



September 2022

EXTRA LARGE UNMANNED UNDERSEA VEHICLE

Navy Needs to Employ Better Management Practices to Ensure Swift Delivery to the Fleet

GAO Highlights

Highlights of [GAO-22-105974](#), a report to congressional committees

Why GAO Did This Study

The Navy is developing the XLUUV in response to a need to lay undersea mines. This ability could prevent an adversary from accessing strategic waterways and entry points on land. The Navy considers uncrewed autonomous vehicles to be prototypes that it is pursuing as a research and development effort. However, these XLUUVs are expected to serve a key role in the fleet and could protect sailors from performing dangerous missions.

The joint explanatory statement accompanying the Consolidated Appropriations Act, 2022, included a provision for GAO to review the XLUUV and the Navy's adherence to acquisition best practices. This report assesses (1) the extent to which the XLUUV is meeting cost and schedule targets, and (2) the Navy's efforts to develop, design, and produce the XLUUV compared to leading practices for product development.

GAO compared the XLUUV acquisition plan with the President's Budget for fiscal year 2023; compared XLUUV contracts, documents, and cost and schedule outcomes to leading practices for product development; and interviewed officials responsible for the XLUUV effort.

What GAO Recommends

GAO is making two recommendations to the Navy, to (1) conduct production readiness reviews prior to additional purchases beyond the five XLUUVs, and (2) develop cost and schedule estimates to improve the feasibility of acquiring the vehicles in a timely manner. The Navy concurred with both of the recommendations.

View [GAO-22-105974](#). For more information, contact Shelby S. Oakley at (202) 512-4841 or OakleyS@gao.gov.

September 2022

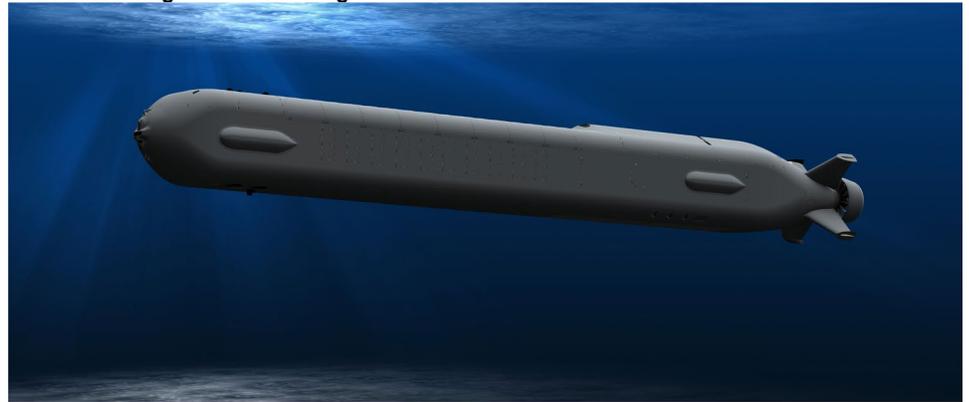
EXTRA LARGE UNMANNED UNDERSEA VEHICLE

Navy Needs to Employ Better Management Practices to Ensure Swift Delivery to the Fleet

What GAO Found

The Navy is attempting to rapidly deliver five Extra Large Unmanned Undersea Vehicles (XLUUV) to the fleet for deploying undersea mines without the need for sailors. However, the XLUUV effort is at least \$242 million or 64 percent over its original cost estimate and at least 3 years late. The contractor originally planned to deliver the first vehicle by December 2020 and all five vehicles by the end of calendar year 2022. The Navy and the contractor are in the process of revising the delivery dates. But both expect the contractor to complete and deliver all five vehicles between February and June 2024.

Artist Rendering of the Extra Large Unmanned Undersea Vehicle



Source: U.S. Navy. | GAO-22-105974

The contractor did not demonstrate its readiness to fabricate XLUUV because it was not required to do so. For acquisition programs, DOD and Navy typically conduct a production readiness review. While XLUUV is a prototype and not an acquisition program, the Navy plans to field the vehicles quickly. Key differences between the XLUUV and the contractor's prototype, the Echo Voyager, required the contractor to redesign critical components. Rather than address issues before starting fabrication, the contractor did not identify the full impact of these issues until after fabrication began. Then, significant delays were exacerbated by the COVID-19 pandemic. Further, the Navy has begun assessing the possibility of adding more capability and vehicles to this effort. If the Navy forgoes a production readiness review for its next XLUUV purchase, it risks beginning fabrication without information to assess the contractor's cost, schedule, and performance targets.

The Navy determined that XLUUV was critical to fulfilling an emergent need, which, under DOD policy, generally requires a capability be provided within 2 years. However, the Navy did not develop a sound business case, including cost and schedule estimates, to ensure that it could deliver the vehicles quickly to the fleet because XLUUV is a research and development effort. According to DOD urgent capability acquisition best practices, an acquiring organization should make cost and schedule trade-off decisions to get solutions to the fleet faster. Without more complete cost and schedule estimates, the Navy does not have the information it needs for decision-making and, thus, could continue experiencing cost overruns and schedule delays as it builds the XLUUV.

Contents

Letter		1
	Background	2
	XLUUV Exceeded Cost and Schedule Targets and Navy Did Not Verify That the Contractor Was Ready to Begin Fabrication	7
	Navy Did Not Ensure It Could Deliver XLUUV to the Fleet within a 2-Year Time Frame	13
	Conclusions	17
	Recommendations for Executive Action	18
	Agency Comments	18
Appendix I	Objectives, Scope, and Methodology	21
Appendix II	Comments from the Department of the Navy	23
Appendix III	GAO Contact and Staff Acknowledgments	25
Related GAO Products		26
Tables		
	Table 1: Cost Growth for Extra Large Unmanned Undersea Vehicle (in millions then-year dollars)	8
	Table 2: Original and Rebaselined Dates for Delivery of Extra Large Unmanned Undersea Vehicles	9
	Table 3: Key Differences between Echo Voyager Prototype and Extra Large Unmanned Undersea Vehicle (XLUUV) and Effect on Fabrication	10
	Table 4: Status of Key Elements of a Basic Business Case for Extra Large Unmanned Undersea Vehicle (XLUUV) Effort Currently and When the Contractor Began Fabrication of the Five Prototype XLUUVs	14
Figures		
	Figure 1: Artist Depiction of the Extra Large Unmanned Undersea Vehicle	2

Figure 2: Major Milestones for the XLUUV Program to Date	6
Figure 3: Extra Large Unmanned Undersea Test Vehicle	7

Abbreviations

CDR	critical design review
DOD	Department of Defense
FPI	fixed-price incentive
JEON	Joint Emergent Operational Need
XLUUV	Extra Large Unmanned Undersea Vehicles

This is a work of the U.S. government and is not subject to copyright protection in the United States. The published product may be reproduced and distributed in its entirety without further permission from GAO. However, because this work may contain copyrighted images or other material, permission from the copyright holder may be necessary if you wish to reproduce this material separately.



September 28, 2022

Congressional Committees

The Navy is developing the Extra Large Unmanned Undersea Vehicle (XLUUV) in response to a critical and time-sensitive need to lay undersea mines. The fleet's ability to lay a minefield could prevent an adversary from accessing strategic waterways and entry points on land. While the Navy considers the XLUUV to be a prototype effort that is in the early stages of development, its strategic plans demonstrate that XLUUVs will likely serve a key role in the future fleet, especially because they could remove sailors from performing dangerous missions.¹

The Joint Explanatory Statement accompanying the Consolidated Appropriations Act, 2022, contained a provision for us to review the XLUUV, including the Navy's adherence to acquisition best practices.² This report assesses (1) the extent to which the XLUUV is meeting its cost and schedule targets and what issues, if any, XLUUV is facing in achieving these targets; and (2) the Navy's efforts to develop, design, and produce the XLUUV compared to leading practices we previously identified for product development.

To identify cost and schedule targets for the XLUUV as well as issues the Navy is facing, if any, in meeting those targets, we compared the XLUUV acquisition plan with the fiscal year 2023 President's Budget. We also compared XLUUV documentation and cost and schedule outcomes to leading practices for product development we have identified. See related GAO products at the end of this report for references to this work. For both objectives, we interviewed officials responsible for the XLUUV effort to understand any deviations between planned and actual cost and schedule. See appendix I for more information about our objectives, scope, and methodology.

We conducted this performance audit from April 2022 to September 2022 in accordance with generally accepted government auditing standards.

¹For the purposes of this review, we are using the gender-neutral term uncrewed as a replacement for the term unmanned except when referring to the proper name of a Navy document or program.

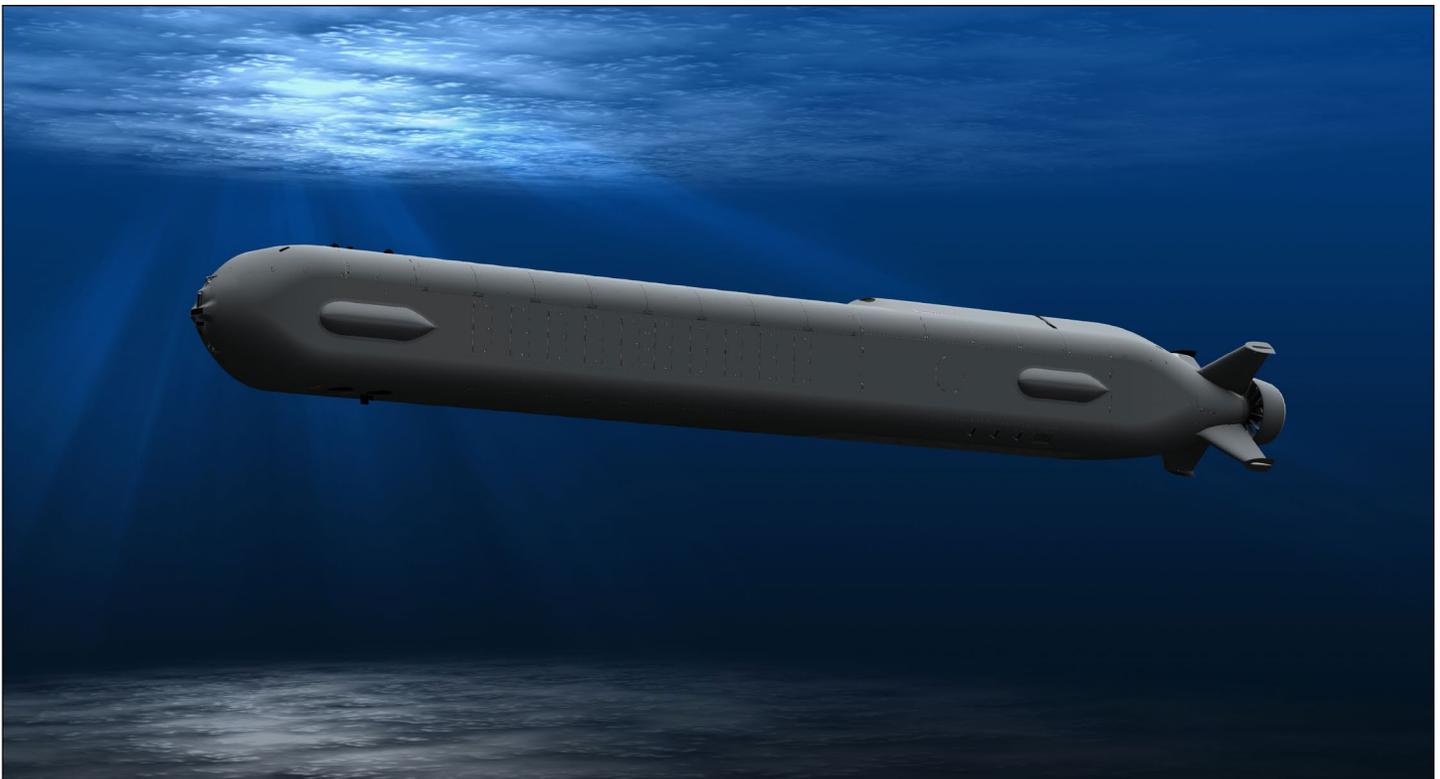
²168 CONG. REC. H1709, H2106 (Mar. 9, 2022) (joint explanatory statement to the Consolidated Appropriations Act, 2022, div. C, Dept. of Defense Appropriations Act, 2022).

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.

Background

The XLUUV is a large uncrewed submarine that the Navy initially plans to use to deploy mines. To accomplish its mission, XLUUV has several key requirements related to endurance, depth, navigation, communication, payload capability, and obstacle avoidance. Figure 1 is the Navy's depiction of an XLUUV.

Figure 1: Artist Depiction of the Extra Large Unmanned Undersea Vehicle



Source: U.S. Navy. | GAO-22-105974

The XLUUV is based on a prototype vehicle called the Echo Voyager, which, according to The Boeing Company officials, Boeing built with its own resources as a demonstration of autonomous system technology. According to these officials, the Echo Voyager is designed to carry

equipment for a variety of missions and was not specifically designed for mine laying. The Echo Voyager also has different limitations regarding its range for operations in terms of length of mission and depth.

The XLUUV has two key design characteristics—modularity and floodability.

- **Modularity.** The body of the vehicle is comprised of four sections or modules. This modularity allows some of the inner components, such as the batteries or payloads, to be added or removed when the vehicle is in the water, dependent upon the Navy’s needs. According to Navy officials, the Navy could add two additional batteries to the XLUUV if, for example, it needs more power for a mission due to increased range or payload requirements. Also according to Navy officials, the Navy plans to begin exploring the development of a universal payload module, which could carry many types of equipment for a variety of missions. The Navy could then install this module into the vehicle in place of the mine payload.
- **Floodability.** By design, the vehicle’s hull is not watertight, which allows it to change depth underwater using a bladder and tank system that is less susceptible to corrosion. The tanks contain oil instead of water. To sink, the vehicle maintains the oil in the tank, allowing the vehicle to take on a maximum amount of water. To rise, the vehicle pumps oil from the tank into the bladder, which pushes water from the vehicle. Critical components that must be dry, such as batteries and electronics, are encased in watertight spaces called pressure vessels.

The XLUUV is a part of a larger portfolio of uncrewed maritime systems. In April 2022, we reported on four uncrewed maritime system efforts managed by the uncrewed program office within Naval Sea Systems Command’s Program Executive Office for Unmanned and Small Combatants.³ We compared the Navy’s approach to acquiring these four systems to its guidance and best practices. We recommended improvements to the Navy’s overall management, planning, and cost estimating for its portfolio of uncrewed maritime system efforts. The Navy agreed to implement our recommendations for the uncrewed maritime portfolio of systems.

³GAO, *Uncrewed Maritime Systems: Navy Should Improve Its Approach to Maximize Early Investments*, [GAO-22-104567](#) (Washington, D.C.: Apr. 7, 2022).

Navy's Approach to XLUUV Effort

In January 2015, the Navy identified advanced mining as a Joint Emergent Operational Need (JEON). According to Department of Defense (DOD) guidance, a JEON is an urgent operational need identified by the fleet or the Chairman of the Joint Chiefs of Staff as a need across military services that impacts an anticipated contingency operation. If left unfulfilled, JEONs can lead to capability gaps and result in a loss of life or critical mission failure. DOD guidance provides that capability gaps in this process are generally to be addressed within a 2-year time frame. In fiscal year 2017, the Navy identified the XLUUV as a solution to address the JEON and established a plan to purchase up to five XLUUVs as a research and development effort.

Typically, the Navy executes research and development efforts to, among other testing and studying, do basic research, applied research, scientific experiments, and design studies. The Navy considers these five XLUUVs to be prototypes, but is also planning to use these vehicles for military operations as soon as possible to fulfill the JEON. In other words, according to requirements documentation, DOD and the Navy are pursuing the XLUUV because it fulfills an emergent need for anticipated military operations. According to senior Navy officials, since the XLUUV is a research and development effort that has not transitioned to a pathway within the DOD Adaptive Acquisition Framework, DOD and Navy guidance for the Adaptive Acquisition Framework is not applicable to XLUUV. In general, DOD and Navy acquisition guidance instructs programs to create documentation and analysis to support program decisions.⁴

⁴In 2019, DOD introduced the Adaptive Acquisition Framework. DODI 5000.02, Operation of the Adaptive Acquisition Framework (Jan. 23, 2020) (Chg. 1, effective June 8, 2022). The framework establishes six acquisition pathways, including the urgent acquisition pathway. In 2022, the Navy introduced policy to implement the Adaptive Acquisition Framework. Under this policy, urgent operational needs—which include JEONs—are to be addressed using the Navy's urgent needs process and DOD's urgent capability acquisition pathway. SECNAV Instruction 5000.2G, Dept. of the Navy Implementation of the Defense Acquisition System and the Adaptive Acquisition Framework (Apr. 8, 2022), encl. 3, Dept. of the Navy Urgent Needs Process and Urgent Capability Acquisition. Under both the Navy's urgent needs process and DOD's urgent capability pathway, capabilities are to be fielded in less than 2 years. SECNAV Instruction 5000.2G; DODI 5000.81, Urgent Capability Acquisitions (Dec. 31, 2019). A Navy official indicated that the XLUUV is not currently on an adaptive acquisition framework pathway or the Navy's urgent operational needs process. However, Navy budget documents show that the Navy may be planning to transition the effort to an acquisition pathway, particularly if the program expands beyond the 5 prototypes vehicles.

The Navy developed an acquisition strategy for acquiring the XLUUV in two phases. In the first phase, the Navy planned to competitively award two contracts to different contractors for designing the XLUUV. In the second phase, the Navy planned for one or both of these same contractors to fabricate and test up to five prototype vehicles total.

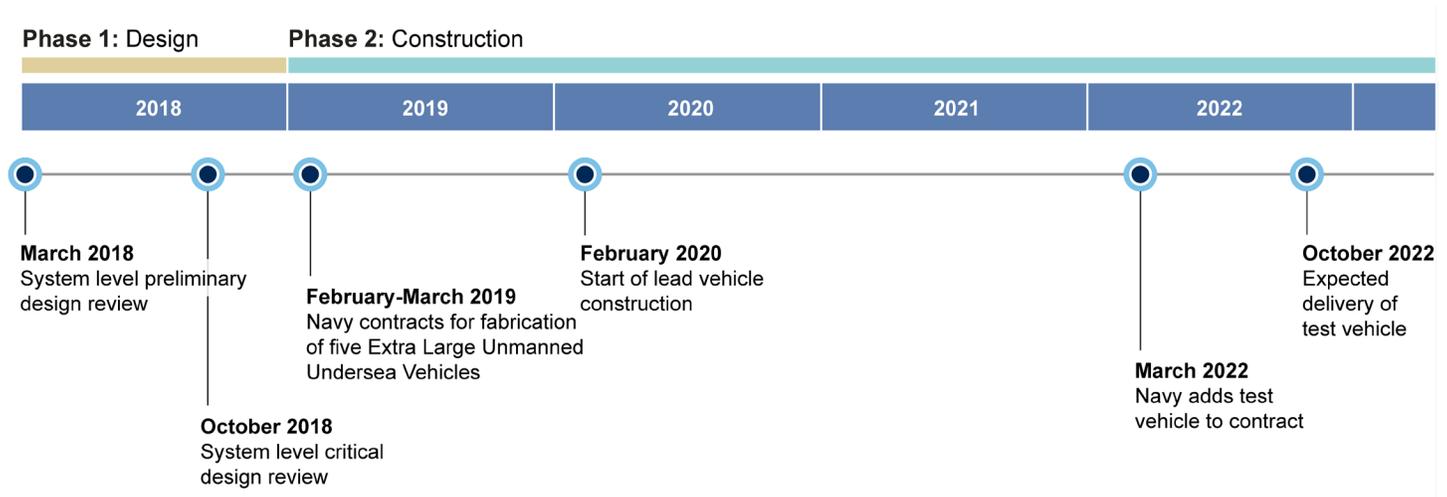
- **Phase one:** design. In accordance with its strategy, the Navy awarded design contracts to two contractors, Boeing and Lockheed Martin Corporation, in September 2017.⁵ In October 2018, the Navy completed phase one with each contractor completing a critical design review that evaluated whether each contractors' system design was stable and the expected performance was achievable.⁶
- **Phase two:** construction. As planned, the Navy sought proposals from both contractors for fabrication and testing of up to five prototype XLUUVs. In February and March 2019, the Navy selected one contractor—Boeing—and exercised a contract option for fabrication and testing of all five XLUUV prototypes. The contract provided for delivery of the first vehicle within 2 years—that is, delivery to the Navy was scheduled for December 2020. The option for the fabrication and testing of the 5 prototype vehicles was a fixed-price incentive contract type. The ceiling price to fabricate all five vehicles is currently \$281.5 million, including technical manuals and other documentation. Fixed-price incentive contracts are designed to provide contractors an incentive to control costs by using a profit adjustment formula to link

⁵The contracts' XLUUV prototype vehicle design line items were cost-plus-incentive-fee—a type of cost-reimbursement contract type that provides for the initially negotiated fee to be adjusted later by a formula based on the relationship of total allowable costs to total target costs, sometimes called a share line.

⁶The critical design review (CDR) confirms the system design is stable and is expected to meet system performance requirements, and also that the system is on track to achieve affordability and cost goals as evidenced by the detailed design documentation. CDR also establishes the initial product baseline.

the contractor’s final profit to the actual costs.⁷ In this case, Navy officials’ acknowledged that the contract’s ceiling price would likely be exceeded. Figure 2 illustrates the major milestones for the XLUUV program to date.

Figure 2: Major Milestones for the XLUUV Program to Date



Source: GAO analysis of Navy documentation and interviews with Navy Officials. | GAO-22-105974

In March 2022, the Navy added to the contract a test vehicle that it plans to use for testing and fleet familiarization while the contractor builds the five planned prototype XLUUVs. The test vehicle is comprised of some elements of the contractor’s original prototype, the Echo Voyager, and the Navy’s planned XLUUV. The test vehicle has no payload module. According to Navy officials, the Navy plans to take delivery of the test

⁷As we previously reported, fixed-price incentive (FPI) contracts specify several contract elements, including a profit adjustment formula referred to as a share line. In accordance with the share line, the government and the shipbuilder share responsibility for cost increases or decreases compared to the agreed upon target cost. The final negotiated cost is subject to a ceiling price, which is the maximum that may be paid to the contractor, except for any adjustment under other contract clauses. Generally, the share line functions to decrease the shipbuilder’s profit as actual costs exceed the target cost. Likewise, the shipbuilder’s profit increases when actual costs are less than the target cost for the ship. Since the shipbuilder’s profit is linked to actual performance, FPI contracts provide an incentive for the shipbuilder to control costs. Incentive arrangements can be designed to achieve specific objectives by motivating contractor efforts that might not otherwise be emphasized and discouraging contractor inefficiency and waste, see [GAO-17-211](#).

vehicle in October 2022 following contractor-led developmental testing. Figure 3 is a picture of the test vehicle.

Figure 3: Extra Large Unmanned Undersea Test Vehicle



Source: Navy program office. | GAO-22-105974

XLUUV Exceeded Cost and Schedule Targets and Navy Did Not Verify That the Contractor Was Ready to Begin Fabrication

The XLUUV effort has exceeded its cost estimate by hundreds of millions of dollars and is over 3 years late, according to current estimates. These cost overruns and schedule delays are attributable, in part, to the Navy's decision to not require the contractor to demonstrate its readiness to fabricate the prototype XLUUVs, as called for by leading acquisition practices.⁸ Without knowledge to inform decision-making, delays ensued as the contractor implemented updates, revisions, and alterations after the Navy contracted to purchase the five XLUUVs in February and March 2019, according to Navy officials.

⁸Throughout the remainder of this report, general references to XLUUVs are to the five prototype XLUUVs the Navy contracted for in February and March of 2019.

XLUUV Is Over Budget and Late

The XLUUV effort has exceeded its original cost estimate by at least \$242 million or 64 percent, according to the fiscal year 2023 President's Budget request. The Navy now plans to spend \$621 million to build the five planned XLUUVs, a cost that includes the newly added the test vehicle for \$73 million. This cost growth accounts for the government's liability and does not include cost growth absorbed by the contractor. See table 1 for cost growth information.

Table 1: Cost Growth for Extra Large Unmanned Undersea Vehicle (in millions then-year dollars)

Planned costs (fiscal year 2023 President's Budget)	\$621
Spent to Date (as of June 2022)	\$504
Additional planned costs (fiscal year 2023)	\$117
Original cost estimate (2016)	\$379
Total cost growth	\$242

Source: GAO analysis of Navy documentation. | GAO-22-105974

Seventy-three million dollars of the effort's cost growth is due to the Navy's decision to add the test vehicle. The Navy's original cost estimate did not provide sufficient detail for analyzing the source of the remaining \$169 million of cost growth. However, Navy officials told us that \$43 million of the cost growth was from the design phase and an additional \$50 million is attributed to the fabrication phase. The Navy also spent \$21 million on a test site for the XLUUV that Navy officials told us was not a part of the original cost estimate. Lastly, Navy officials attributed the remaining \$55 million in cost growth to increased program office costs resulting from the effort taking longer than planned.

The delivery of the first XLUUV is now expected to be over 3 years late. The contractor originally planned to deliver the first XLUUV in December 2020 and all five by the end of calendar year 2022. As of June 2022, the Navy said it is in the process of rebaselining the schedule and has yet to firmly establish new estimated delivery dates for XLUUV one through five. However, Navy officials told us that the contractor has tentatively targeted February 2024 to June 2024 for delivery of all five vehicles, as shown in table 2.

Table 2: Original and Rebaselined Dates for Delivery of Extra Large Unmanned Undersea Vehicles

Original dates				
Vehicle 1	Vehicle 2	Vehicle 3	Vehicle 4	Vehicle 5
December 29, 2020	June 29, 2021	December 29, 2021	June 29, 2022	December 29, 2022
Tentative dates based on current rebaseline process				
Between February 2024 and June 2024 for all five vehicles				

Source: GAO analysis of Navy documentation and interviews. | GAO-22-105974

Navy Did Not Assess the Contractor’s Readiness to Fabricate XLUUV

The Navy did not require the contractor to demonstrate its readiness to fabricate and deliver the XLUUVs prior to beginning fabrication, as called for by leading acquisition practices. Schedule delays ensued as the contractor struggled to fabricate the XLUUV, which has key differences from the Echo Voyager prototype it previously built, according to Navy officials. According to the contractor, to meet the Navy’s requirements, it had to:

- revise the design for critical components;
- update subcontractor cost proposals for major sections such as the hull, pressure vessels, and battery; and
- alter manufacturing processes to account for the differences with Echo Voyager.

We highlight four key differences between the Echo Voyager prototype and the XLUUV and their effect on fabrication in table 3 below.

Table 3: Key Differences between Echo Voyager Prototype and Extra Large Unmanned Undersea Vehicle (XLUUV) and Effect on Fabrication

Key difference from Echo Voyager	Description of difference	Effect on fabrication
Endurance	XLUUV requires different endurance and has a different operational profile than the Echo Voyager, according to Navy and contractor officials. As a result, XLUUV requires a battery with larger energy capacity to power the vehicle.	The battery is unique to XLUUV and presented challenges in design and fabrication, according to Navy officials. The XLUUV contractor selected a new subcontractor for the battery, according to Navy officials. According to the contractor, this selection was due to the original battery vendor declining to continue into production. This resulted in developing a new battery design to meet the Navy’s safety requirements, which required significant time and effort. As of June 2022, Navy officials said the subcontractor has yet to deliver the newly designed battery to the Navy for testing. Without the battery, the Navy may have to alter the fabrication schedule for the vehicle.
Pressure vessels	The pressure vessels were made of a different material to meet Navy requirements, according to Navy officials.	According to the Navy, the type of material needed for the pressure vessels took longer to obtain. Further, the new materials posed more technical challenges as compared to the original material, according to Navy officials. As a result, the new material added complexity to building the pressure vessels.
Payload	Contractor officials said they redesigned the Echo Voyager’s payload module to meet the Navy’s requirements for mine handling.	According to the contractor, it redesigned the payload module to meet the Navy’s safety-related requirements. This required significant changes to the hull portion of the vehicle’s payload module.

Key difference from Echo Voyager	Description of difference	Effect on fabrication
Lift	The contractor used an elevator to raise and lower the Echo Voyager, according to Navy officials. However, the Navy requires the XLUUV to be raised from and lowered into the water by a crane.	The contractor said it redesigned the payload module and other parts of the XLUUV to meet lift requirements. This change increased the complexity of constructing the vehicle.

Source: GAO analysis of Navy and contractor information and interviews with Navy and contractor officials. | GAO-22-105974

Even though its requirements led to significant changes to the vehicle’s design, the Navy did not require the contractor to demonstrate its readiness to begin fabrication of the XLUUVs. In the context of weapon systems manufacturing, a production readiness review typically examines a system to determine if the design is ready for production and if the prime contractor and major subcontractors have accomplished adequate production planning. Leading practices we identified illustrate that a properly executed production readiness review should provide knowledge to decision makers.⁹ It should also help ensure that the government does not incur unacceptable risk that increases the chances of breaching the established thresholds of cost, schedule, and performance or other criteria. The review evaluates the full, production-configured system to determine if it correctly and completely implements all system requirements, providing decision makers with relevant information before a program proceeds with production.

According to Navy officials, the Navy was not required to conduct a production readiness review for the XLUUV. However, while the Navy considers the XLUUV a prototype, it plans to use the five vehicles for operational missions. The Navy does not consider the XLUUV effort to be an acquisition program. However, we believe that leading practices we identified are applicable to the XLUUV and illustrate that adopting certain elements of a production readiness review would have helped inform the Navy’s cost and schedule targets and its decision-making.¹⁰ Navy officials told us that they reviewed the contractor’s readiness for fabrication as a part of the critical design review prior to contracting for the fabrication of the five prototype vehicles. However, these officials neither elaborated on

⁹GAO, *Best Practices: DOD Can Achieve Better Outcomes by Standardizing the Way Manufacturing Risks Are Managed*, [GAO-10-439](#) (Washington, D.C.: Apr. 22, 2010).

¹⁰[GAO-10-439](#).

what they assessed nor were they able to provide us with any documentation of this review.

The Navy has also not decided what aspects of acquisition guidance the XLUUV effort will follow in the future. The Navy plans to transition the XLUUV effort to an acquisition program at some point, but has yet to decide on when this transition will take place. As a result, the Navy has yet to modify the XLUUV's acquisition strategy to include future capability, including whether or not the Navy will require a production readiness review for any future construction of additional XLUUVs. The Navy is, however, already planning for the effort's future. For example, the Navy is requesting \$117 million in the fiscal year 2023 budget to, among other things, begin assessing the possibility of future XLUUV capabilities beyond the needs established in the JEON. According to Navy and DOD acquisition guidance, a production readiness review generally would be completed before a major capability acquisition program approaches the decision to enter production and deployment. However, DOD guidance permits entry to the major capability pathway at the point of the production and deployment decision. As a result, the Navy could bypass the requirement to conduct a production readiness review prior to beginning production and deployment. If the Navy chooses to build new XLUUVs but forgo a production readiness review, it would miss the opportunity to gain knowledge about the effort's risks, such as whether the contractor can meet cost, schedule, and performance targets.

Other Factors Further Delayed Fabrication

According to contractor and Navy officials, delays in fabrication were exacerbated by challenges from the COVID-19 pandemic and the effects of processing deviations to design specifications.

COVID-19 Related Supply Challenges

Supply issues affected the contractor's ability to receive material purchases in time to support its schedule. Contractor officials told us that it has been difficult to maintain their schedule through the series of economic disruptions resulting from the COVID-19 pandemic. Further, contractor officials told us that they spent a significant amount of resources to find the parts called for in the design or suitable alternative parts. Contractor officials said the Navy has taken steps to help them with supply chain issues by funding some of the efforts to locate and assess the viability of using alternative, but available, parts.

Processing Deviations to the Design Specifications

If shipbuilders discover that they cannot build a ship according to the plan in the ship's specifications, they can request a deviation from the plan. According to the Navy, the contractor has submitted over 1,500 deviation requests since the critical design review in October 2018. This includes

13 major deviations to the hull, pressure vessels, batteries, and the payload, among others. As of May 2022, the Navy approved two of these 13 major deviations and has yet to make a decision regarding the remaining 11 major deviations. For submarine programs, the Navy has a standard process for deciding whether to approve or deny a contractor's deviation request. This process is intended to help ensure that the submarine—or in this case, the XLUUV—will work as intended despite altering the contract specification. However, Navy officials noted that the deviation request process can be slow for a new vessel class (like XLUUV) because Navy engineers must rely solely on contractor-provided data to inform their decision rather than the Navy's own readily-available operational data based on past experience. Navy officials also stated that they are continuing to evaluate the process they use for adjudicating deviation requests. This is in light of the unique challenges of engineering uncrewed vehicles, such as ensuring that the ship can be operated and maintained without people on board.

Navy Did Not Ensure It Could Deliver XLUUV to the Fleet within a 2-Year Time Frame

Even though the Navy identified the XLUUV as a solution to a JEON, it did not develop an executable plan, or business case, to help ensure that it could deliver the first vehicle within a 2-year time frame specified in DOD guidance. We previously found that key information, such as developing schedule and cost estimates, helps organizations to make informed trade-off decisions before investing hundreds millions of dollars.

Navy Did Not Develop an Executable Business Case to Help Ensure It Could Deliver XLUUV to the Fleet within 2 Years

The Navy did not develop an executable business case for its XLUUV efforts to help ensure that it could deliver XLUUV to the fleet within the time frames in DOD guidance. Specifically, while the Navy determined that XLUUV was a solution to an emergent need, it did not develop the knowledge necessary to help ensure that it could deliver the vehicle within the expected 2-year time period outlined in DOD guidance.¹¹ It has been 7 years since DOD first validated the JEON and 5 years since the Navy began the XLUUV effort. While first-in-class or prototype weapons present significant challenges, we have frequently reported on the benefits of an executable business case before setting baselines and

¹¹DOD, *Manual for the Operation of the Joint Capabilities Integration and Development System* (Aug. 31, 2018). In October 2021, DOD issued a new version of this manual. We used the previous manual since it was in place at the time that the Navy was planning the XLUUV effort.

committing resources to challenging fabrication efforts.¹² A sound business case requires balance between the concept selected to satisfy operator needs and the resources—knowledge, funding, and time—needed to deliver the product. In the case of XLUUV, despite the urgency of the need, the Navy lacked knowledge to determine that it could deliver to its schedule targets. Instead, the Navy accepted the set cost from the contractor for the fabrication of the five XLUUVs without ensuring that the effort was executable.

While the Navy is pursuing the XLUUV as a research and development or prototyping effort and not yet as an acquisition program, it intends for the five XLUUVs to be fleet assets responsible for executing a critical mission—not just assets used for research. For this reason, we believe that the concepts underlying these leading practices are applicable to the XLUUV effort—even if, at this point, it is not practical to complete full, independent assessments of requirements, cost, and schedules that the Navy typically develops when pursuing a major acquisition. We previously found that key enablers of a good business case include basic and feasible requirements, reliable cost estimates, and reasonable schedule targets. Table 4 illustrates the key elements of a basic business case and whether the Navy completed them.

Table 4: Status of Key Elements of a Basic Business Case for Extra Large Unmanned Undersea Vehicle (XLUUV) Effort Currently and When the Contractor Began Fabrication of the Five Prototype XLUUVs

Elements of a basic business case	Completed at time fabrication began?	Currently complete?
Key requirements document	Yes	Yes
Reliable cost estimate ^a	No	No
Reasonable schedule ^b	No	No

Source: GAO assessment of XLUUV program documentation. | GAO-22-105974

^aOur cost guide states that a reliable cost estimate should be completed with the level of detail necessary to make informed decisions at key points in the program.

^bAccording to our cost guide, programs can help ensure that their key dates are executable by developing reasonable schedules.

The Navy made a decision to spend hundreds of millions of dollars to build XLUUVs. But, without a sound business case, the Navy does not have informed cost and schedule targets for the XLUUV going forward.

¹²GAO, *Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Program Costs*, [GAO-20-195G](#) (Washington, D.C.: March 2020).

As such, the Navy increased its risk that the XLUUV's cost growth and schedule delays will continue, further affecting its ability to deliver the needed capabilities to the fleet.

Navy Did Not Assess the Risk in XLUUV's Schedule

The Navy did not assess the contractor's ability to fabricate the XLUUV in the 2-year time frame. GAO-identified leading practices state that developing a reasonable schedule is a critical tool for understanding and managing risks that could impact projects and efforts. This tool gives decision makers confidence that schedule estimates are credible, based on known risks, and can be relied upon to track progress.¹³ However, the Navy did not develop a schedule or conduct a schedule risk analysis to determine the feasibility of the contractor's schedule for fabricating and delivering the five planned XLUUVs. It did not do so because it considers this effort a prototype and is pursuing these assets under research and development authorities. However, the Navy plans to spend at least \$600 million on this effort and use these systems for operational missions.

Moreover, developing a reasonable schedule enables decision makers to make informed trade-off decisions because it highlights the risks and activities most likely to delay an effort. In the case of XLUUV, by not analyzing the XLUUV schedule, the Navy missed the opportunity to focus attention on the uncertainty of fabricating an XLUUV that would meet the Navy's requirements. The Navy also missed the opportunity to assess the uncertainty inherent in the effort and use this assessment to create a more accurate schedule. Further, this analysis could have triggered the Navy to make trade-off decisions if the planned schedule was not congruent with the goals of the effort.

According to DOD urgent capability acquisition best practices, an acquiring organization should make trade-off decisions to ensure that an 80 percent solution gets to the warfighter in a timely manner rather than a 95 percent solution that is too late. For example, a program emphasizing schedule, like an emergent need, may use a schedule risk analysis to help inform decisions that result in reducing some features to deliver a capability sooner. In the case of XLUUV, the Navy did not have information about schedule risks to make an informed trade-off decision that balances the needs and resources available for an emergent need within urgent time frames. As we previously found, making these

¹³[GAO-20-195G](#).

decisions is critical to ensuring that a capability can be delivered in a timely manner.¹⁴

Navy officials told us that they did not assess the schedule because the contract provided for delivery of the XLUUV within 2 years at a ceiling price—effectively prioritizing cost over schedule, despite the 2-year timeframe in DOD guidance. XLUUV officials told us that the Navy is going forward with developing the planned XLUUV since the contract included a ceiling price that set the maximum amount the government will pay the contractor (subject to adjustment under other contract clauses). In other words, Navy officials clearly stated that they do not plan to make trade-offs to improve schedule at this point in the effort. As a result, the Navy does not have the information necessary to ensure that the contractor can meet the schedule, which heightens the risk of additional delays.

Even after the contractor exceeded the XLUUV's original timelines, the Navy is not planning to ensure that the contractor has a reasonable schedule for the new time frames. The Navy still has significant fabrication and testing milestones to complete. For example, the Navy is planning to assess the performance of the system with the newly delivered test vehicle. However, any problems discovered through testing will require correction during fabrication. Thus, the process to correct these issues could further lengthen planned time frames.

Navy Did Not Develop a Cost Estimate to Guide Investments

Even though it has invested over \$600 million in the XLUUV, the Navy did not develop a reliable cost estimate with enough detail to guide its investment in the first five XLUUVs. Without a reliable estimate, the Navy could not be reasonably certain that the contractor could deliver the 5 vehicles within the 2 year timeframe. The Navy's acquisition plan for the XLUUV contained a single number for the total estimated cost of the first five XLUUVs. Thus, the Navy's estimate for the first five XLUUVs did not contain any additional details about how it derived the total cost or the costs of different aspects of the effort, such as testing and software, among other details. This level of estimation is not useful for decision-making. Without a more complete cost estimate, Navy decision makers lacked details and analyses necessary to support trade-off decisions that could improve the execution of the program to achieve its schedule goals.

¹⁴GAO, *Leading Practices: Agency Acquisition Policies Could Better Implement Key Product Development Principles*, [GAO-22-104513](#) (Washington, D.C.: Mar. 10, 2022).

Leading practices we identified for cost estimating emphasize the importance of developing reliable cost estimates that help to inform key decisions, such as analysis of the key assumptions that drive the estimated cost. Navy officials told us that they have yet to develop a more complete cost estimate because they are not required to do so since the Navy decided to pursue this as a prototype effort. Navy officials also said that developing a more complete cost estimate would slow the program. However, the Navy's approach of not developing a complete cost estimate inhibits their ability to make informed trade-off decisions between cost and schedule, which reduces the likelihood of achieving the 2-year timeframe for addressing a JEON established in DOD guidance. In all, the XLUUV is already over 3 years late with no indication that its projected cost or schedule is achievable.

The Navy developed a rough order magnitude cost estimate in December 2020 for the purchase of up to 15 additional XLUUVs. Senior Navy officials told us that they have not updated this estimate based on the actual cost data from the fabrication of the 5 prototype XLUUVs.¹⁵ Further, officials said that better cost data will likely be available following vehicle testing. We have previously found that prototyping can improve the fidelity of cost estimates for future purchases.¹⁶ Taking steps to fully understand the costs of the prototyping effort would help the Navy make more informed purchasing decisions in the future.

Conclusions

The Navy is pursuing the XLUUV in response to an emergent need to combat threats that could significantly hinder the safety of our nation in the near future. The contract provided for delivery of a vehicle that meets the Navy's needs within 2 years, but the Navy never verified that the contractor could actually accomplish this by conducting a production readiness review. The Navy is beginning to embark on developing XLUUV capabilities beyond the JEON without an acquisition strategy for assessing readiness for production. Further, it has now been 7 years since the emergent need was identified and the Navy does not have a single XLUUV that meets its requirements and the effort has nearly doubled in cost. Instead, the Navy continues to invest hundreds of millions of dollars into the XLUUV without adequate cost and schedule

¹⁵The Navy provided this cost estimate after we sent our draft report for their review. As a result, we did not assess the credibility of this estimate.

¹⁶GAO, Weapon Systems: Prototyping Has Benefited Acquisition Programs, but More Can Be Done to Support Innovation Initiatives, [GAO-17-309](#) (Washington, D.C.: June 27, 2017).

information to make informed decisions that could improve the feasibility of acquiring the five XLUUVs within a specific time frame and better inform estimates for the Navy's planned acquisition program. Consequently, additional schedule delays and cost growth are likely before XLUUVs are complete and can meet requirements.

Recommendations for Executive Action

We are making two recommendations to the Secretary of the Navy.

The Secretary of the Navy should ensure that the office acquiring the XLUUV include a production readiness review as part of its acquisition strategy for any additional purchases of XLUUVs beyond the five prototype XLUUVs and the test vehicle it already purchased. (Recommendation 1)

The Secretary of the Navy should ensure that the office acquiring the XLUUV develop more complete cost and schedule estimates that follow leading practices, such that the Navy can determine whether the contractor's planned timelines for the 5 prototype XLUUVs are achievable within planned costs. (Recommendation 2)

Agency Comments

We provided a draft of our report to the Navy for comment. We incorporated technical comments as appropriate. The Navy's written comments are reprinted in appendix II of this report. The Navy concurred with both of our recommendations.

We are sending copies of this report to the appropriate congressional committees, Secretary of Defense, Secretary of the Navy, and other interested parties. This report will also be available at no charge on GAO's website at <http://www.gao.gov>.

If you or your staff have any questions concerning this report, please contact me at (202) 512-4841 or by e-mail at oakleys@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may

be found on the last page of this report. Key contributors to this report are listed in appendix III.

A handwritten signature in black ink that reads "Shelby S. Oakley". The signature is written in a cursive, flowing style with a large initial 'S' and 'O'.

Shelby S. Oakley
Director, Contracting and National Security Acquisitions

List of Committees

The Honorable Jack Reed
Chairman
The Honorable James M. Inhofe
Ranking Member
Committee on Armed Services
United States Senate

The Honorable Jon Tester
Chair
The Honorable Richard Shelby
Ranking Member
Subcommittee on Defense
Committee on Appropriations
United States Senate

The Honorable Adam Smith
Chairman
The Honorable Mike Rogers
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable Betty McCollum
Chair
The Honorable Ken Calvert
Ranking Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

Appendix I: Objectives, Scope, and Methodology

The Joint Explanatory Statement accompanying the Consolidated Appropriations Act, 2022, contained a provision for us to review the Extra Large Unmanned Undersea Vehicle (XLUUV), including the Navy's adherence to acquisition best practices.¹ This report assesses (1) the extent to which the XLUUV is meeting its cost and schedule targets and what issues, if any, XLUUV is facing in achieving these targets; and (2) the Navy's efforts to develop, design, and produce the XLUUV compared to GAO's leading practices for product development.

To identify cost and schedule targets for XLUUV, and issues the Navy may have faced in meeting those targets, we reviewed the XLUUV's Single Acquisition Management Plan, Master Test Strategy, budget briefs, and contracts and modifications, as well as other documents related to the effort. We also provided a list of questions to the Navy to which they provided written answers. We assessed this information against leading practices we identified for weapon system manufacturing and fabrication. We further interviewed Navy officials from the program office managing the XLUUV, Office of the Chief of Naval Operations, and Naval Systems Engineering & Logistics Directorate, and contractor officials from The Boeing Company (the XLUUV prime contractor) and Huntington Ingalls Industries (a subcontractor), to gain a greater understanding of why any deviations from original targets may have occurred.

To identify how the Navy's efforts to develop, design, and produce the XLUUV compared with leading practices we identified, we evaluated the Navy's efforts for cost assessments, schedule assessments, and requirements, against GAO's *Cost Estimating and Assessment* and *Schedule Assessment guides*.² Specifically, we reviewed the XLUUV documentation and compared it to leading practices we identified for establishing a business case prior to making significant investments. We also assessed the Navy's decision to prioritize cost and schedule while developing the XLUUV and compared it to the Department of Defense

¹168 Cong. Rec. H1709, H2106 (Mar. 9, 2022) (joint explanatory statement to the Consolidated Appropriations Act, 2022, Div. C, Department of Defense Appropriations Act, 2022).

²GAO, *Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Program Costs*, [GAO-20-195G](#) (Washington, D.C.: March 2020); and GAO *Schedule Assessment Guide: Best Practices for Project Schedules*, [GAO-16-89G](#) (Washington, D.C.: Dec. 22, 2015).

(DOD) Instruction, *Manual for the Operation of the Joint Capabilities Integration and Development Systems*.

We conducted this performance audit from April 2022 to September 2022 in accordance with generally accepted government auditing standards. 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.

Appendix II: Comments from the Department of the Navy



DEPARTMENT OF THE NAVY
OFFICE OF THE ASSISTANT SECRETARY
RESEARCH, DEVELOPMENT AND ACQUISITION
1000 NAVY PENTAGON
WASHINGTON DC 20350-1000

SEP 20 2022

Ms. Shelby S. Oakley
Director, Contracting and National Security Acquisitions
U.S. Government Accountability Office
441 G Street, NW
Washington DC 20548

Dear Ms. Oakley,

Attached are the Department of Defense (DoD) technical comments and responses to the recommendations in the GAO Draft Report, GAO-22-105974, "EXTRA LARGE UNMANNED UNDERSEA VEHICLE: Navy Needs to Employ Better Management Practices to Ensure Swift Delivery to the Fleet".

Sincerely,

A handwritten signature in blue ink, appearing to read "Fred Stefany", is positioned above the typed name and title.

Frederick J. Stefany
Principal Civilian Deputy
Assistant Secretary of the Navy
(Research, Development and Acquisition)

Attachments:
As stated

**GAO DRAFT REPORT DATED AUGUST 30, 2022
GAO-22- 105974(GAO CODE 105974)**

**“EXTRA LARGE UNMANNED UNDERSEA VEHICLE Navy Needs to Employ Better
Management Practices to Ensure Swift Delivery to the Fleet.**

**DEPARTMENT OF DEFENSE COMMENTS
TO THE GAO RECOMMENDATIONS**

RECOMMENDATION 1: The Secretary of the Navy should ensure that the office acquiring the XLUUV include a production readiness review as part of its acquisition strategy for any additional purchases of XLUUVs beyond the five XLUUVs and the test vehicle it already purchased.

DoD RESPONSE: Concur.

RECOMMENDATION 2: The Secretary of the Navy should ensure that the office acquiring the XLUUV develop more complete cost and schedule estimates that follow leading practices such that the Navy can determine whether or not the contractor’s planned timelines are achievable within planned costs. If not, the Navy should use the information to make trade-off decisions that improve the feasibility of fielding the vehicles in a timely manner.

DoD RESPONSE: Concur – For the initial five prototypes, the Navy conducted market research IAW FAR part 10 to determine sources capable of satisfying the Navy’s anticipated requirement for XLUUV. As part of this market research, a Request for Information with a series of questions to include cost schedule and performance tradeoffs was issued. Nine responses were received from industry which informed the Navy that industry had vehicles and vehicle designs that could be modified to address the proposed specifications of XLUUV; that autonomy for the length of mission, level of control and weapons deployment was a high risk area; reliability may drive significant amount of redundancy; and cost for design and production of prototype XLUUVs fall within the budget estimates.

Additionally, the Navy made the decision to procure XLEO to include making some capability trade-offs in order to reduce risks to the prototyping effort,

Finally, based on performance to date, the Navy is collecting all cost, schedule and capability data to inform our assessment of contractor proposed costs and schedules going forward and to inform consideration of potential trade-offs.

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

Shelby S. Oakley, (202) 512-4841 or oakleys@gao.gov

Staff Acknowledgments

In addition the contact name above, the following staff members made key contributions to this report: Diana Moldafsky, Assistant Director; Laurier Fish, Analyst-in-Charge; Matthew T. Crosby; Lori Fields; Stephanie Gustafson; Joy Kim; Amanda Parker; and Sophia Payind.

Related GAO Products

Weapon Systems Annual Assessment: Challenges to Fielding Capabilities Faster Persist. [GAO-22-105230](#). Washington, D.C.: June 8, 2022.

Uncrewed Maritime Systems: Navy Should Improve Its Approach to Maximize Early Investments. [GAO-22-104567](#). Washington, D.C.: April 7, 2022.

Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Program Costs. [GAO-20-195G](#). Washington, D.C.: March 12, 2020.

Navy Shipbuilding: Increasing Focus on Sustainment Early in the Acquisition Process Could Save Billions. [GAO-20-2](#). Washington, D.C.: March 24, 2020.

Technology Readiness Assessment Guide: Best Practices for Evaluating the Readiness of Technology for Use in Acquisition Programs and Projects. [GAO-20-48G](#). Washington, D.C.: January 7, 2020.

Guided Missile Frigate: Navy Has Taken Steps to Reduce Acquisition Risk, but Opportunities Exist to Improve Knowledge for Decision Makers. [GAO-19-512](#). Washington, D.C.: August 9, 2019.

Navy Shipbuilding: Past Performance Provides Valuable Lessons for Future Investments. [GAO-18-238SP](#). Washington, D.C.: June 6, 2018.

Weapon System Requirements: Detailed Systems Engineering Prior to Product Development Positions Programs for Success. [GAO-17-77](#). Washington, D.C.: November 17, 2016.

GAO's Mission

The Government Accountability Office, the audit, evaluation, and investigative arm of Congress, exists to support Congress in meeting its constitutional responsibilities and to help improve the performance and accountability of the federal government for the American people. GAO examines the use of public funds; evaluates federal programs and policies; and provides analyses, recommendations, and other assistance to help Congress make informed oversight, policy, and funding decisions. GAO's commitment to good government is reflected in its core values of accountability, integrity, and reliability.

Obtaining Copies of GAO Reports and Testimony

The fastest and easiest way to obtain copies of GAO documents at no cost is through our website. Each weekday afternoon, GAO posts on its [website](#) newly released reports, testimony, and correspondence. You can also [subscribe](#) to GAO's email updates to receive notification of newly posted products.

Order by Phone

The price of each GAO publication reflects GAO's actual cost of production and distribution and depends on the number of pages in the publication and whether the publication is printed in color or black and white. Pricing and ordering information is posted on GAO's website, <https://www.gao.gov/ordering.htm>.

Place orders by calling (202) 512-6000, toll free (866) 801-7077, or TDD (202) 512-2537.

Orders may be paid for using American Express, Discover Card, MasterCard, Visa, check, or money order. Call for additional information.

Connect with GAO

Connect with GAO on [Facebook](#), [Flickr](#), [Twitter](#), and [YouTube](#).
Subscribe to our [RSS Feeds](#) or [Email Updates](#). Listen to our [Podcasts](#).
Visit GAO on the web at <https://www.gao.gov>.

To Report Fraud, Waste, and Abuse in Federal Programs

Contact FraudNet:

Website: <https://www.gao.gov/about/what-gao-does/fraudnet>

Automated answering system: (800) 424-5454 or (202) 512-7700

Congressional Relations

A. Nicole Clowers, Managing Director, ClowersA@gao.gov, (202) 512-4400, U.S. Government Accountability Office, 441 G Street NW, Room 7125, Washington, DC 20548

Public Affairs

Chuck Young, Managing Director, youngc1@gao.gov, (202) 512-4800
U.S. Government Accountability Office, 441 G Street NW, Room 7149
Washington, DC 20548

Strategic Planning and External Liaison

Stephen J. Sanford, Managing Director, spel@gao.gov, (202) 512-4707
U.S. Government Accountability Office, 441 G Street NW, Room 7814,
Washington, DC 20548

