United States Government Accountability Office

Report to Congressional Committees

August 2016

NUCLEAR WASTE

Waste Isolation Pilot Plant Recovery Demonstrates Cost and Schedule Requirements Needed for DOE Cleanup Operations

Accessible Version

GAO-16-608

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GAO Highlights

Highlights of GAO-16-608, a report to congressional committees

Why GAO Did This Study

DOE's WIPP is the only deep geologic repository for the disposal of U.S. defense-related nuclear waste. In February 2014, waste operations were suspended following a truck fire and an unrelated radiological release. DOE estimated in February 2015 that it would complete recovery activities and restart limited waste operations by March 2016. To resume full operations, DOE planned to build a new ventilation system at WIPP. DOE completed an AOA to identify the best solution for this system in December 2015.

The Senate Report accompanying a bill for the National Defense Authorization Act for Fiscal Year 2015 included a provision for GAO to review WIPP operations. This report examines the extent to which DOE (1) met its initial cost and schedule estimates for restarting waste disposal operations, and (2) followed best practices in analyzing and selecting an alternative for the new ventilation system. GAO examined documentation on the WIPP recovery estimates. GAO compared DOE's February 2015 cost and schedule estimates and AOA with best practices GAO published.

What GAO Recommends

GAO recommends that DOE require cleanup operations to follow best practices for cost and schedule estimates and require projects, including the WIPP ventilation system, to implement recommendations from independent AOA reviews or document the reasons for not doing so. DOE concurred with the recommendations.

View GAO-16-608. For more information, contact David C. Trimble at (202) 512-3841 or trimbled@gao.gov.

What GAO Found

The Department of Energy (DOE) did not meet its initial cost and schedule estimates for restarting nuclear waste disposal operations at the Waste Isolation Pilot Plant (WIPP), resulting in a cost increase of about $64 million and a delay of nearly 9 months. DOE incurred this cost increase and delay partly because it did not follow all best practices in developing the cost and schedule estimates. In particular, DOE's schedule did not include extra time, or contingency, to account for known project risks. Instead, DOE estimated it would restart waste operations in March 2016 based on a schedule with no contingency that gave DOE less than a 1 percent chance of meeting its restart date. In January 2016, DOE approved new estimates that added 8.5 months to the schedule, extending the restart to December 2016; increased the estimated cost of recovery by $2 million; and resulted in an additional $61.6 million in costs for operating WIPP in fiscal year 2016. DOE's WIPP operations activity manager said the revised schedule included contingency. However, according to DOE officials, they did not follow other best practices. For example, DOE did not provide evidence of having an independent cost estimate to validate the revised estimate. DOE did not follow all best practices for cost and schedule estimates in part because DOE does not require that its cleanup operations, such as WIPP, follow these practices. Therefore, DOE cannot have confidence that its estimates are reliable. In contrast, DOE established new requirements in June 2015 that its capital asset projects, such as the new ventilation system at WIPP, follow these best practices. By also requiring cleanup operations to follow them, DOE would have more confidence in the estimates for cleanup operations and capital asset projects.

DOE did not follow all best practices in analyzing and selecting an alternative for the new ventilation system at WIPP. As a result, DOE's analysis was not reliable and DOE cannot be confident that the alternative it selected in December 2015 will best provide the needed capabilities at WIPP. The analysis of alternatives (AOA) process entails identifying, analyzing, and selecting a preferred alternative to best meet the mission need. Of the four categories of best practices for AOAs, DOE's process fully met the category for identifying alternatives. For example, DOE identified a broad range of ventilation alternatives. However, DOE only partially or minimally met the other three categories: general principles, analyzing alternatives, and selecting the preferred alternative. DOE did not follow the best practice to select the preferred alternative based on a cost-benefit analysis that assesses the difference between the life-cycle costs and benefits of each alternative. In addition, an independent review that DOE commissioned consistent with best practices found that DOE's AOA did not adequately document a cost-benefit analysis and that, as a result, the selection of the preferred alternative was not supported by compelling information. The independent review recommended that DOE conduct a cost-benefit analysis consistent with best practices. However, DOE did not conduct the recommended analysis and document it before selecting the final alternative because there was no requirement to do so. In June 2015, the Secretary of Energy directed DOE to develop guidance for conducting AOAs consistent with AOA best practices. A DOE official said the department expected to issue the new guidance by December 2016.

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Abbreviations

AOA	analysis of alternatives
cfm	cubic feet of air per minute
DOE	Department of Energy
EM	Office of Environmental Management
NWP	Nuclear Waste Partnership LLC
Trinity	Trinity Engineering Associates
WIPP	Waste Isolation Pilot Plant

U.S. GOVERNMENT ACCOUNTABILITY OFFICE
441 G St. N.W.
Washington, DC 20548

August 4, 2016

Congressional Committees

The Department of Energy's (DOE) Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, serves as the only deep geologic repository in the U.S. for the disposal of defense-related nuclear waste. WIPP is designed to safely dispose of a specific type of defense waste, referred to as transuranic waste,[1] generated by DOE's nuclear weapons research, production, and cleanup activities at sites across the country. The waste is disposed of in underground rooms mined out of an ancient salt formation more than 2,000 feet below the earth's surface. Since WIPP began to accept waste in 1999, DOE has depended on WIPP's capability to accept transuranic waste shipments. In February 2014, waste operations at WIPP were suspended following two accidents underground: a fire on a salt-hauling truck and an unrelated radiological release from a waste container that contaminated portions of the facility underground and released a small amount of radiation into the environment above ground. The suspension of WIPP's operations has impaired DOE's ability to meet its cleanup and national security missions as well as regulatory cleanup milestones agreed to with states that host DOE sites.

The department has made it a top priority to restart WIPP's waste disposal operations. In September 2014, DOE issued a WIPP recovery plan.[2] This plan describes the major activities needed to restart operations, first on a limited basis and then moving to full operations. WIPP's full operations include waste disposal operations concurrent with mining and mine maintenance activities. A key set of activities in the

[1]The word "transuranic" is used for elements that have atomic numbers greater than that of uranium. Transuranic waste is defined in the WIPP Land Withdrawal Act of 1992 as waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for—(A) high-level radioactive waste; (B) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the Environmental Protection Agency, does not need the degree of isolation required by the disposal regulations; or (C) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with part 61 of title 10, Code of Federal Regulations. Pub L. No. 102-579, § 2 (1992).

[2]Department of Energy, *Waste Isolation Pilot Plant Recovery Plan* (Sept. 30, 2014).

recovery plan is to increase ventilation airflow underground, which was 425,000 cubic feet of air per minute (cfm) before the WIPP accidents. As a result of the radioactive contamination underground, DOE has continually run WIPP's existing ventilation system in a filtered mode, which is not the normal operating mode and has reduced the airflow to 60,000 cfm. Running in filtered mode severely restricts the number of people that can be underground, as well as the activities that can be conducted there, such as mine repair activities using diesel-powered equipment that creates fumes and dust. To increase the airflow to restart limited waste disposal operations, DOE planned two upgrades to the existing ventilation system: an interim system that would increase airflow to about 114,000 cfm, and a supplemental system that would increase airflow to about 180,000 cfm. To resume full operations, DOE planned to build a new permanent ventilation system to replace the existing one and to provide airflow of about 540,000 cfm, which DOE estimates is sufficient to safely support full and concurrent waste operations, mining, and mine maintenance activities. From October 2014 through December 2015, DOE conducted an analysis of alternatives (AOA) to identify the best solution for the new permanent ventilation system. The AOA is a key first step in DOE's procedures for the acquisition of a capital asset such as WIPP's new permanent ventilation system.[3] The process entails identifying, analyzing, and selecting a preferred alternative to best meet the mission need by comparing the operational effectiveness, costs, and risks of potential alternatives.

In February 2015, DOE approved a project management baseline that included the estimated cost and schedule for completing the activities described in the WIPP recovery plan. DOE estimated that it would need $242 million to complete the recovery activities needed to restart limited waste disposal operations by March 2016. DOE also estimated a cost range of $77 million to $309 million to complete the new permanent ventilation system by the end of December 2018, paving the way for resumption of full operations. In the recovery plan, DOE described its schedule as aggressive and noted that it did not include extra time to account for unanticipated delays. In May 2015, a DOE assessment found that pressure to achieve the March 2016 deadline contributed to poor

[3]DOE defines capital assets as land, structures, equipment, and intellectual property that are used by the federal government and have an estimated useful life of 2 years or more.

safety practices in WIPP recovery efforts.[4] In July 2015, DOE announced that it experienced delays in implementing the project baseline, including delays related to procuring equipment and delays related to correcting deficiencies in safety practices. As a result of these delays, the department announced that it would revise the WIPP project management baseline with the goal of developing a more realistic schedule. In January 2016, DOE approved the revised estimates for the project cost and schedule to restart limited waste operations. Nonetheless, the department still faces challenges in completing the recovery. For example, in March 2016, the Defense Nuclear Facilities Safety Board, which oversees DOE's nuclear facilities such as WIPP, reported that DOE had made progress in revising its nuclear safety plans at WIPP but additional work remained to address safety concerns to prevent a recurrence of the February 2014 radiological accident.[5] As we found in our most recent High-Risk Series update, DOE has a history of exceeding its cost and schedule estimates and then creating new baselines.[6] We have also found that when DOE creates new baselines during the execution of projects, it can be challenging to independently assess DOE's performance in managing these projects.[7]

The Senate Armed Services Committee report accompanying a bill for the National Defense Authorization Act for Fiscal Year 2015 included a provision for us to review recovery operations at WIPP.[8] Our report examines the extent to which DOE (1) met its initial cost and schedule estimates for restarting waste disposal operations at WIPP and (2) followed best practices in analyzing and selecting an alternative for the new ventilation system.

[4]Department of Energy, Office of Enterprise Assessments, *Memorandum: Office of Enterprise Assessments Operational Analysis of Safety Trends at the Waste Isolation Pilot Plant, May 2014 - May 2015* (Oct. 15, 2015).

[5]Defense Nuclear Facilities Safety Board, *Staff Issue Report: Waste Isolation Pilot Plant Documented Safety Analysis* (Washington, D.C.: Mar. 28, 2016).

[6]GAO, *High Risk Series: An Update*, GAO-15-290 (Washington, D.C.: Feb. 11, 2015).

[7]GAO, *Department of Energy: Better Information Needed to Determine If Nonmajor Projects Meet Performance Targets*, GAO-13-129 (Washington, D.C.: Dec. 19, 2012).

[8]S. Rep. No. 113-176, at 286 (2014).

To address both objectives above, we conducted a site visit to WIPP in January 2015. During the site visit we obtained documentation and interviewed officials from DOE's Office of Environmental Management (EM), which is responsible for oversight of WIPP and exercises this responsibility primarily through its Carlsbad Field Office. We also interviewed representatives at WIPP from Nuclear Waste Partnership LLC (NWP), which is the private contractor that manages and operates WIPP for DOE. To examine the extent to which DOE met its initial (February 2015) cost and schedule estimates for restarting waste disposal operations, we compared DOE's initial cost and schedule estimates to restart limited waste disposal operations contained in its February 2015 WIPP recovery project management baseline with DOE's revised estimates in its January 2016 revised baseline. We reviewed DOE's reports on the reasons it exceeded the initial estimates and the risk management plans for WIPP recovery prepared by NWP which were used in developing the initial estimates. We compared the initial cost and schedule estimates from the February 2015 recovery baseline with the best practices described in our cost and schedule guides.[9] We reviewed documentation on the revised (January 2016) baseline and interviewed DOE and NWP on the approach followed to develop the revised cost and schedule estimates to restart limited waste disposal operations in the baseline, but we did not assess the revised estimates against the best practices because of the time frame of our review. To examine the extent to which DOE followed best practices in analyzing and selecting an alternative for the new ventilation system, we reviewed documentation on the process DOE followed and compared the process with best practices for conducting an AOA that we published in December 2014.[10] During the review, we also interviewed officials from DOE's Office of Enterprise Assessments, which provides internal oversight of DOE facilities; the

[9]GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP (Washington, D.C.: March 2009); and *GAO Schedule Assessment Guide: Best Practices for Project Schedules,* GAO-12-120G (Washington, D.C.: May 2012).

[10]GAO, *DOE and NNSA Project Management: Analysis of Alternatives Could Be Improved by Incorporating Best Practices*, GAO-15-37 (Washington, D.C.: Dec. 11, 2014). We compiled the best practices identified in this report by reviewing AOA policies and guidance used by seven public and private-sector entities with experience in the AOA process. GAO verified these practices with subject-matter experts. We updated these AOA best practices in an October 2015 report: *Amphibious Combat Vehicle: Some Acquisition Activities Demonstrate Best Practices; Attainment of Amphibious Capability to be Determined,* GAO-16-22 (Washington, D.C.: Oct. 28, 2015).

Defense Nuclear Facilities Safety Board, which provides external oversight of DOE defense nuclear facilities; the U.S. Mine Safety and Health Administration, which provides external oversight of mining activities at WIPP; and the U.S. Environmental Protection Agency and New Mexico Environment Department, both of which provide external regulation of WIPP. (See app. I for further information on the scope and methodology of our review.)

We conducted this performance audit from November 2014 to August 2016 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.

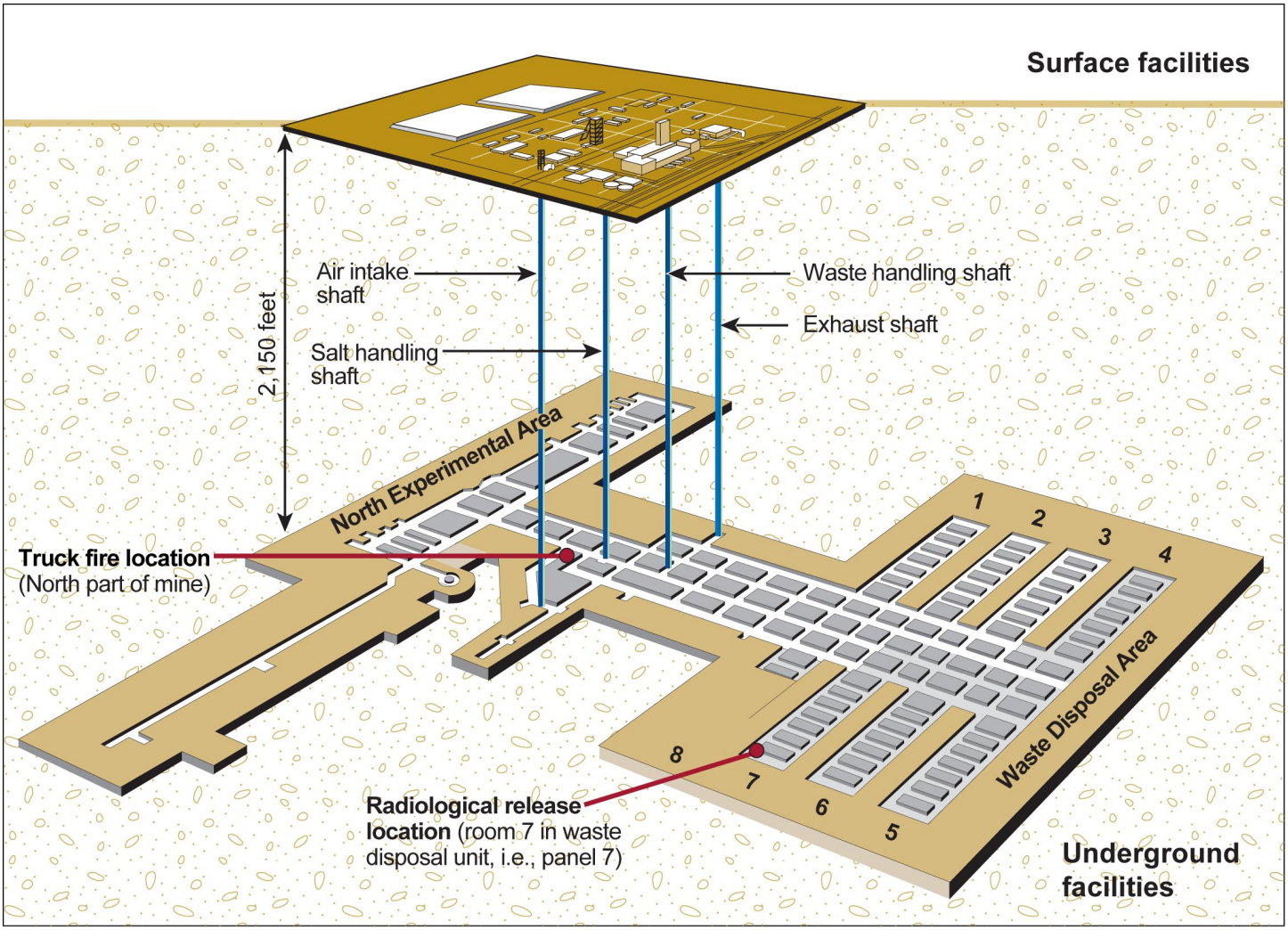
Background

This section describes (1) WIPP's layout and base operations, (2) the February 2014 truck fire and radiological release accident investigation reports, (3) DOE's requirements for operations activities and for project management applicable to the WIPP Recovery effort, (4) best practices for cost and schedule estimating, (5) best practices for conducting an AOA, (6) Revisions in 2014 and 2015 to DOE's requirements for AOAs, and (7) DOE's AOA process for WIPP's new permanent ventilation system.

WIPP Facility Layout and Base Operations

As shown in figure 1, WIPP's layout consists of surface facilities, underground facilities, and four shafts that connect the surface with the underground. WIPP's underground facilities currently include seven waste disposal units or panels where waste containers are placed for final disposal, an area designated for constructing future disposal units, and an area for experimental research. The four shafts connecting the surface and underground facilities are (1) the air intake shaft, which is the primary air supply to the underground; (2) the exhaust shaft, through which all air exits the underground; (3) the salt handling shaft, which is used to remove mined salt from the underground and also supplies air to the underground; and (4) the waste handling shaft which is used to transport waste containers to the underground. Figure 1 also shows the locations of the February 2014 accidents that led to the suspension of WIPP's operations.

Figure 1: The Waste Isolation Pilot Plant's Surface Facilities, Shafts, and Underground Facilities and Location of the Two Incidents in February 2014



Source: Department of Energy. | GAO-16-608

Under normal operating conditions, base operations at WIPP include waste handling to receive waste from generator sites and prepare and place the waste, ongoing maintenance of the WIPP surface facilities and underground, as well as support functions such as program management, engineering, quality assurance, safety and security, and environmental management. In addition, NWP reviews and certifies waste containers on DOE's behalf at DOE's transuranic waste generator sites. During implementation of the WIPP recovery plan, DOE continued aspects of

these base operations such as maintenance of the surface facilities and program management. In addition, NWP continued to review and certify waste packages at select sites.

WIPP Truck Fire and Radiological Release Accidents and Investigation Reports

The salt truck fire, which occurred on February 5, 2014, created substantial smoke and soot that damaged key equipment and facilities in the underground. On February 14, 2014, the radiological release occurred when a transuranic waste container was breached. The breach was caused by a chemical reaction inside the container between materials that DOE later determined should not have been packaged together. The reaction generated enough heat to increase pressure in the container. The pressure forced open the container's lid and propelled its radioactive waste contents, combustible gases, and other materials into the air and on to adjacent waste containers. The radioactive contents, gases, and other materials ignited and triggered a fire in the disposal room by igniting other materials in the room. WIPP's ventilation system failed to contain all of the airborne radiological material underground and allowed a small amount to enter the environment. As a result of the release, portions of the WIPP underground and the existing ventilation system were radiologically contaminated.

DOE issued an accident investigation report on the salt truck fire in March 2014 and an accident investigation report on the radiological release in April 2014 called "phase one report."[11] The phase one report focused on the release to the environment and the response at WIPP to the release. One year later, in April 2015, DOE issued a phase two report that focused on the radiological release from inside the waste container.[12] The reports determined that the causes of the accidents included the degraded condition of critical equipment, inadequacies in the design and operations of WIPP's ventilation system, and deficiencies in the management of WIPP's safety programs that are intended to control and discipline operations to protect workers, the public, and the environment from radiological and other hazards. In total, the three reports made 100

[11]Department of Energy, *Accident Investigation Report: Underground Salt Haul Truck Fire at the Waste Isolation Pilot Plant on February 5, 2014* (Washington, D.C.: Mar. 13, 2014) and *Accident Investigation Report: Phase 1 Radiological Release Event at the Waste Isolation Pilot Plant on February 14, 2014* (Apr. 22, 2014).

[12]Department of Energy, *Accident Investigation Report: Phase 2 Radiological Release Event at the Waste Isolation Pilot Plant on February 14, 2014* (Apr. 15, 2015).

recommendations to DOE and NWP to complete corrective actions.[13] For example, the phase one report identified a number of weaknesses with the WIPP nuclear safety documentation and recommended that this documentation be revised prior to resuming limited waste disposal operations to ensure the repository can be operated safely with respect to workers, the public, and the environment.[14]

DOE's Requirements for Operations Activities and for Project Management Applicable to the WIPP Recovery Effort

DOE is managing the recovery activities to restart limited waste disposal operations at WIPP and to design and build the new permanent ventilation system capital asset project following two separate project management requirements. DOE requires that the recovery activities to restart limited waste disposal operations and overall base operations of WIPP be managed following EM's protocol for operations activities. This protocol defines operations activities to include activities that are project-like with defined start and end dates and reoccurring facility or environmental operations.[15] The new permanent ventilation system project must follow DOE's Order 413.3B, which governs project management for the acquisition of capital assets.[16] The following is a description of the two different requirements:

[13]In addition to the accident investigations, in February 18, 2016, DOE's Office of Enterprise Assessments' Office of Enforcement concluded an investigation and issued a preliminary notice of violation to NWP for violations of worker safety and health and nuclear safety requirements in connection with the accidents. In its notice, DOE proposed no civil penalties for the worker safety and health violations cited because DOE's Carlsbad Field Office had previously reduced NWP's contract fee in response to the salt haul truck fire and radiological release accidents.

[14]The documentation, called a documented safety analysis, is an analysis of the extent to which a nuclear facility can be operated safely with respect to workers, the public, and the environment, including a description of the conditions, safe boundaries, and hazard controls that provide the basis for ensuring safety. The phase one report recommended that DOE revise the WIPP Documented Safety Analysis, Revision 4, dated November 2013, DOE/WIPP-07-3372.

[15]Department of Energy, Office of Environmental Management, *Policy and Protocol for Office of Environmental Management Operations Activities* (Mar. 15, 2012). According to the protocol, operations activities include treatment, stabilization, packaging, storage, transportation, and disposition of waste and nuclear materials; operations of environmental remediation systems; long-term environmental stewardship; and facility shutdown and deactivation activities.

[16]Department of Energy, *Program and Project Management for the Acquisition of Capital Assets*, DOE Order 413.3B (Washington, D.C.: Nov. 29, 2010).

- **EM operations activities protocol.** EM's protocol establishes a framework for managing and reporting the progress of cleanup operations by requiring, among other things, that project performance be measured objectively and that management actions be taken to mitigate risks and manage costs. EM's protocol directs EM sites to develop performance baselines—or estimates—for cost, schedule, and scope to use in assessing the project's performance over the fiscal year, multiyear contract period of performance, and the life cycle of the project.[17] The protocol directs that the project develop estimates but does not include specific requirements that must be followed, such as the steps that must be followed to develop cost and schedule estimates.

- **DOE Order 413.3B.** DOE's order provides program and project management direction for the acquisition of capital assets, with the stated goal of delivering fully capable projects within the planned cost, schedule, and performance baseline. The order establishes five critical decision processes of project development that each end with a major approval milestone—or "critical decision" point—that cover the life of a project. The order specifies the requirements that must be met, including for developing and managing project cost and schedule estimates to move a project past each critical decision milestone. DOE also provides suggested approaches for meeting the requirements contained in the order through a series of guides, such as a guide for cost estimating. In June 2015, the Secretary of Energy directed that this order be revised to require that cost and schedule estimates be developed, maintained, and documented in a manner consistent with methods and the best practices identified in GAO's cost and schedule assessment guides and other published standards and best practices, such as the Federal Acquisition Regulation and Office of Management and Budget guidance.[18]

[17]According to EM's operations activity protocol, a contract period of performance baseline is only applicable if required by contract.

[18]Department of Energy, Secretary of Energy, *Memorandum for Heads of All Department Elements: Project Management Policies and Principles* (Washington, D.C.: June 8, 2015).

GAO's Best Practices for Cost and Schedule Estimating

The GAO Cost Estimating and Assessment Guide and the GAO Schedule Assessment Guide compiled best practices corresponding to the characteristics of high-quality and reliable cost and schedule estimates.[19] A high-quality, reliable cost estimate has the following four characteristics:

- **comprehensive** (e.g., has enough detail to ensure that cost elements are neither omitted nor double counted),
- **well-documented** (e.g., allows for data it contains to be traced to source documents),
- **accurate** (e.g., is based on an assessment of most likely costs and has been adjusted properly for inflation), and
- **credible** (e.g., discusses any limitations because of uncertainty or bias surrounding data or assumptions).

Similarly, a high-quality, reliable schedule has four characteristics:

- **comprehensive** (e.g., captures all government and contractor activities necessary to accomplish a project's objectives),
- **well-constructed** (e.g., sequences all activities using the most straightforward logic possible),
- **controlled** (e.g., is updated periodically to realistically forecast dates for activities), and
- **credible** (e.g., uses data about risks to predict the level of confidence in meeting a completion date and necessary schedule contingency and high-priority risks are identified based on conducting a robust schedule risk analysis).

The characteristics of a high-quality and reliable cost estimate are supported by best practices listed in appendix II, and the characteristics of a high-quality and reliable schedule are supported by best practices listed in appendix III.

[19] GAO-09-3SP and GAO-12-120G.

GAO's Best Practices for Analysis of Alternatives

In a December 2014 report we compiled 24 best practices for conducting an AOA.[20] As noted above, the AOA is a key first step in acquisition of a capital asset such as WIPP's new permanent ventilation system. The process entails identifying, analyzing, and selecting a preferred alternative. Conforming to these best practices helps ensure that the preferred alternative selected is the one that best meets the agency's mission needs. We grouped these 24 best practices into the following four categories:

- **General principles.** This category includes best practices to be applied in planning, conducting, and documenting the AOA, such as defining functional requirements based on the mission need and conducting the analysis without a predetermined solution.
- **Identifying alternatives.** The identifying alternatives category includes best practices that help ensure the alternatives to be analyzed are sufficient, diverse, and viable.
- **Analyzing alternatives.** The analyzing alternatives category contains best practices related to estimating the costs and benefits of each alternative over its life cycle.
- **Selecting a preferred alternative.** The selecting a preferred alternative category includes best practices to help ensure a preferred alternative is selected that best meets the mission need by comparing alternatives based on their costs and benefits and independently reviewing the AOA process. Appendix IV lists the 24 best practices organized by the four categories.

Revisions in 2014 and 2015 to DOE's Requirements for Analysis of Alternatives

DOE's procedures for conducting an AOA have changed twice since DOE began the AOA process for the WIPP permanent ventilation system. DOE started the AOA process for this system in October 2014. At that time, DOE was operating under AOA requirements defined in Order 413.3B. The AOA process, as defined in the order, occurs during the span of the first two critical decisions—Critical Decision-0 and Critical Decision-1 (Approve Alternative Selection and Cost Range). In December 2014, the Secretary of Energy established a new requirement that for projects estimated to cost $50 million or more, the responsible program office is to

[20]GAO-15-37.

conduct an AOA independent of the contractor responsible for the project.[21] Later, in June 2015, the Secretary of Energy directed the department to develop guidance for conducting AOAs consistent with the AOA best practices that GAO has published.[22] The Secretary further required that AOAs be conducted and documented in a manner consistent with the guidance when it is complete. A DOE official told us in June 2016 that the department expected the guidance to be completed by December 2016. The Secretary's action followed a recommendation that we made in December 2014 that DOE revise its Order 413.3B to adopt AOA best practices.[23]

DOE's AOA Process for WIPP's New Permanent Ventilation System

DOE's changes in its requirements for the AOA process under Order 413.3B took effect in the midst of DOE's AOA process for WIPP's new permanent ventilation system. DOE's process was conducted as follows:

- DOE EM approved the mission need for the new ventilation system project in October 2014.
- Also in October 2014, NWP started an initial AOA and completed it in January 2015 shortly after the Secretary's December 2014 directive on the independence of AOAs and prior to the Secretary's June 2015 directive about the use of the AOA best practices; therefore the new requirements did not apply to NWP's AOA.
- To respond to the Secretary's December 2014 directive, DOE contracted in spring 2015 with a contractor unaffiliated with WIPP—Trinity Engineering Associates (Trinity)—to do a second AOA. DOE specifically directed Trinity in its contract to implement all of the AOA best practices that we compiled in our December 2014 report. The

[21]Department of Energy, Secretary of Energy, *Memorandum for Heads of All Department Elements: Improving the Department's Management of Projects* (Washington, D.C.: Dec. 1, 2014).

[22]Secretary of Energy, *Memorandum*, June 8, 2015.

[23]GAO-15-37. Specifically, in our December 2014 report, we found that DOE's requirements for the AOA process in Order 413.3B conformed to only 1 of the 24 best practices for conducting an AOA and when the requirements were combined with associated guidance—which includes nonmandatory approaches for meeting requirements—we found that they conformed to 9 of the 24 best practices. We recommended that DOE update its Order 413.B requirements to incorporate best practices for conducting an AOA.

WIPP program manager in the Carlsbad Field Office told us that he included the best practices in the contract to provide more formality to their process. Trinity completed its AOA in October 2015.

- DOE evaluated the preferred alternatives proposed by NWP and Trinity, and it selected and approved a final alternative to complete Critical Decision-1 in December 2015.

DOE Did Not Meet Its Initial Cost and Schedule Estimates for Restarting Waste Disposal Operations

DOE did not meet its initial cost and schedule estimates for the efforts needed to restart WIPP disposal operations, resulting in about $64 million in added costs and a delay of nearly 9 months. Two primary factors contributed to the cost increase and schedule delay. First, DOE only partially followed best practices in developing its initial cost and schedule estimates, which made them unreliable and increased the likelihood that they would be exceeded. Second, DOE did not successfully manage key project risks it had identified that had potential to cause delay.

DOE Incurred A Cost Increase of about $64 Million and a Nearly 9-month Delay in Its Efforts to Restart WIPP Operations

DOE incurred a cost increase of about $64 million and a nearly 9-month schedule delay in its efforts to restart WIPP waste disposal operations. Specifically, in January 2016, approximately a year after approving the initial project baseline, DOE approved a new project management baseline that increased the estimated costs for the recovery project by $2 million (from $242 million to $244 million) and added 8.5 months to the project schedule, extending the date when limited waste disposal operations might begin from March 2016 to December 2016. According to DOE officials, the project was unable to meet its estimated completion date due to delays, including delays associated with procuring components for the interim ventilation system upgrade that were found to be faulty, and delays associated with DOE's decision to require the project to adhere to new nuclear safety requirements. According to the operations activity manager for WIPP in the Carlsbad Field Office, the recovery project only exceeded the $242 million baseline by $2 million in part because DOE overestimated the cost of some project activities and spent contingency funds to make up for cost increases in certain parts of the project. For example, DOE overestimated the cost for decontaminating the WIPP underground by more than $6 million, which offset a $5 million cost increase caused by delays associated with the faulty ventilation system components. However, we identified an additional $61.6 million cost increase in base operations that was attributable to the delay in completing the recovery project. Specifically, DOE's justification supporting the President's fiscal year 2016 budget

request to Congress from February 2015 estimated about $130.6 million for WIPP's base operations in fiscal year 2016. According to DOE officials, as DOE revised its cost and schedule estimates for the WIPP recovery project in the fall of 2015, DOE also revised its cost estimate for WIPP's base operations and provided the updated information to the congressional appropriations committees. In December 2015, DOE received $192.1 million for fiscal year 2016 base operations, an increase of $61.6 million (47 percent) over the initial estimate for base operations in fiscal year 2016. According to the operations activity manager for WIPP in the Carlsbad Field Office and representatives from NWP, this increase to base operations occurred because DOE estimated the cost of base operations on the assumption of restarting WIPP in March 2016 following its initial schedule estimate. The delay in the recovery efforts required DOE to keep base operations running alongside the recovery efforts for a longer period of time than initially planned.

DOE's Initial Cost and Schedule Estimates for Restarting Operations at WIPP Were Unreliable

DOE did not meet its initial schedule and cost estimates for restarting waste disposal operations at WIPP, in part because DOE did not develop the estimates following all best practices, rendering the estimates unreliable and increasing the likelihood that they would be exceeded. More specifically, of the four characteristics of a high-quality and reliable cost estimate, DOE's initial cost estimate substantially met two characteristics—comprehensive and well-documented—but partially met or minimally met the other two characteristics—accurate and credible. We made the following observations:

- DOE **substantially met** best practices for a comprehensive cost estimate by, for example, including a majority of life-cycle costs and identifying the cost estimating ground rules and assumptions.
- DOE **substantially met** best practices for a well-documented estimate by including the actual sources for the cost data and documenting that the cost estimate was reviewed and accepted by DOE management.
- DOE **partially met** best practices for an accurate estimate by, for example, only documenting a portion of the process they used to adjust costs to account for inflation.
- DOE **minimally met** best practices for a credible estimate by, for instance, not developing an independent cost estimate. Had DOE completed an independent cost estimate, the department would have

had an unbiased and objective benchmark to assess whether the cost estimate prepared by NWP could be achieved, and thus would have been positioned to reduce the risk that the project would proceed underfunded.

Regarding DOE's initial schedule for restarting waste disposal operations, DOE substantially met two of the four characteristics of a high-quality schedule—comprehensive and controlled—but partially met the characteristics—well-constructed and credible—resulting in a schedule that was also unreliable and unrealistic. We made the following observations:

- DOE **substantially met** best practices for a comprehensive schedule because, for example, the schedule reflected the activities in the recovery work breakdown structure, which defined the work necessary to accomplish the project's objectives. In addition, work scope was assigned in the schedule as the responsibility of NWP or DOE.

- DOE **substantially met** best practices for a controlled schedule by, for example, regularly updating its master schedule and using the schedule as the basis for measuring performance.

- DOE **partially met** best practices for a well-constructed schedule because, for instance, a significant number of activities in the schedule had incorrect or missing logic relationships that are important for determining how delays or accelerations in one activity would affect the start or finish of other activities later in the schedule.

- DOE **partially met** best practices for a credible schedule, in particular, because its schedule did not include extra time, or contingency, to account for known project risks. As noted above, DOE acknowledged in its WIPP recovery plan that the schedule did not include contingency that may be needed due to unanticipated difficulties or delays with the project. However, DOE did not acknowledge in the plan that the schedule also did not include contingency for the occurrence of known and quantified risks that had been anticipated in its project risk analysis—such as the risks that were the primary causes of the project delays. Notably, DOE's risk analysis predicted that the March 2016 date to restart operations had a less than 1 percent confidence level, meaning in effect that DOE had a less than 1 percent chance of meeting the March 2016 deadline. EM officials said the department used a less than 1 percent confidence level because it wanted to have an aggressive goal for

restarting operations. According to EM officials, when EM managers presented this schedule to senior DOE decision-makers for approval, they described the schedule as “aggressive” but did not clarify that there was less than a 1 percent chance of meeting the schedule. According to these officials, they did not think that senior managers would understand the project management terminology regarding confidence levels.

In January 2016, DOE approved revised cost and schedule estimates for restarting WIPP’s limited waste disposal operations.[24] The operations activity manager for WIPP in the Carlsbad Field Office said the revised schedule included contingency and the revised restart date of December 2016 had an 80 percent confidence level. However, according to DOE officials, they did not follow other best practices. For example, DOE did not provide evidence of having an independent cost estimate which would have provided DOE an unbiased and objective benchmark to validate the estimates prepared by NWP. As noted above, we did not assess DOE’s revised estimates against all of the best practices. The full results of our analysis of the initial cost and schedule estimates can be found in appendixes II and III.

DOE did not follow all best practices in developing the initial cost and schedule estimates for the WIPP recovery project or in developing new estimates because, unlike DOE’s requirements for capital asset projects under Order 413.3B, DOE’s EM operations activities protocol that governs cleanup operations such as WIPP recovery does not require the use of best practices in developing such estimates. As mentioned above, DOE EM’s protocol requires that EM sites develop or approve baselines for each project’s cost and schedule to judge project performance. However, the protocol does not specify any best practices in terms of the steps to follow in developing the cost and schedule estimates in these baselines. The absence of a requirement to follow best practices for cost and schedule estimating is in contrast to a decision in June 2015 by the Secretary of Energy to require that all capital asset projects with an estimated cost of $10 million or more follow such practices under Order

[24]DOE revised its estimates by establishing an integrated baseline for WIPP that combined recovery activities, WIPP’s life-cycle base operations, and capital asset projects. According to NWP, the integrated baseline primarily focused on fiscal years 2016 and 2017 because those years complete the current base contract between DOE and NWP.

413.3B. Operations activities such as the WIPP recovery activities are not considered capital asset projects and therefore are not required to follow these requirements even though EM's operations activities share many of the same characteristics as capital asset projects. Without requiring EM's operations activities such as WIPP to follow all best practices when developing cost and schedule estimates DOE cannot have confidence that it is producing reliable baselines needed to monitor its performance in managing these activities. Without reliable baselines, DOE will also continue to be at risk of cost overruns and delays in achieving its cleanup missions such as the permanent disposal of transuranic waste from sites across the country.

DOE has reported progress in completing the activities needed to restart limited waste operations using its revised cost and schedule estimates, although it still faces challenges and it remains unclear whether DOE identified and analyzed the risks associated with these challenges in revising the estimates. In terms of progress, for example, in December 2015, NWP submitted revisions to WIPP's nuclear safety documentation to EM for review. In addition, DOE reported in March 2016 that NWP completed most of the construction of the interim ventilation system upgrade in the underground. However, as noted above, in March 2016, the Defense Nuclear Facilities Safety Board reported that additional work was needed to revise WIPP's nuclear safety documentation to prevent recurrence of a radiological release accident.[25] In addition, in April 2016, DOE's Office of Enterprise Assessments, which provides independent internal oversight of DOE's management of safety, issued two reports that found that although NWP had made improvements in its operational safety and emergency management programs and procedures, significant challenges remained to fully meet DOE requirements and effectively plan and implement these programs and procedures.[26] As we noted above, DOE officials acknowledged that the department did not follow all best practices in developing the revised estimates to restart WIPP operations. Without having followed all best practices, including having an independent cost estimate conducted to validate the estimates, DOE cannot be confident that NWP sufficiently accounted for these challenges

[25]Defense Nuclear Facilities Safety Board, *Staff Issue Report,* Mar. 28, 2016.

[26]Department of Energy, Office of Enterprise Assessments, *Assessment of Selected Conduct of Operations Processes at the Waste Isolation Pilot Plant* (April 2016); and Office of Enterprise Assessments, *Emergency Management Assessment of the Waste Isolation Pilot Plant* (April 2016).

in revising its risk analysis and that DOE set an appropriate allowance for contingency to reduce the risk of cost overruns and delays in restarting WIPP's operations.

DOE Did Not Successfully Manage WIPP Recovery Project Risks That Contributed to the Project Cost Increase and Schedule Delay but Has Revised Its Risk Management Process

DOE did not successfully manage key risks that it had identified and that contributed to the project's cost increase and schedule delay but has taken steps to revise the risk management process for the WIPP recovery project. DOE's EM operations activities protocol requires the use of a risk management process to identify and mitigate risks to completing a project within its baseline cost and schedule estimates. For the WIPP recovery project, DOE and NWP developed a project risk register to support the initial project management baseline for WIPP recovery. The risk register listed the risks that could increase costs or delay completion. DOE and NWP assessed the likelihood and consequence of each risk and identified a mitigation plan for each risk that described the actions to reduce the impact on the project if the risk were realized.

In a public statement explaining the need to revise its baseline for the recovery project, DOE cited problems with three activities that the department had previously identified in its project risk register: (1) completing revisions to WIPP's nuclear safety documentation; (2) installing the interim ventilation system upgrade; and (3) completing the corrective actions that address the recommendations in the phase two accident investigation report. DOE had identified risks related to each of these activities in the project risk register but was not able to effectively mitigate them, as discussed below:

- **WIPP nuclear safety documentation.** NWP identified the risk of a potential delay of up to 6 months in restarting operations if DOE decided that the WIPP nuclear safety documentation should be revised according to standards that were in the process of being updated rather than according to the existing standards.[27] According to DOE, when NWP started to revise the safety documentation in the

[27]Department of Energy, *DOE Standard: Preparation of Nonreactor Nuclear Facility Documented Safety Analysis*, DOE-STD-3009-2014 (Washington, D.C.: November 2014). The DOE standard describes a method for preparing a documented safety analysis that is acceptable to DOE for nonreactor nuclear facilities such as WIPP. The November 2014 standard—which had not yet been issued when NWP conducted its risk analysis—is an update to the prior version issued in 1994. According to the document, the 2014 update clarifies and updates facility safety requirements.

summer of 2014, the contractor assumed it should follow the existing standard. NWP added this risk to its project risk register to account for the possibility that EM could require NWP to revise the nuclear safety documentation according to the new standards. To mitigate this risk, NWP's plan was to ensure they had concurrence with DOE to start the revisions using the existing standards. DOE issued the new standards in November 2014 and notified NWP in December 2014 that the WIPP safety documentation would need to comply with them. According to an NWP recovery project manager, this change in policy resulted in a 7-month delay in NWP's schedule for revising the WIPP safety documentation.

- **Interim ventilation system.** NWP identified the risk of a potential delay of 3 months to complete the installation of the interim ventilation system upgrade if NWP faced difficulties acquiring the components for the system. To mitigate this risk, NWP's plan was to identify difficult-to-procure equipment early in the project, ensure it had a valid and up-to-date list of qualified suppliers, and monitor and review equipment purchases. According to NWP officials, this plan was partially effective. Specifically, NWP officials said that they discovered that components for the interim ventilation system were damaged when they inspected the components before formally accepting them. In addition, they said that the costs to return the components to the manufacturer and repair them were paid for by the manufacturer. However, the NWP officials said that as a result of receiving the faulty equipment, the installation of the interim ventilation system was delayed about 4 months because NWP needed to send the components back to the manufacturer and make corrections to its shipping process to prevent a reoccurrence of these issues.

- **Corrective actions from the phase two accident investigation report.** NWP identified the risk of potential delay of up to 6 weeks regarding the length of time DOE needed to complete the phase two accident investigation. In the summer and fall of 2014, when NWP was developing the initial project management baseline, DOE's phase two accident investigation was still underway. According to NWP officials, they needed to wait for DOE to complete the accident investigation and issue the final report with recommendations before they could begin developing and implementing corrective actions. DOE issued the final report in April of 2015. According to the operations activity manager for WIPP in the Carlsbad Field Office, completing the corrective actions in response to the report's recommendations resulted in a 3-month delay.

NWP officials said that in recognition of the need for a more effective risk management process, they revised their process as part of revising the recovery cost and schedules estimates. These officials explained, for example, the revised process now involves more frequent discussions and updating the status of potential risks with managers at WIPP who oversee the departments where the project risks are generated. We did not conduct an assessment of the effectiveness of this new risk management process.

DOE Did Not Follow All Best Practices in Analyzing and Selecting an Alternative for the New Ventilation System at WIPP

DOE did not follow all best practices in analyzing and selecting an alternative for the new ventilation system at WIPP. As a result, DOE's analysis was not reliable and DOE cannot be confident that the selected alternative will best provide the needed capabilities. Of the four categories of the best practices, DOE fully met the category for identifying alternatives. However, DOE partially or minimally met the other three categories of best practices—general principles, analyzing alternatives, and selecting the preferred alternative—because of key limitations. (See app. IV for the detailed results of our analysis of DOE's AOA process.)

DOE Fully Met Best Practices in the Identifying Alternatives Category

DOE's AOA process fully met the best practices in the identifying alternatives category. To identify alternatives, DOE relied on analyses conducted by NWP, the contractor responsible for the project, and the second contractor—Trinity. These analyses were completed in January and October 2015, respectively. NWP and Trinity identified a broad range of alternatives. Specifically, they identified nine ventilation system alternatives that the contractors determined should be analyzed because the alternatives could meet the mission need and other screening criteria that they defined: NWP identified six and Trinity identified three. The alternatives included continued use of the existing exhaust shaft as well as constructing a new shaft or more than one shaft, such as a new exhaust shaft and a new air intake shaft. In addition, the studies identified different ventilation filtration capacities and modes of operation that included continuous filtering of all exhaust air or filtering air only when a radiological release is detected underground.

DOE Partially Met Best Practices in the General Principles Category

DOE's AOA process partially met the best practices in the general principles category, which covers how the AOA process is planned, conducted, and documented. In particular, DOE partially or minimally followed the best practices of defining the mission need for the project,

analyzing alternatives without a predetermined solution, and defining the functional requirements based on the mission need. As the AOA related to the best practices of defining the mission need for the project and analyzing alternatives without a predetermined solution, DOE did not define the mission need for the new ventilation system by focusing only on the capabilities needed for the project, but instead defined the need for the system to include a particular solution, which included constructing a new ventilation exhaust shaft. Because DOE defined the mission need by mentioning a new exhaust shaft, both contractors appeared to have analyzed alternatives with a preference for the alternatives that included constructing a new shaft. Specifically, NWP completed its analysis of the six alternatives by proposing two for further consideration by DOE, one that did not include a new shaft and one that did. NWP's alternative that did not include a new shaft was its highest-scoring alternative and the alternative that included a new shaft was its third-highest scoring alternative. NWP officials told us that they proposed the second alternative along with the highest-scoring one because they believed the mission need statement discussed a new shaft. Regarding Trinity, in its final AOA report, Trinity stated that the mission need statement endorsed a new exhaust shaft. Trinity then analyzed three alternatives, one of which included using the existing shaft, and proposed an alternative to DOE that included constructing a new shaft. In its final assessment, DOE assessed the two alternatives proposed by NWP and the one proposed by Trinity and selected NWP's alternative that included constructing a new shaft, shown as the second of the three alternatives in table 1. According to best practices, the AOA process should be an unbiased inquiry into the costs, benefits, and capabilities of all alternatives. [28] By conducting the AOA with a predetermined solution, DOE undermined the credibility of its final decision.

[28]GAO-16-22.

Table 1: Alternatives Proposed by Contractors to DOE for Further Evaluation for the New Permanent Ventilation System at the Waste Isolation Pilot Plant

Contractor that proposed the alternative	Description of alternative
Nuclear Waste Partnership LLC	• Use existing exhaust shaft and add new filtration capacity sufficient for full mining and waste operations.
Nuclear Waste Partnership LLC	• Use existing exhaust shaft and add new filtration capacity sufficient for waste operations and build new exhaust shaft for mining operations without filtration.
Trinity Engineering Associates	• Build new exhaust shaft with filtration capacity sufficient for full mining and waste operations.

Source: Department of Energy (DOE) documents. | GAO-16-608

Note: Nuclear Waste Partnership LLC completed an analysis of six alternatives in January 2015 and proposed two to DOE for further evaluation. Trinity Engineering Associates completed an analysis of three alternatives in October 2015 and proposed one to DOE for further evaluation.

Another limitation under the general principles category was that DOE partially followed the best practice of defining the functional requirements that the ventilation system would need to satisfy. DOE did not consistently define two key functional requirements of the project—(1) the rate of airflow needed to support full operations at WIPP, and (2) the expected operational life of the new system—which limited the reliability of the overall AOA process as follows:

- Regarding the estimated airflow, DOE did not specify a functional requirement in its mission need statement for the rate of airflow that the new ventilation system must be capable of providing for full operations at WIPP. Instead, the mission need statement described the minimum airflow required by WIPP's hazardous waste facility permit, which was 260,000 cfm, and the actual airflow at WIPP before the accidents, which was 425,000 cfm. In conducting its AOA, NWP calculated its own airflow that it thought would be necessary for full operations at WIPP, which they estimated was about 540,000 cfm. NWP estimated the higher airflow based on its analysis of underground operations and used this amount to analyze a range of alternatives. In contrast, Trinity used the airflow associated with the WIPP hazardous waste facility permit, 260,000 cfm, as the estimated airflow in conducting its AOA. The federal project director in the Carlsbad Field Office told us that he did not direct Trinity to redo its analysis using NWP's higher airflow because he believed that airflow was needed for examining the scale of the system and would be defined lower during design. Moreover, he said that he wanted to maintain Trinity's independence from NWP to be consistent with the December 2014 DOE requirement for conducting independent AOAs.

However, as a result of not defining the same functional airflow requirement for both contractors, DOE officials explained that they needed to conduct additional analysis to compare the alternatives proposed by NWP and Trinity.

- Regarding the estimated operational life of the new ventilation system, DOE did not specify a functional requirement in its mission need statement for the estimated operational life of WIPP. Without such a requirement, NWP used 2030 as the estimated end date for WIPP operations—this date was based on DOE's approved life-cycle plan for ending WIPP's operations current at the time NWP conducted its analysis. NWP completed its AOA in January 2015 when it presented two alternatives to DOE for further evaluation—as described above, NWP had proposed these two alternatives from an initial group of six alternatives. In February 2015, EM revised the estimated operational life of WIPP, extending it from 2030 to 2050 to more accurately reflect DOE's schedules for transuranic waste cleanup at DOE sites. Trinity did not start its AOA process until after DOE had revised the estimated operational life of WIPP to 2050 and therefore used the 2050 date in conducting its AOA. In analyzing NWP's two proposed alternatives, DOE used the new estimated operational life of 2050 and did not reassess the four previously eliminated alternatives using the revised date.

By not following the best practice of specifying functional requirements at the start of the AOA process, including specifying the airflow that the system needed to deliver and the estimated end date of operations for WIPP, it is unclear whether the AOAs conducted by NWP and Trinity and DOE's subsequent analyses of these AOAs allowed DOE to select the alternative that best meets mission needs.

DOE Minimally Met Best Practices in the Analyzing Alternatives Category

DOE's AOA process minimally met the best practices in the analyzing alternatives category. Significant limitations in this category included DOE and its contractors not consistently examining life-cycle costs for each alternative and not quantifying their benefits.[29] Regarding examining life-cycle costs:

- NWP did not examine full life-cycle cost estimates for all of the alternatives it examined. Specifically, NWP's AOA completed in January 2015 examined the estimated costs for the design and construction of each of the six alternatives, but did not examine the full life-cycles of these alternatives. As a result, NWP eliminated four of its six principal alternatives from further evaluation before examining each of them in terms of full life-cycle costs. According to the NWP project manager who led NWP's AOA team, the team did not have sufficient time to examine the full life-cycle costs of each alternative. In addition, according to DOE officials, NWP was not required to examine the full life-cycle costs of each alternative under DOE Order 413.3B because they completed the analysis in January 2015, which was several months before the Secretary's June 2015 directive to incorporate AOA best practices in the order. According to AOA best practices, the team conducting the AOA should be given enough time to complete the AOA process to ensure a robust and complete analysis.

- NWP and Trinity used different assumptions in developing life-cycle cost estimates, which prevented DOE from directly comparing the life-cycle estimates for the three proposed alternatives. We found that DOE relied on NWP and Trinity to define the assumptions they used rather than providing the contractors consistent guidance or direction. As a result, NWP assumed certain costs should be excluded in estimating the life-cycle costs of its two proposed alternatives. These costs included the costs for major equipment replacements or upgrades which NWP assumed would not be needed during the 30-year operational life of the system; costs for providing facility security, quality assurance, and nuclear safety that are provided to all facilities at WIPP; and costs for the final closure of the new exhaust shaft after

[29]Under DOE Order 413.3B life-cycle costs cover all direct, indirect, recurring, nonrecurring, and other related costs incurred or estimated to be incurred in the planning, design, development, procurement, production, operations and maintenance, support, recapitalization, and final disposition of real property over its anticipated life span for every aspect of the program, regardless of funding source.

2050 when the system will be decommissioned. In contrast, Trinity assumed these costs should be included in estimating the life-cycle costs of its alternatives. As a result of including these additional costs, Trinity's estimated life-cycle cost was substantially more than NWP's estimate—Trinity's estimate for its proposed alternative was $3.45 billion and NWP's estimates for its two proposed alternatives were $368.8 million and $467.6 million.

Regarding quantifying benefits, DOE and its contractors did not provide any measures of the benefits or effectiveness for each of the alternatives in their analyses. By not ensuring that the life-cycle costs of each alternative were developed in a consistent manner and not ensuring that the benefits or effectiveness of each alternative were quantified, DOE did not have an accurate and complete picture of all the alternatives to make reliable comparisons between them.

DOE Partially Met Best Practices in the Selecting a Preferred Alternative Category

DOE's AOA process partially met the best practices in the selecting a preferred alternative category which covers selecting an alternative that best meets the mission need and also independently reviewing the overall AOA process. Most notably, DOE and its contractors did not follow the best practice to select the alternatives based on a cost-benefit analysis and only partially followed the best practice to independently review the AOA process, as follows:

- Regarding cost-benefit analysis, DOE and its contractors did not select the alternatives based on such an analysis which compares the life-cycle costs and benefits or effectiveness of each alternative.[30] As noted above, DOE and its contractors did not consistently examine life-cycle cost estimates for each alternative and did not quantify their benefits. Therefore, DOE did not produce the information needed for a cost-benefit analysis. By not selecting the alternatives based on a cost-benefit analysis, DOE did not adequately justify that the selected final alternative would best provide the capabilities needed at WIPP.

[30]Specifically, a cost-benefit analysis compares alternatives using the net present value of the estimated life-cycle costs and benefits or effectiveness of each alternative. The present value of an estimate reflects the time value of money, the concept that a dollar in the future is worth less than a dollar today because the dollar today can be invested and earn interest. The present value of an estimate is calculated using an interest rate called a discount rate.

- Regarding independently reviewing the AOA process, DOE conducted an independent review of the AOA process (which assessed whether best practices were followed) but did not implement the recommendation identified by the review. Specifically, an independent review conducted by DOE's Office of Project Management Oversight and Assessments found that the project team did not adequately document a cost-benefit analysis and that, as a result, the selection of the preferred alternative was not supported by compelling information. The review recommended that DOE perform a cost-benefit analysis to be consistent with best practices and support the selection of the final alternative. However, DOE and NWP did not conduct the recommended cost-benefit analysis and document it before DOE selected the final alternative. According to the DOE officials who led the independent review of the AOA process, the project team was not required by DOE's Order 413.3B to implement the recommendation or justify and document the reasons for not doing so. Therefore, DOE EM approved the selection of the preferred alternative for the permanent ventilation system project in December 2015 without implementing the independent review's recommendation.

Conducting an independent review of the AOA is a best practice because it is one of the most reliable means to ensure that bias does not influence the AOA process and that the AOA is sufficiently thorough to ensure that a preferred solution is chosen and not a favored solution. DOE's independent review was an internal control to help DOE meet its goal for the capital asset project, in this case selecting the alternative that will best provide the capabilities to meet the mission need. Under federal standards for internal control, management is to evaluate and document internal control issues and determine appropriate corrective actions.[31] By not implementing the recommendation from the independent review to do a cost-benefit analysis or not justifying and documenting the reason for not doing so, DOE cannot provide assurance that the final alternative selected would best provide the capabilities needed at WIPP.

Conclusions

Restarting WIPP's waste disposal operations is a top priority for DOE, and it has made progress in its efforts to restart limited waste disposal operations. However, DOE did not meet its initial cost and schedule

[31]GAO, *Standards for Internal Control in the Federal Government*, GAO-14-704G (Washington, D.C.: Sept. 10, 2014).

estimates to restart operations and incurred a cost increase of about $64 million—$2 million to the recovery project and $61.6 million in base operations—and a delay of nearly 9 months. DOE incurred the cost increase and schedule delay, in part, because DOE's initial estimates did not follow all best practices and were therefore unreliable. Notably, DOE did not include any contingency in its schedule, giving itself less than a 1 percent chance of success—said another way DOE gave itself a 99 percent chance of failure in meeting its schedule to restart operations. Moreover, when DOE revised its cost and schedule estimates for WIPP recovery it still did not follow all best practices. DOE did not develop its estimates for WIPP recovery following best practices, in part because DOE does not require its cleanup operations activities, such as WIPP, to follow them. This lack of a requirement is in contrast to a new policy put into effect in June 2015 by the Secretary of Energy, which established the requirements that DOE develop cost and schedule estimates for its capital asset projects following best practices—such projects include the new permanent ventilation system at WIPP. Without similar requirements for EM operations activities to follow best practices, DOE cannot have confidence that it is producing reliable baselines needed to monitor its performance in managing these activities and reduce the risk of cost overruns and delays in achieving its cleanup missions, such as the permanent disposal of transuranic waste from DOE sites across the country. By also requiring cleanup operations to follow best practices, DOE would have more confidence in the estimates for its cleanup operations activities and its capital asset projects.

In selecting the preferred alternative for the new permanent ventilation system at WIPP, DOE relied on an AOA process that did not follow all best practices. In particular, DOE only partially followed or did not follow best practices to define functional requirements based on the mission need, compare alternatives using a cost-benefit analysis, or independently review the AOA process. By not following these and other practices, DOE's AOA process was not reliable. Notably, DOE conducted an independent review of the process which found that the project team did not adequately document a cost-benefit analysis and that, as a result, the selection of the preferred alternative was not supported by compelling information. Nonetheless, DOE did not implement the recommendation of the review to conduct a cost-benefit analysis before the department selected the preferred alternative. DOE officials explained that the project team was not required by DOE's Order 413.3B to implement the recommendation. By not implementing the recommendation of the independent review or not justifying and documenting the reason for not doing so, DOE cannot provide assurance that the final selected

alternative would best provide the capabilities needed at WIPP. More broadly, without requiring in its Order 413.3B that recommendations from independent reviews of AOAs be implemented or that the reason for not doing so be justified and documented, DOE cannot have assurance that it selects, for all capital asset projects, preferred alternatives from its AOAs that best meet the mission need.

Recommendations for Executive Action

To help ensure that DOE develops and uses reliable cost and schedule estimates and AOAs, we recommend that the Secretary of Energy take the following three actions:

- Direct EM to revise its protocol governing cleanup operations activities to require use of best practices in developing cost and schedule estimates.
- Direct EM to implement the recommendation made by DOE's Office of Project Management Oversight and Assessments in its independent review of the AOA for WIPP's new permanent ventilation system to perform a cost-benefit analysis consistent with best practices for conducting an AOA, or justify and document why the office does not intend to do so.
- Direct DOE to revise its Order 413.3B to require that DOE offices implement any recommendations from an independent review of the extent to which an AOA followed best practices, or justify and document the rationale for not doing so.

Agency Comments and Our Evaluation

We provided a draft of this report to DOE for review and comment. In written comments, reproduced in appendix V, DOE concurred with the report's recommendations. DOE stated that our recommendations were consistent with its commitment to continuous improvement in project management. In addition, DOE stated that it had two issues that the department believed needed to be addressed. DOE also provided technical comments that were incorporated, as appropriate.

DOE identified the following two issues:

- DOE stated that WIPP recovery activities were under way concurrent with DOE-wide efforts to improve project management, including revisions to its project management order (DOE Order 413.B). DOE stated that, consequently, EM project management practices were

separate from evolving department project management guidance and that it is now in the process of bringing EM practices into conformance with the department's project management guidance.

- DOE stated that the report needs to be clear, in each instance, regarding the $64 million cost increase for WIPP attributed to schedule delays in recovery activities, to indicate that $2 million of the cost increase was WIPP recovery project-related and that $61.6 million was due to reexamination and assessment of the cost of base operations.

We do not believe changes are needed to the report for either of these issues. The report explains that WIPP recovery activities were based on EM's operations activities protocol and that actions were under way within the department to improve project management, including revisions to DOE's project management order. In addition, the report includes a breakout of the cost increase. We did, however, revise the conclusions to reflect this breakout.

As noted above, DOE concurred with the report's three recommendations. Regarding the first recommendation—that EM revise its protocol governing cleanup operations activities to require use of best practices in developing cost and schedule estimates—DOE stated in its written comments that it concurred with clarification. DOE stated that EM is transitioning from the operations activities protocol to a new directive that is expected to include a key decision approving a cost and schedule baseline. As EM develops the guidance for this key decision, it will include the use of cost and schedule best practices. DOE stated that EM plans to finalize this new directive by September 2016 and seek departmental approval by December 2016.

Regarding the second recommendation— that EM implement the recommendation made by DOE in its independent review of the AOA for WIPP's new ventilation system to perform a cost-benefit analysis consistent with best practices, or justify and document why it does not intend to do so—DOE stated in its written comments that it concurred with clarification. DOE stated that in accordance with GAO best practices, further cost-benefit analysis will be conducted on the project prior to approval of Critical Decision-2 (Approve Performance Baseline). DOE stated that several alternatives remain to be evaluated including the size of the ventilation system and the location of the exhaust shaft.

Regarding the third recommendation—that DOE revise its project management (Order 413.3B) to require that DOE offices implement recommendations from independent reviews of the extent to which an AOA followed best practices, or justify and document the rationale for not doing so—DOE concurred with the recommendation. DOE stated that it will prepare a project management policy on how DOE offices should respond to recommendations from independent reviews. DOE stated that it will prepare this policy by December 2016 and update DOE Order 413.3B at the next available opportunity.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Energy, and other interested parties. In addition, the report is available at no charge on the GAO website at http://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-3841 or trimbled@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix VI.

David C. Trimble
Director, Natural Resources and Environment

List of Committees

The Honorable John McCain
Chairman
The Honorable Jack Reed
Ranking Member
Committee on Armed Services
United States Senate

The Honorable Lamar Alexander
Chairman
The Honorable Dianne Feinstein
Ranking Member
Subcommittee on Energy and Water Development
Committee on Appropriations
United States Senate

The Honorable Mac Thornberry
Chairman
The Honorable Adam Smith
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable Mike Simpson
Chairman
The Honorable Marcy Kaptur
Ranking Member
Subcommittee on Energy and Water Development
Committee on Appropriations
House of Representatives

Appendix I: Objectives, Scope, and Methodology

Our report examined the extent to which the Department of Energy (DOE) (1) met its initial cost and schedule estimates for restarting waste disposal operations at the Waste Isolation Pilot Plant (WIPP) and (2) followed best practices in analyzing and selecting an alternative for the new ventilation system. To address both objectives, we conducted a site visit to WIPP in January 2015. During the site visit we obtained documentation and interviewed officials from DOE's Office of Environmental Management (EM), which is responsible for oversight of WIPP and exercises this responsibility primarily through its Carlsbad Field Office. We also interviewed representatives at WIPP from Nuclear Waste Partnership LLC (NWP), which is the private contractor that manages and operates WIPP for DOE.

To examine the extent to which DOE met its initial cost and schedule estimates for restarting waste disposal operations, we compared DOE's initial cost and schedule estimates to restart limited waste disposal operations contained in its February 2015 WIPP recovery project management baseline with DOE's revised estimates in its January 2016 integrated project management baseline for WIPP. We reviewed DOE's budget justification supporting the President's fiscal year 2016 budget request to Congress from February 2015 and the amounts DOE received for WIPP in the 2016 Consolidated Appropriations Act.[1] We reviewed DOE's reports on the reasons it exceeded the initial estimates for restarting waste disposal operations and DOE's risk management plans for WIPP recovery prepared by NWP and used in developing the February 2015 estimates. We also compared DOE's initial cost and schedule estimates to restart limited waste disposal operations from the February 2015 WIPP recovery project management baseline with the best practices described in our cost and schedule guides that identified the characteristics of high-quality, reliable cost and schedule estimates because these were the approved estimates when we conducted our analysis.[2] Specifically, we compared DOE's initial WIPP recovery cost estimate presented in DOE's project management baseline document and supporting documents and data with the best practices in our Cost

[1]Pub. L. No. 114-113 (2015).

[2]GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP (Washington, D.C.: March 2009) and *GAO Schedule Assessment Guide: Best Practices for Project Schedules,* GAO-12-120G (Washington, D.C.: May 2012).

Estimating and Assessment Guide. In addition, we compared DOE's initial WIPP recovery schedule presented in DOE's project management baseline document and supporting documents and data with the best practices in our Schedule Assessment Guide. We interviewed the Carlsbad Field Office officials who oversee the recovery project and NWP's cost estimator and scheduler. We provided a draft of our cost and schedule assessments to the Carlsbad Field Office and NWP and revised the draft, as appropriate, after discussing our assessment with the federal officials and the contractor. We reviewed documentation on the revised (January 2016) baseline and interviewed DOE and NWP officials on the approach followed to develop the revised cost and schedule estimates to restart WIPP's waste disposal operations in the baseline, but we did not assess the revised estimates against the best practices because of the time frame of our review.

To examine the extent to which DOE followed best practices in analyzing and selecting an alternative for WIPP's new ventilation system, we used as criteria the best practices for conducting an AOA identified in GAO-15-37 issued in December 2014.[3] GAO developed the best practices identified in this report by reviewing AOA policies and guidance used by seven public and private-sector entities with experience in the AOA process, and verified these practices with subject-matter experts. DOE's AOA process for the WIPP ventilation system consisted of three elements: NWP's January 2015 AOA that resulted in the selection of two preferred alternatives proposed for further analysis, a second AOA completed by Trinity Engineering Associates (Trinity) in October 2015 which resulted in a single preferred alternative proposed to DOE, and DOE's final alternative evaluation process led by the Carlsbad Field Office that considered the three alternatives proposed by the initial studies. Our analysis assessed the overall AOA process considering each element. We compared the process with the best practices and determined a score for the overall process. We reviewed project documentation from the Carlsbad Field Office, NWP, and Trinity and interviewed Carlsbad Field Office officials and NWP representatives in charge of the AOA. In addition, in October 2015, as we were conducting our engagement, EM and DOE's Office of Project Management Oversight and Assessments completed separate assessments of the WIPP AOA for

[3]GAO, *DOE and NNSA Project Management: Analysis of Alternatives Could Be Improved by Incorporating Best Practices*, GAO-15-37 (Washington, D.C.: Dec. 11, 2014).

the new ventilation system. We reviewed documentation of these reviews and interviewed the DOE officials who worked on them. We examined the extent that the independent assessments followed the best practice to have an independent entity assess the extent that a project's AOA followed all best practices.

To score DOE's AOA process, a GAO analyst examined the AOA documentation received from the agency and then assigned a score for each of the 24 best practices. Following this, a GAO AOA specialist independent of the engagement team reviewed the AOA documentation and the scores assigned by the analyst for accuracy and cross-checked the scores in all the analyses for consistency. We used a five-point scoring system to determine the extent to which DOE's AOA process conformed to the best practices.[4] After determining a score for each individual best practice, we calculated the score for each category—(1) general principles, (2) identifying alternatives, (3) analyzing alternatives, and (4) selecting a preferred alternative—by calculating the average of the scores for the best practices that fall under each category. If the score for each best practice and the average score for each category was "fully met" or "substantially met," we concluded that the AOA process conformed to best practices and therefore could be considered reliable. In contrast, if the score was "partially met," "minimally met," or "not met," we concluded that the AOA process did not conform to best practices and therefore could not be considered reliable. We shared our analysis with DOE officials and representatives from NWP for review and incorporated their technical comments and any additional evidence they provided in our analysis, as appropriate. We also interviewed officials from DOE's

[4]The five-point scoring system was based on the scoring system we have used to assess other federal programs and projects' cost and schedule estimates against best practices published in our Cost and Schedule guides. The scoring system does not weight cost estimating, scheduling, and AOA best practices because it is not possible to quantitatively determine the relative weights of each of the criteria. Weighting has the potential to vary across programs, as well as due to where a program may be in its different stages of its life cycle. Therefore, the fairest standardized methodology to evaluate programs is to have all criteria weighted equally. The system we used was as follows: "fully met" (i.e., five points) means that DOE's documentation demonstrated that DOE completely met the best practice; "substantially met" (i.e. four points) means that DOE's documentation demonstrated that DOE met a large portion of the best practice; "partially met" (i.e., three points) means that DOE's documentation demonstrated that DOE met about half of the best practice; "minimally met" (i.e., two points) means that DOE's documentation demonstrated that DOE met a small portion of the of the best practice; and "did not meet" (i.e., one point) means that DOE's documentation did not demonstrate that DOE met the best practice.

Office of Enterprise Assessments, which provides internal oversight of DOE facilities; the Defense Nuclear Facilities Safety Board, which provides external oversight of DOE defense nuclear facilities; the U.S. Mine Safety and Health Administration, which provides external oversight of mining activities at WIPP; as well as the U.S. Environmental Protection Agency and the New Mexico Environment Department, both of which provide external regulation of WIPP.

We conducted this performance audit from November 2014 to August 2016 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: Assessment of DOE's Cost Estimate for the WIPP Recovery Project Compared with Best Practices

Table 2 below assesses the Department of Energy's (DOE) initial cost estimate in its February 2015 project management baseline for the Waste Isolation Pilot Plant (WIPP) recovery project compared to best practices for cost estimating published in the GAO Cost Estimating and Assessment Guide.[1] Overall, of four characteristics of a high-quality and reliable cost estimate, DOE's initial cost estimate substantially met two characteristics—comprehensive and well-documented—but partially met or minimally met the other two characteristics—accurate and credible.

Table 2: Assessment of DOE's February 2015 Cost Estimate for the WIPP Recovery Project Compared with Industry Best Practices

Best practice characteristic and overall assessment	Best practice	Detailed assessment[a]
Comprehensive: Substantially met	The cost estimate includes all life-cycle costs.	**Substantially met.** The cost estimate prepared by the Department of Energy's (DOE) Waste Isolation Pilot Plant (WIPP) contractor—Nuclear Waste Partnership LLC (NWP)—on DOE's behalf, was not a life-cycle cost estimate. However, the estimate covered the costs for all activities in DOE's WIPP recovery plan to restart limited waste disposal operations and also covered the order of magnitude cost range for construction of the new permanent ventilation system needed to return WIPP to full operations. In addition, DOE issued a directive to NWP to update the life-cycle cost estimate for WIPP to account for increased operating costs at WIPP.
	The cost estimate completely defines the program, reflects the current schedule, and is technically reasonable.	**Substantially met.** The cost estimate was based on DOE's WIPP recovery plan document, prepared on its behalf by NWP, and which established the technical baseline for the work. Evidence was provided to show Carlsbad Field Office approval of the estimate, but none was shown to support approval by DOE headquarters.
	The cost estimate work breakdown structure is product-oriented, traceable to the statement of work/objective, and at an appropriate level of detail to ensure that cost elements are neither omitted nor double-counted.	**Substantially met.** The work breakdown structure showed the work of the project, and used an appropriate level of detail to ensure that no costs were omitted. However, the work breakdown structure may not have adequately captured sustainment costs.
	The estimate documents all cost-influencing ground rules and assumptions.	**Fully met.** Ground rules and assumptions were documented in the cost estimate. For example, the estimate documented assumptions such as funding support and constraints as well as technical and programmatic risks.

[1]GAO, *GAO Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Capital Program Costs*, GAO-09-3SP (Washington, D.C.: March 2009).

Best practice characteristic and overall assessment	Best practice	Detailed assessment[a]
Well-documented: Substantially met	The documentation captures the source data used, the reliability of the data, and how the data were normalized.	**Substantially met.** The cost estimate was based on historical data for NWP work at WIPP as well as vendor quotes for recovery tasks. However, it was not possible to trace all vendor quotes to the estimate.
	The documentation describes in sufficient detail the calculations performed and the estimating methodology used to derive each element's cost.	**Partially met.** Some portions of the estimating methodology were broken out and documented, but there were gaps in the documentation. For instance, in some cases, material costs were not broken out separately but were instead rolled up into an overall cost number.
	The documentation describes, step by step, how the estimate was developed so that a cost analyst unfamiliar with the program could understand what was done and replicate it.	**Partially met.** The documentation provided included narrative descriptions, an executive summary, introduction, risk and uncertainty analysis, and steps taken to estimate costs. But it did not explain whether a sensitivity analysis was conducted or how the estimate would be updated to reflect actual costs and changes. Also, the documentation provided was not at a level of detail that would allow for a full replication of the estimate.
	The documentation discusses the technical baseline description and the data in the baseline are consistent with the estimate.	**Fully met.** The technical baseline description came from DOE's WIPP Recovery Plan and the estimate was consistent with this document.
	The documentation provides evidence that the cost estimate was reviewed and accepted by management.	**Substantially met.** Documentation was provided that showed management approval of the estimate, including resolution of comments on earlier drafts of the estimate. However, the documentation did not include estimate details and cost contingency.
Accurate: Partially met	The cost estimate results are unbiased, not overly conservative or optimistic, and based on an assessment of most likely costs.	**Minimally met.** A clear link between the risk and uncertainty analysis and the cost estimate was not presented, and therefore we were unable to determine what the level of confidence was for the point estimate.
	The estimate has been adjusted properly for inflation.	**Partially met.** Costs were developed in constant year dollars and then escalated to future year dollars. Documentation was not sufficient to determine if historical data were adjusted for inflation and normalized to constant year dollars.
	The estimate contains few, if any, minor mistakes.	**Partially met.** We found inconsistencies between the final documented estimate and the electronic cost model. As a result, we were unable to fully assess whether the estimate contained any errors. Spot checks did not specifically reveal any double-counting or omissions but these problems could not be ruled out given the inability to trace the estimate from the cost model.
	The cost estimate is regularly updated to reflect significant changes in the program so that it always reflects current status.	**Substantially met.** We found that the cost estimate had been updated to reflect changes and program assumptions. In addition, an earned value management system is in the process of being implemented, which will assist with keeping the estimate current.

Best practice characteristic and overall assessment	Best practice	Detailed assessment[a]
	Variances between planned and actual costs are documented, explained, and reviewed.	**Partially met.** Documentation was provided which described cost variances and contained information on the impact to the project as well as corrective actions. However, in some cases, the documentation did not allow us to directly link specific project problems with their corresponding cost variance.
	The estimate is based on a historical record of cost estimating and actual experiences from other comparable programs.	**Partially met.** Most of the raw historical data used to develop the estimate were not provided. Some data were provided from WIPP operations prior to the shutdown of operations in February 2014. However, these data were not readily reviewable by a third party
	The estimating technique for each cost element was used appropriately.	**Not met.** NWP did not have documentation that would have allowed us to determine if data provided by subject-matter experts were properly adjusted for bias, which prevented us from determining whether historical data were adjusted correctly to reflect current circumstances.
Credible: Minimally met	The cost estimate includes a sensitivity analysis that identifies a range of possible costs based on varying major assumptions, parameters, and data inputs.	**Not met.** A sensitivity analysis was not conducted for this cost estimate.
	A risk and uncertainty analysis was conducted that quantified the imperfectly understood risks and identified the effects of changing key cost driver assumptions and factors.	**Substantially met.** Separate risk analyses were conducted for technical and programmatic risk, estimate uncertainty, and schedule uncertainty. However, probabilities for the nonrisk-adjusted point estimate were not reported.
	Major cost elements were cross-checked to see whether results were similar.	**Not met.** Major cost elements were not cross checked with alternative methodologies to see if results are similar.
	An independent cost estimate was conducted by a group outside the acquiring organization to determine whether other estimating methods produce similar results.	**Minimally met.** An independent cost estimate was not conducted. Documentation was provided showing a review from another team within the same contractor organization. However, the work of this other team was not independent and did not develop a separate estimate using the same ground rules and assumptions.

Source: GAO analysis of the WIPP recovery project management baseline cost estimate approved by DOE in February 2015. | GAO-16-608

[a]The ratings we used in this analysis are as follows: "Fully met" means DOE provided complete evidence that satisfies the entire best practice. "Substantially met" means DOE provided evidence that satisfies a large portion of the best practice. "Partially met" means DOE provided evidence that satisfies about half of the best practice. "Minimally met" means DOE provided evidence that satisfies a small portion of the best practice. "Not met" means DOE provided no evidence that satisfies the best practice.

Appendix III: Assessment of DOE's Schedule for the WIPP Recovery Project Compared with Best Practices

Table 3 below assesses the Department of Energy's (DOE) initial schedule in its February 2015 project management baseline for the Waste Isolation Pilot Plant (WIPP) recovery project compared to best practices for developing a schedule estimate published in the GAO Schedule Assessment Guide.[1] Overall, DOE's schedule substantially met two of the four characteristics of a high-quality schedule—comprehensive and controlled—but partially met the characteristics of well-constructed and credible.

Table 3: Assessment of DOE's February 2015 Schedule for the WIPP Recovery Project Compared with Industry Best Practices

Best practice characteristic and overall assessment	Best practice	Detailed assessment[a]
Comprehensive: Substantially met	Capturing all activities.	**Substantially met.** The Department of Energy's (DOE) schedule, prepared by its Waste Isolation Pilot Plant (WIPP) contractor—Nuclear Waste Partnership LLC (NWP)—reflected the activities in the work breakdown structure—which defines the work necessary to accomplish a project's objectives. Key milestones were captured and identified and work scope was assigned as the responsibility of either NWP or DOE. However, we found many instances of repeated activity names and descriptions in the schedule which may obscure the required work for each activity.
	Assigning resources to all activities.	**Partially met.** The schedule included costs and the total cost given in the schedule was largely aligned with the total budgeted cost. However less than 10 percent of the remaining activities in the schedule had resources assigned to them. No evidence was provided that the schedule was used to explore possible resource availability conflicts.
	Establishing the durations of all activities.	**Substantially met.** Durations were established for activities using the most likely estimate, according to NWP officials. Our analysis found that 90 percent of the activities in the recovery schedule were less than 2 working months in duration, representing manageable pieces of work.
Well-constructed: Partially met	Sequencing all activities.	**Partially met.** We found that the schedule predominately used finish-to-start logic, which clearly indicated the activities that were supposed to finish before others begin, but we also found a significant number of missing logic links between activities. Without these links, activities that slip early in the schedule would not transmit delays to activities that should depend on them.

[1]GAO, *GAO Schedule Assessment Guide: Best Practices for Project Schedules*, GAO-12-120G (Washington, D.C.: May 2012).

Best practice characteristic and overall assessment	Best practice	Detailed assessment[a]
	Confirming that the critical path is valid.	**Partially met.** A critical path was identified for the schedule. According to NWP officials, it was used to track the progress of the project. The critical path contained some long duration activities which should have been reevaluated to determine if they could have been broken up into more manageable pieces. Additionally, due to the problems with logic links between activities discussed in the best practice above (i.e., sequencing all activities), we were unable to validate the reliability of the critical path.
	Ensuring reasonable total float.	**Partially met.** The schedule included large total float values that probably did not represent the actual degree of flexibility in the schedule. NWP officials stated they would address the schedule logic and the large total float values as the work progressed and more was known about the activities.
Credible: Partially met	Verifying that the schedule is traceable horizontally and vertically.	**Partially met.** We found that the schedule was traceable vertically, with all levels of detail of the schedule derived from the same integrated master schedule. However, the schedule was not fully traceable horizontally, in particular because of the activities with missing logic links discussed in the above best practice.
	Conducting a schedule risk analysis.	**Minimally met.** A schedule risk analysis was performed. However, according to NWP officials, it relied on a prior version of the schedule. Therefore it was outdated. In addition, the analysis focused on the activities on the critical path only, whereas it should have focused on all work activities. DOE also did not use the risk analysis to determine a risk-adjusted project completion date. Specifically, the completion date it selected, March 31, 2016, did not include contingency to account for the known risks that DOE analyzed. The completion date, in fact, had a less than 1 percent confidence level, or chance of success, in being achieved.
Controlled: Substantially met	Updating the schedule with actual progress logic.	**Substantially met.** NWP officials stated that many activities had their status checked either daily or weekly and that the critical path was updated weekly by trained project schedulers. Officials provided an example of a monthly schedule report, but it did not address logic or critical path changes.
	Maintaining a baseline schedule.	**Substantially met.** The documentation provided showed that the baseline schedule was being maintained through a change control process and used as the basis for measuring performance. However, NWP officials told us that they do not have the schedule basis documentation that is essential for validating and defending the baseline schedule.

Source: GAO analysis of the WIPP recovery project schedule estimate approved by DOE in February 2015. | GAO-16-608

[a]The ratings we used in this analysis are as follows: "Fully met" means DOE provided complete evidence that satisfies the entire best practice. "Substantially met" means DOE provided evidence that satisfies a large portion of the best practice. "Partially met" means DOE provided evidence that satisfies about half of the best practice. "Minimally met" means DOE provided evidence that satisfies a small portion of the best practice. "Not met" means DOE provided no evidence that satisfies the best practice.

Appendix IV: Assessment of DOE's Analysis of Alternatives for the WIPP Ventilation System Project Compared with Best Practices

Table 4 below compares the Department of Energy's (DOE) analysis of alternatives (AOA) process completed in December 2015 for the new permanent ventilation system at the Waste Isolation Pilot Plant (WIPP) to best practices for conducting an AOA published in a December 2014 GAO report.[1] DOE's overall AOA process consisted of an initial AOA by DOE's WIPP contractor, Nuclear Waste Partnership LLC, completed in January 2015; a second AOA by a contractor unaffiliated with WIPP, Trinity Engineering Associates, completed in October 2015; and DOE's final evaluation of the three preferred alternatives proposed by the contractors' analyses. Overall, DOE's AOA process fully met the category for identifying alternatives and partially or minimally met the other three categories of best practices—general principles, analyzing alternatives, and selecting the preferred alternative.

[1]GAO, *DOE and NNSA Project Management: Analysis of Alternatives Could Be Improved by Incorporating Best Practices*, GAO-15-37 (Washington, D.C.: Dec. 11, 2014). GAO developed the best practices identified in this report by reviewing AOA policies and guidance used by seven public and private-sector entities with experience in the AOA process, and verified these practices with subject-matter experts.

Table 4: Assessment of DOE's Analysis of Alternatives (AOA) for the WIPP Permanent Ventilation System Project Compared with AOA Best Practices

Best practice category and score[a]	Best practice	Detailed assessment[a]
General principles: Partially met	1. The customer defines the mission need without a predetermined solution.	**Partially met.** The Department of Energy's (DOE) mission need memorandum for the Waste Isolation Pilot Plant (WIPP) new permanent ventilation system defined the capabilities needed for the system's equipment without specifying a particular configuration. However, the memorandum suggested that a new shaft was needed.
	2. The customer defines functional requirements based on the mission need and without a predetermined solution.	**Partially met.** DOE's mission need memorandum defined high-level functions but DOE did not develop a functional requirements document with detailed definitions of the requirements and analysis of how they were based on the mission need. DOE did not clearly define two requirements in its mission need memorandum: the total airflow needed to support full WIPP operations and end date for WIPP's operating life. As a result, DOE's AOA teams—one organized by its WIPP contractor, Nuclear Waste Partnership LLC (NWP) and a second organized by a contractor unaffiliated with WIPP, Trinity Engineering Associates (Trinity)—did not use the same airflows to analyze alternatives and did not consistently use the same end date for WIPP's operating life in analyzing all alternatives. DOE's final conceptual design report defined the safety-related functional requirements based on the mission need that would apply to all three preferred alternatives.
	3. The customer provides the team conducting the AOA with enough time to complete the AOA process to ensure a robust and complete analysis.	**Minimally met.** DOE started the AOA process in October 2014 and completed it in December 2015. However, DOE did not ensure that its AOA teams had the time to estimate both the life-cycle costs and benefits of each alternative. In addition, DOE did not take the time to implement recommendations made by its own independent review of the AOA process.
	4. The team includes members with diverse areas of expertise including, at a minimum, subject-matter expertise, project management, cost estimating, and risk management.	**Partially met.** DOE's AOA teams assembled by its contractors provided documentation that indicated they included expertise in relevant technical and regulatory subject matters such as nuclear safety, mine safety, and mine and nuclear ventilation. The final AOA reports did not include resumes to show the level of expertise. NWP's AOA did not include expertise in cost estimating and risk management.
	5. The team creates a plan, including proposed methodologies, for identifying, analyzing, and selecting alternatives, before beginning the AOA process.	**Partially met.** DOE's AOA teams did not have detailed planning documents before starting the AOA process that identified the methodologies to be followed for identifying, analyzing, and selecting the alternatives. DOE did not have a documented plan for integrating the two initial AOAs by its contractors and conducting the final evaluation process.
	6. The team documents all steps taken to identify, analyze, and select alternatives in a single document.	**Partially met.** DOE's AOA reports, including its final conceptual design report, documented many steps completed to identify, analyze, and select the final alternative. Certain key steps were not well-documented such as the WIPP contractor's analysis that supported selection of two preferred alternatives in its January 2015 AOA report and the selection criteria developed by DOE for choosing the final alternative.

Best practice category and score[a]	Best practice	Detailed assessment[a]
	7. The team documents and justifies all assumptions and constraints used in the analysis.	**Partially met.** DOE's AOA teams defined and justified many assumptions and constraints such as regulatory requirements. DOE did not ensure that specific assumptions were consistently defined or justified for all alternatives analyzed. For example, DOE's AOA teams did not consistently use 2050 as WIPP's mission end date for analyzing all alternatives and did not consistently justify the total airflow needed to support full operations.
	8. The team conducts the analysis without a predetermined solution.	**Minimally met.** Because DOE defined the mission need by mentioning a new exhaust shaft, DOE's AOA teams appeared to have analyzed alternatives with a preference for the alternatives that included constructing a new shaft. After DOE's AOA teams proposed a total of three alternatives to be evaluated for a final selection, DOE appeared to have a preference for one of NWP's proposed alternatives. For example, DOE did not take the time to conduct and document a cost-benefit analysis, as was recommended by DOE's independent assessment of the AOA process, to justify the selection of the final alternative.
Identifying alternatives: Fully met	9. The team identifies and considers a diverse range of alternatives to meet the mission need.	**Fully met.** DOE's AOA teams identified nine principal ventilation alternatives that were analyzed. These included using the existing shaft(s) or drilling new shaft(s), splitting or combining airflows for mining and waste disposal operations, different ventilation filtration capacities, and different modes of operation.
	10. The team describes alternatives in sufficient detail to allow for robust analysis.	**Fully met.** DOE's AOA teams described the main features, including nuclear safety features, of the nine principal alternatives, their major equipment and components, and operating modes. NWP developed diagrams for each alternative showing the path of airflows. The descriptions of alternatives were primarily qualitative.
	11. The team includes one alternative representing the status quo to provide a basis of comparison among alternatives.	**Fully met.** DOE's AOA teams included the existing WIPP ventilation system with the interim and supplemental upgrades being completed as part of the recovery project as the alternative representing the status quo.
	12. The team screens the list of alternatives before proceeding, eliminates those that are not viable, and documents the reasons for eliminating any alternatives.	**Fully met.** DOE's AOA teams screened a number of alternatives that they determined were not viable because they would not meet the mission need capabilities for nuclear safety or full operations before conducting their analyses of the nine principal alternatives.
Analyzing alternatives: Minimally met	13. The team develops a life-cycle cost estimate for each alternative, including all costs from inception of the project through design, development, deployment, operation, maintenance, and retirement.	**Minimally met.** DOE did not ensure that its AOA teams developed life-cycle cost estimates for all principal alternatives, or that they were calculated in a consistent manner. NWP did not develop life-cycle cost estimates for four of the six principal alternatives it analyzed. Trinity developed life-cycle cost estimates for its three principal alternatives. DOE did not ensure that life-cycle cost estimates for the final three alternatives were calculated in a consistent manner to allow reliable comparison.

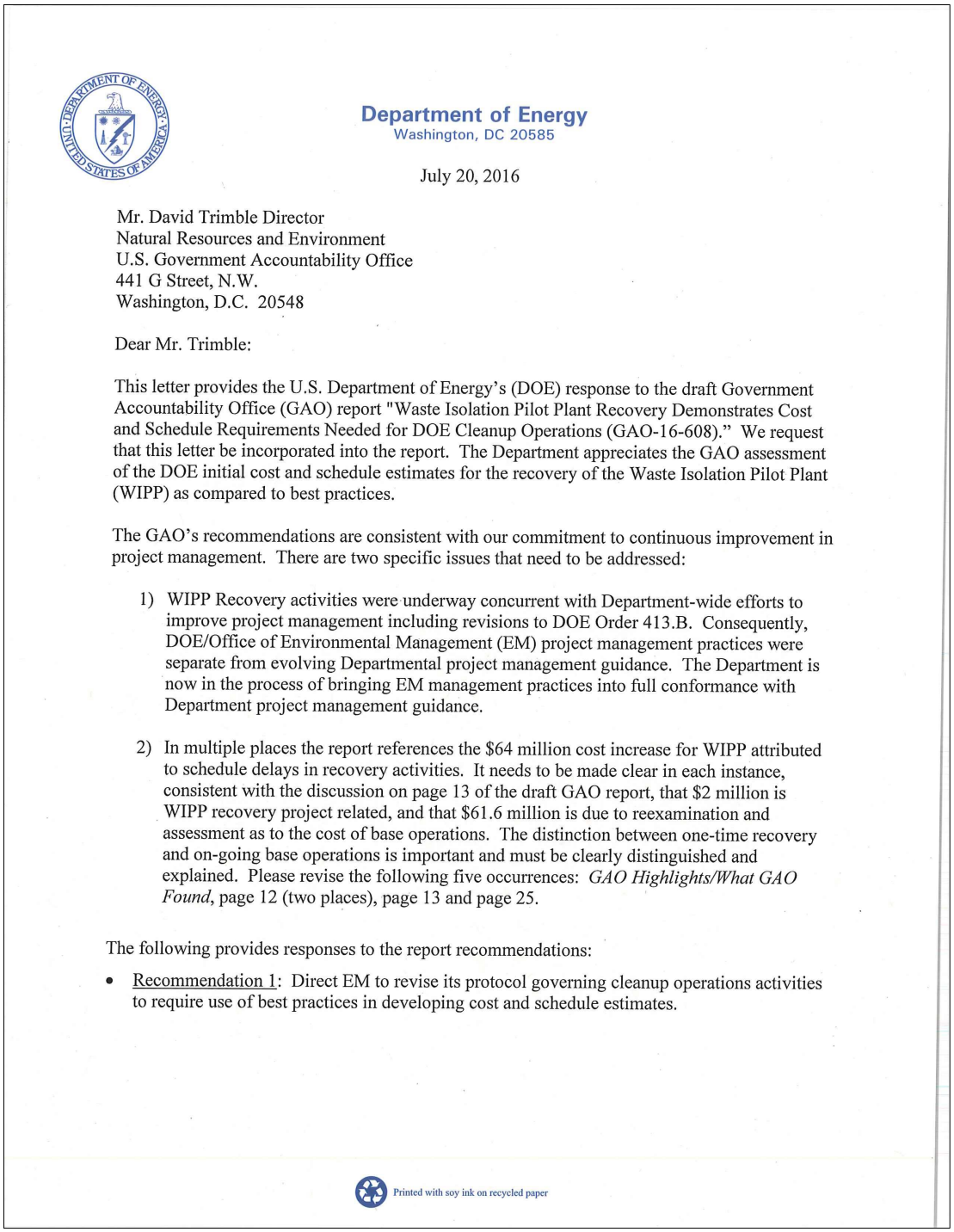
Best practice category and score[a]	Best practice	Detailed assessment[a]
	14. The team presents the life-cycle cost estimate for each alternative as a range or with a confidence interval, and not solely as a point estimate.	**Minimally met.** DOE did not ensure that its AOA teams developed life-cycle cost estimate ranges for all principal alternatives.
	15. The team expresses the life-cycle cost estimate in present value terms and explains why it chose the specific discount rate used.	**Partially met.** DOE did not ensure that its AOA teams expressed life-cycle cost estimates in present value terms for all of the nine principal alternatives that were analyzed and that present values were calculated in a consistent manner. For example, DOE did not ensure that its AOA teams used the same discount rates in calculating present values. NWP used Office of Management and Budget guidance for selecting the discount rate. Trinity used a different rate but did not explain the reason for the discount rate.
	16. The team uses a standard process to quantify the benefits/effectiveness of each alternative and documents this process.	**Not met.** DOE's AOA teams did not use a standard process to quantify benefits or effectiveness for each alternative.
	17. The team quantifies the benefits/effectiveness resulting from each alternative over that alternative's full life cycle, if possible.	**Not met.** DOE's AOA teams did not quantify measures of benefits or effectiveness for each alternative as part of the AOA
	18. The team explains how each measure of benefit/effectiveness supports the mission need.	**Minimally met.** DOE's AOA teams described pros and cons or qualitative benefits for each alternative in relation to the mission need but did not describe quantitative measures of benefits or effectiveness for each alternative.
	19. The team identifies and documents the significant risks and mitigation strategies for each alternative.	**Minimally met.** DOE's AOA teams identified and documented qualitative risks and mitigation strategies for each alternative. DOE developed risk and uncertainty analysis for two of the nine alternatives that were analyzed. The risk and uncertainty analysis only covered the design and construction phase of the alternatives and not the full life cycle of the system.
	20. The team tests and documents the sensitivity of both the cost and benefit/effectiveness estimates for each alternative to risks and changes in key assumptions.	**Not met.** DOE's AOA teams did not conduct a sensitivity analysis of the cost or benefits or effectiveness estimates for the alternatives.

Best practice category and score[a]	Best practice	Detailed assessment[a]
Selecting a preferred alternative: Partially met	21. The team or the decision maker defines selection criteria based on the mission need.	**Partially met.** DOE's AOA teams identified selection criteria but did not develop detailed definitions of the criteria. The criteria established by NWP and Trinity reflected elements of project management—technical, safety, regulatory, cost and schedule—and not specific capabilities needed to meet the mission need or functional requirements. DOE developed final selection criteria to evaluate the final three alternatives but did not document how the criteria aligned with the mission need.
	22. The team or the decision maker weights the selection criteria to reflect the relative importance of each criterion.	**Partially met.** DOE's AOA teams did not weight selection criteria consistently. For example, the teams weighted similar criteria differently (e.g., schedule and technical criteria). NWP changed how it weighted the selection criteria resulting in selection of two preferred alternatives during its January 2015 AOA.
	23. The team or the decision maker compares alternatives using net present value, if possible.	**Not met.** DOE's AOA teams did not conduct cost-benefit analysis to compare alternatives using net present value and did not document reasons it was not possible. As discussed above, DOE's AOA teams did not consistently examine life-cycle cost estimates for each alternative and did not quantify benefits of alternatives. Therefore, DOE did not produce the information needed for meeting the best practice.
	24. An entity independent of the AOA process reviews the extent to which all best practices have been followed (for certain projects, additional independent reviews may be necessary at earlier stages of the process such as for reviewing the study plan or for reviewing the identification of viable alternatives).	**Partially met.** DOE completed two separate independent reviews of the AOA process. The first review was by DOE's Office of Project Management Oversight and Assessments. The second was by the Office of Environmental Management (EM). The first review found that DOE did not justify the selection of the chosen alternative and recommended that DOE conduct a cost-benefit analysis to justify the final alternative. DOE did not fully address the recommendation because the project team was not required to. The second review by EM did not fully and accurately examine the extent that best practices were followed.

Source: GAO analysis of information from DOE, Nuclear Waste Partnership LLC, and Trinity Engineering Associates. | GAO-16-608

[a]The score for each category represents the average scores of the best practices included in that category. An overall score of "fully met" or "substantially met" means that the AOA was reliable. The five-point scoring system that we used was as follows: "Fully met" means that DOE's documentation demonstrated that it completely met the best practice; "Substantially met" means that DOE's documentation demonstrated that it met a large portion of the best practice; "Partially met" means that DOE's documentation demonstrated that it met about half of the best practice; "Minimally met" means that the DOE's documentation demonstrated that it met a small portion of the best practice; and "Not met" means that DOE's documentation did not demonstrate that it met the best practice.

Appendix V: Comments from the Department of Energy



Department of Energy
Washington, DC 20585

July 20, 2016

Mr. David Trimble Director
Natural Resources and Environment
U.S. Government Accountability Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Mr. Trimble:

This letter provides the U.S. Department of Energy's (DOE) response to the draft Government Accountability Office (GAO) report "Waste Isolation Pilot Plant Recovery Demonstrates Cost and Schedule Requirements Needed for DOE Cleanup Operations (GAO-16-608)." We request that this letter be incorporated into the report. The Department appreciates the GAO assessment of the DOE initial cost and schedule estimates for the recovery of the Waste Isolation Pilot Plant (WIPP) as compared to best practices.

The GAO's recommendations are consistent with our commitment to continuous improvement in project management. There are two specific issues that need to be addressed:

1) WIPP Recovery activities were underway concurrent with Department-wide efforts to improve project management including revisions to DOE Order 413.B. Consequently, DOE/Office of Environmental Management (EM) project management practices were separate from evolving Departmental project management guidance. The Department is now in the process of bringing EM management practices into full conformance with Department project management guidance.

2) In multiple places the report references the $64 million cost increase for WIPP attributed to schedule delays in recovery activities. It needs to be made clear in each instance, consistent with the discussion on page 13 of the draft GAO report, that $2 million is WIPP recovery project related, and that $61.6 million is due to reexamination and assessment as to the cost of base operations. The distinction between one-time recovery and on-going base operations is important and must be clearly distinguished and explained. Please revise the following five occurrences: *GAO Highlights/What GAO Found*, page 12 (two places), page 13 and page 25.

The following provides responses to the report recommendations:

- Recommendation 1: Direct EM to revise its protocol governing cleanup operations activities to require use of best practices in developing cost and schedule estimates.

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Management Response (EM Lead): Concur with clarification. EM is in the process of transitioning from the Operations Protocol developed in 2012 to a new EM Cleanup Directive. The EM Cleanup Directive is expected to include a "Key Decision," approving the establishment of a cost and schedule baseline. As EM develops the guidance for the development of this "Key Decision" it will include the use of cost and schedule best practices. The EM Cleanup Directive is expected to serve as an alternative approach in addressing certain scope defined in OMB Circular A-11.

Implementation Schedule: EM will finalize the EM Cleanup Directive by September 2016 and seek Departmental approval by December 2016.

- Recommendation 2: Direct EM to implement the recommendation made by DOE's Office of Project Management Oversight and Assessments in its independent review of the AOA [Analysis of Alternatives] for WIPP's new permanent ventilation system to perform a cost-benefit analysis consistent with best practices for conducting an AOA, or justify and document why the office does not intend to do so.

  Management Response (EM Lead): Concur with clarification. While the intent of Project Management Oversight and Assessments recommendations are beneficial, in accordance with GAO best practices, further cost-benefit analysis will be conducted on the project prior to approval of Critical Decision-2, *Approve Performance Baseline*. Several alternatives remain to be evaluated including size of the ventilation system and location of the exhaust shaft.

  Implementation Schedule: Complete prior to CD-2/3 approval.

- Recommendation 3: Direct DOE to revise its Order 413.3B to require that DOE offices implement any recommendations from an independent review of the extent to which an AOA followed best practices, or justify and document the rationale for not doing so.

  Management Response (Office of Project Management Lead): Concur. DOE will provide project management policy regarding how DOE offices should disposition recommendations from independent reviews.

  Implementation Schedule: DOE will prepare the project management policy by December 2016 and update DOE Order 413.3B to include the Secretarial policy at the next available opportunity.

DOE has made considerable progress towards safe recovery of the WIPP facility in response to the February 2014 fire event and unrelated radiological release. Although DOE did not meet its original schedule for restarting disposal operations at WIPP and costs to complete recovery activities have increased, we are working methodically to resume operations when it is safe to do so.

If you should have any questions please contact me, or Mark Senderling, Acting Deputy Assistant Secretary for Waste Management, at (202) 586-0370

Sincerely

Monica C. Regalbuto
Assistant Secretary
for Environmental Management

Enclosure

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Appendix VI: GAO Contact and Staff Acknowledgments

GAO Contact

David C. Trimble, (202) 512-3841 or trimbled@gao.gov.

Staff Acknowledgments

In addition to the contact named above, Daniel Feehan, Assistant Director; Cheryl Arvidson; Mark Braza; Richard P. Burkard; Jennifer Echard; Brian M. Friedman; Carly Gerbig; Jason Lee; Eli Lewine; Cynthia Norris; and Katrina Pekar-Carpenter made key contributions to this report.

Appendix VII: Accessible Data

Agency Comment Letter

Text of Appendix V: Comments from the Department of Energy

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Washington, DC 20585

July 20, 2016

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consistent with best practices for conducting an AOA, or justify and document why the office does not intend to do so.

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Sincerely

Monica C. Regalbuto

Assistant Secretary for Environmental Management

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