



STUDY GUIDE

For the

REGISTERED WATERPROOFING CONSULTANT (RWC®) EXAM

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RWC EXAM STUDY GUIDE

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**STUDY GUIDE
RWC® EXAMINATION
RCI, INC.**

INTRODUCTION

One early goal of RCI, Inc. was to develop a highly recognized registration program. The Registered Waterproofing Consultant (RWC) Program was developed in 2004. The primary beneficiaries of this registration program are the public, the waterproofing industry, and those individuals who become registered.

Registration is a two-part process. The comprehensive application allows RCI to verify certain aspects of education and waterproofing experience. The examination confirms these qualifications by testing one's knowledge of above and below-grade waterproofing and the applicant's ability to use this knowledge in practical applications.

This study guide outlines subjects that are addressed in the computer-based examination; however, it is not intended to be an inclusive listing of every topic addressed. This document is strictly a guide. The examination is not tailored to any one particular area of building envelope waterproofing or to the design and construction practices unique to any one geographic area. It deals with waterproofing consulting in general. It may include all phases of waterproofing consulting such as: evaluation, design, testing, materials, and all waterproofing systems.

In order to receive a passing score on the examination, the candidate must be thoroughly familiar with a broad spectrum of principles related to waterproofing issues. This includes knowledge of different waterproofing materials, systems, and installations when reviewing, specifying and inspecting construction projects. Qualified applicants must be aware of applicable building codes and standards. Education and training is extremely important. Practical application under the guidance of a qualified mentor may be even more important because it reinforces formal education and training, and provides a sound foundation for a broad variety of responsibilities. It pulls everything together. The weakness most often identified with exam failure is a narrow focus in the industry.

The RWC exam is offered by Castle Worldwide, a computer-based testing company which has over 1,000 conveniently located testing centers. Approved applicants will be sent exam registration forms. After these are processed at RCI, candidate information will be conveyed to Castle and the candidates will be contacted to schedule a testing session. The examination is up to four hours in length and consists of 60 multiple-choice questions that will test knowledge in the following waterproofing areas: materials, systems, design, industry standards, and testing and investigations. Some problems may involve mathematical computations that require familiarity with basic algebra, geometry and trigonometry. Reference materials, charts and/or tables needed for the solution of problems will be provided within the exam.

To earn the RWC designation, both the General Knowledge Consultant (GCK) and Registered Waterproofing Consultant exams must be taken and passed. There is no separate application for the general exam; approval of the RWC application will qualify the candidate to take this exam. If only one of these two exams is passed, the candidate is required to retake only the exam he or she failed. The exam that has been passed will be valid until the candidate passes the other exam and the designation is earned. Candidates who do not initially pass an exam will have the option to retry every four months. Once an applicant has passed the GCK exam, it will not need to be retaken should there be interest in other RCI consultant designations (Registered Roof Consultant and Registered Exterior Wall Consultant).

Approved applications have a two-year shelf life; and once the application has expired, reapplication will be necessary.

Although not required, RCI's Waterproofing course may be useful for anyone pursuing this designation. A sample of references which were used to develop the RWC exam is as follows:

References*

	Title	Author	Publication Date
1	<i>ASTM International Standard Guide 5898 Details for Adhered Waterproofing</i>	Committee D08.22	2006
2	<i>Construction Waterproofing Handbook 2nd Edition</i>	Michael T. Kubal	2008
3	<i>Manual of Low-Slope Roof Systems Fourth Edition</i>	C.W. Griffin and R.L. Fricklas	2006
4	<i>NRCA Waterproofing Manual</i>	NRCA	2005
5	<i>Principles of Design and Installation of Below-Grade and Building Deck Waterproofing in 2010</i>	Rutila, Klein, Normandeau	October 2011-Online
6	<i>RCI Manual of Practice</i>	RCI, Inc.	2010
7	<i>RCI Waterproofing Course Manual</i>	RCI, Inc.	2018
8	<i>RCIF Roof Drainage</i>	Stephen Patterson, Madan Metha, J. Richard Wagner	2003
9	<i>SWR Institute Below-Grade Waterproofing Manual</i>	Sealant, Waterproofing & Restoration Institute	1999
10	<i>The Manual of Below-Grade Waterproofing Systems 2nd Edition</i>	Justin Henshell	2016

* The references listed above are only some of the many that were used in the development of this exam. This is meant to serve as a guide to illustrate the types of references used; this is not a recommendation or suggestion to purchase all of the publications listed. The most useful tool in preparation for the exam is the following list of skills, knowledge and responsibilities identified by the task force as those associated with acceptable performance within the waterproofing consulting profession. It is recommended that the applicant review this list as it relates to one's experience/skill set and then prepare accordingly with the courses and/or publications which may be helpful to the individual.

As part of the exam revision process, the task force of subject matter experts systematically compiled a list of objectives that relate to the responsibilities, knowledge, and skills associated with acceptable performance within the waterproofing consulting profession. This list provided the organizational framework for the exam and is included below. The percentage of questions on the exam from each section is indicated.

Sections	Section/Objective Title	Percentage of questions from section on exam
Section 1	Materials	22%
Objective 1.1	Identify different waterproofing materials	
Objective 1.2	Describe how to properly select waterproofing materials	
Objective 1.3	Demonstrate knowledge of how to properly use materials for waterproofing	
Section 2	Systems	21%
Objective 2.1	Describe the difference between waterproofing and dampproofing	
Objective 2.2	Describe waterproofing system applications	
Objective 2.3	Demonstrate knowledge of below-grade waterproofing systems	
Objective 2.4	Demonstrate knowledge of above-grade waterproofing systems	
Section 3	Design	33%
Objective 3.1	Describe how to design above-grade and below-grade waterproofing systems	
Objective 3.2	Describe the performance criteria of a waterproofing system	
Objective 3.3	Demonstrate how to perform various calculations pertaining to waterproofing	
Objective 3.4	Demonstrate knowledge of how to properly detail waterproofing systems	
Objective 3.5	Describe geotechnical conditions	
Objective 3.6	Describe various drainage systems related to waterproofing	
Section 4	Industry Standards	7%
Objective 4.1	Identify safety hazards associated with waterproofing systems	
Objective 4.2	Identify standards and codes applicable to waterproofing	
Section 5	Testing and Investigation	17%
Objective 5.1	Demonstrate knowledge of various test and investigative methods for existing waterproofing	
Objective 5.2	Describe testing methods related to new or replacement waterproofing installations	
	Total	100%

RWC Exam Sample Questions

Sample questions are provided from each section of the exam and are indicative of the types of questions you will encounter. Exhibits and answers have been provided at the end of the study guide. Partial credit is **not** given for one correct answer where two are required.

Materials

1. The excavation for the basement of a new office building has been completed. It has been determined that the underslab waterproofing will be applied directly over the prepared grade prior to any preliminary working ("mud") slab being poured on-site.

Which type of waterproofing material should be installed?

- A. acrylic modified cementitious compound
- B. bentonite clay panels
- C. rubberized asphalt membrane
- D. thermoplastic CPE membrane

2. Which type of material only becomes waterproof when exposed to moisture?

- A. acrylic modified cement
- B. bentonite clay panels
- C. hot rubberized asphalt membrane
- D. thermoplastic membrane

3. A concrete structure constructed over a retail area is intended to be a pedestrian walkway to gain access to an adjacent building.

Which two systems would be used to waterproof the top surface of the concrete structure? (Choose two.)

- A. two-ply modified-bitumen membrane with an aluminum foil-faced surfacing
- B. polyurethane coating with embedded sand aggregate surfacing
- C. prefabricated cardboard bentonite panels with concrete pavers
- D. PVC single-ply membrane with metal walkway planks

4. Pavers will be installed on pedestals that are to be placed over a waterproofing membrane applied on a concrete plaza deck.

Which two materials would be installed between the pedestals and waterproofing membrane? (Choose two.)

- A. high density polyisocyanurate insulation board
- B. extruded polystyrene insulation board
- C. exterior glass mat gypsum board
- D. prefabricated drainage composite panel

5. You are retained by an architect to provide design review as a waterproofing consultant for a new project consisting of a below-grade cast-in-place concrete parking structure. The geotechnical report indicates that corrosive soils are present in the building site. The project is located in a northern climate and freeze-thaw cycling is expected over the service life of the structure. The architect has specified a crystalline coating to be applied on the interior side of the below-grade walls.

Which two considerations should your review include? (Choose two.)

- A. Negative-side waterproofing will leave the concrete structure exposed to a potentially harmful corrosive environment.
- B. Freeze-thaw cycling may cause damage to the concrete due to moisture being trapped in the concrete by the coating.
- C. Crystalline coatings typically have high vapor transmission ratings, which may cause high humidity inside the structure.
- D. The crystalline coating's effectiveness may be damaged by the carbon dioxide emissions inside the parking garage over time.

6. A contractor proposed to use a hot-applied rubberized asphalt (HARA) membrane instead of a solvent-based liquid applied membrane on a concrete deck application.

Which two application advantages does the HARA membrane provide? (Choose two.)

- A. low odor
- B. no cure time
- C. works well at lower ambient temperatures
- D. compatible with PVC flashings

7. A concrete contractor has submitted a Request for Substitution for replacing the specified PVC water stop with a hydrophilic rubber water stop in the vertical and horizontal foundation joints.

You approve this request with which condition?

- A. Make the replacement, but not in the keyway of the foundation wall or slab.
- B. Make the replacement, but not on the inboard side of the reinforcing bars.
- C. Make the replacement, but not within 1 inch [25 mm] of the concrete face.
- D. Make the replacement, but not at the top and side of the keyway.

Systems

8. While designing the connecting tunnel between an existing office building and a new parking garage, it was determined that the tunnel will need to be protected from damage due to moisture. The tunnel will be constructed using a cast-in-place concrete floor and ceiling slab with 8 inch [200 mm] thick reinforced concrete masonry unit walls. The geotechnical report indicates that the tunnel will be exposed to hydrostatic pressure on a seasonal basis.

Which material should be applied to the exterior of the tunnel construction?

- A. fiber-reinforced cement parging
 - B. self-adhered modified-bitumen membrane
 - C. siloxane compound
 - D. clay emulsified asphalt
9. For conditions where void (carton) forms are required due to expansive soils, which two waterproofing systems would you recommend for use as a positive side, underslab, waterproofing system? (Choose two.)

- A. adhesive-coated HDPE sheet waterproofing
- B. bentonite sheet waterproofing
- C. thermoplastic sheet waterproofing
- D. cementitious waterproofing

10. Chronic leaks have been occurring in a parking deck with a cast concrete slab wearing surface over the waterproofing system, which is installed on a structural concrete substrate.

Which two actions should be performed to rehabilitate the waterproofing? (Choose two.)

- A. Clean the surface of the concrete topping slab and apply crystalline waterproofing.
- B. Remove the topping slab, install hot-fluid-applied polymer modified asphalt waterproofing, and place a new 6 inch [150 mm] concrete topping slab.
- C. Remove the topping slab, install bentonite panel waterproofing, and place a new 6 inch [150 mm] concrete topping slab.
- D. Prepare the surface of the concrete topping slab and install a new hot-fluid-applied polymer modified asphalt waterproofing.

11. Refer to Exhibit #1

Which waterproofing is an acceptable material for the condition represented in the photograph shown in the exhibit?

- A. bentonite sheets
- B. butyl rubber
- C. liquid-applied membranes
- D. PVC sheets

12. A parking garage deck waterproofing system has horizontal joints that are expected to experience 50% movement.

According to ASTM C920, the horizontal joints should be treated with which sealant?

- A. Type M, Grade NS, Class 25
- B. Type M, Grade P, Class 50, Use T
- C. Type M, Grade P, Class 25, Use T
- D. Type M, Grade NS, Class 50, Use NT

Design

13. According to ASTM C981, what are the conditions related to drainage for a concrete plaza, over occupied space, with a built-up asphalt bituminous membrane for waterproofing?

- A. The deck can be level since these membranes can withstand ponding.
- B. The deck must be sloped 1/4 inch/foot [2%] to drain.
- C. The deck must be sloped 1/8 inch/foot [1%] to drain.
- D. The deck can be level only if you use a drainage board over the membrane.

14. Which waterproofing system would be applied to concrete that was placed seven days ago and may be subject to dynamic cracks?

- A. prefabricated bentonite geocomposite sheet
- B. fully adhered polymer-modified bitumen sheet
- C. crystalline cementitious waterproofing
- D. liquid-applied bitumen-extended urethane

15. Joints in a concrete substrate are to be placed at 30 feet [9 m] on-center.

What represents the joint movement and adequate joint width required with a Coefficient of Linear Expansion for concrete of 6.20×10^{-6} inch/(inch.degree F) [11.1×10^{-6} mm/(mm.degree C)], with a low temperature of 40 degrees F [4 degrees C] and a high temp of 140 degrees F [60 degrees C], sealant movement of 50%, and zero tolerances?

- A. movement = 0.2232 inch [5.6 mm]; joint size = 3/8 inch [9 mm]
- B. movement = 0.2232 inch [5.6 mm]; joint size = 1/2 inch [13 mm]
- C. movement = 0.3125 inch [7.8 mm]; joint size = 5/8 inch [16 mm]
- D. movement = 0.3125 inch [7.8mm]; joint size = 3/8 inch [9 mm]

- 16.** You are asked to specify a sealant for a parking deck expansion joint. The structural engineer has indicated the 1 inch [25 mm] wide joint will need to accommodate up to 1/2 inch [12.5 mm] movement.

Which sealant would you recommend?

- A.** Type S; Grade NS; Use T; movement up to 25%
- B.** Type M; Grade NS; Use T; movement up to 50%
- C.** Type S; Grade P; Use NT; movement up to 125%
- D.** Type M; Grade P; Use NT; movement up to 25%

- 17.** You are considering several designs for the perimeter details of a proposed vegetative waterproofing assembly.

According to the RCI Waterproofing Manual, which two advantages would a 4 foot [1.2 m] wide ballasted strip have over a monolithic concrete traffic slab in this scenario? (Choose two.)

- A.** access to repair membrane flashings
- B.** prevention of root growth towards membrane flashings
- C.** ventilation of root systems
- D.** compliance with wind uplift requirements

- 18.** What is a water table?

- A.** An underground lake which intersects the footings.
- B.** The level of water in the ground below which the soil is saturated.
- C.** Water that is retained by an impermeable clay layer.
- D.** Water that flows across the foundation from one side to the other.

- 19. Refer to Exhibit #2**

During the preliminary design of a third-floor employee terrace area for a new office building, you are asked to design the terrace drainage system. The configuration of the terrace area is shown in the exhibit. The design rainfall is 4 inches per hour. Due to available space in the ceiling plenum, the maximum roof leader pipe slope is limited to 1/4 inch per foot [2 percent].

Referring to the exhibit, what is the size and slope of the last section of horizontal roof leader piping prior to continuing down through the building?

- A.** 6 inch diameter pipe at 1/2 inch per foot slope [4 percent]
- B.** 6 inch diameter pipe at 1/4 inch per foot slope [2 percent]
- C.** 6 inch diameter pipe at 1/8 inch per foot slope [1 percent]
- D.** 8 inch diameter pipe at 1/8 inch per foot slope [1 percent]

Industry Standards

20. What describes a safe oxygen level for human occupancy in an excavation greater than four feet deep?

[What describes a safe oxygen level for human occupancy in a confined space?]

- A. an oxygen level greater than 10.5%, but less than 12.8%
- B. an oxygen level greater than 16.5%, but less than 19.5%
- C. an oxygen level greater than 19.5%, but less than 23.5%
- D. an oxygen level greater than 23.5%, but less than 33.3%

21. You are specifying a self-adhesive rubberized asphalt membrane for a below-grade foundation wall.

Which two design considerations should be included in your specifications? (Choose two.)

- A. Treat cracks less than 1/16 inch [1.6 mm].
- B. Ensure substrate is clean, dry, and frost free.
- C. Prime the substrate.
- D. Prepare voids and honeycombs with silicone sealant.

Testing and Investigation

22. You are asked to investigate water infiltration problems on the topmost level of a below-grade parking garage. The upper surface of the garage at grade is grass covered. From inside the garage, you can see that the main garage roof structure is composed of 5 foot [1.5 m] wide single-span precast concrete double-tees. After heavy rains and snow melts, water leaks appear through the joints between the precast members in widely-dispersed areas of the garage. A recent building condition report indicates that the garage structure is about 30 years old and the original waterproofing consists of an organic felt built-up membrane. The total area of the waterproofed surface is approximately 20,000 square feet [1860 square meters].

Which two investigative procedures would be appropriate to determine remedial action? (Choose two.)

- A. Conduct a series of 25 4 inch [100 mm] diameter test cores through the full waterproofing and structural system from the top side, chosen at random, to get a number of samples of the membrane and concrete condition. Conduct moisture content testing on the membrane samples.
- B. Remove the landscaping material at the roof/wall junction at the exterior edge of the garage down to the membrane level to expose the system construction.
- C. Perform chloride ion tests on the concrete to establish the extent of corrosion. Conduct electronic leak detection tests on the membrane from the upper surface of the deck.
- D. Dig three test openings 6 feet by 6 feet [1.8 m by 1.8 m] in size, chosen over leaking areas, down to the membrane level, and investigate the condition and the construction of the waterproofing membrane.

23. Refer to Exhibit #3

You observed the crack shown in the exhibit at a below-grade parking garage.

Which repair method should you recommend?

- A.** self-adhering tape
- B.** chemical grout injection
- C.** rout and seal crack with silicone sealant
- D.** rout and seal crack with urethane sealant

24. You are asked to perform quality control testing on an extensive garden roof with a 15- degree slope. The membrane is a black, fully adhered EPDM over rigid insulation.

Which test should you use?

- A.** EFVM
- B.** nuclear
- C.** capacitance
- D.** ASTM D5957 flood test

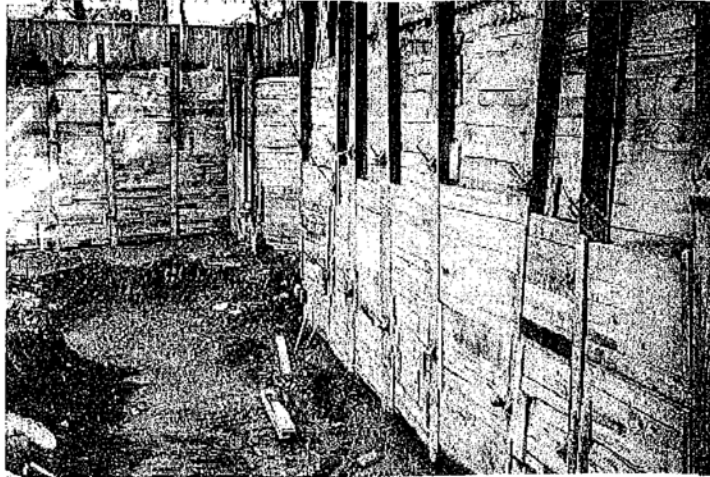
25. Refer to Exhibit #4

The exhibit shows a wet-film thickness measurement on a liquid-applied membrane with an 80% solids content based on the measured wet-film thickness shown on the exhibit.

What is the expected minimum dry-film thickness at the measured location?

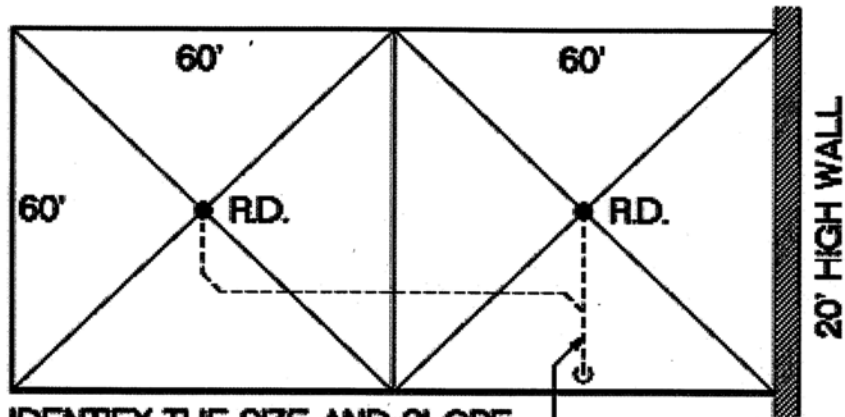
- A.** 12.5
- B.** 44
- C.** 48
- D.** 52

Exhibit #1



Courtesy of Henshell & Buccellato, Consulting Architects

Exhibit #2



IDENTIFY THE SIZE AND SLOPE OF THIS SECTION OF ROOF LEADER PIPING

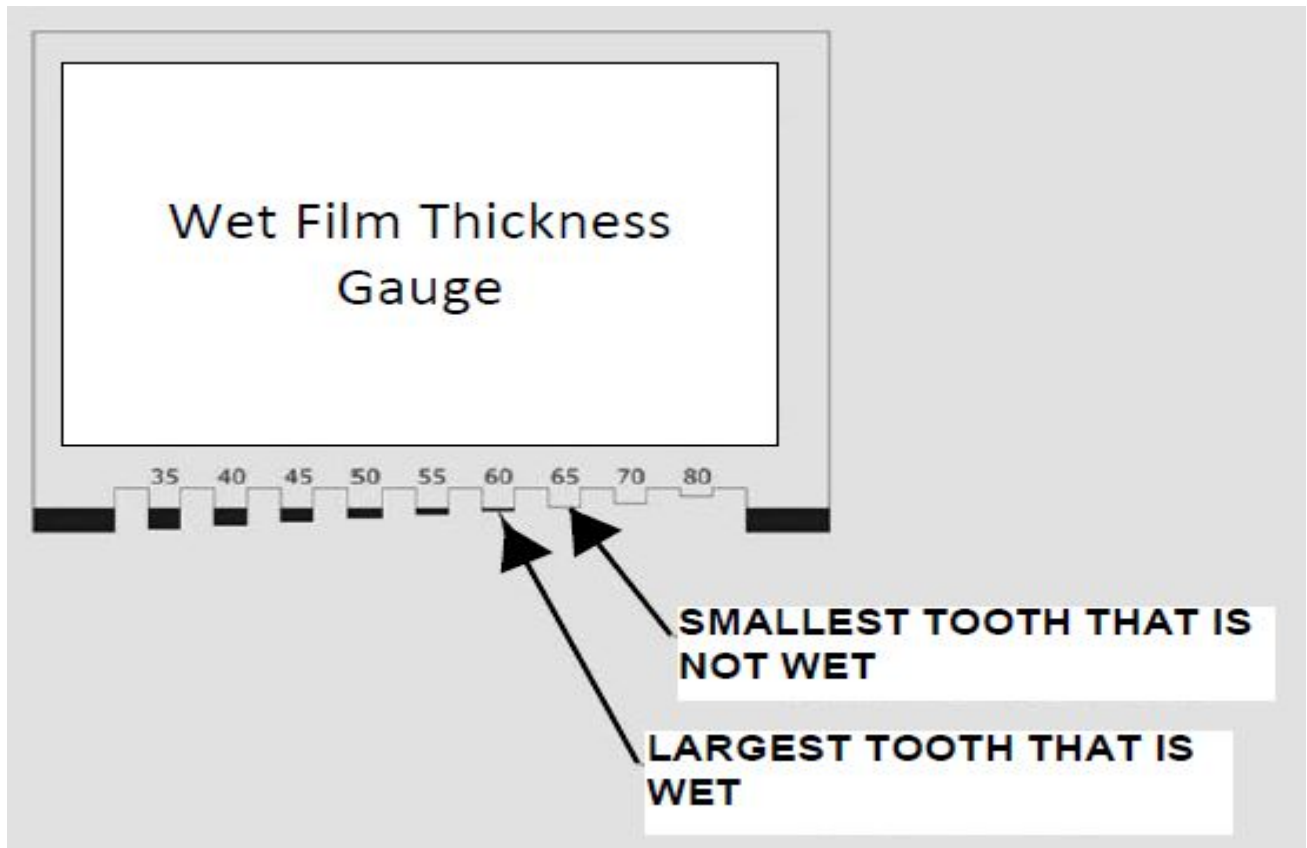
SIZE OF HORIZONTAL STORM DRAINAGE PIPING

SIZE OF HORIZONTAL PIPING (inches)	HORIZONTALLY PROJECTED ROOF AREA (square feet)					
	Rainfall rate (inches per hour)					
	1	2	3	4	5	6
¹/₈ unit vertical in 12 units horizontal (1-percent slope)						
3	3,288	1,644	1,096	822	657	548
4	7,520	3,760	2,506	1,800	1,504	1,253
5	13,360	6,680	4,453	3,340	2,672	2,227
6	21,400	10,700	7,133	5,350	4,280	3,566
8	46,000	23,000	15,330	11,500	9,200	7,600
10	82,800	41,400	27,600	20,700	16,580	13,800
12	133,200	66,600	44,400	33,300	26,650	22,200
15	218,000	109,000	72,800	59,500	47,600	39,650
¹/₄ unit vertical in 12 units horizontal (2-percent slope)						
3	4,640	2,320	1,546	1,160	928	773
4	10,600	5,300	3,533	2,650	2,120	1,766
5	18,880	9,440	6,293	4,720	3,776	3,146
6	30,200	15,100	10,066	7,550	6,040	5,033
8	65,200	32,600	21,733	16,300	13,040	10,866
10	116,800	58,400	38,950	29,200	23,350	19,450
12	188,000	94,000	62,600	47,000	37,600	31,350
15	336,000	168,000	112,000	84,000	67,250	56,000
¹/₂ unit vertical in 12 units horizontal (4-percent slope)						
3	6,576	3,288	2,295	1,644	1,310	1,096
4	15,040	7,520	5,010	3,760	3,010	2,500
5	26,720	13,360	8,900	6,680	5,320	4,450
6	42,800	21,400	13,700	10,700	8,580	7,140
8	92,000	46,000	30,650	23,000	18,400	15,320
10	171,600	85,800	55,200	41,400	33,150	27,600
12	266,400	133,200	88,800	66,600	53,200	44,400
15	476,000	238,000	158,800	119,000	95,300	79,250

Exhibit #3



Exhibit #4



Answers to Sample Questions

Note your answers. Review the appropriate document(s) in those areas to better understand the rationale behind the indicated correct answer.

Take advantage of the programs provided by RCI, including courses on the national and regional levels.

1. B
2. B
3. B and D
4. B and D
5. A and B
6. B and C
7. C
8. B
9. A and C
10. B and C
11. A
12. B
13. B
14. A
15. B
16. B
17. A and C
18. B
19. D
20. C
21. B and C
22. B and D
23. B
24. B
25. C