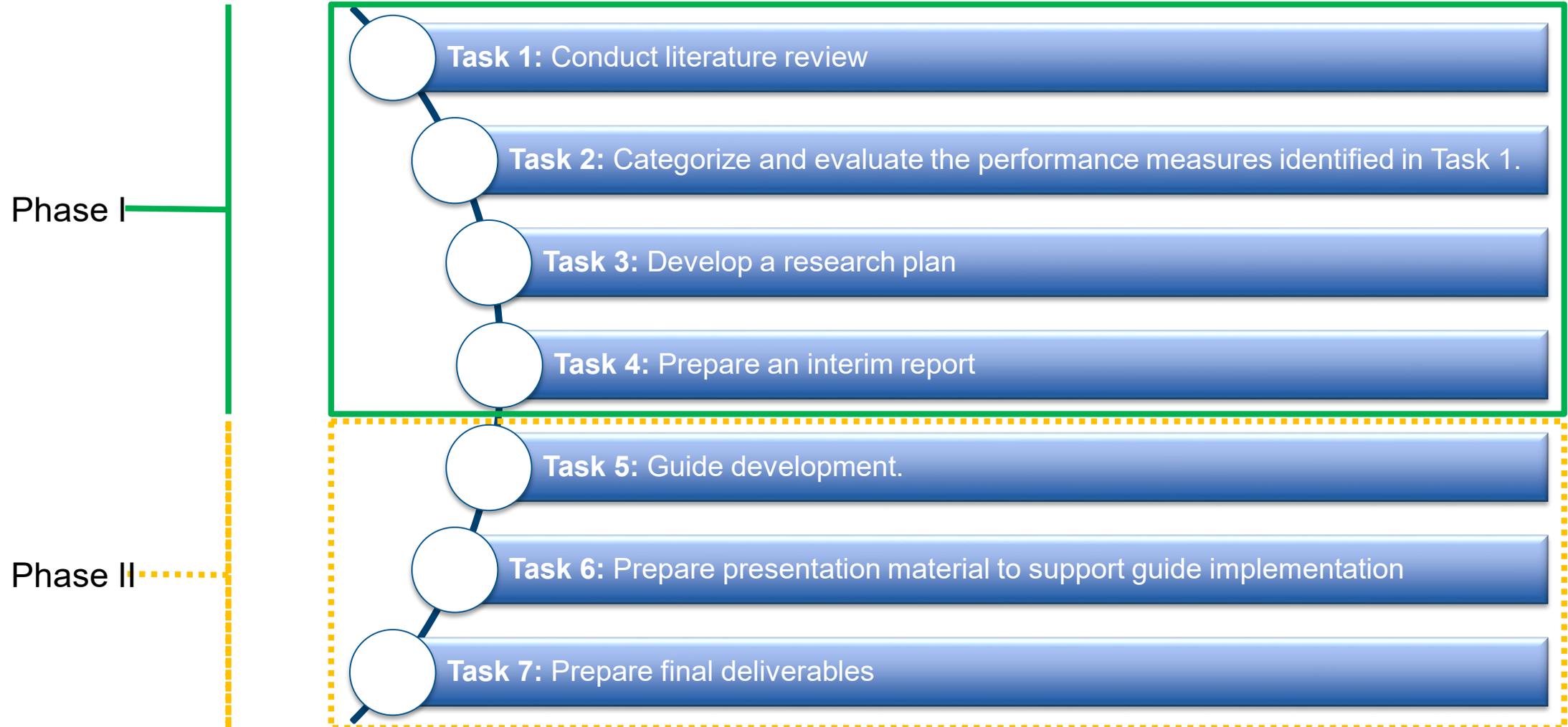
New ways of engaging with traveling public

New tools for data visualization and performance reporting

Research Objective

- Develop a guide for applying performance measures to snow and ice control operations
- Appropriate for assessing agency and contractor performance with focus on safety, mobility, and sustainability

Research Tasks and Phasing



Research Outcomes

- Achieve greater consistency in how state and local agencies define success in snow and ice control
- Provide a specific and implementation-ready resource that will be applicable to a wide variety of agency types, capabilities and scenarios
- Allow state and local agencies to adopt a performance measurement framework that enables them to control and manage their processes effectively within local constraints

Guide Purpose

- Present **core set of measures** for snow and ice control
- Provide insight on developing a **performance framework**
- Help decision-makers identify **adjustments in resources**
- Highlight **best practices** in winter maintenance
- Provide **detailed procedures** to monitor performance
- Provide approach to **identify measures and set targets**
- Be **flexible and inclusive**



Who does the guide benefit?

Agency Staff



- Monitor performance levels
- Make resource adjustments

Contractors



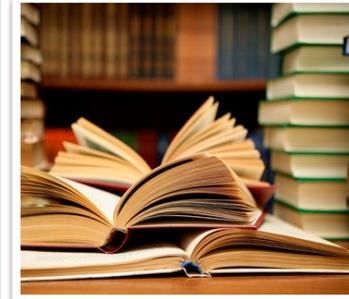
- Evaluate their performance
- Communicate results with clients

Policy Makers



Learn how performance can be measured while accounting for external factors

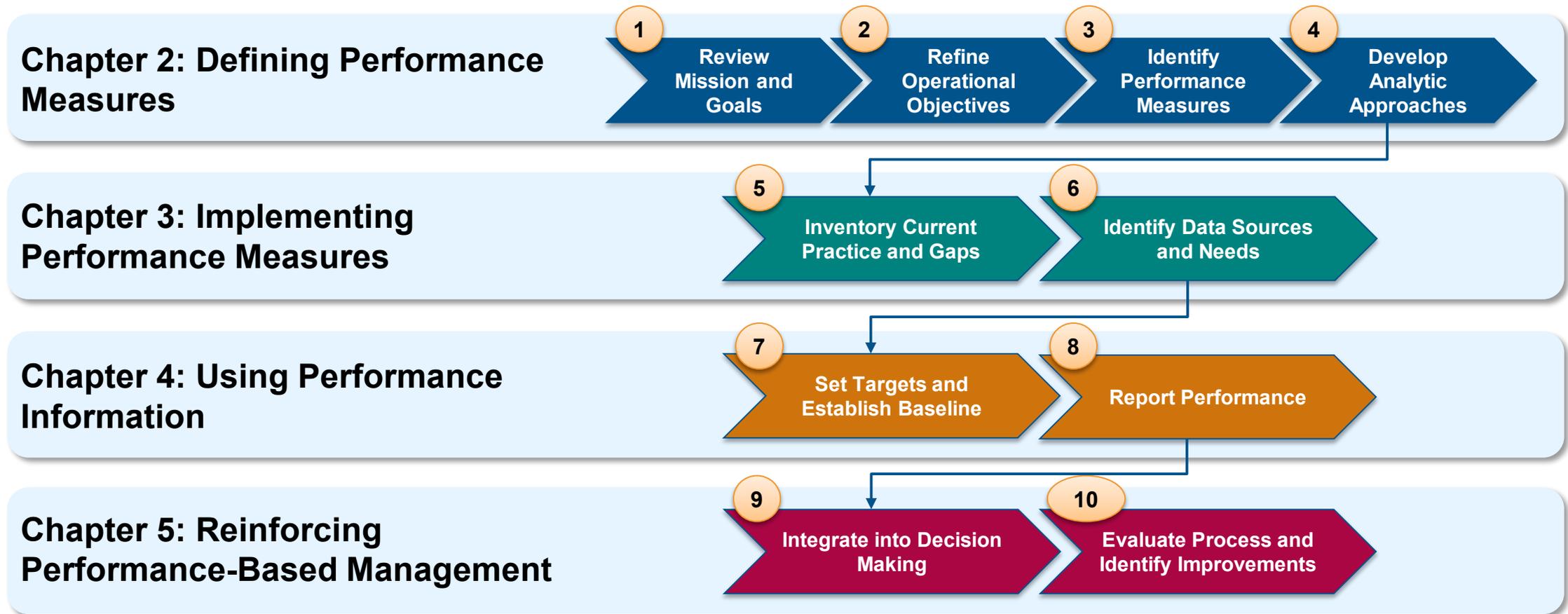
Researchers



Learn about the state-of-the-practice

Guide Overview

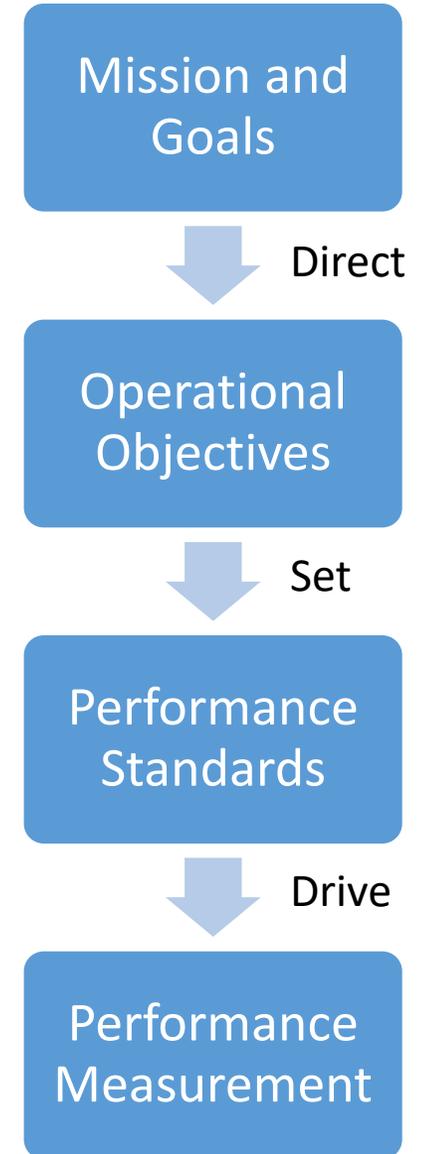
10-step process for snow and ice-control performance measures



Defining Performance Measures

Agencies creating a core set of performance measures should note:

- No measure is a perfect representation of the complexity of snow and ice response
- Not all measures important to an agency can be fully controllable by agency's response
- Starting the process is the first and often the most important step
- Some level of subjectivity in performance measurement cannot be avoided
- Performance measures need to be simple and easily understood



Step 1 - Review Mission and Goals

Review agency's state mission and goals to determine how they relate to snow and ice control

The following questions help identify key elements in determining goals:

- How critical is snow and ice control to the agency mission?
- Is there a handbook/policy for snow and ice control?
- What is the nature of the jurisdiction that the agency manages?
- What is the public sector role in snow and ice response?
- What type of facilities (e.g. arterials, freeways) does an agency manage?
- What type of operational strategies are in use?



FreePNGimg.com

Step 2 – Define Operational Objectives

Develop operational and maintenance objectives to meet/refine goals

Snow and ice-control outcome based objectives are defined in the following seven categories:

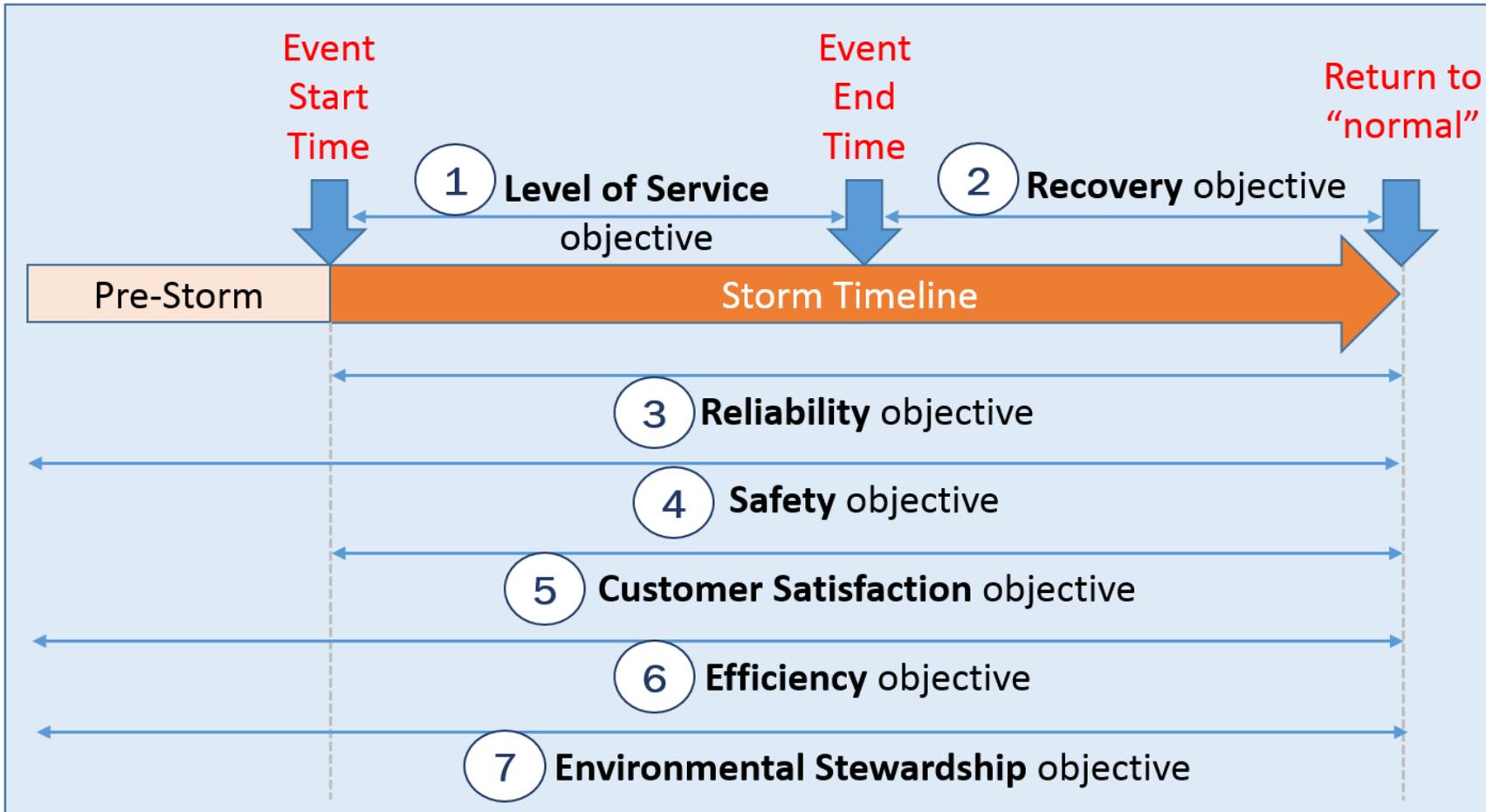
1. Level of Service (LOS) during event
2. Travel reliability during event
3. Recovery from event
4. Safety
5. Level of customer satisfaction
6. Efficiency
7. Environmental Stewardship



Clipart Panda

Step 2 – Operational Objectives

Seven Categories of Operational Objectives for Snow and Ice Control



Step 3 – Identify Performance Measures

Once the objectives are identified, it is possible to link them to performance measures

Objective	Identified Performance Measures
Maintain Level of Service <u>during</u> event	Percent of time road segments meet agency-defined level of service thresholds <u>during</u> winter storms
Meet recovery criteria set by agency	Percent of segments meeting time to regain or recover to “acceptable criteria” for agency-defined segments after the end of event
Meet reliability targets for specific routes	Percent of trips within accepted difference between measured travel time index and “additional expected” travel time index for snow and ice events for selected routes
Support safe operations of the roadway	Five-Year Rolling Average of Fatalities and Injuries (Number, Rate) during a Winter Season
Meet customer satisfaction ratings	Customer Satisfaction Ratings for Snow and Ice Response
Support efficient use of resources to meet operational objectives	Cost of Snow and Ice Control spent to meet an established performance criteria for a given winter severity
Support environmental stewardship goals by optimizing material use	Agency within “acceptable” difference between expected and actual use of salt and other materials in a season

PM #1 – Level of Service During Event

Measure

- **Percent of time identified road segments meet agency-defined level of service thresholds during winter storms**

Utility

- Measures agency performance of winter maintenance activities
- Acts as a surrogate for crash risk and to some extent mobility needs
- Used to monitor contractor performance

Calculation

- Monitor the service level threshold throughout the event on available roadways
- Calculate percentage of event duration during which the service level threshold was maintained compared to the chosen threshold for the segment

LOS defined as:

- Qualitative assessment of conditions
- Accumulation-related threshold
- Friction-related threshold
- Travel speed-related threshold

LOS will vary based on:

- Roadway functional class
- Observed severity of event
- Day of week
- Time of day
- Operational Strategies in use (eg. VSL)



PM #2 - Recovery

Measure

- Percent of identified segments meeting time to regain or recover to “acceptable criteria” for agency-defined segments after end of event

Utility

- Assesses winter storm management and response performance
- Supports response decisions and post-event analysis

Calculation

- Amount of time that passes from the end of a winter event until acceptable surface condition exists again (e.g., bare pavement)
- Measure does not apply in the same way across all segments of roadway (i.e., different criteria)

Criteria defined by the agency:

- Acceptable condition
- Performance target
- Roadway segment prioritization
- Storm Severity



Monocounty.ca.gov

PM #3 - Reliability

Measure

- Percent of trips within accepted difference between measured travel time index (TTI) and “additional expected” TTI for snow and ice events

Utility

- Provides a measure of service quality and mobility for travelers for specific trips (on certain corridors and time periods)

Calculation

- Ratio of peak-period travel time to free-flow travel time averaged across urban areas, road sections, and time period weighted by VMT
- Assesses TTI during storms versus pre-specified additional TTI for trips and storm severity levels

TTI determined by:

- Estimated based on expert judgment
- Calculated based on historical data
- Modeled

TTI will vary based on:

- Roadway functional class
- Observed severity of event
- Day of week
- Time of day



FHWA

PM #4a - Fatalities

Measure

- Five-Year Rolling Average of Number of Fatalities during a Winter Season

Utility

- Allows for seasonal evaluations
- Key input to maintenance and incident management planning
- Helps identify locations in need of safety interventions, technologies, programs, practices, and enforcement

Calculation

- Calculated every winter season and averaged to account for seasonal differences
- Multiple seasons used to normalize for expected variations in crash rates

Data Used:

- Detailed crash records
- Weather event data

Types of Measure:

- Fatal crashes vs. fatalities
- Season vs. winter events
- Rate vs. number



Weather.com

PM #4b - Injuries

Measure

- Five-Year Rolling Average of Number of Serious Injury Crashes during a Winter Season

Utility

- Allows for seasonal evaluations
- Key input to maintenance and incident management planning
- Helps identify locations in need of safety interventions, technologies, programs, practices, and enforcement

Calculation

- Serious injuries are defined by FHWA as “disabling injury” or as “A” on National Safety Council KABCO injury classification scale
- Calculated every winter season and averaged to account for seasonal differences
- Multiple seasons used to normalize for expected variations in crash rates

Data Used:

- Detailed crash records
- Traffic volume data
- Weather event data

Types of Measure:

- Serious injury crashes vs. serious injuries
- Season vs. winter events
- Rate vs. number



Weather.com

PM #5 – Customer Satisfaction

Measure

- Customer satisfaction ratings for snow and ice response

Utility

- Provides support to event response decisions and post-event analysis by allowing agency to see how perception of performance changes amongst customers

Calculation

- Track traveler feedback at regional/statewide level through periodic surveys, focus groups, or other engagement
- Consider severity of event (satisfaction decreases with severity increases)

Data collected by:

- Seasonal survey of customer satisfaction
- Survey after specific events



Clipartix.com

PM #6 – Agency Efficiency

Measure

- Standardized cost of snow and ice control spent to meet an established performance criteria for a given winter severity

Utility

- Helps to assess efficiency of agency spending (by translating usage of resources into cost of winter maintenance operations)

Calculation

- Overall cost is standardized by one or more characteristics of maintained/served area (e.g lane-miles) and the severity of the event or season
- $\text{Cost of Winter Operations (per storm and season)} = \text{Output of usage indicators of labor, equipment, material, and other resources}$

Factors that drive cost:

- Geographic size
- Functional class or roadway and priority segments
- Density of roadways
- Rural versus Urban
- Microclimates and hot spots
- Timing of events
- Number of events
- Intensity of events



Theneworleanstribune.com

PM #7 – Environmental Stewardship

Measure

- Agency within “acceptable” difference between expected and actual use of salt and other materials in a season

Utility

- Assesses amount of materials used in a given storm or season to achieve the agency’s LOS while utilizing only the materials necessary
- Provides winter maintenance managers an overall perspective of how the agency is performing

Calculation

- Modeled or Estimate of “Expected amount of material” usage based on winter severity and response objectives (requires historical data, miles of roadway by functional class, and LOS parameters for particular regions)
- Actual Usage
- Acceptable difference (e.g., +/- 10%) between expected and actual use

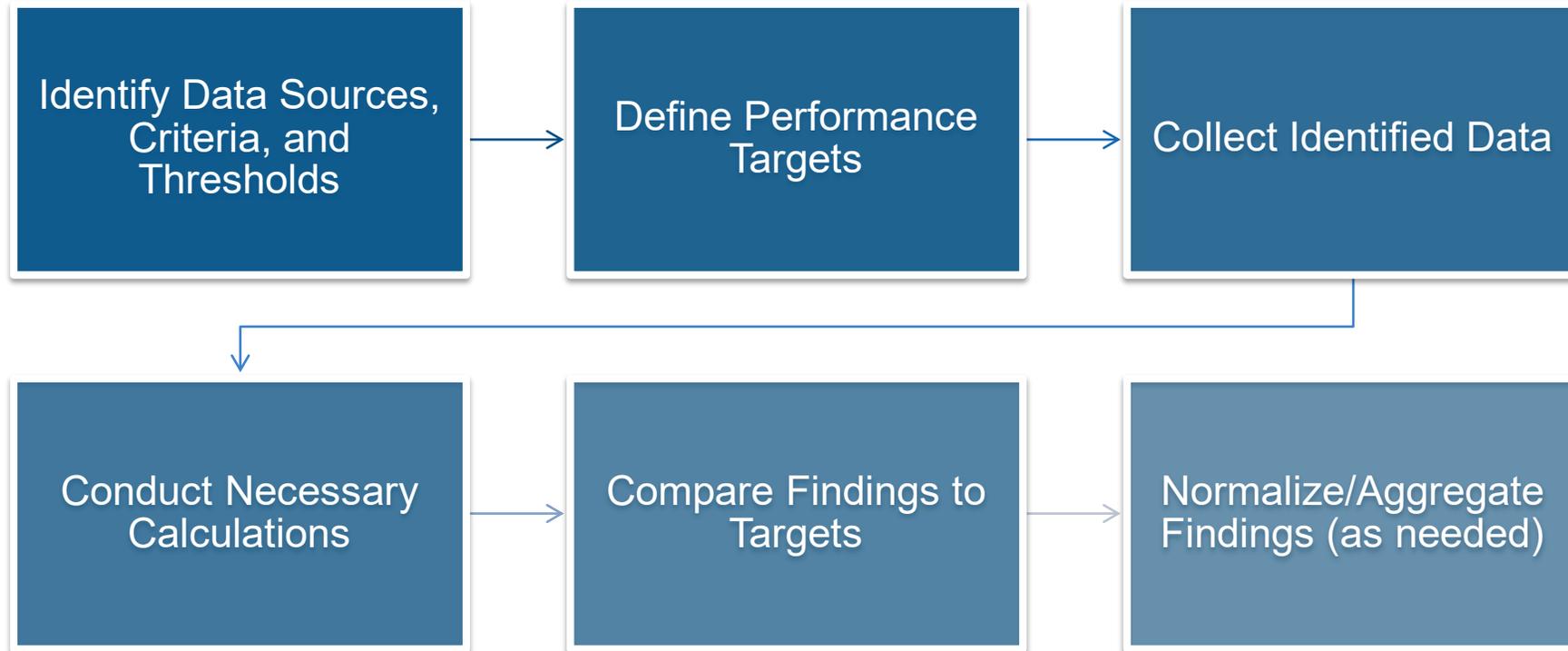
Material usage impacted by:

- Storm/Season Severity
- Varying LOS
- Proactive Approaches (e.g., treated salt, anti-icing and pre-wetting)
- Computerized Dispensing Equipment
- Equipment calibration
- Yearly weather patterns



Nj.gov

Step 4 - General Approach to Analysis (varies by measure)



Severity Index

Severity is fundamental to many of the performance measures and used by agencies to classify individual events and the winter season

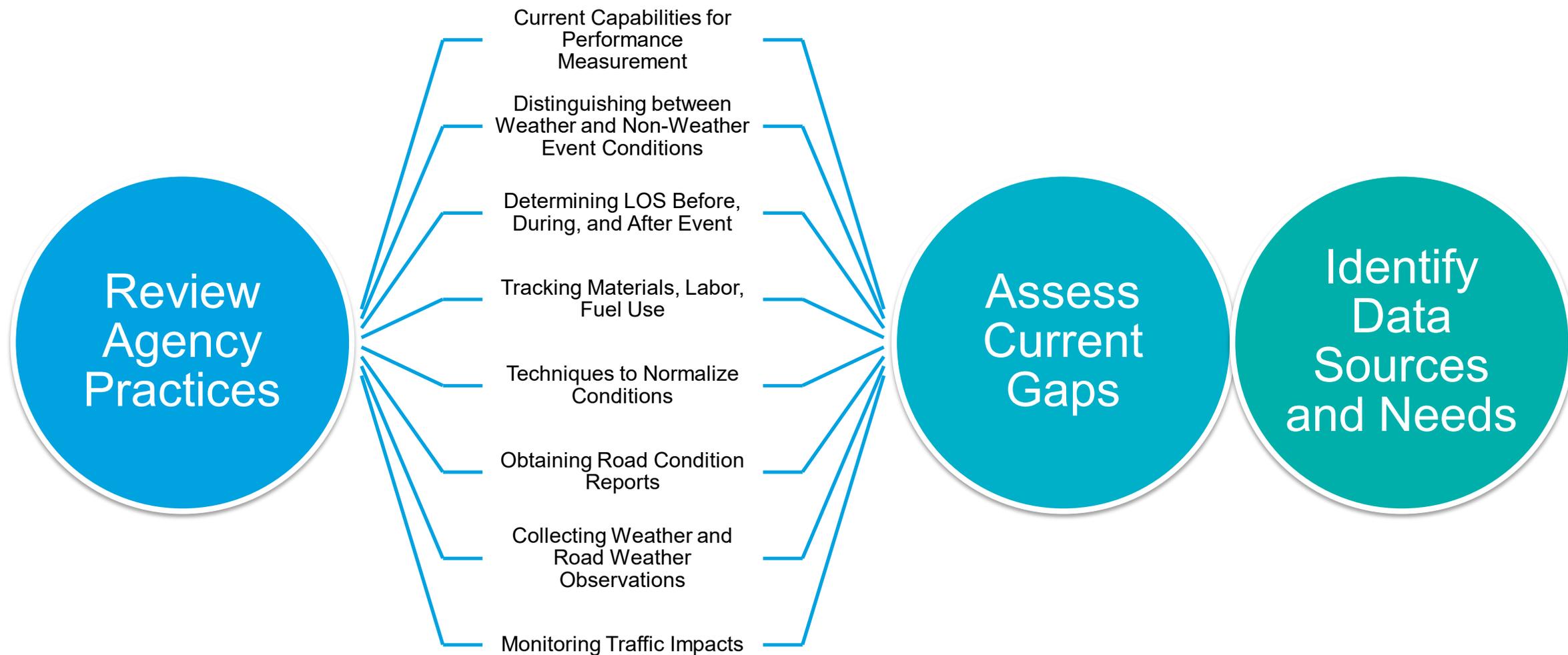
Storm Severity Index (SSI) Elements

- Storm Type
- Temperature
- Precipitation
- Drift
- Wind
- Visibility
- Forward Speed
- Area Covered
- Storm Behavior
- Topography
- Timing
- Duration (weather-hours)

Winter Severity Index (WSI) Elements

- Temperature averages and extremes
- Snowfall totals
- Average and highest snow depth
- Duration of winter-weather conditions
- Aggregated value of impact (e.g., economic loss)
- Measured by aggregating, averaging, or normalizing features over the season

Implementing Performance Measures

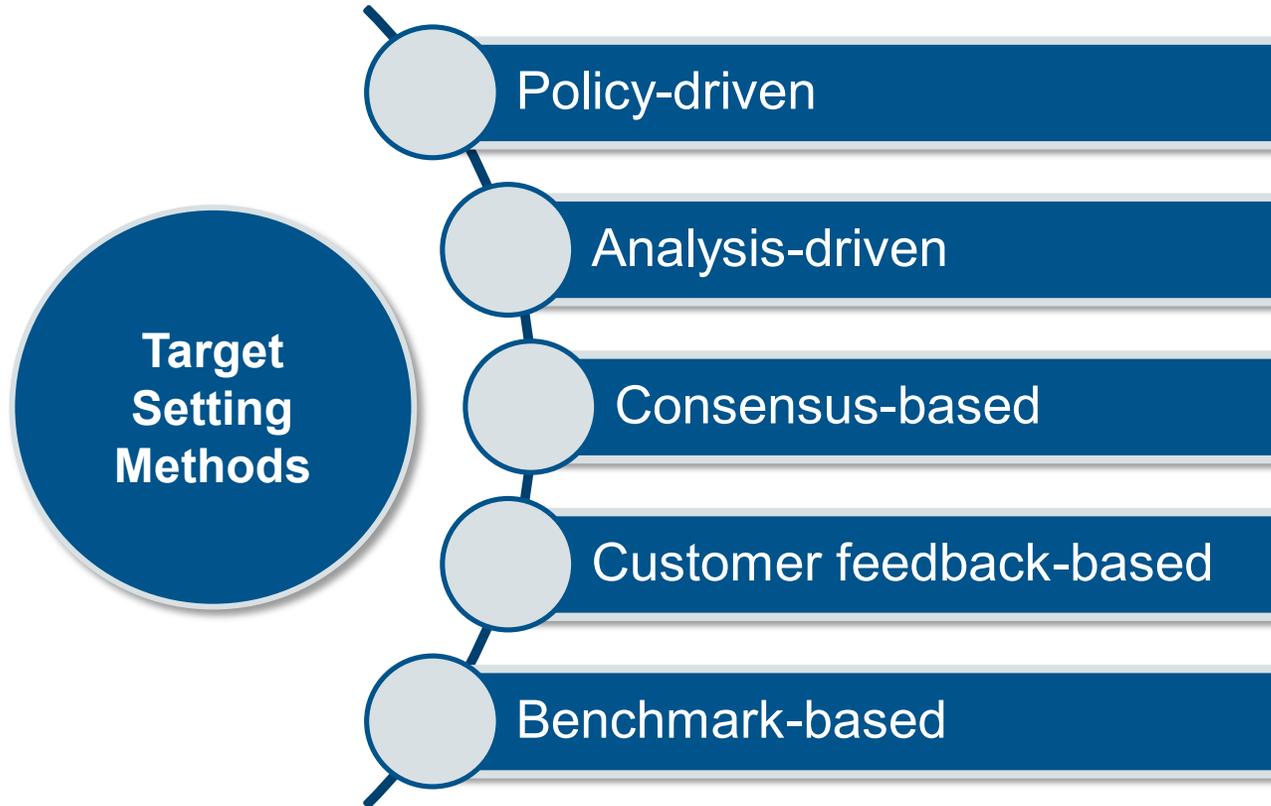


Step 6 – Identify Data Needs and Sources

Key data elements for collection to estimate performance measures:



Step 7 – Set Targets and Establish Baseline



Importance considerations when target setting:

- Timeframes (short, mid, and long-range targets)
- Targets rarely fit neatly into any one method
- Targets will likely involve a combination of approaches

Target Setting Steps



Target Setting – Example 1

Minnesota DOT's Use of Targets

Two primary measures to gauge winter maintenance performance:

- Return to Bare Pavement, targets vary by road classification:
 - Super commuter: 0-3 hours
 - Urban commuter: 2-5 hours
 - Rural commuter: 4-9 hours
 - Primary collector: 6-12 hours
 - Secondary collector: 9-36 hours
- Public Satisfaction, targets:
 - Equal to or greater than 7.0 = satisfaction

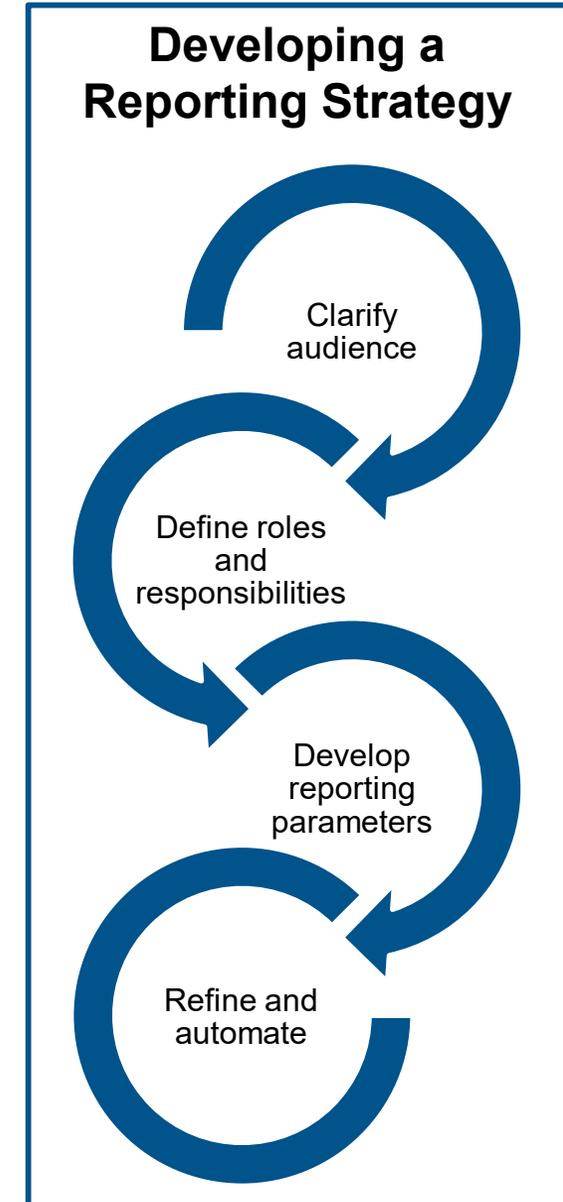


Step 8 – Report Performance

The report should explain how an agency handles snow and ice control

Examples of current DOT reporting include:

- Posting annual reports online with winter maintenance activities
- Producing fact sheets and other materials with activity information
- Having dedicated, publicly available performance reports (e.g., Minnesota, Wisconsin)
- Developing internal data collection and reporting
- Using dashboards to convey info at a high frequency (e.g., Iowa)
- Using advanced analysis and visualization tools (e.g., RITIS)



Step 9 – Integrate into Decision Making

Types of Decisions that Should Be Informed by Performance Measures		Level of Support (high, medium, low, blank- NA)		
		Safety	Mobility	Sustainability
Level 1- High-Level Decision-Maker				
1	Making the case for additional investment	H	H	M
2	Reporting on the cost effectiveness of current responses	M	M	H
3	Gaining public and other decision-makers' support for program	H	H	M
4	Improving decision-making with respect to budgeting and programming funds			H
Level 2- Statewide/Regional Operations/Maintenance Leads				
5	Maintaining adequate winter mobility in the state		H	
6	Supporting better allocation of funds between regions/districts	H	H	H
7	Managing performance of contracted services		H	
8	Optimizing material management (balancing available supply and demand)			H
9	Minimizing environmental impacts			H
10	Supporting workforce development			H
11	Supporting traveler information and emergency declarations		H	
12	Supporting asset equipment maintenance decisions			H
Level 3- Field Maintenance Supervisors				
13	Supporting strategic decision-making for event preparation and response	H	H	
14	Supporting tactical strategies on where and how to respond	H	H	
15	Improving the ability to relate crew performance to level of service		H	H
16	Providing effective feedback to field personnel on their performance	H	H	H

Step 10 – Evaluate and Improve

- **Performance measures are not static**
 - Measures should be modified along with mission, goals, objectives, and institutional capabilities
 - Increased capabilities result in more comprehensive measures which result in informed decisions
- **Targets should be regularly assessed and revised**
 - Targets may need to change as agencies progress towards their objectives
 - Re-examine targets annual or biennially to determine how realistic they are
 - Adjustments should be based on agency performance and customer satisfaction
- **Performance improvements can occur each season**
 - Continuously improve agency capabilities in data collection, analysis, and reporting
 - Improve collaboration between fleet operators, managers, and decision makers
 - Invest in data and technology and staff training

Key Recommendations

Use weather "events" as the starting point

- Allows for greater flexibility in the definition of performance measures.
- Consistency across the agency's jurisdiction is more important than the definition itself.
- Data collection, aggregation and analysis can be tied to specific points in the event timeline (before, during, and after the event ends).

Develop both a "storm severity" and a "seasonal severity" index

- The value of a performance measurement is greatly enhanced by pairing it with severity both at the event and seasonal level.
- The effectiveness of a severity index is simply determined by its degree of correlation with the maintenance response.

Key Recommendations

Pick a consistent LOS and recovery criteria and how it is measured across the agency

- Subjectivity is unavoidable in snow and ice performance measurement.
- There likely is no “correct or universally applicable” LOS or recovery standard nationally.
- Defining how these are measured can be made more consistent within the agency.

Report performance information

- This allows regional and county staff to compare resource use with that of their peers.
- DOTs develop annual performance measurement reports, fact sheets and other publications that provide information about winter storm maintenance activities.
- This type of report gathers data to help agencies identify good performance as well as areas that need improvement.

Today's Speakers

- Deepak Gopalakrishna, *ICF*,
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 - Jeremy Schroeder, *Atheny
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