Ripple Effects: Water Risk and Resilience Across the Semiconductor Value Chain

A Global Insights Report
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About This Report

The SEMI Environmental Risk Mitigation and Reporting (ERMR) Working Group, established in January 2023, aims to develop a baseline and roadmap of best practices for identifying, managing, governing and reporting climate, water, and biodiversity risks across the semiconductor value chain.

This insights report — the second in a series by SEMI's ERMR Working Group[1] — presents a comprehensive assessment of water-related risks across the global semiconductor value chain. By analyzing 140 semiconductor production facilities across 89 unique water basins worldwide using Waterplan's AI-powered multi-indicator risk engine, the report establishes the first global baseline of water risk hotspots in the semiconductor sector. Beyond identifying these hotspots, it explores the industry's opportunities, gaps, and challenges in water risk assessment and management, offering actionable recommendations and best practices to advance corporate water resilience and stewardship. Designed to elevate water risk as a strategic business concern, the report aims to guide future investigations and inform risk mitigation strategies across operations and supply chains.

We anticipate that the insights from this report will benefit a diverse range of stakeholders, including:

- **Corporate sustainability professionals** developing and implementing initiatives related to water risk assessment, management, governance, and reporting.
- **Enterprise risk management professionals** evaluating operational, supply chain, regulatory, reputational, and other business risks tied to water resource security in critical operations.
- **Business continuity planners** focused on creating systems to prevent and recover from water-related threats to company operations.
- **Procurement and supply chain managers** seeking to embed water risk criteria into their sourcing and supply chain processes.
- **Advocacy, academic, and civil society organizations** aiming to understand the relationship between water risks and the intricate semiconductor supply chain.
- **Policymakers and regulators** integrating water risk considerations into regulations affecting semiconductor and other industrial water users.
- **Consultants and advisors** providing guidance and expertise around water-related matters.

[1] SEMI's Environmental Risk Mitigation and Reporting Working Group published its inaugural report in 2024. You can access the full report here: https://discover.semi.org/rs/320-QBB-055/images/SEMI-Nasdaq-Whitepaper-FINAL.pdf.

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Executive Summary

Key Insight 1: Water risk presents financially material impacts across the semiconductor value chain, demanding close and proactive attention.[2]

Water risk extends beyond declining water availability and includes flooding, water quality degradation, water infrastructure vulnerabilities, local regulatory challenges, and reputational issues. These risks pose serious threats to business continuity, triggering idle time, recovery costs, delivery delays, and revenue loss, which in turn cause cascading impacts across global supply chains.

S&P Global projects that by 2050, water-related risks — including stress, drought, and flooding — could cost the world's largest Information Technology (IT) companies in the S&P Global 1200 index up to $24 billion annually. As a result, water security is emerging as a critical driver of credit profiles in the semiconductor sector.

In our analysis, we identified flooding and reputational water-related risks as the most significant threats to the semiconductor value chain compared to other water risk types. Specifically, frequent flooding and strained relationships with local communities due to water allocation conflicts are concerns in major semiconductor hubs that are significant consumers of water, like Taiwan, Shanghai and Xi'an of China, South Korea, and parts of the U.S., including Arizona and California.

While the semiconductor industry is frequently scrutinized for its high water usage, only 16% of the sites analyzed in this study are currently affected by water scarcity. However, as climate change and infrastructure strain intensify water-related challenges, the frequency and severity of disruptions may increasingly exceed the scope of existing contingency and business continuity plans. Notably, over 40% of facilities announced since 2021 are located in watersheds projected to face high or extremely high water stress between 2030 and 2040, underscoring the urgency of forward-looking risk modeling to anticipate and mitigate future vulnerabilities.

Integrating water risk assessment into new site planning and due diligence can help ensure both short- and long-term operational resilience and foster strong relationships with local communities and stakeholders. Additionally, collaboration between insurers and industry to co-develop tailored solutions can play a critical role in addressing vulnerabilities at key points in the value chain.

[2] *Note:* This executive summary presents key insights from the full analysis. References and supporting data are provided in the section 'Key Insights' of this report.

Key Insight 2: Limited disclosure of supplier-level water data can hinder effective risk management across the semiconductor value chain.

While many companies perform annual water accounting and water risk assessments for their own direct operations, there is no comprehensive approach to supplier-specific water data reporting, target setting, and water risk management within the supply chain.[3] According to the 2024 CDP Water Report, 1 in 5 companies reported US$77 billion under threat because of water-related risks within their supply chain. However, only half of those companies engage with their suppliers on water issues.

Limited transparency in water-related disclosures from suppliers prevents companies from effectively managing risks across their full value chain and prioritizing actions that strengthen long-term business resilience. For semiconductor end users, these risks often lie deep within multi-tiered supplier networks, requiring engagement beyond direct suppliers. Despite growing awareness of water vulnerabilities, supplier engagement remains fragmented and largely reactive. Many suppliers operate in regions facing severe water stress or flood risks, yet they often lack the resources or incentives to adopt robust water stewardship practices. The 2025 CDP Disclosure Dividend Report reveals that only 35% of companies engaging Tier 1 suppliers on water-related issues support supplier capacity building, 20% invest in innovation, and only 9% offer financial incentives. CDP data show that this limited engagement presents a significant opportunity to strengthen supplier collaboration and unlock strategic and financial value, with potential returns on investment reaching up to 21:1.

While CDP, GRI, SASB and other existing voluntary disclosure frameworks and standards provide a foundation for water-related reporting, the absence of sector-specific water data frameworks and industry-wide benchmarks makes it difficult for companies across the semiconductor value chain to compare supplier performance or identify high-risk suppliers. Pre-competitive initiatives to exchange water data, co-develop supplier training programs, and collaborate on regional water resilience projects, can help address existing disclosure gaps.

There is also a strategic opportunity to strengthen inter-company collaboration between sustainability, procurement, and supply chain planning teams. The 2024 CDP Water Report highlights that 118 companies across various industries incorporate

[3] Water data requests are occurring in both directions — semiconductor design and manufacturing companies are being asked to provide data to their customers (i.e., semiconductor end users), while also seeking data from their upstream suppliers, including foundries, equipment manufacturers, and chemicals and materials providers.

progress toward corporate water targets into the remuneration policies for their Chief Procurement Officers. This approach not only reinforces accountability and cross-functional alignment, but it also elevates water stewardship as a strategic priority across the organization.

Key Insight 3: Managing water risks requires localized assessments and awareness of contextual impacts and dependencies that shape regional vulnerability.

Contextual water-related risks stem from a facility's dependence on local water availability, quality, and infrastructure, as well as catchment-level dynamics, such as competing demands, regulatory pressures, and community expectations — all of which influence long-term water security.

As businesses increasingly embrace science-based sustainability strategies, several frameworks offer structured methodologies to support contextual water stewardship:

- **Alliance for Water Stewardship (AWS):** A site-level framework focused on catchment-based water risk assessment and stakeholder collaboration;
- **Task Force on Nature-related Financial Disclosures (TNFD):** Offers the LEAP framework — Locate, Evaluate, Assess, Prepare — to identify, assess, and disclose nature-related risks, including water;
- **Science Based Targets for Nature (SBTN):** Enables companies to set freshwater targets aligned with ecological limits, emphasizing full value chain assessments and place-based action.
- **Water Resilience Coalition's Net Positive Water Impact (NPWI):** Encourages companies to contribute more to basin health than they impact, addressing water availability, quality, and accessibility;

This contextual approach distinguishes operational water management from corporate water stewardship by encouraging companies to look beyond their own operations and consider the broader catchment-level dynamics. It also highlights the importance of engaging with local stakeholders — including regulators, utilities, and communities — to proactively address emerging risks and build partnerships.

From the 2025 WWF's and GlobeScan's Shaping the Future Water Agenda report, there is also a strong consensus on the need for greater alignment and integration of water-related sustainability efforts with climate action and nature-based solutions. Programs addressing water, climate, and nature are often developed in isolation, overlooking critical inter-dependencies and leading to missed co-benefits and unintended trade-offs. The report emphasizes that climate adaptation and resilience require more attention, with water and nature playing central roles in effective solutions. Importantly, water risks are dynamic and can intensify over time due to climate change, land use change, urban development and population growth, as well as evolving regulatory frameworks. A forward-looking, catchment-based approach to water stewardship is, therefore, essential for safeguarding regional water security.

Key Insight 4: Coordinated water stewardship should be embedded into corporate sustainability strategies to drive proactive engagement and collective action.

Companies in the semiconductor value chain are deeply interconnected, often sharing suppliers within the same water basins, creating a strategic opportunity for collective water stewardship. Collective action can be defined as a collaborative framework involving stakeholders with complementary roles, who leverage knowledge, resources, and expertise to jointly identify and implement solutions to shared freshwater challenges across geographic scales. Because water is a shared resource, collective action is essential to deliver the scale, reach, and urgency needed to tackle common water challenges within catchments.

While sector-specific efforts, particularly around PFAS (perfluoroalkyl and polyfluoroalkyl substances), are gaining traction through initiatives like the Semiconductor PFAS Consortium and the SEMI PFAS Initiative, broader partnerships are still emerging. Survey data from SEMI members show that companies in regions like the U.S. and Taiwan face water supply risks linked to aging infrastructure, yet collaboration with local utilities remains limited.

The 2024 report "Unpacking Collective Action in Water Stewardship", published by WWF and other water experts, recommends that companies scale their impact by engaging across multiple levels:

- Globally, by harmonizing fragmented dialogues;
- Within sectors, by moving beyond isolated company efforts;
- Across sectors, by addressing shared challenges in co-located industries;
- Through public-private partnerships aligned with policy goals;
- At the catchment level, rather than through isolated projects.

Initiatives like the Alliance for Water Stewardship (AWS), the Responsible Business Alliance (RBA), and the CEO Water Mandate's Water Resilience Coalition have been developing standards and tools, and have been providing best practice examples for advancing collective action in high-opportunity catchments. Best practice examples from other industries can also serve as valuable blueprints for water-intensive sectors, including semiconductors. For example, WWF's Collective Action Programs in the apparel and textile sector showcase how collaboration among corporate partners, governments, financial institutions, and civil society can drive basin-level water stewardship, delivering measurable water savings, restoring freshwater habitats, advancing green financing, and scaling wastewater reuse through on-the-ground projects.

Beyond industry collaboration, proactive engagement with policymakers and transparent communication with regulators, communities, and industry groups are essential. These efforts build trust, foster peer learning, and help standardize water stewardship practices across sectors. They also position companies to align with emerging regulations, such as the EU Corporate Sustainability Reporting Directive (CSRD) and Corporate Sustainability Due Diligence Directive (CSDDD). Broader policy frameworks, such as the European Water Resilience Strategy, can further reinforce and scale corporate water initiatives, ensuring they are both impactful and future-ready.

Key Insight 5: Innovation and technology should play a central role in advancing water stewardship across the semiconductor supply chain.

The semiconductor industry is uniquely positioned to harness innovation and technology to mitigate water risks and advance stewardship across its supply chain. However, progress is often hindered by systemic underinvestment in water resource management, driven by complex political, regulatory, and governance challenges, as well as financial constraints, including high upfront costs, extended payback periods, and limited opportunities for monetization.

At the heart of these issues lies the widespread undervaluation and mispricing of water. Undervaluation of water technologies, from wastewater treatment plants and pipelines to digital water-related services, reflects the failure to recognize the full social, environmental, and economic value of water, often due to the perception of water as being abundant and free. Mispricing results from overlooking the true costs of supply and environmental impacts, leading to weak market signals and inefficient use. Together, these dynamics reinforce each other, perpetuating underinvestment and exacerbating the global water crisis. For instance, out of US$58.5 billion invested in climate tech globally in 2021, less than 1% was allocated for water tech. Addressing water pricing is, therefore, critical to unlocking sustainable investment and responsible management.

Based on self-reported survey results[4], semiconductor companies are deploying advanced water management solutions, including onsite recycling systems, real-time water monitoring, and predictive analytics, to detect leaks early and optimize efficiency across operations. In water-scarce regions, companies are increasingly turning to alternative sources, such as municipal wastewater, and repurposing process-based wastewater to support other operational needs. By embracing Artificial Intelligence (AI) driven systems for real-time monitoring, scenario modeling, and catchment-level risk forecasting, companies can further enhance their adaptive capacity and guide mitigation strategies using both global datasets and local indicators. Additionally, investing in green infrastructure, such as rain gardens, bioswales, green roofs, permeable pavements, artificial wetlands, and sponge cities, can mitigate water-related risks while delivering environmental co-benefits, such as reduced urban heat and improved air quality.

Unlocking investments in water-focused innovations not only strengthens resilience within direct operations but also promotes technology adoption among suppliers, fostering broader water stewardship across the value chain. By enabling cross-industry collaboration and sharing best practices, organizations can accelerate progress and cultivate a culture of continuous improvement, creating a ripple effect of enhanced water stewardship throughout the entire value chain.

[4] Written surveys were completed by 11 SEMI ERMR member companies.

1. Water Risk: A Critical Business Challenge for the Semiconductor Value Chain

Semiconductors underpin a vast array of critical technologies — from communications and power generation to artificial intelligence (AI), electric and autonomous vehicles, robotics, healthcare, military systems, and quantum and cloud computing. Disruptions or slowdowns in semiconductor manufacturing can trigger widespread consequences across global industries and markets.[5]

Beyond its critical role in modern technology and national security, the semiconductor sector is also among the most resource-intensive industries globally, with substantial dependencies on water, energy, and raw materials. Among its critical inputs, water stands out due to its vast consumption — a single fabrication plant can use up to 10 million gallons of water per day, equivalent to the daily water consumption of a city with 300,000 residents.[6] At the global level, water consumption across semiconductor manufacturing operations is estimated to reach approximately 264 billion gallons annually, underscoring the sector's significant impact on freshwater resources.[7] Specifically, ultrapure water (UPW), purified to the strictest standards, is essential for cleaning and rinsing silicon wafers, as well as for etching and other precision chemical processes. Even minor fluctuations in water quality can compromise product integrity, making consistent access to high-quality water a non-negotiable requirement for operational reliability.

The quality of wastewater can pose not only a significant environmental but also a regulatory risk. In semiconductor manufacturing, wastewater often contains PFAS (perfluoroalkyl and polyfluoroalkyl substances), a group of persistent synthetic chemicals widely used in semiconductor manufacturing, that pose significant environmental and health risks. Toxic metal pollutants generated by wastewater from semiconductor production — including barium, copper, manganese, and chromium — are regulated under both existing and emerging regulations.[8]

[5] BCG & Semiconductor Industry Association. 2021. Strengthening the Global Semiconductor Supply Chain in an Uncertain Era. https://www.bcg.com/publications/2021/strengthening-the-global-semiconductor-supply-chain

[6] Puisor, V. 2025. Managing the Impact of Semiconductor Manufacturers' Use of Freshwater. Semiconductor Digest. https://www.semiconductor-digest.com/managing-the-impact-of-semiconductor-manufacturers-use-of-freshwater/

[7] Jones, C. 2022. Water Supply Challenges for the Semiconductor Industry. Semiconductor Digest. https://www.semiconductor-digest.com/water-supply-challenges-for-the-semiconductor-industry/

[8] Ceres. 2022. The global assessment of private sector impacts on water. https://www.ceres.org/resources/reports/global-assessment-private-sector-impacts-water

Water-related impacts extend beyond manufacturing to the use phase of semiconductors. The exponential growth of AI is driving the proliferation of data centers, which are among the top ten water users in the industrial and commercial sectors in America.[9,10] They consume large volumes of water for cooling and humidification, and the quality of source water directly impacts cooling efficiency and the potential for water reuse. Poor water quality also increases the frequency of blowdown events, which require treatment or responsible disposal. By 2028, the total annual onsite water consumption by U.S. data centers could increase two to four times compared to 2023 levels, potentially reaching 150 to 280 billion liters.[9] As demand for data centers grows, this surge in water usage is poised to intensify pressure on already strained water infrastructure.

The indirect, embodied water footprint of data centers — primarily tied to electricity generation — can be even more substantial than direct usage. In 2023, U.S. data centers had an estimated indirect water footprint of 800 billion liters, with roughly 20% drawing from watersheds already under moderate to high stress.[9]

Moreover, climate impacts manifest largely through the water cycle, driving more frequent and intense droughts, floods, and rising sea levels. As a result, effective water risk management is essential not only for water resilience but also for broader climate adaptation.[11] This is especially critical in high-impact sectors like semiconductors, where water plays a vital role in both manufacturing processes and supply chain continuity.

Despite the essential role of water, water risk and the embodied and operational water footprint of semiconductors and AI systems have not received significant attention. While some studies have assessed water risks across the ICT industry[12],

[9] Shehabi, A., S. J. Smith, A. Hubbard, A. Newkirk, N. Lei, MAB Siddik, B. Holecek, J. Koomey, E. Masanet, and D. Sartor. 2024. 2024 United States Data Center Energy Usage Report. Energy Analysis and Environmental Impacts Division, Lawrence Berkeley National Laboratory. https://escholarship.org/uc/item/32d6m0d1.

[10] Alliance for Water Stewardship. 2025. Water Stewardship in Data Centres. https://a4ws.org/resource/water-stewardship-in-data-centres/.

[11] The World Bank. 2024. Water Security and Climate Change: Insights from Country Climate and Development Reports. https://www.worldbank.org/en/topic/water/publication/ccdr-water-sector-synthesis.

[12] Alliance for Water Stewardship and WWF. 2021. Water Risk in the ICT Sector: The Case for Action. https://a4ws.org/resource/water-risk-in-the-ict-sector-the-case-for-action/.

specific semiconductor segments[13],[14] or individual companies[15], broader risks remain poorly understood at the semiconductor value chain level.

For many companies, water risk lies deep within complex, transnational supply chains, where their ability to control impacts is often limited. The semiconductor supply chain is among the world's most complex, segmented and international networks. It involves over 1,000 production steps and crosses more than 70 international borders before a final product reaches end customers.[16] No single country holds end-to-end control over the production and supply stages that lead to finished semiconductor chips. Instead, different countries and regions specialize in distinct segments of the value chain, creating a tightly interdependent global ecosystem (Fig. 1).[17]

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[13] Frost, K. and I. Hua. 2017. A Spatially Explicit Assessment of Water Use by the Global Semiconductor Industry. 2017 IEEE Conference on Technologies for Sustainability (SusTech), 12-14. November. https://doi.org/10.1109/SusTech.2017.8333525.

[14] Frost, K., and I. Hua. 2019. Quantifying spatiotemporal impacts of the interaction of water scarcity and water use by the global semiconductor manufacturing industry. Water Resources and Industry 22, 100115, https://doi.org/10.1016/j.wri.2019.100115;

[15] Company-level assessments are discussed, if not fully published, in corporate CDP Water responses, sustainability reports and other disclosures. For example, see TSMC. 2023 Sustainability Report. https://esg.tsmc.com/en-US/file/public/e-all_2023.pdf. Foxconn Hon Hai Technology Group. 2023 Sustainability Report. https://www.foxconn.com/en-us/CSR/csr-report; Samsung. Water Risk Assessment. https://www.samsung.com/global/sustainability/popup/popup_doc/AYUqiWq6CUgAIx_C/.

[16] Alam, S., Chu, T., Lohokare, S., Saito, S., and B., McKinley. 2020. Globality and Complexity of the Semiconductor Ecosystem. Accenture and Global Semiconductor Alliance. https://www.gsaglobal.org/globality-and-complexity-of-the-semiconductor-ecosystem/.

[17] Semiconductor Industry Association (SIA). 2025. State of the U.S. Semiconductor Industry. https://www.semiconductors.org/wp-content/uploads/2025/07/SIA-State-of-the-Industry-Report-2025.pdf.

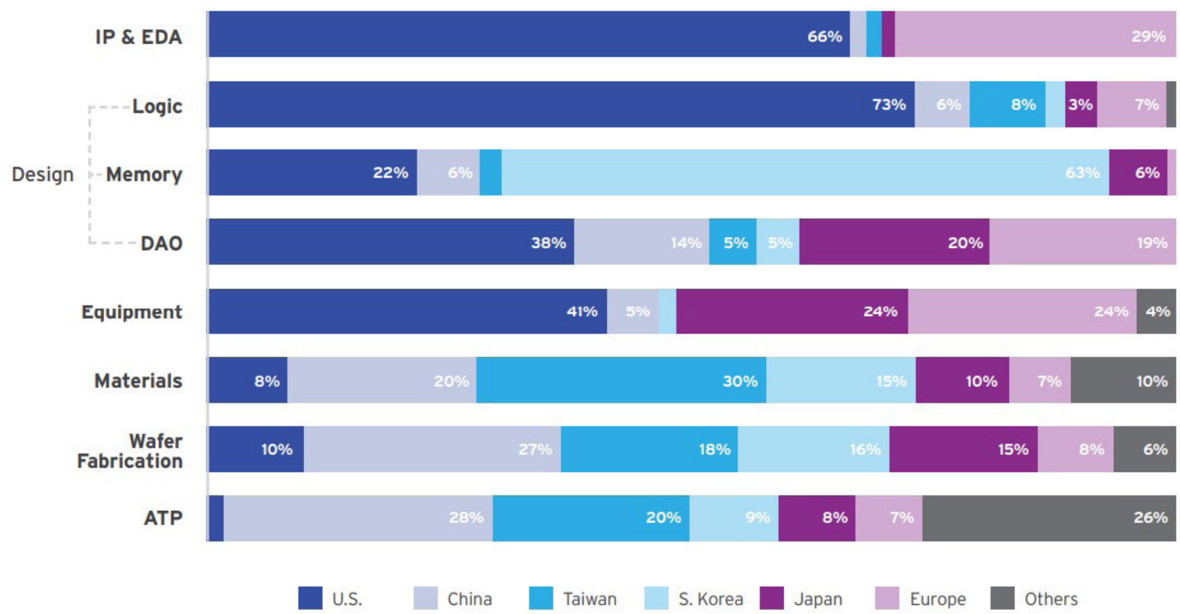

Figure 1. Semiconductor industry value added by activity and region, 2024 (%). Value contributions are based on company revenues and headquarters location for IP (Intellectual Property) & EDA (Electronic Design Automation), design, manufacturing equipment, and raw materials. Wafer fabrication and ATP (Assembly, Testing & Packaging) are measured by installed capacity and the geographic location of production facilities. *(Source: SIA, adapted from IPnest, Wolfe Research, Gartner, SEMI, and BCG analysis).*

The semiconductor industry is structured around a range of distinct business models and capabilities, each responsible for different stages of the value chain — from fabrication to end-user delivery:

- Raw materials extraction and processing
- Electronic design automation and core Intellectual Property (IP)
- Design
- Semiconductor manufacturing equipment
- Fabrication
- Assembly, testing, and packaging (ATP)

According to the 2024 CDP Water Report, 1 in 5 companies reported US$77 billion under threat because of water-related risks within their supply chain. However, only half of those companies engage with their suppliers on water issues.[18] The geographic concentration typical of semiconductor manufacturing introduces even

[18] CDP. 2024. Stewardship at the Source: Driving water action across supply chains. https://www.cdp.net/es/insights/global-water-report-2023. *Note:* The report focuses on 3,163 large companies with an annual revenue of more than US$250 million. These companies disclosed to CDP's annual water security questionnaire in response to a request from investors, in 2023.

greater vulnerability — more than 50 supply chain nodes are dominated by a single region that controls over 65% of the global market share.[19]

As companies expand materiality assessments beyond tier one suppliers, shared water dependencies become more apparent, reshaping how water risk is understood and managed. In this context, stranded asset risks tied to water issues may emerge from both short-term volatility (such as droughts) and long-term changes (including declining water quality or increased stress). Insurance is increasingly recognized as an important tool for enhancing supply chain resilience, yet 81% of semiconductor companies cite limited access to suitable insurance solutions as a major barrier, particularly in addressing risks like water shortages.[20] In response, Alternative Risk Transfer solutions are gaining momentum, offering more flexible coverage options as traditional insurance models struggle to accommodate the substantial financial exposures typical of the semiconductor sector.

[19] BCG and Semiconductor Industry Association. 2021. Strengthening the Global Semiconductor Supply Chain in an Uncertain Era. https://www.bcg.com/publications/2021/strengthening-the-global-semiconductor-supply-chain

[20] Lloyd's. 2023. Loose Connections: Rethinking Semiconductor Supply Chains. https://www.lloyds.com/news-and-insights/futureset/futureset-insights/rethinking-semiconductor-supply-chains.

2. Study Approach

This study adopts a holistic approach to water risk assessment, encompassing a substantial portion of the global semiconductor value chain. The analysis covered 140 semiconductor production sites[21], with location data aggregated at the catchment level, resulting in 89 unique basins.[22] By shifting the lens from individual facilities to the broader hydrological context, the study offers a more comprehensive understanding of water-related risks across diverse geographies.

Rather than evaluating facilities in isolation, the catchment-level methodology enables identification of regional water risk hotspots and supports more targeted mitigation strategies. This approach integrates both quantitative assessments — using scientific datasets and hydrological models — and qualitative insights from company surveys to capture internal vulnerabilities and stakeholder dynamics.

The selected SEMI's ERMR member companies span the full semiconductor value chain and were grouped into five segments for analysis:

- Chemicals and Materials
- Equipment Manufacturing
- Wafer Fabrication (Front-end Fabs and Foundries)
- Back-End Manufacturing (including OSAT and Packaging)
- R&D Labs

This segmentation ensures that water risks are evaluated across upstream, midstream, and downstream operations, providing a nuanced view of how water dependencies and vulnerabilities manifest throughout the value chain.

The first phase of this study involved a comprehensive screening of locations where semiconductor companies and their direct manufacturing suppliers operate. From this screening, eleven locations were selected for deeper, city-level analysis: Austin (USA), Bengaluru (India), Dresden (Germany), Kyoto (Japan), Kanagawa (Japan), Linkou (Taiwan), Mie (Japan), Pyeongtaek (South Korea), San Jose (USA), Suzhou (China), and Xi'an (China).

[21] Location data used in this analysis were provided by companies within the SEMI and the Semiconductor Climate Consortium membership, as well as collected from publicly available sources.

[22] Lehner, B. and Grill G. 2013. Global river hydrography and network routing: baseline data and new approaches to study the world's large river systems. Hydrological Processes, 27(15): 2171-2186. https://doi.org/10.1002/hyp.9740.

Quantitative Water Risk Assessment

The water risk assessment was conducted using Waterplan, an AI-powered software-as-a-service (SaaS) platform that integrates scientific datasets and local public sources to evaluate water-related risks and dependencies at the catchment level.[23] Waterplan's methodology leverages AI data analytics and large language models to align risk indicators with globally recognized frameworks, enabling a consistent and scalable approach to water risk evaluation.

This study employed a sampling-based approach to provide an indicative snapshot of potential risks across key geographies, rather than a comprehensive assessment of the entire global semiconductor supply chain. Waterplan's Water Risk Framework evaluates Overall Water Risk across four key categories - Physical, Regulatory, Reputational, and Infrastructure (Fig. 2). Physical risks are further broken down into water scarcity, flood, and water quality.

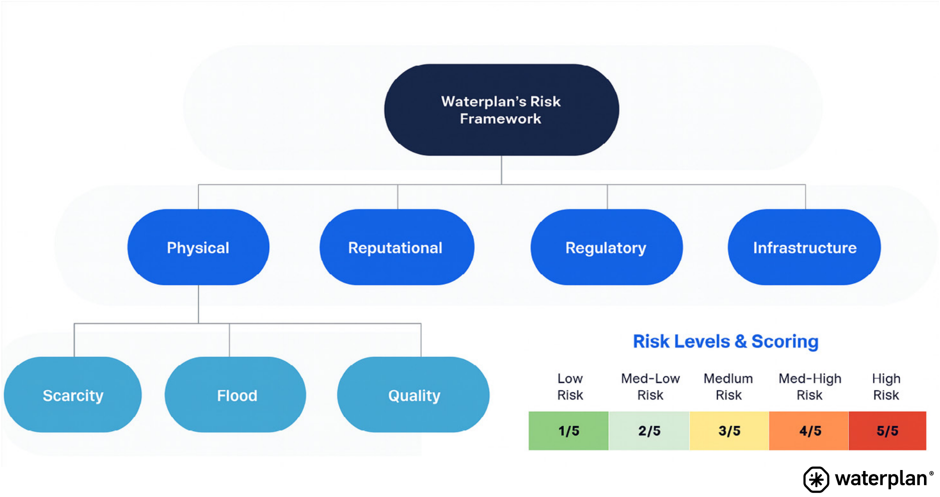

Figure 2. Water risk types *(Source: Waterplan).*

- Physical Risk includes hazards, such as droughts, floods, and pollution, assessed using global datasets (GRACE, ERA5, and GloFAS).
- Regulatory Risk captures the potential for changes in water laws or enforcement that could affect operations.
- Reputational Risk reflects public and stakeholder scrutiny, particularly in water-stressed or ecologically sensitive regions.
- Infrastructure Risk assesses the reliability of water delivery systems.

[23] Waterplan. Water Risk License. https://www.waterplan.com/solutions/water-risk.

Each risk category was assessed using a set of specific indicators, grouped into three core components:

- **Hazard:** External factors that may negatively impact water availability, quality, or access. These include events, such as flooding and droughts, pollution incidents, or regulatory restrictions.
- **Exposure:** The degree to which an organization interacts with external hazards. This is influenced by factors, such as geographic location, proximity to water sources, and the extent of direct operations and supply chain dependence on water resources.
- **Vulnerability:** Internal conditions that shape an organization's capacity to anticipate, manage, and recover from external hazards. These may include governance structures, operational flexibility, adaptive capacity, and access to contingency resources.

Risk refers to the potential for adverse operational impacts stemming from external water-related hazards and internal vulnerabilities, including limited response capacity or inadequate infrastructure. Importantly, risk is not a prediction or guarantee that an event will occur; rather, it represents an estimate of the potential severity of negative impacts should such an event materialize.

In Waterplan's Water Risk Framework, these components collectively determine the overall risk score, rated on a scale from 1 (lowest risk) to 5 (highest risk). A low score indicates stable conditions unlikely to disrupt operations, while a high score signals conditions that could lead to significant material impacts. The composite score is derived by averaging across the individual risk categories.

The Waterplan Risk Framework evaluates hazards at the catchment level, rather than at individual sites. Catchments — also referred to as watersheds — are geographic areas where precipitation collects and drains toward a common outlet, such as a river, lake, or ocean. By applying the global hierarchical HydroBASINS system at Levels 5 and 7, the framework provides a holistic view of water risk drivers across broader geographies, while still allowing for integration of localized data.

The screening phase of the quantitative assessment of physical water risks is grounded in globally recognized scientific datasets, ensuring methodological rigor and credibility:

- GRACE (Gravity Recovery and Climate Experiment): Tracks changes in Earth's gravitational field to detect long-term shifts in water storage.[24]
- ERA5 (Climate Reanalysis Model): Provides historical and near-real-time data on precipitation and potential evaporation, essential for climate impact assessments.[25]
- GloFAS (Global Flood Awareness System): Forecasts and monitors flood events using advanced hydrological and meteorological models.[26]

These datasets are updated monthly, ensuring that the screening remains dynamic and reflective of current hydrological conditions. By flagging high-level risks at the catchment scale, organizations can identify regions that warrant deeper investigation.

The Regulatory Risk Score is derived by averaging 11 indicators that assess various dimensions of regulatory challenges.[27] Six of these indicators are static and sourced from the Integrated Water Resources Management (IWRM) Data Portal, reflecting a country's progress toward SDG 6.5.1 targets through measures, such as freshwater policy and law status, water management plan implementation, business involvement, and instrumentation for basin and aquifer monitoring.[28] The remaining five indicators are dynamic, updated annually using the World Bank's World Governance Indicators, and evaluate broader governance effectiveness, including corruption, government inefficiency, legal compliance risks, political instability, and regulatory quality.[29]

The Reputational Risk Score represents the likelihood of a company being linked, through traditional or social media news, to a water-related issue that negatively impacts stakeholders or the environment.[30] Waterplan's AI analyses the media

[24] https://gracefo.jpl.nasa.gov/science/water-storage/.

[25] https://climate.copernicus.eu/climate-reanalysis.

[26] https://global-flood.emergency.copernicus.eu/.

[27] Waterplan. 2024. Waterplan Risk Framework. What is the Regulatory Risk Score? https://help.waterplan.com/en/articles/55-waterplan-risk-framework-what-is-the-regulatory-risk-score.

[28] IWRM Data Portal: https://iwrmdataportal.unepdhi.org/.

[29] The World Bank. Worldwide Governance Indicators. https://www.worldbank.org/en/publication/worldwide-governance-indicators.

[30] Waterplan. 2024. Waterplan Risk Framework. What is the Reputational Risk Score? https://help.waterplan.com/en/articles/56-waterplan-risk-framework-what-is-the-reputational-risk-score.

sentiment on a monthly basis, and the Reputational Risk Score is obtained by averaging key risk indicators, each contributing to the final score according to its assigned weight:

- *Media Attention Indicator:* Measures the volume of water-risk-related articles associated with a site's region and compares it to a national sample. A higher ratio indicates greater reputational exposure. The Media Attention Indicator accounts for approximately one-third of the overall Reputational Risk Score calculation.

- *Sentiment Analysis Indicator:* Uses machine learning to assess whether the tone of these articles is positive or negative. A higher proportion of negative sentiment increases the risk score. The Sentiment Analysis Indicator contributes approximately one-third to the overall calculation of the Reputational Risk Score.

- *Relative Social Interest:* Evaluates how concerned the general population in the country is about water-related issues (for the country-level indicator) and assesses regional sensitivity to water risks, comparing interest across states or provinces (for the state-level indicator). The Relative Social Interest at the Country and State levels indicators carry weights of 16% each for the calculation of the Reputational Risk Score.

Infrastructure Risk focuses on the reliability of third-party water supply systems that influence water availability. The Infrastructure Risk Score is derived by averaging three key indicators, each rated on a scale from 1 (lowest risk) to 5 (highest risk), capturing different dimensions of infrastructure challenges[31]:

- *National Budget for Water Resources Infrastructure:* Evaluates a country's investment in water-related infrastructure, including "hard" assets like dams, pumping stations, and treatment plants, as well as "soft" measures such as catchment management and sustainable drainage. This excludes drinking water and sanitation infrastructure. It is assessed using data from the Integrated Water Resources Management (IWRM) Data Portal.

- *Non-Revenue Water (NRW):* Assesses the volume of water lost before reaching end users, expressed in liters per capita per day. Elevated NRW levels indicate inefficiencies, potential contamination risks, and increased

[31] Waterplan. 2024. Waterplan Risk Framework. What is the Infrastructure Risk Score? https://help.waterplan.com/en/articles/53-waterplan-risk-framework-what-is-the-infrastructure-risk-score.

operational costs. Data sources include the World Bank[32], Eurostat[33], and methodologies from Liemberger & Wyatt[34].

- *Age of Infrastructure (Dams):* Assesses the average age of dams and associated facilities used for water supply, irrigation, hydroelectric generation, and flood control. Aging infrastructure is correlated with increased service disruptions, safety risks, and rising capital expenditures for maintenance. The dataset includes over 11,000 facilities globally and more than 70,000 in the United States. Age estimates are derived using a normal distribution model for each country, with the final average calculated from the central 68% percentile of dam ages.

The deep-dive water risk assessments incorporate contextual indicators tailored to specific regions. These include water level and quality measurements, infrastructure plans, water allocation policies, and regional regulations. These localized data help illuminate nuanced factors, such as legal frameworks, ecosystem sensitivities, and stakeholder dynamics, that can amplify or mitigate water risks. The layered approach empowers decision-makers to prioritize areas of concern, develop targeted mitigation strategies, and engage with local stakeholders to address site-specific challenges.

Qualitative Water Risk Assessment

To complement the quantitative analysis, the second phase of this study explored qualitative risk assessment, offering deeper insights into internal vulnerabilities and stakeholder engagement to support a more holistic understanding of water-related challenges.

To solicit stakeholder insights, we engaged SEMI's ERMR member companies in written surveys and targeted interviews.[35] The surveys and interviews explored a range of topics, including past incidents (e.g., water supply disruptions, negative media coverage), risk mitigation strategies (e.g., water recycling, alternative sourcing, stakeholder engagement), and internal challenges (e.g., budget constraints, data gaps, and executive buy-in). Respondents were encouraged to share specific examples of incidents and mitigation measures, such as contingency plans, on-site

[32] The World Bank. Public-Private Partnership Resource Center. https://ppp.worldbank.org/ppp-knowledge-lab.

[33] Eurostat. https://ec.europa.eu/eurostat/.

[34] Liemberger, R., and Wyatt, A. 2019. Quantifying the global non-revenue water problem. Water Supply, 19 (3), 831-837. https://iwaponline.com/ws/article-abstract/19/3/831/41417/Quantifying-the-global-non-revenue-water-problem.

[35] The full set of survey and interview questions is provided in the Appendix of this report.

treatment systems, as well as successful water-related projects.

This broad thematic scope provided valuable context for interpreting the quantitative findings. It illuminated how companies internally assess and respond to water risks, revealing varying levels of preparedness and resilience. Each company's participation was solely for empirical purposes and does not imply endorsement of the study's findings or recommendations.

Limitations

This study is subject to several limitations stemming from its intentionally targeted scope. The selection of supply chain locations and interview participants was based on purposive sampling — a non-probability technique — which may not fully represent the broader semiconductor industry. As a result, the findings may reflect the perspectives of participants with strong views or specific experiences related to water risk management.

The analysis relies on location data provided by SEMI's ERMR member companies and publicly available sources, which may vary in completeness or accuracy. Recognizing these limitations, the catchment-level focus offers a broad geographic perspective rather than a site-specific evaluation. Importantly, this research does not aim to provide a comprehensive evaluation of all semiconductor supply chain segments. Instead, it offers an indicative snapshot intended to spark dialogue and invite feedback from industry, policy, academic, and civil society stakeholders.

To effectively translate the findings into actionable plans, it is essential to account for each organization's distinct operational context and adaptive capacity, applicable water regulatory frameworks, and stakeholder landscape.

3. Water Risk Assessment Results

This study evaluated six key water risk categories: water scarcity, flooding, water quality, regulatory challenges, infrastructure vulnerabilities, and reputational risks. None of the semiconductor production sites included in this study were classified as high overall risk based on the average across all categories (Fig. 3). Only two out of 140 sites — both located in Bengaluru, India — were identified as having medium-high overall risk. Among individual risk types, flooding emerged as the most prevalent, with 76% of basins scoring high or medium-high. Reputational (47%), water quality (42%), and infrastructure risks (36%) followed, with numerous locations rated medium-high to high. Despite frequent scrutiny of the semiconductor industry's water consumption, only 16% of the sites analyzed were affected by water scarcity.

Due to the complexity and jurisdiction-specific nature of water regulations, a full assessment of regulatory risks across all 140 sites was not feasible; instead, a rigorous screening process prioritized 11 sites for detailed city-level analysis. For further details, please refer to the section *Regulatory Risks.*

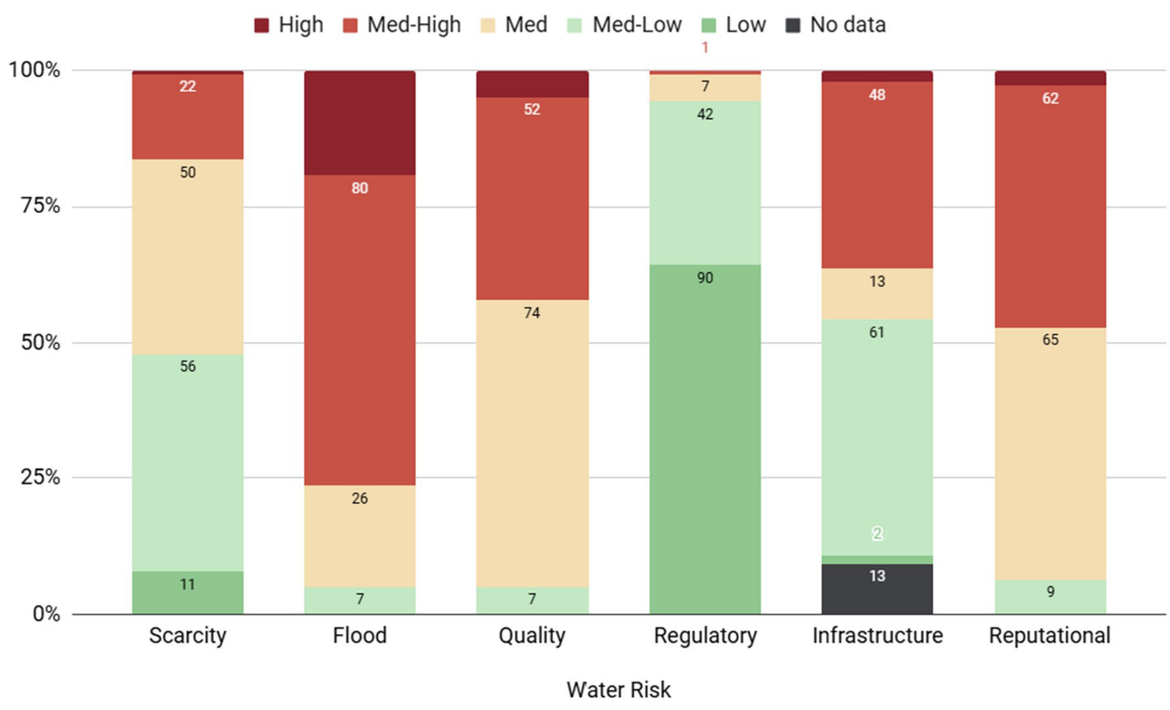

Figure 3. Global distribution of water risks across the semiconductor supply chain by risk type: Scarcity, Flood, Quality, Regulatory, Infrastructure, and Reputational *(Source: Waterplan Water Risk Framework).*

Across all segments of the value chain, a range of water-related risks was identified, with flood risk consistently emerging as the most prominent (Fig. 4). Furthermore, when evaluating the magnitude of these risks, over 80% of wafer fabrication sites and 88% of chemical and materials sites were found to face medium-high or high flood risk. The following section explores each water risk type in greater depth.

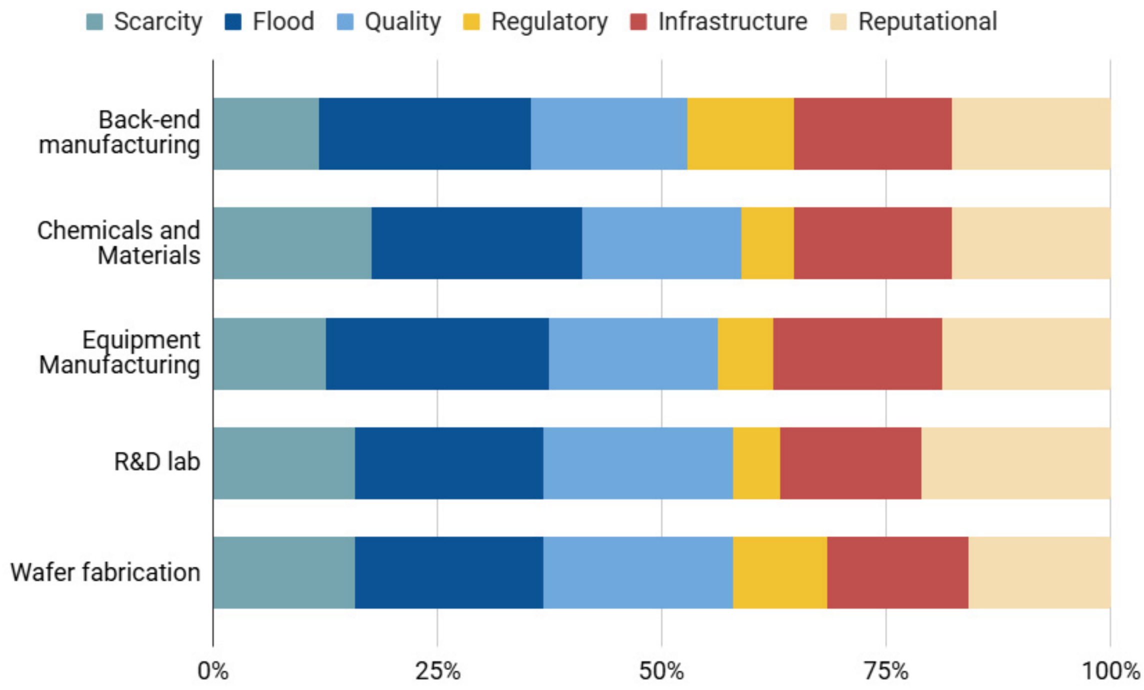

Figure 4. Global proportional distribution of water-related risks across the semiconductor value chain, broken down by value chain segment and risk type *(Source: Waterplan Water Risk Framework).*

Water Scarcity

Water scarcity represents a foundational risk to the semiconductor industry — particularly for wafer fabrication — which depends on uninterrupted access to large volumes of ultra-pure water for rinsing and cleaning processes. Although the semiconductor industry is frequently scrutinized for its significant water consumption, our analysis shows that only 16% of the sites evaluated are currently impacted by water scarcity (Fig. 3). Across the basins analyzed in this study, the primary drivers of scarcity risk were groundwater depletion and aridity, defined by the imbalance between precipitation and water loss through evaporation and transpiration.

Understanding geographic distribution and underlying drivers of water scarcity risk is essential for anticipating future constraints and developing resilient water strategies. This study identified significant scarcity risk in locations of R&D labs, with several sites exposed to medium-high levels of risk. These include Phoenix (Arizona), Taylor (Texas), San Francisco Bay Area (California), and Tianjin (China). Unlike Taylor, Austin-based sites face lower groundwater scarcity risks due to their location in distinct water basins with differing risk profiles and a more diversified water supply. Austin primarily relies on surface water from the Colorado River, while Taylor depends on a mix of groundwater and surface water sources.[36,37] This highlights the critical need for targeted, site-specific water risk assessments, source vulnerability mapping, and proactive water stewardship, especially in regions where industrial expansion intersects with diminishing water availability.

Regional Spotlight: Phoenix, Arizona

Phoenix stands at the intersection of rapid industrial growth and intensifying water scarcity. As a key hub for semiconductor R&D and advanced manufacturing, the region's dependence on large volumes of ultra-pure water places it in a critical position. The decline of the Colorado River, ongoing groundwater depletion, and persistent aridity — driven by rising temperatures and declining precipitation — are the primary contributors to the city's medium-high water scarcity risk.[38] With the groundwater providing over 40% of Arizona's overall water supply, unmet demand in the industrial sector in the region is increasing.[39]

Greater Phoenix is currently home to more than 75 semiconductor companies including Intel and Taiwan Semiconductor Manufacturing Company (TSMC). Since 2020, Arizona has welcomed over 40 new semiconductor projects, reinforcing its position as a key hub for advanced manufacturing.[40] Notably, TSMC has announced plans to triple its Phoenix campus over the next decade, adding three new fabrication plants, two advanced packaging facilities, and a major R&D team center alongside

[36] Austin Water. Water Forward - Protecting our Core Colorado River Supplies. https://www.austintexas.gov/department/water-forward-protecting-our-core-colorado-river-supplies.

[37] Texas Water Development Board. Taylor County Water Supply Planning Information & Resources. https://www.twdb.texas.gov/waterplanning/rwp/outreach/doc/taylor.pdf.

[38] Arizona Department of Water Resources. Drought Frequently Asked Questions. https://www.azwater.gov/drought/drought-frequently-asked-questions.

[39] The Nature Conservancy. Water Security for Arizonans. https://www.nature.org/en-us/about-us/where-we-work/united-states/arizona/stories-in-arizona/water/.

[40] Arizona Commerce Authority. 2024. Arizona: Home of America's Semiconductor Resurgence. https://www.azcommerce.com/news-events/news/2024/7/arizona-home-of-america-s-semiconductor-resurgence/.

its existing foundry.[41] Not all companies operating in the region publicly disclose water consumption data, making it difficult to accurately quantify the sector's total water use across the state. This lack of transparency poses challenges for regional water planning and water risk assessments.

Semiconductor facilities in the Greater Phoenix region will continue facing pressure to secure reliable water sources amid competing demands from agriculture, urban development, and ecosystem needs. Moreover, as climate models project worsening conditions through 2040, Phoenix exemplifies the urgent need for catchment-level water stewardship and forward-looking water risk management.[42] Without proactive mitigation strategies, such as water reuse, alternative water sourcing, and infrastructure upgrades, these risks could escalate into operational disruptions and long-term constraints on industry growth.

Regional Spotlight: Taiwan

Manufacturing advanced semiconductors requires highly specialized expertise and infrastructure, which remain concentrated among a small number of firms and geographic locations, most notably in Taiwan. This concentration limits the ability of leading electronics companies to quickly pivot to alternative suppliers for critical components when disruptions occur.

Taiwan, a global hub for semiconductor production, is facing mounting water stress. While flood risks — driven by sea level rise and storm surges — are well-documented, water scarcity is emerging as a critical concern. Operational disruptions at such key nodes in the global semiconductor production network can trigger cascading effects across supply chains, impacting both individual companies and the broader industry ecosystem. For example, Taiwan's most severe drought in 56 years (from October 2020 to June 2021) caused its largest reservoir to drop to levels below 12% of its capacity.[43] In response, authorities mandated water use reductions for the technology sector, with semiconductors being a primary target. According to MSCI, 97% of semiconductor fabrication sites in the region were exposed to varying levels of freshwater withdrawal restrictions, with peak restrictions reaching 15–17%

[41] TSMC. 2025. TSMC Intends to Expand Its Investment in the United States to US$165 Billion to Power the Future of AI. https://pr.tsmc.com/english/news/3210.

[42] Lepawsky, J. 2024. Climate change induced water stress and future semiconductor supply chain risk. iScience 27, 108791. https://pmc.ncbi.nlm.nih.gov/articles/PMC10826299/pdf/main.pdf.

[43] Wang, A. 2021. Taiwan's worst drought in decades deepens chip shortage jitters. Taipei Times, 22 April. https://www.taipeitimes.com/News/feat/archives/2021/04/22/2003756133.

and resulting in an average water reduction of 8% across 31 sites.[44]

Although Taiwan's water management systems — including collaboration between the Water Resources Agency and major technology companies operating in the region —have helped maintain reservoir levels between 50-90% in recent years[45], climate projections for 2030 and 2040 indicate medium-high water stress across Taiwan's watershed.[46] These risks are compounded by declining rainfall reliability, groundwater depletion, aging infrastructure, and the pressures of an export-oriented economy with underpriced water supplies. A stress test by S&P Global estimates that TSMC's feedwater demand could double from 2022 levels by 2030.[46] Under a repeat of the 2021 drought scenario, TSMC's output could fall 1-10% below forecasted production. Sustained industrial expansion in Taiwan is projected to further strain water availability. Without targeted mitigation, semiconductor operations in Taiwan may face heightened vulnerability to supply disruptions and reputational risks.

Water Quality

Water quality is a foundational pillar of operational reliability in the semiconductor industry. Ultra-pure water — thousands of times purer than drinking water — is essential for nearly every stage of semiconductor production, from wafer cleaning to chemical dilution. Even minor fluctuations in source water quality can lead to costly disruptions, equipment damage, or compromised product integrity. As global water sources face increasing stress from pollution, agricultural runoff, and legacy contamination, the ability to assess, anticipate, and respond to water quality risks is mission-critical for semiconductor manufacturers.

In this study, 42% of assessed locations were classified as high or medium-high water quality risk, with surface water degradation identified as the primary driver. One of the locations with high risk of water quality was Xi'an, China, which is a significant hub for the semiconductor industry and is a home to numerous companies specializing in memory IC design, foundry services, and testing. Wastewater from fabrication processes are known to contain hazardous substances, such as arsenic, phosphorous, hydrofluoric acid, and other toxic solvents. Beyond operational impacts, poor water quality in surrounding ecosystems can trigger regulatory

[44] MSCI. 2021. How Climate Change Affected Thirsty Chipmakers. https://www.msci.com/research-and-insights/blog-post/how-climate-change-affected-thirsty-chipmakers.

[45] Taiwan News. 2025. Water for Taiwan's chip industry remains stable. https://www.taiwannews.com.tw/news/6056359.

[46] S&P Global. 2024. Sustainability Insights: TSMC And Water: A Case Study of How Climate Is Becoming a Credit-Risk Factor. https://www.spglobal.com/ratings/en/regulatory/article/240226-sustainability-insights-tsmc-and-water-a-case-study-of-how-climate-is-becoming-a-credit-risk-factor-s12992283.

scrutiny and reputational risk.

Regional Spotlight: Xi'an, China

Xi'an, the largest city in the northwest region of China, is located in the Yellow River basin and is home to 120 semiconductor design companies.[47] The city's rapid expansion has significantly increased demand for water and intensified existing water pollution challenges. Overconsumption of upstream Wei River resources has made it difficult for Xi'an to withdraw sufficient surface water for local supply. Compounding this issue, surface water degradation — driven by industrial runoff, legacy contamination, and limited wastewater treatment capacity — has positioned Xi'an among the high-risk locations identified in this study.

To address uneven water resource distribution and enhance supply capacity, Xi'an and the broader Wei River basin are part of a new inter-basin transfer initiative involving a tunnel project. In addition, the Xi'an Water Authority has implemented a range of urban water management measures, including water-saving programs, multifunctional and cascaded water use, rainwater harvesting, and water reclamation systems.[48] In light of these challenges, companies operating in Xi'an should prioritize catchment-level collaboration to mitigate current and emerging water risks and ensure long-term water security. This can be achieved through co-investment in infrastructure upgrades, sharing water demand forecasts to support municipal planning, and active participation in public-private partnerships to accelerate project implementation.

Flood Risks

Flooding has emerged as the most recurrent and geographically widespread risk among the semiconductor supply chain hubs analyzed (Fig. 5). High and medium-high flood risk was identified in 76% of the locations analyzed, with most sites exhibiting vulnerability to elevated precipitation levels, further amplifying their overall exposure to flooding. Our assessment identified China as having the highest concentration of semiconductor foundries exposed to flooding risk, with particularly elevated exposure in Suzhou, Shenzhen, Shanghai, and Nanjing. This geographic clustering of risk underscores the need for targeted resilience planning and coordinated water stewardship across high-risk regions.

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[47] Invest in China. 2023. IC industry shows rapid development in Xi'an. https://investinchina.chinaservicesinfo.com/s/202305/05/WS6454c849498ea274927b98b2/ic-industry-shows-rapid-development-in-xian.html.

[48] International Water Association (IWA). Xi'an. https://iwa-network.org/city/xian/.

Facilities are particularly vulnerable to flooding when located in low-lying urban areas or within floodplains, where stormwater infrastructure is often insufficient to manage extreme precipitation or high-flow events. Semiconductor clusters in regions like Suzhou and Xi'an (China), Kyoto (Japan), and Austin (U.S.), are increasingly exposed to seasonal rains and climate-driven hydrological shifts.

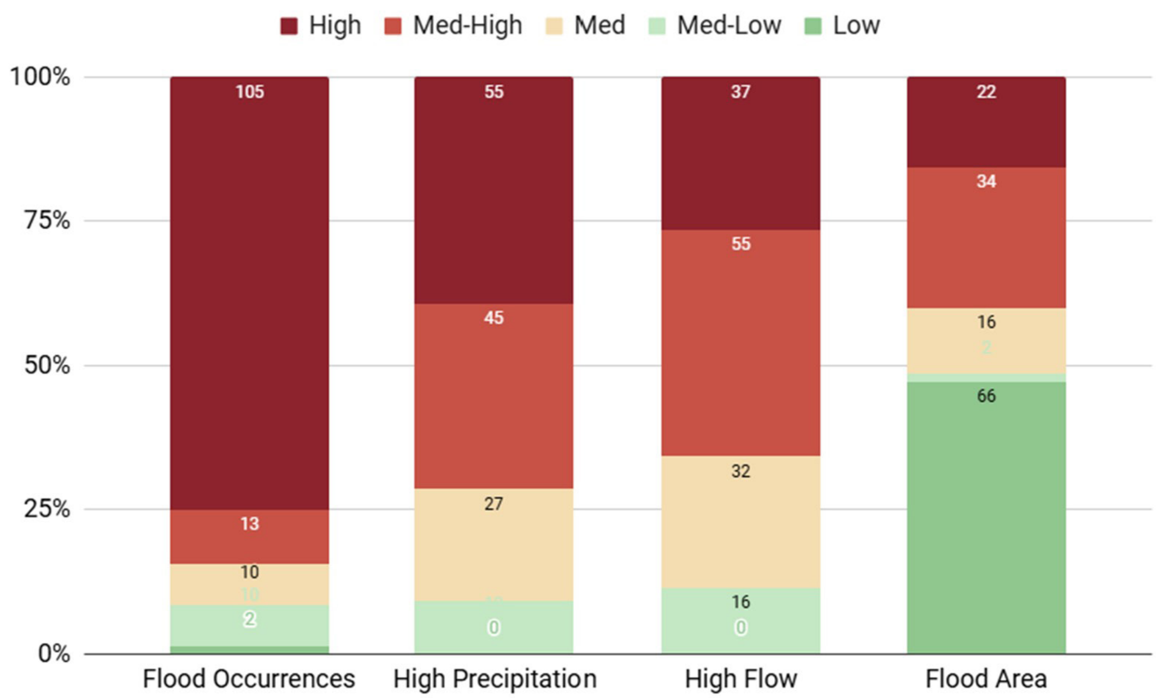

Figure 5. Flood Risk: Distribution of locations by key drivers of flood risk at the basin level. *(Source: Waterplan Water Risk Framework).*

Beyond production halts and delays, flood events can result in immediate shutdowns of manufacturing facilities and warehouses, disrupt logistics and transportation networks, and affect worker safety. Sites that are situated directly within floodplains or designated flood zones will generally require flood infrastructure solutions in place as well as site-specific contingency planning to ensure continuity during extreme events.

Flooding — though inherently a water-related issue — is typically addressed through climate or land-use frameworks, complicating its classification as a water risk. Moreover, transferring flood risk is far from straightforward. According to Munich Re, global flood events have caused US$325 billion in losses over the past five years, yet only about US$70 billion of those losses were covered by insurance.[49]

[49] MunichRe. Floods, storm surges, flash floods: Risks are on the rise. https://www.munichre.com/en/risks/natural-disasters/floods.html#-24989000.

The relatively low proportion of insured flood losses is influenced by both supply and demand factors. In many regions, insurance offerings for flood coverage remain limited. At the same time, even in flood-prone areas, demand for such coverage is often lacking. In many countries, flood protection is not automatically included in standard building insurance policies, requiring property owners to purchase separate coverage.[35] Additionally, a significant portion of flood-related losses is from damage to public infrastructure, such as roads, railways, and bridges, which typically remain uninsured.

Advancements in data and analytics have enabled the growth of parametric insurance, which differs from traditional indemnity coverage by paying out based on predefined triggers, such as water depth, rather than assessed damages.[50] While parametric policies follow the same regulatory standards, they carry basis risk, meaning payouts may not align with actual losses. Accurate pricing and trigger selection are crucial, especially for flood coverage, where variables, such as ground composition and infrastructure, complicate measurements. Semiconductor companies have a significant opportunity to collaborate with insurers to close flood protection gaps. Evidence suggests that targeted, bespoke interventions at critical points along the supply chain are more effective than broad, end-to-end solutions applied across the entire complex network.[20]

Regional Spotlight: Greater Shanghai

China's chipmakers now account for about 30% of global mature-node wafer capacity, with Shanghai playing a central role in this expansion.[51] China commands a major share (38%) of the global market for assembly, test, and packaging (ATP)[52], and it has also seen a nearly sixfold increase in its number of IC design companies, growing from 582 to 3242 between 2010 and 2022.[53] Still, China held just 7.2% of global semiconductor industry market share in 2023.[54]

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[50] Insurance Information Institute. 2021. Flood: Beyond Risk Transfer. https://www.iii.org/white-paper/flood-beyond-risk-transfer-042921.

[51] Ruhlig, T. 2025. China's legacy chip buildout A new EU strategic dependency that needs de-risking& The Swedish Institute of International Affairs. https://www.ui.se/globalassets/ui.se-eng/publications/ui-publications/2025/ui-brief-no.-2-2025-china-legacy-chips.pdf. *Note:* The global front-end manufacturing capacity for mature-node semiconductors referenced here pertains to process nodes in the 20–45 nm and 50–180 nm ranges.

[52] Randall, S. 2024. Exploring China's evolving role in advanced packaging. Technode. https://technode.com/2024/03/01/exploring-chinas-evolving-role-in-advanced-packaging/.

[53] Ezell, S. 2024. How Innovative Is China in Semiconductors? *Information Technology & Innovation Foundation*, 13, https://itif.org/publications/2024/08/19/how-innovative-is-china-in-semiconductors/.

[54] Semiconductor Industry Association. 2024. 2024 Factbook. https://www.semiconductors.org/wp-content/uploads/2024/05/SIA-2024-Factbook.pdf.

The SEMICON China 2025 event held in Shanghai underscores the city's importance, attracting global leaders and investors to discuss trends in AI, advanced packaging, and IC innovation.[55] While the Greater Shanghai region is known for its robust infrastructure and manufacturing capacity, climate models project a moderate to high increase in flood risk by 2050 due to a combination of extreme precipitation events, sea level rise, and storm surge inundation. For example, Tropical Storm Co-May in July 2025 brought record rainfall and severe flooding, resulting in port closures, suspended rail services, and the evacuation of over 280,000 residents.[56] These disruptions triggered Level II emergency protocols and extended average vessel waiting times at Shanghai Port to 7 days from 2 days, contributing to significant delays.[57]

These risks are particularly relevant for back-end semiconductor facilities located in nearby cities, such as Suzhou and Jiangyin, which form part of the broader Yangtze River Delta industrial corridor. The semiconductor industry's reliance on uninterrupted operations and sensitive equipment makes it especially vulnerable to flooding. Even short-term disruptions can lead to production delays, equipment damage, and increased operational costs. Additionally, the dense urban environment of Greater Shanghai amplifies surface runoff and strains drainage systems, increasing the likelihood of localized flooding during heavy rainfall.

To mitigate these risks, companies operating in the region are encouraged to invest in flood-resilient infrastructure, enhance emergency preparedness, and collaborate with local authorities on watershed-level planning. Evaluating flood risk exposure should also include mapping the locations of worker communities relative to operational sites, ensuring that both workforce safety and business continuity are considered. As climate impacts intensify, proactive adaptation will be essential to safeguarding critical semiconductor assets and maintaining uninterrupted operations in this strategically vital region.

[55] Hongfei Technology. 2025. Global Semiconductor Industry Barometer: 32nd SEMICON China Concludes Successfully in Shanghai. https://www.hvvac.com/Global-Semiconductor-Industry-Barometer-32nd-SEMICON-China-Concludes-in-Shangha.html.

[56] Reuters. 2025. Shanghai relocates hundreds of thousands due to tropical storm. https://www.reuters.com/sustainability/climate-energy/shanghai-relocates-hundreds-thousands-due-tropical-storm-2025-07-30/.

[57] Barakat, M. 2025. Typhoon Co-May disrupts port operations and transportation in eastern China. https://mykn.kuehne-nagel.com/news/article/typhoon-co-may-disrupts-port-operations-china.

Regulatory Risks

As governments around the world respond to growing water stress, industrial water users are increasingly subject to heightened scrutiny — facing stricter water permit requirements, tighter allocation limits, and more rigorous compliance obligations. In some cases, escalating water scarcity or declining water quality can prevent facilities from securing the necessary permits and allocations, posing a direct threat to operational continuity.

Since water governance is highly decentralized, policies governing water withdrawal, discharge, and stormwater management are often set and enforced at the state, municipal, or even basin level. This makes localized regulatory assessments essential for identifying potential changes that could materially impact operations. Conducting such assessments across all 140 semiconductor production sites was not feasible due to the nuanced, jurisdiction-specific nature of water law and the need for in-depth engagement with local governance frameworks. Instead, we applied a rigorous screening process to prioritize 11 sites for detailed city-level analysis: Austin (USA), Bengaluru (India), Dresden (Germany), Kyoto (Japan), Kanagawa (Japan), Linkou (Taiwan), Mie (Japan), Pyeongtaek (South Korea), San Jose (USA), Suzhou (China), and Xi'an (China).

Our analysis found that the most significant regulatory risk driver in these locations is restrictions on water consumption, particularly through drought contingency measures (Fig. 6). In the semiconductor sector, rapidly expanding operations are introducing new pressures on local water systems, even in regions with historically stable regulatory frameworks. For example, emerging regulations targeting water contaminants, such as PFAS, may present more immediate regulatory exposure and operational risk.

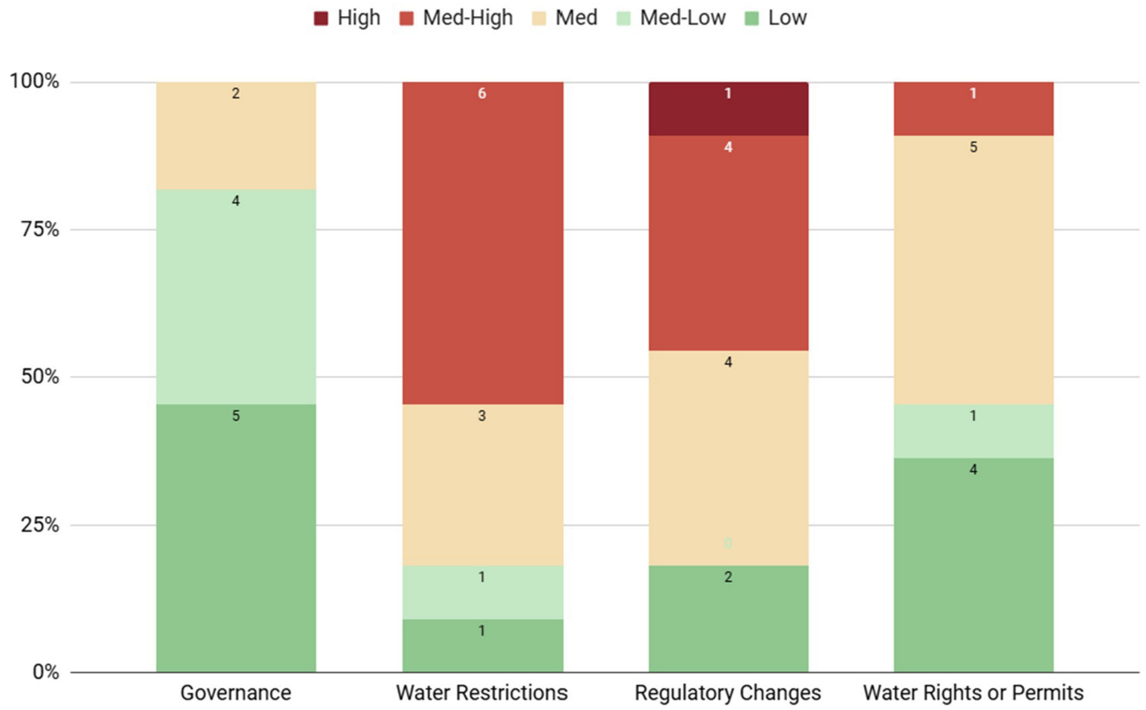

Figure 6. Regulatory Risk: Localized indicators of regulatory risk across 11 city-level locations *(Source: Waterplan Water Risk Framework).*

While the analyzed sites appear to operate under stable national water regulations, regulatory risk and impact manifest at the local level, where industry operations directly interact with local water systems and governance. Regulatory risk is shaped not only by the stability of the regulatory environment but also by the pace and scale of business operations. This dynamic interaction increases the likelihood of regulatory scrutiny and potential compliance challenges. As the industry grows, so does its visibility and impact, which can trigger shifts in regulatory expectations and enforcement. Therefore, regulatory risk must be evaluated not only in terms of policy stability, but also in light of the evolving ways companies interact with water resources. Proactive monitoring of local and international policy shifts, and active engagement with regulatory authorities and water governance institutions will be critical to mitigating future regulatory risks, particularly in regions where water stress is projected to intensify.

Regional Spotlight: Pyeongtaek, South Korea

Pyeongtaek, home to the world's largest semiconductor production facility operated by Samsung Electronics, is emerging as a region of concern for regulatory water risk. Although currently classified as medium-low risk, companies in the region must comply with several water-focused regulations, including the Water Environmental Conservation Act[58], the Act on Promotion and Support of Water Reuse[59], the Water Supply and Waterworks Installation Act[60], and the Sewage Act[61]. In addition, South Korea has recently announced further revisions to its Water Environment Conservation Act and Sewage Act, aimed at strengthening the regulation of emerging pollutants, such as PFAS and persistent organic pollutants (POPs).[62] These revisions include enhanced regulatory controls on hazardous substances, requiring advanced water treatment technologies for compliance, and integration of pollution controls into stormwater systems. Overall, these changes signal a move toward more rigorous expectations for industrial water users. For semiconductor manufacturers, whose processes rely on PFAS and require uninterrupted access to ultra-pure water, even incremental regulatory changes can create operational challenges and heighten reputational risk. To stay ahead of these risks, companies operating in South Korea must invest in circular water systems, advanced treatment technologies, and proactive stakeholder engagement.

Samsung's Pyeongtaek site exemplifies this approach: it complies with government pollutant regulations through real-time monitoring and advanced chemical management, exceeds requirements by integrating pollution controls into its stormwater system, and has removed the use of PFAS in the products in line with EU and U.S. standards.[63] The site has also achieved Platinum certification under the Alliance for Water Stewardship (AWS) Standard.[64] These measures not only ensure compliance but also strengthen resilience in a region where water governance is evolving rapidly. As South Korea positions itself as a global semiconductor leader,

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[58] Water Environmental Conservation Act: https://elaw.klri.re.kr/eng_mobile/viewer.do?hseq=46344&type=sogan&key=16.

[59] Act on Promotion and Support of Water Reuse: https://elaw.klri.re.kr/eng_mobile/viewer.do?hseq=64733&type=part&key=39.

[60] Water Supply and Waterworks Installation Act: https://elaw.klri.re.kr/eng_mobile/viewer.do?hseq=37566&type=part&key=33.

[61] The Sewage Act: https://elaw.klri.re.kr/eng_mobile/viewer.do?hseq=62185&type=part&key=33.

[62] Enviliance Asia. 2025. South Korea announces revisions to Water Environment Conservation Act and Sewage Act to regulate emerging pollutants. https://enviliance.com/regions/east-asia/kr/report_14056#:~:text=On%20June%2012%2C%202025%2C%20the,public%20attention%20in%20recent%20years.

[63] Samsung Semiconductors. Water Stewardship. https://download.semiconductor.samsung.com/resources/others/Samsung_Semiconductors_Water_Stewardship_ENG.pdf.

[64] The Alliance for Water Stewardship. 2024. Certification Report for Samsung Electronics - Pyeongtaek. https://a4ws.org/wp-content/uploads/2024/07/Samsung-Pyeongtaek-Certification-Report-2024.pdf.

proactive water stewardship in hubs like Pyeongtaek will be critical to sustaining growth and maintaining a social license to operate.

Reputational Risks

As public awareness of water scarcity and environmental impacts increases globally, companies face growing pressure to demonstrate responsible water use, particularly in regions experiencing acute water stress. For any type of industrial process that requires high volumes of water, or that discharges water to nearby water bodies, the reputational stakes are generally significant. Perceived overuse or mismanagement of water resources can provoke strong reactions from local communities, non-government organizations (NGOs), and media, potentially leading to public opposition, tighter regulations, and disruption of a company's social license to operate. Moreover, reputational damage can cascade across the supply chain, undermining investor confidence and diminishing brand value.

Our analysis found that 47% of the sites are exposed to high or medium-high reputational risks related to water, reflecting widespread stakeholder sensitivity to water use and management across key manufacturing regions. The three primary drivers include: (1) heightened community and media scrutiny, present in nearly 90% of assessed locations; (2) elevated risk of water-related conflicts at the national or state level, affecting over 40% of sites; and (3) external exposure, observed at 15% of sites (Fig. 7).

Reputational risk is highly context-dependent, shaped by geography, local water conditions, and the region's role in the global semiconductor supply chain. This variability underscores the need to understand both the operational footprint and the socio-environmental dynamics of each location. As scrutiny intensifies across jurisdictions, managing reputational risk has become essential to sustaining operational resilience and long-term business viability. Therefore, proactively addressing reputational risk early in the project lifecycle, ideally during the conceptual design and site selection phase, is essential for successful implementation. Engaging with local communities from the outset to build goodwill and collaborative buy-in by acknowledging and responding to their needs and concerns helps establish trust and foster long-term stakeholder alignment. This early engagement can significantly mitigate reputational exposure and support smoother project execution.

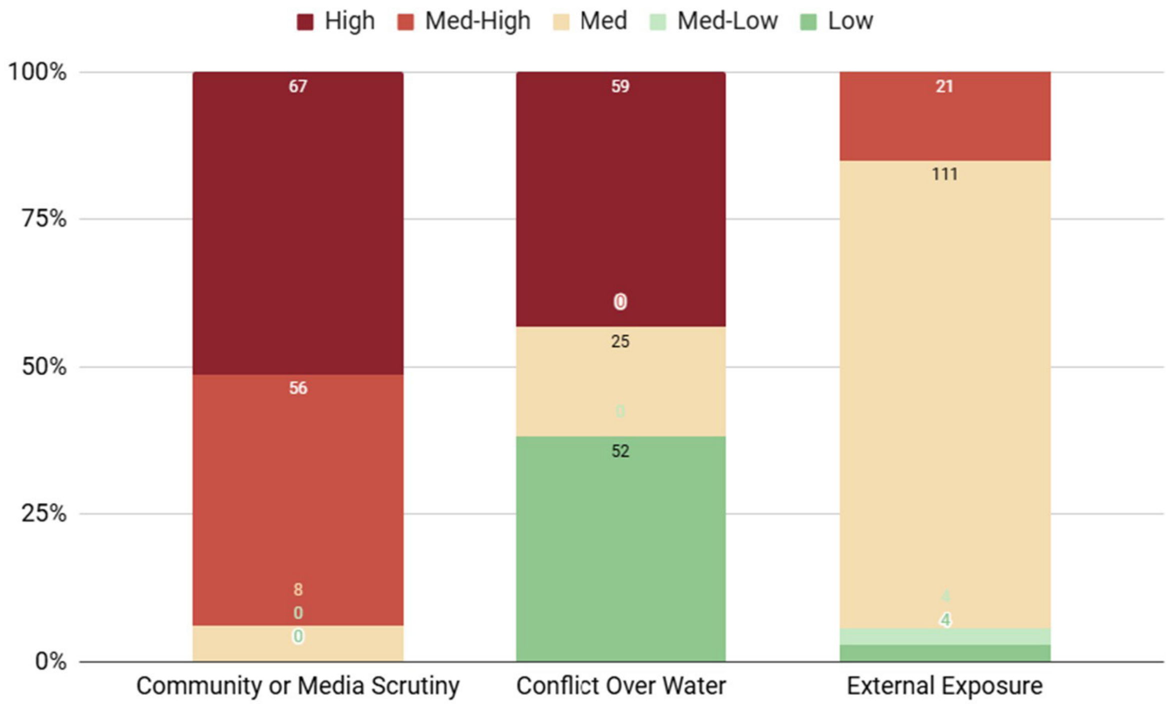

Figure 7. Reputational Risk: Distribution of sites by key drivers of reputational risk at the basin level. *(Source: Waterplan Water Risk Framework).*

Regional Spotlight: Multiple Regions

Reputational risk within the semiconductor supply chain varies significantly across geographies, shaped by local environmental sensitivities and stakeholder dynamics. Manufacturing hubs in Pyeongtaek (South Korea) and Tainan (Taiwan) are in heavily industrialized zones where environmental concerns frequently attract public scrutiny. In Pyeongtaek, reputational risk is considered medium-high due to growing attention on water pollution.[65] In Tainan, public concern over water allocation between industrial, agricultural, and domestic use has led to high reputational risk scores, driven by perceptions of semiconductor manufacturing as a major water consumer.[66,67]

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[65] See examples: Pyeongtaek City requested the government and Gyeonggi Province to declare a special disaster area, https://www.mk.co.kr/en/society/10921102; Pyeongtaek isolates toxic chemicals after spill into local stream, https://koreajoongangdaily.joins.com/news/2024-01-11/national/environment/Pyeongtaek-isolates-toxic-chemicals-after-spill-into-local-stream-/1956504.

[66] The New York Times. 2021. Drought in Taiwan Pits Chip Makers Against Farmers. https://www.nytimes.com/2021/04/08/technology/taiwan-drought-tsmc-semiconductors.html.

[67] FDI Intelligence. 2023. Thirsty chip facilities under scrutiny in water stressed areas. https://www.fdiintelligence.com/content/c31f977a-a8b7-5ffc-9eaa-daa48a8d1d41.

Chemical and material production sites, such as those in Mie (Japan) and Jiangsu (China), face elevated reputational risk due to water usage and discharge practices, compounded by increasingly stringent environmental regulations.[68,69] R&D centers in Bengaluru (India) and San Jose (California, U.S.), while not primary users or polluters of water, operate in dense urban environments near engaged civil society groups, making them vulnerable to reputational pressures.

Importantly, reputational risk is rarely confined to the semiconductor sector alone. In Phoenix (Arizona), for example, broader regional challenges, such as water scarcity, rapid population and industrial growth, and community tensions, intensify reputational exposure regardless of a facility-specific water footprint.[70] Similar dynamics are evident in Québec City (Canada), where debates over water prioritization continue[71], and in Dresden (Germany), where rising environmental awareness has elevated the risk profile of the region's expanding semiconductor hub.[72]

These regional examples reflect a broader industry trend — reputational pressure is intensifying globally, mirroring patterns observed in other water-intensive sectors, such as data centers, which are also integral to the semiconductor value chain. As public expectations for responsible water stewardship grow, proactively managing reputational risk is essential not only to maintain stakeholder trust, but also to ensure business continuity and operational resilience.

[68] The Asahi Shimbun. 2024. Japan eyes tougher stance on PFAS and water suppliers. https://www.asahi.com/ajw/articles/15353228.

[69] Enviliance Asia. 2024. China's Jiangsu province issues regulations on ecological, environmental protection. https://enviliance.com/regions/east-asia/cn/report_11952.

[70] The World Economic Forum. 2024. The water challenge for semiconductor manufacturing: What needs to be done? https://www.weforum.org/stories/2024/07/the-water-challenge-for-semiconductor-manufacturing-and-big-tech-what-needs-to-be-done/.

[71] Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques [Ministry of the Environment and the Fight Against Climate Change]. 2018. 2018–2030 Québec Water Strategy. https://www.environnement.gouv.qc.ca/eau/strategie-quebecoise/strategie2018-2030-en.pdf.

[72] McKinsey. 2024. McKinsey on Semiconductors: Creating value, pursuing innovation, and optimizing operations. https://www.mckinsey.com/~/media/mckinsey/industries/semiconductors/our%20insights/mckinsey%20on%20semiconductors%202024/mck_semiconductors_2024_webpdf.pdf.

Infrastructure Risks

Across many regions, aging infrastructure and operational inefficiencies are emerging as critical threats to industrial water security. For the semiconductor industry, the condition and performance of local water systems represent a significant vulnerability. Challenges such as underfunded maintenance programs, high levels of non-revenue water (i.e., losses from leaks or inefficient usage), and structural degradation of dams can result in service disruptions, unexpected costs, and safety risks.

Our water risk assessment revealed that 36% of all evaluated sites face high or medium-high infrastructure risk. Additionally, around 80% of sites are exposed to aging dams, further compounding infrastructure-related vulnerabilities (Fig. 8).

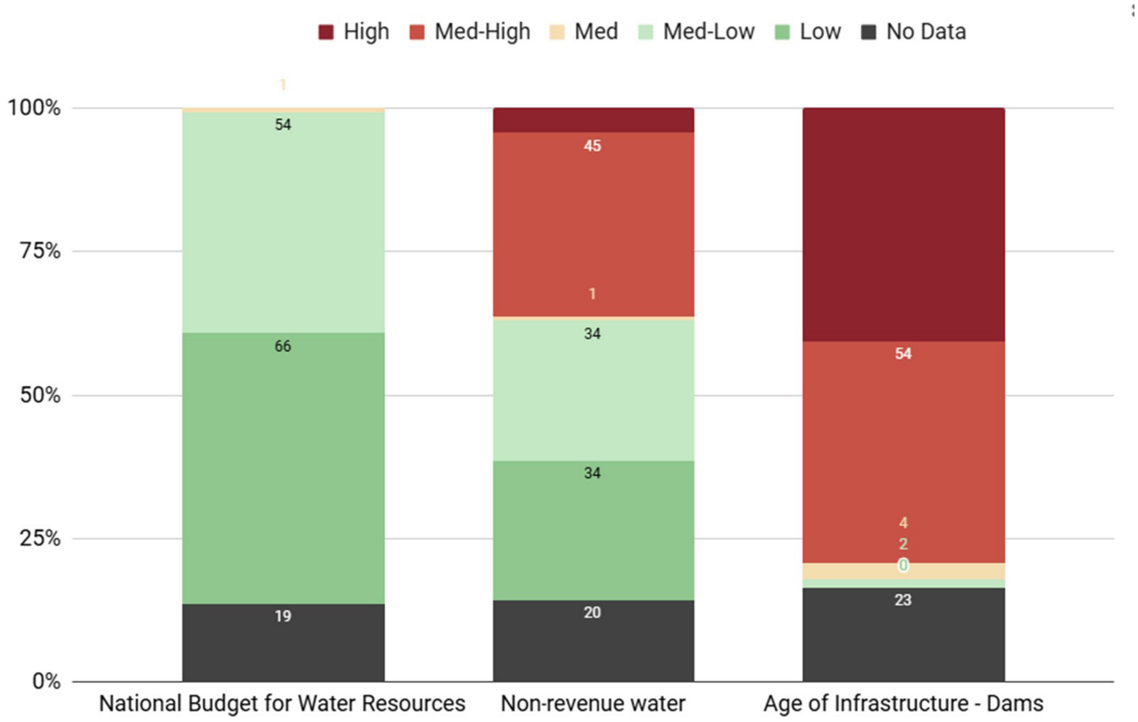

Figure 8. Infrastructure Risk: Distribution of sites by key drivers of reputational risk at the basin level. Note that some regions are marked as "No Data" due to either a lack of data or low-quality data. For example, national budget for water resources is assessed using data from the Integrated Water Resources Management (IWRM) Data Portal.[73] These data are based on survey responses; if a country did not participate, it is marked as "No Data" in this report. *(Source: Waterplan Water Risk Framework).*

[73] IWRM Data Portal: https://iwrmdataportal.unepdhi.org/.

As the semiconductor industry undergoes rapid expansion into regions with aging infrastructure or water stress, such as North America, Europe, and Taiwan, the physical capacity of local water infrastructure is increasingly being tested. Key systems, including pump stations, conveyance networks, wastewater treatment plants, and collection systems, must be evaluated for their ability to support rising water demand and discharge volumes. Without adequate upgrades, these infrastructure components may fall short, leading to operational bottlenecks and requiring capital-intensive investments to ensure continued reliability and scalability. Proactive assessment of infrastructure capacity is essential to align site growth with long-term water system resilience.

Regional Spotlight: Multiple Regions

Water infrastructure challenges are becoming a critical concern for semiconductor operations, especially in regions where aging systems and deferred maintenance intersect with rising industrial demand.

In the U.S., the average water-network pipe is 45 years old, with some cast-iron pipes exceeding 100 years in age.[74] Among the medium-high risk sites identified, Austin (Texas) stands out due to outdated infrastructure and elevated levels of non-revenue water. It is estimated that leaks and inefficiencies across Austin's water system result in the loss of more than 8 billion gallons annually, equating to approximately US$12 million in yearly losses.[75] These losses stem from the cost of treating water that is ultimately wasted and from inaccurate billing that fails to reflect actual consumption by consumers and businesses.

In addition, U.S. water utilities, particularly smaller ones, have been slow to adopt technologies that enhance operational efficiency. To date, investment in the sector has largely focused on opportunistic upgrades, rather than comprehensive modernization. These upgrades have primarily supported data collection and visualization, including the deployment of geographic information systems (GIS), smart meters, and enhancements to supervisory control and data acquisition (SCADA) systems. However, full-scale network optimization remains limited, leaving many utilities vulnerable to inefficiencies and infrastructure-related risks.[76]

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[74] The American Society of Civil Engineers (ASCE). 2021. Wastewater. 2021 Infrastructure Report Card. https://infrastructurereportcard.org/cat-item/wastewater-infrastructure/.

[75] Black & Veatch. 2024. Water Loss Program Review, Analysis & Optimization. https://www.austintexas.gov/sites/default/files/files/Water/B%26V%20Austin%20Water%20Loss%20100124.pdf.

[76] McKinsey. 2021. US water infrastructure: Making funding count. https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/us-water-infrastructure-making-funding-count.

Taiwan is also addressing aging infrastructure, particularly leaky pipelines. The Taipei Water Department reported a reduction in leakage rates from 11.2% in 2022 to 10.3% in 2024, reflecting efforts to minimize water loss and enhance system efficiency.[77] At the same time, Taiwan's water pricing remains among the lowest in Asia, which may incentivize excessive consumption by heavy industrial users. This pricing imbalance presents a latent financial risk for water-intensive sectors, especially semiconductors. For companies with high water dependency, any future adjustments in water tariffs to reflect increasing water stress could lead to significant cost increases, making water pricing reform a critical factor in long-term operational planning and risk management.[78]

Proactive mitigation is essential to safeguarding semiconductor operations against escalating water stress. Key strategies include securing alternate water sources, such as water reuse, and forming partnerships with local utilities to enhance system reliability and unlock new funding for infrastructure improvements. Since public funding for utility infrastructure may not be fast enough to keep pace with the semiconductor industry's rapid growth and rising water demands, private collaboration and investment can play a critical role, offering immediate capital for project implementation and accelerating infrastructure upgrades. Together, these approaches help minimize future disruptions and ensure long-term operational continuity in water-stressed regions.

[77] Taipei Water Department. 2024. Enhancing Disaster Preparedness and Reducing Leaks for Water Supply Resilience: Sustainable and Reassuring Good Water for Taipei. https://english.water.gov.taipei/News_Content.aspx?n=82A83F699502B12F&s=AEDDE483A90365B6.

[78] Fitch Ratings. 2021. Taiwan Drought Highlights Water Stress as Growing Environmental Risk. https://www.fitchratings.com/research/corporate-finance/taiwan-drought-highlights-water-stress-as-growing-environmental-risk-04-05-2021.

4. Key Insights

Key Insight 1: Water risk presents financially material impacts across the semiconductor value chain, demanding close and proactive attention.

Water risks — including scarcity, flooding, infrastructure strain, and reputational exposure — pose financially material threats across the semiconductor value chain. These risks vary by geography and value chain segment, and their impacts can cascade across global supply chains, disrupting operations, delaying deliveries, and impacting revenue. S&P Global estimates that by 2050, water-related risks, including stress, drought, and flooding, could cost the world's largest IT companies up to $24 billion annually.[79]

The severe flooding in Thailand in 2011 — the worst in 70 years — was a pivotal moment that revealed the far-reaching ripple effects supply chain disruptions can have on the semiconductor industry. It was the first major event to demonstrate how the failure of a single production node could cascade across global operations, exposing vulnerabilities in just-in-time manufacturing models. Output of electronic components dropped by over 65%, and recovery was uneven due to the concentration of facilities in flood-affected regions.[81]

[79] S&P Global. 2025. For the world's largest companies, climate physical risks have a $1.2 trillion annual price tag by the 2050s. https://www.spglobal.com/sustainable1/en/insights/special-editorial/ceraweek-physical-risk. Note: The S&P Global analysis applies the SSP2-4.5 climate scenario - a 'middle-of-the-road' pathway in which greenhouse gas emissions remain near current levels before gradually declining mid-century, without reaching net zero by 2100 - and does not account for climate adaptation measures.

[80] *Note:* Although extreme heat is not a water risk in itself, it is included in our analysis due to its compounding effects on other water-related risks and its financial materiality to semiconductor operations. High temperatures can exacerbate water scarcity by increasing evaporation rates, reducing reservoir levels, and straining cooling systems that rely on water. In semiconductor manufacturing, where ultrapure water is essential for chip fabrication and cooling, these indirect impacts of heat can significantly disrupt operations. Moreover, extreme heat often coincides with drought conditions, amplifying stress on shared water resources and infrastructure. Therefore, in this analysis we treat extreme heat as a convergent risk — one that intensifies water-related threats and contributes to overall supply chain vulnerability.

[81] Chongvilaivan, A. 2012. Thailand's 2011 flooding: Its impacts on direct exports and global supply chain disruptions. UNESCAP. https://repository.unescap.org/server/api/core/bitstreams/ebda450b-d530-468f-9c59-3da513321b0e/content.

Our analysis highlights flooding and reputational risk as the most significant threats to the portion of the semiconductor value chain examined in this study. This finding aligns with the results of a previous water risk assessment for the ICT sector conducted by the Alliance for Water Stewardship (AWS), the Responsible Business Alliance (RBA), and World Wildlife Fund (WWF).[82] The risks highlighted in our study are especially acute in regions, such as Taiwan, Shanghai and Xi'an (China), South Korea, Arizona, and California, where high water consumption intersects with increasing stress and community tensions over water allocation.

Infrastructure risk is emerging as another critical concern. Aging dams in Québec (Canada), outdated systems in Austin (Texas), and sediment-filled reservoirs in Taiwan illustrate how physical infrastructure can become a bottleneck. These vulnerabilities may require capital-intensive upgrades and public-private partnerships to ensure long-term water security.

Although the semiconductor industry is often under scrutiny for its substantial water consumption, only 16% of the sites analyzed in this study

[82] Alliance for Water Stewardship, World Wildlife Fund, and Responsible Business Alliance. 2021. Water Risk in the ICT Sector: The Case for Action. https://a4ws.org/water-risk-in-the-ict-sector/.

currently face water scarcity. Yet, as climate change and infrastructure limitations intensify water-related risks, the potential for more frequent and severe disruptions may surpass the capacity of existing contingency and business continuity plans. Importantly, 40% of existing semiconductor facilities, 24–40% of those under construction, and over 40% of facilities announced since 2021 are located in watersheds projected to face high or extremely high water stress between 2030 and 2040.[83] As the industry expands further to meet rising demand for AI, data centers, and advanced electronics, site selection for new facilities must be informed by forward-looking water risk modeling to proactively address emerging vulnerabilities. For example, recent investment surges in Dresden and other regions of Germany — driven by initiatives from the German and EU governments to strengthen domestic chip production — highlight the urgency of proactive planning. A notable development is the launch of the European Semiconductor Manufacturing Company (ESMC), a joint venture between TSMC, Bosch, Infineon, and NXP, which began construction of its first fabrication facility in August 2024.[84] Future-looking water risk assessments should, therefore, be integral to decision-making for greenfield and brownfield developments, mergers and acquisitions, and other major capital investments. This proactive approach not only safeguards operational stability but also fosters collaboration and trust with local communities and stakeholders.

As one of the key drivers of the global economy, semiconductor companies must recognize that managing supply chain disruptions caused by high-impact, low-probability events is not optional but central to resilient planning. If manufacturers remain unaware of the vulnerabilities embedded in just-in-time procurement models, they may prioritize lean operations, industrial clustering, and economies of scale at the expense of resilience. Without a clear understanding of where water-related risks originate and a robust business continuity plan, organizations are unlikely to respond timely or effectively when disruptions occur, leading to operational and financial impacts.

In this context, water security is emerging as a critical element of credit profiles in the semiconductor sector.[85] As a result, risk transfer mechanisms, such as customized insurance solutions, offer a critical layer of resilience. There is a meaningful opportunity for collaboration between insurers and the semiconductor industry

[83] Lepawsky, J. 2024. Climate change induced water stress and future semiconductor supply chain risk. iScience 27. https://www.cell.com/action/showPdf?pii=S2589-0042%2824%2900012-9.

[84] TSMC. 2024. ESMC Breaks Ground on Dresden Fab. https://pr.tsmc.com/english/news/3169.

[85] S&P Global. 2024. Sustainability Insights: TSMC And Water: A Case Study of How Climate Is Becoming a Credit-Risk Factor. https://www.spglobal.com/ratings/en/regulatory/article/240226-sustainability-insights-tsmc-and-water-a-case-study-of-how-climate-is-becoming-a-credit-risk-factor-s12992283.

to co-develop targeted instruments that address vulnerabilities at key supply chain nodes.[86] As insurers expand their focus beyond carbon emissions to include broader environmental risks, water-related vulnerabilities in industrial supply chains can become important. Access to reliable water data and the ability to engage in informed risk conversations present a strategic opportunity for insurers to support the transition to more resilient operations. For example, by co-developing water risk rating frameworks — informed by watershed-level data, facility-level exposure, and supplier practices — insurers and semiconductor companies can collaborate to embed water resilience into underwriting, investment, and operational planning.

While this assessment provides a baseline of water risk exposure across the value chain, it does not quantify a residual risk[87] and does not evaluate individual company resilience. It is intended as a starting point for deeper engagement with water risk assessment and management, industry-wide collaboration, innovation, and transparency to ensure long-term sustainability and operational resilience. By recognizing water risks as core business risks, semiconductor companies can strengthen their adaptive capacity and enhance their ability to respond timely and effectively to future disruptions.

Case Study: TSMC's Enterprise Approach to Water Risk and Climate Resilience

TSMC operates in regions highly exposed to a broad spectrum of climate and natural hazards, including droughts, floods, typhoons, snowstorms, earthquakes, and extreme temperatures. These risks pose serious threats to supply chain stability, equipment reliability, and transportation continuity. In response, TSMC has developed a corporate enterprise risk management (ERM) framework that integrates climate-related risks, including water stress, into its strategic planning and operational resilience efforts.[88] Leveraging scenario analysis based on IPCC AR6 climate pathways, TSMC evaluated potential short-, mid-, and long-term physical risks to its global facilities and five key supply chains: direct raw materials, indirect raw materials, equipment, fab facilities, and parts and components. The evaluation covered risks, such as flooding, drought, extreme heat, typhoons and associated wind damage, mudslides and landslides from heavy rainfall, rising sea levels, and

[86] Lloyd's. 2023. Loose Connections: Rethinking Semiconductor Supply Chains. https://www.lloyds.com/news-and-insights/futureset/futureset-insights/rethinking-semiconductor-supply-chains.

[87] Residual risk is defined as the disaster risk that remains in unmanaged form, even when effective disaster risk reduction measures are in place, and for which emergency response and recovery capacities must be maintained. The presence of residual risk implies a continuing need to develop and support effective capacities for emergency services, preparedness, response and recovery, together with socioeconomic policies such as safety nets and risk transfer mechanisms, as part of a holistic approach. (Source: UNDRR, https://www.undrr.org/terminology/residual-risk).

[88] TSMC. 2023. Climate and Nature Report. https://esg.tsmc.com/file/public/2023-TCNFDReport-e.pdf.

other climate- and water-related hazards.

To manage these risks, TSMC established Climate Risk Adaptative Standards that guide facility design and operational protocols across multiple dimensions, including power and water shortages, flood protection, and stakeholder expectations. These standards are regularly updated and embedded into new plant construction, ensuring resilience is built into infrastructure from the outset. Since 2022, the company has also applied a four-step methodology — identification, management, reduction, and elimination — to assess and mitigate disaster risks across its supply chain. In 2023, TSMC distributed Sustainable Management Self-Assessment Questionnaires to over 1,100 tier 1 suppliers, covering 741 facilities. The results showed that 3.5% of supplier sites face recurring extreme weather events and would be vulnerable to shipping disruptions without a business continuity plan. In response, TSMC ensured that 87.2% of supplier facilities have water shortage preparation plans aligned with its Business Continuity Planning (BCP) standards, and 97.6% have wastewater management systems in place. All tier 1 suppliers completed flood tolerance assessments.

TSMC also launched the Supplier Healthiness Assessment Rectification Program (S.H.A.R.P.), which includes audits, interviews, and on-site evaluations to assess disaster preparedness and provide targeted support. The company leverages machine learning and AI to monitor global weather patterns and predict potential disruptions, enabling proactive responses to emerging threats.

To further strengthen its water governance, TSMC implements water management practices in accordance with the Alliance for Water Stewardship (AWS) Standard. Multiple fabs undergo AWS verification or re-certification annually, consistently maintaining platinum-level performance. For water shortage, TSMC adopted response measures in compliance with the "TSMC Water Supply Shortage Crisis Management C.I." based on the drought monitoring signals issued by the Water Resources Agency.[89]

[89] TSMC. 2023 Sustainability Report. Water Stewardship. https://esg.tsmc.com/en-US/file/public/e-APractitionerofGreenPower_2.pdf.

Key Insight 2: Limited disclosure of supplier-level data can hinder effective risk management across the semiconductor value chain.

Corporate disclosures on water usage and water risk are often confined to direct operations. However, given the complexity and interconnected nature of the semiconductor supply chain, supplier engagement is critical to building business resilience. While some companies have begun requesting water-related data and encouraging sustainable water management practices, a comprehensive supplier-focused approach to water data reporting, water target setting, and risk mitigation remains largely absent. Addressing this gap at the industry level is essential to safeguard the resilience and sustainability of the semiconductor value chain in the long run.

Recent CDP data reveal that only 36% of companies (982 out of 2,739) engage their Tier 1 suppliers in water-related data collection.[90] Supplier engagement on water-related topics remains limited across other critical areas as well: 35% of companies support capacity building, 20% foster innovation and collaboration, and only 9% offer financial incentives. These figures underscore a significant opportunity for companies to deepen supplier engagement and unlock greater environmental and strategic value through disclosure. As the financial case for environmental action continues to strengthen, companies that strategically leverage their disclosure data are beginning to realize what CDP terms the "disclosure dividend." Drawing on data from nearly 25,000 corporate disclosures in 2024, CDP found that for every dollar invested in climate risk response, companies could see returns of up to US$21, with an average return on investment of 7:1. The CDP data underscore that disclosure is not just a reporting exercise, but it's also a strategic foundation for action. Companies that actively measure and manage their environmental impacts are better positioned to future-proof operations and realize measurable financial and strategic benefits, such as improved access to capital, enhanced business resilience, and stronger regulatory alignment.

While CDP disclosure offers a foundation for water-related reporting, without sector-specific benchmarks and harmonized water metrics, semiconductor companies face challenges in comparing supplier performance, identifying water risk hotspots, and prioritizing mitigation efforts across complex, transnational supply chains.

[90] CDP. 2025. The Disclosure Dividend 2025: Assessing business resilience in a rapidly changing world. https://www.cdp.net/en/insights/disclosure-dividend-2025. *Note:* The CDP analysis is based on data from 2,739 companies that submitted water-related disclosures during the 2024 CDP cycle and reported engagement with their Tier 1 suppliers.

Water-related issues can be integrated into existing supplier engagement programs and supplier codes of conduct to communicate water policies, targets, expectations, and requirements. Leading companies are advancing water stewardship by requesting water-related data from suppliers, implementing capacity-building initiatives, and promoting best practices.

Case Study: Data-Driven Approach to Water Risk and Supply Chain Resilience by Apple

Apple has advanced its corporate water stewardship for over a decade, integrating water management across its value chain through initiatives like the Supplier Clean Water Program and site-level strategies focused on efficiency, alternative sources, and replenishment.[91] In its direct operations, water is used for cooling, domestic needs, irrigation, and lab processing. Suppliers — primarily industrial water users — typically source freshwater municipally, treat it for production, and discharge it after onsite wastewater treatment. To assess the associated water use across materials, manufacturing, logistics, and product life cycles, Apple applies a life cycle assessment (LCA) approach, prioritizing primary data, such as metered water usage and supplier surveys. Where primary data are unavailable, industry averages are applied.

Apple also maps water use against local conditions, such as scarcity, quality, and access, using the World Resources Institute (WRI) Aqueduct baseline water stress (BWS) criteria, adjusted for regional factors, such as imported water. Sites are categorized into low, medium, or high stress, with high stress defined as a BWS score of 40% or greater. To better reflect actual water management practices, Apple supplements hydrologic data with hydroeconomic basin analysis, offering a more accurate view of water storage, diversion, and return flows.

Based on its water risk analysis, Apple set a goal to enroll high-water-use supplier sites located in high-stress basins into its Supplier Clean Water Program, targeting an average water reuse rate of 50% by 2030. Each participating supplier undergoes a baseline assessment across four core categories: water management, water conservation, wastewater management, and wastewater reuse. Through its Supplier Code of Conduct and Responsibility Standards, Apple enforces rigorous expectations around water and wastewater practices, stormwater control, resource consumption, and WASH (water, sanitation, and hygiene) standards. By integrating water use and water risk data into decision-making and goal setting, Apple

[91] Apple. 2025. Apple's Water Strategy. https://www.apple.com/environment/pdf/Apples_Water_Strategy.pdf

strengthens both operational resilience and supply chain accountability.

Key Insight 3: Managing water risks requires localized assessments and awareness of contextual impacts and dependencies that shape regional vulnerability.

Water risks are inherently location-specific, shaped by factors, such as local availability, quality, infrastructure, and competing demands. To manage these risks effectively, companies must adopt a contextual approach that considers catchment-level dynamics and shared dependencies, including regulatory pressures and community expectations. This includes recognizing external impacts, such as water pollution, resource depletion, and infrastructure strain, as well as dependencies on local water sources, governance, and stakeholder cooperation.

This approach distinguishes operational water management from broader corporate water stewardship and emphasizes the importance of engaging with local stakeholders, such as regulators, utilities, communities, and other water users, to proactively address risks and build long-term resilience.

As companies increasingly embrace science-based sustainability strategies, several industry frameworks offer structured methodologies to support contextual water stewardship, including:

1. **The Alliance for Water Stewardship (AWS) Standard** provides a globally recognized framework for site-level water stewardship.[92] It encourages companies to assess water risks and opportunities within the catchment context, focusing on shared challenges, such as water governance, balance, and quality. By guiding organizations through several steps, including stakeholder engagement, data collection, and risk mapping, the AWS Standard helps companies move beyond compliance toward proactive and collaborative water management.

2. **The Task Force on Nature-related Financial Disclosures (TNFD)** provides a structured LEAP framework — Locate, Evaluate, Assess, Prepare — for assessing and disclosing nature-related dependencies and impacts across business, including those related to water.[93] While this approach is primarily designed to support companies in conducting the due diligence required for

[92] The Alliance for Water Stewardship (AWS). https://a4ws.org/aws-standard/.

[93] Taskforce on Nature-related Financial Disclosures (TNFD). 2023. Guidance on the identification and assessment of nature-related issues: the LEAP approach. https://tnfd.global/publication/additional-guidance-on-assessment-of-nature-related-issues-the-leap-approach/.

disclosures aligned with TNFD recommendations, it also serves as a guidance for identifying and assessing nature-related issues, even for organizations not subject to formal disclosure requirements.

3. **The Science Based Targets for Nature (SBTN)** framework complements other frameworks by enabling companies to set science-based targets that reflect both local and global ecological limits.[94] It requires a full value chain assessment — covering direct operations and upstream suppliers — before target-setting, ensuring that corporate action is grounded in a comprehensive understanding of water impacts. SBTN also emphasizes place-based action, directing efforts to regions where nature and communities are most vulnerable.

4. **The Water Resilience Coalition's Net Positive Water Impact (NPWI)** initiative is open to companies across any sectors and geographies, and it aims to ensure that a company's contributions to basin health exceed its water-related impacts, thereby strengthening long-term resilience in water-stressed regions.[95] The framework is structured around three pillars, each addressing the core dimensions of water stress: water availability, quality, and accessibility. These pillars guide action at the site, sub-basin, and basin levels, helping to define the appropriate scale and scope of activities needed to achieve meaningful impact.

Together with water risk assessments, these frameworks enable companies to adopt a forward-looking, context-based approach to water stewardship. This approach integrates local realities with corporate sustainability goals, fosters stakeholder collaboration, and strengthens resilience across supply chains. By embracing this collaborative model, companies can move beyond traditional operational water management to address shared risks at the catchment level and build long-term resilience.

[94] The Science Based Targets Network (SBTN). https://sciencebasedtargets.org/about-us/sbtn.

[95] Brill, G., K. Schachtschneider, A. Chapagain, G. Moreira, D. Carlin, (2024). Net Positive Water Impact: An Introduction. CEO Water Mandate and Water Resilience Coalition. https://ceowatermandate.org/wp-content/uploads/2024/09/NPWI_Introduction_F.pdf.

The *Shaping the Future Water Agenda* report also reveals a strong consensus among experts on the need to better align water-related sustainability efforts with climate action and nature-based solutions.[96] About 80% of respondents believe that water deserves the same urgency and resources as climate and biodiversity, while 70% call for deeper integration of water stewardship into broader sustainability programs. Additionally, 84% view water ecosystems as essential to nature-based solutions, and 94% stress embedding water stewardship within biodiversity initiatives to unify climate mitigation, conservation, and water management. Yet, water, climate, and nature programs are often siloed, overlooking interdependencies and trade-offs. Experts warn that a narrow focus on carbon — described as “carbon tunnel vision” — can hinder progress on water and nature priorities. To enable more effective climate adaptation and resilience, it is essential to place water and nature at the center of solution development.

Case Study: Samsung’s Adoption of the Alliance for Water Stewardship Standard

For many companies, water stewardship begins at the operational level, such as manufacturing sites or office campuses. The Alliance for Water Stewardship (AWS) provides a globally recognized framework that encourages facilities to adopt a catchment-based perspective, recognizing that water quantity and quality are shaped by broader regional dynamics. This approach helps companies identify shared risks and opportunities beyond the fence line and fosters collaboration with stakeholders including regulators, utilities, and local communities.

The AWS Standard begins with a foundational step “Gather and Understand”, which guides organizations in characterizing their catchment by collecting data on[97]:

- Site water sources, discharge points, and affected catchments
- Relevant stakeholders and their water-related challenges
- Catchment-level water data, infrastructure, and water access, sanitation and hygiene (WASH) conditions
- Current and future shared water challenges

[96] WWF and GlobeScane. 2025. The Future Water Agenda: How water can lead the way for sustainability and collective action. https://wwfint.awsassets.panda.org/downloads/the-future-water-agenda-report---globescan-wwf--final-.pdf. Note: A global survey consultation was conducted online between November and December 2024 to understand the views of expert stakeholders across sectors. A total of 352 stakeholders from 63 countries and territories participated voluntarily in the survey, with 68% indicating they were based in the Global North and 32% in the Global South.

[97] LimnoTech. Setting the Catchment Context. https://www.limno.com/water-stewardship-aws-catchments/#:~:text=The%20site's%20water%20sources%2C%20discharge,achieving%20AWS%20outcomes%20(Criteria%201.8).

- Site-specific risks and opportunities
- Best practices aligned with AWS outcomes

Samsung Semiconductor has embraced this approach as a cornerstone of its sustainable water management strategy. In March 2023, its Hwaseong facility became the first in South Korea to achieve Platinum certification, the AWS's highest recognition.[98]

Building on this milestone, Samsung expanded the AWS certification across its global operations, including sites in Korea (Giheung/Hwaseong, Pyeongtaek, Cheonan/Onyang, Suwon, Gumi, Gwangju), China (Xi'an), and Vietnam. Samsung is set to expand the AWS certification to its operations in India, reinforcing its commitment to sustainable water management. This initiative supports the company's broader corporate objective to maintain water withdrawal at 2021 levels through 2030. To achieve this, Samsung continues to explore solutions that secure industrial water supply while minimizing direct water withdrawal.

To operationalize the AWS framework, Samsung follows a structured process that includes the following steps[99]:

1. **Inspect water management status and perform risk analysis:** Samsung's AWS-aligned water stewardship process begins with a comprehensive assessment of its water supply chain, identifying potential risks and impacts. Domestic sites disclose current water management status and collaborate closely with central and local governments, as well as industry partners, to ensure transparency and alignment.
2. **Develop a water stewardship plan:** Based on these insights, Samsung develops strategic water stewardship plans through active stakeholder engagement. This includes briefing sessions with environmental organizations, consultations with local communities, and multi-channel communication to build consensus and align on shared goals.
3. **Implement stewardship measures:** Implementation involves managing water by type, calculating reuse volumes, and setting annual savings targets

[98] Samsung. 2023. Samsung Semiconductor Site Awarded Highest Level Global Certification for Water Resource Management. https://news.samsung.com/global/samsung-semiconductor-site-awarded-highest-level-global-certification-for-water-resource-management.

[99] Samsung. Samsung Semiconductor awarded the highest level of AWS through innovative technology. https://semiconductor.samsung.com/sustainability/environment/preserving-nature/alliance-for-water-stewardship-certification/.

to improve efficiency. Samsung also encourages its partners to establish water conservation goals and monitors their progress annually, promoting a collaborative approach to sustainable water management.

4. **Monitor and evaluate performance:** Water management performance is regularly reviewed and updated. Samsung partners with NGOs, local researchers, communities, and internal stakeholders to monitor nearby ecosystems and support river conservation efforts.

5. **Communicate and disclose transparently:** Samsung maintains open communication about its water usage and stewardship strategies. These efforts are shared with stakeholders through the Ministry of Environment's Reuse Committee and are disclosed publicly via the company's website and sustainability reports.

Key Insight 4: Coordinated water stewardship should be embedded into corporate sustainability strategies to drive proactive engagement and collective action.

Companies in the semiconductor value chain are deeply interconnected, often sharing suppliers that operate within the same water basins. This interconnectedness presents a strategic opportunity for meaningful collaboration and collective action, encouraging suppliers, customers, and peers to jointly participate in water stewardship initiatives.

Collective action in the context of water stewardship can be defined as *"a coordinated set of engagements among interested parties playing complementary roles, which pools together knowledge, resources and/or expertise to jointly identify and implement solutions at various geographic scales, with the aim to address shared freshwater challenges".*[100] Because water is a shared resource, collective action is essential to achieve the scale, reach, and urgency required to address common water challenges within catchments.

Many semiconductor companies are collaborating on sector-specific water quality issues — particularly around PFAS. For example, the PFAS efforts are increasingly supported by the Semiconductor PFAS Consortium under the Semiconductor

[100] Various Organizations. 2024. Unpacking collective action in water stewardship: shared solutions for shared water challenges. https://wwf.panda.org/wwf_news/?11419466/Unpacking-collective-action-in-water-stewardship.

Industry Association (SIA)[101] and the SEMI PFAS Initiative[102], which promote science-based approaches to PFAS reduction and replacement.

However, broader water stewardship partnerships are still emerging. Our analysis identified that a subset of companies, particularly several in the U.S. and Taiwan, are exposed to water supply risks due to aging water infrastructure. While a few companies reported engaging with their local water utilities, this does not appear to be a common practice. Companies operating in shared basins have a strategic opportunity to collaborate with municipalities and local utilities to identify infrastructure plans and explore joint investments that enhance water system resilience.

In Europe, water utilities are increasingly focusing on modernizing infrastructure and adopting digital technologies, such as real-time asset monitoring and enhanced water data collection and management systems. According to Bluefield projections, spending in the European water sector on data management, cybersecurity, and compliance is expected to grow at a compound annual growth rate (CAGR) of 12.2% between 2024 and 2033.[103] By adopting a proactive, context-based approach, semiconductor companies can collaborate with local water utilities to exchange data and expertise to better address challenges and uncover opportunities related to their water supply.

To drive meaningful impact and scale, efforts must mobilize a critical mass of organizations across sectors and enhance collaboration in key areas[100]:

- Globally, by harmonizing fragmented dialogues;
- Within sectors, by moving beyond isolated company efforts;
- Across sectors, by addressing shared challenges in co-located industries;
- Through public-private partnerships aligned with policy goals;
- At the catchment level, rather than through isolated projects.

Best practice examples from other sectors can offer valuable guidance for water-intensive industries like semiconductors. For instance, WWF's Collective Action Programs in the apparel and textile industry demonstrate how coordinated efforts

[101] Semiconductor Industry Association (SIA). Semiconductor PFAS Consortium. https://www.semiconductors.org/pfas/.

[102] SEMI. SEMI PFAS Initiative. https://www.semi.org/en/semi-pfas-initiative.

[103] Bluefield. 2025. Europe Digital Water Market Outlook: Key Drivers, Competitive Shifts and Forecasts, 2024-2033. https://www.bluefieldresearch.com/research/europe-digital-water-market-outlook/.

among corporate partners, governments, financial institutions, and civil society can foster basin-level water stewardship.[104] Through on-the-ground programs in five key river basins — spanning Türkiye, Pakistan, Viet Nam, India, and China — project partners have achieved tangible outcomes, including measurable water savings, restoration of freshwater ecosystems, expansion of green financing, and scaled wastewater reuse.

Beyond industry collaboration, proactive engagement with policymakers and transparent communication with regulators, local communities, and industry groups are critical. These actions foster trust, facilitate peer-to-peer learning, and support the development of standardized water stewardship practices. They also help companies prepare for and align with emerging regulations such as the EU Corporate Sustainability Reporting Directive (CSRD) and the EU Corporate Sustainability Due Diligence Directive (CSDDD), which require disclosure and due diligence on water-related impacts across the value chain.

In this context, alignment with broader policy frameworks, such as the European Water Resilience Strategy, can further enhance corporate efforts. This strategy emphasizes integrated water management, cross-sector collaboration, and investment in water-smart innovation. It also encourages public-private partnerships to drive breakthroughs in dry cooling technologies and advanced water treatment — solutions that are particularly relevant to water-intensive industries like semiconductors. By embracing systems-level solutions, such as collective action, multi-stakeholder engagement, and cross-sector collaboration, the semiconductor industry can strengthen its adaptive capacity, mitigate water-related risks, and contribute to long-term water security and operational resilience.

Supplier Engagement

Expanding supplier engagement to include water-related topics offers mutual benefits for both suppliers and their customers. Since significant water risks and dependencies often lie deep within supply chains, it is essential for companies to identify effective strategies to mobilize suppliers. Supplier collaboration should be strategically focused on the segments of the supply chain with the greatest potential to reduce water impacts. Companies can prioritize supply chain segments via water risk assessments and questionnaires to suppliers to understand adaptive capacity to these risks.

[104] WWF. 2025. Drop by drop: Highlights from WWF's collective action programs on water stewardship in the Apparel and Textiles Sector. https://www.worldwildlife.org/publications/drop-by-drop-highlights-from-wwf-s-collective-action-programs-on-water-stewardship-in-the-apparel-and-textiles-sector.

Once these high-impact areas and suppliers are identified, companies can assess which collaboration pathways best fit their specific context. Key pathways for engagement can include: (1) Operational enhancements, (2) Financial activation, (3) Advocacy engagement, (4) Industry alignment, and (5) Procurement incentivization.[105] Some of these approaches may need to be gradually integrated into existing procurement and supplier evaluation practices, such as supplier data collection and analysis, supplier scorecards or a Supplier Code of Conduct.

Industry Collaboration

Addressing shared water challenges through industry-wide collaboration is essential not only for maintaining operational resilience but also for building trust, enabling peer-to-peer learning, and advancing standardized water stewardship practices.

Prominent initiatives led by the Alliance for Water Stewardship[106] and the Responsible Business Alliance[107] have laid groundwork through sector-specific standards and tools, while also providing best practice examples of advancing water stewardship.

A notable example in the semiconductor sector is the SEMI Water Management Working Group, which is developing tools such as water management maturity scales and regulatory scans through collective efforts across the value chain. Key collaborators include the SEMI Accelerating Sustainability with Smart Manufacturing Task Force, the Alliance for Water Stewardship (AWS), and the International Roadmap for Devices and Systems (IRDS) Environmental Sustainability of Semiconductor Facilities Forum.

Beyond technical collaboration, the adoption of common reporting frameworks across the supply chain can streamline data collection and improve consistency. Sector-wide water-related commitments, when disseminated throughout the supply chain, help align efforts and drive meaningful progress. Supporting suppliers in adopting recognized water stewardship practices, including setting context-specific water targets, ensures that sustainability efforts extend beyond direct operations and strengthens collective impact.

[105] Dobson, R., Watt, J. and Morgan, A. 2023. Collaborating with key suppliers to advance water stewardship. https://wwfint.awsassets.panda.org/downloads/advancing-water-stewardship-through-supplier-collaboration_hr.pdf.

[106] The Alliance for Water Stewardship. Water in the technology sector. https://a4ws.org/priority-sectors/tech-and-microelectronics/water-stewardship/.

[107] Responsible Business Alliance (RBA). Water Stewardship. https://www.responsiblebusiness.org/initiatives/rei/water-stewardship/.

Policymakers and Regulators

Proactive engagement with policymakers is a critical component of effective water stewardship, particularly as regulatory landscapes evolve to address growing water-related challenges. By participating in policy dialogues, companies can help shape frameworks that are both ambitious and practical, while also ensuring alignment with their operational realities.

A recent example of such engagement is the initiative led by SEMI Europe, which coordinated with member companies — both within and outside the European Union — to submit formal input during the March 2025 stakeholder consultation for the EU Water Resilience Strategy. This effort exemplifies how industry associations can serve as a bridge between regulators and businesses, opening new opportunities for dialogue and collaboration as the strategy develops.

To effectively address water-related disaster risk reduction, companies must move beyond isolated efforts toward system-scale solutions that support integrated resilience strategies and policy advocacy across sectors. A structured, collaborative approach begins with clearly defining the problem and engaging diverse stakeholders — governments, businesses, nonprofits, and communities — to align on how water is valued across regions.[108] Real-world initiatives like the California Water Action Collaborative (CWAC)[109] and the Texas Water Action Collaborative (TxWAC)[110] demonstrate how cross-sector partnerships can drive scalable, consensus-based water stewardship action to advance sustainable solutions for California's and Texas's major water challenges and balance corporate and community resilience.

Policy engagement also supports companies in preparing for emerging regulations focused on water-related impacts, including the EU CSRD and the EU CSDDD. By staying ahead of regulatory trends and contributing to their development, companies can not only ensure compliance but also help shape a more resilient and sustainable water future for the sector.

Local Communities

As transparency expectations rise, particularly in water-stressed regions, failure to engage collaboratively with local communities can result in both operational and

[108] Deloitte. 2023. Tackling America's water crisis: A cross-sector approach. https://www.deloitte.com/us/en/insights/industry/government-public-sector-services/tackling-our-water-crisis.html.

[109] California Water Action Collaborative (CWAC). https://cawateraction.org/.

[110] Texas Water Action Collaborative (TxWAC). https://texanbynature.org/projects/texas-water-action-collaborative/.

reputational risks. Reputational risk is a growing concern for the semiconductor industry, as reflected in our water risk assessment and broader global scrutiny of high-water-use sectors. Public expectations for sustainable water practices and corporate accountability continue to intensify, underscoring the need for proactive water risk management.

An industry-specific example of community-centered stewardship comes from Japan Advanced Semiconductor Manufacturing (JASM), a joint venture among TSMC, Sony Semiconductor Solutions, Toyota Motors, and Denso. In May 2023, JASM reached an agreement with local stakeholders in Kumamoto, Japan, including a farmers group, the Kumamoto Prefectural Government, Kikuyo, and the Kumamoto Groundwater Foundation, to recharge 100% of the groundwater it uses and subsidize rice farmers participating in the recharge initiative.[111] This partnership demonstrates how industry can actively contribute to local water resilience while maintaining operational continuity.

Early and meaningful engagement with communities — especially during project concept and site selection — enables companies to understand local perceptions, basin-level challenges, and shared priorities. This early dialogue can help foster trust, create opportunities for collaboration, and allow companies to integrate community-informed solutions into project design. It also helps shift the narrative from industry as a consumer of limited resources to a partner in solving local water challenges.

By embracing community engagement, companies not only mitigate risk and strengthen their social license to operate, but also contribute to integrated water management, cross-sector collaboration, and long-term water security.

Case Study: Intel's Approach to Community Engagement

Like all water users, companies depend on the health of watersheds and the vital services they provide. Ensuring balanced water quantity, high water quality, and thriving ecosystems supported by resilient infrastructure and strong community governance is essential for long-term water security and regional sustainability.

Intel has made water stewardship a core pillar of its corporate environmental strategy, setting a company-wide goal to achieve net positive water use by 2030. This means that by 2030, Intel aims to replenish more water than it consumes

[111] The Japan Times. 2024. Japan's chipmaking rush pressures Kumamoto's special water supply. https://www.japantimes.co.jp/environment/2024/11/17/sustainability/kumamoto-water-semiconductors/#:~:text=Economic%20boom,during%20the%20wafer%2Dcleaning%20process.

across its direct operations.[112] To realize this vision, Intel has adopted a collaborative approach, working closely with municipal governments, water utilities, NGOs, and community organizations to identify and fund water restoration projects that deliver measurable benefits to local watersheds.

In 2023, Intel supported 44 water restoration projects across multiple countries, collectively restoring over 3.1 billion gallons of water [112]. These initiatives span a wide range of geographies and project types, including:

- Infrastructure investments, such as pipelines, wells, and treatment plants in Arizona, Oregon, New Mexico, and Israel, which enhance water delivery and treatment capacity;
- Nature-based solutions and watershed restoration efforts that improve ecosystem health and community water access;
- Rainwater harvesting systems in schools and public facilities, helping reduce groundwater extraction and improve local resilience.

To ensure impact and alignment with its sustainability goals, Intel evaluates potential water replenishment projects based on the following criteria:

- Connection to source watersheds and local communities
- Proven capacity and credibility of implementing organizations
- Long-term or critical short-term water benefits
- Opportunities for community and employee engagement
- Potential for scaling and leveraging additional funding.

This structured, criteria-driven approach ensures that each project delivers tangible environmental and social value. Intel's model demonstrates how companies can move beyond operational boundaries to become active partners in regional water resilience. Through investments in local infrastructure and collaboration with public and civil society stakeholders, Intel supports water resource restoration and enhances community well-being.

[112] Intel. Water Restoration 2023 Progress Report. https://www.intel.com/content/www/us/en/environment/restore-water-goal-report.html.

Case Study: Integrating Risk Management and Regional Water Stewardship by SCREEN Semiconductor Solutions

A Japan-based company, SCREEN Semiconductor Solutions, applies a structured approach to water stewardship that integrates site-level risk management with regional ecosystem management.[113] To assess climate-related risks, the company uses municipal hazard maps to evaluate flood exposure and conducts ground elevation measurements for its facilities. Based on these assessments, SCREEN implements flood prevention measures, such as waterproof doors and seals to support operational continuity. In addition to managing site-level water risks, SCREEN engages in regional water stewardship efforts near Lake Biwa, Japan's largest freshwater source. Its strategy includes monthly monitoring of water intake, onsite purification to voluntary standards exceeding regulatory requirements, and reuse of treated water for local agriculture. SCREEN also collaborates with local governments and research institutions to support ecosystem preservation in the Lake Biwa-Yodo River system, guided by its Biodiversity Action Guidelines.

Key Insight 5: Innovation and technology should play a central role in advancing water stewardship across the semiconductor supply chain.

As the semiconductor sector continues to expand and innovate, its growing dependency on water presents both a challenge and an opportunity. Meeting rising global demand for technology while minimizing local water impacts cannot rely solely on traditional efficiency measures. Instead, it requires a holistic understanding across the entire supply chain, reinforcing the need for collaboration and a shift from conventional water management to integrated water stewardship.

Underinvestment in water resources stems from a combination of political, regulatory, and governance challenges that hinder public coordination, and financial barriers that deter private investment, such as high capital costs, long payback periods, and limited monetization potential.[114] At the heart of these issues lies the widespread undervaluation and mispricing of water. Undervaluation reflects the failure to recognize the full social, environmental, and economic value of water, often due to the perception that water resources are abundant and free. Mispricing, meanwhile, results from pricing mechanisms that ignore the true costs

[113] Information provided by SCREEN during this project through a self-reported survey and an interview.
[114] BCG. 2025. What Is Water Really Worth? https://www.bcg.com/publications/2025/what-is-water-really-worth.

of supply and environmental impacts, leading to weak market signals and inefficient use. Together, these dynamics reinforce each other, perpetuating underinvestment and exacerbating the global water crisis. For instance, only 1% of the $58.5 billion invested in climate tech globally in 2021 went to water.[115] Addressing water pricing is, therefore, critical to unlocking sustainable investment and responsible water management.

Self-reported survey data show that many companies are already adopting advanced technologies, such as onsite recycling, real-time monitoring, and predictive analytics, to reduce freshwater consumption, improve water use efficiency, and detect leakage early. In water-scarce regions, companies are turning to alternative sources, such as municipal wastewater.

For instance, TSMC developed a reclamation plant that serves as the central facility for processing, monitoring, and supplying reclaimed water to TSMC's fabs in Southern Taiwan Science Park.[116] It treats industrial wastewater and monitors municipal reclaimed water from nearby plants. TSMC is also investing in technologies for wastewater thickening using waste heat and sludge recycling to minimize environmental impact. By 2026, the plant is expected to supply up to 9.51 million gallons of reclaimed water per day, significantly reducing reliance on municipal water sources and supporting more sustainable operations. In 2022, TSMC launched the Hsinchu Science Park Reclaimed Water Plant Project, aiming to supply over 2.6 millions gallons of industrial reclaimed water per day by 2025 for 2nm process fabs. By 2030, TSMC targets over 60% reclaimed water replacement for its Taiwan fabs to boost resilience and support long-term water recycling.

Another example is the recent capital project announcement by Climate Adaptive Infrastructure (CAI), an investment firm specializing in sustainable infrastructure, which committed $66 million to a Water-as-a-Service (WaaS) initiative for a semiconductor fabrication facility in the Midwest U.S.[117] The project, developed in partnership with Veolia Water Technologies & Solutions, will deliver a state-of-the-art water reuse and treatment facility at the manufacturer's new site, supporting its

[115] The Next Web. 2023. Water tech could be the next gold rush for European VCs. https://thenextweb.com/news/water-technology-investment-europe-startups. Cited in: BCG. 2025. What Is Water Really Worth? https://www.bcg.com/publications/2025/what-is-water-really-worth.

[116] TSMC. 2022. TSMC S.T.S.P. Reclaimed Water Plant Commences Operation – The World's First Industrial Reclaimed Water Plant for Advanced Semiconductor Processes. https://esg.tsmc.com/en/update/greenManufacturing/caseStudy/63/index.html.

[117] Climate Adaptive Infrastructure (CAI). 2025. Climate Adaptive Infrastructure Partners with Veolia Water Technologies & Solutions to Finance and Deliver Innovative $66M Water as a Service Project for a Leading Semiconductor Manufacturer. https://www.climateadaptiveinfra.com/news-and-insights/climate-adaptive-infrastructure-partners-with-veolia-water-technologies-and-solutions%20/.

reshoring strategy and enabling the recycling of approximately 2.1 million gallons of water per day. Under the WaaS model, CAI will finance and own the facility, turning capital expenditure into operating expenditure for the host, while Veolia will manage operations, leveraging its expertise in ultrapure water systems and advanced wastewater treatment. This strategic collaboration exemplifies a capital-efficient approach to industrial water management, addressing growing demands for water reuse and conservation in semiconductor manufacturing. The facility is expected to be operational by late 2026 and will play a critical role in reducing environmental impact and enhancing operational resilience.

Industry-wide efforts are also accelerating the adoption of scalable water management solutions and addressing emerging contaminants. Initiatives like the SEMI Smart Manufacturing Task Force are developing a roadmap for Industry 4.0/5.0 deployment, leveraging connected, sensing, and predictive technologies to improve water efficiency across semiconductor facilities. In parallel, the industry is tackling microcontaminants, such as PFAS, through collaborative programs, including the SEMI Smart Manufacturing Task Force and PFAS-focused initiatives like PRISM and the Semiconductor PFAS Consortium.

According to the 2025 BCG report, investing $1 trillion in water infrastructure between 2020 and 2030 could unlock approximately $7 trillion in net benefits, with each dollar spent yielding a return of nearly $7.11.[118] In contrast, failing to make these investments could result in societal costs ranging from $2 trillion to $10 trillion, underscoring the urgency and value of proactive water infrastructure funding.

Additionally, investing in green infrastructure can mitigate water-related risks, while delivering environmental co-benefits. Green infrastructure offers a sustainable solution to water challenges by using natural systems, such as vegetation, soil, and permeable surfaces, to manage stormwater runoff.[119] Unlike traditional gray infrastructure, which channels untreated runoff into waterways, green infrastructure mimics natural hydrology to absorb and filter rain where it falls, reducing pollution, flooding, and erosion. It improves water quality, replenishes groundwater, and supports climate resilience while delivering economic and health benefits such as lower energy costs, reduced heat and smog, and enhanced public well-being. Examples include rain gardens, bioswales, green roofs, permeable pavements, artificial wetlands, and sponge cities, all of which help the built environment adapt

[118] BCG. 2025. What Is Water Really Worth? https://web-assets.bcg.com/6a/02/67fa829344dea8b6949943cab8e6/what-is-water-really-worth-report.pdf.

[119] AECOM. 2023. A Playbook for Nature-Positive Infrastructure Development. https://www.worldwildlife.org/publications/a-playbook-for-nature-positive-infrastructure-development.

to climate- and water-related impacts and aging infrastructure while promoting equity and livability.

These innovations can not only enhance operational resilience but also promote technology adoption among suppliers, advancing water stewardship throughout the value chain. Cross-industry collaboration and the sharing of best practices are essential to accelerating progress and fostering a culture of continuous improvement.

Case Study: Optimizing Water Use Through Municipal Collaboration by ASM and Veolia

ASM, a global supplier of semiconductor wafer processing equipment, partnered with Veolia Water Technologies & Solutions, to reduce water consumption at its Phoenix, Arizona, facility, located in a water-sensitive region.[120] A joint audit identified the cooling tower system as a major water user and proposed reducing discharge flow to save water, despite increasing dissolved solids. Veolia supported ASM in presenting the plan to the local municipality, which approved a permit revision allowing more cycles of operation. This change reduced daily water use from 28,000 to 9,000 gallons — a 60% decrease — saving over 6.8 million gallons annually and earning ASM Veolia's Return on Environment Award. The initiative also helped to reduce chemical treatment costs, saving over $35,000, and exemplifies how technical innovation, regulatory engagement, and operational flexibility can drive meaningful sustainability outcomes.

[120] Veolia. Semiconductor equipment supplier partners with Veolia to reduce water consumption. https://www.watertechnologies.com/case-study/semiconductor-equipment-supplier-partners-veolia-reduce-water-consumption.

Case Study: Transforming Water Reuse at Lam Research's Silfex Facility Through Partnership with Xylem

Silfex, a division of Lam Research and a manufacturer of precision components for semiconductor manufacturing equipment, partnered with Xylem, an American water technology provider, to enhance water sustainability at its Springfield, Ohio facility.[121] Together, Silfex and Xylem designed and implemented an innovative brine recovery reverse osmosis membrane and ultrapure water system. This system captures reverse osmosis reject water and overflow from precision cleaning processes, recycling it throughout operations. The initiative began with a comprehensive assessment of the plant's water treatment systems, where operators analyzed waste streams by volume and chemical composition. This enabled the facility to recover reserve osmosis reject waters, resulting in a 15% reduction of select ultrapure water system waste streams.

Building on these gains, Silfex and Xylem developed a strategy to recover cleanroom wastewater by segregating and treating streams with minimal risk.[115] This collaborative approach, involving process owners and water quality experts, enabled the facility to recycle up to 80% of its discharge, saving millions of gallons annually and reducing reliance on municipal water. The success of this project supports Lam Research's broader sustainability goals, which include repurposing process-based wastewater and achieving 80 million gallons of water savings by 2025.

[121] Xylem. 2024. Liquid Assets: Boosting semiconductor industry resilience through water reuse solutions. https://www.xylem.com/en-us/making-waves/industrial-news/liquid-assets-boosting-semiconductor-industry-resilience-through-water-reuse-solutions/.

6. Corporate Water Stewardship Journey

As our water risk assessment illustrated, water-related challenges affect e very segment of the semiconductor value chain, requiring tailored approaches to water stewardship.

Facilities across the semiconductor value chain should strengthen their business resilience and continuity planning to address escalating flood risks. Foundries, given their substantial operational water footprints, should further prioritize water availability and pollution mitigation by sourcing municipal reclaimed sources, expanding water reuse and onsite treatment, and partnering with local water utilities. To address rising regulatory risks, chemical and materials suppliers must proactively manage concerns around water quality, especially regarding persistent contaminants such as PFAS, which are facing increasing scrutiny both in the U.S. and globally.

The Alliance for Water Stewardship (AWS) provides a useful three-stage framework to guide companies in advancing their corporate water stewardship journey (Fig. 9):

- Stage 1 encourages organizations to assess how freshwater is material to their business, evaluate water risks across basins they impact or depend on, and prioritize high-risk locations using water risk assessment tools.
- Stage 2 focuses on site-level action, including developing and implementing water stewardship plans, setting targets, and engaging in collective action with stakeholders such as suppliers, communities, civil society, and public agencies.
- Stage 3 emphasizes validating progress against site-level water action plans and targets, certifying actions through standards like AWS and SBTN, and transparently reporting outcomes via frameworks such as CDP, GRI, and TNFD.

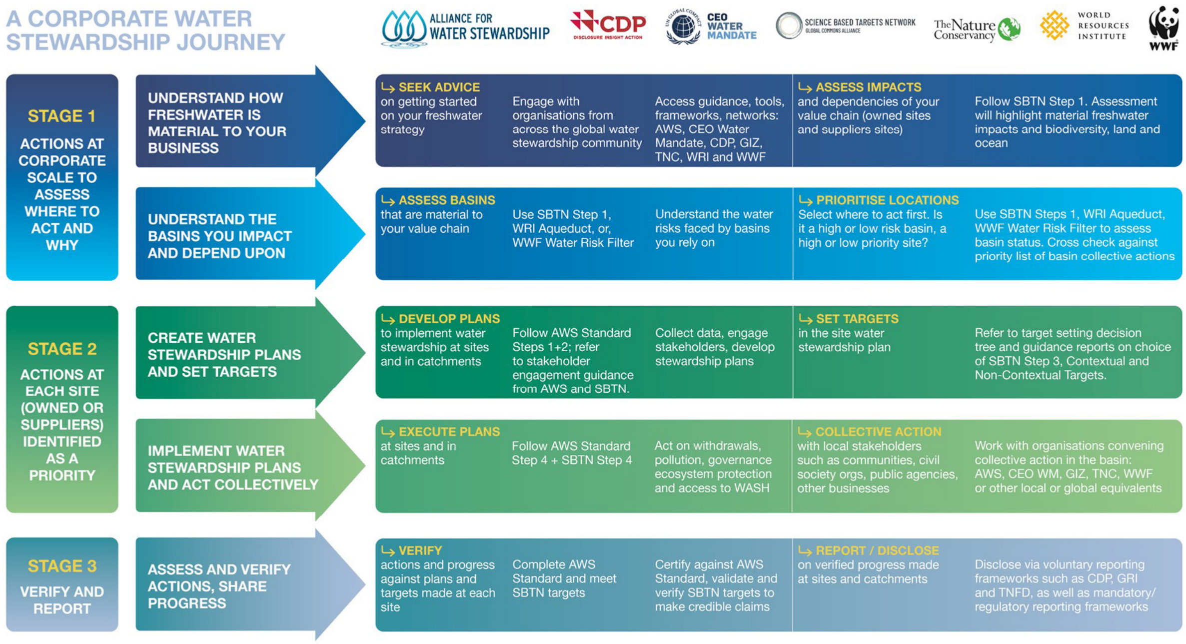

Figure 9. An example of the corporate water stewardship journey. *(Source: The Alliance for Water Stewardship[122]).*

While corporate water stewardship pathways may differ, the AWS framework, alongside other industry standards, follows a common set of steps and can be implemented using a variety of tools and resources (Table 1). This structured journey can support companies in building resilience and credibility in water stewardship across their operations and supply chains.

[122] The Alliance for Water Stewardship. 2023. A Corporate Water Stewardship Journey. https://a4ws.org/resource/a-corporate-water-stewardship-journey/.

Corporate Water Stewardship Journey	Recommended Resources & Tools
Conduct a water materiality assessment by mapping site-level water impacts and dependencies:* - Site-level water withdrawals, consumption and discharges - Water-related life cycle assessments of the company's products and services	The International Water Stewardship Standard (AWS Standard)[123] EFRAG IG 1: Materiality Assessment Implementation Guidance[124] The Global Assessment of Private Sector Impacts on Water, Ceres[125] Setting Enterprise Water Targets: A Guide for Companies, The CEO Water Mandate[126] Ecolab Smart Water Navigator[127]
Perform site-level water risk assessments and prioritize high-risk sites: - Quantitative risk assessment - Qualitative site-level surveys - Context-based risk assessment (e.g., mapping primary water source vulnerability)	Aqueduct Water Risk Atlas, World Resources Institute[128] Aqueduct 4.0: Updated decision-relevant global water risk indicators, World Resources Institute[129] WWF Water Risk Filter[130] WWF Water Risk Filter Suite v2.0, Data & Methods[131] Waterplan Water Risk Framework[132]
Set site-level and corporate water targets	Corporate Water Stewardship and Science-based Targets for Freshwater, Science Based Targets Network[133]

[123] The Alliance for Water Stewardship. The AWS Standard. https://a4ws.org/aws-standard/.

[124] EFRAG. 2022. EFRAG IG1: Materiality Assessment. Implementation Guidance. https://www.efrag.org/sites/default/files/sites/webpublishing/SiteAssets/IG%201%20Materiality%20Assessment_final.pdf

[125] Ceres & Global Institute for Water Security. 2022. The Global Assessment of Private Sector Impacts on Water. https://www.ceres.org/resources/reports/global-assessment-private-sector-impacts-water.

[126] Reig, P., T. Shiao, K. Vigerstol, C. Copeland, A. Morgan, C. Strong, R. Hamilton, R. Dobson, and S. Walker. 2021. Setting Enterprise Water Targets: A Guide for Companies. UN Global Compact CEO Water Mandate, Pacific Institute, CDP, The Nature Conservancy, World Resources Institute, and WWF. www.ceowatermandate.org/enterprise-water-targets.

[127] Ecolab. Ecolab Smart Water Navigator. https://prod.smartwaternavigator.com/.

[128] World Resources Institute. Aqueduct. https://www.wri.org/aqueduct.

[129] Kuzma, S., M.F.P. Bierkens, S. Lakshman, T. Luo, L. Saccoccia, E. H. Sutanudjaja, and R. Van Beek. 2023. Aqueduct 4.0: Updated decision-relevant global water risk indicators. Technical Note. Washington, DC: World Resources Institute. aqueduct-40-technical-note.pdf.

[130] WWF. WWF Risk Filter Suite. https://riskfilter.org/water/explore/introduction.

[131] WWF. WWF Water Risk Filter Suite v2.0, Data & Methods. https://riskfilter.org/data-&-methods.

[132] Waterplan. Water Risk Framework. https://www.waterplan.com/solutions/water-risk.

[133] Science Based Targets Network. 2024. Corporate water stewardship and science-based targets for freshwater. Alignment and interoperability between leading approaches. https://sciencebasedtargetsnetwork.org/wp-content/uploads/Corporate-water-stewardship-and-science-based-targets.pdf.

Develop risk mitigation and water action plans	The International Water Stewardship Standard (AWS Standard)[102] Success Strategies for Developing a Site Water Stewardship Plan within the AWS Standard Framework, LimnoTech[134]
Identify and engage basin-level stakeholders	The International Water Stewardship Standard (AWS Standard)[71] Water Stewardship, Responsible Business Alliance[135] Understanding and Engaging Water-Related Stakeholders, LimnoTech[136] Stakeholder Engagement Guide for Nature-Based Solutions, The CEO Water Mandate[137] Unpacking Collective Action in Water Stewardship, WWF, AWS et al.[138] Advancing Water Stewardship Through Supplier Collaboration, WWF[139]
Report progress through platforms like CDP, TNFD, and voluntary and regulatory sustainability reports and disclosures	CDP Water[140] The Taskforce on Nature-related Financial Disclosures (TNFD)[141] Water Reporting: The Basics, Waterplan[142]

Table 1. Key steps in the corporate water stewardship journey, along with recommended resources and tools.

*(Note: Impacts on water resources determine to what extent activities of the value chain contribute to shared water challenges. Dependencies determine to what extent activities of the value chain are likely to be affected by water challenges because of their dependency on water quantity or quality.)

134 LimnoTech. 2023. Success Strategies for Developing a Site Water Stewardship Plan within the AWS Standard Framework. https://www.limno.com/water-stewardship-site-plan/.

135 Responsible Business Alliance (RBA). Water Stewardship. https://www.responsiblebusiness.org/initiatives/rei/water-stewardship/.

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7. Looking Ahead

This report opens the door to further exploration of corporate water risk, resilience, and stewardship, and shares a perspective on collaboration across the semiconductor value chain. SEMI members can use this paper as a strategic resource to evaluate their own and their suppliers' water risk exposure, identify high-risk geographies, and align their sustainability strategies with emerging water-related regulatory and stakeholder expectations.

By leveraging the catchment-level insights and hotspot mapping, SEMI members can prioritize regions for deeper site-specific assessments, such as evaluating a facility's elevation above a floodplain or proximity to vulnerable water sources, to better understand physical risks and stakeholder dynamics. These granular evaluations complement broader basin-level analyses and support more informed decision-making.

The report also presents an opportunity for SEMI members to engage in collective action, both within the SEMI community and across the broader value chain. Internally, SEMI working groups such as the Environmental Risk Reporting and Mitigation (ERMR) Working Group under the SEMI Semiconductor Climate Consortium (SCC) can use these findings to foster peer-to-peer learning, develop shared tools, and coordinate responses to water-related risks.

Externally, SEMI members can collaborate with their suppliers, customers, and public agencies to advance water stewardship. This can include joint risk assessments in shared water basins, supplier engagement campaigns focused on water use, water efficiency and water risk, as well as participation in multi-stakeholder platforms like the AWS and the RBA.

While action cannot occur everywhere simultaneously, this report highlights strategic hotspots where coordinated efforts could yield the greatest impact. It encourages SEMI members to move beyond isolated company efforts and embrace sector-wide and cross-sector partnerships that address shared challenges in co-located industries. Ultimately, this report aims to spark dialogue and coordinated action among industry, public agencies, government, and civil society, for a resilient and responsible semiconductor value chain.

Feedback is welcome via email at asuleimenova@marvell.com and scc@semi.org.

8. Appendix

Survey Questions

1. Do you respond to CDP Water?
2. What water-related issues are of most concern to your company (including direct operations and/or your suppliers)? (Select all that apply)
   a. Water scarcity / stress / lack of water
   b. Floods
   c. Incoming / supply water quality
   d. Wastewater quality
   e. Water infrastructure
   f. Regulations on water, such as restrictions or new reporting requirements
   g. Reputational risks
   h. Other [write-in below]
3. Has your company experienced any of the following in the last 10 years at any of your sites or your suppliers' sites?
   a. Water availability issues
   b. Water supply disruptions due to infrastructure failure (e.g., dam's structural failure, natural or human-induced damage to water mains)
   c. Major water quality issues - incoming supply
   d. Major water quality issues - discharge
   e. Significant change in water rates, permits, or regulations
   f. Flood events
   g. Other natural hazard, such as landslide, hurricane, tornado, earthquake
   h. Portrayed negatively in the media about water issues
   i. Other [write in below]

4. What water risk mitigation initiatives, if any, have been implemented at your sites or your suppliers' sites over the past 10 years?
    a. Alternative source of water supply
    b. Contingency or emergency response plans for drought or floods
    c. Onsite treatment of incoming water
    d. Hazardous materials / chemicals management policy or spill prevention procedures
    e. Wastewater treatment
    f. Water recycling
    g. Efficiency measures like leak detection and prevention
    h. Investing in more water-efficient technologies
    i. Engaging with local stakeholders
    j. Other [write-in below]
5. What has been the impact of taking the above measure(s) on mitigating water risk?
6. What are the main challenges your company or you're your suppliers face in implementing water risk mitigation? Select all that apply.
    a. Budget
    b. Data
    c. People
    d. Competing priorities
    e. Materiality of water
    f. Getting executive buy-in
    g. Other [write-in below]

7. Which of the following stakeholders do you engage with at least once annually? Select all that apply.
    a. Regulators
    b. Local community
    c. Employees
    d. Suppliers
    e. Customers
    f. NGOs / nonprofits
    g. Water utilities (if applicable)
    h. Other [write-in below]:
8. Can you describe your relationship with, or how you engage with, the above stakeholders? Please provide a written response.
9. Can you provide specific examples or case studies of successful water risk mitigation projects within your organization? Please provide a written response, considering the questions below.
    a. What lessons have you learned from implementing these projects that could benefit the broader industry?
    b. Are there any innovative practices or technologies you've adopted that you believe are industry-leading?
    c. Please provide any supporting information.
10. If you have shared examples above, would you prefer this information be kept anonymized? An anonymized example would describe the program or projects and risk mitigation benefits but would not name your company.
    a. Yes, please anonymize
    b. No, we're happy to share
    c. Other [write-in below]