

# PERFORMANCE AUDIT



Office of the  
Washington  
State Auditor  
Pat McCarthy

## Improving Sound Transit's Project Planning and Design to Reduce Costs

June 18, 2020

Report Number: 1026355

# Table of Contents

Executive Summary	3
Background	5
Audit Results	8
Sound Transit could improve project planning and design with more upfront planning and a formal lessons learned process	8
Recommendations	20
Agency Response	21
Appendix A: Initiative 900 and Auditing Standards	26
Appendix B: Scope, Objectives and Methodology	29

## State Auditor's Office contacts

### State Auditor Pat McCarthy

564-999-0801, [Pat.McCarthy@sao.wa.gov](mailto:Pat.McCarthy@sao.wa.gov)

### Scott Frank – Director of Performance and IT Audit

564-999-0809, [Scott.Frank@sao.wa.gov](mailto:Scott.Frank@sao.wa.gov)

### Christopher Cortines, CPA – Assistant Director for Performance Audit

206-355-1546, [Christopher.Cortines@sao.wa.gov](mailto:Christopher.Cortines@sao.wa.gov)

### Tania Fleming – Principal Performance Auditor

564-999-0823, [Tania.Fleming@sao.wa.gov](mailto:Tania.Fleming@sao.wa.gov)

### Michael Huynh – Lead Performance Auditor

564-999-0831, [Michael.Huynh@sao.wa.gov](mailto:Michael.Huynh@sao.wa.gov)

### Holland Kitchell – Performance Auditor

564-999-0842, [Holland.Kitchell@sao.wa.gov](mailto:Holland.Kitchell@sao.wa.gov)

### James Geluso – Performance Auditor

### Marisa Sanchez-Reed – Associate Performance Auditor

### Willa Hevly – Performance Audit Intern

### Kathleen Cooper – Director of Communications

564-999-0800, [Kathleen.Cooper@sao.wa.gov](mailto:Kathleen.Cooper@sao.wa.gov)

## To request public records

### Public Records Officer

564-999-0918, [PublicRecords@sao.wa.gov](mailto:PublicRecords@sao.wa.gov)

## Americans with Disabilities

In accordance with the Americans with Disabilities Act, this document will be made available in alternative formats. Please email [Webmaster@sao.wa.gov](mailto:Webmaster@sao.wa.gov) for more information.

# Executive Summary

## Background (page 5)

Created in 1993 by King, Pierce and Snohomish counties, Sound Transit is building and operating a high-capacity transit system for the Puget Sound region. Sound Transit has received most of its funding through three voter-approved measures that provide the agency with portions of local sales and property taxes and car tab fees. The most recent measure, called ST3, is one of the largest in the country. It funds an estimated \$54 billion for construction, operations and maintenance over the next 20 years. When complete, Sound Transit's system will connect 16 cities by light rail, 12 cities by commuter rail, and 30 cities by bus in the three counties.

Because Sound Transit has one of the most significant transportation funding packages in the country, some lawmakers have sought to increase accountability and oversight around how Sound Transit uses tax dollars. For example, lawmakers have sought to increase public accountability by mandating direct elections of Sound Transit's Board of Directors. Cost increases and equipment failures on high-profile Sound Transit projects have also raised concerns. Estimates for two light rail extensions increased by \$1.1 billion, 27 percent more than originally estimated. On another light rail project, the station's escalators were not designed for heavy use and broke down repeatedly. Also of concern to some lawmakers and members of the public is the increase in car tab fees after voters passed ST3 in 2016. In 2019, voters approved Initiative 976, which caps the fee at \$30. If the initiative survives legal challenges, Sound Transit could lose \$328 million annually, nearly 15 percent of its annual budget. Given this funding uncertainty and concerns about cost increases, controlling costs is imperative if the agency is to deliver its construction program on time and on budget. This audit examined how Sound Transit can improve project planning and design to reduce costs.

### Note on independence

From 2009 to 2016, State Auditor Pat McCarthy was a member of Sound Transit's Board of Directors. Auditor McCarthy recognized that the appearance of independence could be jeopardized if she were involved in this audit in any way. Once the audit was initiated, Auditor McCarthy recused herself from all meetings and decisions pertaining to this audit. The team conducted this audit with complete independence.

## Sound Transit could improve project planning and design with more upfront planning and a formal lessons learned process (page 8)

Though change orders are expected in large, complex construction contracts, they can be costly and their use should be minimized. Change orders are costly because they sometimes involve redoing work and do not take advantage of competitive

bidding. Sound Transit could reduce remedial work and other change orders with additional upfront planning. Although striking the right balance is difficult, other transit agencies and leading practices suggest Sound Transit could do more upfront planning to reduce overall project costs. The agency has spent millions on change orders in part because of design deficiencies and unexpected soil and groundwater conditions. It could strengthen its design review process by double-checking key areas and adopting standard review checklists. In addition, more underground exploration could have uncovered unexpected soil and groundwater conditions and saved Sound Transit money.

An agencywide program to learn from past projects would likely result in a consistent use of best practices and fewer repeated mistakes on future projects. Best practices in project management include capturing lessons learned in a database and reviewing them before beginning new projects. Sound Transit collected some lessons from previous projects, but currently lacks a formal process to ensure the lessons learned inform future projects. Sound Transit is in the early stages of renewing an agencywide program to collect and use lessons learned from past experiences.

## Recommendations (page 20)

We made a series of recommendations for Sound Transit to improve aspects of its planning and design processes and develop a systematic way to learn from past experiences. Our recommendations to improve planning and design processes include strengthening the design review process to catch more deficiencies and performing more underground exploration to avoid costly change orders when the risk of adverse conditions is high. We also recommended Sound Transit develop an agencywide lessons learned program to learn from past projects and avoid repeating mistakes.

### Next steps

Our performance audits of state programs and services are reviewed by the Joint Legislative Audit and Review Committee (JLARC) and/or by other legislative committees whose members wish to consider findings and recommendations on specific topics. Representatives of the Office of the State Auditor will review this audit with JLARC's Initiative 900 Subcommittee in Olympia. Sound Transit's Board of Directors will also hold a public hearing on this performance audit.

Please check the JLARC ([www.leg.wa.gov/JLARC](http://www.leg.wa.gov/JLARC)) and Sound Transit ([www.soundtransit.org/get-to-know-us/board-directors/board-meetings](http://www.soundtransit.org/get-to-know-us/board-directors/board-meetings)) websites for the exact dates, times and locations. The Office conducts periodic follow-up evaluations to assess the status of recommendations and may conduct follow-up audits at its discretion. See **Appendix A**, which addresses the I-900 areas covered in the audit. **Appendix B** contains information about our methodology.

# Background

## Sound Transit has been expanding regional transit services for nearly 30 years through voter-approved measures

Created in 1993 by King, Pierce and Snohomish counties, Sound Transit provides transit services in the Puget Sound region to connect “more people to more places.” Sound Transit began operating regional bus services in 1999, and commuter rail from Tacoma to Seattle later that year. Its first light rail services started in Tacoma in 2003, and Seattle in 2009.

Sound Transit is governed by an 18-member Board of Directors which includes the state’s Secretary of Transportation and the county executives from King, Pierce and Snohomish counties. The county executives appoint locally elected officials from their counties to fill the rest of the board’s membership. The board is responsible for establishing policies and approving major contracts. At critical milestones of every project, the board makes key decisions by adopting budgets, determining the final projects to be built and establishing baselines for the project’s scope, schedule and budget.

Sound Transit has received most of its funding through three voter-approved measures: Sound Move (1996), ST2 (2008) and ST3 (2016). Each measure included a list of projects that the measure would fund. The agency’s funding is derived primarily from a portion of the local sales tax, but also includes car tab fees, property taxes and federal grants.

The most recent, and by far the largest, measure is ST3, which funds an estimated \$54 billion for construction, operations and maintenance over the next 20 years. Plans for this measure include several projects to extend light rail from Seattle to Everett in the north, Tacoma in the south and Issaquah in the east. When complete, it will connect 16 cities by light rail, 12 cities by commuter rail, and 30 cities by bus in King, Pierce and Snohomish counties (Exhibit 1).

**Exhibit 1 – Map showing Sound Transit’s current and planned transit lines**



Source: Sound Transit

Sound Transit's projects are managed across different phases of work, including planning, design and construction. Sound Transit has hired consultants and contractors to design and construct every project listed in the three voter-approved measures. Large projects are usually broken into multiple contracts, designed and built by multiple contractors over several years. For example, Sound Transit has about 10 separate contracts to design the Northgate Link light rail extension and construct its tunnels, elevated track and stations. Sound Transit employees supervise the contractors to ensure they follow Sound Transit's policies and procedures governing project design and construction.

When Sound Transit was established nearly 30 years ago, the agency was focused on design and construction, which included implementing and building the initial 10-year plan approved by voters. Now, Sound Transit oversees the planning, construction and operations of light rail, transit centers, stations and other transit infrastructure in three counties. Sound Transit currently has more than 1,000 employees.

## Questions persist about the cost and oversight of Sound Transit's projects

Because Sound Transit has one of the most significant transportation funding packages in the country, some lawmakers have sought to increase accountability and oversight around how Sound Transit uses tax dollars. Several legislators have introduced bills that sought direct elections to the Sound Transit board. And since the three county executives appoint most board members, some legislators told us it is hard to hold board members accountable for the large scope of work they oversee.

Cost increases and equipment failures on high-profile Sound Transit projects have raised questions about how the agency oversees and manages its projects. The cost of extensions to the light rail system in Federal Way and Lynnwood increased by more than 27 percent from the original estimates – nearly \$1.1 billion in additional costs. Another \$20 million will be spent to replace escalators at the University of Washington light rail station, which opened in 2016. The escalators have been intermittently out of service since it first opened because the equipment installed was not designed to handle the heavy traffic at this transit station.

A recent concern to some lawmakers and members of the public is the increase of Sound Transit's car tab fees after voters passed ST3 in 2016. The fee affects drivers in King, Pierce and Snohomish counties, and is based on a vehicle's value. Vehicle value is assessed using its Manufacturer Suggested Retail Price (MSRP) and a depreciation schedule set by the Legislature, which can result in some vehicles being valued up to 40 percent more than Kelley Blue Book (KBB) or market values. With this increase, some drivers are now paying hundreds or even thousands of dollars in car tab fees.

In 2019, voters statewide passed Initiative 976, which caps the fees at \$30 for all Washington counties. If the initiative survives legal challenges, the Washington State Office of Financial Management estimates that Sound Transit could lose \$328 million annually, which is nearly 15 percent of its annual budget. A bill proposed in the 2020 legislative session would have also capped car tab fees at \$30. Given this funding uncertainty and concerns about cost increases and post-construction problems, controlling costs is imperative if the agency is to deliver its construction program on time and on budget.

## This audit examined how Sound Transit can improve project planning and design to reduce costs

With changes to Sound Transit's funding sources under scrutiny by the Legislature and courts, we focused on whether Sound Transit could improve its project management and oversight processes to control costs of future projects. To do this, we examined Sound Transit's oversight and management of 12 construction contracts associated with five projects. These five projects were funded by the first two voter-approved tax measures, Sound Move and ST2, as none of the projects funded by ST3 have started construction. Because major project changes can indicate poor project management, we reviewed large change orders to these contracts to determine if Sound Transit could make improvements. Our audit scope included more than 300 change orders totaling \$172 million. Appendix B contains more detailed information about these contracts and the audit's scope and methodology.

The audit answers the following question:

- How can Sound Transit improve its oversight and management of its projects?

# Audit Results

## **Sound Transit could improve project planning and design with more upfront planning and a formal lessons learned process**

### **Answer in brief**

Though change orders are expected in large, complex construction contracts, they can be costly and their use should be minimized. Change orders are costly because they sometimes involve redoing work and do not take advantage of competitive bidding. Sound Transit could reduce remedial work and other change orders with additional upfront planning. Although striking the right balance is difficult, other transit agencies and leading practices suggest Sound Transit could do more upfront planning to reduce overall project costs. The agency has spent millions on change orders in part because of design deficiencies and unexpected soil and groundwater conditions. It could strengthen its design review process by double-checking key areas and adopting standard review checklists. In addition, more underground exploration could have uncovered unexpected soil and groundwater conditions and saved Sound Transit money.

An agencywide program to learn from past projects would likely result in a consistent use of best practices and fewer repeated mistakes on future projects. Best practices in project management include capturing lessons learned in a database and reviewing them before beginning new projects. Sound Transit collected some lessons from previous projects, but currently lacks a formal process to ensure the lessons learned inform future projects. Sound Transit is in the early stages of renewing an agencywide program to collect and use lessons learned from past experiences.

## **Though change orders are expected in large, complex construction contracts, they can be costly and their use should be minimized**

### **Change orders are contract amendments that modify a contract's scope of work**

After project designs are finalized and construction contracts are executed, any changes to contract terms are documented through change orders. Change orders usually authorize more money, and sometimes more time, to complete additional



or unanticipated work. The change requested can be as modest as adjusting the angle of a loading ramp or as significant as spending millions to bring in heavy equipment to freeze groundwater. In addition to describing the change itself, Sound Transit requires that documentation include the change's effect on cost and schedule and the reason for the change.

### **Change orders are expected in construction contracts, but some are avoidable**

Different situations can lead to change orders. With project development and construction lasting years, and contracts and designs spanning hundreds or even thousands of pages, change orders are inevitable in large construction contracts. The type of contracting method, such as design-build, general contractor/construction manager or design-bid-build, can lead to differences in the use of change orders based on the phase of project development at the time the contract is executed. Change orders are contractual requirements used to manage new or unforeseen circumstances or make necessary changes to complete the project. For example, unexpected and severe weather events sometimes necessitate that contractors halt work, resulting in change orders to adjust project schedules. Change orders like these are necessary and unavoidable.

Even so, some changes to contracts can be avoided or minimized. Change orders that occur to fix mistakes in design and contract documents could be avoided with improved design work. Other change orders occur because of things missed in planning, particularly around unidentified underground conditions. Underground conditions must be addressed, but potentially at a much cheaper price with additional planning.

### **Change orders are costly because they may involve redoing work and do not take advantage of competitive bidding**

Change orders caused by missing information or mistakes in designs are deficiencies that can also lead to redoing work. Such deficiencies identified after the contract has been signed but before construction begins can result in redesign costs and require change orders. However, costs can rise for deficiencies that are discovered only after construction starts or has been completed. At that point, in addition to the costs and delays associated with redesign and change orders, addressing the design deficiency may require remedial work, such as tearing out existing construction.

Even change orders that do not create remedial work can be expensive because they happen after the contract is awarded and therefore are not competitively bid. Competitive bidding helps ensure the lowest price possible for the contracted work since contractors compete with each other. Change order prices are not negotiated in a competitive environment since they occur after contracts are executed. When construction is already under way and deadlines for operating services must be met, it may be necessary to resolve change orders quickly to keep the project moving, even if not at the best price.

For example, the contractor on the University Link light rail extension project in Seattle expected about 20 percent of the soil excavated for tunnels would contain high acidity levels and have to be hauled to a landfill, at a cost of \$315,000, or \$3.75 per bank cubic yard. Instead, the contractor found high acidity levels in most of the excavated soil. The change order to haul away much more soil cost Sound Transit nearly \$1.3 million, or \$4.62 per bank cubic yard – 20 percent higher than the original price.

Sound Transit's contracts and change orders show the potential for cost savings obtained through competitive bidding. We found the agency's change order prices were consistently higher than cost estimates, while competitively bid contracts were consistently lower. In awarding contracts, Sound Transit considers cost estimates for all planned work to ensure the contractor offers reasonable prices. The agency's consultants calculate cost estimates for entire contracts as well as individual change orders. Comparing these cost estimates to winning bids and to the cost of actual change orders demonstrates how much Sound Transit might save by including as much of the work as possible in the original contract. For the contracts we examined, the winning bids averaged 15 percent less than the consultant's cost estimates. On the other hand, change orders averaged 8 percent more than the cost estimates. Sound Transit stated that this is not unusual for large, public infrastructure projects.

## Sound Transit could reduce change orders with additional upfront planning

Sound Transit has documented policies and procedures to help control a project's scope, schedule and budget, and guide project management. Its procedures instruct staff on how to define the project's scope and estimate the budget and schedule. In addition, at key points in design and construction, projects must pass through review and approval by Sound Transit's Phase Gate committee made up of agency leaders. Project teams must complete key activities, such as determining the contracting methods that will be used before starting design and construction, as well as performing periodic cost and schedule estimates. The review process is intended to oversee each capital project from a variety of lenses throughout project development, design, construction, and into operations, and determine if it is ready to move forward. Before Sound Transit authorizes construction to begin, its management and Board of Directors must approve the project's budget and schedule. All subsequent project changes are compared to the approved budget and schedule.

### Spending more money up front and conducting additional planning could limit change orders, reducing overall costs

Although Sound Transit has policies and procedures in place to minimize project changes, the agency still issued hundreds of change orders. We examined more than

300 change orders worth \$172 million, and found Sound Transit issued more than 160 change orders, worth \$100 million, to address mistakes or missing information in its designs and contracts. Among the reasons given for these changes were:

- Design deficiencies, such as electrical systems that lacked power supplies
- Structures that did not meet building codes
- Contractors encountering adverse underground conditions that were not described in contract documents

Limiting change orders that result from design deficiencies or unanticipated ground conditions will require Sound Transit to spend more money upfront to complete more planning. However, spending on additional planning work could reduce the likelihood of addressing the problem through more expensive change orders during construction. Leading practices support this. For example, state and federal guidelines for underground investigations say that they should “fully define the subsurface conditions for design and construction purposes” and that “improved site characterization directly reduces the likelihood of encountering unforeseen ground conditions during construction.” This is typically achieved through drilling exploratory holes. Costs for drilling are often substantially less than costs to accommodate the conditions during construction.

### **Although striking the right balance is difficult, other transit agencies and leading practices suggest Sound Transit could do more upfront planning to reduce overall project costs**

Deciding how much planning work to complete is a balancing act. Spending too much time planning in order to make designs perfect may needlessly delay the project and increase costs. However, spending too little time may increase the chances that something critical is overlooked. For instance, in underground investigations, the number of holes drilled depends on the size and complexity of the individual project. With budget and time constraints, it may be difficult to decide exactly how many holes to drill. But finding adverse underground conditions earlier allows for more planning and any mitigation work to be included in the original contract, saving money through competitive bidding.

Although not directly comparable to Sound Transit, Los Angeles Metro, the Regional Transportation District of Denver (RTD Denver), and the Washington State Department of Transportation (WSDOT) said they have learned it is better to spend more time on exploration than they had in the past. It helps them reduce the risk of encountering unexpected underground conditions during construction, when it will almost certainly cost more in time and money to resolve. A manager at RTD Denver said the agency has not encountered a major, unexpected underground issue in 12 years.

Sound Transit builds different types of projects or faces different soil conditions than the agencies mentioned. However, it must still strive to gain an adequate understanding of underground conditions for all of its projects. Sound Transit

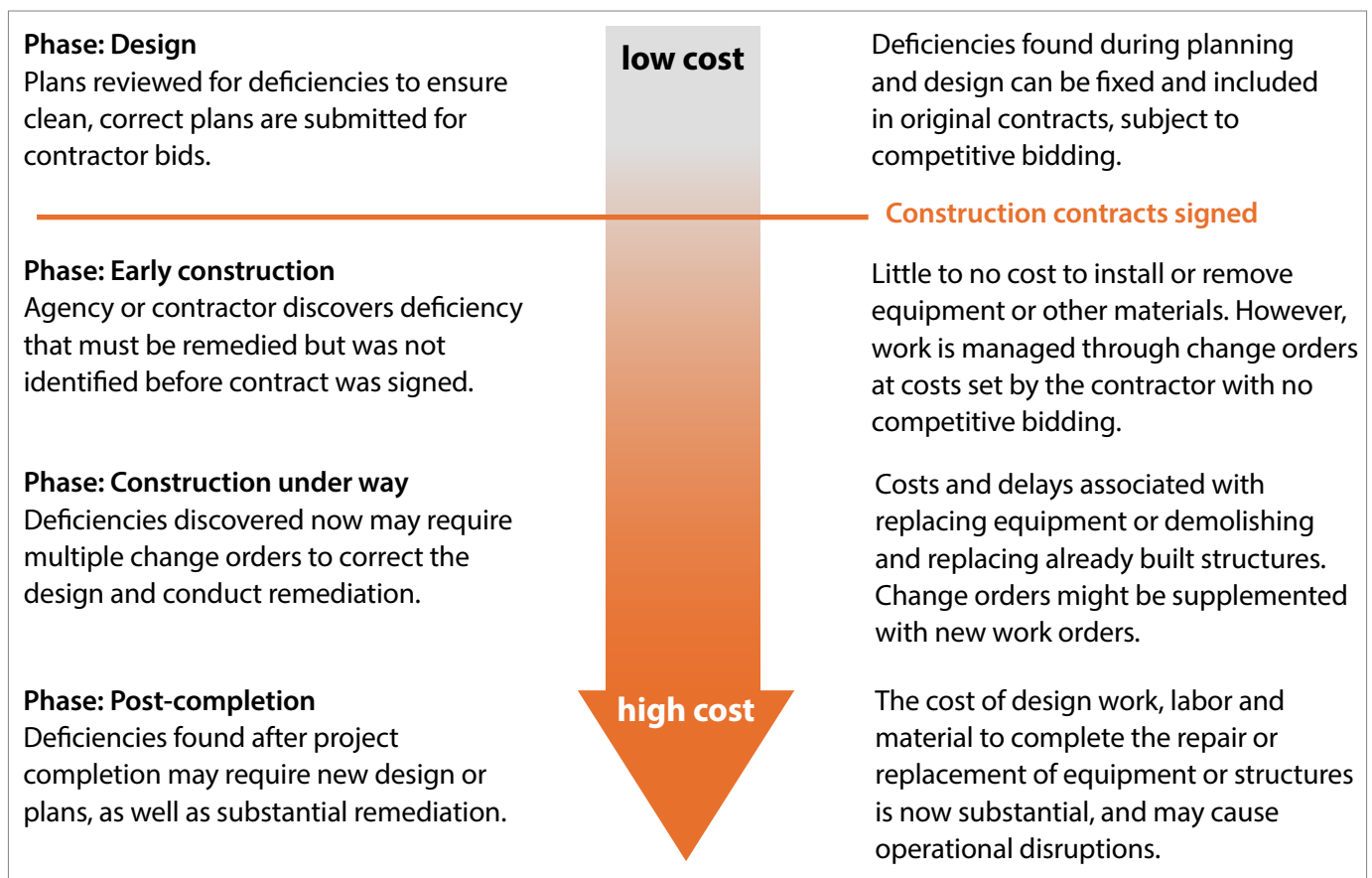
could better implement leading practices to catch more mistakes and ensure contract documents are complete before construction begins. As recommended by leading practices, Sound Transit may need to do more investigation to “fully define” underground conditions than these other agencies when there is variation in underground conditions or when its projects are complex.

### Sound Transit has spent millions on change orders in part because of design deficiencies that could have been avoided

Of the \$172 million in change orders we reviewed, Sound Transit spent \$23 million, or 13 percent, to correct mistakes in design and contract documents. While these changes do not represent the most common type of change order, they nonetheless offer good opportunities for more cost savings than other types. Examples include \$1.9 million to correct electrical mistakes such as power supplies missing from electrical equipment, and almost \$4 million to revise plans to meet existing building code requirements after the construction contract had already been awarded.

Design deficiencies can lead to extra cascading costs if they are not caught before construction starts. Exhibit 2 illustrates these rising costs, as do two examples from the projects we reviewed (discussed on the following page).

#### Exhibit 2 – The later deficiencies are caught, the higher the cost to fix them



The first example involves escalators at the University of Washington light rail station. The escalators specified in the plans and subsequently installed were designed to be somewhat more robust than a typical commercial grade escalator. Sound Transit chose these escalators because they were less expensive, but still met design specifications. However, installation issues, maintenance issues and heavy use resulted in repeated breakdowns. They have been closed intermittently since the station opened in 2016. The situation was further exacerbated because the station did not have public stairs near the escalators, causing inconvenience and delays for transit riders. After an investigation into why the escalators were breaking down, the agency could find no records of any maintenance done before the station was opened to the public. Sound Transit plans to spend at least \$20 million to replace the escalators at least 15 years ahead of schedule.



Travelers avoid an out-of-service escalator at the University of Washington light rail station.

Photo source: KUOW Photo/Anna Boiko-Weyrauch.

In another instance, at the Capitol Hill light rail station, Sound Transit spent \$300,000 in 2015 to correct an error in design that called for electrical equipment to be installed too close to ventilation equipment. This fire hazard was not allowed by fire codes and should have been detected in design review. The deficiency was not discovered until after the project was built, during an inspection by the Seattle Fire Department. Ultimately, Sound Transit had to remove the ventilation equipment and reinstall it.

## Sound Transit could strengthen its design review process by double-checking key areas and adopting standard review checklists

Sound Transit's design work is prepared primarily by contracted design firms that submit plans to Sound Transit for review. Sound Transit specialists are assigned portions of the plans to check according to their areas of expertise. For example, a Sound Transit electrical engineer is assigned to review all electrical work in the plans. Sound Transit's procedures state reviewers are responsible for "verifying technical adequacy and compliance of the design documents to the Design Criteria Manual and to the applicable codes and standards." A Sound Transit manager compiles all review comments and returns them to the design contractors to be addressed. Before the design is finalized, Sound Transit works with the design contractor to ensure all comments have been addressed.

There are risks of overlooking deficiencies and missing information in designs because large construction projects are complicated. Sound Transit's design documents can be thousands of pages long and full of complex drawings, and the agency does not employ full-time reviewers. Instead, managers identify the areas of expertise needed on the review team and select reviewers based on their expertise, availability and workload. For many of the contracts we examined, only one specialist was assigned to review an area of the design, such as one electrical

engineer reviewing all electrical work that might be spread across hundreds of pages. Managers oversee the work of reviewers, but they are only responsible for ensuring procedures are followed correctly, not whether the designs comply with all specifications, codes or standards.

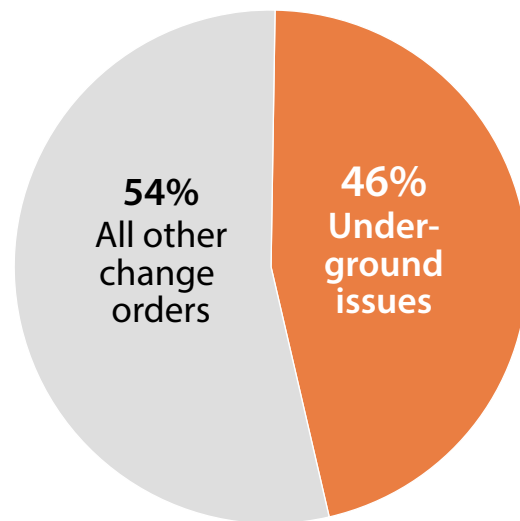
Improvements to the design review process could include using additional staff and leading practices to review design documents. Sound Transit has recognized that adding more reviewers would likely improve the chances of finding mistakes, and said it is working on revising its procedures. Another leading practice is using checklists to ensure important issues are not overlooked. Checklists help reviewers identify areas that are more prone to deficiencies, and thus capture and build institutional knowledge to avoid repeating mistakes. This body of knowledge can help managers decide what areas are worth double-checking before returning the design documents to contractors.

### Sound Transit has spent millions on unexpected soil and groundwater conditions

Sound Transit spent more than \$79 million to address unexpected underground conditions. These change orders made up nearly half the cost of all change orders we analyzed and occurred on every project we reviewed (Exhibit 3). In one example, contractors found large amounts of contaminated soil during construction on the D to M Street project, one section of Sound Transit’s commuter rail line. Sound Transit said it chose not to investigate underground conditions in certain areas because it would have had to drill on high-traffic streets. Such drilling is disruptive to the public: the agency must close down public streets, hire traffic control crews, drill through existing asphalt or concrete, and repair the road afterwards.

However, the cost of dealing with unexpected contaminated soil proved to be even more expensive. The contractor’s original bid on this project included soil removal at \$12 per ton. When 466,000 more tons of contaminated soil was found than expected – nine times what Sound Transit estimated – the contractor submitted a change order charging \$28.80 per ton, more than twice the rate in the original bid. Sound Transit spent more than \$13 million to remove contaminated soil that was not discovered as part of its investigation. Change orders for this issue alone accounted for 20 percent of the total contract.

**Exhibit 3 – Change orders for underground conditions totaled more than \$79 million, nearly half the total value of all change orders analyzed**



Source: Auditor analysis of Sound Transit data.

In another example, Sound Transit did not have an adequate understanding of the volume of groundwater at a construction site. On the Northgate Link light rail extension, Sound Transit identified groundwater during exploration of the area planned for tunnels. Sound Transit originally planned to spend around \$375,000 to mitigate this issue but the contractor found far more water than expected. As a result, Sound Transit issued around 40 change orders for testing, wells to capture and remove groundwater, and additional equipment needed to address the problem. In the end, Sound Transit paid more than \$50 million to deal with this issue – 10 percent of the total contract. Sound Transit is seeking to recover some of these costs from the design consultant in court.

## More underground exploration could have uncovered these issues and saved Sound Transit money

The potential savings that would result from more extensive investigations are significant. Based on the average cost of drilling approved through change orders, we estimate that by spending an additional \$2 million, Sound Transit could have increased the amount of underground exploration on all five of the projects examined by 25 percent. Spending an additional \$8 million would have doubled the amount of exploration. While there is no guarantee Sound Transit would have found every adverse underground condition by drilling more, the additional work could have reduced the risk of unexpected issues.

Furthermore, the more accurate understanding of underground conditions would likely have saved the agency money in the long run. Sound Transit could have incorporated the work needed for underground remediation into the initial, competitively bid contracts rather than change orders. This would have saved the agency as much as \$18 million on the change orders we examined. For example, on the D to M Street project, had the volume of contaminated soil been more closely estimated when Sound Transit solicited the contract for bids, the price per ton might have increased from the original bid of \$12 per ton. However, if the contracted price remained at \$12, Sound Transit would have spent \$5.6 million to remove the soil, saving as much as \$7.8 million. On the Northgate light rail project, Sound Transit could have more accurately estimated groundwater levels and planned accordingly. The contractor might have had the correct equipment at the outset, or Sound Transit could have rerouted the tunnel to avoid the groundwater entirely, as it did on another project.

Sound Transit said it considers the geological environment, engineering and construction needs, property access, contracting method, time constraints and cost-benefit analysis when planning underground investigations. It also said fully understanding underground conditions by increasing the amount of exploration is not always practical. It hires design consultants to prepare and implement



Testing underground conditions sometimes involves working in city-center locations.

Photo source: Sound Transit.

investigation plans to establish underground conditions for a project. Sound Transit said these plans take into account property constraints and other factors that may limit the ability to drill at certain locations. The agency sometimes has difficulty accessing project sites before construction starts. Because Sound Transit rarely owns the land or has not yet purchased it while a project is in early planning and design phases, it must work with private property owners and local governments to gain access to drilling sites. Additionally, the agency sometimes cannot drill in the ideal location because structures are in the way.

Sound Transit said it also considers the costs and benefits of further underground exploration. For example, Sound Transit said it is not always practical to do a proportionate amount of investigation as WSDOT because Sound Transit's bridges and other raised structures are often larger and would require much more investigation, which would be prohibitively expensive and maybe unnecessary. Furthermore, Sound Transit states that the region's great variations in soil and groundwater conditions make fully defining underground conditions challenging. To account for this, the agency includes a disclaimer in contract documents stating the potential for unknown underground conditions and includes contingency funds to cover the potential costs, which is common in construction. However, a strategy of relying on contingency funds to remedy unanticipated underground conditions during construction may not be as cost-effective as spending more during planning and design. In the two preceding examples, concerning contaminated soil and groundwater, Sound Transit exceeded the amount set aside in its contract contingency funds. However, the entire Northgate Link light rail project is currently within its baseline budget.



## An agencywide program to learn from past projects would likely result in a consistent use of best practices and fewer repeated mistakes on future projects

### Best practices in project management include capturing lessons learned in a database and reviewing them before beginning new projects

The Project Management Institute (PMI) is the leader in project management practices. Its certifications are recognized globally and its standards guide project management in every industry. PMI outlines several leading practices for lessons learned programs, particularly on how to store information and when to review it.

First, PMI recommends adding lessons learned to a database that can be searched by keywords. When lessons are stored in a searchable database, it becomes easier for staff to find relevant information. For example, RTD Denver’s lessons learned program includes a database of lessons: each entry describes the issue that occurred, the lesson learned, and steps to prevent its recurrence.

RTD Denver also produces lessons learned reports for each project (see Exhibit 4). In the course of one project, for example, it learned that contractors needed more specific design requirements than were typically provided for structures other than bridges. As a result, the lessons learned program recommended RTD Denver update its manuals to specify design requirements for all transit structures. The Federal Transit Administration and the Kentucky Transportation Cabinet also have lessons learned databases.

“Lessons learned” can be described as knowledge and understanding acquired via experience. Lessons captured may be positive or negative, but they should be factually correct and identify a decision, design or process that supports a positive result or reduces the risk of repeated failure.

### Exhibit 4 – An example of a lessons learned entry from the RTD Denver FasTracks program

RTD FasTracks 2016 Lessons Learned



#### Structure Design Criteria – Other Structures

<b>North Metro</b>		Lesson Type:	Needs Improvement
Database LL #:	LL-NM-15	Phase:	Design-Build
Date Submitted:	10/19/2016	Date Approved:	1/4/2017

#### Overview

Structure design requirements included in the contract are adequate for bridges. However, other structures, such as station canopies, need more concise structural requirements included in the contract. It is noted that the North Metro project is being delivered using a design-build project delivery approach whereby the contractor is responsible for the design of structures to meet RTD’s design criteria and any project specific design requirements.

#### Background

Volume II, Attachment 4 Design Construction Requirements, Section 10.0 of the Conformed Contract outlines the general structural requirements for “bridges and structures”. However, the requirements are more applicable to bridges and retaining walls than other structures that are designed (e.g. station canopy foundations or OCS pole foundations). This proved difficult during North Metro design reviews since there were no specific requirements that could be verified during reviews of certain other structures.

#### Lesson

Volume II, Attachment 4 Design Construction Requirements, Section 10.0 of the Conformed Contract and the RTD Commuter Rail Design Criteria do not have sufficient structural requirements for structures other than bridges.

#### Steps to Implement

The RTD Commuter Rail Design Criteria Manual should be reviewed and revised accordingly to reflect the specific design criteria that transit structures should be designed to meet RTD’s expectations, regulatory requirements, and Stakeholder requirements. For specific project requirements (such as Volume II, Attachment 4, Section 10.0 of the Conformed Contract), the RFP should be reviewed for any additional project specific structural requirements prior to issue to ensure that all transit structures are fully defined to accommodate the design-build project delivery mechanism.

Source: RTD Denver.

Second, PMI recommends incorporating lessons learned into project planning. It states that the value of a lessons learned program is applying lessons to current and future projects. For example, project managers should review lessons from other projects when developing plans for a new project to help them gauge project risks and develop mitigation strategies. Before creating its transit-oriented development plan, the Greater Cleveland Regional Transit Authority researched lessons learned from transit agencies across the country and created a list of lessons to apply to its own projects. Los Angeles Metro now requires more planning work around utility investigations after it spent millions on one project to relocate unexpected utility lines during construction.

### **Sound Transit collected some lessons from previous projects, but currently lacks a formal process to ensure the lessons learned inform future projects**

Sound Transit does not currently have a formal, agencywide lessons learned program, although it has had one in the past. Our 2007 performance audit examining Sound Transit's management of the initial light rail extensions found that Sound Transit lacked a formal process to document and share lessons learned; the audit recommended the agency establish one. The agency had a lessons learned program from 2009 to 2018, but it was underutilized and Sound Transit retired the program so it could be restarted under new direction. The previous program focused on collecting lessons and did not include processes to address when and how to review lessons learned and incorporate them into new projects. Further, it lacked adequate resources to be successful, with one budget analyst assigned to the program as a secondary responsibility.

Sound Transit still lacks a formal program to incorporate lessons into its project designs, but it has made some improvements to better capture lessons learned. After the escalator failures at the University of Washington light rail station, the agency updated its Design Criteria Manual for construction projects to specify that escalators at light rail stations must be "transit grade" and capable of sustaining heavy use. In addition, Sound Transit's engineering department now shares new technical requirements with staff in between published updates to the Design Criteria Manual. Construction managers, design engineers and design consultants meet periodically to discuss issues and incorporate lessons learned into Sound Transit's procedures. The agency directs managers who oversee project design and construction to look for common issues across all projects. In addition, the agency incorporates lessons learned into the reporting for its internal project management oversight process for all capital programs. Currently, Sound Transit relies on key roles to ensure important lessons are consistently shared in the absence of a formal lessons learned program. However, it is still possible for an important lesson to be overlooked.

## **A formal lessons learned program could help Sound Transit avoid recurring mistakes**

Many change orders we reviewed resulted from similar mistakes. For example, we found 10 change orders related to similar electrical issues on four different light rail expansion contracts. The first of these change orders occurred in 2012, with the remaining nine recurring over the next seven years. Issues related to unexpected underground conditions (discussed on pages 14 – 16) recurred multiple times over six years.

While a robust lessons learned program would not have prevented such deficiencies from happening the first time, it may have reduced the likelihood they would recur in future projects. Had Sound Transit captured the deficiencies relating to electrical specifications or the repeated presence of adverse underground conditions in a formal lessons learned program, design reviewers may have flagged the issues in later project plans.

## **Sound Transit is in the early stages of renewing an agencywide program to collect and use lessons learned from past experiences**

Sound Transit is currently developing a new agencywide lessons learned program. As it does, it can use its existing systems to gather information from past projects. For example, it already collects information from construction change orders, including the reason for the change and how it fixed the problem, which could provide a foundation for a lessons learned database. Sound Transit already tracks change orders in two databases, but their primary purpose is to document and track payments.

In 2019, Sound Transit also hired an employee, placed in the agency's Project Transition Office, to develop the new lessons learned program. Sound Transit stated the goal of the renewed program is to find a practice or process that easily facilitates the collection and application of lessons learned for various agency projects and initiatives. However, at the time this report was published, Sound Transit had not yet launched a formal lessons learned program. It plans to use the recommendations from this audit report to inform the program's development and launch.

# Recommendations

## For Sound Transit

1. Improve the design review process to reduce avoidable design deficiencies, as described on pages 12–14. Such controls could include:
  - Assigning at least two reviewers for each specialist area on design review teams to double-check design documents
  - Creating checklists for reviewers indicating areas most prone to deficiencies
2. Use information from investigations and change orders of past projects to help determine the likelihood of adverse underground conditions for current, similar projects. If there is a high likelihood, Sound Transit should increase its underground exploration, as described on pages 14–16.
3. Develop a formal, agencywide lessons learned program to track and incorporate lessons into future project planning, as described on pages 17–19. The program should include these elements:
  - a. A mechanism to identify and capture lessons learned
  - b. An easily accessible database to store them
  - c. A process to ensure lessons learned are used to inform future project planning

# Agency Response



June 4, 2020

Mr. Scott Frank  
 Director of Performance and IT Audit  
 Washington State Auditor  
 Insurance Building  
 Capitol Campus  
 302 Sid Snyder Avenue SW  
 Olympia, Washington 98504

**Subject: Performance Audit Agency Management Response**

Dear Mr. Frank:

Thank you for the opportunity to comment on the Washington State Auditor's Office's performance audit of Sound Transit.

Sound Transit is deeply committed to our agency's mission to remedy decades of regional underinvestment in developing the kind of regional high-capacity transit system other large metropolitan areas depend on for mobility, economic opportunity and environmental sustainability. Your audit report offers a number of recommendations that we concur with for executing this complex body of work on behalf of the region's taxpayers. We have already begun taking responsive actions.

For example, we've taken lessons learned from the active construction work on our East Link Extension and Northgate Link Extension projects to inform the Lynnwood Link Extension project, in order to identify design deficiencies sooner and correct them prior to construction. Additionally, we are intensifying focus on best practices and industry standards for implementing field investigations early in our design processes, which will help us better inform future project plans.

When it comes to the change orders the audit focuses on, we recognize that every dollar entrusted to Sound Transit is important for implementing high-stakes regional transit investments. This is the case now more than ever under the extreme fiscal impacts Sound Transit and other agencies face due to the economic impact of COVID-19. However, it is worth noting that even before Sound Transit expands its success through our execution of your recommendations, our change orders already fall within industry standards, especially given the complexity of some of our work, such as tunneling.

Our total change orders for \$2.3 billion worth of construction projects amount to 8% of contract values. This calculation, which yields results that are within

Central Puget Sound Regional Transit Authority • Union Station  
 401 S. Jackson St., Seattle, WA 98104-2826 • Reception: (206) 398-5000 • FAX: (206) 398-5499  
[www.soundtransit.org](http://www.soundtransit.org)

**CHAIR**  
**Kent Keel**  
*University Place Councilmember*

**VICE CHAIRS**  
**Dow Constantine**  
*King County Executive*

**Paul Roberts**  
*Everett Councilmember*

**BOARD MEMBERS**  
**Nancy Backus**  
*Auburn Mayor*

**David Baker**  
*Kenmore Mayor*

**Claudia Balducci**  
*King County Council Chair*

**Bruce Dammeier**  
*Pierce County Executive*

**Jenny Durkan**  
*Seattle Mayor*

**Debora Juarez**  
*Seattle Councilmember*

**Joe McDermott**  
*King County Council Vice Chair*

**Roger Millar**  
*Washington State Secretary  
 of Transportation*

**Ed Prince**  
*Renton Councilmember*

**Kim Roscoe**  
*Fife Mayor*

**Nicola Smith**  
*Lynnwood Mayor*

**Dave Somers**  
*Snohomish County Executive*

**Dave Upthegrove**  
*King County Councilmember*

**Peter von Reichbauer**  
*King County Councilmember*

**Victoria Woodards**  
*Tacoma Mayor*

**CHIEF EXECUTIVE OFFICER**  
**Peter M. Rogoff**

Mr. Scott Frank  
June 2, 2020  
Page 2

typical ranges for our industry, includes but is not limited to the \$172 million in change orders that your office reviewed. The \$23 million in change orders for which your review identified design deficiencies represent only 1% of contract values. Had your scope of work and format allowed for a more in-depth exploration of some of the individual change orders, you would have seen many successes addressing the kinds of challenges that can and do arise in complex projects employing a variety of delivery methods.

Thank you for your work to assist Sound Transit in fulfilling its mission. We are committed to the actions identified in our response and to continually expanding our successful track record.

Sincerely,



Peter M. Rogoff  
Chief Executive Officer  
Sound Transit

Enclosure: Sound Transit State Auditor Management Responses

Mr. Scott Frank  
June 2, 2020  
Page 3

**Sound Transit  
SAO Audit Management Response  
June 2, 2020**

---

**RECOMMENDATION/ISSUE 1:**

Improve the design review process to reduce avoidable design deficiencies, as described on pages 12-14. Such controls could include:

- Assigning at least two reviewers for each specialist area on design review teams to double-check design documents;
- Creating checklists for reviewers indicating areas most prone to deficiencies.

**AGENCY RESPONSE:**

Sound Transit agrees and is already acting upon the recommendation that we should continue to improve the design review process to reduce avoidable design deficiencies. Sound Transit is in the process of updating the design review procedures as documented by our Engineering Procedures. Recommendations from this audit will inform this work. In addition, Sound Transit continues to monitor trends with design deficiencies observed on all active projects, and we are working closely in partnership with the consultant industry to identify root causes and long-term solutions to reduce the number of design deficiencies.

In 2019, Sound Transit established a ‘Design Summit’ forum bringing together our agency’s leadership with influence on design in partnership with representation of active consultant designers working for Sound Transit. This forum is focused on enhancing the quality of design and has recently reviewed a case study of the Lynnwood Link Extension project, utilizing lessons learned from active construction on East Link and Northgate Link to identify deficiencies early on and correct them prior to construction.

Recommendations discussed in partnership with the consultant industry will be incorporated into Sound Transit processes and procedures to further manage these occurrences. Sound Transit continues to uphold our consultant contract terms requiring consultants to correct deficiencies at their own costs and understand the benefit of early identification and resolution to inform construction contract price negotiations.

**ACTION STEPS AND TIMEFRAME:**

Sound Transit is taking action to update design deliverable expectations documented in Engineering Procedure 03. This update, which we are working to complete by the end of 2020, is informed by evaluation of other transit industry best practices to ensure appropriate oversight and clarity of review responsibilities. It is also informed by the results of this audit, consultant industry input, and industry best practices for various contracting delivery methods such as design-build.

Mr. Scott Frank  
June 2, 2020  
Page 4

- Sound Transit continues to hold the quarterly Design Summit forum and utilizes this forum to better define and measure design quality, which will directly reduce design deficiencies and other owner-directed changes.

### **RECOMMENDATION/ISSUE 2:**

Use information from investigations and change orders of past projects to help determine the likelihood of adverse underground conditions for current, similar projects. If there is a high likelihood, Sound Transit should increase its underground exploration, as described on pages 14-16.

### **AGENCY RESPONSE:**

Sound Transit agrees with the recommendation and is already actively implementing it in our current work. Projects including Downtown Redmond Link Extension, West Seattle to Ballard and Tacoma Dome Link Extension have implemented early field investigations to validate site conditions and inform design solutions. As design progresses, further investigations will be performed. Sound Transit continues to follow best practices and industry standards for field investigations in a manner that reflects the complexity and scale of the work performed by the agency. Sound Transit is in the process of updating agency engineering procedures to include prescriptive requirements for subsurface investigations during planning and design that will further mitigate this risk.

### **ACTION STEPS AND TIMEFRAME:**

- Continue to implement field investigations early in design process.
- Update Engineering Procedure 03 by the end of 2020, informed in part by lessons learned on active Sound Transit construction and the results of this audit.

### **RECOMMENDATION/ISSUE 3:**

Develop a formal, agency wide lessons learned program to track and incorporate lessons into future project planning, as described on pages 17-19. The program should include these elements:

- a. A mechanism to identify and capture lessons learned
- b. An easily accessible database to store them
- c. A process to ensure lessons learned are used to inform future project planning

### **AGENCY RESPONSE:**

Sound Transit agrees with the recommendation and has begun taking actions to ensure we increase our focus on enabling and promoting the use of learning from past projects to support our success on future projects. The agency's previous such program captured lessons learned and saved them in internal documentation accessible to all staff. However, there was little structure to assist staff in finding and applying relevant lessons learned to their projects or situations; it was incumbent upon staff to seek out the lessons learned that could be relevant to their upcoming work. By identifying organizational and other



Mr. Scott Frank  
June 2, 2020  
Page 5

improvements, we are striving to make lessons more easily accessible and impactful in informing future projects.

Work to increase our effectiveness in identifying and sharing lessons will include making our repository easy to access, search and expand. We will explore a verbal or in-person component to amplifying lessons learned that facilitates sharing among staff and increasing understanding of how to apply lessons. We will work to provide multiple mechanisms to capture lessons, such as workshops, individual interviews, data analysis, etc. Our focus will include working to promote repetition of successes and avoid repetition of mistakes by continuing to grow a psychologically safe culture of continuous learning and appropriate risk-taking.

**ACTION STEPS AND TIMEFRAME:**

Sound Transit takes the lessons learned program as a priority and will continue to embed the lessons learned program structure into all of our current and future projects. The work to undertake and fully develop a lessons learned process will be ongoing. Sound Transit will develop the tools and resources necessary to support the lessons learned program and structure, which includes the implementation of a formal program, framework, training and ongoing refinements.

# Appendix A: Initiative 900 and Auditing Standards

## Initiative 900 requirements

Initiative 900, approved by Washington voters in 2005 and enacted into state law in 2006, authorized the State Auditor’s Office to conduct independent, comprehensive performance audits of state and local governments.

Specifically, the law directs the Auditor’s Office to “review and analyze the economy, efficiency, and effectiveness of the policies, management, fiscal affairs, and operations of state and local governments, agencies, programs, and accounts.” Performance audits are to be conducted according to U.S. Government Accountability Office government auditing standards.

In addition, the law identifies nine elements that are to be considered within the scope of each performance audit. The State Auditor’s Office evaluates the relevance of all nine elements to each audit. The table below indicates which elements are addressed in the audit. Specific issues are discussed in the Results and Recommendations sections of this report.

I-900 element	Addressed in the audit
1. Identify cost savings	<b>Likely.</b> The audit identified cost savings that could have been achieved in past projects if Sound Transit had conducted more underground exploration and addressed design deficiencies before beginning construction. It also identified improvements Sound Transit could make in its planning and design processes that could lead to cost savings for future projects.
2. Identify services that can be reduced or eliminated	<b>No.</b> The audit evaluated management and oversight of construction projects, not operations or services.
3. Identify programs or services that can be transferred to the private sector	<b>No.</b> The audit focused on Sound Transit’s management of construction work performed by contractors from the private sector, not whether project management should be transferred to the private sector.
4. Analyze gaps or overlaps in programs or services and provide recommendations to correct them	<b>Yes.</b> The audit identified gaps in Sound Transit’s design review and underground investigation processes.

## I-900 element

## Addressed in the audit

- |   |  |
|---|--|
| 5. Assess feasibility of pooling information technology systems within the department   | <b>No.</b> The audit did not review feasibility of pooling IT systems because the audit focused on project management and oversight.   |
| 6. Analyze departmental roles and functions, and provide recommendations to change or eliminate them  | <b>Yes.</b> The audit evaluated the roles and functions of Sound Transit’s staff and recommended improvements to its oversight and management of underground investigations and project designs. |
| 7. Provide recommendations for statutory or regulatory changes that may be necessary for the department to properly carry out its functions | <b>No.</b> The audit did not recommend any statutory or regulatory changes.  |
| 8. Analyze departmental performance data, performance measures and self-assessment systems  | <b>No.</b> The audit did not analyze Sound Transit’s performance measures or self-assessment systems. It focused on improving the agency’s project management and oversight processes.           |
| 9. Identify relevant best practices   | <b>Yes.</b> The audit identified best practices related to underground investigations and lessons learned programs.  |

## Compliance with generally accepted government auditing standards

We conducted this performance audit under the authority of state law (RCW 43.09.470), approved as Initiative 900 by Washington voters in 2005, and in accordance with generally accepted government auditing standards as published in Government Auditing Standards (December 2011 revision) issued by the U.S. Government Accountability Office. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

## A note on auditor independence

From 2009 to 2016, State Auditor Pat McCarthy served on Sound Transit’s Board of Directors, including a period of time as the chair. Once the audit was initiated, both Auditor McCarthy and Deputy State Auditor Keri Rooney, who was also involved in meetings and discussions related to projects covered by this audit, recused themselves from all meetings and decisions pertaining to the audit. Therefore, it is our assessment that the Office of the Washington State Auditor and audit team were independent as to the subject matter of the audit.

## The mission of the Office of the Washington State Auditor

To provide citizens with independent and transparent examinations of how state and local governments use public funds, and develop strategies that make government more efficient and effective. The results of our work are widely distributed through a variety of reports, which are available on our website and through our free, [electronic subscription service](#).

We take our role as partners in accountability seriously. We provide training and technical assistance to governments and have an extensive quality assurance program. For more information about the State Auditor's Office, visit [www.sao.wa.gov](http://www.sao.wa.gov).

# Appendix B: Scope, Objectives and Methodology

## Objective

The purpose of this performance audit was to determine if Sound Transit could improve oversight and management of its construction projects. The audit addresses the following objective:

- How can Sound Transit improve its oversight and management of its projects?

## Scope

The audit focused on Sound Transit's oversight and management of 12 construction contracts associated with five projects, each contract serving a segment of a project. The projects were funded by two tax initiatives: Sound Move, approved in 1996, and ST2, approved in 2008. We examined major scope, schedule and budget changes to the contracts and determined why these changes were made. All 12 contracts are open for administrative reasons, although construction has been completed for eight of them.

## Methodology

We obtained the evidence used to support the findings, conclusions, and recommendations in this audit report during our fieldwork period (April 2019 to December 2019), with some additional follow-up work afterward. This section summarizes the work we performed to address the audit objective.

### **Objective: How can Sound Transit improve its oversight and management of its projects?**

To answer the audit question, we examined contract documents, Sound Transit's policies and procedures, and interviewed Sound Transit management and staff as well as staff from other transit and transportation agencies. We also researched leading practices.

### *Selected a sample of contracts*

First, we selected a judgmental sample of contracts based on their dollar value, number of change orders, and differences between initial cost estimates and current or final cost estimates. We used large differences between the two cost estimates and a high number of change orders as indicators of major scope, schedule or budget changes. We selected 12 contracts associated with five projects. The contracts currently total \$2.3 billion. Since it was a judgmental sample, the contracts selected may not be representative of all Sound Transit contracts.

- **D Street to M Street Track and Signal:** The construction contract for Sound Transit’s D to M Street project extends the Sounder commuter rail line in Tacoma for \$67 million, including \$25.9 million in change orders.
- **Northgate Link:** The Northgate Link Extension adds three new light rail stations in Seattle, two underground (U District and Roosevelt stations) and an elevated station at Northgate. The Northgate station includes bus connections, a park-and-ride and a bicycle/pedestrian bridge. The four contracts we reviewed total \$1 billion, including \$84.7 million in change orders (contract value shown in parentheses):
  - Tunnel excavation from University of Washington Station to Maple Leaf Portal (\$500.6 million)
  - Structural work and design finishes for U District Station (\$164.8 million)
  - Structural work and design finishes for Roosevelt Station (\$162 million)
  - Structural work and design finishes for Northgate station, including the elevated guideway and parking structure (\$183.8 million)
- **Operations and Maintenance Facility – East:** The design-build contract for an Operations and Maintenance Facility in Bellevue. The facility supports the region’s light rail fleet. The project costs \$225 million, including \$5.6 million in change orders.
- **Tacoma Trestle Track & Signal:** The construction contract for the Tacoma Trestle Track and Signal project, which involved the demolition and reconstruction of the original 100-year-old trestle. The project costs \$86 million, including \$28 million in change orders.
- **University Link:** The University Link Extension project extends light rail from Downtown Seattle to the University of Washington via tunnels. The five contracts we reviewed total \$862.1 million, including \$33.6 million in change orders (contract value shown in parentheses):
  - Tunnel excavation from University of Washington Station to Capitol Hill Station (\$315.2 million)
  - Tunnel excavation from Downtown Seattle to Capitol Hill Station (\$157.3 million)
  - Structural work and design finishes for Capitol Hill Station (\$115.7 million)
  - Structural work and design finishes for University of Washington Station (\$150.3 million)
  - Track and signal work from Downtown Seattle to University of Washington Station (\$123.6 million)

### ***Reviewed change orders and interviewed project teams***

To determine whether there were major changes to scope, schedule or budget, we reviewed change orders worth more than \$100,000 and all change orders with any schedule adjustments. The 12 contracts totaled \$2.3 billion, and had 2,220 change orders issued from 2010 through December 2019. We reviewed 324 change orders, about 15 percent of all change orders. However, the cost of these change orders totaled \$172 million, or 94 percent of the total value of all change orders. We used Sound Transit's classification of change orders but also categorized change orders based on the justification given for the change to analyze them. We also interviewed Sound Transit project staff to ask them if there were major changes to contracts.

### ***Reviewed Sound Transit's policies and procedures and interviewed management***

To determine whether Sound Transit could make improvements to its project management and oversight to prevent these change orders, we had to determine how the agency currently oversees and manages changes to contracts. To do this, we reviewed Sound Transit's policies and procedures, and interviewed agency managers as well as members of Sound Transit's Board of Directors, Change Control Board, and Phase Gate Committee. We also reviewed agency policies and procedures regarding design review and underground exploration.

### ***Researched leading practices and interviewed other transit agencies***

To determine what improvements Sound Transit could make to minimize the use of change orders, we researched leading practices around design and underground exploration and identified federal guidelines from the Federal Transit Administration and the American Association of State Highway and Transportation Officials. Because we found some change orders to address design deficiencies and underground conditions were similar to each other, and learned that Sound Transit did not have an agencywide lessons learned program, we also researched leading practices concerning how to incorporate lessons learned into project management to help the agency avoid repeating mistakes. We also researched how other government agencies have implemented lessons learned programs.

To determine how other transit or transportation agencies explore underground conditions prior to construction, we interviewed the Washington State Department of Transportation, the Denver Regional Transportation District, TransLink Vancouver, Bay Area Rapid Transit, the New York Metropolitan Transit Authority, and Los Angeles Metro. We selected the first three because of their relative proximity to the Puget Sound area, and the latter three because they, with Sound Transit, were among the top 10 transit agencies with the largest capital budgets. We asked agencies about strategies they used to minimize risks related to underground conditions.

### ***Calculated potential costs to conduct additional underground exploration***

We also reviewed information from Sound Transit documenting costs for underground exploration. We calculated the cost of doing more underground exploration before construction by first calculating the average cost to drill one hole approved through a change order. Such change orders inherently show the actual cost of additional exploration on projects. The cost to drill one hole varied greatly between change orders depending on its depth and other factors, and ranged from \$16,000 to \$85,000. Since reports documenting completed underground explorations show the depth of exploratory holes also

varied greatly, we concluded the average cost per hole was the appropriate calculation. We also reviewed these documents to determine how many exploratory drill holes were made for all five projects we reviewed. We used our average cost calculation to determine the additional total cost to increase the number of exploratory drill holes by 25 percent. The amount of exploration is dependent on the risk inherent in projects so it is difficult to determine exactly how many holes to drill. We chose 25 percent arbitrarily as the figure can easily be multiplied and divided.

### ***Calculated potential cost savings through competitive bidding***

We reviewed contract documents and change orders to determine potential cost savings if Sound Transit included work in the original contract rather than through change orders. Sound Transit hires consultants to estimate the cost to complete work included in contracts and change orders. We compared these estimates to winning bids for Sound Transit's traditional, design-bid-build construction contracts and the actual cost of change orders from the contracts we reviewed. We then calculated the percent differences. The winning bids from contractors were, on average, 15 percent less than the consultant's cost estimates. On the other hand, change orders, which are not competitively bid, were 8 percent more than the independent cost estimates. We removed one change order and comparison from this calculation because it was a major outlier. With that comparison included, the actual costs of change orders were on average 17 percent more than independent cost estimates. We added the percent differences together to find the average percent difference between change orders and competitive bids. We then multiplied it with the cost of change orders from design deficiencies and unexpected underground conditions for the design-bid-build contracts we reviewed. Since we conducted a judgmental sample, we could not project this calculation to all contracts.

We also only used change orders from design-bid-build contracts because cost savings obtained through competitive bidding are more apparent with this traditional contracting approach. For design-bid-build contracts, designs are finalized before contractors submit bids to build the work described in the designs. Change orders are issued when the construction contractor must complete work not described in the contract and design. Sound Transit also uses other contracting methods. We excluded change orders with those contracting approaches in this calculation.

## **Work on internal controls for design reviews and project changes**

Since we found a large portion of preventable project changes occurred because of design deficiencies, we reviewed internal controls around completing designs. Sound Transit hires design engineers to design projects and ensures the projects meet standards and specifications through various approvals and review processes. We interviewed agency staff and reviewed Sound Transit's procedures to gain an understanding of its design review process and to determine how it could be improved. As discussed earlier, we researched leading practices around design reviews to see if Sound Transit could make improvements to its internal controls.



We also reviewed Sound Transit's oversight of project changes. We interviewed agency staff and management and members of the Board of Directors to determine how project changes are approved. We asked them about the review process and what information they consider when reviewing requests for project changes.

We did not review the governance structure of Sound Transit's Board of Directors, which is the agency's governing body, but examined how it oversees project changes. We also did not review Sound Transit's contracting approaches, whether the best contracting approaches were used for the projects we examined, or whether competitive bidding processes were followed. Different contracting approaches affect how cost and schedule risks are shared between the owner and the contractor, and can therefore affect potential changes to contracts. Although we focused heavily on planning and design, we did not review the work of Sound Transit's design consultants. We also did not review the day-to-day management of construction crews.



“Our vision is to increase **trust** in government. We are the public’s window into how tax money is spent.”

– Pat McCarthy, State Auditor

Washington State Auditor’s Office  
P.O. Box 40031 Olympia WA 98504

[www.sao.wa.gov](http://www.sao.wa.gov)

**1-866-902-3900**



Office of the Washington State Auditor