

Reducing Impact of Construction Operations on the Environment

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Abstract

Construction projects can have a significant impact on the surrounding environment. Storm water runoffs carrying eroded soil and potentially hazardous materials from construction site can impact water quality in nearby waters, increase sedimentation, affect navigation and recreational activities and disrupt aquatic life. Construction and demolition activities generate large amounts of solid waste that is estimated to equal 40% of the total solid waste stream in the United States. Inadequate construction sequencing and poor quality assurance measures may result in indoor air contamination that can continue to impact indoor air quality over the life time of the building. A recent research project conducted by the author has investigated current strategies for reducing environmental impact of construction operations. This paper reports on the research findings. Specific strategies discussed in the paper include controlling storm water runoff to reduce erosion and contamination of receiving waters, recycling and reusing materials to reduce volume of construction waste, proper sequencing of construction activities to ensure indoor air quality and development of indoor air quality management plans.

Keywords

Construction Waste Management, Storm Water Management, IAQ, Recycling, LEED

1. Introduction

Construction projects can have a significant impact on the surrounding environment. Construction impact on the environment can be classified into 3 main categories: disturbance of project site, generation of waste and indoor air quality. The following sections further discuss these categories:

1.1 Disturbance of Project Site

Construction earthwork activities disturb the site's natural drainage systems, native vegetation and wildlife. Earthwork activities contribute to site erosion and increase the quantity of storm water runoff. Storm water runoff is increased because of site clearing operations that destroy existing natural vegetation which helps slow runoff. Runoff is also increased because of cut and fill operations that change natural site grading and

because of the use of impervious surfaces such as roofing materials and pavement that reduce the site's natural capacity to absorb rain water.

Construction activities do not only affect the quantity of the storm water runoff but also affect its quality. Eroded soil caused by site clearing and earthmoving operations as well as other hazardous material from construction site contaminate the storm water runoff. The contaminated runoff can impact water quality in nearby waters, increase sedimentation, affect navigation and recreational activities and disrupt aquatic life.

1.2 Generation of Waste and Depletion of Natural Resources

Construction and demolition activities generate large amounts of solid waste that is estimated to equal 40% of the total solid waste stream in the United States (LEED 2003). Most construction projects use large quantities of virgin material even when recycled materials could be used. In addition, construction projects consume large quantities of water and temporary electrical power.

1.3 Indoor Air Quality Problems

Inadequate construction processes may result in indoor air quality (IAQ) contaminations that can continue over the lifetime of the building. Such contamination affects building occupants' comfort and productivity and may cause adverse health problems such as eye, nose, throat, and skin irritation. Contamination is created by dust generated during the various demolition and construction activities and by volatile organic compounds (VOCs) emitted from wet construction materials such as paints, sealants, and coatings. If adequate precautions are not taken, the contaminants move from the location of their sources to other sections of the building through the HVAC system and/or through workers' movement. Microorganisms such as molds which are produced when construction materials are exposed to moisture when left unprotected from rain or when exposed to condensation from the HVAC system or to plumbing leaks can also cause contamination. IAQ problems are also caused by inadequate construction sequencing that results in the installation of contaminant absorbing materials "sinks", such as carpets, insulation, ceiling tiles, and gypsum products before the complete application and ventilation of VOC emitting materials. These "sinks" when installed before VOC emitting materials, absorb contaminants and then slowly release them back into the building overtime. Controlling indoor air quality is a bigger challenge in renovation projects than in new construction because of the presence of building occupants.

2. Research Objectives, Methodology and Scope

The objective of a recent research project conducted by the author was to identify current strategies used in the building construction industry to reduce many of the negative impacts of construction on the environment. The research included a literature search and a number of interviews with industry professionals. This paper reports on the research findings. Although design activities can greatly affect the construction project's impact on the environment, the objective of the research was to only identify strategies used during the construction phase.

3. Reducing Construction Impact on the Environment

The processes used to reduce construction impact on project site; waste generation and indoor air quality are similar. These processes, as illustrated in Figure 1, starts with an environmental plan. The environmental plans clearly define the strategies required in each case. The plans depends on the unique conditions of the project including the availability of recycling facilities near the project's location, whether

the project is a new construction or a renovation and the possible impacts of construction and demolition activities on adjacent buildings. The plans should consider the cost and benefits of available strategies.

The project manager of the general contractor/ CM is responsible for developing the environmental plans at project start-up. Once the plans are developed, they should be submitted to the Architect/Engineer for review and comments. The approved plans should be communicated to all project team members to ensure that all participants in the construction process are aware of the environmentally conscious procedures. Communication of plans can take place during subcontractors' orientation meeting prior to their mobilization on site. The project superintendent in particular should be familiar with all plans and should ensure the completion of all activities necessary to comply with the plans. If needed, the GC/CM should provide training for project personnel regarding the implementation and enforcement of the plans. During construction, the planned strategies are implemented and periodic inspections and testing are conducted to ensure performance. The following sections further discuss environmental plans.

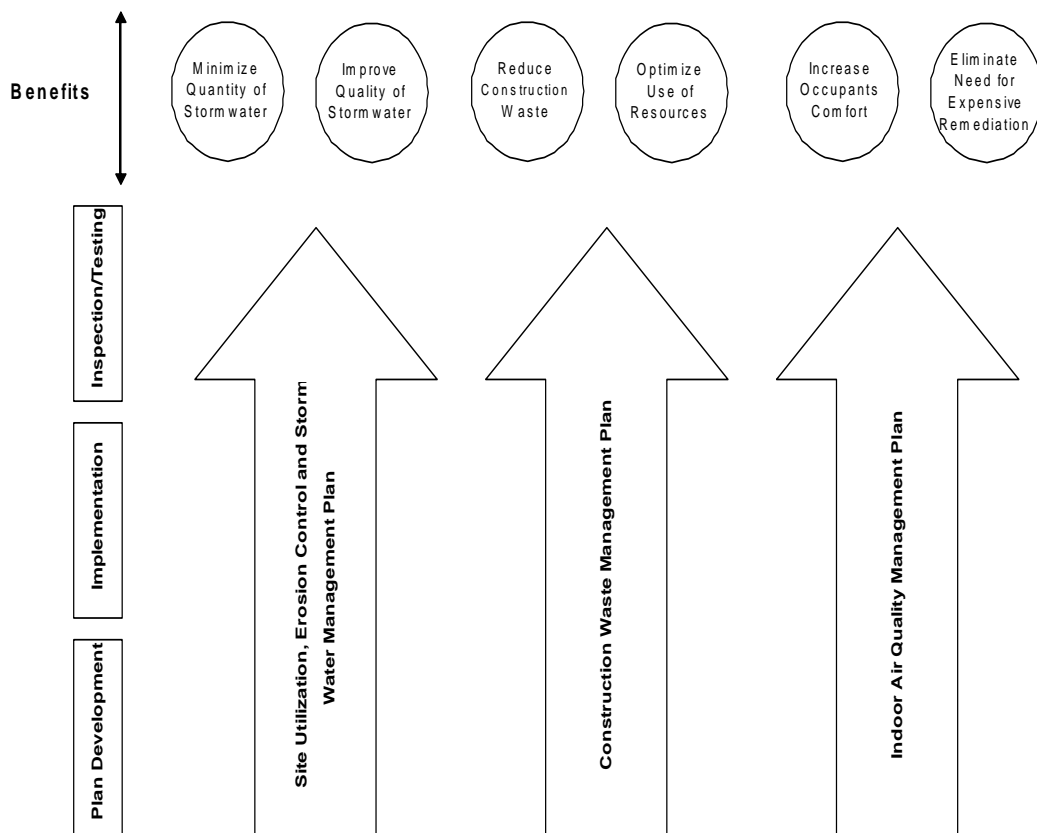


Figure 1: Components of Environmental Plan

3.1 Site Utilization, Erosion Control and Storm Water Management Plan

The process of minimizing site disturbance and the associated increase of soil erosion and storm water runoff starts with the development of a plan for site utilization, erosion control and storm water management. The plan should include a clear description of:

- Site utilization map showing the protected areas of the site and the construction areas that can be used by the various subcontractors for staging, parking, construction entrances, waste removal, concrete washouts, fuel storage, trailer location and on-site construction materials storage. Construction materials stored on site should be protected from the elements to prevent contamination of stormwater runoff. When developing the map, the objective should be to minimize the areas to be disturbed while still meeting construction and economic needs. Not having such a map allows subcontractors to use the site haphazardly discouraging any efficient use of the site.
- Schedule of Grading activities. Grading activities should be scheduled on dry days.
- Erosion control measures. These measures prevent erosion by stabilizing the soil. They include using special plants that retain soil in place and using temporary seeding, permanent seeding and mulching (EPA 1992).
- Sedimentation control measures. These measures are used to retain sediment after erosion has occurred in order to prevent the sedimentation of storm sewers or nearby streams. They include silt fences, filters on storm water inlets, earth dikes, sediment basins and sediment traps. The selection of these measures depends on the site's conditions (EPA 1992).
- Inspection plan. During construction, inspections should be conducted at least every two weeks and within 24 hours of large storms. Inspections should include review of protective measures and collection of data to compare storm water runoff volumes to predevelopment conditions. Inspections should also ensure that hazardous chemicals are properly stored and secured. Inspections of storm water controls should continue during building occupancy to ensure their proper operations.

3.2 Construction Waste Management Plan

Construction waste generation can be significantly reduced by recycling and reusing construction materials. The process of reducing waste starts with the development of a waste management plan. The plan should address the following:

- Waste management goals such as “reuse or recycle 60% or project wastes”
- Salvage, reuse, and recycle opportunities. The type and quantities of materials to be salvaged, reused and recycled should be identified. To accomplish this, the site should be surveyed before demolition. Materials that are typically salvaged include doors, windows, antique moldings, cabinets, appliances, bathroom fixtures, bricks, and wood beams and posts.
- Markets for recycled materials. Knowing these markets is essential to determine the economic feasibility of construction waste recycling. Markets vary by location. Materials that typically generate resale revenue when recycled include metals such as steel, cardboard, masonry, concrete, and asphalt. In case of materials that do not generate revenue when recycled, such as scrap wood and gypsum wallboard, an economic benefit is still achieved by avoiding landfill-tipping fees. Some materials can be reprocessed and reused on site such as demolished concrete, which can be grinded and used as structural fill instead of purchasing and hauling gravel (LEED 2003).
- Procedures for waste separation. Waste separation and adequate monitoring of recyclables is important for the success of the construction waste management program. The personnel responsible for recycling should be properly trained on the effective procedures of recycling..
- Procedures for removing salvaged, reused and recycled materials off-site. Several alternatives could be used. Salvage or recycling companies can remove recycle/reuse materials or the contractor can drop the materials at their location. Also, some charities such as Habitat for Humanity could be contacted to pickup the materials. When the contractor plan for the removal alternative, he/she has to contact the salvage/recycling companies to determine their requirements on whether the materials have to be source separated or can be co-mingled.
- Procedures for handling hazardous waste generated from demolition activities. Hazardous products include lead paint, asbestos, fluorescent lamps and PCB ballast. Special attention must be taken when

handling hazardous wastes, which must be disposed of at a hazardous waste facility. Qualified professionals may be needed for proper handling and disposal.

- Procedures for program evaluation. The waste reduction program should be evaluated by measuring the volume of waste produced by construction, and the volume of recycled/ salvage materials. These volumes are compared to the project guidelines for materials' recycling and reuse. The revenue generated by recycling and salvaging should also be calculated to help the project team evaluate the cost effectiveness of the program.

In addition to the waste management plan, the contractor can use other procedures to minimize waste and optimize the use of natural resources. These include:

- Use products with less packaging and encourage manufacturers to recycle their packaging materials.
- Ensure that construction materials is adequately stored and handled to prevent damaged material from going to the waste stream
- Minimize ordering errors to reduce amount of waste on the construction site.
- Use an effective materials management system to minimize the amount of time that materials are on site and reduce the chance of damage.
- Adequately inspect the amount and quality of materials upon delivery and require suppliers to take back substandard or excess items.
- Use construction methods that minimize waste such as using reusable metal forms for concrete instead of wooden forms.
- Purchase materials to minimize waste. For example, purchase 9' sheets of drywall if the ceiling height in a building is nine feet. (Sustainable 1996)
- Efficiently design temporary lighting so that most of it can be turned off during non-construction hours.
- Eliminate the energy waste of round-the-clock security lighting by installing motion sensors that activate security lighting only as necessary (Sustainable 1996)
- Use energy efficient lamps (such as compact fluorescent lamps) for temporary lighting.
- Use low-flow fixtures to reduce water use during construction
- Use efficient landscaping irrigation techniques during construction such as drip watering or capturing stormwater and reusing it for irrigation (Sustainable 1996).
- Use products with significant recycled content when feasible. Using such products help divert recyclable from landfill disposal and reduces the depletion of natural resources.

3.3 Indoor Air Quality Management Plan

The process of minimizing construction impact on indoor air quality starts with the development of an indoor air quality (IAQ) management plan. The plan should address the following:

- The protection of the ventilation system components during construction (IAQ 1995). On all projects, the protection of the HVAC system is especially important during the installation of VOC emitting materials. Exposed or open ductwork within the construction area should be sealed to avoid VOC contamination. When feasible, 100% outside air should be used to exhaust VOC contaminated air directly to the outside. On renovation/addition projects, The HVAC air distribution system should be designed so as to not allow transfer of airflow from the construction area to the occupied area. This is achieved by sealing off the return air inlets in the construction area with plastic and creating alternative exhaust measures such as temporary exhaust fans. If the return air system in the construction area must be operated during construction, temporary upgraded high-efficiency filters should be installed to remove contaminants from the air before they enter the HVAC return system.
- Maintaining a pressure differential between occupied and construction area. Occupied areas should maintain a relative positive pressure compared to construction areas. The pressure differential helps

prevent airborne contaminants from migrating into occupied areas (Sustainable 1996). Relative air pressure sensors can be installed with alarm controls to monitor pressure differentials. Maintaining pressure differential require the erection of temporary barriers between construction areas and occupied areas. Positive pressure is created in occupied area by ensuring that the air volume supplied to the occupied space is greater than that supplied to the area under construction. Negative pressure can be created in the construction area by using temporary exhaust fans.

- Isolation of construction areas. The plan should include a layout of construction barriers used to isolate the area of construction from occupied areas. These barriers prevent the migration of contaminants and reduce construction noise that can disrupt occupant activities. All holes, pipes, conduits, or other openings penetrating the construction barrier to an occupied area should be sealed air tight to stop movement of contaminants.
- Egress routing for dust control. On renovation/addition projects, egress routing should be carefully planned to avoid passage of construction workers, materials and/or equipment through occupied building areas.
- Housekeeping procedures. Adequate cleaning of construction projects helps reduce dust, and fungi and help control IAQ contamination. HVAC components such as coils, fans and air filters need special cleaning before system startup.
- Inspection and testing plan. All components of the IAQ management plan such as construction barriers should be regularly inspected to ensure their adequacy. The air in the building is also tested to assure proper quality is being maintained.
- Cleanup of contaminated components after construction is complete. If air testing indicates that specified contaminants limits are exceeded in a given area, this area should be flushed out and retested. This process is repeated until contaminants levels are less than recommended limits.
- Specifying low emission construction products. Although product specification is usually the responsibility of the Architect/Engineer, the contractor can request substituting specified products with low VOC emitting products.
- Scheduling of activities to reduce IAQ problems. Contaminant absorbing materials such as ceiling tiles, carpets, and insulation should be installed after VOC emitting materials such as paints, sealants and coatings are installed and given the opportunity to off-gas their contaminants through proper ventilation of the building. (LEED 2003).

4. Conclusions

Construction and demolition activities have a large impact on the environment. Fortunately, there are several strategies that can lower the environmental impact of construction. The paper discussed many of these strategies. Successful implementations of these strategies do not only reduce impact of construction activities on the environment but also have several other benefits. Strategies that promote environmentally sensitive use of the project site usually produce cost savings to the contractor due to lowered site restoration and landscaping costs after project completion. Strategies that promote prevention of air quality problems are much more cost effective than carrying out remediation work if air quality problems and associated health complications do occur. Strategies that minimize construction waste lower the landfill-tipping fee that the contractor has to pay.

5. References

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