USING A COMPARATIVE METHOD OF HUMAN HEALTH AND ENVIRONMENTAL RISK TO OPTIMIZE THE IDAHO COMPLETION PROJECT'S CLEANUP AND CLOSURE

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ABSRACT

In response to a challenge from the Department of Energy Environmental Management Program Secretarial Officer Jessie Roberson, DOE sites were instructed to change from a risk management approach to a new approach that accelerates risk reduction and closure. The Idaho National Engineering and Environmental Laboratory responded by restructuring the site business into two distinct units, the laboratory, and the Idaho Completion Project (ICP). The ICP is organized differently than it was in the past. Instead of an organization by program (High Level Waste (HLW), Spent Nuclear Fuel (SNF), Environmental Restoration (ER), etc), the ICP is organized around projects of cleaning and closing geographical areas. The purpose of changing the organization was to change the focus from performing program mission scope and handing off from one program to another, to integrating all tasks towards completing the cleanup and closure of the EM mission.

This new organization made a number of beneficial changes including an early focus on the end state of the geographical area. With this focus on integration and acceleration of risk, there became a need for a methodology that could compare risk reduction approaches across all the project site areas to help decision-makers with prioritization and scheduling decisions. These are primarily sequencing or approach decisions and are supplemented with end state decisions where final cleanup requirements are met. Answering the question 'what is the fastest and most cost-effective manner to achieve the largest risk reduction' is a very different question than 'are the actions producing adequate risk reduction to meet human health and environmental risk objectives.

Comparative risk reduction evaluations of the entire ICP, where there is about 14 billion dollars of scope to be performed, would typically not be possible without a great deal of effort, time, and cost. However, the method described in this paper was used to perform relatively quick and inexpensive analysis of risk reduction over time alternative evaluations. The ICP scope and schedule was analyzed using this fast, comparable approach where results of focusing on risk reducing or eliminating activities will be demonstrated. A comparison of the old baseline to the new accelerated baseline is provided.

INTRODUCTION

The Idaho National Engineering and Environmental Laboratory (INEEL), located in southeastern Idaho, has an Environmental Management (EM) cleanup project, called the Idaho Completion Project (ICP). The ICP has many elements of environmental management including hazardous and radioactive wastes and materials to disposition, soils and groundwater to remediate, buildings to cleanup and dismantle, and active and non-active waste systems to close.

Just over two years ago, the Top-to-Bottom review[1] was performed by the Department of Energy where a major finding dealt with DOE's approach to managing environmental risks. A fundamental change was recommended to change from a focus on managing the risks at the DOE sites to one of eliminating the risks faster. The fundamental shift in focus resulted in the Department developing performance management plans (PMPs)[2] and negotiating letters of intent (LOIs) with various DOE site regulators. The focus on risk reduction rather than risk management can imply several types of risk. This paper discusses the environmental risk analysis. Although the methodology was first applied to reduction of technical and programmatic risk reduction, the model described in this paper was adjusted to perform environmental risk reduction evaluations. Programmatic and technical risk reduction can be analyzed in a parallel manner but is not the focus of this paper.

In response to the Idaho PMP, the ICP rebaselined the INEEL EM life cycle[3,4] to accelerate the work as defined in the PMP that moved up the completion date from 2070 to 2035. The Idaho PMP emphasized specific accelerated risk reduction with a number of completion milestones ahead of the 2035 final completion milestone. To facilitate the focus on EM completion, the ICP has organized differently than the traditional programmatic approach (High Level Waste, Spent Nuclear Fuel, Environmental Restoration, Waste Management, etc) to an organization focused on completing site geographical areas. This was the first fundamental change made by the ICP to become end state focused. The reorganization also helped integrate the broad environmental management activities necessary to achieve the end state[5].

Milestones drove the ICP in the past and the Idaho PMP continued that paradigm by creating additional acceleration milestones for each program area. These additional milestones were incorporated into the new life cycle plan. Additional opportunities were not considered in the life-cycle plan since its purpose was to meet the PMP guidance. Even with the baseline acceleration of 35 years, DOE continues to challenge the ICP to accelerate risk reduction across the project. This requires analysis to support decisions as to how and where accelerated risk reduction is possible and a method that can communicate the comparable benefits of one acceleration opportunity over another. The decision support tools to perform this assessment and analysis across the ICP with the broad type of environmental management activities were not available except through multiple participant integrated facilitated meetings and often these meetings were too high a level to do specific tradeoff analyses.

To be able to identify and analyze opportunities for acceleration, an ICP-level decision support tool was needed. The tools that did exist are those used for individual or comprehensive risk assessment where computer and conceptual models are used to evaluate the risk to human health and the environment for residual risks left in place [6,7]. These models are generally very complex and deal specifically with the decision of how much residual risk can be left rather than comparing different accelerated cleanup strategic alternatives. For example, these models are used to determine the cleanup levels for a particular risk area and what residual, what controls and isolation would be necessary to complete EM's risk reduction prior to transitioning to any long-term management of the residual risk. What these models don't necessarily do is to allow comparative evaluations of multiple risk management strategies in a timely manner to find where to best focus limited budget dollars to reduce the most risk as soon as possible. In other words, an approach is needed to decide how to sequence the activities to accelerate risk reduction to the approved residual level. This paper will describe a technique used at the ICP to evaluate different acceleration strategies for faster risk reduction and elimination. The technique used will compare the various alternative baselines and produce environmental risk reduction curves that can be used to communicate the effectiveness of the various cleanup acceleration strategies.

APPROACH

The purpose of this tool development was specifically to provide decision support of ICP level strategic alternatives focused on accelerating risk reduction. The tool will not substitute for the tools used to define the cleanup action levels. In the past, qualitative decision approaches were used in facilitated meetings where risk reduction differences were generally very qualitative or were specific to a small scope of work and did not encompass the entire ICP. Other decision support analysis generally used traditional techniques such as Multi-Attribute Utility analysis Theory (MAUT), Analytical Hierarchy Process (AHP), Simplified Multi-Attribute Rating Technique (SMART), Kepner-Tregoe (KT) and these are often integrated with roadmapping processes [8-10]. In the case of analyzing environmental risk strategies, any one of these methods would be useful once alternatives could be defined in a way that differentiating comparisons could be made. These methods were either too high of a level analysis or requires such analytical rigor that the cost and time needed for such an analysis was prohibitive. The tool needed to perform cross-cutting analyses of alternatives considered anywhere in the ICP, quickly, and be comparable enough that the decision-maker could decide where to focus limited resources. To accomplish this need, the tool discussed in this paper was developed in several steps.

First, the ICP would need to have the elements of risk grouped into sub-systems within the ICP scope. These sub-systems would be groups of environmental risks that should be mitigated as a unit. For example, a building may have a process that must be used to complete the disposition of some waste. There may be RCRA-type systems that require closure after the processing is complete. The building may require deactivation prior to being decontaminated and decommissioned (D&D). The soils under and near the building would need to be mitigated integrated with the facility. All these activities would be part of the overall risk reduction steps for this sub-system within the ICP.

Second, the potential risk elements would need to be defined. With all the sub-systems defined, the types of risks were defined using decision criteria guidelines such as differentiating and not redundant.

Third, the risk reducing activities would need to be defined for each sub-system. Of course the activities usually represent a specific strategy. Even though these are defined for the baseline, it is important that the tool be capable of analyzing alternative strategies.

Fourth, the associated risk for each sub-system would need to be normalized across all the ICP. The normalization will allow summaries to be useful in comparing strategic acceleration strategies.

Each of these steps will be discussed with examples in the PMP Baseline Analysis section. The analytical data development that supports the comparisons of alternatives will be performed in much the same way and although some results will be shown, the details of the analysis are too broad to discuss in detail in this paper.

PMP Baseline Analysis

The ICP 2002 Life Cycle Baseline was used as a starting point to define the four process steps discussed in the approach section. The life cycle was rebaselined to achieve the milestones described in the DOE-Idaho Operations (NE-ID) PMP.

Step 1: Sub-Systems Defined

The ICP is made up of several geographical area completion and closure projects. Each geographical area was divided up into sub-systems. For example, within the Idaho Nuclear Technology and Engineering Center (INTEC) Clean and Close Project, is the Tank Farm that has activities to treat the waste, wash the tanks and perform RCRA closure, remediate the soils, and monitor the ground water. Since these activities would be best performed integrated in schedule as well as the scope definition for each step with each other, the tank farm became one of these sub-systems. Another sub-system involved the INTEC 603 fuel basin and dry storage facility. In this case, the removal of the basin water, closure of the Voluntary Consent Order tanks and lines, RCRA closure, spent nuclear fuel removal from the dry storage area, D&D, and soils risk mitigation are grouped into another sub-system still within the same Clean/Close INTEC area. INTEC, as a whole, is divided into 19 sub-systems at this time.

The other geographical areas are also divided into sub-systems. The Test Area North (TAN) area is divided into seven sub-systems, the Radioactive Waste Management Complex (RWMC) area is divided into four sub-systems, and the Balance of INEEL Cleanup (BIC) is divided into nine sub-systems.

Step 2: Risk Elements Defined (Criteria)

After reviewing the sub-systems and the risk reducing activities, several criteria were identified that represented the value of the risk reducing steps. Conceptual and analytical risk models have defined the actions that can be taken to reduce or eliminate the risks. To reduce or eliminate risk, the source term of concern can be removed, stabilized, or isolated. The strategy used to reduce or eliminate the risk is often specific to the source term of concern, the condition of the source term and the modes of migration or uptake of the source term by the end-effectors.

The components of environmental risk that we are trying to reduce or eliminate make up the list of criteria or risk elements. These criteria were found by reviewing the purpose of the various risk reducing or eliminating activities for what was accomplished by that activity. Each criterion is discussed with some examples of where it applied to the ICP.

ICP Risk Elements or Criteria

- Near-term Ground Water Risk
- Long-term Ground Water Risk
- Airborne Risk
- Homeland Security Risk
- Risk Management Costs
- Worker Risk (Exposure)
- Environmental Risk Through Animals and Birds

Near-term Ground Water Risk

There are a number of activities planned for risk mitigation within the ICP where the risk is specifically in the near-term and is unacceptable without mitigation over the next 300 to 1000 years. These source terms are generally the short-lived isotopes like cesium-137, strontium-90 or fast migrating radionuclides such as carbon-14 or technetium-99.

Long-term Ground Water Risk

The activities involving the reduction or elimination of long-term ground water risk are disposition of stored waste or materials, long-term isolation of a source term from any migration mechanism, long-term stabilization, pump and treat of the ground water, or removal of the source term for placement in an engineered disposal facility. Generally, the activity reduces or eliminates a risk that could be a problem in the future if institutional control is lost or migration is allowed for long enough that a source term of concern could migrate to end-effectors. The long-term risk generally peaks after 1000 years.

Airborne Risk

Some of our source term of concern is in wind-blown areas where it can migrate through fires or high winds until it is mitigated. Examples of source term where airborne mobility is of concern includes areas where the contamination is on the surface and not contained in a facility.

Homeland Security Risk

This risk is associated with materials or waste that could be used in a terrorist activity and where the activity generally includes moving the material or wastes under stronger institutional control. Examples would include the special nuclear material or spent nuclear fuel consolidation.

Risk Management Costs

Each of these sub-systems require some institutional controls that use resources to manage. The more risk that must be actively managed, the higher the costs for that management. This criterion measures the changes as activities are performed to transition a managed risk from active to passive controls. For example, the tank farm requires much more active management when the tanks are full than after they are empty. The empty tanks require more management than they will after closure is completed. The tank farm requires more active observation before soil mitigation than after. Another example is where a source term is stabilized in place (Brownfield) and this requires more management than if the source term was cleaned up to a Greenfield.

Worker Risk (Radiation Exposure)

This criterion compares the potential of exposure to the worker for the various sub-systems. Sub-systems where there is enough source term to provide dose to a worker would be improved once the source-term is eliminated or isolated.

Environmental Risk Through Animals and Birds

Some sub-systems have mobility of a source term by plants or animals as a concern. These risks come from areas with contaminated ponds or plants with source term of concern that can be transported by animals.

Step 3: Defining the risk reducing or eliminating activities

This step divided the activities that were defined in the life-cycle plan into specific steps that were decoupled in schedule. For example in the tank farm sub-system, the emptying of tanks is a removal of the source term action just like the cleaning of the tanks, but due to the activity schedule logic, they were separate risk reducing activities within the same sub-system. However, because the cleaning of the tanks and stabilization step was part of the same closure activity, they were combined in the initial schedule logic of activities. In later analysis, the cleaning step was segregated from the stabilization step due to new schedule logic that decoupled the activities. Activities in the life-cycle that did not result in risk reduction were not included. These include such activities as planning, surveillance and maintenance, and final documentation following cleanup.

Step 4: Normalizing the risks across the ICP

The normalizing step is the heart of what makes this risk assessment useful for strategic decision support. In this step, the sub-systems are compared with each other within each of the criteria. This comparison resembles the pair-wise comparisons or the AHP decision approach. Each sub-system is compared to the others across a 0 to 10 scale where 10 is the worse and 0 is used when the risk does not apply or exist. There are a number of approaches useful for this comparison but the approach that provides the fastest results is to group the highest risks together and the lowest risks and begin to place the remainder between using subjective comparative ranking skills of one of the AHP approaches. A scale on the wall where each of the sub-systems can be placed works well in place of performing a pair-wise comparison of all the potential pairs. However, what is needed to use this simpler tool is an unbiased or a balanced bias view, often called a cross-cutting team, to place these sub-systems in the approximate position they belong in. It is important to realize that an exact location is not needed and several sub-systems can have the same score for a particular criterion. What will balance out the imperfections in absolute values is the comparable changes to the criterion score as risk reducing activities are performed. Figure 1 shows the ranking of the initial baseline of sub-systems against the long-term ground water risk criterion

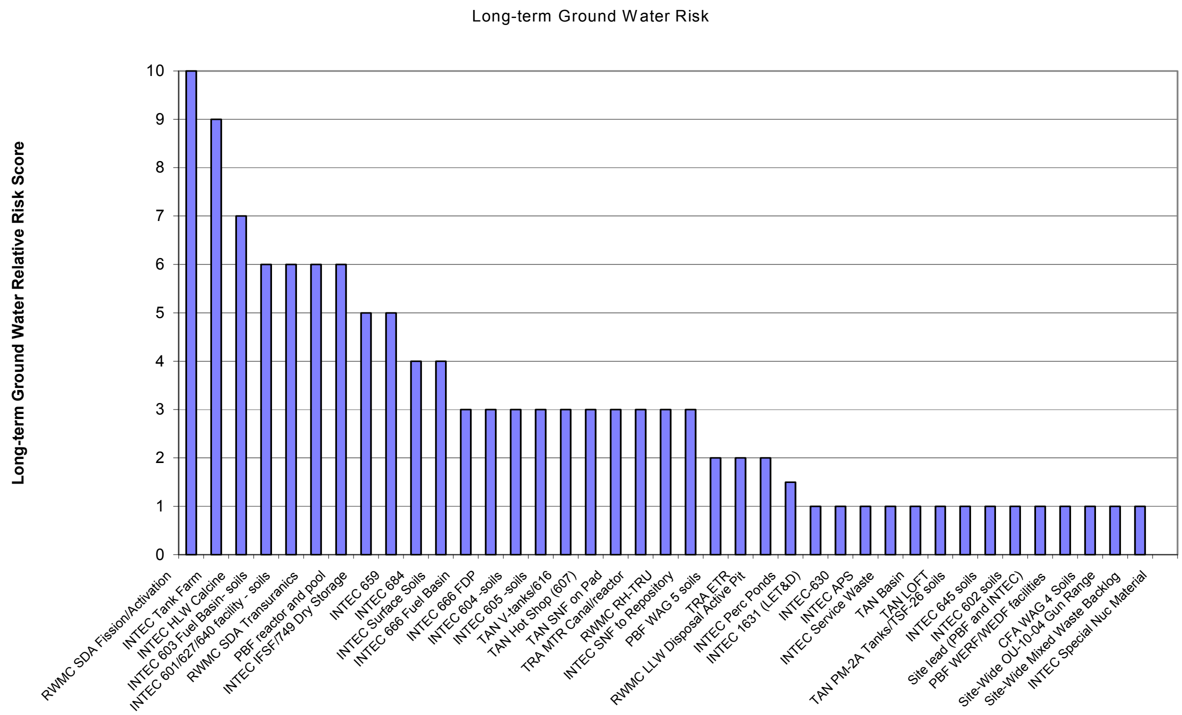

Fig. 1 The Long-term ground water risk comparative rankings of the icp sub-systems

The second step of the normalization process involves going through the risk reducing steps and adjusting the scores of the sub-system appropriately after each step. Remember, each step does not necessarily affect each criterion, in fact, at the ICP, the steps were usually focused on a couple of criteria. The normalization process is aided by a completion rule that is consistently applied throughout the scoring of the sub-systems across the criteria. Zero score is reserved for the exclusive use of the risk not applying or the cleanup reaches a Greenfield status where uncontrolled use of the land for anything without institutional control is achieved. For example, in the tank farm sub-system, there is no Homeland Security or animals/bird environmental risk associated so the value given these two criteria is zero. If a Brownfield is the endpoint, the value of 0.5 for the risk of concern is used as defined endpoints where the final activity will achieve the risk that is protective of human health and the environment but with institutional controls. This provides a way to show where residual risk may remain. Remember that the amount of residual risk remaining is analyzed by the more detailed risk assessment and modeling techniques and this decision support tool is not designed for that decision.

Once the initial and final states are scored for each criterion separately, the scores are stepped down through the specific steps defined in Step 3. Figure 2 shows an example of the tank farm where three activities are planned for the reduction of risk. The scores by criterion are stacked and color coordinated.

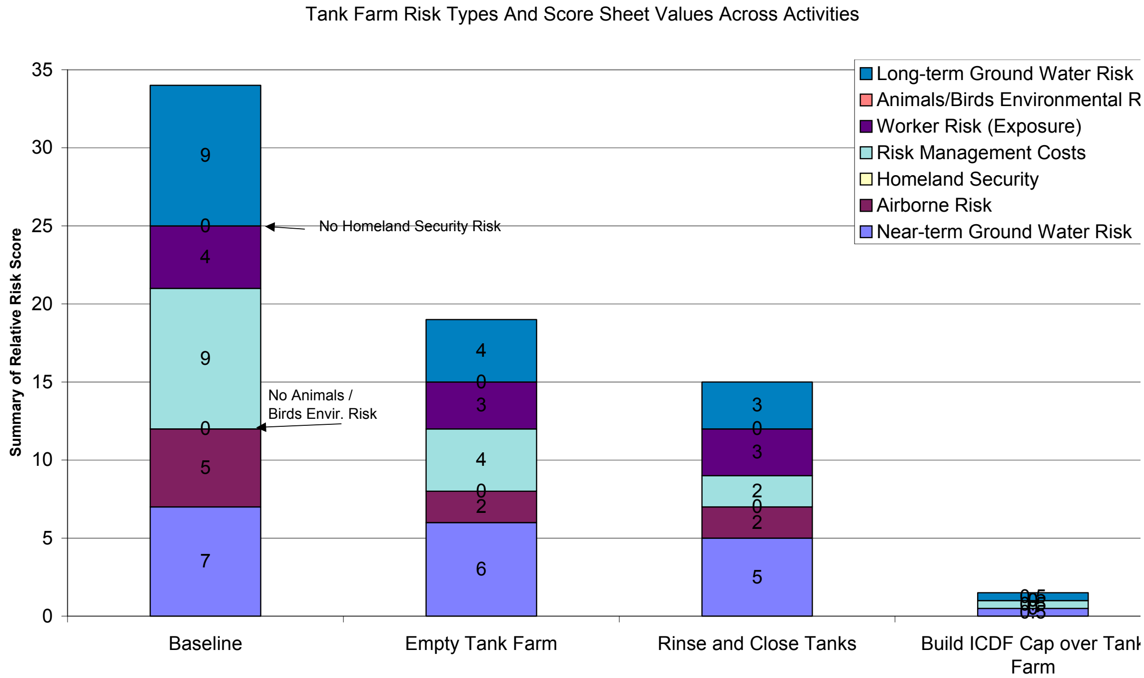

Fig. 2 Results of the normalization process to the icp sub-system INTEC tank farm

In this example, the tank farm sub-system represents one of the highest long-term ground water risks prior to any risk reduction. After the tank farm is empty, much of the long-term ground water risk (top of the bar) is eliminated but since the near-term ground water risk (bottom of the bar) is mostly due to releases around the tank farm and removing the contents did not mitigate this risk, the near-term risk value only reduced slightly due only to the reduction of the potential for further release. As the tank is rinsed and closed, the long-term risk reduces further but is still significant because the released material in the ground around the tank farm is not yet mitigated. In fact, the near-term risk is not significantly mitigated until the isolation step of building an engineered cap over the tank farm is completed. In this case, as stated in the process description, the criteria of long-term and near-term risks as well as the costs to manage the risks do not go to zero in this case due to the required long-term institutional control. Also shown are two zero scores for the Animal/Bird Environmental Risk and Homeland Security Risk that do not apply to the tank farm sub-system.

COMPARISON OF RISK-REDUCING STRATEGIES

The results of the step-down in criteria scores can be integrated with the schedule to generate the time-phased risk reduction chart. Each or the criteria can be weighted the same or differently depending on the values of the decision-maker. For this analysis, the weights are the same for all the criterial. The baseline chart for the ICP 2002 Life-cycle plan that is consistent with the PMP is shown in Figure 3. Here, the sub-systems that make up each geographical area are summarized to simplify the graph. However, each of the sub-systems may be plotted individually or together as is necessary for decision support.

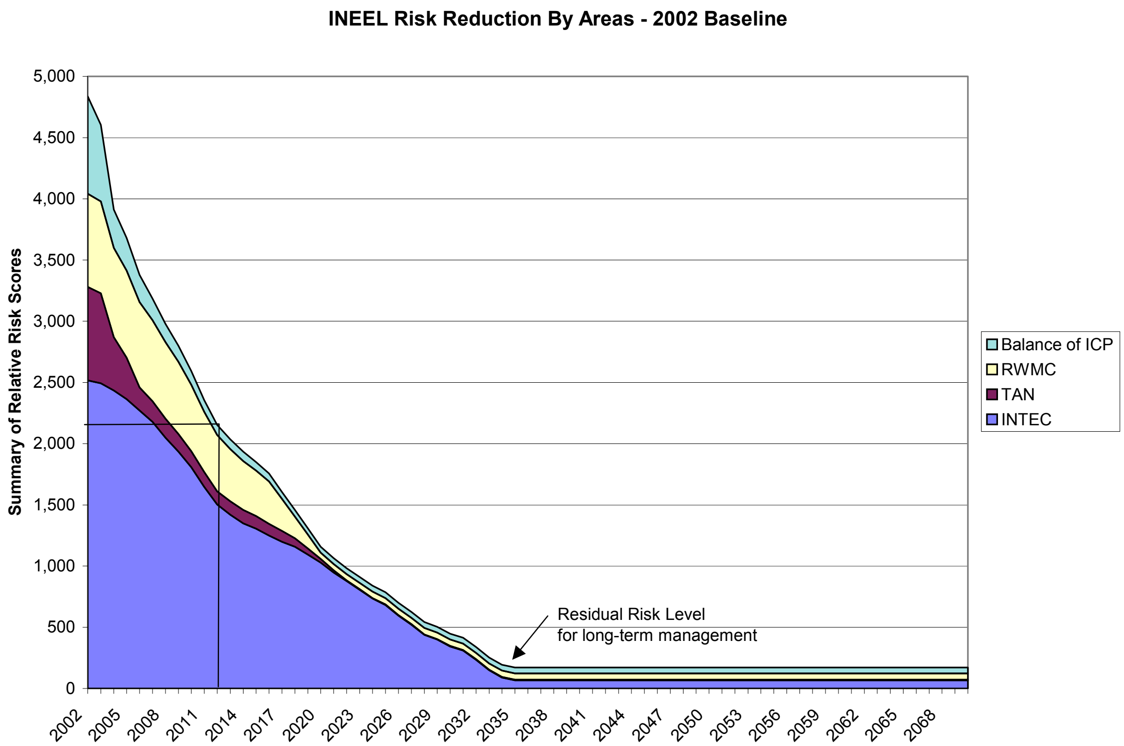

Fig. 3 ICP 2002 Life-Cycle Plan Risk Reduction Curve

As stated earlier in this paper, it is recognized that these risks are not linear and this tool is not useful in deciding the final cleanup actions for a given source term. However, it should be recognized that what this decision support tool does provide is a focus on the risks that are being managed, what is planned, what is useful to reduce or eliminate the risk, and provide a fast "what-if" tool that helps identify opportunities to reduce risk faster. Figure 3 shows that the risk is reduced to a residual level that is determined through the regulatory decision processes that use the detailed cumulative risk models to define what must be performed to reach human health and the environment protection. The decision support tool discussed in this paper can be used to help analyze how to approach the end state residual level faster in time. As an example of this evaluation, Figure 4 shows the baseline prior to the PMP against the summary line from Figure 3 to show the results of this acceleration strategy on the risk reduction over time curve. In this case, each total line is shown to simplify the graph for understanding purposes. This graph shows the results of a scheduling scenario that completes waste and material disposition faster, D&D all EM facilities and most of the remediation by 2035. As can be seen in both baseline cases, the activities reach a residual amount due to both alternatives getting to the same end state. The only real difference is how quickly this end state was achieved.

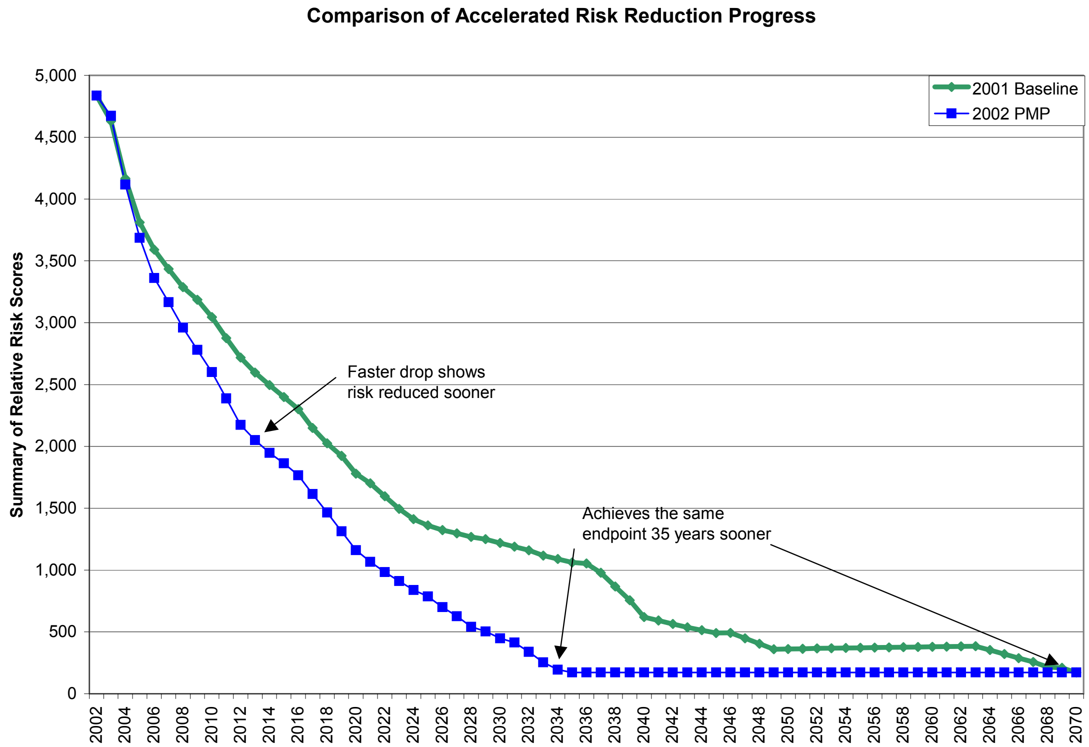

Fig. 4 Comparison of the ICP 2002 PMP life-cycle plan to the 2001 life-cycle plan

NEXT STEPS

This decision support tool has resulted in helping management focus on the activities that cause risk-reduction to happen and differentiate from the activities that only manage the risks. Reviews of the risk sub-systems strategies and comparative risk levels continue as additional knowledgeable project personnel are given opportunity to provide input. This form of validation to the model will continue as more is learned about each sub-system.

Additionally to evaluating the model, the INEEL is working to integrate the risk reduction decision support tool with the geologic information system (GIS). The integrated system will provide an improved communication mechanism so risk reduction curves will be supplemented with spatial views showing the relative risk changes over time in geographical areas with drill-down or zooming features available using the GIS interface. Examples of these graphs will be shown in the presentation.

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