

## **Ramona Apartments Ecoroof Final Project Report**

### **Project Summary**

Project Type: Mixed-use, midrise apartments. Five stories of wood-framed construction over a concrete podium.

Project Address: 1550 NW 14th Avenue, Portland, OR 97209

Project Size: 230,762 square feet (6 stories, 138 apartments and 14,444 square feet of ground floor community facilities leased by the Portland Public Schools and Zimmerman Community Center).

Ecoroof Size: 31,597 square feet

Ecoroof Total Cost: \$384,130

BES Grant Request: \$157,985

### **Project Description**

Below the visible plants and soils of the Ramona's ecoroof, there is a multi-layered structure that completes the building's continuous air barrier, provides moisture protection, and provides thermal resistance. The following list describes each layer of the roof and its purpose in the roof system:

1. Plywood sheathing - a layer of tongue and groove plywood is installed on top of the roof trusses.
2. Vapor barrier – a vapor barrier is installed on top of the plywood. The edges are lapped and mopped with a sealant.
3. Insulation – two layers of rigid insulation are installed above the vapor barrier. The joints are staggered and spray foam sealant is applied at any penetrations. By installing rigid insulation on top of the trusses instead of batt insulation between the bottom chords of the trusses, we get better thermal performance for several reasons:
  - » We avoid the installation problems that can occur with batts – compression of the batt, gaps between batts – that reduce its effectiveness.
  - » We avoid the thermal breaks of the framing between the batts that lower the average R-value of the assembly
  - » We avoid having to ventilate the attic space above the batts which brings cold air into the building and allows heat to leak out through the lights and other ceiling penetrations in the top floor.
4. Leak Protection – a layer of wore mesh is installed on top of the insulation as part of a leak

detection system. If a leak ever occurs, it usually shows up at the low point of a low-slope roof. By installing this layer, we can detect where the leak in the membrane is and can repair it with minimal disturbance to the ecoroof.

5. Protection board – This board protects – and augments – the insulation.

*Notes on the Insulating Value:*

- » Total R-value of the roof assembly is R-32.5.
- » In the wintertime, the wet soil has little or no insulating value, but the drainage mat adds an air space which improves the insulating value of the roof. According to one source, the air space may increase the insulating value by R-1.
- » In the summer, the soil and plants may provide two benefits:
  - i. Attic cooling - We expect that they will keep the surface of the roof cooler and reduce the build-up of heat in the attic space. We don't have data to estimate the impact of this.
  - ii. PV panel efficiency - As a rule-of-thumb, the efficiency of a solar cell decreases by 0.5% for every 1.8 °F above 77 °F. Some researchers believe that combining an ecoroof with PV panels increases the efficiency of the PV panels by reducing the ambient temperature on the roof. Studies are underway to gather more data about this.

6. Roof membrane – The roof membrane is a torch-applied, multi-ply SBS-modified bitumen membrane.

7. Protection board – another layer of protection board was installed on top of the membrane to protect it from foot traffic and UV damage during the rest of the roof installation.

8. Root barrier – a thick layer of a root barrier was installed on top of the protection board. This prevents roots from the plants from working their way into the seams of the membrane and causing leaks.

9. Drainage mat – a layer of drainage mat goes down on top of the root barrier. This helps to hold more water on the roof and allows it to be used by plants or evaporate. It also allows water to flow to the drain without taking soil with it.

10. Filter fabric – the filter fabric sits on top of the drainage mat to prevent the loss of soil.

11. Soil, gravel, and rock – Finally, 3.5” of lightweight soil was installed on top of the filter fabric. Pea gravel is installed for walking paths and against the parapets and other locations that are more likely to have leaks. Lightweight lava rock was installed around the PV panels to save weight in locations where plants won't grow.

- » The materials were selected to be as lightweight as possible while still providing good performance. The weight is a big factor on a wood-frame structure.

12. Gravel and paving stones were added to provide pathways for future maintenance.

In addition to the ecoroof, the building’s courtyard contains permeable surfaces, plants, gravel and sand that are designed to filter and retain stormwater. Together with the roof, these elements treat one hundred percent of the property’s stormwater. Additional benefits of the ecoroof are the mitigation of the urban heat island effect and providing an environment for native habitat.

The Ramona’s roof also holds both a 30kWh photovoltaic array, expected to generate enough energy to run the Ramona’s elevators and hallway lights, and 64 solar hot water panels, which will supply approximately half of the building’s hot water.

**Budget**

Membrane/water proofing	105,952
Root barrier	14,178
Drain mat	26,101
Protection board	13,904
Soil	18,480
Plants	33,031
Gravel/pavers	3,847
Edging	6,520
Irrigation	14,000
Crane	3,160
Labor	84,831
<b>Subtotal</b>	<b>324,004</b>
Est. Additional Structural Work	50,126
Est. Additional Design Work	10,000
<b>TOTAL</b>	<b>384,130</b>

**Maintenance**

Overall, the ecoroof will require minimal maintenance. The primary task will be weeding the roof a few times a year to prevent any invasive plants that may take root. Monthly weed control is required during the first and second years’ growing season, after which quarterly weeding should be sufficient.

**Lessons Learned**

We expect that we will learn more lessons over the next few years as the roof matures.

Here are some observations from the design and construction phase:

1. Ecoroof industry - We first installed an eco-roof about 10 years ago on Buckman Terrace Apartments. The level of knowledge in the field has changed dramatically since then. However, it still has a long way to go. In designing this roof, we encountered widely varying opinions among the city, the designers, the manufacturers, and the installers about the best products and methods to use. BES needs to continue its efforts to collect data, share results, and foster communication in the industry.

2. Ecoroofs and wood-frame buildings – The ecoroof adds significant weight to a wood-frame structure. The structural system and the roof trusses must be stronger to support the weight and to resist the additional shear forces. These costs need to be calculated as part of the cost of the ecoroof.

- a. Knowing soil weight and depth – It is critical to know the weight early in the design process of the building before the work is bid. We need to continue to gather information about the type of soil mixes and depths that will support a viable ecoroof in our climate.
- b. Incremental costs of structure – The incremental costs of the added structural work may vary based on the building design. Because we used a brick skin for all 6 stories on the building, the incremental costs of adding the ecoroof were smaller than they might have been. If we built a wood-frame building in a less urban location, we would probably use lap siding. In that case, the added weight on the roof would probably cause a bigger increase in added structural costs.

3. Plants vs. Cuttings – There appear to be pros and cons for each of these ways of putting the plant material on the roof. We originally specified potted plants, but added some cuttings to replace plants that died before getting on the roof.

- a. Potted plants - These can get the roof started right away, but also may have a few drawbacks:
  - i. Getting the soil right – In a roof like ours with specialized lightweight soil mixes, the plants need to be started in the nursery in the same soil. This means more diligence in quality control to be sure this is done right. It also means that it might not be possible to change the soil mix during the course of construction. Sometimes this is necessary because of availability or desirable because of possible savings or even as a way to upgrade if contingency is available late in the project.
  - ii. Insects and birds – It seems that the potted plants can arrive with insects in the root balls. The crows find them and pull the plants out of the pots or out of the soil to get the insects. We have heard that this is common and we have also heard that it may not be as much of a problem in the summer when food is more abundant.
  - iii. Weather – A cold snap in February killed a lot of our plants before they arrived at the project.
- b. Cuttings – These may require less labor because there is no digging involved, they avoid the problem of getting the soil right and being locked into a type of soil, and would probably avoid the problem of insects. They may have some drawbacks.
  - i. Coverage – We received conflicting advice about the density of coverage (pounds per 100 SF). Having clear answers about this would be helpful in designing and bidding the work.
  - ii. Weather - We understand that these might work best in the spring when they can take root more easily. We aren't certain if these are viable at other times of the year. It's worth finding out.

- iii. Wind – We received conflicting advice on whether or not cuttings needed to be protected with some type of mesh covering to prevent them from blowing away. If they do, this would be an added expense that would have to be factored in. It would be good to know more about whether or not this is needed and, if so, whether it is only needed at certain times of the year.
- iv. Birds – It seems possible that the birds may like the cuttings as food. We'll find out soon enough.

4. Designing for Measurement Devices – At BES's request, we added flumes at two of the roof drains so that BES can measure the amount of stormwater getting to the storm system. This raised the level of the primary roof drain so that it is closer to the height of the adjacent overflow roof drain. As a result, we have been getting water flowing out of the overflow spouts. Normally this is an indication that a primary drain is plugged. To avoid getting that false signal, we need to raise the intake of the overflow. Two lessons from this are:

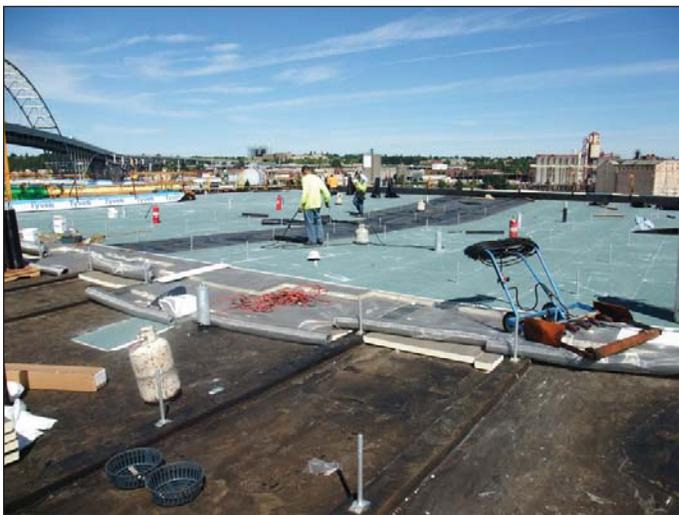
- a. Specs for the flume – Since BES was supplying this, I'm not sure we had specs for the flume in advance. (Or maybe we did, but just didn't anticipate the effect of adding it.) Having these specs would also ensure that we make the well around the drains large enough to accommodate the flume.
- b. Flume location – If we had designed in advance, it would have made it difficult to change the location of the flumes as the plan for the ecoroof evolved.
- c. Permanent vs. temporary installation – It's probably best to design a temporary method to raise the intake for the overflow drain so that it can be lowered again when the flume is removed in the future. Otherwise, the intake for the overflow would be too high and would allow too much standing water on the roof.



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### Photo Legend

1. Vapor barrier is installed over plywood sheathing.
2. The multi-layered system: vapor barrier, rigid insulation, leak detection, protection board and first layer of membrane.
3. Workmen torch down the siplast membrane.
4. Soil being delivered to the roof by crane.
5. Soil being unloaded.
6. The primary and back-up drains.
7. Potted plants ripped out by birds.
8. South wing of the roof looking east.
9. Aerial view of the roof with soil, PV panels and solar hot water panels.



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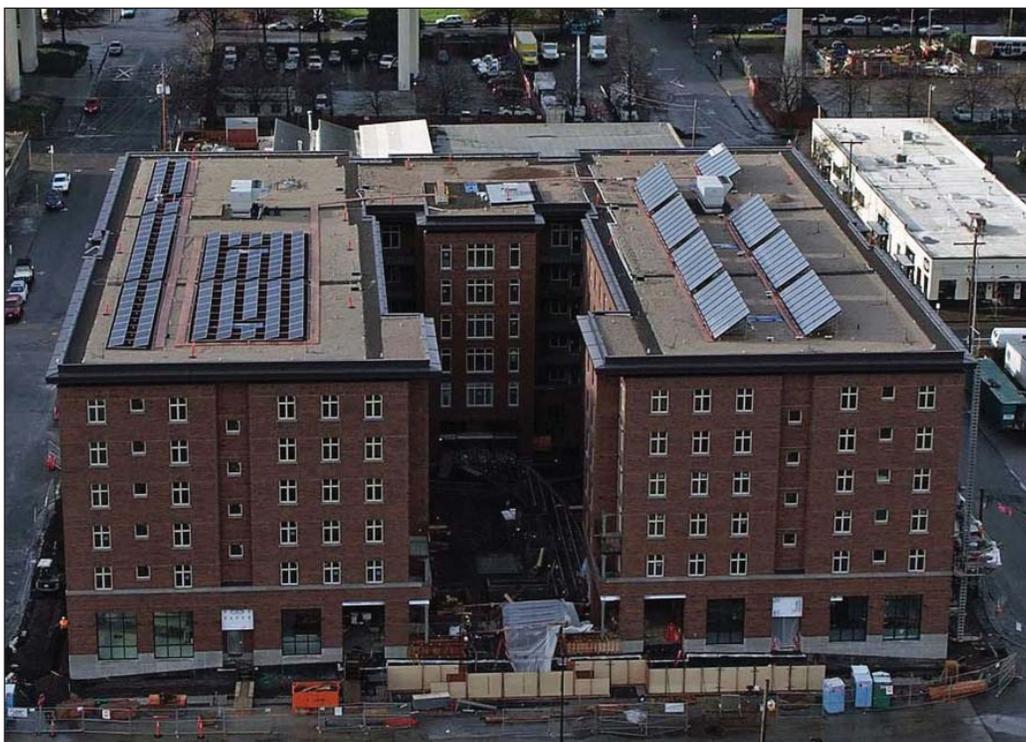
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