Reed College Apartments

5510-5522 SE 28th Avenue

Project Summary

Project Type:	Retrofit of a multi-family residential property – demonstration project.
Technologies:	East side soakage trench
Major Benefits:	• Runoff from more than 12,000 sq. ft. of impervious surface - roof and parking lot - has been removed from the combined sewer. • The stormwater system removes more than 269,000 gallons of runoff from the sewer in a typical rain year, with corresponding reductions in runoff pollutants.
Cost:	$33,042 (unit cost of $2.75 per sq. ft. of impervious area managed). Environmental Services provided $30,000 in grant funds for the project[1].
Constructed:	Summer 2002

Overview of the Stormwater System

- Downspouts from two apartment buildings (a total of 7,900 sq. ft. of roof) have been diverted to new subsurface lateral pipes. The laterals connect with new stormwater trunk lines that direct runoff to the soakage trench.
- Runoff from the parking lot (4,100 sq. ft.) drains to one of the new stormwater trunk lines which carries runoff to the soakage trench.
- A silt basin provides pre-treatment for runoff draining to the soakage trench.

Aerial photo of Reed College Apartments, 2002

[1] Portland's Bureau of Environmental Services implemented the Willamette Stormwater Control Program in 2001. The Program offered financial grants and technical support for a series of projects to retrofit existing commercial properties with stormwater controls incorporating green technologies. The Program recruited these demonstration projects to research the feasibility, cost and performance of commercial stormwater retrofits in the area served by the combined sewer. The Program provided grant funds for a total of eleven projects. The projects were completed by July 1, 2003.

Stormwater Capacity and System Components

Stormwater Management Goal

The goal was to meet the Bureau of Development Services (BDS)[2] standard for stormwater disposal. When BDS approved the project in 2002, the disposal standard was to infiltrate at least 3 in. of runoff in 24 hours, which is about the size of the 10-year design storm. All design standards in this report were current in the year 2002.

Outline of soakage trench along the front of the Reed College Apartments - SE 28th is to the left. Not to scale.

Geotechnical Evaluation/Infiltration Test

Geotechnical engineers tested soil infiltration rates at 3 locations on the site of the soakage trench. They augered test holes ranging from 2 to 15 feet deep. Perforated pipes were inserted into the holes and filled with water before falling-head tests were conducted. The test results ranged from 13 in. per hour to 27 in. per hour of infiltration. The engineers reported the soil texture as ranging from silty-sand to sandy-silt, the percentage of sand increasing with depth.

The Natural Resources Conservation Service (NRCS) soil survey for Multnomah County classifies the soils as 51C-Urban Land-Latourell complex. The classification is described as highly developed land atop stratified soils and sometimes fill. The survey provides an estimated infiltration rate of 0.6 – 6.0 in. per hour.

System Components

Soakage Trench

(See Site Plan for details; Figure 1, pg. 8)

Catchment Area: 12,000 sq. ft. total (roofs and parking lot)

Facility footprint[3]*:* 625 sq. ft. *Internal Volume*: 765 cu. ft.

Overflow: No overflow system is required – the soakage trench[4] meets City standards for stormwater disposal.

Capacity: The design is consistent with the configuration from the SWMM for an "eastside soakage trench" and provides slightly more internal volume.

[2] BDS develops standards for stormwater disposal and inspects projects to confirm compliance with those standards.

[3] The footprint has been calculated as the wetted (ponded) surface area when the facility reaches maximum capacity.

[4] The standard eastside soakage trench meets the City's standard for complete stormwater disposal in soils, which infiltrate at least 2 in. per hour. The City requires 24 feet of trench per 1000 square feet of impervious area (drainage catchment). The trench is 3 ft. deep, 2.5 ft. wide, and filled with drainage rock. Flow enters the trench through a pervious pipe that travels the length of the top of the trench. Assuming a porosity of 35%, the trench provides an internal volume of 63 cu. ft. per 1,000 sq. ft. of catchment.

Additional Information:

- The top of the soakage trench is approximately 2.5 ft. below grade; it is covered with soil, and the ground surface is seeded with grass.
- The trench is slightly deeper and wider than recommended by the SWMM: it is approximately 125 ft. long, 5 ft. wide, and about 3.5 ft. deep. It is lined with filter fabric.
- There are three layers of material in the trench:
    - 12 inches of drain rock (top layer)
    - filter fabric
    - 18 in. of sand (bottom layer)
- Flow enters the system through a perforated pipe that travels horizontally along the top of the layer of drain rock.

Looking into the silt basin - note debris in the bottom; spring 2004.

- The trench is 15 ft. from the closest building foundation; it is 20 ft. from the public right of way.
- Flow test: After completion of the project, City staff tested the facility's ability to accept the 25-year storm. To mimic peak flows, a hose passing 380 gpm was introduced at the top of the silt trap after 5 minutes of moderate flows. No problems were observed during the two-minute interval during which the peak rate was applied. The system received a total of 3,900 gallons in 13 minutes (note: the facility has an interior capacity greater than 5,000 gallons).

Piping

- Fourteen downspouts on two buildings were disconnected from the sewer and connected to two new stormwater trunk lines. The laterals total 275 lineal feet of 4-in. ABS pipe.
- The trunk lines total 300 lineal ft. of 6-in. ABS pipe. They run parallel to the building edges.
- The parking lot catch basin, which drains the entire parking lot, was disconnected from the sewer and connected to one of the new stormwater trunk lines.
- The new pipes were sized using the Rational method for a 10-year storm and a 5-minute initial time of concentration.

Silt Basin

Runoff travels through the silt basin prior to entering the soakage trench.

Landscaping

Four existing trees were removed on the west side of the property to allow for installation of the new trunk line pipes.

Irrigation

An irrigation system was not required.

Budget

The final project budget submitted by the Reed College property manager totaled $33,042, including design and construction. The final budget is shown below.

Reed College Apartments Budget Summary		
Item	**Item Cost**	**Total Cost**
Design	$ 6,600.00	**$ 6,600.00**
Demolition, excavation, grading		**$ 7,900.00**
Concrete & asphalt demo, removal, export	$ 2,820.00	
Pipe work - excavate and haul soil	$ 3,387.00	
Soakage trench - excavate and haul soil	$ 1,693.00	
Construction Management *	**$ -**	$ -
Construction:		**$ 16,750.00**
Soakage trench installation	$ 6,380.00	
Pipe installation: materials and labor	$ 3,170.00	
Pipe installation: backfill with 3/4 in. minus rock	$ 2,258.00	
Pipe installation: fill and replace asphalt	$ 4,092.00	
Pipe installation: replace concrete walk	$ 850.00	
Landscaping (s.f.)		
Tree removal and turf re-seeding	$ 1,000.00	**$ 1,000.00**
Permitting		
Site Development permit	$ 792.00	**$ 792.00**
TOTAL		**$ 33,042.00**

* The plumbing contractor managed the project and didn't track management costs separately.

I. Budget Elements

Non-construction Activities
The total cost for overall project management, engineering design, and permitting was $7,392, comprising 22% of the budget. This cost does not include construction management costs (see below).

- **Management (Project and Construction Management)**
  Project management activities were very limited compared to many of the other grant projects. The plumbing contractor managed construction activities. All of his time was incorporated into the construction charges for the project.

- **Design**
  Charges for engineering services including engineering design, surveying, hydraulic evaluations, plan drawings, and permit submittals totaled $6,600, comprising 20% of the budget.

- **Permitting**
  The cost for the site development permit, which incorporates the plumbing permit, was $792, comprising 2% of the budget.

Construction Activities
Demolition, excavation, construction, and landscaping costs totaled $25,650, comprising 78% of the budget.

Flow test - City staff simulated the peak of the 25-yr. storm (hydrant water was injected into the silt basin); 2002

- **Demolition, Excavation, and Grading**
  The site preparation activities, including excavation for the pipes and the soakage trench, cost $7,900 (24% of the budget).

- **Construction**
  Construction activities including downspout disconnection, pipe installation, and installation of the soakage trench totaled $16,750 (50% of the budget).

- **Landscaping**
  Reed College staff removed 4 trees on the west side of the apartments to allow room for construction of the pipe system. The college staff also seeded the ground with turf grass upon completion of the project. Environmental Services staff estimated Reed's costs for these activities at $1,000, about 3% of the project budget.

II. Cost Elements

Pipe Work
The largest single cost was the installation of 575 lineal ft. of small-diameter pipe - 4 in. downspout laterals and a 6" stormwater trunk line. The cost of the pipe construction work was $16,577, including included the costs of asphalt and concrete cutting and removal, excavation, pipe installation, backfilling, and replacement of asphalt and concrete.

Two-thirds of the piping was installed below hard surfaces, which added significantly to costs. The 385 lineal ft. of piping under asphalt and concrete averaged $35 per lineal ft. The average unit cost for piping under grassy/landscaped areas was about $15 per lineal ft. The average cost for all of the piping was $29 per lineal ft.

Soakage Trench
The second largest cost was from the construction of the trench for $8,073.

Engineering Services
The third largest cost was for the design provided by engineering services. As described above, the list of engineering activities is extensive for such a relatively simple project.

III. Cost Comparisons

The relatively high cost of installing an extensive network of new collection pipes, particularly to install pipes under asphalt and concrete, is reflected in this project. Two thirds of the construction cost, including demolition and excavation, was for new pipes, and 80% of the cost for the new pipes was for installation under asphalt and concrete.

The project could have been simplified by modifying the network of downspouts and reducing their number (with a corresponding reduction in lateral pipes). The average catchment per downspout is just 560 square feet of roof, similar to the average for single-family residential homes. In contrast, catchments for downspouts on commercial buildings often exceed 1,500 sq. ft.

The following changes might have reduced project costs. The roof on apartment building #2 is 3,900 sq. ft. in area and slopes to one side. The number of downspout could be reduced from 5 to 3 (average catchment size of 1,300 square feet per downspout). A reasonable cost to replumb the gutters and downspouts would be $1,000. The savings in pipe costs would be $2,600 (2 x 37 lineal ft. x $35 per lineal ft.). The estimated net costs savings would be about $1,600 (the savings in pipe work minus the cost of replacing the gutter and downspouts). It is unknown if the configuration of building #1 is conducive to gutter and downspout alterations.

Maintenance and Monitoring

The owner of the property is responsible for all maintenance activities. Environmental Services will monitor the performance of the soakage trench at the Reed College Apartments for at least five years. Confirming the hydraulic performance of the facility will be a primary focus. Environmental Services will also regularly evaluate the level of effort required to maintain the facility, the success of the planting regime, and comments from the owner.

Successes and Lessons Learned

The Cost of the New Collection and Conveyance System

Construction of the soakage trench seems relatively cost effective even though the new pipe system was more expensive than the facility. Although modification of the gutters and downspouts could have reduced the amount of pipe needed, the project illustrates the extent by which a pipe system installed under asphalt and concrete can increase costs.

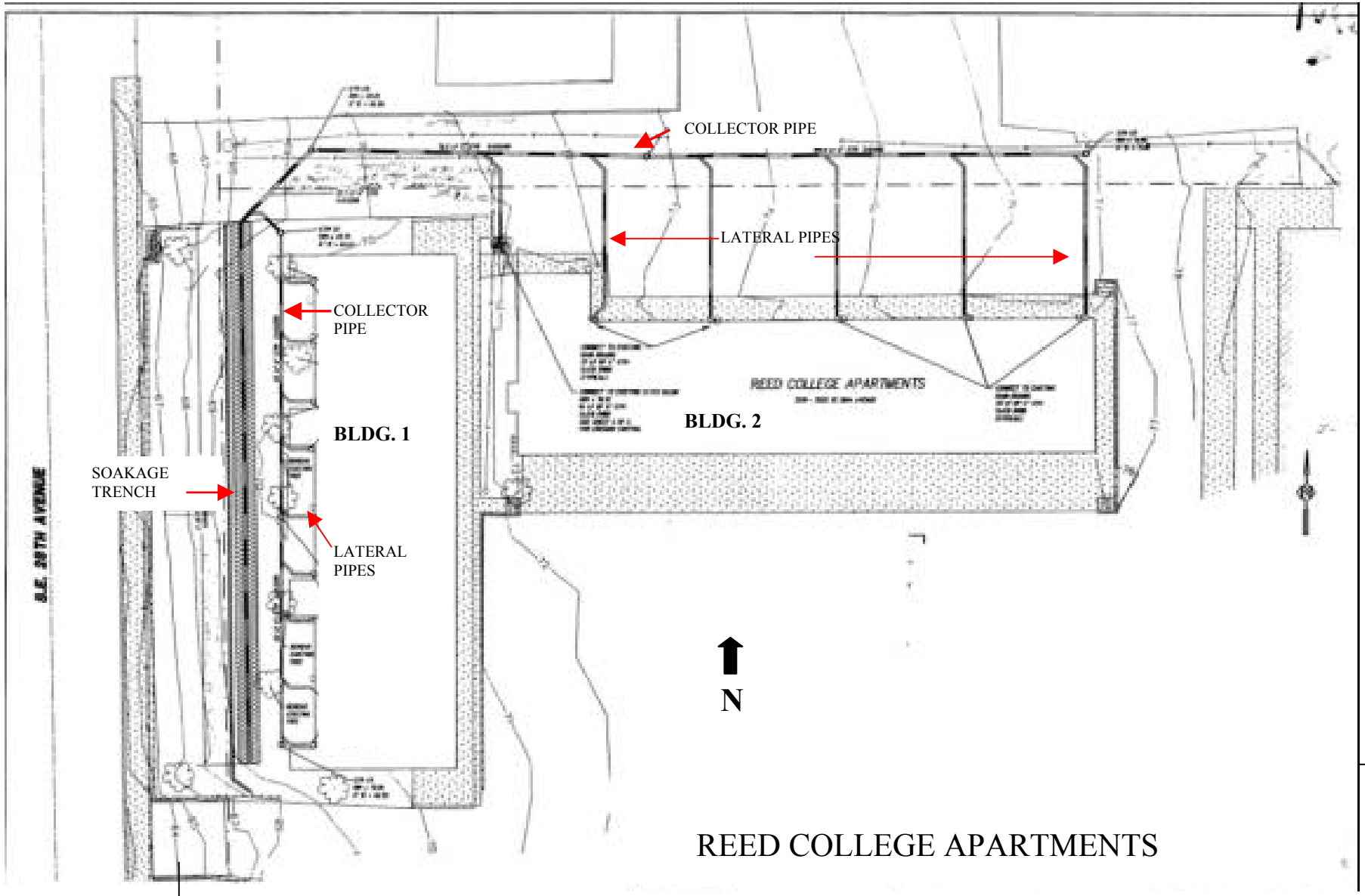
Stormwater Facilities in the Public Right of Way

The initial project plans were for construction of a swale in roughly the same location as the soakage trench. Since the configuration would have required part of the facility to sit in the public right-of-way – which the City does not allow – the soakage trench became a good alternative. Because the soakage trench could be buried more than 2 ft. below grade, it was possible to site the facility entirely on private property. Its depth is a function of the elevation of the pipe system delivering runoff to the facility.

Flow Test

Flow tests have documented the ability of the soakage trench to accept the peak of the 25-year storm.

Figure 1


COLLECTOR PIPE
LATERAL PIPES
COLLECTOR PIPE
BLDG. 1
SOAKAGE TRENCH
LATERAL PIPES
REED COLLEGE APARTMENTS
BLDG. 2
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REED COLLEGE APARTMENTS