the remediation. When the benefit is greater than the cost, additional remediation is required. Conversely when the benefit is less than the cost, additional remediation is not required.

4.4.3 Remediation Methods and Cost

For the Rancho Seco facility the remediation techniques examined are scabbling, pressure water washing, wet and dry wiping, grit blasting for embedded and buried piping, grit blasting of surfaces and soil excavation. The principal remediation method expected to be used is scabbling, which is intended to include needle guns and chipping. The total cost of each remediation method is provided in Appendix 4-A. The cost inputs are defined in Section 4.5.1, Calculation of Total Cost.

4.4.3.1 Concrete Surfaces

Industry experience has shown that a major fraction of concrete contamination occurs in the top 10 millimeters of the concrete. The ALARA evaluation was performed by bounding the cost estimate for a scabbled depth of 0.125 and 0.25 inches. For each evaluation the same manpower cost is used. However, the manpower and equipment costs for the lower bounding depth do not include compressor and consumable supply costs which adds some conservatism to the cost estimate, i.e., biases the cost low. The major variables for the bounding conditions are the costs associated with manpower and waste disposal.

4.4.3.2 Structure Activated Concrete

Concrete activation is associated with the containment building. Characterization of the reactor bioshield and loop area concrete has provided information regarding the identification, concentration, and distribution of the radionuclides. In addition to the observed concrete activation products, the concrete surfaces in the containment structure are radioactively contaminated by the deposition and transport of fluids and airborne distribution that occurred during plant operation. Based upon the difficulty that these activated and contaminated characteristics have raised in demonstrating compliance with the dose criteria in 10 CFR 20, Subpart E at other commercial reactor decommissioning projects; Rancho Seco has decided to remove and dispose of all containment building interior concrete without having performed an ALARA analysis.

4.4.4 Remediation Cost Basis

The cost of remediation depends on several factors such as those listed below. This section describes the attributes of each remediation method that affect cost. The detailed cost estimates for each method are provided in Appendix 4-A.

- Depth of contaminants;
- Surface area(s) of contamination relative to total;
- Types of surfaces: vertical walls, overhead surfaces, media condition;
- Consumable items and equipment parts;
- Cleaning rate and efficiency (decontamination factor);
- Work crew size;

- Support activities such as, waste packaging and transfer, set up time and interfering activities for other tasks; and
- Waste volume.

4.4.4.1 Scabbling

NUREG/CR-5884, Volume 2, "Revised Analyses of Decommissioning for the Reference Pressurized Water Reactor Power Station," [Reference 4-3] states that scabbling can be effectively performed on smooth concrete surfaces to a depth of 0.125 inches at a rate of 115 ft^2 per hour. The scabbling pistons (feet) are contained in a close-capture enclosure that is connected by hoses to a sealed vacuum and collector system. The waste media and dust are deposited into a sealed removable container. The exhaust air passes through both roughing and absolute HEPA filtration devices. Dust and generated debris are collected and controlled during the operation.

The unit cost is presented in Table 4-2. Scabbling the room assumes that 100% of the concrete surface contains contamination at levels equal to the DCGL and that 12.5% of this residual activity is removed by each pass and that it takes eight passes to effectively remove all the residual activity. The debris is vacuumed into collectors that are transferred to containers for truck or rail shipments. For the evaluation, the truck container is assumed to carry 13.6 m^3 of concrete per shipment based on the NUREG-1496, Volume 2 [Reference 4-4] guidance contained in Table 4-1.

Based on evaluation of concrete core samples, scabbling is expected to be the principal method used for remediation of concrete surfaces. The cost elements used to derive the unit costs for the ALARA evaluation are listed in Appendix 4-A. The methods for calculating total cost are provided in Section 4.5.1.

4.4.4.2 Pressure Water Washing

The unit costs provided in Table 4-2 for pressure water washing were established by assuming that 20,312 m^2 of the site structures' surface area is pressure washed using the surface area example of NUREG/CR-5884, Volume 1, "Revised Analyses of Decommissioning for the Reference Pressurized Water Reactor Power Station," [Reference 4-5], Table 3.22. This information was used to provide a cost per square meter factor. Appendix 4-A provides the cost details. The equipment consists of a hydrolazer and when used, a header assembly. The hydrolazer type nozzle directs the jet of pressurized water that removes surficial materials from the concrete. The header minimizes over-spray. A wet vacuum system is used to suction the potentially contaminated water into containers for filtration or processing. The cleaning speed is approximately 240 ft^2 (22.3 m^2) per hour and the process generates about 5.4 liters of liquid per square meter as discussed in NUREG/CR-5884, Volume 2. The contamination reduction rates are dependent on the media in which the contaminants are fixed, the composition of the contaminants, cleaning reagents used and water jet pressure. Mitigation of loose contaminants is high. Reduction of hard-to-remove surface contamination is approximately 25% for the jet pressure and cleaning speed used. The use of reagents and slower speeds can provide better contamination reduction rates but at proportionally higher costs. The formula associated with the cost elements is provided in Section 4.5.1 and the cost elements are provided in Appendix 4-A.