Electric Utilities: Navigating the Water Crisis

Discussion Document

Summer 2008

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Recent Headlines

3/5 - Severe, Extended Droughts Seen for Colorado River Basin, *Engineering News-Record*

7/17 - DOE Laboratories Join Forces to Address Water-Energy Issues, NETL Press Release

10/3 - Without Water Magic, We Could Have a Western Wasteland , *Engineering News-Record*

12/3 - Southeast Utilities Remain Confident in Their Ability to Outlast Drought, SNLi

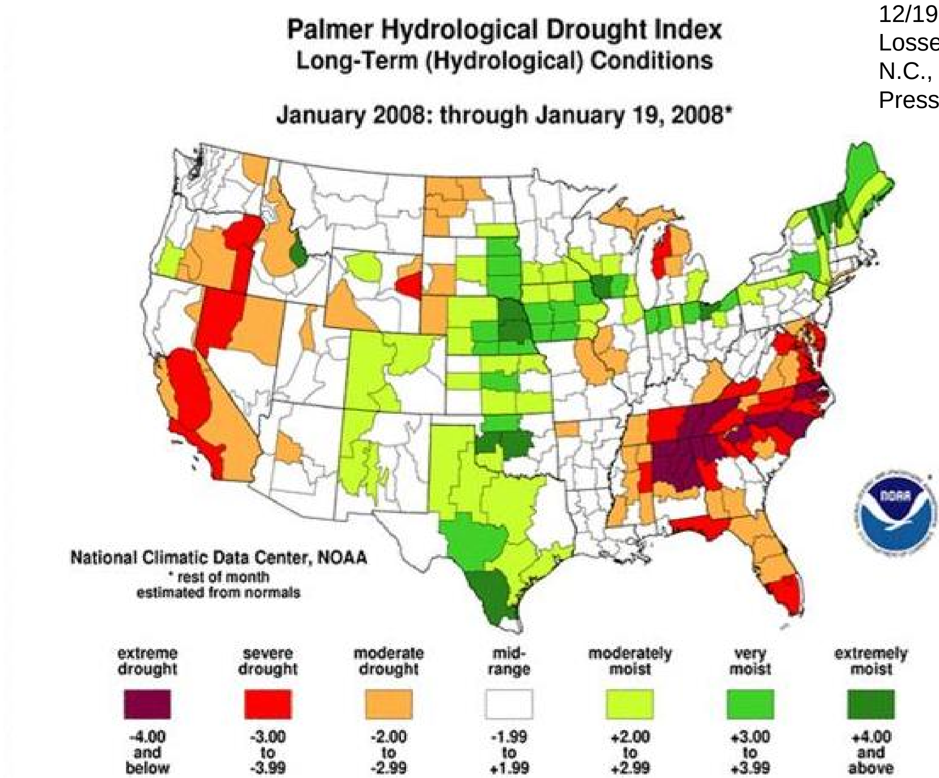
12/18 - Dried Up: The Southeast's Desperate Bid for a Drought Solution, *Newsweek*

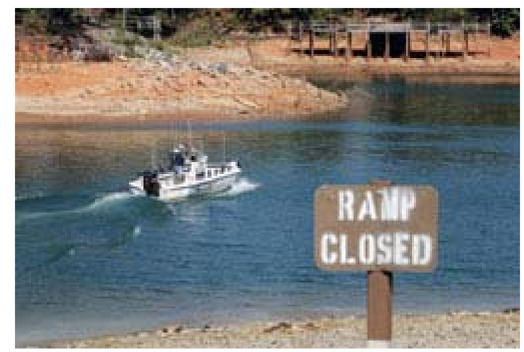
12/18 - California Hopes Storms Ease Drought, *Associated Press*

12/19 - Drought Losses Massive in N.C., Associated Press

12/20 - $600 million in Drought Aid for Nation's Farmers, *Atlanta Journal-Constitution*

January 2007 — **June 2007** — **January 2008**





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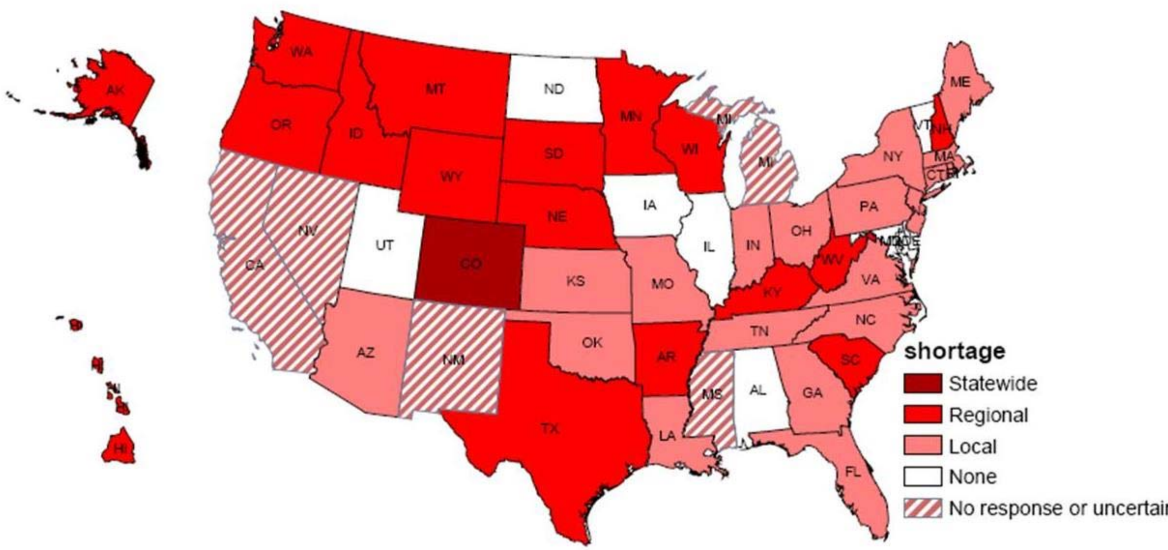
Water Shortages are Forecast to Continue

We have probably not yet seen the worst of the drought conditions…and there are no “silver bullet” solutions on the horizon

- The Southwest and Northwest, two of the fastest growing regions, have low precipitation and growing water concerns
- Population (and consequently, load) growth in these regions, combined with the electric industry's reliance on surface water, presents a distinct risk
- Surface water sources, many of which have been hard-hit in the recent droughts, are unlikely to recover quickly
- Construction of new reservoirs is limited due to a combination of environmental pressures and dwindling sites
- Alternative technologies, such as air- and hybrid-cooled technologies, present significant technical and physical implementation barriers



Survey of Likely Water Shortages Over the Next Decade Under Average Conditions (GAO, 2003)

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Energy-Water Conflicts Have Already Started

Energy-water conflicts have always been a concern but have increased in frequency during the last five years

1. Browns Ferry Nuclear Power Plant, part of the TVA complex on the Tennessee River, often experiences warm river flows, such that the temperature of the water at the plant's cooling intakes often approaches or exceeds the Alabama water quality criterion of 86°F, nearly the plant's discharge limit of 90°F (Curlee and Sale, 2003; Gibson, 2006).
2. Washoe County, Nevada residents expressed opposition to a proposed coal-fired power plant's planned water use (*Reno Gazette-Journal*, 2005).
3. A proposed coal-fired power plant on Lake Michigan (Wisconsin shore) is strongly opposed by environmental groups because of potential effects of the facility's cooling water-intake structures on the lake's aquatic life (*Milwaukee Journal Sentinel*, 2005).
4. Low water on the Missouri River leads to high pumping energy, blocked screens, lower efficiency, load reduction, or shutdown at power plants (Kruse and Womack, 2004).
5. Georgia Power lost a bid to draw water from the Chattahoochee River for power plant cooling (Hoffman, 2004).
6. A New York Entergy plant was required to install a closed-cycle cooling water system to prevent fish deaths resulting from operation of its once-through cooling water system (Clean Air Task Force, 2004).
7. Hot discharge water from the Brayton Point coal plant on the Massachusetts/Rhode Island border cited by EPA as contributing to an 87 percent reduction in fin fish in Mt. Hope Bay; EPA mandates a 94% reduction water withdrawal, replacing seawater cooling with freshwater cooling towers (Clean Air Task Force, 2004).
8. University of Texas researchers said power plants would have to curtail production if 20th century drought conditions recurred (Clean Air Task Force, 2004).
9. As a result of the 1999 drought, water-dependent industries along the Susquehanna reported difficulty getting sufficient water supplies to meet operational needs (GAO, 2003).
10. The Tennessee governor imposed a moratorium in 2002 on the installation of new merchant power plants because of cooling constraints (Curlee and Sale, 2003).
11. Southern States Energy Board-member states cited water availability as a key factor in the permitting process for new merchant power plants (Feldman and Routhe, 2003).
12. The South Dakota governor called for a summit to discuss drought-induced low flows on the Missouri River and the impacts on irrigation, drinking-water systems, and power plants (U.S. Water News Online, 2003).
13. Arizona rejected permitting for a proposed power plant because of potential impact on a local aquifer (*Tucson Citizen*, 2002).
14. Idaho opposed to proposed power plants because of impact on aquifer (U.S. Water News Online, 2002).

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Both Methods of Generation Cooling Are Vulnerable to Drought

Two cooling system designs are prevalent in the United States today: open loop (or once-through) and closed loop. Neither cooling system is advantageous in drought conditions: open loop systems have high withdrawal rates and closed loop systems have high consumption rates

Fuel and Plant Type	Cooling Process	Water Intensity (gal/MWh)			
		Steam Condensing			Other Use
		Withdrawal	Consumption	Consumption / Withdrawal (%)	Withdrawal / Consumption
Fossil, Biomass, or Waste Fired Steam Generation	OL	20,000 – 50,000	~300	1 – 2%	~30
	CL + Tower	300 – 600	300 – 480	80 -100%	
	CL + Pond	500 – 600	~480	80 – 96%	
	Dry	0	0	n/a	
Nuclear	OL	25,000 – 60,000	~400	1 – 2%	~30
	CL + Tower	500 – 1,100	400 – 720	65 – 90%	
	CL + Pond	800 – 1,100	~720	65 – 90%	
	Dry	0	0	n/a	
Natural Gas Combined Cycle	OL	7,500 – 20,000	100	<1%	7 – 10
	CL + Tower	~230	~180	78%	
	Dry	0	0	n/a	
Coal Integrated Gasification (IGCC)	CL + Tower	~250	~200	80%	7 – 10 + 130 (process water)

Notes; OL=open loop, CL= closed loop; Other Uses include cooling loads for turbines, equipment washing and hygiene

- Thermoelectric generation withdraws about 136 billion gallons of water per day and consumes 3.3 billion gallons per day
- A typical combined cycle plant[1] with a closed loop system and cooling tower will withdraw 1.8 million gallons of water and consume 1.4 million gallons every day – the equivalent of filling and draining more than *two* Olympic sized swimming pools
- Withdrawal and consumption needs are higher with scrubbers and/or CO_2 capture
  - Wet scrubbers being added to existing coal-fired generation for SO_2 control will increase withdrawal and consumption by about 5 percent
  - CO_2 capture, if widely adopted, could increase withdrawals by 1.7 to 4.1 billion gallons per day
- In addition to generation concerns, coal mining consumes 70– 60 million gallons of water per day

[1]Assumes a 550MW plant running at 60% capacity and producing 7,920 MWhs

Energy Demands on Water Resources, Report to Congress, US. Dept. of Energy, 12/2006; NETL Issue Note, 9/26/07

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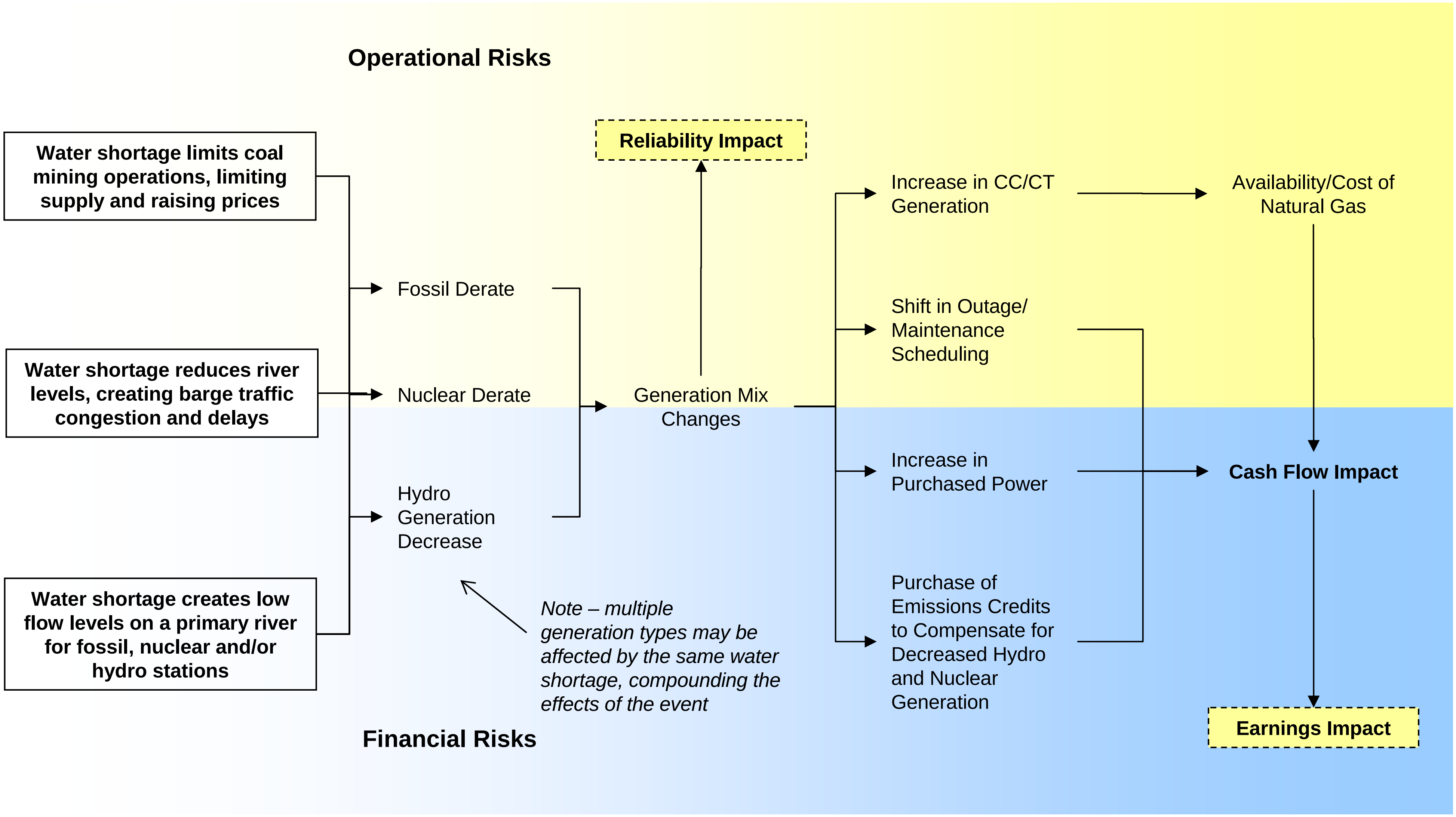
Risks to the Electric Utility – Illustrative Example

A water shortage presents both operational and financial risks to an electric utility, therefore mitigation strategies should be established to deal with both risks.



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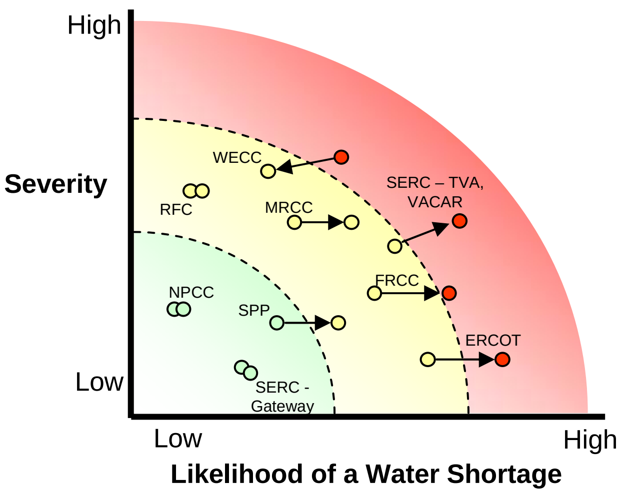
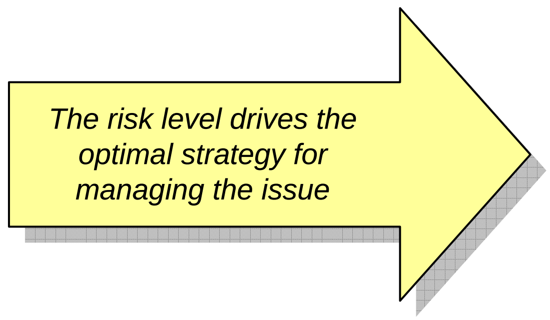
The ScottMadden Risk Preparedness Model

The ScottMadden Risk Preparedness Model helps calibrate organizational readiness to specific challenges and provides the foundation for further mitigation strategy analysis

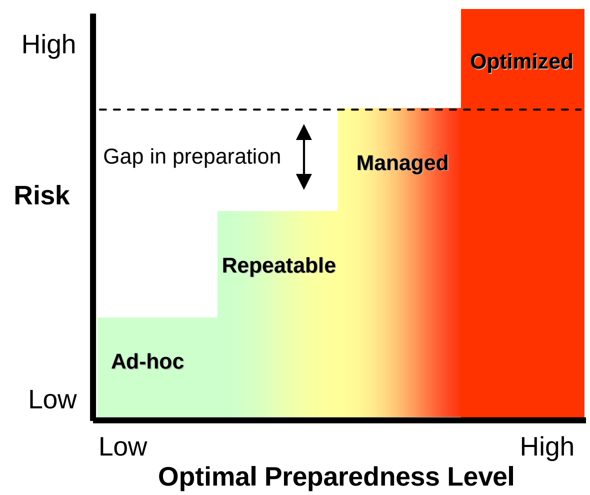
First, an assessment is made to determine what level of risk a utility is facing

…then, depending on the risk, an appropriate readiness level is targeted





Note: Background color indicates appropriate preparedness level



For water risks, mitigation is primarily designed to create flexibility to react creatively to events rather than to prevent them

Ad-hoc

- No formal mitigation strategy
- No alternative generation sources identified
- Reliance on individual initiatives and smart people
- "Just do it" approach
- No measurements or evaluations

Repeatable

- Mitigation strategy by plant only
- No alternative generation sources identified
- Some processes documented for key activities
- Metrics established by plant, department
- Water issue appears on risk map
- Independent departmental response to water risk

Managed

- Integrated mitigation strategy by group/generation type
- Alternative generation sources established
- Tightly integrated processes across the organization
- Metrics integrated across each group

Optimized

- Fully integrated mitigation strategy across the enterprise
- Alternative generation sources secured
- World-class processes are competitive advantages
- Leading and lagging performance metrics established for the organization

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Project Approach - Risk Preparedness Assessment

The sustained water shortage creates the need to place water accurately on the risk map and assess the organization's readiness to respond

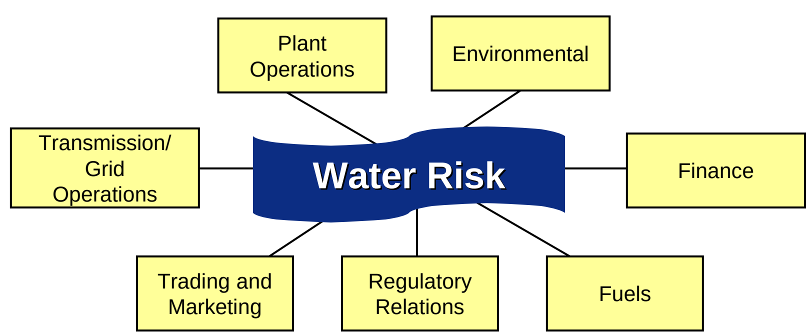
Key Tasks

- Identify current water risks along the power generation value chain
  - Fuel
  - Production
  - Purchased power
  - Key bodies of water
- Assess organizational preparedness to respond to water risk
  - Roles and responsibilities
  - Measures
  - Process (communications, decision making)
  - Organization
- Review current mitigation plans and identify gaps
- Prepare recommendations to close gaps
- Prepare implementation plan for next steps

Deliverables

- Risk map assessment of water shortage
- Organizational preparedness assessment
- Key gaps
- Recommended actions and mini business cases to close gaps
- Implementation plan

Water risk preparedness will require cooperation and integrated planning from a number of organizations….



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Typical Schedule - Risk Preparedness Assessment

Task	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
1. Planning and Organization ◆ *Finalize scope* ◆ *Identify data needs* ◆ *Schedule interviews and update meetings*						
2. Risk and Preparedness Assessment ◆ *Conduct interviews and review available documentation* ◆ *Develop organizational preparedness assessment* ◆ *Identify gaps relative to risks* ◆ *Identify primary risks and exposure*						
3. Opportunity Identification ◆ *Identify and prioritize mitigation alternatives* ◆ *Identify actions required to achieve improvements* ◆ *Prepare "mini" business cases to support recommended mitigation actions* ◆ *Prepare high-level project plan for next steps*						

- Project takes four to six weeks, depending on finalized scope
- Begins with interviews with key internal stakeholders (typically 15 to 20 interviews)
- Includes a review of internal strategy, commitments, requirements, plans, reporting, and other internal documentation
- Is conducted by small project team comprised of senior-level consultants working collaboratively with key client personnel

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