NOAA/NESDIS

NESDIS-HBK-1222.1

PROJECT EFFORT AND COST ESTIMATION HANDBOOK

September 27, 2019

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Approval Page

Document Number: **NESDIS-HBK-1222.1**	
Document Title Block: **NESDIS PROJECT EFFORT AND COST ESTIMATION HANDBOOK**	
Process Owner: David Spencer	**Document Release Date:** September 27, 2019

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27 Sept. '19
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9/27/2019
Date:

Document Change Record

VERSION	Description	CCR #	Revised Sections	Date
1.0	Initial Release			27 Sep 2019
	.			
	.			

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PREFACE

P. 1 PURPOSE

This handbook describes a process for a NESDIS project to estimate its total projected cost and effort, and its required budget allocation over its execution lifetime.

P. 2 APPLICABILITY

This handbook is a companion guide to the Project Management Procedural Requirements document NESDIS-PR-1210.1.

P. 3 APPLICABLE AND REFERENCE DOCUMENTS

Ref No.	Document Title	Document Description
A-1	NESDIS-PR-1220.1	NESDIS Project Formulation Process

Ref No.	Document Title	Document Description
R-1	PMBOK Guide (6th Edition)	Project Management Institute
R-2	Historical Mass, Power, Schedule & Cost Growth for NASA Instruments & Spacecraft	The Aerospace Corporation, 2016 NASA Cost Symposium presentation
R-3	NESIDS-PR-1223.1	NESDIS Project Milestones
R-4	FY'18 Accounting Code Guidance	NESDIS Chief Financial Officer
R-5	NASA Cost Estimating Handbook	NASA CEH v4.0 (February 2015)
R-6	NASA WBS Handbook	NASA/SP-2010-3404
R-7	NESDIS-HBK-1221.1	NESDIS Work Breakdown Structure
R-8	NESDIS-HBK-1224.1	NESDIS Cost and Schedule Status Tracking Handbook
R-9	NASA Systems Engineering Handbook	NASA/SP-2016-6105 Rev 2

1. Introduction

This document provides the process a proposed (new) NESDIS project should use to estimate its total projected cost and effort, and its required budget allocation over its execution lifetime, for presentation to the Milestone Decision Authority (MDA). The project will carry out the initial project effort and cost estimation exercise during the Project Formulation Phase. This will provide a project cost estimation covering the entire project lifecycle, from Key Decision Point A (KDP-A) or equivalent milestone when the project would be authorized to execute by the MDA, to the end of the project when the system is disposed of or otherwise completed.

The project must also provide the cost estimation information during the Formulation Phase to the NESDIS Office of the Chief Financial Officer (OCFO), in order to inform OCFO that the project is being considered for execution. With assistance from OCFO, the project can then track its costs incurred once authorized for execution, using metrics and financial management structures that align with the tracking and reporting carried out by OCFO. It is therefore important that the project informs and involves OCFO during the project cost estimation process to align with the cost reporting requirements.

The project will repeat the cost estimating process described in this document during the various phases of the project, and augment with actual costs and contract values as available to increase the accuracy of the estimate. The initial cost estimate is used during the Project Formulation Phase (as documented in [A-1]), during which period the project presents initial project costing and effort estimation to gain MDA approval to proceed beyond KDP-A (or equivalent milestone). Note that a specific NESDIS process document [R-3] describes the milestones during general project formulation and early estimation phases.

Cost estimation or “cost engineering” is a project management discipline in its own right, and requires specific tools, skill sets and experience to be fully effective. This document discusses three methods of cost estimation: **comparative** (or analog) cost estimation for satellite missions and related hardware, **parametric** cost estimation using established cost models and tools, and **engineering** or “effort-based” cost estimation for bottom-up cost estimates based on known labor rates and other fixed costs. This handbook does not prescribe particular models for the first two methods but does prescribe a NESDIS format for the engineering estimate.

Almost all errors on a detailed cost estimate or grass roots estimate lead to a low estimate. Errors rarely lead to a higher estimate. An excellent way to increase the confidence in an estimate is to use an alternate method like parametric estimation, or estimates by similarity, to lend credibility to the final estimate. A believable cost estimate is developed using multiple approaches, and the discrepancies reconciled and documented.

This project cost estimation process handbook draws upon [R-1], the Project Management Institute's Project Management Body of Knowledge Guide, for general project management processes. This document does not define how costs and efforts are tracked once a project is authorized to proceed beyond KDP-A. These post-KDP-A processes is documented in the Cost and Schedule Status Tracking Handbook [R-8].

This document is organized as follows. Section 2 describes the process of generating a cost estimate. Section 3 describes various models available to Project Managers (PMs) to build and validate their estimates. Section 4 discusses critical links between project budget development and NESDIS budget processes. Sections 5 and 6 provide specific guidance for using the NESDIS Cost Estimation spreadsheet. This Cost Estimation spreadsheet is maintained by NESDIS Office of System/Service Architecture and Engineering (SAE). PMs should obtain the latest version of the Cost Estimation spreadsheet from SAE before beginning the cost estimating process.

2. Cost Estimation Process Overview

The process shown in Figure 2-1 is from [R-5], the NASA Cost Estimation Handbook, and provides a generic roadmap for completing the cost estimation process. This process applies equally to NESDIS projects. PMs often choose to use an iterative approach to refine cost estimates as understanding of requirements and technical solutions evolve.

Figure 2-1 NASA Cost Estimation Process Flow

Note: not evident in Figure 2-1 is the use of multiple cost estimation approaches in parallel, and the cross-checking between those different cost estimation models. This allows cost estimates developed by different approaches to be verified, and major risk factors to be considered.

The subsections that follow explain these cost estimation steps in the NESDIS project formulation process context.

Step 1: Customer Request and Understand the Project

Every project starts with an identified need. The project will express its needs as a set of formal Level 1 requirements from an end user or customer, or a more informal “Statement of Need” that defines a problem in terms of a required data set or a required service. For example, the National Weather Service may ask NESDIS to supply data from a partner mission, develop an entirely new weather data domain, or build a new system to improve data continuity. The prospective PM presents the proposed project to the NESDIS Enterprise Architecture Committee (NEAC) so the architecture board can appropriately support the PM from an enterprise perspective.

The initial presentations to the NEAC should contain a clear statement of need for the project, accompanied by high-level requirements, to explain why the project is important to the user, what the alternatives are, and the consequences of not executing the project.

Step 2: Build or Obtain a Work Breakdown Structure

The Work Breakdown Structure (WBS) is the fundamental method of decomposing a project into discrete, hierarchical tasks, ensuring all project disciplines are covered and all tasks eventually contribute to the cost estimate. By using an initial, high-level WBS to express the scope of the project, cost items can be deduced from specific items in the WBS. For example, if the Level 2 WBS shows an instrument development task, then the cost estimate(s) should include costs for developing an instrument, any associated algorithms, and data processing infrastructure.

The NESDIS WBS Handbook [R-7] presents the NESDIS process standard for a NESDIS-centric project WBS down to Level 3. The intention is for the NESDIS WBS to apply to the wide variety of project types that NESDIS executes, from satellite acquisitions to software developments. As a Best Practice, cost estimators should consult WBSs from similar, recent NESDIS projects prior to developing the WBS and cost estimate wherever possible.

The PM develops the WBS for the proposed project to at least Level 2 during the Pre-Formulation phase. The accompanying cost estimate should align with the WBS; for example, where the WBS identifies specific engineering activities, the cost estimate would show staff executing those activities, appearing as Labor costs of the Cost Estimation spreadsheet.

Involvement of the NESDIS Office of the Chief Financial Officer

The project should consult with the OCFO during the process of creating the project's WBS. These consultations serve to ensure the WBS and Work Packages (WPs) align with current cost tracking tools and reporting processes, particularly where specific WPs are used to capture costs that must be accounted as Construction Work In Progress (CWIP). CWIP Work Packages are those whose costs contribute to a tangible asset that NESDIS must account for. For example, Operations & Maintenance (O&M) costs for a project are not creating a tangible asset, however, the development costs, the purchases of hardware and the development of software, do create a CWIP asset.

Individual WPs must not contain both CWIP and non-CWIP costs. OCFO will help PMs determine which WPs will count as CWIP, and which will not. OCFO can then provide Task (accounting) Codes for specific WPs, or groups of WPs, to differentiate costs applied to CWIP items, and those costs that do not contribute to CWIP items. The PM should use these task codes to report all costs, including labor efforts, spent by the project at Work Package level.

Projects should also consult OCFO at this stage of project planning for guidance on how OCFO wishes to present the project at Quarterly Reports. OCFO can provide recommendations on how PMs can roll up expenditure against WPs to feed into OCFO's Quarterly Reports to NESDIS Management.

OCFO can also assist with additional Department of Commerce (DOC) NOAA Finance cost reporting and execution guidance/requirements levied on NESDIS Financial Management Centers. The NESDIS Cost and Schedule Status Tracking Handbook [R-8] provides guidance for PMs on how to track cost and schedule progress during project execution.

Step 3: Define or Obtain the Project Technical Description

The technical description of the project defines the project baseline, providing guidance to the cost estimator on the hardware systems, what type of instruments might be developed, and what Commercial-Off-The-Shelf (COTS) hardware or software systems are needed by the project. Some factors will have a direct impact on the cost estimate, while others will inform the level of cost uncertainty, or suggest risks inherent in the project.

The technical description can include Key Performance Parameters (KPPs) that drive system complexity and therefore cost. The technical description may also include example external contract costs from projects with comparative technical scope, historical launch costs, and examples of equivalent Information Technology (IT) infrastructure costs. The Technology Readiness Level (TRL) of any hardware systems involved can also be included in the technical description as well as the TRL of any comparable systems used to provide relevant cost comparisons. A standard definition for TRLs can be found in the NASA Systems Engineering Handbook [R-9].

The technical description can include additional factors such as the mission or project lifecycle, the operational requirements, organizational responsibilities, technical and programmatic interfaces, and if a driving factor, the project timeline. List and incorporate any factors or assumptions driving project scope into the technical description.

The cost estimator should present clear extrapolation from the project technical description to cost estimates based on comparative projects, where this information provides the Basis of Estimates (BoEs) for the costs. For example, a NESDIS project requiring an active Light Detection and Ranging (LiDAR) instrument can provide a detailed technical description of the proposed instrument. Extrapolations can be made from the description of the proposed instrument by comparison to previous examples that have been built and flown, and these extrapolations can be used to inform the cost of a new instrument (for example, an instrument requiring twice the resolution of an older model might cost four times as much, based on previous history of equivalent technologies).

The BoE for costs must clearly state all assumptions and comparisons based on the project definition, the WBS, and the project technical description. While neither this Handbook nor [A-1] prescribe the format or contents of the project's technical description, the project should include the following contents at a minimum:

- Level 0 and Level 1 Requirements;
- Statement of Need;
- Project scope description, i.e. what defines and drives the scope (cost/schedule/programmatic and technical baseline) of the project;
- Major risk factors, issues and assumptions used in producing the cost estimate;
- Comparison to other NESDIS, NOAA, NASA or international projects/systems;
- List of NESDIS organizational elements participating in the project, and the roles they will play (should be captured in the Level 1 Requirements);
- Key elements of hardware, software or systems that must be developed;
- Key external procurements and/or services contracts;
- TRL of comparable systems within and outside NESDIS;
- Overview of staffing profile, including core project team and supporting NESDIS and external team members;
- Numbers and roles of Contractor staff foreseen;
- Involvement of national and international partners;
- Estimates of commercial vendors involved and expected contract prices, using comparable contract examples if available.

Step 4: Develop Ground Rules and Assumptions

At the pre-KDP-A stage of cost estimation and discussions with the NEAC, the project should describe the assumptions and rules that underpin the project in the context of the preliminary project definition.

Step 5: Select Cost Estimation Methodologies

Section **Error! Reference source not found.** describes three cost estimation methodologies. The Engineering estimate method is typically used during the Pre-Formulation Phase; in this methodology, internal project costs are primarily driven by labor profile, and other costs are expressed as lump sums.

The other two methods are more valid where high-quality databases of previous mission costs exist. Either or both of the parametric and comparative estimation methods can be applied at the discretion of the PM. The project should explain the rationale for using either comparative or parametric method, for example if the method and the models have been used before within NESDIS, NOAA or NASA, and how accurate the estimates were shown to be in hindsight.

Cost estimators are advised to develop estimates using at least two different methodologies, in order to have independent cost comparisons to take forward into the final cost estimation phase. This allows the project to develop and reconcile discrepancies between the cost models.

Step 6: Select/Build Cost/Model Tools

The project should populate the engineering estimate following the guidelines in this document and the NESDIS Cost Estimation spreadsheet. For the comparative and parametric models, there will be steps to follow to set up the tools depending on their construction, and the cost estimator should document all inputs to these tools and the cost results. The project should structure the lower levels of the cost estimate, for all models used, to align to the project WBS, so that the cost can be managed as the project is implemented, and the cost actuals used to provide detailed data as an input to cost estimation of future projects.

Step 7: Gather and Normalize Data

The project cost estimator will gather all data points used as inputs to the chosen estimation method. Some sections of the Cost Estimation spreadsheet allow BoE description for cost estimates; others like the Labor Cost tab use the estimator's best prediction of Full Time Equivalent (FTE) Level of Effort (LoE). All estimations should be accompanied by a write-up of the team profile with each phase (for example, "The Project Manager will be full time throughout all project phases, but the Project Budget Analyst will be shared between projects and dedicate 1 day per week to this project.")

Normalizing data includes updating labor rates and other prices to reflect the current Fiscal Year and updating comparative or parametric cost models with new data from more recent missions or other similar projects.

Step 8: Develop the Cost Estimates

Beyond plugging in a forecasted project baseline into a tool or set of cost models, the "develop" aspect of cost estimation requires the PM to confer with colleagues who have recent experience with similar projects and missions, and also examine other recent cost estimates for similar projects within NESDIS or NASA as available. In the NESDIS context, the PM must ensure that the cost estimate considers all potential team member roles and engineering/management WPs, so requires extensive consultation with all NESDIS organizational elements who will be supporting the project. What staff are NESDIS partners (and external partners, where applicable) able to commit, at what FTE levels and labor rates? What costs for hardware/software/facilities/services will partners incur and charge to the project?

At this point, the benefits of having multiple cost estimates using different methodologies can help the cost estimator consider a range of factors contributing to overall cost. Some models may provide better cost estimates in certain areas than others.

At the Pre-Formulation phase, the project total cost estimates should be agnostic to how long the project will actually take to execute. The total cost for end-to-end project completion should stay the same regardless of whether the project is spread out over 5 years or 10 years to completion (the total work scope should be the same, unless "marching army" costs are considered). Post-KDP-A planning will consider how the project fits within the annual NESDIS budget allocation, what resources are available to execute the project over time, and what time-dependent elements exist.

The cost estimates produced at the Pre-Formulation Phase will only be a Rough Order of Magnitude (ROM) cost, sufficient for the MDA to approve or disapprove continuing the proposed project. Further factors can be considered, and greater accuracy added, as the project continues through successive cost modelling and refinement exercises in subsequent phases.

Step 9: Develop and Incorporate the Cost Risk Assessment

The cost risk is also the margin or Management Reserve (MR) applied to the total project budget. There may be different levels of risk applied to different areas of the project, or one overall figure for the whole project. The total reserve budget should be summed and described to the NEAC. Some projects might choose to calculate a top-level MR after all project costs have been summed. Other projects may decide to allocate specific levels of MR to specific cost items or domains in the project cost items, and sum these to form the total project reserve. The NESDIS Cost Estimation spreadsheet allows the cost estimator to apply MR at the project level, and/or to pick specific areas of costing to apply specific MR values.

Ensure that all cost areas have at least a minimum level of MR applied to them. No cost domain is without cost risk; even travel costs can come in above initial estimates. At KDP-A, a project-level MR of at least 20% should be applied to the total project cost.

To support the case where different amounts of MR should be allocated to different domains, the NESDIS Cost Estimation spreadsheet provides a dedicated Management Reserve tab. This tab allows the cost estimator to pull in any costs calculated in other tabs, for example the LaborCost tab, and apply a percentage MR to the cost. The calculated MR would then be added onto the ROLLUP sheet, and contribute to the total project cost with MR incorporated.

For example, if an instrument development element of the project requires a total MR of 30% per guidelines but the base MR is 20%, then a domain-specific MR of 10% (project MR + instrument MR = 30%) can be applied to the instrument-specific WPs. Other project areas could have no specific MR, if the project-level MR is sufficient.

Steps 10& 11: Document and Present the Project Cost Results

At this stage, the PM will write an analysis of the cost methods used, the BoE's input to the estimates, and the risks and assumptions accounted for in developing the estimate. The PM will present the analysis to the NEAC to validate assumptions and identify any discrepancies or opportunities with other Enterprise activities. This Handbook prescribes the format for the Engineering Cost Estimate spreadsheet, but does not mandate documentation or presentation formats beyond that.

Step 12: Update the Cost Estimate

With input from the NEAC, the MDA will request a refinement of the cost estimate if, in their opinion, there is additional information that can be incorporated into the cost estimate, any of the data used in the estimate is inaccurate, or an area of the estimate needs further work. The PM should use the experience available in the NEAC, and the ability of the NEAC to enlist additional assistance from their respective organizational elements, to maximize the accuracy of the cost estimate.

3. Cost Estimation Methodologies

There are three main methods of preliminary cost estimation defined in the NASA Cost Estimation Handbook [R-5]:

- Comparative;
- Parametric;
- Engineering.

During the initial (pre-KDP A) estimation phases, a Rough Order of Magnitude (ROM) cost estimate is the best accuracy that can be expected with the information available, yielding estimates with a certainty of ±30% at the early stages of project scope definition, whichever cost estimation method is chosen. If appropriate, more than one estimation method can be used for cross-checking.

The Engineering Cost method is the standard for NESDIS PMs. Beyond the Engineering method, PMs should use a combination of cost estimation methods, choosing whichever method(s) best suit the type of project, and which have known and verifiable heritage. If a second or third cost method is also presented, it will serve as a useful comparison to the bottom-up Engineering Cost method.

3.1. Engineering Cost Estimation

NESDIS requires all projects to present an Engineering Cost Model at KDP-A, regardless of which other cost models are used for the initial estimate. Furthermore, the Engineering Cost Model must be maintained accurately over the lifetime of the project (for example, labor actuals and contract award amounts can be entered as a historical record) and re-presented at any re-baselining of the project.

This is also referred to as “bottom-up” estimating, and is a technique commonly used by commercial industry when estimating the cost of projects, whether software or space mission development, and their effects on staffing and other resource levels. This method also appears in the NASA Cost Estimation Handbook [R-5].

The engineering build-up methodology involves computing individual labor effort estimates for each and every discrete task in the WBS – and so requires a WBS to Level 2 at least. Identifying the Level 2 WBS elements allows the labor resources needed to accomplish a task to be defined. Labor efforts represent a significant portion of a project’s total cost, so this cost methodology exposes the main cost driver and project staffing profile.

As per commercial industry practice, labor effort requirements are estimated separately from materials and services requirements, and both types of cost should be evident in the WPs. For example, a hardware procurement WP would incorporate the labor effort involved in managing the hardware procurement and testing it once it is delivered; the WP will also include the cost of the hardware from the vendor, and the cost of any facilities needed at the Customer site to take delivery of the hardware and test it in a suitable environment.

The Engineering method allows FTE labor levels to be estimated on a monthly basis, and costed for different roles (for example, a Project Manager will have a higher per-FTE labor cost than an Entry-level Technician). This method also enables direct input and subsequent adjustment of known, discrete costs; for example, the predicted award value of a commercial contract can be entered into the cost model, and later updated with the actual award amount.

One of the benefits of this bottom-up method is that it helps with project staffing and phasing, as it identifies key phases in the project, and assigns the appropriate staffing levels to cover the effort associated with those particular events. This method also allows direct estimation of project overheads associated with staffing numbers, and the fact that different staff skill sets – both Federal and contract staff – have different cost rates. There are also mandatory project cost overheads that require the equivalent number of FTE staff working on the project to be known.

This is one of the only cost estimating methodologies that can be used and improved in later phases of the project, as more cost assumptions are clarified, and staffing profiles reach more steady levels.

3.2. Comparative Cost Estimation

The comparative method develops a project cost estimate by using the costs of an original well-documented, as-executed project that was very similar in size, scope and risk to the project being estimated. The design and requirements of the comparable system must be similar enough to be a valid comparison, and the differences in new technologies, scope and price inflation accounted for. The costs for comparable projects must be the certified "as-executed" costs after project completion, not the initial cost estimate.

A "rebuild to print" of a previous satellite system, instrument or other hardware may not cost the same 5 years later, even when adjusted for inflation. New technologies, components or processes may have replaced the original system in the time since its initial build, or parts and expertise may no longer be available.

The disadvantage of using comparative methods is that the cost estimates of the original system may have been overly optimistic, with the actual cost of individual subsystems difficult to obtain from studying subsequent cost increases over the lifetime of the project. If there is only one analogous system, the original system may not have been representative of what a rebuild would cost, as "one-off" system costs would not reflect some cost savings from multiple builds of the same system.

Comparative costs provide ROM cost guidance only but should not be used as the sole source of the final cost estimate. The accuracy of the comparative estimate reduces as the scope of the system or service deviates from the original system being used as the comparison.

3.3. Parametric Cost Estimation

Certain projects are well suited to the use of product parameters and historical data to estimate cost, where the parameters of a product's design or function (such as hardware-related or software-related parameters) are compared to historical systems with well-documented costs. These parametric cost models establish an empirical relationship between the system design parameters and resulting project cost and schedule.

Parametric cost estimation refers to cost estimate models whereby the cost estimator can input specific physical, technical or logistical parameters associated with a project, particularly defining the end product(s) and services the project will produce into pre-established cost models. These pre-established models use a historical database of relevant projects and their costs, with weightings given to the effect certain modeled attributes had on the eventual overall cost. Both hardware and software-based parametric estimates have proven to be good at producing viable estimates. When the hardware or software is similar (in family) to several previous projects used to develop the parametric model, the parametric estimate can be very accurate.

3.3.1 Parametric Cost Estimation for Satellite Missions

Of all NESDIS projects, parametric cost estimation is most relevant to satellite missions. Partner agencies such as NASA have established historical databases of satellite missions and their total end-to-end mission costs (both predicted and historical), as well as cost metrics for individual subsystems such as instruments.

When a NESDIS project includes satellite flight hardware and ground segments, parametric cost estimation provides access to historical cost actuals and their relationship to the design parameters. The method uses empirical data collected from many executed space missions to define relationships between satellite and instrument design parameters, and their eventual cost from KDP-A to mission disposal. For example, the power budget for a satellite partly defines its size, and size drives complexity, launch costs, operations complexity and so on.

NASA tools allow a cost estimator to enter a wide array of ROM design parameters for a new satellite system, and have a validated tool produce a range of costs based on the uncertainty in these estimates and the level of risk involved in the new project. Parametric estimation assumes that the same cost factors that drove the previous mission design and cost, will also drive the present mission. The advantage of parametric estimation is that if there are tens or hundreds of comparable data points from comparable system designs, the outliers will be smoothed out, and a good ROM estimate will result. Most parametric models are specialized; there are models for small satellites, models for astronomical observatories, and models for Earth Observation satellites, as each domain is driven by particular technical requirements.

3.3.2 Parametric Cost Estimation for Software

Cost estimation tools also exist that can take the input of software project scope to estimate total lifecycle cost. There are models tuned to the traditional waterfall software development cycle using simple metrics such as thousand Source Lines Of Code (SLOCs), and there are cost estimation models for more recent software development paradigms such as iterative methodologies.

Models such as COCOMO and its successors originated in cost estimation for the aerospace industry. The parametric inputs are qualitative factors such as required software reliability, hardware memory constraints, capability levels of the software developers, and attributes of the overall project.

Whichever software parametric cost estimation model is chosen, the KDP-A package must describe why that particular cost estimation model was chosen, how the projected attributes of the planned software development project have mapped to the inputs of the parametric model, and which type of comparative software projects the parametric model uses.

3.3.3. Cost Estimation in Iterative Development Environments

Projects using the iterative development paradigm are typically software-product focused, with multiple, short-duration release lifecycles and a high degree of scope uncertainty during the initial iterations of the development lifecycle. This makes iterative development projects harder to estimate from a cost and schedule perspective, as it can be unclear how many iterations will be required before the product reaches a release state, and even what constitutes the "final" output of the iterative development process. The requirement for a start-to-finish project cost estimate is not waived, however.

In order to pass KDP-A, iterative development projects should define a planned commitment to a baseline functionality, through documentation of "Business Epics" and "Architecture Epics". Business Epics define the high-level features and objectives of the product being developed, and the non-functional requirements (constraints on the product). Architecture Epics describe the technologies and tools used to drive the solution.

As part of the Basis of Estimate document, iterative software projects will develop an initial Capabilities and Constraints (CAC) document to capture the system capabilities from the User perspective, containing iterative artifacts such as User Stories, Use Case Analyses, and Product Vision and Product Release Roadmap, describing how the backlog of product features would be implemented. This document will be presented to the MDA during the Project Formulation Phase and updated as necessary throughout the iterative release cycles of the project. The MDA may request successive updates of the documentation set during project execution, in lieu of the milestone reviews typical of other lifecycle models.

For KDP-A, the iterative development project should present a baseline product release schedule and a labor profile in the engineering cost estimate.

Cost estimating of iterative software development projects using parametric models should identify the cost model used for creating the estimation. When using the Engineering Build-Up methodology described later in this document for cost estimation, projects should focus on the "average" staffing levels supporting the iterative project. Even when accounting for 'surge' periods in the development lifecycle, the cost estimator should be able to predict an average level of FTE personnel over the project development and product release period, and should clearly state assumptions regarding the end-to-end schedule that led to the total cost estimate.

The cost margin allocated to an iterative project should reflect the level of risk in cost and schedule, and any heritage of the iterative development. Higher cost margins are expected for iterative projects, when compared to traditional sequential project lifecycles with well-defined baselines and clear roadmaps to a finished system.

4. NESDIS Financial Reporting Considerations

This section provides guidance from the NESDIS OCFO for consideration during the cost planning and execution phases of the project. Prospective projects must understand their cost reporting obligations and incorporate these into their planning process during the formulation phase. It is vital to the successful execution of every project that the PM consults with OCFO before the project is authorized to execute, so that the appropriate financial reporting mechanisms can be put into place.

Project planning and management provides an opportunity to connect the technical aspects of the project to NESDIS OCFO strategic management, budget formulation, performance planning, execution, monitoring and the financial statement reporting requirements.

NESDIS OCFO manages the NESDIS strategic management and budget formulation processes resulting in future year appropriations as well as the budget execution, monitoring and financial reporting processes. OCFO monitors the utilization of resources, advises on resource alternatives and identifies the management impact of resource allocation among the NESDIS Financial Management Centers (FMCs). In addition, OCFO issues guidance for budget execution and ensures that DOC NOAA Finance guidance is implemented throughout FMCs.

4.1. NESDIS Portfolio Management

The NESDIS portfolio management process provides corporate decision-making fora and consists of four phases that comport with applicable laws and policies for the management of federal agencies: strategic management, budget formulation, annual planning, and execution and evaluation.

Within the portfolio management framework, the Integration Council is responsible for effective horizontal and vertical integration of development activities and provision of operational products and services. It is responsible for management of resources, identifying funding for new requirements, and ensuring performance aligns to strategic goals.

4.2. Strategic Management

In late spring/early summer, NESDIS OCFO works with SAE to initiate the strategic management process for the FY+3 budget year. OCFO examines funding requests to ensure the project or program request is mature and works with each program to strengthen written justifications, and refine outyear costs. Together, OCFO and the portfolio managers ensure that the requests sent forward to the NOAA Strategic Planning process will allow NESDIS to meet the goals established in the NESDIS Strategic Implementation Plan.

4.3. Budget Formulation

Project cost estimates developed after the KDP-A Planning phase should feed into the budget formulation cycle to ensure the funding and outyear budget profile is consistent with program planning estimates.

In order to clearly understand and defend project costs estimates during the budget formulation process, it is important that a WBS is used to develop and track project costs, and that the WBS is documented and is compatible with the NESDIS common WBS format.

NESDIS OCFO includes strategic and funding requirements in the budget and works with the NOAA Budget Office and the DOC to develop the annual President's budget request.

4.4. Annual Performance Planning

After the release of the President's Budget in February, OCFO releases fiscal guidance to each FMC to begin drafting Office-Level Annual Operating Plans, including the milestones and obligation plan by quarter, for the upcoming FY. These plans identify the priorities for each FMC and are discussed in detail at the Spring Planning Meeting, typically in May of each year. The plan contents are refined over the summer, and are approved by NESDIS Leadership before the FY begins. Further refinements to obligation & cost plans and milestones are made, if necessary, when the final appropriation is released.

4.5. Budget Execution and Cost Tracking

Projects that receive funding are required to develop a monthly obligation plan to reflect the timing of the obligation. Obligation plans are developed at the fund code, project code, and object class code level of detail. All obligation plans are submitted in the NOAA financial systems, including the Commerce Business System (CBS) and Management Analysis Report System (MARS).

Projects are required to develop a monthly cost plan to reflect the timing of when expenses will be costed. Project cost plans help manage undelivered orders (UDOs or unliquidated obligations.) Cost plans are developed at the fund code and project code levels.

The Data Analysis and Systems Integration Branch (DASIB) of NESDIS OCFO executes annual data calls to all NESDIS FMC's and provides guidance on the completion of obligation and cost plans including templates and formats.

Throughout the fiscal year the NESDIS FMC's participate in Quarterly Program Reviews (QPR). The QPR provides an assessment on the program budget execution against the obligation and cost plans, and identifies opportunities for NESDIS leadership to allocate resources as needed.

Guidance on processes for tracking budget execution can be found in NESDIS Cost and Schedule Status Tracking Handbook [R-8].

4.6. Identifying and Reporting Construction Work In Progress and Internal Use Software in Development

CWIP and Internal Use Software in Development (IUSD) cost information is collected by NESDIS OCFO, for inclusion in the DOC financial statements.

CWIP/IUSD are temporary holding accounts used to accumulate costs during the design and construction / development of Property, Plant, and Equipment (PP&E) and Internal Use Software (IUS) that will eventually be placed in service and depreciated in DOC financial statements. The costs remain in the CWIP/IUSD account until PP&E / IUS is ready for its intended use and accepted by NESDIS. In addition to the acquisition costs of PP&E/IUS, certain costs associated with preparing the PP&E/IUS for service must be capitalized and therefore need to be recorded in the CWIP/IUSD account.

Three major groups of assets are generally capitalized and may require the use of the CWIP/IUSD process:

- Real Property – the construction or significant improvement of a facility;
- Personal Property – the acquisition, development, construction or installation of equipment or asset which is not real property, or the significant improvement or modification to the original; and
- Internal Use Software – the acquisition, development or modification to software that will be used internally.

In order to be considered a new CWIP/IUSD asset, a construction / development project must meet all of the following four criteria for capitalization:

- Have an aggregate acquisition cost of $200,000 or more, and
- Have an estimated service life of two years or more, and
- Provide a long-term future economic benefit to the NOAA organization which maintains or obtains control, and
- Is not intended for sale in the ordinary course of operations.

Additions, alterations, betterments, rehabilitations, leasehold improvements, replacements or upgrades that meet the above criteria and extend the useful life of the asset by two years or more should be treated as a CWIP/IUSD activity.

CWIP/IUSD should be accounted for in accordance with the NOAA CWIP Policy found on the NOAA CWIP website (http://www.corporateservices.noaa.gov/~finance/CWIP.html). The NOAA CWIP website includes key information, including the CWIP Policy, checklists, fact sheets, forms and templates. Questions regarding the process should be directed to CWIP.Notification@noaa.gov, nesdis.fab@noaa.gov, and the NESDIS Finance and Accountability Branch (FAB) CWIP Program Manager.

Note that since website and email addresses may change over the lifetime of this document, please check with the OCFO for the latest source and guidance related to CWIP/IUSD information. OCFO can also provide guidance when setting up the project's WBS and task codes. This ensures that the project properly and separately estimates, accounts, and tracks CWIP/IUSD-category costs during a project's execution. The optimal time to contact OCFO for CWIP/IUSD guidance is during the Project Formulation Phase. See also the NESDIS WBS Handbook [R-7] for guidance.

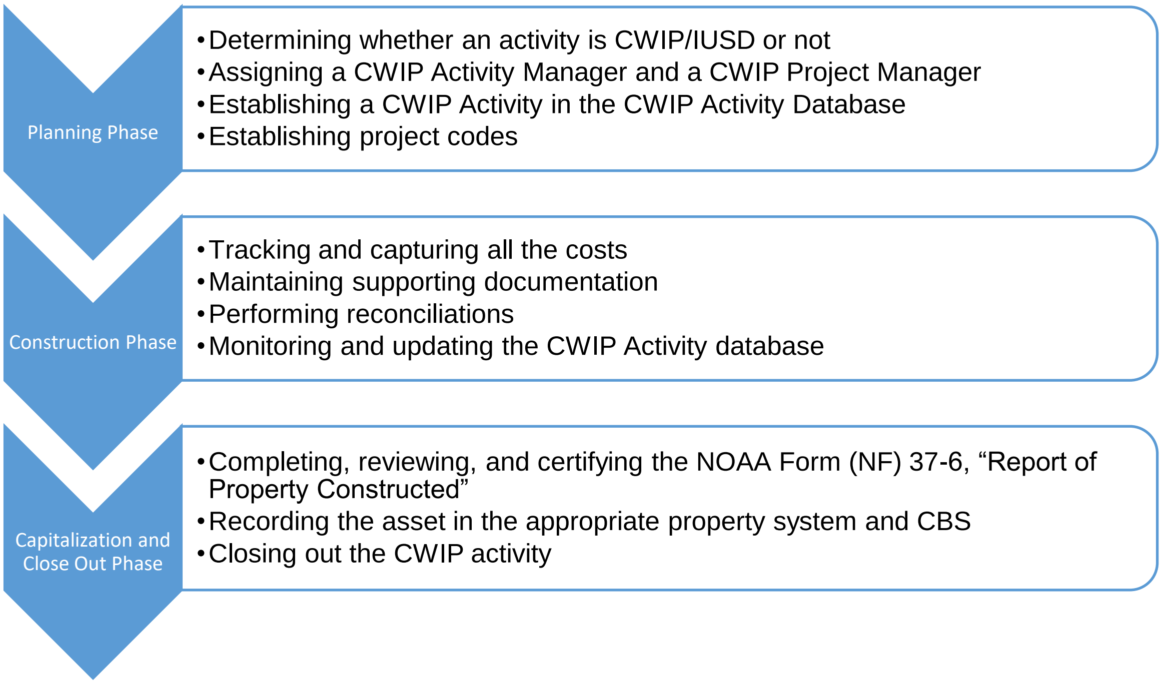

Figure 4-1 Overview of the CWIP Process

5. NESDIS Engineering Build-Up Cost Estimation Template

All prospective new NESDIS projects should use the NESDIS Cost Estimation spreadsheet. This costing spreadsheet will be filled out the first time a project's cost and effort is estimated during the Project Pre-Formulation phase. Early in the Pre-Formulation Phase, the estimation exercise will provide an initial total cost estimate based on the project tasks, team composition and work scope as defined at that early stage in project formulation. The cost estimate will include a margin appropriate to the level of risk and uncertainty inherent in the project. The cost estimate from the Engineering Build-Up method can be compared to that produced by other methods, though they do not have to match. Significant differences in the cost estimates produced by different methods and/or tools should be investigated and reconciled.

The NESDIS Cost Estimation spreadsheet was created by consulting a variety of internal NESDIS and non-NESDIS sources. The spreadsheet – both the WBS structure and the cost items – is structured to prompt the PM to consider how the project is constructed from the bottom-up, and how labor, materials and other resources are deployed in the day-to-day execution of the project. It also aligns with OCFO reporting needs and the involvement of partner agencies.

The project cost estimation spreadsheet(s) should cover the entire project or program duration. Multi-year, high-cost projects, or high-value programs made up of distinct sub-projects, can be presented as a related set of individual cost spreadsheets. Where a cost spreadsheet tab covers only one Fiscal Year, duplicate tabs can be used for each Fiscal Year with their costs added to the overall program/project total.

The initial cost estimate and margins provided at KDP-A should be revisited in later project phases, as the completed work progress better informs the estimates for future work. The original cost estimation can also be revisited if the project requirements, baseline, or costs-to-complete change, or other conditions change which make the original baseline invalid.

The final, approved version of the NESDIS Cost Estimation spreadsheet presented at KDP-A is not intended for tracking project execution after Milestone Decision Authority approval of the project. The processes for cost tracking and reporting are described in a separate document, the NESDIS Cost and Schedule Status Tracking Handbook [R-8].

The discussion that follows describes the structure of the NESDIS Cost Estimation spreadsheet and explains how to use the sheets.

5.1. Project Cost Margins

The NESDIS Project Cost Estimation spreadsheet includes an entry in the Rollup sheet where the top-level project cost margin (referred to as Management Reserve, or MR, in this document) can be specified as a percentage of overall project cost. The project-level MR is a percentage of the total project cost added as a contingency fund, reflecting the level of risk carried by the whole project at any particular phase.

Some WBS or costing elements might have different levels of MR. For example: the Project Management WP1 effort is seen as less risk of scope creep, so only has a 15% margin, but a higher-risk spacecraft acquisition cost has a higher margin at 30%). In these situations, the individual MRs can be calculated, then added together to form the total project MR. NASA cost estimation guidelines [R-5] recommend a top-level MR of around 30% of the total mission cost. Figures collected from recent NASA missions at the start of Phase B [R-2] provide actual cost growth over initial estimations. These were found to be up to 70% for instruments (due to a high-risk, new technology development), and up to 50% for the spacecraft platform (somewhat lower risk when common platforms and technologies are re-used).

The NESDIS PM or cost estimator will decide the appropriate MR for the project, accounting for the TRL of the components, the amount of new technology development required, and current uncertainties in the mission or project baseline. The PM or estimator must document the basis, ground rules and assumptions that justify the selected MR.

The level of MR can decrease as future re-baselining exercises are used to obtain more precise cost estimates, and firm prices are obtained as vendor contracts are put into place.

Higher initial MR must be used if the proposed project is considered “high-risk,” or carries a large degree of uncertainty in its cost/effort inputs. New software developments following iterative methodologies, where the baseline develops with successive iterations and product releases, would fall into this category due to inevitable changes and evolution during the iterative development cycles.

Lower MR can be used for software development projects which have a high level of software module re-use, and/or are based upon existing software and algorithms, and satellite projects that are evolutions of previous missions that had well-understood costs and risks.

Table 5-1 provides a suggestion of cost margins (management reserve) at the project formulation phase for different categories of project.

Table 5-1 Suggested Project MR at Pre-Formulation Phase, by Project type

Type of Project	Suggested MR
New/high-risk/low-TRL technology development (conceptual flight hardware, new data or science domain, new software processes), potentially involving many external partners	35%
Upgrade of an existing, large/complex or multi-partner software or hardware system	30%
Upgrade/rebuild of small, existing systems (flight systems, in-use software)	20%
Iterative ground software development based on well-defined initial scope/existing system	25%
Iterative ground software development for a new or poorly-defined system	35%
High-impact satellite acquisition involving many internal and/or external/international partners, requiring a large degree of co-ordination and inter-dependencies	30%
Project performed largely internally, with few external dependencies	20%
Operations of an existing system	10%
Sustainment of an existing system	15%

The PM may decide to assign MR to individual project cost elements; for example, one value for System Engineering WP and another value for Contracts and Travel etc.

Table 5-2 provides some general guidelines on MR levels for different cost areas within a project.

Table 5-2 Suggested Project MR at Pre-Formulation Phase, by Project Domain

Project Domain	Suggested MR
Cost-plus external contracts/acquisitions	35%
Re-use of Enterprise Ground Systems	20%
Operations and Sustainment	15%
Instrument or Satellite Procurement	35%
Algorithm Development	25%

5.2. Cost Spreadsheet Organization

Multi-year projects will need a separate labor costing tab for each fiscal year, as personnel Level of Effort (in FTE) can change from month to month, depending on the particular project phase, milestones, deliveries, and tasks in that month.

The Project Summary template totals projected cost on a per-fiscal year basis, to align with Federal budget cycles. Work Packages and other tasks involving labor must be split at fiscal year boundaries, so a WP category can assign different labor costs in different fiscal years; for example, “WP 1.1 Project Manager” can have different labor rates in FY18 compared to FY19.

6. Navigating and Using the Cost Estimation Spreadsheet

The order of information in this section matches the order of appearance of the tabs in the spreadsheet, from left to right. This section also provides examples from a sample spreadsheet.

6.1. The INTRO tab

This tab allows the PM to provide critical project information and has the rollup cost of the project presented in units of $1,000,000. The values for the total project price [millions of dollars] and margin are pulled from the ROLLUP tab.

NESDIS PROJECT COST VERSION xxx DATED yyyy PREPARED BY:

Project Name:

Main project deliverable:

Primary Executing Office:
Primary Accounting Codes per Fiscal Year

Project Manager:

Project Price per this Costing ($M)
$15.00
which includes a margin of 50%

Project Approval granted: [date]

Project Termination: [expected date]

This project costing spreadsheet spans fiscal years: (FY'18 and FY'19)

NOTES:

This NESDIS sample WBS and Costing template was prepared from available information at time of writing.

This spreadsheet is meant as a template, to be modified or expanded to suit each project.
WBS contents is not presriptive. Adapt to suit the individual project. Remove unused WP.

It is recommended to have separate costing spreadsheets for individual, large sub-projects within an overall Program. For example, a Ground Segment project within a Flight program should have it's own spreadsheet.

The spreadsheet can cover an entire project duration. Labor for each Fiscal Year has its own spreadseeht as daily labor rates change between Fiscal Years

Government and Contractor Rate numbers are placeholders only.
Make sure to input daily labor rates as correct at time of project costing.
WBS structure can be adapted for any type of project, whether flight project, Research & Development project, software development, hardware purchases, service contracts etc.

PAC / ORF / CWIP funds line items should be distinguished by accounting charge code.
Each individual cost item and code must be ONLY ONE of PAC/ORF/CWIP.
Ensure no cost items are double-counted.

Please inform OSAAP of any issues with the spreadsheet or suggestions for improvements.

Figure 6-1 Project INTRO tab in NESDIS Cost Estimation spreadsheet

6.2. The ROLLUP tab

The ROLLUP tab captures all the cost items on the other tabs in the spreadsheet. It includes space to record accounting codes for multiple fiscal years and can be extended as needed. The ROLLUP tab is a mandatory intermediate step before passing costed items to the “Program WBS” tab.

The ROLLUP tab uses rolled-up costs to calculate the IT Security surcharge, the NOAA Hollings tax, and the NESDIS tax. The margin level is also specified here, and is applied on top of all costs and the IT Security surcharge; the total margin amount is added to the Reserve line in the Program WBS tab.

If the surcharges and taxes listed above do not apply to a particular project funding type, they can be removed from the ROLLUP tab, and replaced with other surcharges as appropriate. Any project-level surcharges, such as the Acquisitions and Grants Office (AGO) contract tax or NESDIS Satellite Applications and Research (STAR) tax, should be explained on the ROLLUP tab. Where surcharges or markups apply to a particular WP, the taxes should be applied at WP level.

Be cautious when editing any fields on the ROLLUP tab, as many items are calculated by formulas, are dependent on information in other tabs, or are used in other calculations.

NESDIS Project Cost Summary				**Basis of Estimate**
		Cost FY'18	**Cost FY'19**	
Federal Employee Labor Cost		$3,259,450.00		From LABOR sheets
Contractor Labor		$821,850.00		
Contracts and Grants			$3,759,500.00	From CONTRACTS sheet; goes to NASA Spacecraft
Travel Costs			$6,475.00	From TRAVEL spreadsheet; rolls up to OVERHEADS in Program WBS
Project Overheads		$86,650.00		From OtherDirectCosts sheet
TOTAL:		**$4,167,950.00**	**$3,765,975.00**	calculated: both FY'18 and FY'19
IT Security @ Rate:	30%	$1,250,385.00	$1,129,792.50	30% for development, 10% for Ops & Maint phase; calculated on total Project Cost. OtherDirectCost
Margin / Reserve @ rate:	50%	$2,083,975.00	$1,882,987.50	NESDIS to set minimum level of reserve funds. Reserve amounts set depending Tech Readiness Level and project type. Calculated on total project cost, added
NOAA Hollings Tax	0.01%	$750.23	$677.88	Applies to everything but NESDIS tax. Added to OtherDirectCosts in Program
NESDIS Tax	5%	$375,115.50	$338,937.75	Apply to everything but Hollings Tax. Added to OtherDirectCosts
TOTAL PROJECT PRICE (all FY)		**$14,996,546.36**		

Figure 6-2 Project ROLLUP tab in NESDIS Cost Estimation spreadsheet

6.3. The FY'18 Labor Cost tab

This sheet presents a convenient method for capturing labor costs on the basis of FTE effort in days per month. Instead of the cost estimator trying to calculate how many days a project activity will take, and the blended daily rate of personnel working on that activity, the labor effort is more easily be expressed in FTE-per-month terms.

Monthly FTE estimation allows a realistic appraisal of when the labor effort is being spent and ensures that the surges and ebbs in project workload can be captured. Most NESDIS staff will multi-task on their projects, supporting several projects at once, and there will be periods when certain roles are not needed.

External personnel from outside the project, brought in to support specific reviews or activities, can also be represented in the LaborCost tab, using the highest labor rate for the cost estimate.

The labor effort each month should be aligned with the predicted timings of major project phases and events. The “Key Activities” row captures when specific project events will occur, for example, “PDR” to denote a Preliminary Design Review occurring in a specific month. This helps estimate the FTE profile over the months and can help later re-baselining (re-estimating) the project costs as activities slip in time, as the workload can shift to re-align with the activity.

A full work month of one person’s equivalent labor is represented in each column as 1.0 FTE for that month, remembering that Statutory Holidays, vacation and sick time are counted towards work-days. These charges are reflected in the “Government FTE Benefits” which is calculated as a portion of the total labor cost. Each specific role must have a Pay Band assigned. If two persons are filling the same role but at two different Federal pay bands, then two labor lines are required.

Annual labor rates in the spreadsheets are taken from the current Office of Personnel Management (OPM) rates for Federal pay bands and can be replaced with actual rates as changes are made to Federal employee pay. Contractor positions might be assigned as a lump sum elsewhere, but if a contractor is tracking effort across multiple WP or multiple projects, a calculated daily cost rate might be more appropriate.

Civil Servant benefits (currently 30% of labor costs) and annual training costs (currently $2K per annum per FTE) are also accounted for in the overall cost estimation. The cost of total benefits is carried forward to a dedicated entry in the Program WBS tab of the spreadsheet.

The Cost Estimation spreadsheet includes several basic assumptions; if the program or project needs to amend these fundamental assumptions, additional cost entries would need to be added. The basic assumptions are as follows:

- One FTE day equals 8 hours of effort;
- One work week equals 5 days;
- Overtime cannot be pre-planned in a project’s budget, but if needed during execution, would typically be drawn from Management Reserve.

The “Labor Rate per Day” entry for each category of project team member must include all associated salary overheads, such as Annual Leave, Statutory Holidays and other Federal or Contractor employee benefits. This ensures that when multiplied by the FTE labor days, the resulting cost includes all considerations. The “Government FTE Benefits” such as Annual Leave, pensions and other considerations are calculated and costed as a fixed percentage of the total labor cost, which is then added together to form the total cost of each Federal Employee labor allocation. Similarly, a fixed dollar value is assigned to the roll-up of all Federal FTE expenditure, to reflect personnel training overheads. All such fixed rate amounts must be confirmed with the OCFO staff before submitting any final cost estimations, as rates can vary between fiscal years.

While it is understood that Federal labor costs are paid from each NESDIS Office’s base funding, the calculation of the Federal labor costs can be used to cross-check the allocation of base funding to projects, ensuring there are sufficient base funds to cover all labor required of Federal employees, remembering not all Federal labor is devoted to projects. Labor rates for Contractor personnel are assumed to incorporate all additional benefits and overheads, and therefore reflect the total rate at which the Government is charged per day of contractor labor. Note that different Contractors will have different FTE rates, so can be entered individually into the Labor sheet as illustrated in Figure 6-4.

All project budget projections are to be considered as NOAA-proprietary sensitive information, and therefore must not be shared beyond Federal project management and NESDIS financial/contract management staff.

FY 2018 Labor: Personnel Roles and Monthly FTE Effort

Dollars

Date: Full Time Equiv. FTE 1.0 = Full Time for that month. 0.5 FTE = half-time for that month

Key Activities KDP-A SRR PDR

Role and FTE [person-days]	WP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANNUAL FTE	BAND	DOLLARS
FEDERAL EMPLOYEES																
Project Manager	1.1.0	1	1	1	1	1	1	1	1	1	1	1	1	1.00	ZT-V	$133,739
Deputy Project Manager	1.1.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.50	ZP-II	$42,704
Contracting Officer	1.3	0.4	0.4	0.2	0.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.78	ZA-I	$44,213
Alternate Contracting Officer	1.4	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZA-II	$55,281
Lead Budget Analyst	1.5	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZA-III	$73,104
Project Comptroller	1.6	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZA-IV	$102,725
Chief Systems Engineer	2.1	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZA-V	$106,730
Systems Engineer	2.1	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZP-I	$37,082
Requirements and Configuration Manager	2.2	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZP-II	$55,515
Testing Lead Conductor	2.8	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZP-III	$73,104
Hardware Engineer	2.3	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZP-IV	$102,725
Systems Test Engineer	2.8	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZP-V	$106,730
Product Development Lead	2.3	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZS-I	$23,506
Software Development Lead	2.3	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZS-II	$29,734
Software Engineer	2.4	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZS-III	$37,082
Database Engineer	2.5	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZS-IV	$45,644
Software Architect	2.3.1	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZS-V	$55,515
Software Test Lead	2.4	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZT-I	$29,734
Software Test Conductor	2.8	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZT-II	$45,644
Data Management Engineer	2.9	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZT-III	$55,515
Senior Scientist / Principal Investigator	4.1	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZT-IV	$73,104
Deputy Scientist	4.1	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZT-V	$86,930
Data Processing and Analysis	4.2	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZS-IV	$45,644
System Operations Lead	7	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZS-V	$55,515
Sustainment and Maintenance Lead	7.11	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZT-I	$29,734
Network Engineering Team	5.7	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZT-II	$45,644
JCSDA Data Assimilation	4.6	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZT-III	$55,515
Data Stewardship Lead	4.5	0.4	0.6	0.2	0.3	1.0	1.0	1.0	1.0	0.3	0.5	0.7	0.8	0.65	ZT-IV	$73,104
SUBTOTAL FEDERAL FTE LABOR		12	17	7	9	28	28	28	28	10	15	20	23	19		$1,721,221
FEDERAL BENEFITS @ 30%																$516,366
ANNUAL TRAINING @ $2K PER FTE																$37,050
TOTAL FEDERAL ANNUAL COST																$2,274,637
CONTRACTOR PERSONNEL																
System Operations Engineer	9.1	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.70	L5	$227,500
Technician	9.3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.50	L2	$98,500
Sustainment and Maintenance Tech	9.2	1.0	1.0	1.0	1.0	0.5	0.8	1.0	1.0	1.0	1.0	1.0	1.0	0.94	L4	$282,500
Software Engineer	10.1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.50	L3	$120,000
Documentation Management	10.2	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.80	L1	$116,000
SUBTOTAL CONTRACTOR LABOR		3.50	3.50	3.50	3.50	3.00	3.30	3.50	3.50	3.50	3.50	3.50	3.50	3.44		$844,500
TOTALS		15	20	10	13	31	31	31	31	14	19	24	26	22		$3,119,137

COST BAND CONVERSION TO DOLLARS PER OPM: DCB RATES

uses VLOOKUP function

PATH-BAND	ANNUAL RATE	OPM CATEGORY
ZA-I	57049	ADMINISTRATIVE
ZA-II	85048	ADMINISTRATIVE
ZA-III	112468	ADMINISTRATIVE
ZA-IV	158039	ADMINISTRATIVE
ZA-V	164200	ADMINISTRATIVE
ZP-I	57049	PROFESSIONAL
ZP-II	85408	PROFESSIONAL
ZP-III	112468	PROFESSIONAL
ZP-IV	158039	PROFESSIONAL
ZP-V	164200	PROFESSIONAL
ZS-I	36163	CLERICAL AND SUPPORT
ZS-II	45745	CLERICAL AND SUPPORT
ZS-III	57049	CLERICAL AND SUPPORT
ZS-IV	70222	CLERICAL AND SUPPORT
ZS-V	85408	CLERICAL AND SUPPORT
ZT-I	45745	SCIENTIFIC & TECHNICAL
ZT-II	70222	SCIENTIFIC & TECHNICAL
ZT-III	85408	SCIENTIFIC & TECHNICAL
ZT-IV	112468	SCIENTIFIC & TECHNICAL
ZT-V	133739	SCIENTIFIC & TECHNICAL

Not WP specific, so added separately to Program WBS

CONTRACTOR RATES

BAND	ANNUAL RATE
L5	325000
L4	300000
L3	240000
L2	197000
L1	145000

Figure 6-3 Project LABOR tab in NESDIS Cost Estimation spreadsheet

6.4. The CONTRACTS tab

The CONTRACTS tab is where external contract purchase amounts can be entered directly as a single lump sum. The AGO overhead rate is also included, which could be adjusted for each individual contract if needed.

This tab is not only for external-to-NOAA contracts, but should be used to roll-up transfers to other organizations within NESDIS. These partner organizations should provide their own costing breakdown as part of the overall project cost and effort estimation, unless their portion is a very small project, or a fee-based service, which is best quoted as a lump sum cost. However, with the standardization of this cost estimation spreadsheet across NESDIS, all NESDIS Offices and Centers performing “significant” work as part of a project will be providing their own independent cost breakdowns using the same spreadsheet template.

Total Contract / Grant Cost	AGO Overhead	Notes / BoE	Accounting Code FY'18	Accounting Code FY'19
	3%	Prescribed rate		
$1,500,000.00	45000			Assume these are all NASA spacecraft contracts
$50,000.00	1500			
$100,000.00	3000			
$2,000,000.00	60000			
$100,000.00	3000			
	$3,759,500.00			
	Assigned to FY'19 NASA Spacecraft costs			

Figure 6-4 Project CONTRACTS tab in NESDIS Cost Estimation spreadsheet

6.5. The TRAVEL tab

The TRAVEL tab provides a simple way to estimate travel costs when destinations and accommodation costs are known in advance; for example, if a project is expected to have regular collaboration with an entity in Los Angeles, a monthly flight and accommodation in the Los Angeles area can be added to the travel budget at the Pre-Formulation Phase.

Actual cost figures can be obtained from the tools used for booking Federal employee travel. As a ROM estimation, this tab should provide reasonable estimates, or those cost estimates can be pulled in from other sources as direct lump sum figure.

If a project is in its Pre-Formulation Phase where the travel profile is not defined to the high level of detail shown below, the total cost for travel in the ROLLUP tab can be overridden with a ROM value that reflects an rough estimation of the cost of travel as a portion of the total project budget; for example, “The travel budget will be ~10% of the total project cost.” Ensure this approximation is stated as the BoE.

Project Travel Worksheet	Destination / Reason / Dates	# Nights	Hotel Cost/ Night	Rental Car/day	Per Diem/Allowance per day	Fuel/day [est]	Meals/ day	Misc. costs	One-time Charges - Registation fees etc	Basis of Estimate
TOTALS:										
$2,675.00	American Meteorological Society, Austin TX	5	200	50	75	10	50	100	650	AMS 2018 information
$750.00	American Geophysical Union, DC								750	AGU information
$3,050.00	WMO ICT-IOS-10 Geneva	4	300	0	90	0	60	250	1000	Previous Geneva trips
Travel Costs: Project Accounting Code										
COMBINED TRAVEL BUDGET	$6,475.00	Assigned to FY'19		Cost counted as FY'19 overhead						

Figure 6-5 Project TRAVEL tab in NESDIS Cost Estimation spreadsheet

6.6. The Other Direct Costs tab

The Other Direct Costs tab can be used to capture miscellaneous costs, whether monthly for a specified duration, annual or one-off lump sum charges. Allowable Other Direct Costs (ODC) such as those expensed by partner educational institutions are described in OMB Circular A-21 and the Cost Accounting Standards described in U.S.C. Title 48 CFR Chapter 9. This tab can also be used to cover NESDIS internal costs that would be billed to the project, as long as percentage-based overheads (such as the NESDIS 5% Overhead) in other tabs are not repeated here.

OTHER DIRECT COSTS	Monthly	Annual	One-Off Charges	Basis of Estimate
Insurance				
Office Space and Facility Overhead Charge	300			
IT Support	50			
Factory Floor / Cleanroom / Test Area / Office Rental			10,000	
Software Licenses and Fees		1250		
Equipment Rental (Hardware)			30,000	
Training Courses and Materials				
Warranties	100			
Data Archiving and Stewardship [CLASS/NCEI]		10,000		
Hardware Purchases			30,000	
TOTALS	**$5,400**	**$11,250**	**$70,000**	
Total Overheads Duration [months] in FY'18	12	FY'18 TTL:	**$86,650**	Added to Overheads for FY'18

Figure 6-6 Project ODC tab in NESDIS Cost Estimation spreadsheet

All cost values and cost items found in the example costing template are arbitrary placeholders, intended to illustrate how to use the spreadsheet. Cost estimators must enter actual cost items for their project and may delete or add other cost items as necessary.

Appendix A: List of Acronyms

AGO	Acquisitions and Grants Office
ATP	Authorization to Proceed
BoE	Basis of Estimate
CAC	Capabilities and Constraints
CBS	Commerce Business System
CEH	Cost Estimating Handbook
COTS	Commercial Off The Shelf
CWIP	Construction Work In Progress
DASIB	Data Analysis and Systems Integration Branch
DOC	Department of Commerce
FAB	Finance and Accountability Branch
FMC	Financial Management Center
FTE	Full Time Equivalent
IT	Information Technology
IUS	Internal Use Software
IUSD	Internal Use Software in Development
KDP	Key Decision Point
KPP	Key Performance Parameter
LiDAR	Light Detection and Ranging
LoE	Level of Effort
MARS	Management Analysis Report System
MDA	Milestone Decision Authority
MR	Management Reserve
NASA	National Aeronautics and Space Administration
NEAC	NESDIS Enterprise Architecture Committee
NESDIS	National Environmental Satellite, Data and Information Systems
NF	NOAA Form
NOAA	National Oceanic and Atmospheric Administration
O&M	Operations & Maintenance
OCFO	Office of the Chief Financial Officer
ODC	Other Direct Costs
OPM	Office of Personnel Management
OSAAP	Office of Systems Architecture and Advanced Planning
PDR	Preliminary Design Review
PM	Project Manager
PMBOK	Project Management Book of Knowledge
PP&E	Property, Plant, and Equipment
QPR	Quarterly Program Review
ROM	Rough Order of Magnitude
SAE	Office of System/Service Architecture and Engineering
SLOC	Source Lines of Code
STAR	Satellite Applications and Research
TRL	Technology Readiness Level

UDO	Undelivered Orders
WBS	Work Breakdown Structure
WP	Work Package

Appendix B: Generic Program WBS

The NESDIS WBS Handbook [R-7] presents the process standard for a NESDIS-centric project WBS breakdown, with WPs provided to Level 3. The intention is for the NESDIS WBS to apply to the wide variety of project types that NESDIS executes, from satellite acquisitions to software developments.

The NESDIS WBS for system, hardware and software development is shown in Figure B-1. As a template, the WBS can be adapted to any NESDIS project, as long as all project activities are covered and their costs rolled-up into the cost sheets. Projects should use the NESDIS WBS standard to define their particular project and total up the labor costs from the WP under which they occur. The NESDIS WBS to Level 3 is reflected in the cost spreadsheet.

Existing WP numbering (example: 1.0 Project Management) must be maintained across all NESDIS projects. Project activities that do not appear in the generic NESDIS WBS can be added to the project-specific WBS used for cost estimation and project planning without overwriting existing WBS Elements or the numbering scheme.

NESDIS SAE should be notified of any project activities that do not appear in the current NESDIS WBS to Level 3. The NESDIS WBS can be considered a “living” document that will evolve as NESDIS expands its activities into new domains.

WP 1 Project Management	WP1 Level 3	WP 2 System Engineering	WP2 Level 3	WP3 Quality and Mission Assurance	WP4 Science and Stewardship	WP4 Level 3	WP5 Common Services	WP6 Ground Infrastructure	WP6 Level 3	WP7 Mission Operations and Sustainment	
WP 1.1 Project Management Office	WP1.1.1 Project Travel	2.1 Chief Systems Engineer		WP3.1 Mission Assurance	4.1 Science Capabilities Definition	4.1.1 Enterprise Algorithm Requirements Specification	5.1 IT Security Engineering	6.1 Satellite Communications Infrastructure	WP6.1.1 Space-to-Ground Communications	WP7.1 Operations Development Plan	
	WP1.1.2 Contractor Support	2.2 Requirements Management		WP3.2 Product Assurance		4.1.2 Science Algorithm Requirements Specification	5.2 Mission Science Network		WP6.1.2 Network Infrastructure	WP7.2 Ops Tools Development	WP7.2.1 Flight Procedure Dev. Environment
	WP1.1.3 NESDIS and NOAA Taxes	2.3 System/Product Design Phase	2.3.1 Requirements Specification	WP3.3 Quality Assurance/Control		4.1.3 Weather/Science Instrument Requirements Specification	5.3 Mission Science Services		WP6.1.3 Partner Antenna Access Network		WP7.2.1 TM/TC Database
	WP1.1.4 External Management Reviews		2.3.2 Architectural Design			4.1.4 Observing Systems Specification	5.4 Administrative (Internal IT) Networks and Services	6.2 Data Management Services	WP6.2.1 Data Scanning and Routing		WP7.2.2 Flight Dyanmics Database
	WP1.1.5 Project Admin Support		2.3.3 Detailed Design Phase		4.2 Algorithm Development	4.2.1 Operational algorithm specification and validation	5.5 Enterprise Services		WP6.2.2 Product Generation		WP7.2.3 Control System Ops Dev
	WP1.1.6 Contract Technical Management		2.3.4 Unit Coding and Test			4.2.2 Operational algorithm development	5.6 Cloud Services		WP6.2.3 Product Distribution	WP7.3 Satellite Simulator Procurement	WP7.3.1 Sim Requirement Specification
WP 1.2 Lead Budget Analyst			2.3.5 Software Integration			4.2.3 Research to Operations	5.7 Network Engineering		WP6.2.6 Data Analytics		WP7.3.2 Sim Development Management
WP 1.3 Project Comptroller			2.3.6 Software Functional Tests			4.2.4 Algorithm commissioning, verification and ground truth testing	5.8 Secure Ingest Gateway for External Data Sources	6.3 Science Application Assessment Support		WP7.4 Flight Procedure Development	WP7.4.1 Plaform Ops Dev
WP 1.4 Project Admin Overhead		2.4 System Delivery and Verification	2.4.1 User Training and Documentation			4.2.5 Sensor commissioning and calibration	5.9 DoC/NOAA/NESDIS General Counsel - legal, regulatory support	6.4 Satellite Command and Control Systems (Enterprise Infrastructure)			WP7.4.2 Instrument Ops Dev
WP 1.5 Budget Analyst			2.4.1 System Integration and Testing		4.3 Data Exploitation and Research	4.3.1 Algorithm assessment and refinement	5.10 NESDIS IIA	6.5 Short-Term Telemetry and Other Satellite Data Archiving		WP7.5 Ops Databases	WP7.5.1 TM/TC
WP 1.6 Project Comptroller			2.4.2 System Validation and Deployment			4.3.2 Algorithm Proving Ground	5.11 Regulatory considerations: NTIA / FCC Filings / ITU / ITAR / Export Control / CCSDS	6.6 Mission Telecommunications Network			WP7.5.2 Control System Ops DB
WP 1.7 Risk Management		2.5 System Deployments, Sustainment and Maintenance	2.5.1 System Warranty Phase			4.3.3 User Community Engagement		6.7 General Ground Systems IT Support Infrastructure			WP7.5.3 Flight Dynamics DB
		2.6 Interface Management			4.4 Science System Maintenance	4.4.1 System Performance Monitoring and Corrective Maintenance		6.8 Enterprise-level Common Ground Systems for Satellite Missions	6.8.1 Flight Dynamics Systems	WP7.6 Ops V&V Tests	WP7.6.1 Control System Testing
		2.7 Use Case Analysis	2.7.1 Use Case Testing			4.4.2 System Preventive Maintenance and Upgrades			6.8.2 Station Scheduling Systems		WP7.6.2 Ops Procedure Verification
		2.8 End-to-end System Validation Testing				4.4.3 System Quality Assessment and Performance Trending			6.8.3 Multi-Mission/Fleet Planning Systems		WP7.6.3 Ops Scenario Tests
		2.9 Mission CONOPS, pre-Ops Dev operational concept design			4.5 Data Stewardship	4.5.1 Data Stewardship System Requirements				WP7.7 Exercise & Rehearsal Campaign	WP7.7.1 E&R Plan
		WP2.10 Config & Data Management				4.5.2 Data Submission Agreements and Format Definition					WP7.7.2 E&R Scenario Definition & Prep
		WP2.11 Change Management				4.5.3 Data Management Plans Engagement					WP7.7.3 E&R Test Conduct
						4.5.4 Data Archiving and Access Management					WP7.7.4 E&R Evaluation
						4.5.5 Data Stewardship System Management				WP7.8 Ops Documentation	WP7.8.1 User Documentation
					4.6 Joint Center for Satellite Data Assimilation	4.6.1 Observing System or Data Set Definition Support					WP7.8.2 Ops Handbooks
						4.6.2 Assimilation Algorithm Preparation					WP7.8.3 Ops Process Documentation
						4.6.3 Comparative Data Set Identification					WP7.8.4 Training Course Prep & Conduct
						4.6.4 Data Comparison Exercises (Spot-checks)				WP7.9 Ops Team Effort	WP7.9.1 Controllers
						4.6.5 Offline Data Assimilation Testing (Do No Harm tests)					WP7.9.2 Ops Engineers
						4.6.6 Operational Assimilation Testing					WP7.9.3 Flight Director & Mission Managers
					4.7 Cooperative Institutes , Grants, Research Initiatives					WP7.10 Ops Phases	WP7.10.1 Ground Segment Unit Tests
											WP7.10.2 GS Integration Tests & Training
											WP7.10.3 Ops Dev & Validation
											WP7.10.4 System Ops Validation Tests
											WP7.10.5 E&R Campaign
											WP7.10.6 Launch & Early Orbit Phase
											WP7.10.7 Commissioning & Cal Ops
											WP7.10.8 Contingency Ops
											WP7.10.9 Routine Phase
											WP7.10.10 System End-of-Life Ops
										WP7.11 Warranty, Sustainment and Disposal	WP7.11.1 Warranty Testing
											WP7.11.2 Sustainment Operations
											WP7.11.3 Upgrade Testing
											WP7.11.4 System Disposal

Figure B-1 WBS Cost Rollup for a generic NESDIS project in the system/hardware/software development domain

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