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Construction Noise Control Program for the Clinton Combined Sewer Overflow Tunnel Project

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ABSTRACT

The Clinton Combined Sewer Overflow Tunnel Project in Syracuse, NY involved the excavation and construction of a new 6 million gallon underground CSO preliminary treatment facility. The project broke ground in 2011 and is nearing completion at an approximate cost of $76 million. Construction of this project required work to be performed day and night for three years within close proximity to several noise-sensitive abutters including low income housing, a rescue mission for the homeless, a pharmaceutical manufacturer, more upscale townhouses, and a museum. This paper will describe the development and implementation of the project's Construction Noise Control Program - including the development of contractor specifications, measurement of ambient and construction noise levels, development of the project's Construction Noise Control Plan, and means and methods for overseeing contractor compliance in the field. This paper will also report on the noise control program's successful outcome and number of noise complaints received during construction.

1. PROJECT DESCRIPTION

Onondaga County in Central Upstate New York has developed an award-winning[1] *Save the Rain* program stormwater management plan to reduce pollution to Onondaga Lake and its tributaries. This occurs when stormwater from wet weather events combines with sanitary wastewater to overload the sewer and result in a combined sewer overflow (CSO) release into local waterways and diminished water quality in tributaries to Onondaga Lake. The *Save the Rain* program includes constructing a 6 million gallon CSO storage facility located on a six acre site in the City of Syracuse. The CSO Facility project was implemented in 2009, replacing a more costly $100 million program alternative, as an environmentally green solution effective in controlling CSO events into Onondaga Lake tributaries; thus aiding in the near billion-dollar cleanup effort of Onondaga Lake.

The CSO Facility is being constructed underground and features three parallel 16-foot square tunnels to store stormwater event wastewater until it can be accepted to the Syracuse Metropolitan Sewage Treatment Plant (Metro) for treatment. Conveyance piping for the nine off-site sewers was installed in 2009, and additional on-site conveyance piping to the facility is being installed under this project. The project also includes construction of two above-ground buildings providing tunnel access and housing ancillary pumps, process equipment and odor-control systems.

Construction of the CSO Facility started in November 2011 and is anticipated for completion in late 2013. During that period, construction is being conducted five to six days per week and up to 24 hours per day. To address potential construction noise impacts on surrounding noise-sensitive residential properties and commercial businesses, the project developed Noise Specification 01511 which calls for a Construction Noise Control Plan and implementation of a comprehensive community and on-site sound monitoring program throughout noise-generating phases of construction. Community noise monitoring was conducted continually during construction at the nearest five receptors around the project area. The construction area and five community noise monitoring locations are presented here in **Figure 1**.

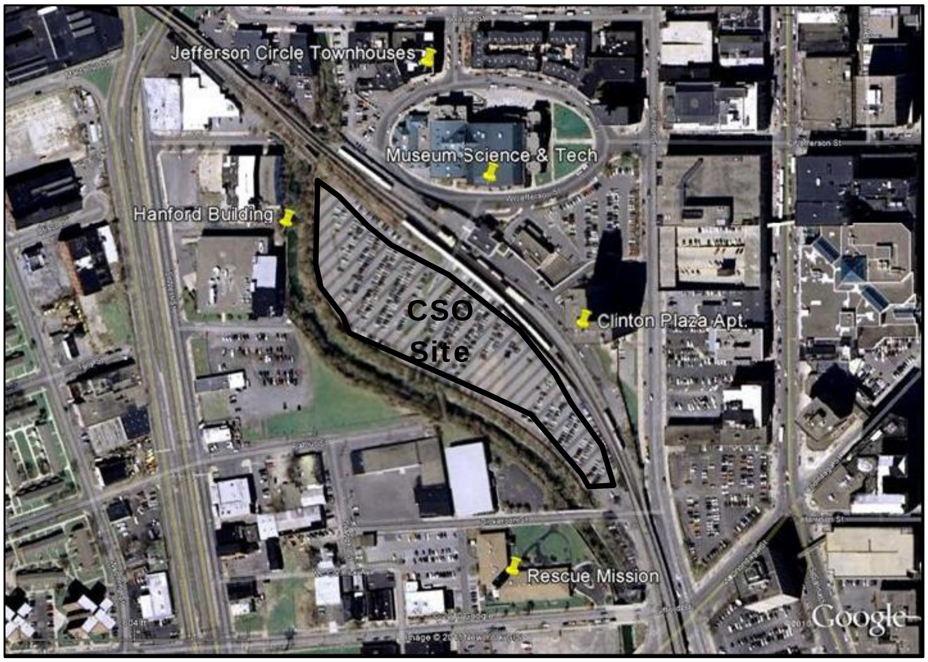

Figure 1. Project Area and Noise Receptors

2. NOISE CONTROL PROGRAM COMPONENTS

Whereas there was a general lack of quantitative municipal noise ordinance restrictions or previously committed noise limits for this project, great latitude was given to the project to devise its own construction noise control program. The components (scope) that made up the project's construction noise control program eventually included the following items:

A. Develop the Project's Noise Control Specification

A construction noise control specification (Specification 01511) was developed specifically for this project. The specification was patterned after the one used at the Central Artery/Tunnel Project[(2)] (The Big Dig) in Boston, which also served as the default criteria in the FHWA's Roadway Construction Noise Model (RCNM). The specification is performance-based, meaning that it establishes limits and measures for contractor compliance but does not direct the contractor on how to achieve these requirements. The specification (a) defines restricted equipment use and activities; (b) establishes community receptor locations and outdoor noise criteria which in general allow the contractor to produce up to 5 decibels more noise on an L10 basis than existed prior to construction; (c) establishes construction equipment noise emission limits at 50 feet; (d) establishes performance requirements for control measures such as noise barriers, curtains and backup alarms; and (e) establishes the procedure to follow in the event of noise complaints.

B. *Perform background noise monitoring*

Background noise measurements were performed for one week in February 2011 at the five community receptor locations identified in Specification 01511. Larson Davis Model 720 noise monitors were deployed to collect background noise data including Lmax, Leq, L1, L10, L90 and Lmin metrics in A-weighted decibels (dBA) with an RMS 'slow' time response. The measured data was reduced into average results for a "typical" 24-hour period at each receptor and further separated into the three time periods required in Specification 01511, namely daytime (7AM to 6 PM), evening (6 PM to 10 PM) and nighttime (10 PM to 7 AM). The community receptors' outdoor noise limits were then established for various land-uses including residences, commercial businesses and institutions, and industrial sites. The resulting background L10 levels and corresponding receptor L10 criteria limits can be seen in **Table 1**.

Table 1. Receptor Background Noise Levels and Lot-Line L10 Noise Limits

Site	Receptor Location and Address	Land Use	Background L10 Noise Level in dBA			Receptor L10 Noise Limit in dBA		
			Day	Evening	Night	Day	Evening	Night
N-1	Clinton Plaza Apartments	Res	60	58	57	75	63	62
N-2	Rescue Mission	Res	56	53	52	75	58	57
N-3	SteriPharma Hanford Building	Com	57	54	54	80	None	None
N-4	Jefferson Clinton Commons Townhouses	Res	69	64	65	75	69	70
N-5	Museum of Science & Technology (MOST)	Com	60	55	54	80	None	None

C. *Develop Construction Noise Control Plan*

In an effort to proactively anticipate and avoid excessive noise levels, a Construction Noise Control Plan (CNCP) was developed. The Cadna-A noise model, as shown in **Figure 1**, was used for this task augmented with equipment noise emission data taken from the FHWA's RCNM model. Several phases of work were evaluated including Phase A - Bridge Demolition, Bridge Installation and 12" Sewer Installation; Phase B - Chambers, Excavation, Overflow, and Conveyances; Phase C.1 - Soldier Pile Wall Construction; Phase C.2 - Cut/Cover Tunnel Construction; Phase D - Building Construction; and Phase E - Site Restoration, 16" Force Main, and Utilities. Predicted noise level results for the loudest phase of work (i.e. Phase B) are shown in **Figure 2**.

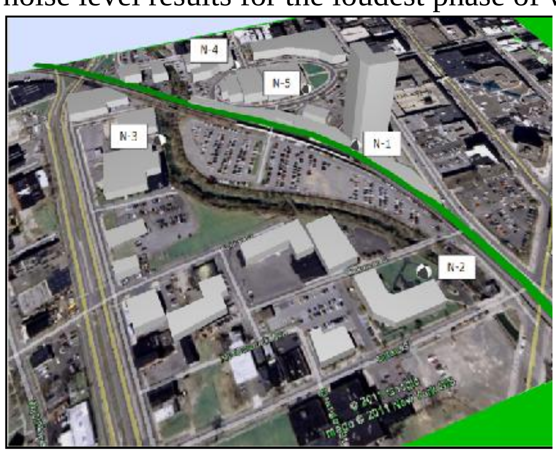

Figure 1. Cadna-A Model Configuration

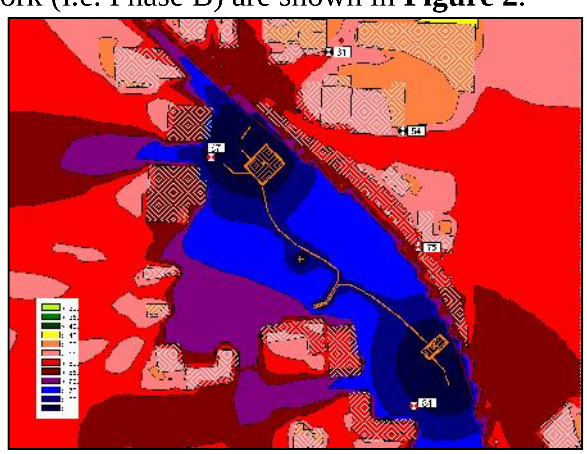

Figure 2. Cadna-A Noise Prediction Results

D. Devise and implement a noise monitoring program

Construction noise levels were monitored throughout construction to ensure contractor compliance with Specification 01511. To this end, a Larson Davis Model LxT noise monitor was deployed as a long-term noise monitor at one of the five community receptor locations and left in place for approximately a week at a time. The monitor would be relocated as needed as the work progressed closer to other receptors. In addition, equipment emission noise measurements were performed by hand using a Larson Davis Model 824 noise meter at a reference distance of 50 feet from the equipment operating in the field. For this project is was determined that EEA personnel would use and maintain the noise monitors on-site and send the resulting data to Parsons Brinckerhoff for reduction, interpretation and report generation. This process of shared responsibility worked exceptionally well and was cost-effective for the project.

E. Recommend general and case-specific noise mitigation measures

In the event construction noise levels become problematic, general "best practice" and case-specific noise control measures are recommended for consideration. That service notwithstanding, the ultimate responsibility for complying with Specification 01511 noise limits rests with the contractor. If the contractor fails to comply then the work can be temporarily suspended until the contractor devises a solution at no additional cost to the project. Examples of best practice construction noise control measures include:

Source Controls

- Time Constraints – prohibiting work during sensitive nighttime hours
- Scheduling – performing noisy work during less sensitive time periods
- Equipment Restrictions – restricting the type of equipment used
- Emission Restrictions – specifying stringent noise emission limits
- Substitute Methods – using quieter methods/equipment when possible
- Exhaust Mufflers – ensuring equipment have quality mufflers installed
- Lubrication & Maintenance – well maintained equipment are quieter devices
- Reduced Power Operation – use equipment of only necessary size and power
- Limit Equipment On-Site – only have necessary equipment on-site
- Noise Compliance Monitoring – have a technician on-site to monitor compliance
- Quieter Backup Alarms – manually-adjustable, ambient-sensitive, or broadband alarms, or prohibition providing an observer directs the vehicle's rearward motion

Pathway Controls

- Noise Barriers – permanent or portable wooden, metal, plastic or concrete barriers
- Noise Curtains – flexible vinyl curtain systems hung from supports
- Enclosures – encasing localized and stationary noise sources
- Increased Distance – perform noisy activities farther away from receptors

Receptor Controls

- Window Treatments – reinforcing the building facade's noise reduction ability
- Community Participation – open dialog to involve affected residents
- Noise Complaint Process – ability to log and respond to noise complaints
- Temporary Relocation to Hotels – in extreme, otherwise unmitigatable cases

3. OVERSIGHT AND ENFORCEMENT

A. *Routine Continuous Community Noise Monitoring*

Continuous noise monitoring was conducted for the first 15 months of construction. The community monitor was routinely inspected once per week to download data, perform monitor calibration/maintenance, move siting (as needed), and to conduct routine on-site noise source measurements. To allow for extended monitoring periods in all weather conditions, the sound level meter was enclosed in a weather-tight case, and the externally located microphone pre-amp was protected with desiccant. For security and accessibility, the case/microphone assembly was custom-designed to lock into and slide along a monorail post that allowed the assembly to be safely raised and locked in position 10 feet above grade. The sliding system also allowed the monitor to be easily lowered by one person for service without use of ladders. The standard power supply, which used heavy lead-cell batteries to allow for 7 to 8-day periods of unattended operation, was found to be too heavy for safe overhead deployment. Therefore, the lead batteries were replaced with dual high-capacity lightweight rechargeable lithium-ion batteries which were configured in parallel to the sound meter's USB external power and data port.

Continuous noise monitoring was conducted at the nearest lot line of the five noise-sensitive receptors identified in the project's Construction Noise Control Plan. Monitoring locations were rotated to other receptors based on the location of construction within the site perimeter. Monitoring duration was weighted to longer periods (up to three to four weeks at time) for the nearest receptors (N-2 Rescue Mission and N-3 SteriPharma), and receptors where complaints had been received (N-1 Clinton Plaza Apartments). The monitor recorded sound levels during all periods of construction activities except for when the monitoring was being serviced or moved from site to site. Sound level data (20-minute, A-weighted percentiles including the L10) were downloaded each week for summary, evaluation and reporting. Example monitoring results during a week in September 2012 during which there were noise complaints can be seen in **Figure 3**.

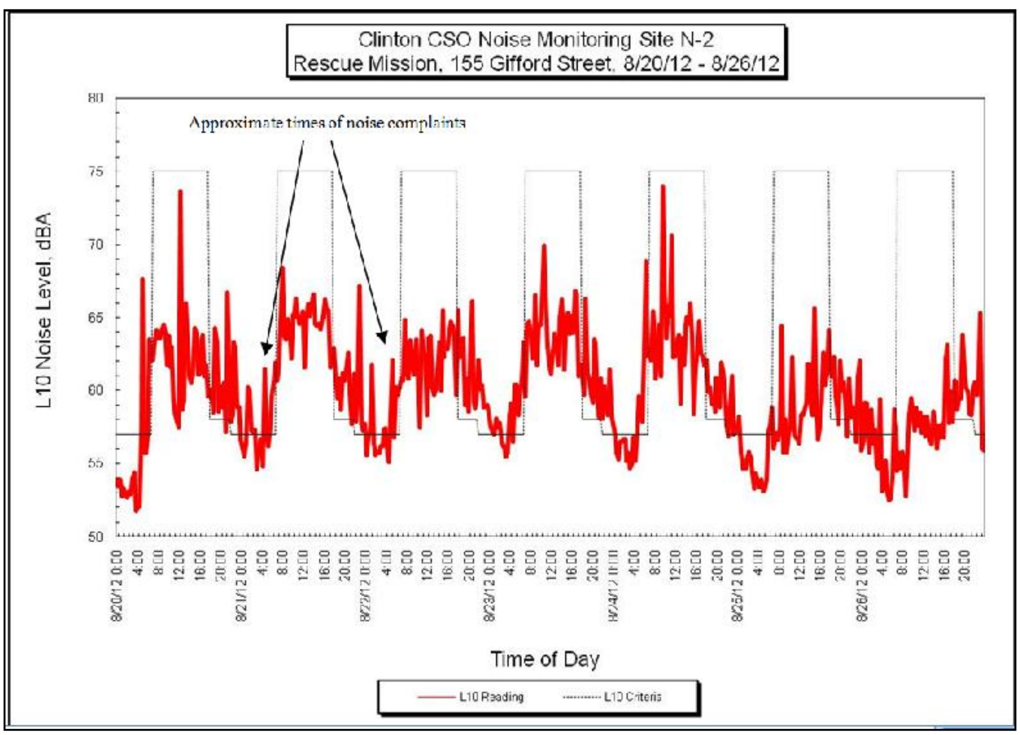

Figure 3. Long-term noise compliance monitoring results with complaints

B. *Routine On-site Noise Source Measurements*

Weekly measurements of major individual construction noise sources were conducted on-site at a reference distance of 50 feet from each major noise source. Sound emission levels for equipment were manually observed and recorded from the sound meter display over a 1-minute time interval for each noise source. Results were compared with project-specific Lmax emission limits at 50 feet for each type of equipment, and controls were recommended when measured emission levels exceeded the project's limits.

C. *Noise Complaint Investigations*

Noise complaints were documented during the construction project and project staff investigated the circumstances involving each compliant. A log was kept to document the date and time of the complaint, the complainant's address, the issue causing the complaint, and the outcome and actions taken as a result of the project's investigation. If the long-term noise monitor was running during the time of the complaint, its data was downloaded and interrogated to see if measured noise levels were exceeding project limits or not. Moreover, handheld noise measurements were performed at 50 feet from the suspected equipment to evaluate compliance with its emission limit.

During the first 15-months of the project five (5) noise complaint events were documented and investigated. Each complaint occurred at night and came from residents living in the 23-story high rise apartments overlooking the project site, i.e. N-1 Clinton Plaza Apartments. A summary of each of the noise complaints, likely causes and corrective actions can be seen in **Table 2**. Excessive noise conditions identified either from analysis of community noise monitoring results or during routine on-site noise source measurements, and proactive actions taken to reduce construction noise and potential for complaints, are summarized in **Table 3**.

Table 2. Noise Complaints and Resulting Actions

Date/ Time	Receptor Location	Complaint Issue	Likely Cause	Result/Action
2/22/12 Night	N-1 Clinton Plaza Apartments	Unknown	Unknown	Not enough details available to investigate, no action taken
3/13/12 Night	N-1 Clinton Plaza Apartments	General noise	Jet grouting drill rig	Recommended new muffler and acoustical curtains for crane, mufflers for air compressors, temporary noise barriers, and avoid night work if possible
3/26/12 Night	N-1 Clinton Plaza Apartments	General noise	Unknown	Monitored noise levels within compliance, no action taken
4/25/12 Night	N-1 Clinton Plaza Apartments	Banging	Hoe ram used to free up stuck grout drill rig	One time problem to free stuck equipment, to be avoided in future
8/21/12 Night	N-1 Clinton Plaza Apartments	Scraping, banging, backup alarms	Transporting soil from stockpiles to conveyance area	Recommended cease hauling by 11 PM, use forward truck movements, install acoustical curtains on tunnel bore and ram

Table 3. Noise Compliance Enforcement Summary

Date	Measured Exceedance	Time	Source	Result/Control
12/12/11 to 1/1/12	On-site	N/A	Ram Hoe	Advised construction team
1/9/12 to 1/15/12	N-2	Early AM	Equipment Mobilization	Advised construction team
2/27/12 to 3/4/12	N-2	Daytime	Drilling and Jet Grouting	Recommend change equipment or abatement
3/12/12 to 3/16/12	N-1 & N-2 & On-site	Night	Soil Mix drill (on-site); drilling and jet grouting	Recommended several mitigation measures
3/17/12 to 3/25/12	N-1	Night	Drilling and Jet Grouting	Drill rig mitigation implemented (-12 dBA); Night SPLs 4 to 6 dBA lower
7/2/12 to 7/8/12	N-2	Night	Pre-Drilling and Jet Grouting	Advised construction team
7/9/12 to 7/15/12	N-2	Night	Pre-Drilling and Jet Grouting	Initially stoppage of noise activity recommended; investigation revealed off-site community noise
8/6/12 to 8/19/12	N-3	Night	Unknown	Night community noise interfered with identification of project noise
10/8/12 to 10/14/12	On-site	N/A	Jack Borer	Mitigation recommended; however jack borer was operated in trench w/ no LOS to receptor which would offer some reduction
11/26/12 to 12/2/12	On-site	N/A	Roller Backup Alarm	Recommend mitigation of adjustable backup alarm if operated at night
12/10/12 to 2/16/12	On-site	N/A	Front-end Loader	Recommend equipment maintenance/replacement. Loader later measured within compliance
General	Primarily N-2	Early AM	Daily Equipment Mob	Sporadic, likely due to equipment startup just before daytime limit took effect

4. UNIQUE CHALLENGES

While every construction noise project will have certain fundamental similarities such as the need to establish fair and reasonable noise criteria and the need for vigilant oversight in the field, there were several unique challenges that presented themselves in the Clinton CSO Tunnel project. In this case, owing to a lack of quantitative local noise ordinance limits, the project was able to develop its own Construction Noise Specification 01511. This is highly unusual given the inherent potential conflict of interest in setting high noise limits in favor of the contractor. However, it was recommended, and soon approved, that the project would adopt a noise specification consistent with the one that served so successfully at the Central Artery/Tunnel Project(2) in Boston (i.e. Specification 721.560). This is also the default approach and criteria found in FHWA's RCNM model, so there was significant precedence that the approach was effective and fair to both the contractor and the community.

Another somewhat unique but certainly challenging aspect of this project was that the most noise-sensitive receptor, N-1 Clinton Plaza Apartments, was a 23-story subsidized housing apartment building directly overlooking the project site. And indeed, the vast majority if not all of the noise complaints received by the project came from residents in this building. However, to make matters more complex, the residents of this building were prone to generating excessively loud noises themselves including shouting, loud music, parties and unmuffled vehicles. Thus, it became difficult when examining the results of the noise data collected at this receptor to determine who was to blame for exceedances, the contractor or the residents.

The solution turned out to be the use two noise monitors running simultaneously, one at the official N-1 receptor location proximal to the Clinton Plaza Apartments, and other placed down in the project work zone close to the equipment to act as a control monitor. When plotted concurrently in time, periods when the contractor was active and producing noise could be clearly seen in relation to the measured results at the receptor's location, as shown in **Figure 4**. In this manner, it could be clearly determined if the contractor was generating excessive noise that required enforcement to bring back into compliance; or as in this case the excessive noise on the third night (March 28-29, 2012) was not attributable to the contractor.

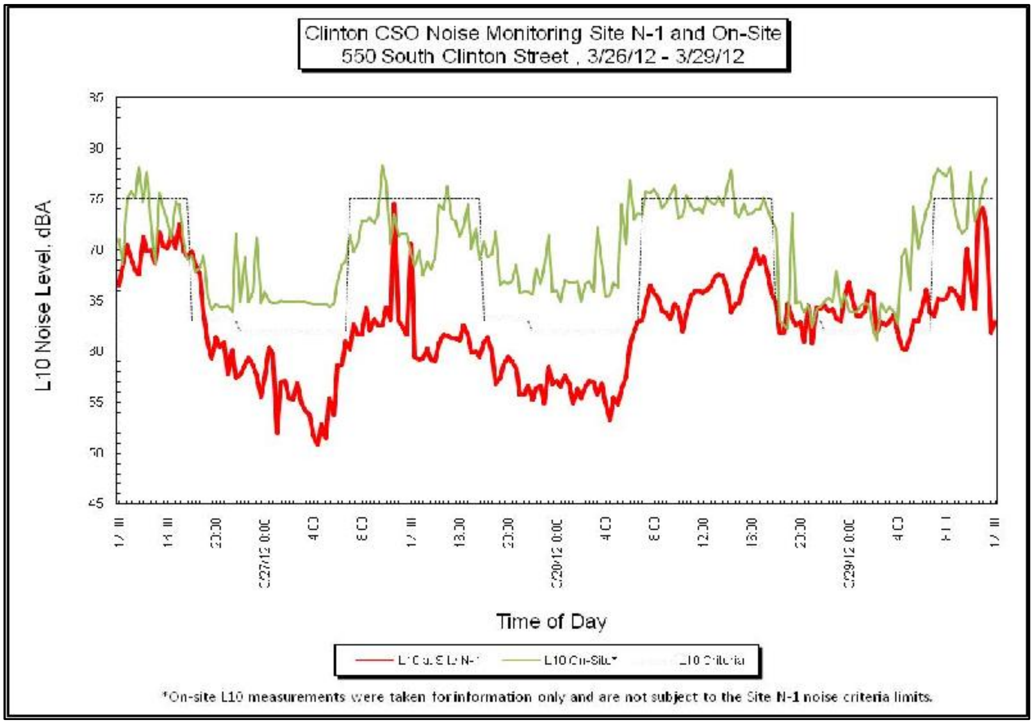

Figure 4. Dual noise monitors in use at receptor N-1

5. CONCLUSION

A construction noise control program was developed and implemented in support of the Clinton CSO Tunnel project in Syracuse, New York. The program was patterned from previously effective programs at other projects and included (1) the development of a project-specific Construction Noise Specification 01511, (2) development of a proactive Construction Noise Control Plan, (3) monitoring of background and construction period noise levels at five community receptors, (4) on-site oversight and compliance enforcement, and (5) recommendation and implementation of noise control measures as warranted.

The results proved successful by any measure; the contractor was able to perform work around the clock and there were only five noise complaints over 15-months of construction. Each complaint was thoroughly evaluated and appropriate corrective actions were taken. As a result, adverse noise impacts to the community were successfully avoided without negatively impacting either the construction project's schedule or budget.

6. REFERENCES

1. The "*Save The Rain"* program was awarded the 2013 US Water Prize by the US Water Alliance in recognition of its support for green infrastructure
2. E. Thalheimer, "*Construction Noise Control Program and Mitigation Strategy at the Central Artery/Tunnel Project"*, Noise Control Eng. J. **48(5)**, Sep-Oct 2000