ROBERT T. LYNCH

BROOKLINE GOLF COURSE

Brookline, Massachusetts

GOLF COURSE MASTER PLAN

APPENDIX A

Arthur Little & Jann Leeming

Report on Forward Tees

To: Mark Mungeam
From: Arthur Little
Re: Forward Tee positioning at Brookline Golf Course
CC: Tim Gerrish
Date: March 9, 2022

The purpose of this memo is to provide notes that accompany the Brookline Golf Course map that I have marked and sent to you. The notes are in somewhat random order.

Your Tee position suggestions
Great...they all fit perfectly.

Tee Colors
Think the colors you've chosen are fine with one exception.
Have them go in Blue/White/Green/Gold/Red order
Golfers are creatures of habit.
Women will "automatically" go to red tees
If they discover the Red Tees are too short, they will move Back to Gold
Men will generally go to White tees.
The majority of them should play the whites.
Some may choose go back to the Blues even though for at least half of them, the Blues at almost 6300 yards are too long.

The tee yardages for Gold & Red that I am suggesting are
Gold: 4464 yards...76.8% of Whites
Red: 3747 yards....64.6% of Whites
Pure math would tell you those numbers should be
Gold: 4526----78% of Whites
Red: 3887----67% of Whites
But the number of holes that play uphill
2/4/7/11/13/15/16
& the nature of the turf that makes the course play longer
indicates that these tees should be shorter than "normal."

Hole by Hole Comments:

#3 The spot marked at 114 is fantastic, but may cause a dangerous situation. If you have to move the Red tees back to 140 with the Gold tees, so be it.

#4 Both the Reds & Gold tees should be on the right side of the hole so that these players can shoot away from the bunker short and right of the green. Understood that this will pull players away from the present cart path. May not be an issue as the majority of Brookline's customers walk.

#5 It would be great if the forward tee could be extended forward to 135 so that players using the red tees could reach the green in regulation.
At 157, it's too long for 65mph players to reach.
Rough needs to be cut to shorten the carry to fairway.

#10--210 yards is really too short for Gold, but there really is no choice. Both Gold & Red play from the same tee.

#11—Not sure this hole can be "cured" due to the very elevated green. Practically no Red player can swing fast enough to get the approach shot up to the green. If they use enough club to get to the green, the shot will go over.
May have to look at this "in the field" to figure out the best solution.

#13 Tried to select tee lengths that make players make strategic choices. "Do I lay up short of cross hazards OR try to carry them."

#14 May have to make close measurements "in the field" to be sure players from both Gold & Red can reach the corner in order to have a "clear" approach shot.

#15 & #16...see note on #13

#17 It would be great if you could build a tee at 110-115 yards right next to cart path. If not red will need to play from 138.

Suggestions for combo tees at Brookline GC—Green/Gold

Note: in reading below, please remember that I am calling the most forward tees Red and the next set back Gold.
X=Chosen Tee

Current Routing

Hole	Green	Gold
1	345-X	281
2	295	246-X
3	140-X	140
4	294	237-X
5	157-X	157
6	484-X	370
7	325-X	240
8	370	298-X
9	332	275-X
1-9	2507	
10	310-X	210
11	263	226-X
12	108-X	108
13	356	284-X
14	356	290-X
15	460	390-X
16	323	269-X
17	138-X	
18	370-X	305
10-18	2385	
1-18	4892	

Alternate Routing

1	356		284-X
2	382		290-X
3	460		390-X
4	108-X		108
5	310-X		210
6	332		275-X
7	345-X		281
8	295		246-X
9	140-X		140
1-9		2388	
10	294		237-X
11	157-X		157
12	484-X		370
13	325-X		240
14	370		298-X
15	263		226-X
16	323		269-X
17	138-X		138
18	370-X		305
10-18		2504	
1-18		4892	

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Brookline, Massachusetts

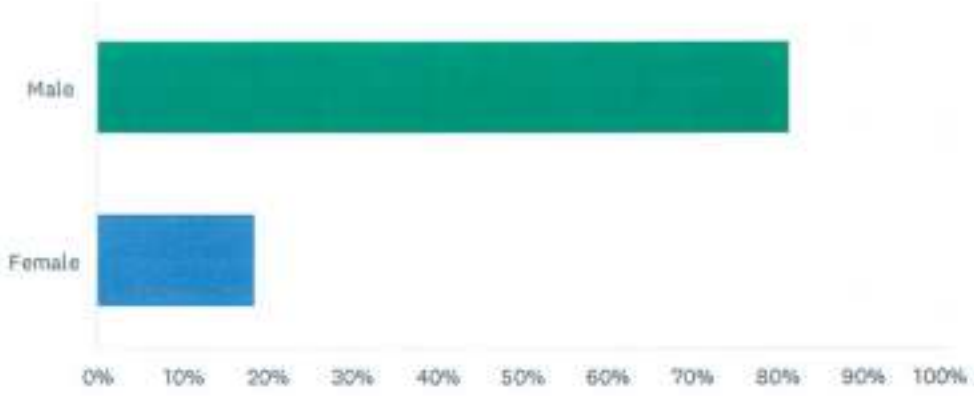
APPENDIX B

Public Survey Results

GOLF COURSE MASTER PLAN

Q1 Gender (Optional)

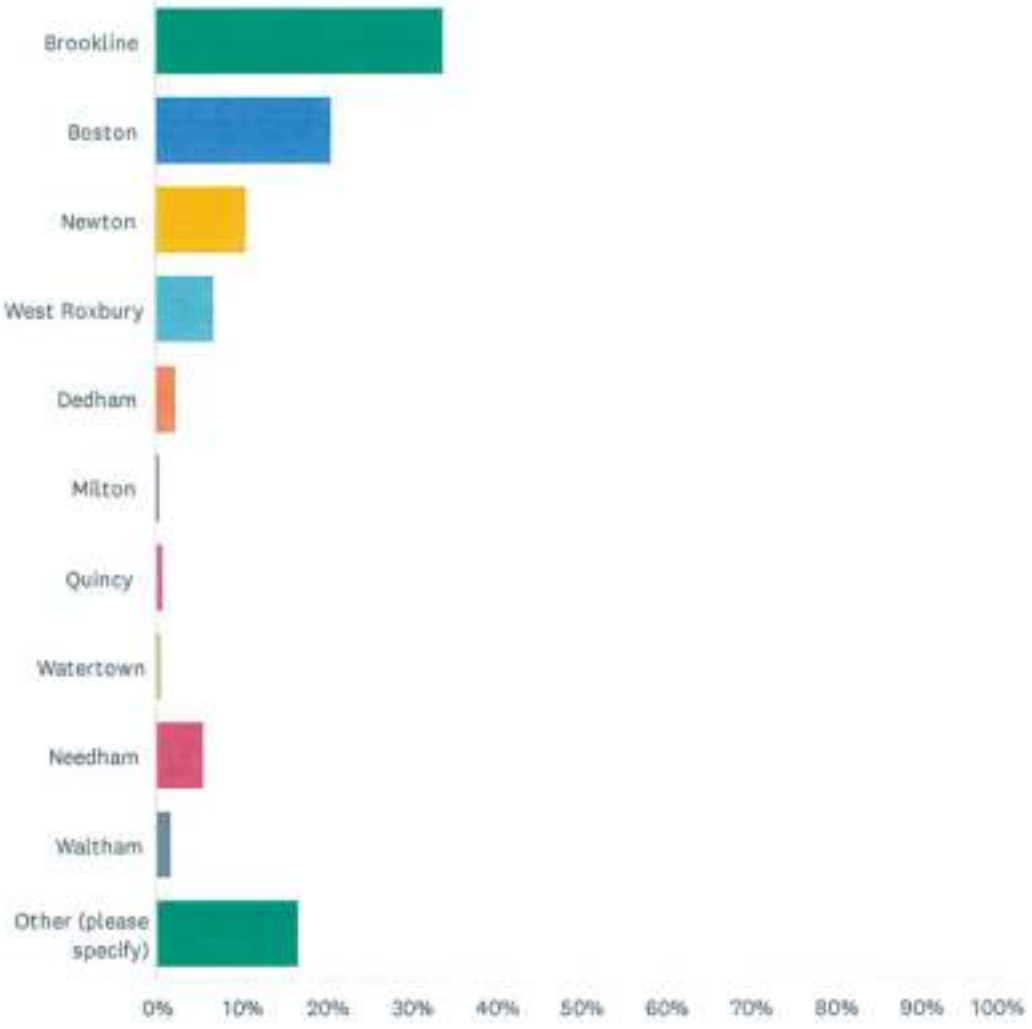
Answered: 553 Skipped: 23



ANSWER CHOICES	RESPONSES	
Male	81.37%	450
Female	18.63%	103
TOTAL		553

Q2 Town of Residence:

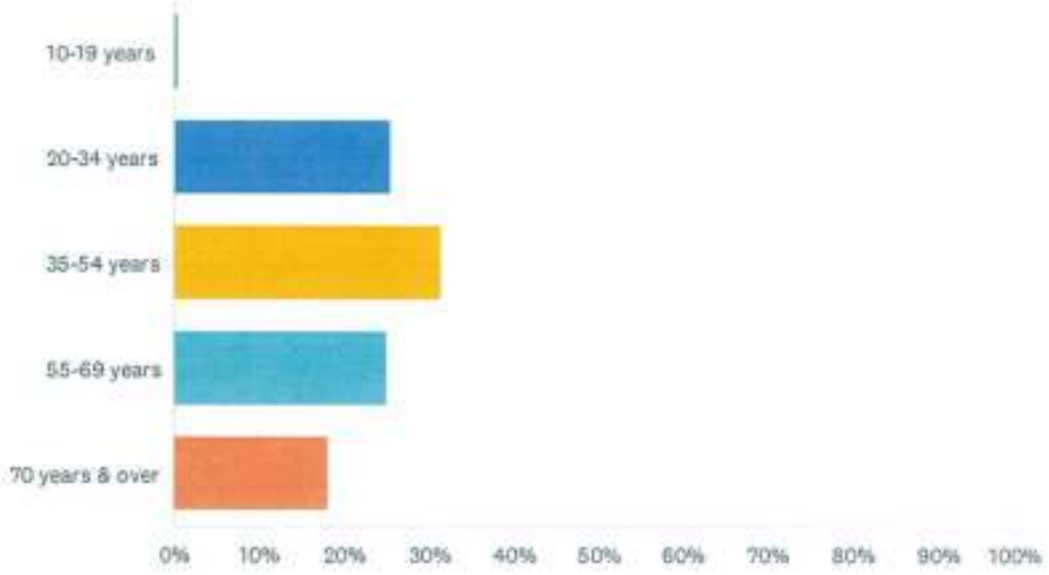
Answered: 576 Skipped: 0



ANSWER CHOICES	RESPONSES	
Brookline	33.05%	193
Dedham	20.88%	179
Newton	10.39%	61
West Roxbury	6.77%	30
Dedham	2.23%	10
Milton	0.36%	2
Quincy	0.85%	5
Whitehouse	0.68%	4
Needham	5.58%	32
Waltham	1.74%	10
Other (please specify)	16.37%	96
TOTAL		573

Q3 Age Category:

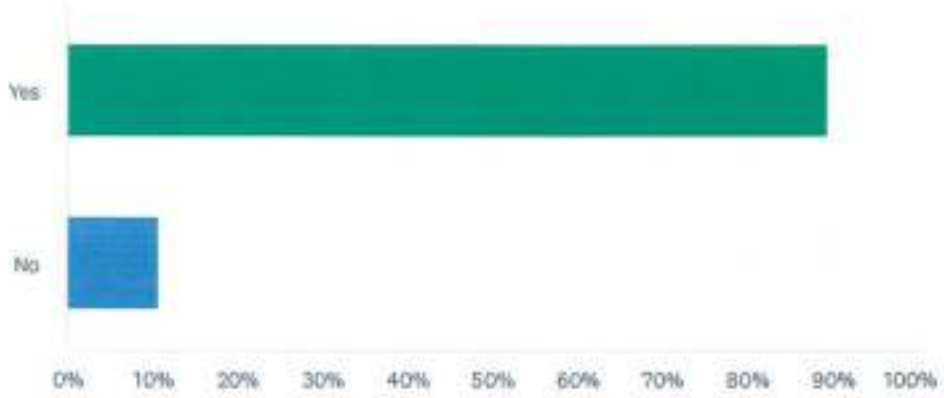
Answered: 576 Skipped: 0



ANSWER CHOICES	RESPONSES	
10-19 years	0.35%	2
20-34 years	25.35%	146
35-54 years	31.25%	180
55-69 years	25.00%	144
70 years & over	18.06%	104
TOTAL		576

Q4 Do you play golf? If No, we'll fast forward to our non-golf specific questions.

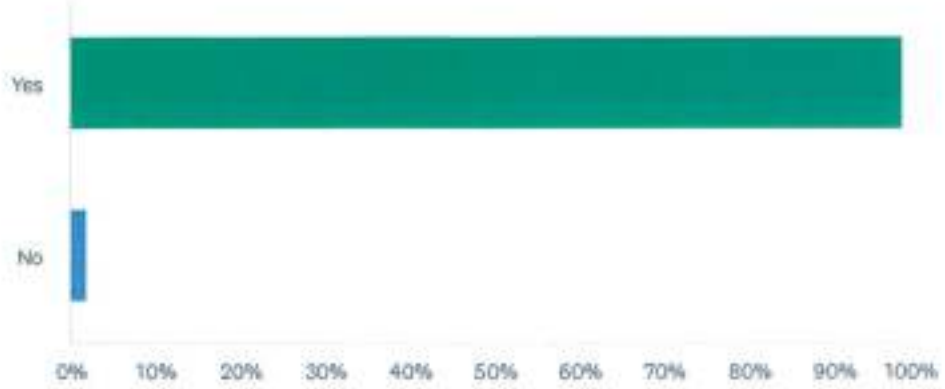
Answered: 576 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	89.41%	515
No	10.59%	61
TOTAL		576

Q5 Do you play golf at Robert T. Lynch Municipal Golf Course (Brookline Golf Course)?

Answered: 315 Skipped: 261



ANSWER CHOICES	RESPONSES	
Yes	98.10%	309
No	1.90%	6
TOTAL		315

Q6 Approximate number of 9 hole rounds played at Brookline Golf Course per year?

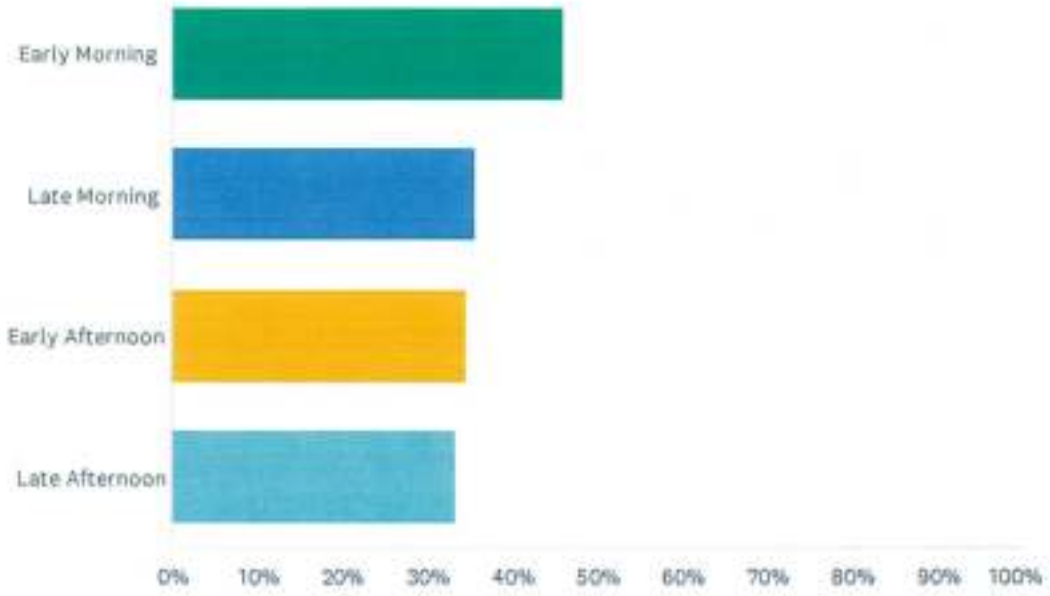
Answered: 321 Skipped: 281

Q7 Approximate number of 18-hole rounds played at Brookline Golf Course per year?

Answered: 315 Skipped: 251

Q8 What time of day do you typically play golf?

Answered: 315 Skipped: 261

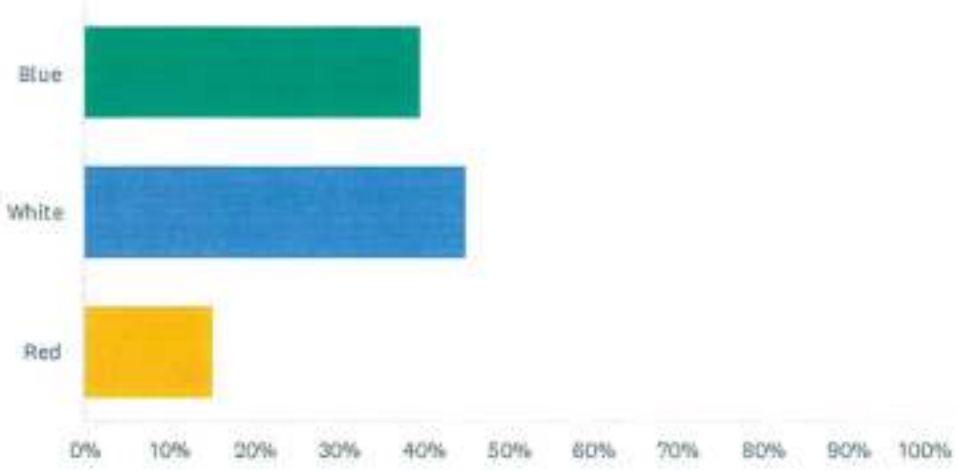


ANSWER CHOICES	RESPONSES	
Early Morning	46.03%	145
Late Morning	35.56%	112
Early Afternoon	34.60%	109
Late Afternoon	33.33%	105

Total Respondents: 315

Q9 Tee Markers you most frequently play from:

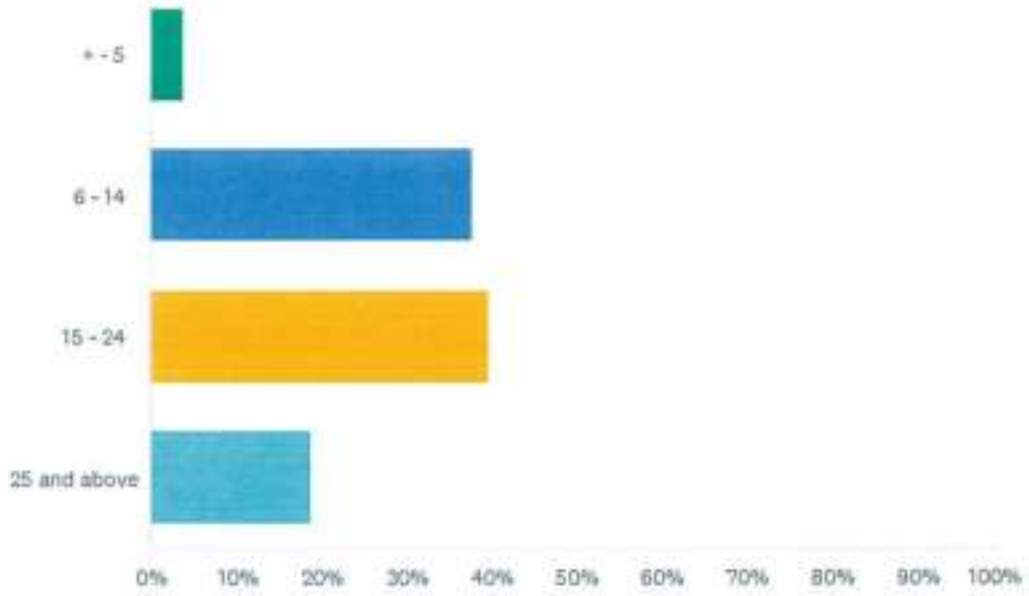
Answered: 315 Skipped: 261



ANSWER CHOICES	RESPONSES	
Blue	39.68%	125
White	45.08%	142
Red	15.24%	48
TOTAL		315

Q10 What is your golf handicap index?

Answered: 315 Skipped: 261



ANSWER CHOICES	RESPONSES	
+ - 5	3.81%	12
6 - 14	37.78%	119
15 - 24	39.68%	125
25 and above	18.73%	59
TOTAL		315

Q11 What is your favorite 2 golf holes at Brookline Golf Course?

Answered: 2[illegible] Skipped: 261

Q12 What do you like about these 2 holes?

Answered: 315 Skipped: 231

Q13 What is your 2 least favorite golf holes at Brookline Golf Course?

Answered: 523 Skipped: 261

Q14 What do you dislike about these holes?

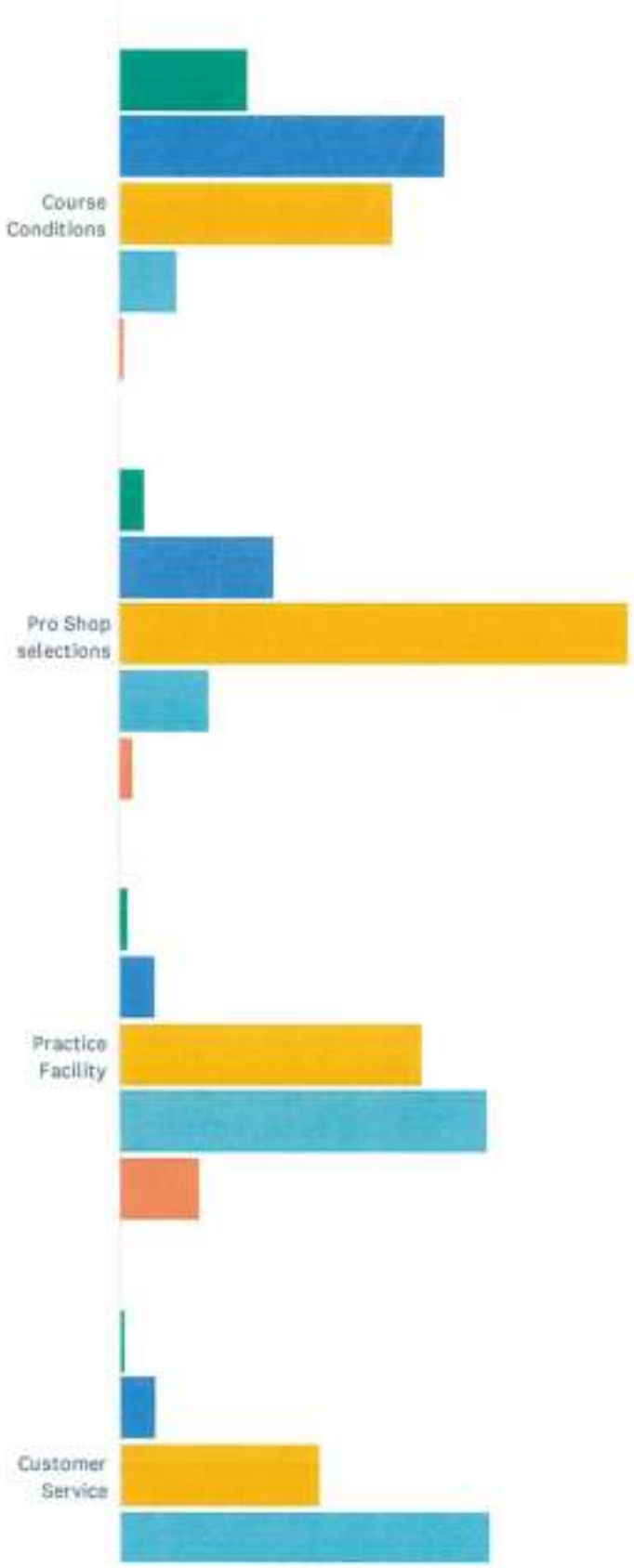
Answered: 315 Skipped: 261

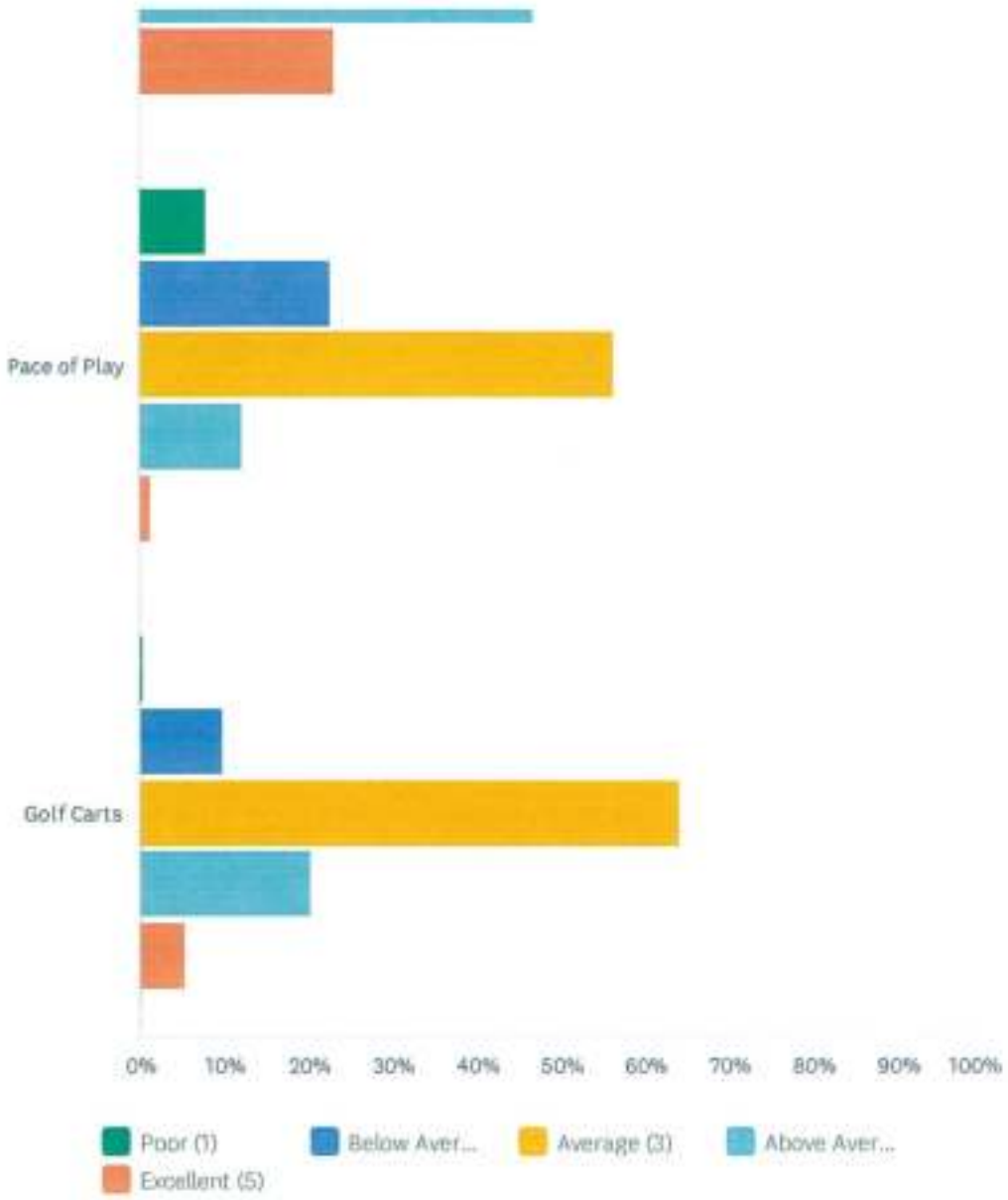
Q15 Other than Brookline Golf Course, what course is your favorite to play, and why?

Answered: 2[illegible] skipped: [illegible]

Q16 Overall Facility: Please rank each aspect of the Golf Experience.

Answered: 315 Skipped: 261

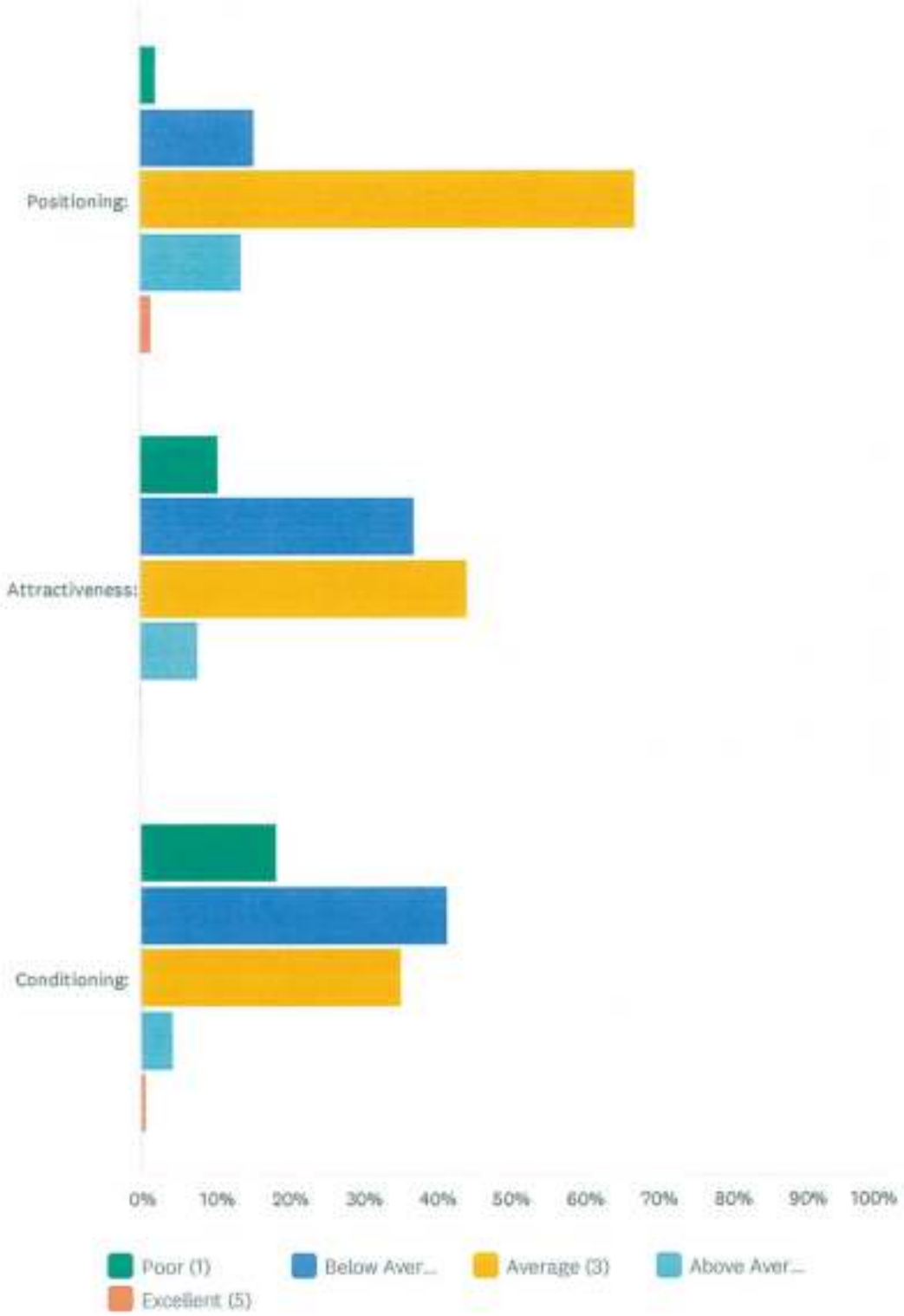




	POOR (1)	BELOW AVERAGE (2)	AVERAGE (3)	ABOVE AVERAGE (4)	EXCELLENT (5)	TOTAL
Course Conditions	16.29% 51	41.21% 129	34.50% 108	7.35% 23	0.64% 2	313
Pro Shop selections	3.22% 10	19.61% 61	64.31% 200	11.25% 35	1.61% 5	311
Practice Facility	0.96% 3	4.49% 14	38.14% 119	46.47% 145	9.94% 31	312
Customer Service	0.64% 2	4.47% 14	25.24% 79	46.65% 146	23.00% 72	313
Pace of Play	7.94% 25	22.54% 71	56.19% 177	12.06% 38	1.27% 4	315
Golf Carts	0.33% 1	9.84% 30	64.26% 196	20.33% 62	5.25% 16	305

Q17 Bunkers: Please rank each attribute.

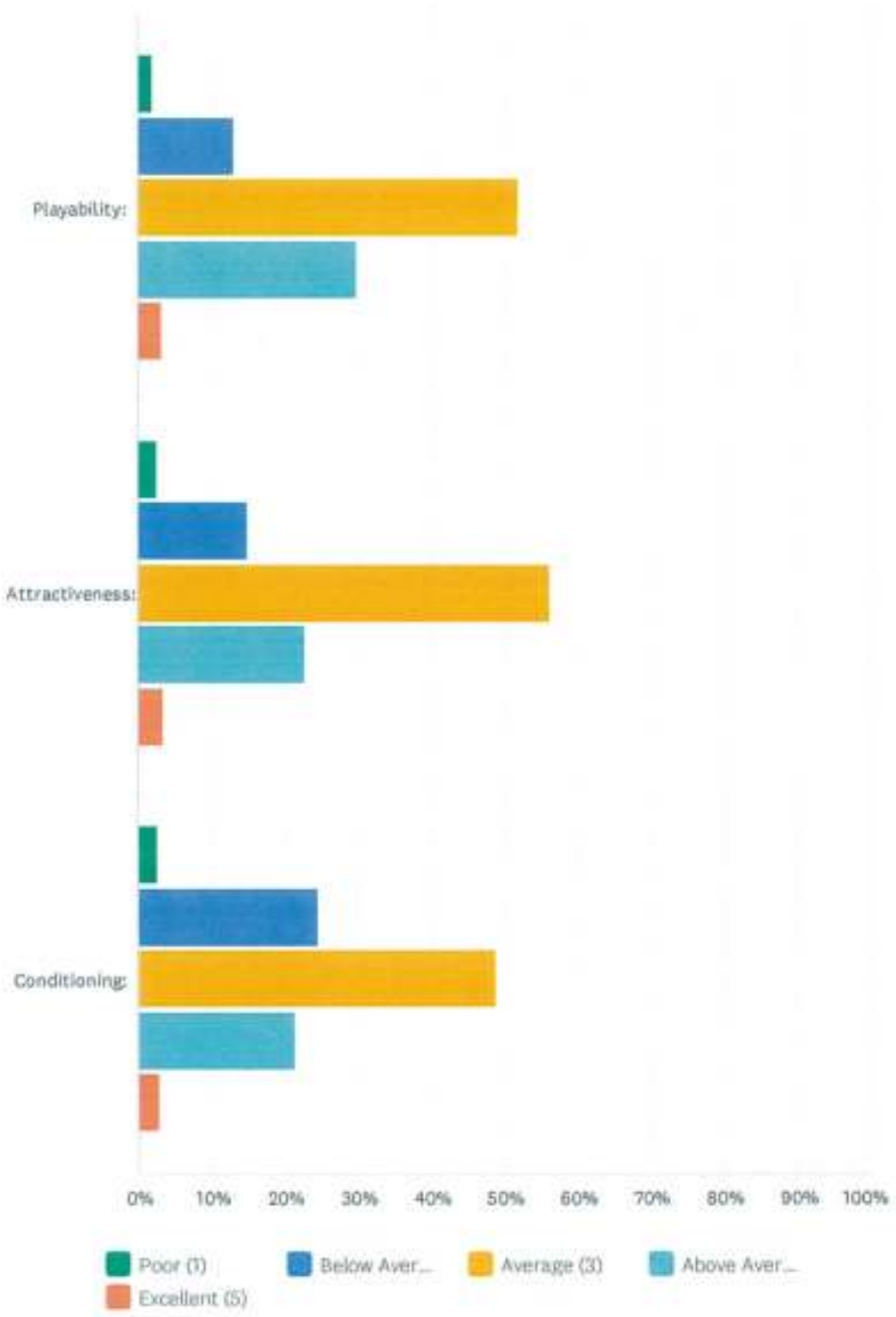
Answered: 315 Skipped: 261



	POOR (1)	BELOW AVERAGE (2)	AVERAGE (3)	ABOVE AVERAGE (4)	EXCELLENT (5)	TOTAL
Positioning:	2.23%	15.25%	67.20%	13.70%	1.59%	
	7	48	211	43	5	314
Attractiveness:	10.48%	37.14%	44.44%	7.62%	0.32%	
	33	117	140	24	1	315
Conditioning:	18.27%	41.67%	35.26%	4.17%	0.63%	
	57	130	110	13	2	312

Q18 Greens: Please rank on each attribute.

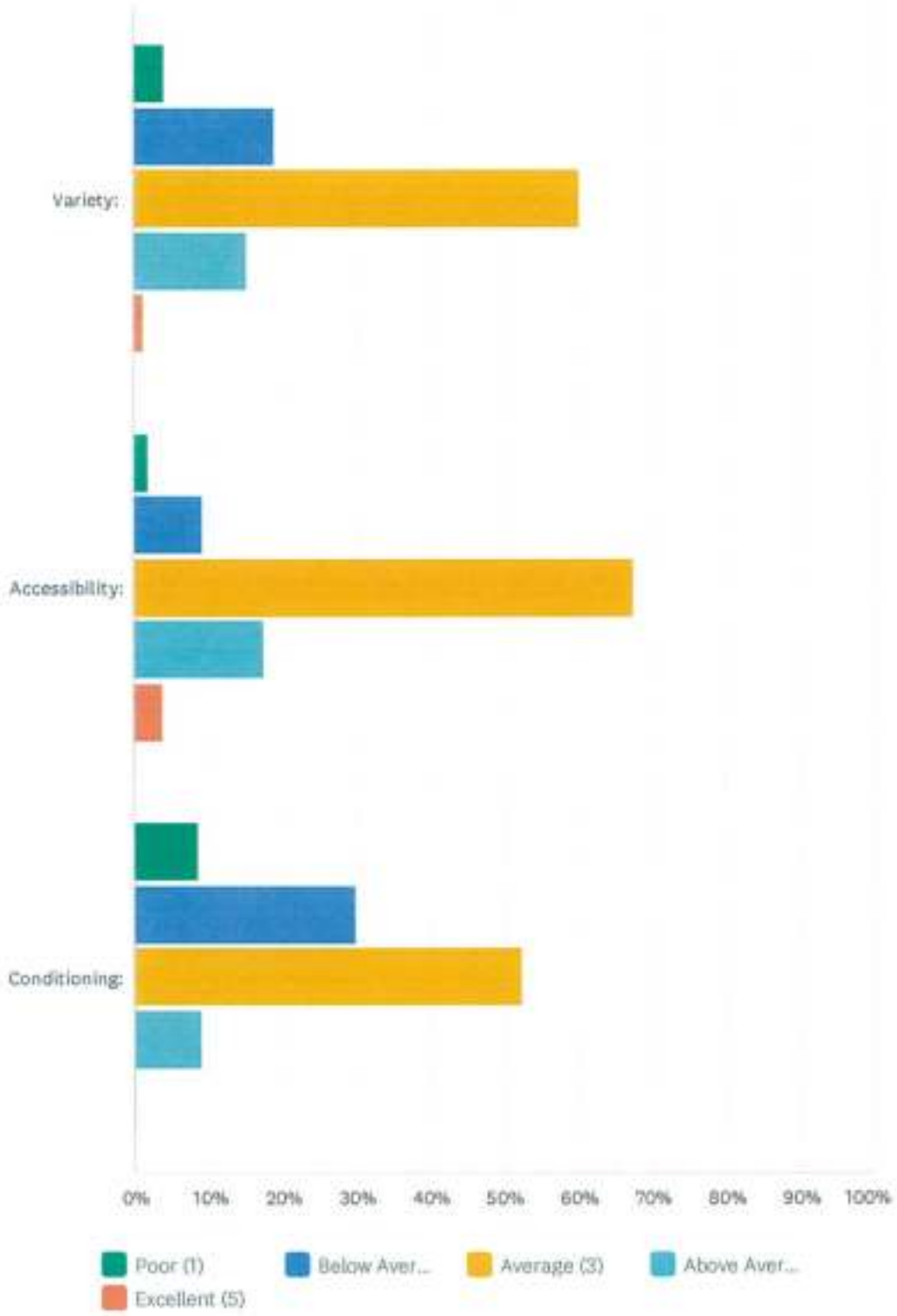
Answered: 315 Skipped: 261



	POOR (1)	BELOW AVERAGE (2)	AVERAGE (3)	ABOVE AVERAGE (4)	EXCELLENT (5)	TOTAL
Playability:	1.02%	13.02%	52.08%	29.84%	3.17%	
	8	41	164	94	10	315
Attractiveness:	2.54%	27.92%	56.19%	22.86%	3.49%	
	8	47	177	72	11	315
Conditioning:	2.54%	24.44%	48.89%	21.27%	2.86%	
	8	77	154	67	9	315

Q19 Tees: Please rank on each attribute.

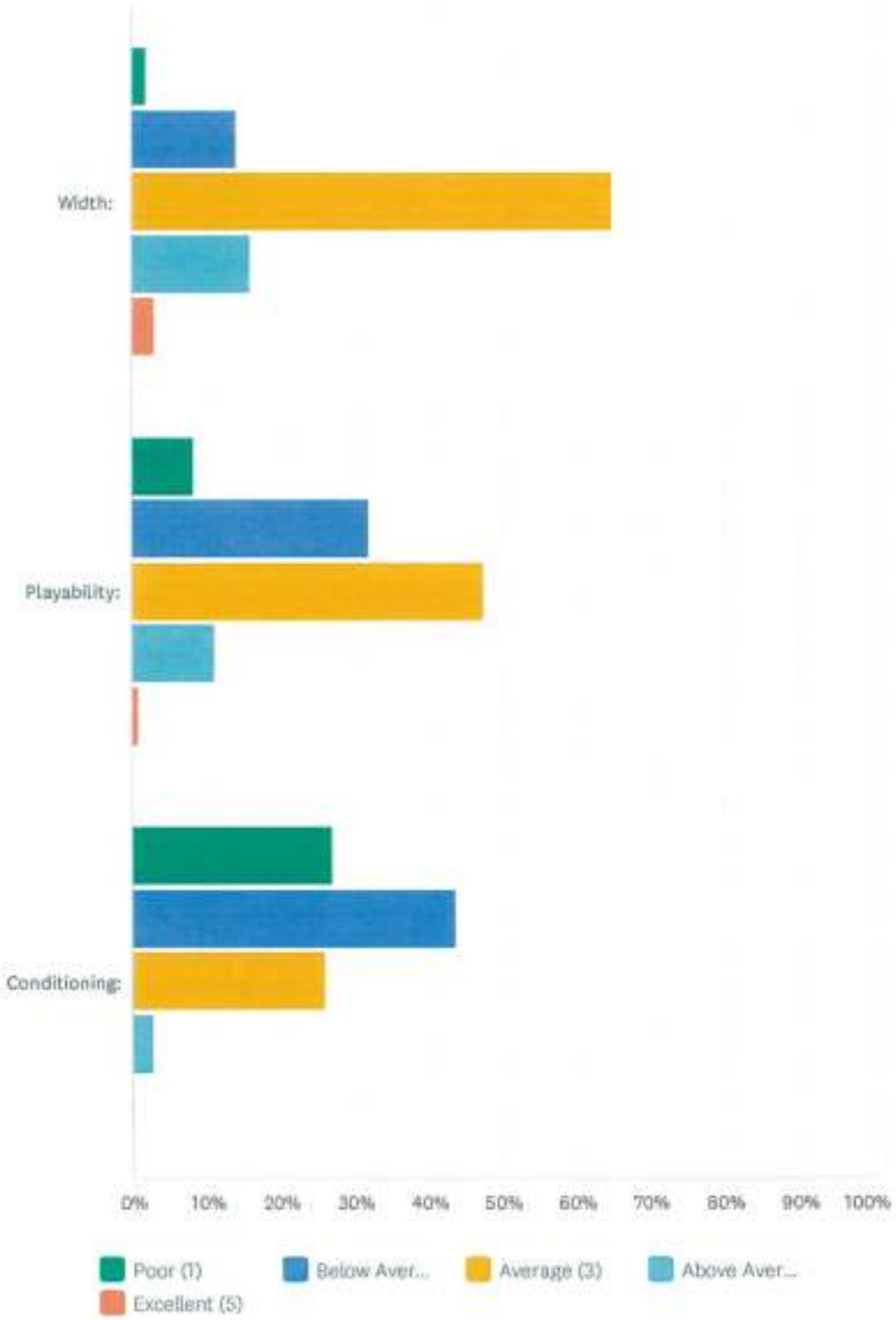
Answered: 315 Skipped: 261



	POOR (1)	BELOW AVERAGE (2)	AVERAGE (3)	ABOVE AVERAGE (4)	EXCELLENT (5)	TOTAL
Variety:	4.12%	19.05%	50.8[illegible]%	25.24%	1.27%	
	13	60	1[illegible]0	40	4	315
Accessibility:	1.90%	9.21%	57.6[illegible]%	17.46%	3.81%	
	6	29	21[illegible]	55	12	315
Conditioning:	8.57%	29.84%	52.38%	8.89%	0.32%	
	27	94	165	28	1	315

Q20 Fairways: Please rank on each attribute.

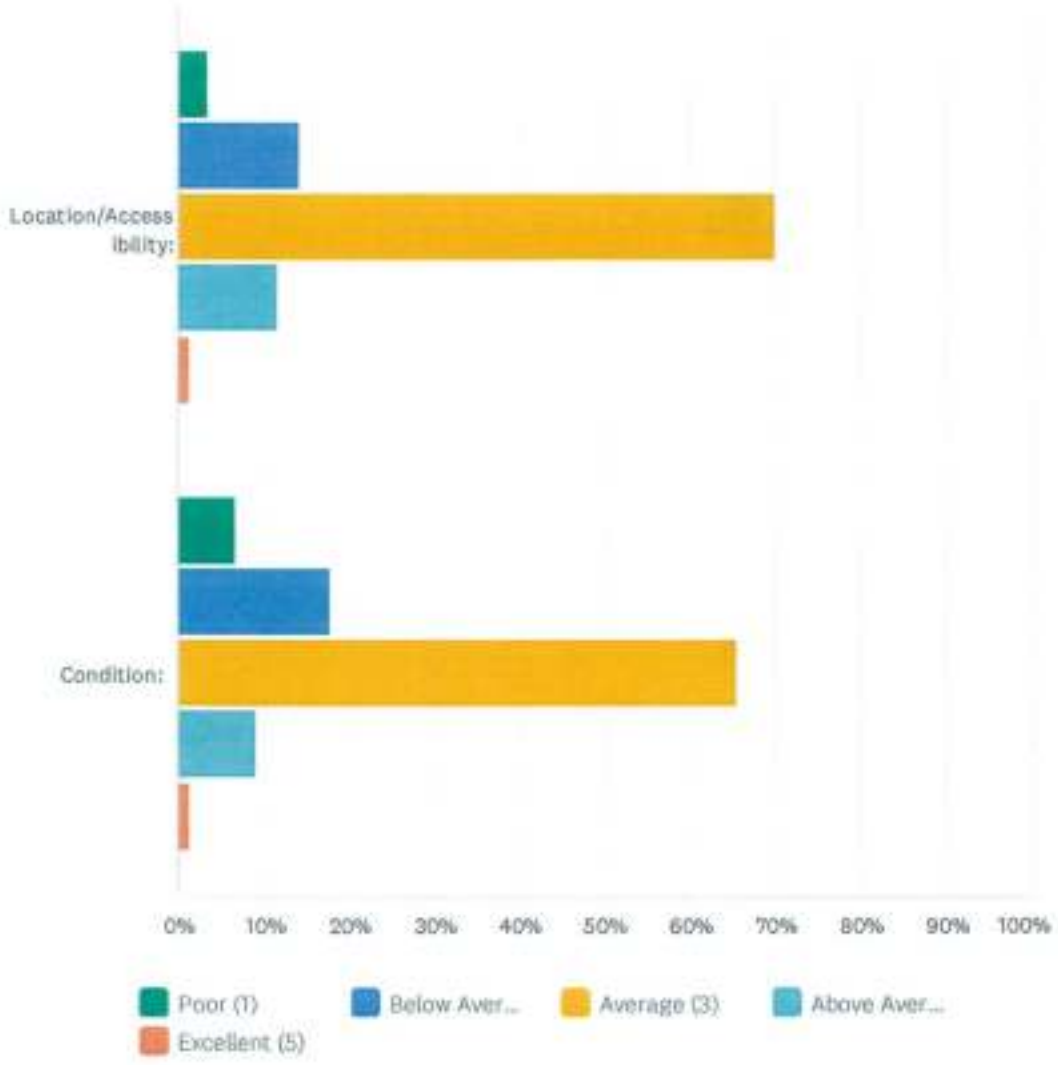
Answered: 315 Skipped: 261



	POOR (1)	BELOW AVERAGE (2)	AVERAGE (3)	ABOVE AVERAGE (4)	EXCELLENT (5)	TOTAL
Width:	1.93%	14.15%	64.95%	16.08%	3.89%	
	6	44	202	50	9	311
Playability:	8.25%	32.06%	47.62%	11.11%	0.95%	
	26	101	150	35	3	315
Condition/ap.	26.98%	43.81%	25.08%	2.86%	0.32%	
	85	138	82	9	1	315

Q21 Cart Paths: Please rank on each attribute.

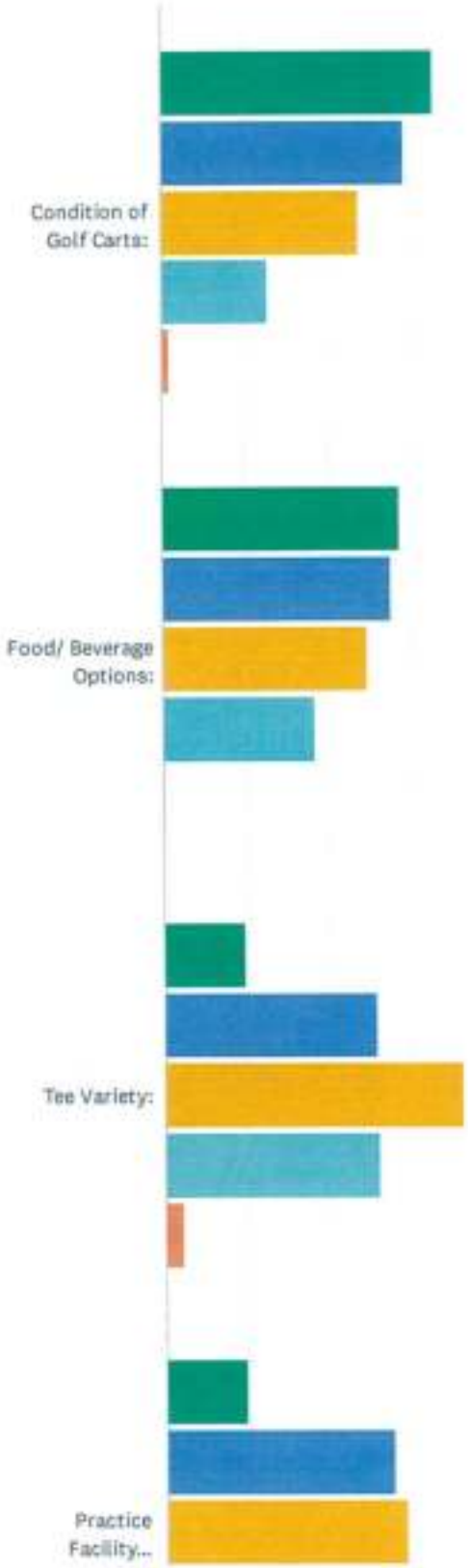
Answered: 315 Skipped: 261

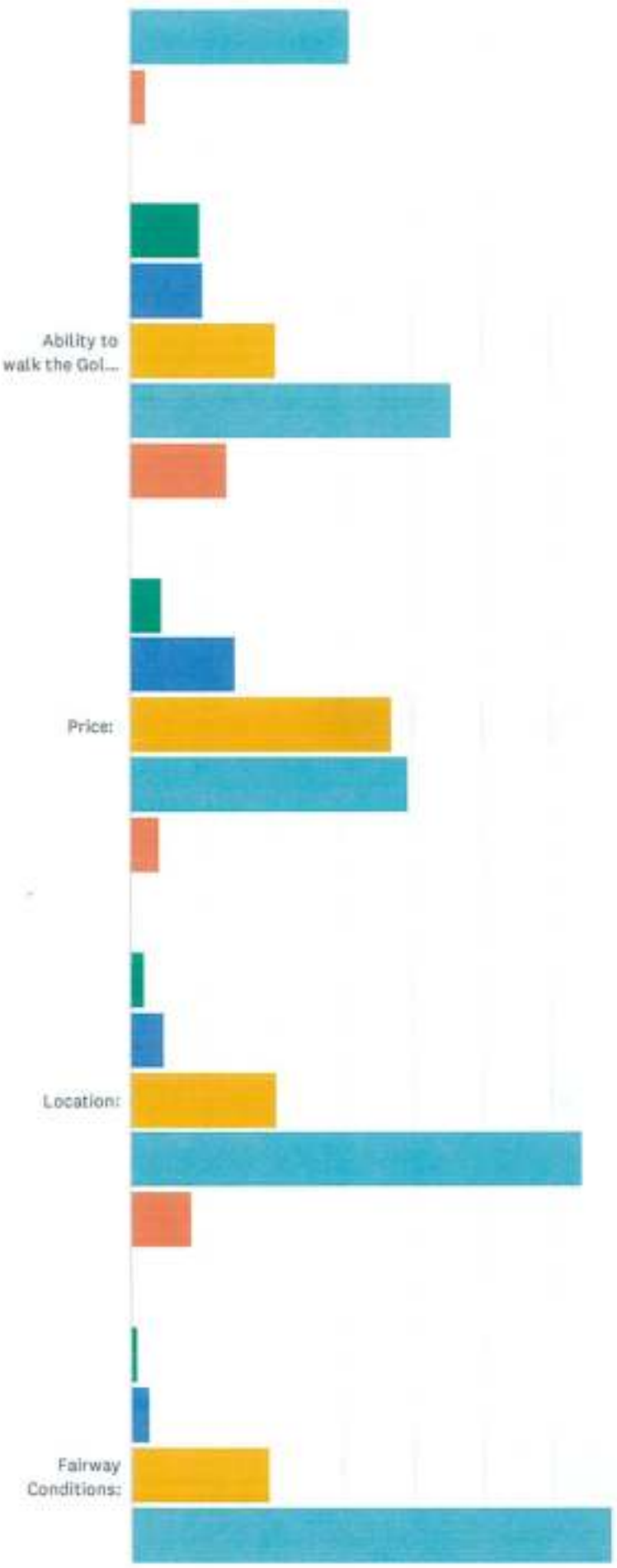


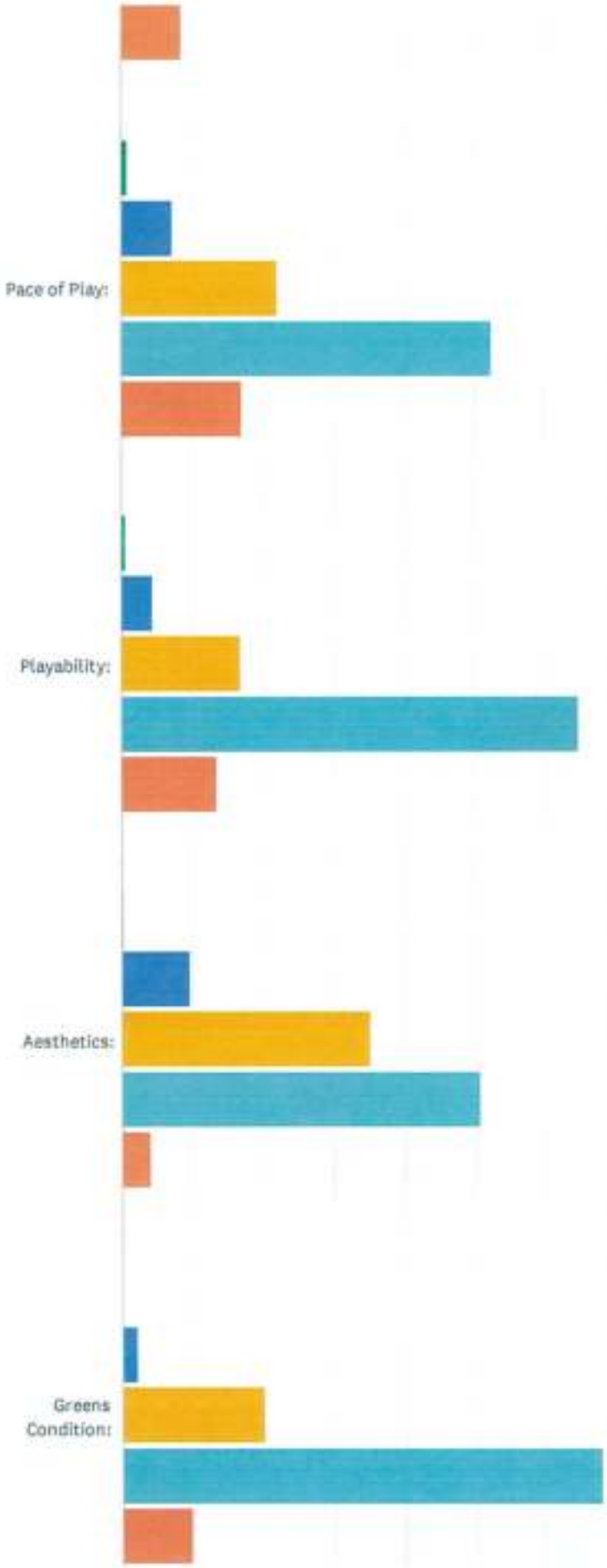
	POOR (1)	BELOW AVERAGE (2)	AVERAGE (3)	ABOVE AVERAGE (4)	EXCELLENT (5)	TOTAL
Location/Accessibility:	3.49% 11	13.97% 44	69.84% 220	11.43% 36	1.27% 4	315
Condition:	6.67% 21	17.78% 56	65.40% 206	8.89% 28	1.27% 4	315

Q22 Please rank the importance of each area in your decision-making process of deciding where to play golf:

Answered: 315 Skipped: 261



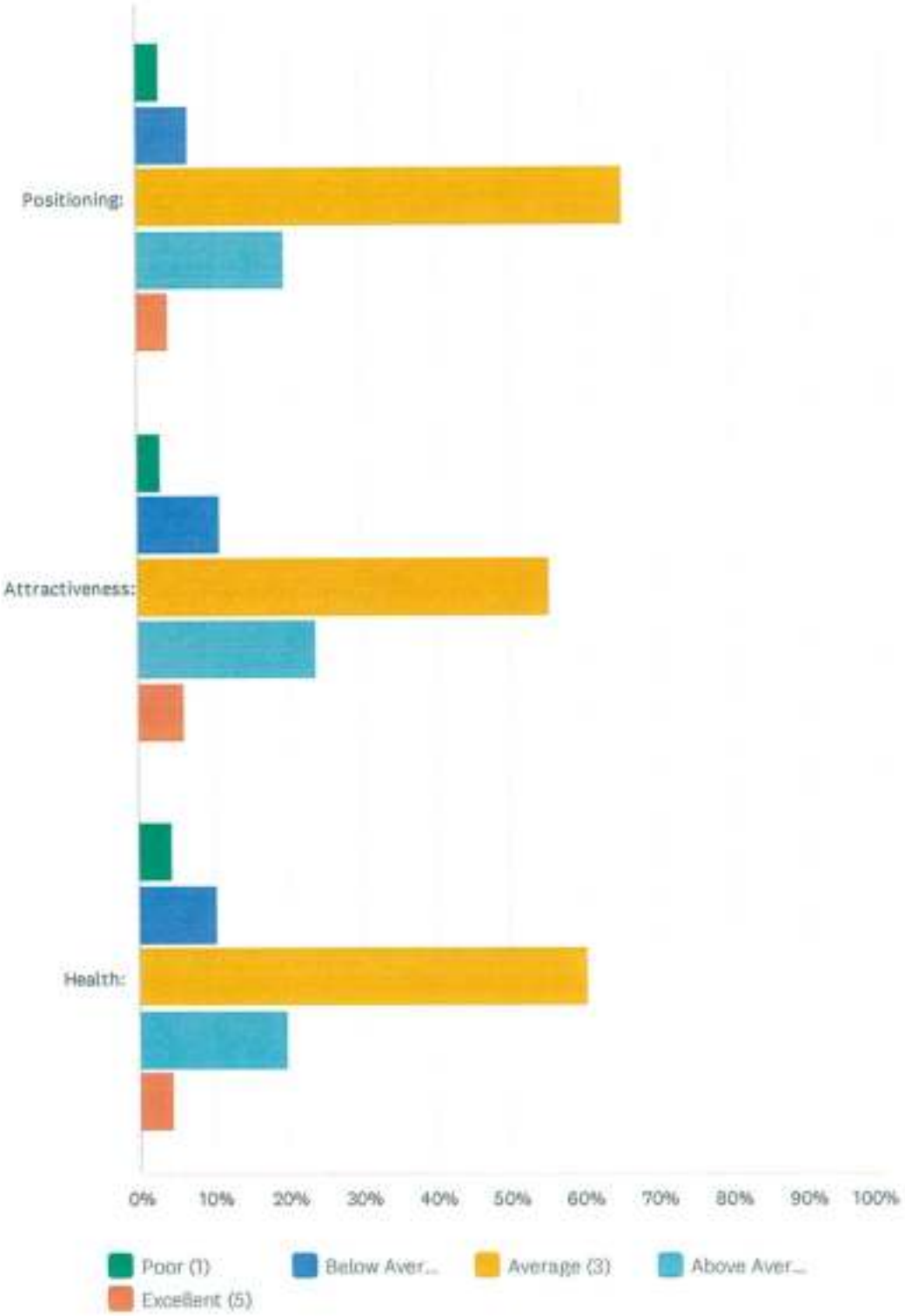

Ability to walk the Gol...
Price:
Location:
Fairway Conditions:


Pace of Play:
Playability:
Aesthetics:
Greens Condition:

	NOT IMPORTANT	NEUTRAL	SOMEWHAT IMPORTANT	IMPORTANT	ULTIMATE FACTOR IN DECISION-MAKING PROCESS	TOTAL	WEIGHTED AVERAGE
Condition of Golf Carts:	33.02% 104	29.52% 93	23.81% 75	12.70% 40	0.95% 3	315	2.19
Food/ Beverage Options:	28.89% 91	27.62% 87	24.76% 78	18.41% 58	0.32% 1	315	2.34
Tee Variety:	9.84% 31	25.71% 81	36.19% 114	26.03% 82	2.22% 7	315	2.85
Practice Facility Options:	9.84% 31	27.62% 87	29.21% 92	31.11% 98	2.22% 7	315	2.88
Ability to walk the Golf Course:	9.84% 31	10.16% 32	20.63% 65	45.71% 144	13.65% 43	315	3.43
Price:	4.44% 14	14.92% 47	37.14% 117	39.37% 124	4.13% 13	315	3.24
Location:	1.90% 6	4.76% 15	20.63% 65	64.13% 202	8.57% 27	315	3.73
Fairway Conditions:	0.95% 3	2.54% 8	19.68% 62	68.25% 215	8.57% 27	315	3.81
Pace of Play:	0.95% 3	7.30% 23	22.22% 70	52.38% 165	17.14% 54	315	3.77
Playability:	0.63% 2	4.44% 14	16.83% 53	64.76% 204	13.33% 42	315	3.86
Aesthetics:	0.32% 1	9.52% 30	35.24% 111	50.79% 160	4.13% 13	315	3.49
Greens Condition:	0.00% 0	2.22% 7	20.00% 63	67.94% 214	9.84% 31	315	3.85

Q23 Trees: Please rank on each attribute.

Answered: 352 Skipped: 224



	POOR (1)	BELOW AVERAGE (2)	AVERAGE (3)	ABOVE AVERAGE (4)	EXCELLENT (5)	TOTAL
Preferring:	3.13%	7.10%	65.63%	19.89%	4.26%	
	31	35	231	75	15	352
Attractiveness:	3.13%	11.08%	55.68%	23.86%	6.25%	
	11	39	196	84	22	352
Health:	4.55%	10.51%	60.51%	19.89%	4.55%	
	16	37	213	70	16	352

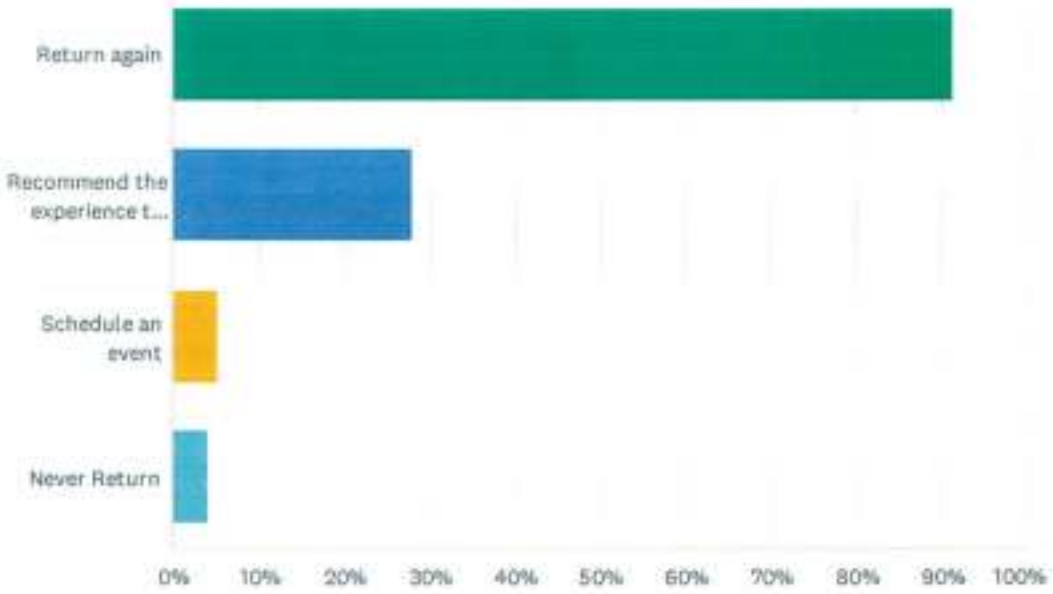
Q24 What two improvements would like to see occur at Brookline Golf Course (for example: improve the drainage, improve speed of service, expand parking area, add additional teeing options, a specific area on the property, etc.) ?

Answered: 357 Skipped: 224

ANSWER CHOICES	RESPONSES	
First Improvement	100.00%	332
Second Improvement	94.60%	338

Q25 Based on your overall experience at Brookline Golf Course, I am likely to:

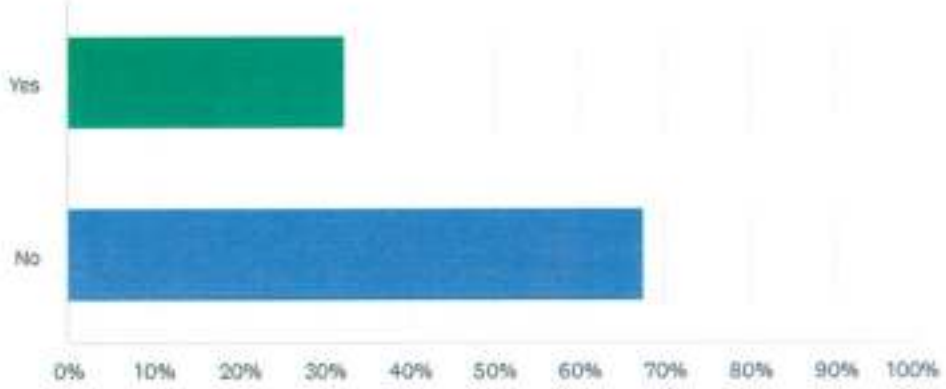
Answered: 352 Skipped: 224



ANSWER CHOICES	RESPONSES	
Return again	91.19%	321
Recommend the experience to a friend	27.84%	98
Schedule an event	5.11%	18
Never Return	3.98%	14
Total Respondents: 352		

Q28 Have you been to the golf course for other acitivities other than golfing or using the practice facility?

Answered: 352 Skipped: 224



ANSWER CHOICES	RESPONSES	
Yes	32.39%	114
No	67.61%	238
TOTAL		352

Q29 If yes, what are those activities?

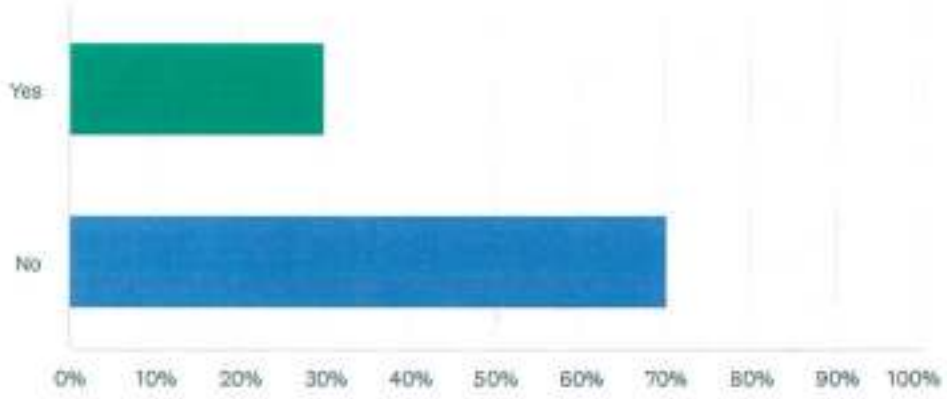
Answered: 381 Skipped: 355

Q30 What other recreational uses would you like to see considered without jeopardizing our ability to feature 18 holes of golf?

Answered: 382 Skipped: 224

Q31 Do you cross country ski?

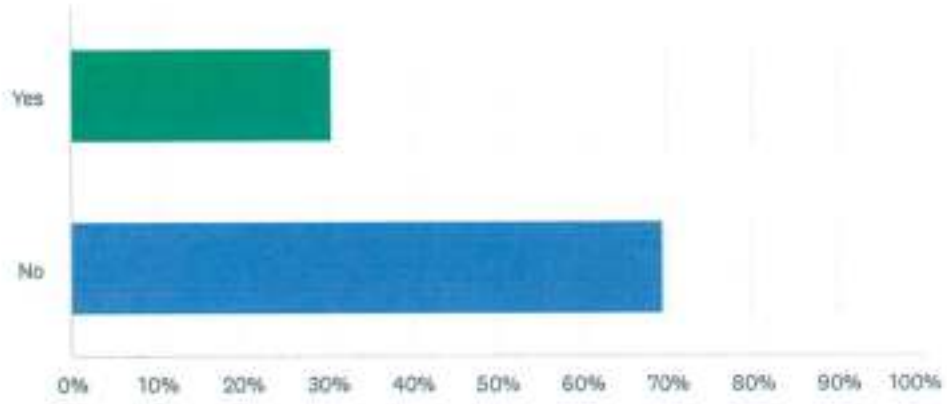
Answered: 352 Skipped: 224



ANSWER CHOICES	RESPONSES	
Yes	29.83%	105
No	70.17%	247
TOTAL		352

Q32 Do you have children that like to go sledding?

Answered: 352 Skipped: 224



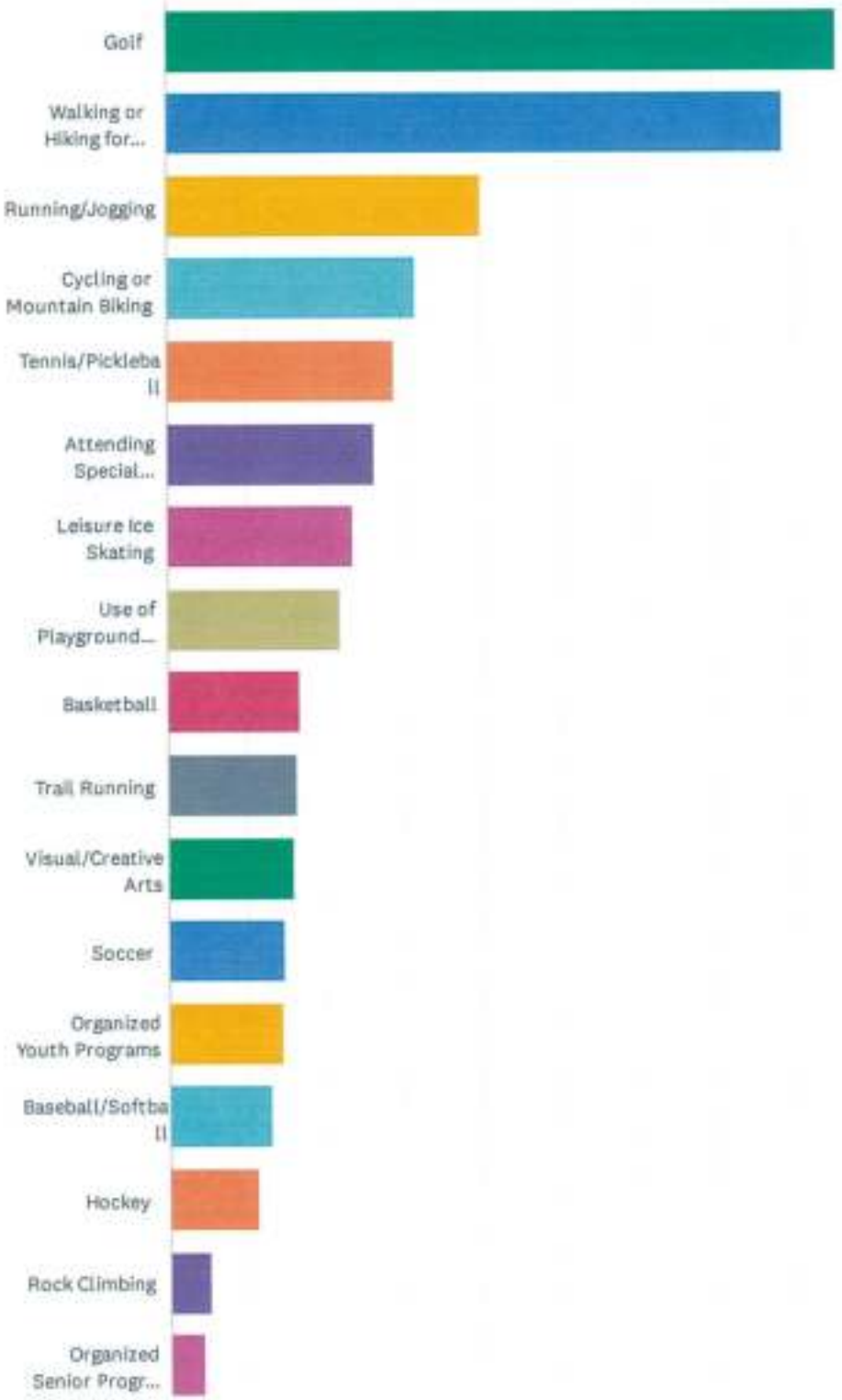
ANSWER CHOICES	RESPONSES	
Yes	30.40%	107
No	69.60%	245
TOTAL		352

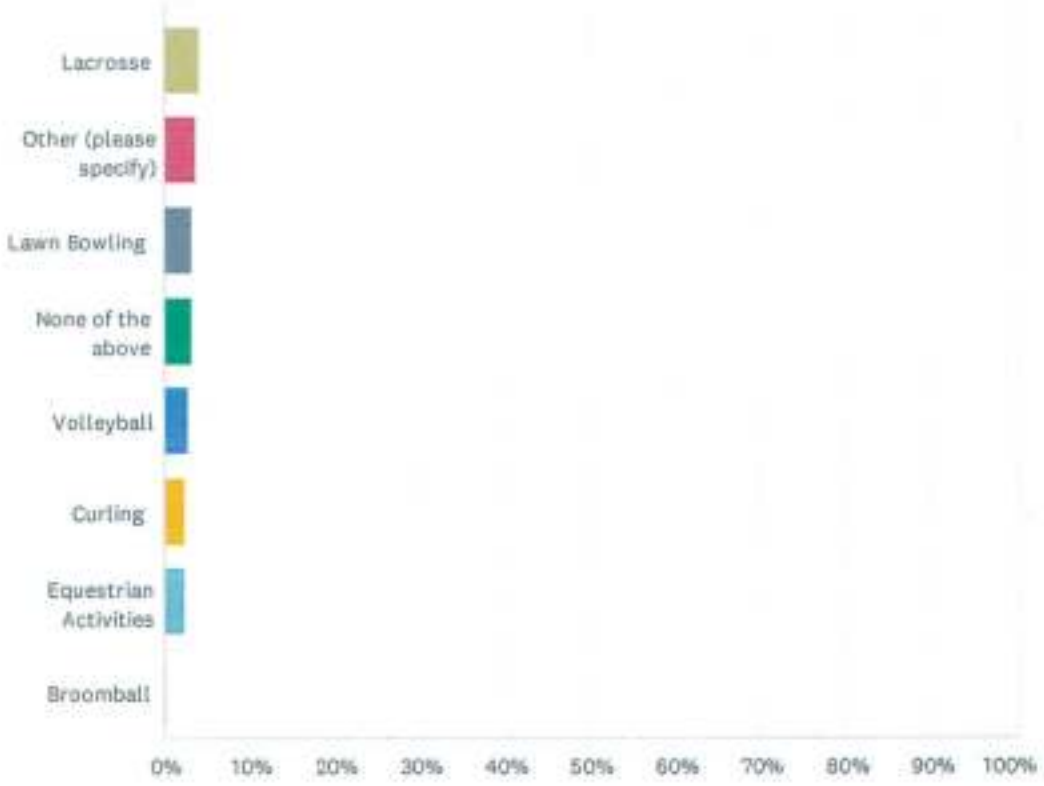
Q33 How do you define sustainability as it relates to the Brookline Golf Course?

Answered: 257 Skipped: 315

Q34 In the past 12 months, which of the following activities have you or anyone in your household participated in, in Brookline or elsewhere? By participation, we mean situations where you or a member of your household actively participate, either at home or in public.

Answered: 352 Skipped: 224



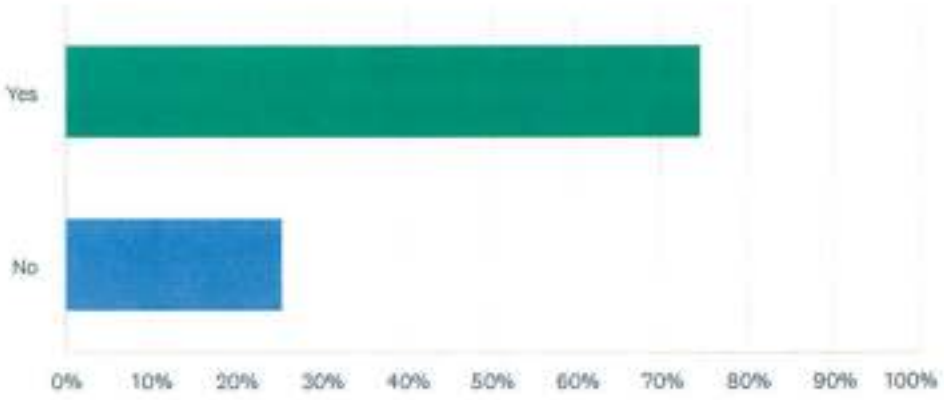

Lacrosse
Other (please specify)
Lawn Bowling
None of the above
Volleyball
Curling
Equestrian Activities
Broomball
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

ANSWER CHOICES	RESPONSES	
Golf	85.80%	202
Walking or Hiking for Leisure	76.69%	270
Running/Jogging	40.26%	141
Cycling or Mountain Biking	32.92%	112
Tennis/Pickleball	28.90%	102
Attending Special Community Events	26.42%	93
Leisure Ice Skating	23.58%	83
Use of Playground Equipment	21.82%	77
Basketball	16.76%	59
Trail Running	16.48%	58
Visual/Creative Arts	16.02%	56
Soccer	14.77%	52
Organized Youth Programs	14.49%	51
Baseball/Softball	13.07%	46
Hockey	11.36%	40
Rock Climbing	5.12%	18
Organized Senior Programs (i.e. billiards, guest speakers, gentle fitness, cards, etc.)	4.26%	15
Lacrosse	3.98%	14
Other (please specify)	3.69%	13
Lawn Bowling	3.13%	11
None of the above	3.13%	11
Volleyball	2.84%	10
Curling	2.27%	8
Equestrian Activities	2.27%	8
Broomball	0.28%	1

Total Respondents: 352

Q35 Are you and any members of your household able to participate in active recreation activities (e.g. sports, physical wellness, outdoor play, etc.), as often as you would like:

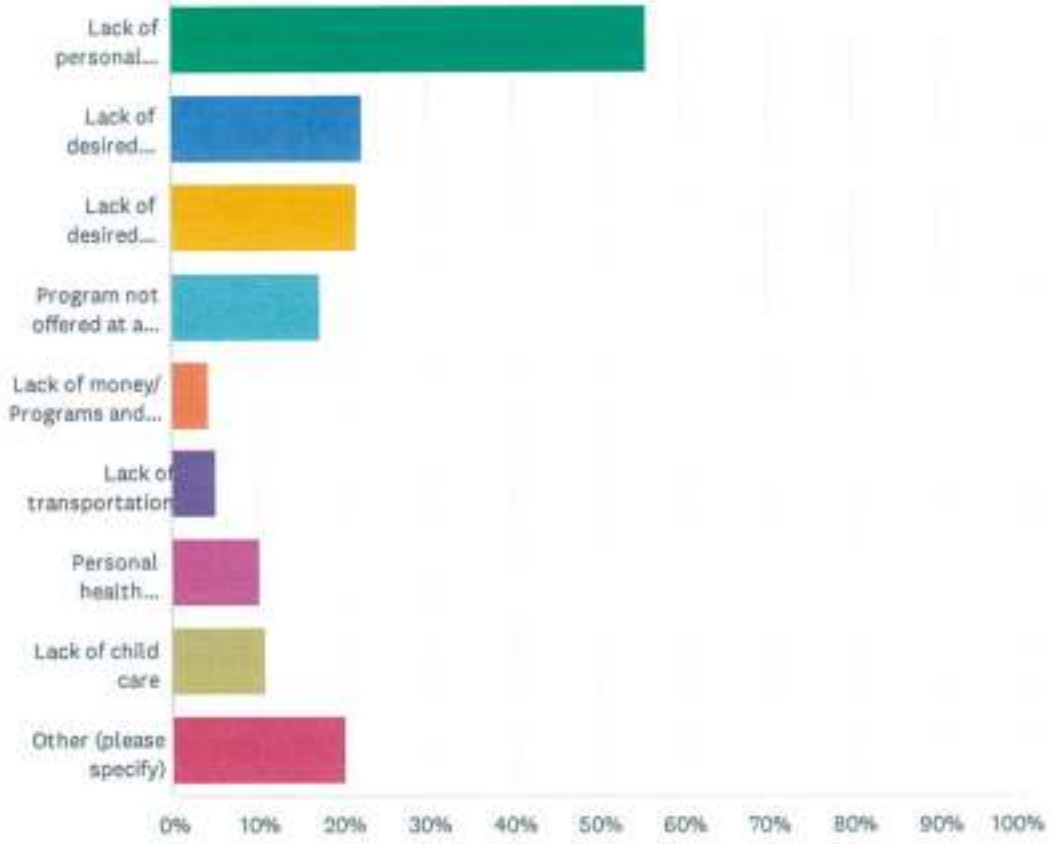
Answered: 352 Skipped: 224



ANSWER CHOICES	RESPONSES	
Yes	74.72%	263
No	25.28%	89
TOTAL		352

Q36 If you answered "No", why are you and any members of your household not able to participate in active recreation pursuits as often as you would like? Check all that apply.

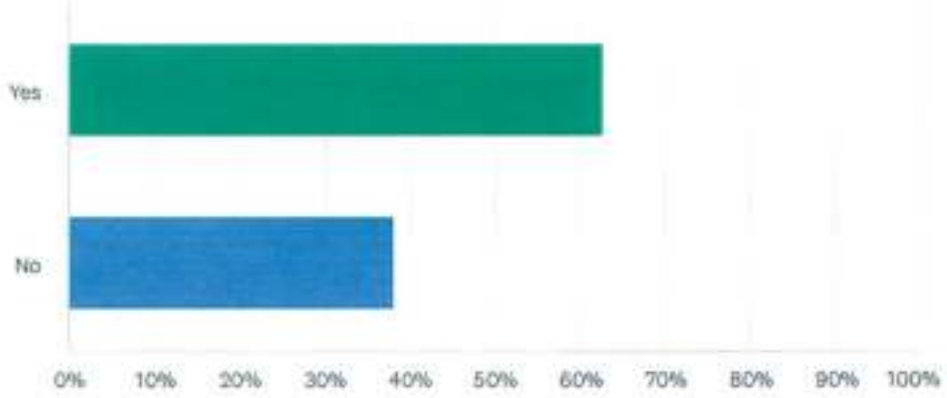
Answered: 138 Skipped: 438



ANSWER CHOICES	RESPONSES	
Lack of personal time/too busy	55.80%	77
Lack of desired facilities	22.46%	31
Lack of desired programs	21.74%	30
Program not offered at a convenient time	17.39%	24
Lack of money/ Programs and facilities too expensive	4.35%	6
Lack of transportation	5.07%	7
Personal health problems/ disability/ age	10.14%	14
Lack of child care	10.87%	15
Other (please specify)	20.29%	28
Total Respondents: 138		

Q37 Are you interested in staying up-to-date on news, events/programs, specials at Brookline Golf Course, then please check yes to sign up for our email club.

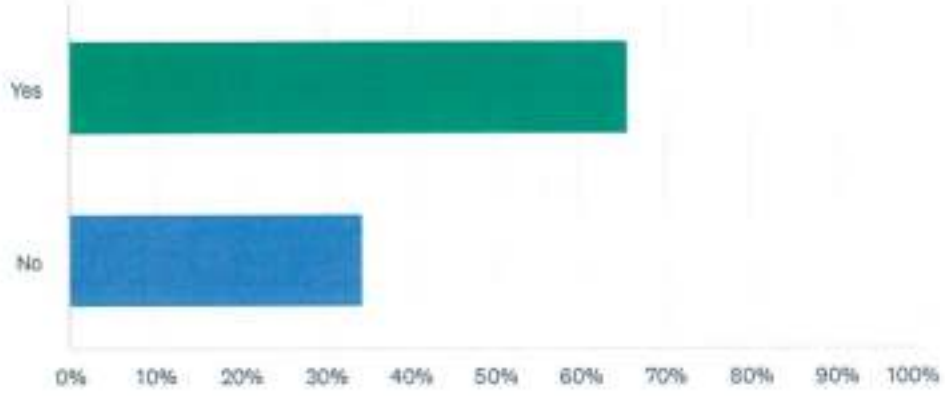
Answered: 352 Skipped: 224



ANSWER CHOICES	RESPONSES	
Yes	62.78%	221
No	38.07%	134
Total Respondents: 352		

Q38 As a small token of our appreciation for filling out this survey, we would like to enter you in a drawing for lunch for two at Hemlock Grill. There will be a total of ten (10) prizes, valued at $20 per person. Only covers the cost of food and non alcoholic beverages.Would you like to be entered to win a lunch for two?

Answered: 347 Skipped: 229



ANSWER CHOICES	RESPONSES	
Yes	65.71%	228
No	34.29%	119
TOTAL		347

ROBERT T. LYNCH

BROOKLINE GOLF COURSE

Brookline, Massachusetts

APPENDIX C

Recommended Tree Planting List

GOLF COURSE MASTER PLAN

BROOKLINE GOLF COURSE

RECOMMENDED TREE PLANTING LIST

1. Western Arborvitae (Thuja plicata)
2. Black Tupelo (Nyssa sylvatica)
3. American Elm (Ulmus americana)
4. Honeylocust (Gleditsia triacanthos)
5. Red Maple (Acer rubrum)
6. White Oak (Quercus alba)
7. Swamp White Oak (Quercus bicolor)
8. Atlas Cedar (Cedrus atlantica)
9. Eastern red cedar (Juniperus virginiana)
10. Western Hemlock (Tsuga heterophylla)
11. Bald Cypress (Taxodium distichum)
12. White Pine (Pinus strobus)
13. Tulip tree (Liriodendron tulipifera)
14. River Birch (Betula nigra)
15. Hackberry (Celtis occidentalis)
16. Shagbark Hickory (Carya ovata)
17. Sassafras (Sassafras albidum)
18. Sugar Maple (Acer saccharum)
19. Sourwood (Oxydendrum arboretum)
20. Black Walnut (Juglans nigra)
21. Flowering Dogwood (Cornus florida)
22. Kousa Dogwood (Cornus kousa)
23. Serviceberry (Amelanchier Canadensis)
24. American Crabapple (Malus hybrids)
25. Eastern Redbud (Cercis canadensis)

ROBERT T. LYNCH

BROOKLINE GOLF COURSE

Brookline, Massachusetts

GOLF COURSE MASTER PLAN

APPENDIX D

Geosyntec

Stormwater Evaluation Memorandum

Geosyntec consultants

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DRAFT Memorandum

Date:	November 15, 2021
To:	Justin Lawson, PGA, General Manager, Brookline Golf Course
From:	Daniel Bourdeau, PE (MA), and Emma Williamson, EIT, Geosyntec Consultants
Subject:	Preliminary Flooding Evaluation Memorandum for the Brookline Golf Course located at 1281 West Roxbury Parkway, Brookline, Massachusetts

INTRODUCTION

Background

This purpose of this memorandum is to provide a preliminary flooding evaluation for the Brookline Golf Course located at 1281 West Roxbury Parkway, Brookline, Massachusetts (the Site). The memorandum includes a summary of observations made during the September 8, 2021 Site visit and recommendations to reduce potential for flooding-related impacts to the Site.

The Brookline Golf Course is an 18-hole course located in the southwestern part of Brookline, Massachusetts. The Site is bounded by West Roxbury Parkway to the south, Hammond Street to the east, the golf course at The Country Club in Brookline ("The Country Club") to the north and residential areas to the east and south. The topography of the Site is generally low and flat, with gradual slopes throughout. The groundwater at the Site is generally near the land surface (up to one (1) foot below ground surface).

The flooding evaluation was conducted because of frequent inundation of playing surfaces, damage to turf, and interruption of play after precipitation events[1].

Stormwater Management and Utilities

The Site receives stormwater runoff from the surrounding developed areas including The Country Club as well as direct runoff from the impervious and pervious surfaces of the Site. Runoff collected in the municipal separate storm sewer system (MS4) within the surrounding developed area discharges onto the Site through several MS4 storm drain outfalls. In addition, stormwater from The Country Club basins is discharged onto the Site through a 10-inch drain pipe controlled

[1] The monthly and yearly precipitation totals from 2000 through 2021 in Boston are included as **Attachment 1**.

with a gate valve at the inlet. Direct runoff from the impervious and pervious surfaces of the Site is managed through a series of on-Site swales (intermittent stream channels), stormwater pipes, and culverts that discharge to an unnamed perennial stream in the western portion of the Site (along the south side of Hole #1). The unnamed perennial stream ultimately discharges off-Site through an 84-inch diameter reinforced concrete pipe (RCP) culvert under Hammond Street. There is also a 24-inch cross-country sanitary sewer pipe that conveys flow from north to southwest across the Site.

Previous Work

In 2011, approximately 2,858 linear feet (LF) of on-Site swales (intermittent stream channels) were dredged which produced approximately 1,538 cubic yards (CY) of sediment (LEC, 2011). The typical width of the swales ranges from 10 to 15 feet and there was one (1) to two (2) feet of accumulated soil sediment and debris that was dredged from the swales. The project also stated that the vegetation that results after the stream is allowed to naturalize will be mowed once annually toward the end of the growing season to "promote seed dispersal and to inhibit woody growth" (LEC, 2011). Additionally, 165 linear feet (LF) of intermittent stream channel was created by daylighting a segment of 36-inch drainpipe (LEC, 2011).

There is a concrete pump chamber and pipe that allows from drawdown of the groundwater at the wetland between Hole #9 and Hole #10 (see Photograph 16 in **Photolog**). Although the pump is not currently functioning, the concrete sump is useable.

FLOODING EVALUATION

A Site visit was conducted on September 8, 2021. Daniel Bourdeau and Emma Williamson of Geosyntec participated in the Site visit. The Site visit included a tour of the Site with focus on those portions of the Site that historically have been inundated during precipitation events that resulted in damage to the course and/or interruption in operations. During the Site visit, many factors that likely contribute to flooding were evaluated and are discussed below. A Photolog of the Site visit is included in **Attachment 2** to this memo.

Peat Soil

The soil at the Site is mainly comprised of peat, which is poorly drained and tends to retain water. Typically, settlement in the peat occurs if the peat is subject to loading or if the water table drops below the peat layer and the peat dries out. Settlement in portions of the Site was observed as evident by the elevated culverts which were once installed below grade (see Photograph 18 in **Photolog**). The geotechnical properties of peat can also cause the peat to expand into streams and swales and reduce conveyance capacity. Evidence of this was observed on-Site in the swales which had limited conveyance capacity due to shallow depths following previous dredging operations.

Swale Vegetation and Sediment

Peat contains nutrients which supports vigorous plant growth, especially in waterways and wetlands. Thick vegetation was observed in the swales that has reduced the conveyance capacity, leading to backup of water in the swales. This vegetation contains thick growth with large root mats that require complete removal; trimming vegetation would likely only moderately improve conveyance capacity. This vegetation was observed in all swales on the Site, most likely due to the shallow channel depths contributed from the peat expansion and sediment accumulation.

The sediment and nutrient load from the MS4 system may also be a contributor to the vegetation and sediment in the swales. Additionally, there are no structural best management practices (i.e., rain gardens, treatment swales, etc.) present in the developed areas to mitigate part of the load from the MS4 system.

Culverts

Culvert pipes used to convey flow across paths and fairways were observed on-Site. Several of these culvert pipes were observed as mounds as the adjacent peat surface has settled leaving the tops of the pipes elevated above the adjacent grade (see Photograph 18 in **Photolog**). In addition, as discussed above, the expansion of peat may have resulted in changes to culvert inverts, decreasing the grade, and reducing the capacity. Additionally, one of the culverts is aligned towards, and not with the flow, further reducing capacity and leading to backups in upstream swale. Thick vegetation was observed on the adjacent slopes of the RCP culvert inlet that conveys flow from the on-Site swales to the unnamed perennial stream. Based on the available information, several of these culverts are corrugated metal pipes installed over 30 years ago which are likely corroded, damaged, or collapsed in areas.

Topography

The topography of the Site is generally low and flat, with some gentle hills where bedrock outcrops were observed. Due to localized peat settlement and the flat topography of the Site, there are several topographical depressions that have been created where runoff accumulates and ponding occurs. These ponded areas are not sloped towards and are not otherwise connected to the swales or other drainage features. These areas drain very slowly due to the shallow groundwater and poor drainage characteristics of peat. As a result, dead or stressed vegetation was observed in these areas during the Site visit.

RECOMMENDATIONS

Geosyntec has identified recommendations based on the Site visit and review of available information to reduce potential for flooding-related impacts to the Site. These recommendations were based on the following objectives:

- Resolve overall flooding issues at the Site, increase playability, and reduce damage to existing grounds and infrastructure from flooding
- Be scalable and repeatable for broader implementation through the course in the future
- Integration with the golf course landscape architect
- Design solutions that are permittable and do not cause downstream impacts
- Implement cost-effective solutions that require manageable long-term maintenance
- Contribute to improvements to water quality of runoff from the contributing MS4 drainage area

The recommendations are presented on **Figure 1** and include the following:

1. **Mow/Trim Vegetation in Swales.** Although it is not possible to remove the roots of the vegetation without dredging or other techniques, mowing and/or trimming the vegetation would increase the conveyance capacity in the vegetated swales by reducing frictional forces and increasing the available cross-sectional area. The vegetation mowing and/or trimming should be prioritized near the culvert inlets and depending on resources include all on-Site swales and performed in accordance with the prior 2011 permit authorization.

2. **Fill Low Areas/Increase Grade.** Due to localized peat settlement and the flat topography of the Site, there are several topographical depressions that have been created where runoff accumulates and ponding occurs which deteriorates turf and disrupts operations. Many of these areas should be filled with light aggregate or sand and graded to mimic naturally occurring topography to slope towards swales or other drainage features to drain stormwater away from areas of play. This work should be coordinated with a golf course landscape architect. Careful consideration is needed to the thickness of fill to account for consolidation of peat due to the loading of the fill material.

3. **Subsurface Seepage Drainage Laterals.** Subsurface seepage drainage laterals should be installed at select locations in conjunction with or as an alternative to filling low areas/increasing grade (described above). This technique involves earth-disturbing activities including trenching and backfilling. This work involves installing the drainage lateral pipes, stabilizing the pipes, and backfilling with suitable material. This work should be coordinated with a golf course landscape architect.

4. **Video Surveillance and Culvert Repair.** As many of the culverts and drainage pipes were installed over 30 years ago, they are likely corroded, damaged, or collapsed in areas. In order to determine the state of the culverts and drainage pipes, video surveillance (i.e., CCTV) should be conducted. The results of the video surveillance will determine culverts and drainage pipes in need of repair and help to prioritize this future work. The sections in poor condition will either need to be replaced or daylighted.

5. **Daylight On-Site Swales and Replace Culverts.** Existing culverts that convey flow between on-Site swales will be evaluated as part of the recommendations including the video surveillance. Several of these culverts appear to be elevated due to settlement of peat at the Site. Portions of these culverts should be daylighted to restore the swale cross section and increase conveyance capacity as discussed in the above recommendation. Some culvert sections may be required for playability or access (e.g., cart path). These culverts should be replaced with appropriate pipe sizes based on the hydrology analysis and set inverts for positive drainage based on current topography.

6. **Temporary Dewatering Sumps.** The capacity of the on-Site swales and drainage features are limited due to the nature of peat and thick vegetation as discussed above. Conveyance capacity results in backup of water onto adjacent playable areas and temporary ponding which damages turf and disrupts operations. Three temporary dewatering sumps and pump pads are recommended (one existing and two proposed) to provide designated points to use portable pumps to evacuate floodwater from the area. It is recommended that temporary portable diesel pumps be on standby so that in the event of a precipitation event leading up to the USGA US Open, the inundation can be quickly evacuated from the Site. As diesel spills may impact the environment, it is recommended that a Spill Prevention, Control, and Countermeasure Plan (SPCC) be created to address and mitigate potential risks. One of two dewatering sumps include a sump and pump pad in the existing on-Site swale between hole #4 and #6 with a designated discharge line to the inlet of the culvert to the southwest of hole #3. The second of two dewatering sumps includes a sump and pump pad at the north end of the existing on-Site swale (at the inlet of the buried culvert) near hole #15 and hole #11 with a designated discharge line to the existing wetland complex located between hole #9 and #10. An existing dewatering sump located to the west of hole #9 draws water from this wetland and discharges to the unnamed perennial stream. These two dewatering sumps would need to be operated in parallel to sequentially move water from the southeast portion of the Site to the unnamed perennial stream. The dewatering sump would consist of an excavation with a vertical standpipe backfilled with a drainage stone. The exact location of the dewatering sump and pump pad will need to consider transportation of the temporary pump to the sump location. Vegetative screenings could be used to limit the visibility of the dewatering sump and pump pad when not being used.

7. **Restore on-Site vegetated swales.** The existing on-Site swales are narrow, shallow, heavily vegetated and include limited riparian buffer. Based on the results of the previously identified studies, these swales could be re-configured to include a larger cross sectional area (i.e., both width and depth) to increase flow capacity and incorporate flood plain and riparian benches. Increased depth would reduce potential for rooted, thick vegetation from eventually overtaking the swales cross section. Additional width and a vegetated riparian corridor would help increase flow capacity as well as create a natural aesthetically pleasing experience for the players (Exhibit 1). Restoration of the existing on-Site swales would

need to take into consideration the existing tree canopy, playable area, and existing infrastructure. Soil quality would also need to be evaluated for potential re-use on-Site as fill/grading material or for off-Site disposal. The layout and design of these features should be coordinated with a golf course landscape architect. An approximate 500 linear foot swale restoration is included with the recommendations as a pilot project.

Exhibit 1. Example of an open flowing drainage swale with a riparian corridor.

8. **Bioretention Pond**. The current layout of the Site includes limited flood storage and stormwater management facilities (e.g., wetlands, ponds, etc.) and relies primarily on conveyance of flows through the Site. Currently, due to the configuration of existing on-Site swales and drainage features, temporary ponding and inundation is occurring widespread throughout the Site. In addition, the Site receives stormwater runoff from the contributing MS4 drainage. Stormwater management is recommended in the form of a bioretention pond to provide water quality benefits and also provide storage volume. Due to the nature of peat and shallow groundwater, a pond design will need to consider the subsurface stratigraphy, slope stability, peat behavior, and likely include a dewatering system (e.g., pump) to evacuate accumulated water by pumping in anticipation of storm events to provide extra storage capacity. These pumping systems may be operated manually or through a real time remote operating system that incorporates forecast and water level data. Pre-design studies are required to support the design of these features including a hydrology analysis and geotechnical investigation. The layout and design of these features should be coordinated with a golf course landscape architect.

Additional studies should be considered to support the development of the above recommendations. These include:

1. **Site Survey**. As settlement has occurred in the peat soil, previous site surveys are most likely no longer accurate, and do not reflect current conditions on-Site. Therefore, we recommend conducting a Site survey to map topography and drainage features in the areas of the recommendations. This could likely be done using a drone survey during the winter months and incorporated into the existing 2011 survey that was conducted by the Town.

2. **Hydrology Model.** A hydrology model of the Site would be used to analyze the rates and volume of stormwater runoff from the surrounding drainage areas as well as direct runoff from the Site. The model would include the contributing MS4 storm drain system as well as the drainage network of on-Site swales and culverts to pinpoint locations of flooding and identify areas for drainage improvements. The model could be used to support the design of drainage improvements such as daylighting swales, culvert replacement and ponds.

3. **Permitting Assessment.** Based on previous work at the Site, the on-Site swales are considered intermittent stream channels and subject to the Massachusetts Wetland Protection Act. A permitting assessment would evaluate the permitting needs and permitting feasibility of the recommendations.

ORDER OF MAGNITUDE COSTS AND FUNDING OPPORTUNITIES

Table 1 presents order of magnitude costs for the recommendations. Due to the source and nature of the stormwater and flooding and location of the Site, funding opportunities were identified as follows to support the implementation of the recommendations:

- **Massachusetts Department of Environmental Protection (MassDEP) Section 319 Non-point Source Competitive Grant Program.** This grant is awarded to projects that address the prevention, control, and abatement of nonpoint source pollution. Generally, eligible projects must implement measures that address the prevention, control, and abatement of nonpoint source pollution, target the major sources of nonpoint source pollution within a watershed, contain an appropriate method for evaluating the projects results, and address activities that are identified in the Massachusetts Nonpoint Source Management Plan. The due date for proposals is December 15, 2021. Grantees receiving competitive sub-awards are required to provide a 40% non-federal match of the total project cost as part of the grant-funded project. The 40% match may be in cash or from in-kind services performed as part of the approved project activities (MassDEP, 2021).

- **MassDEP Section 604b Water Quality Management Planning.** This grant is a vehicle for states to provide funds for eligible entities such as cities and towns to conduct watershed nonpoint source assessment and planning projects. In FFY2021, MassDEP will grant funds for projects that result in the following criteria: development of watershed-based plans (WBPs) for local watershed planning and to support future 319 grant implementation projects; development of preliminary designs and implementation plans that will address water quality impairments in impaired watersheds; development of WBPs for 319 grant Healthy Waterbody Projects to be used to guide watershed projection and management activities; determination of the nature, extent, and causes of water quality problems and

determination of pollutant load reductions necessary to meet water quality standards; or development or green infrastructure projects that manage wet weather events to maintain or restore natural hydrology. The Request for Response was closed on April 14, 2021; however, future funding will likely be available for FFY2022. A match of funds or in-kind services is not required; however, an application that includes a match may increase the competitiveness of a proposal (MassDEP, 2021).

- **MassDEP Stormwater MS4 Municipal Assistance Grant Program.** This program allows groups of Massachusetts municipalities to expand their efforts to meet requirements for the 2016 Small Municipal Separate Storm Sewer System (MS4) General Permits and to reduce stormwater pollution through coordinated partnerships that emphasize resource sharing. The application window closed on September 30, 2021. However, it is likely that there will be funding for FFY2022. Applicants are not required to provide matching funds but are encouraged to identify other known sources of funding from both secured and anticipated sources (MassDEP, 2021).

- **Municipal Vulnerability Preparedness Grant Program.** The Municipal Vulnerability (MVP) program provides support for cities and towns in Massachusetts to begin the process of planning for climate change resiliency and implementing priority projects. The state awards communities with funding to complete vulnerability assessments and develop action-oriented resiliency plans. Applications will be accepted on a rolling basis until January 7, 2022 for the Planning Grant. The Planning Grant requires an in-kind match from municipal staff or volunteers. The Action Grant applications are closed, and the next round is expected to open in Spring 2022. This grant requires a 25% match of total project cost using cash or in-kind contributions.

- **Massachusetts Clean Water State Revolving Fund (CWSRF) Loan Program.** This program was created to provide a low-cost financing method that communities can take advantage of to ensure they are meeting water-quality standards. The program emphasizes watershed management priorities, stormwater management, and green infrastructure. Eligible projects include nonpoint source abatement projects such as stormwater remediation and pollution prevention as well as non-structural projects such as green infrastructure planning projects for nonpoint source problems that are consistent with MassDEP's Nonpoint Source Management Plan and that identify pollution sources and suggest potential remediation strategies. Competitive programs will have demonstrable water quality benefits, will eliminate, or mitigate a risk to public health, is needed to achieve or maintain compliance with applicable discharge permits or other water pollution control requirements, and/or will implement or be consistent with watershed management plans and is consistent with local and regional growth plan. The current subsidy is provided via a 2% interest loan for 20 years. The Division of Municipal Services (DMS) launches a solicitation of proposals for SRF financial assistance in June of each calendar year. The

applications are due by the August deadline in the solicitation. Additionally, there is a "Borrowers Meeting" held to provide information (Borrower Documents, Reports and Publications | Mass.gov).

- **Massachusetts Hazard Mitigation Assistance Grant Overview**. This grant is federally funded and provides significant opportunities to reduce, minimize, or eliminate potential damages to property and infrastructure from natural hazard events. The program is designed to assist applicants in implementing long-term, cost-effective improvements that will reduce, minimize, or eliminate risk to people and property from the effects of natural hazards. Sub-applicants must commit to the non-federal share of the proposed application cost; this is generally 25% of the total estimated project cost. In-kind services are allowable as part of the non-federal match.

RECOMMENDED NEXT STEPS

This memorandum presents recommendations to reduce potential for flooding-related impacts to the Site. These recommendations should be considered by the overall project team including on-Site staff including the Site maintenance coordinator, the golf course landscape architect, the golf course architect, the golf course management team, and the Town of Brookline. Additional engineering analysis and design may be required to support the design and permitting of these recommendations.

REFERENCES

LEC Environmental Consultants, Inc. (2011). *401 Water Quality Certification and 404 Massachusetts General Permit and Supplemental Report*. Prepared for the Massachusetts Department of Environmental Protection. Dated April 20, 2011.

LEC Environmental Consultants, Inc. (2011). *404 Massachusetts General Permit Revision.* Prepared for US Army Corps of Engineers. Dated August 2, 2011.

LEC Environmental Consultants, Inc. (2011). *Notice of Intent Application and Wetland Resource Area Analysis.* Prepared for Brookline Conservation Commission. Dated January 19, 2011.

FIGURE

GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Client: Putterham Golf Course	**Project Number: BR0594**
Site Name: Putterham Golf Course	**Site Location: Brookline, Massachusetts**

Photograph 15

Date: 1 September 2021

Direction:

Comments: Outlet for the upstream Country Club Golf Course. Flow is controlled by a gate valve.

Photograph 16

Date: 1 September 2021

Direction:

Comments: Dewatering sump. Pump is not active.

GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Client: Putterham Golf Course	**Project Number: BR0594**
Site Name: Putterham Golf Course	**Site Location: Brookline, Massachusetts**

Photograph 17

Date: 1 September 2021

Direction:

Comments: Combination of swales and drain pipes.

Photograph 18

Date: 1 September 2021

Direction:

Comments: Drain pipe with settlement in peat soil. The drain pipe is stabilized so that no settlement occurs below it.

GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Client: Putterham Golf Course	**Project Number: BR0594**
Site Name: Putterham Golf Course	**Site Location: Brookline, Massachusetts**

Photograph 19

Date: 1 September 2021

Direction:

Comments: Pond that residential stormwater runoff flows in through before entering the Site drainage system.

Photograph 20

Date: 1 September 2021

Direction:

Comments: Outfall from Massachusetts Department of Conservation and Recreation (DCR) property.

TABLE

Table 1. Order of Magnitude Costs for Recommendations

Recommendation	Quantity	Unit	Cost Per Unit	Total Cost
Short-term Recommendations				
Mow/Trim vegetation in swales	4000	LF	$ 5.00	$ 20,000.00
Fill low areas/increase grade	5	ACRE	$ 7,500.00	$ 37,500.00
Restore Swale	800	LF	$ 75.00	$ 60,000.00
Install subsurface drainage systems	2000	LF	$ 14.00	$ 28,000.00
CCTV and Culvert Repair				
CCTV	1500	LF	$ 3.00	$ 4,500.00
Culvert Repair	300	LF	$ 40.00	$ 12,000.00
Temporary Dewatering Sumps				
Sump construction	2	EA	$ 7,500.00	$ 15,000.00
Pump rental	6	MONTH	$ 1,500.00	$ 9,000.00
Bioretention Pond/Wetland				
Design		EA	$ 20,000.00	$ 20,000.00
Permitting	1	EA	$ 50,000.00	$ 50,000.00
Construction	1	ACRE	$ 50,000.00	$ 50,000.00
Flood Analysis and Pre-Design Studies				
Site survey	1	EA	$ 9,000.00	$ 9,000.00
Hydrology Model	1	EA	$ 7,500.00	$ 7,500.00
Permitting Assessment	1	EA	$ 7,500.00	$ 7,500.00
Subtotal				$ 330,000.00
Contingency (30%)	1	EA	30%	$ 99,000.00
Total				**$ 429,000.00**

Notes:

1. Length of culvert repair costs are estimated to be 20% of overall length of culvert investigated.
2. Pump rental includes three pumps for two months.
3. A 30-percent contingency is commensurate with the level of detail of the recommendations.

LF = Linear Foot

EA = Each

CCTV = closed conduit video surveillance

ATTACHMENT 1

PRECIPITATION DATA

Monthly Total Precipitation for Boston Area, MA (ThreadEx)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	2.62	2.55	3.59	5.02	2.88	6.61	5.20	2.22	2.87	2.86	4.51	4.67	45.60
2001	1.58	1.37	7.57	0.88	1.23	4.99	2.13	4.14	2.29	0.98	0.73	2.83	30.72
2002	3.14	1.81	3.52	2.61	4.48	4.77	1.42	2.13	3.39	3.47	5.03	5.30	41.07
2003	1.81	4.21	4.00	4.00	4.12	4.69	2.11	M	2.65	6.20	2.63	5.06	M
2004	1.01	1.45	3.38	9.57	3.07	1.95	3.87	4.38	7.44	1.88	2.91	3.66	44.57
2005	4.45	2.70	3.89	3.17	3.98	1.46	3.37	2.88	1.78	9.41	3.71	2.87	43.67
2006	4.60	2.64	0.56	1.83	12.48	10.09	3.58	3.20	1.72	4.50	5.80	1.89	52.89
2007	2.57	2.20	4.31	6.71	3.70	2.12	5.26	0.66	1.81	2.08	2.80	5.25	39.47
2008	2.69	7.94	4.66	2.98	2.73	3.46	6.00	4.47	6.45	1.41	4.57	7.10	54.46
2009	3.35	1.94	2.51	4.13	2.69	3.22	6.90	3.24	3.09	5.17	3.34	3.91	43.49
2010	2.91	3.34	14.87	1.78	2.90	3.18	2.66	5.75	1.80	3.90	2.96	3.61	49.66
2011	4.57	4.57	2.10	4.03	3.23	4.76	2.04	7.74	4.40	6.77	4.21	3.97	52.39
2012	2.67	1.00	1.21	3.09	3.43	4.71	3.88	3.08	4.10	2.62	1.01	5.93	36.73
2013	1.08	5.26	3.32	1.37	3.22	10.50	3.61	1.84	2.21	0.61	2.72	4.62	40.36
2014	3.24	4.13	4.48	3.24	2.86	2.62	4.57	1.75	0.70	5.83	5.27	6.56	45.25
2015	3.57	3.37	3.05	2.28	1.22	5.01	2.09	2.19	3.93	1.74	2.07	4.28	34.80
2016	3.27	4.17	3.16	2.91	2.83	1.33	0.87	1.72	1.38	5.46	2.70	3.25	33.05
2017	4.25	3.22	4.18	5.73	3.45	4.85	4.03	1.58	3.73	4.14	1.80	2.49	43.45
2018	4.92	3.77	5.07	4.62	1.90	2.96	4.55	4.65	5.12	3.78	9.26	2.72	53.32
2019	3.62	3.45	2.95	6.52	3.35	5.15	5.81	3.48	2.16	4.45	3.37	6.07	50.38
2020	1.39	3.30	3.60	4.33	2.21	2.66	1.95	2.28	0.97	4.98	4.20	5.67	37.54
2021	2.02	3.05	1.89	4.44	4.92	2.57	10.07	7.00	7.47	M	M	M	M
Mean	2.97	3.25	3.99	3.87	3.49	4.26	3.91	3.35	3.25	3.92	3.60	4.37	43.64
Max	4.92 2018	7.94 2008	14.87 2010	9.57 2004	12.48 2006	10.50 2013	10.07 2021	7.74 2011	7.47 2021	9.41 2005	9.26 2018	7.10 2008	54.46 2008
Min	1.01 2004	1.00 2012	0.56 2006	0.88 2001	1.22 2015	1.33 2016	0.87 2016	0.66 2007	0.70 2014	0.61 2013	0.73 2001	1.89 2006	30.72 2001

ATTACHMENT 2

PHOTO LOG

GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Client: Putterham Golf Course	**Project Number: BR0594**
Site Name: Putterham Golf Course	**Site Location: Brookline, Massachusetts**

Photograph 1

Date: 1 September 2021

Direction:

Comments: Culvert under Hammond Street. Outlet for Site stormwater drainage.

Photograph 2

Date: 1 September 2021

Direction:

Comments: Perennial stream flowing west to east. Discharges to culvert under Hammond Street.

GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Client: Putterham Golf Course	**Project Number: BR0594**
Site Name: Putterham Golf Course	**Site Location: Brookline, Massachusetts**

Photograph 3 **Date: 1 September 2021** **Direction:** **Comments: Culvert that discharges stormwater runoff from Site to perennial stream.**	
Photograph 4 **Date: 1 September 2021** **Direction:** **Comments: Drain that is no longer functioning due to settlement in the peat soil.**	

GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Client: Putterham Golf Course	**Project Number: BR0594**
Site Name: Putterham Golf Course	**Site Location: Brookline, Massachusetts**

Photograph 5

Date: 1 September 2021

Direction:

Comments: Low area where stormwater ponding occurs.

Photograph 6

Date: 1 September 2021

Direction:

Comments: Thick vegetation in swale.

GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Client: Putterham Golf Course	**Project Number: BR0594**
Site Name: Putterham Golf Course	**Site Location: Brookline, Massachusetts**

Photograph 7

Date: 1 September 2021

Direction:

Comments: Thick vegetation in swale.

Photograph 8

Date: 1 September 2021

Direction:

Comments: Thick vegetation in swale.

GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Client: Putterham Golf Course	**Project Number: BR0594**
Site Name: Putterham Golf Course	**Site Location: Brookline, Massachusetts**

Photograph 9

Date: 1 September 2021

Direction:

Comments: Low area where stormwater ponding occurs.

Photograph 10

Date: 1 September 2021

Direction:

Comments: Low area where stormwater ponding occurs.

GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Client: Putterham Golf Course	**Project Number: BR0594**
Site Name: Putterham Golf Course	**Site Location: Brookline, Massachusetts**

Photograph 11

Date: 1 September 2021

Direction:

Comments: Low area where stormwater ponding occurs.

Photograph 12

Date: 1 September 2021

Direction:

Comments: Vegetated swale. Culvert discharging flow from swale against direction of flow in channel.

GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Client: Putterham Golf Course	**Project Number: BR0594**
Site Name: Putterham Golf Course	**Site Location: Brookline, Massachusetts**

Photograph 13

Date: 1 September 2021

Direction:

Comments: Swale with thick vegetation.

Photograph 14

Date: 1 September 2021

Direction:

Comments: Low area where stormwater ponding occurs.

ROBERT T. LYNCH

BROOKLINE GOLF COURSE

Brookline, Massachusetts

APPENDIX E

Irrigation Consulting, Inc.

Irrigation System Evaluation

GOLF COURSE MASTER PLAN

BROOKLINE GOLF COURSE ROBERT T. LYNCH MEMORIAL IRRIGATION SYSTEM EVALUATION REPORT

Prepared for:

Mr. Mark Mungeam, ASGCA
Mungeam Golf Design
195 SW Main Street
Douglas, MA 01516

Prepared by:

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December 2022

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Attached:

Pictures

Brookline Golf Course
Robert T. Lynch Memorial
Irrigation System Evaluation

The following report outlining the findings and results of an evaluation of the eighteen-hole Brookline Golf Course, Robert T. Lynch Memorial irrigation system. We have broken down the evaluation into component parts and have placed them in a logical order of water supply to control system.

BACKGROUND:

Brookline Golf Course established in 1933, is an eighteen-hole public golf course in Brookline, Massachusetts owned by the Town of Brookline. There are normally 33,000 to 35,000 rounds played per year, 80% with carts. The 6,218 yard (blue tees), Par 70 course has narrow fairways and one to three tees per hole. The Course has an approximate elevation change of 34 feet on the 18 holes. the #1 green (174 feet) being the lowest point and the #11/#2 greens (210 feet) being the highest points. The pump houses are at elevations 179 feet (#2 tee) and 195 feet (#14 tee). The current automatic irrigation system was upgraded in 2000 from an approximate 1985 installation with Toro gear driven 670 and 734/735 sprinklers and Toro VTII controllers with a VTIII mechanical central as a mostly single row fairway irrigation system. The irrigation controls and sprinklers were upgraded in 2000, with Toro LTC Plus controllers and a Toro Site Pro computerized central control system as well as isolation valves added. Limited tee improvements were installed in 2022. The irrigation system in addition to the 18 holes irrigates the practice green, practice tee and practice range which were added/installed in 2015. Water supply is potable and consists of two booster pump stations at holes #2 and #14 tees.

WATER SUPPLY:

The irrigation system at Brookline Golf Course is supplied water from two 4-inch potable water sources located at #2 tees and #14 tees which provide approximately 300 gallons per minute each. The #14 station includes a ¾-inch copper feed for a water fountain(s) (Figure 1). Each tap has a 4-inch Elster water meter with strainer (Figure 2) and a 4-inch Febco reduced pressure backflow preventer (825Y) with OS&Y gate valves (Figure 3). The meter has a bypass with associated pipe and NRS gate valves. Water use could be tracked using the flow sensors on the booster pump stations, but there is no logic or display in which to track flow. Water use is currently tracked using the theoretical water use from the Site Pro central control system database. A full cycle of irrigation on the golf course uses approximately 180,000 to 200,000 per cycle theoretically. Watering time is at approximately 12 hours for a full cycle which is well above the 6 to 8 hours recommended for eighteen hole golf courses. In order to reduce this water window, larger supplies from the street or an alternative water source would need to be developed.

BOOSTER PUMP STATIONS

The booster pump stations are located adjacent to the hole #2 tee (Figure 4) and #14 tee (Figure 5) groups in prefabricated pump houses rated for approximately 300 gpm at 60 psi (139 feet) boost (Figure 6). The pumps are 3,600 rpm, direct drive end suction centrifugal pumps, each coupled to 15 horsepower US Electric motors, 200 volts, 87.5% efficient, 42.5 amps. There is a bypass around each pump with associated pipe and valves (Figure 7). Station discharge is 4-inch steel to an exterior 6-inch PVC pipe. The discharges include 1-inch blowout connections on the discharge pipes inside the

pump houses with permanent compressor hose connections (Figure 8).

The booster pump stations include Data Industrial 220B paddle wheel flow sensors (Figure 9) that interface with the control panel logic. There are Murphy pressure gauges installed on the booster pump station discharge piping before the flow meters that also interface with the control panel logic (Figure 10). The stations also include 4-inch Cla-val pressure regulating angle valves (Figure 11).

The control panels, Waterronics CP-15-230-3 (A&B), doors (Figure 12) include system control, MOA switches. A red general fault light is mounted outside on the pump house. The systems include high temperature low pressure and high pressure safeties with indicator lights on the door. There is a rotary disconnect for the incoming power supply to each control panel.

The interior of the control panels (Figure 13) include Allen Bradley starters for the pumps. There is fused motor protection, a fused protected stepdown transformer (120/24) volts and a phase monitor. The panels also include Mitsubishi programmable logic controllers (PLC). The PLCs receive inputs from the Murphy pressure switches and flow sensors. Each panel also includes corrosion inhibitors.

The pump houses are prefabricated concrete construction with flat roofs (Figures 14 and 15). There are single steel doors for access with protective locking cages in good condition. The concrete floor and walls are in good condition. The pump houses are not insulated. Light consists of one 67 watt bulb with protective glass and light switches by the doors. There is no outdoor light. There is no exhaust fan for cooling of the pump house and equipment. There is a duplex receptacle underneath the control in #2 tee pump house and another on the wall. #14 tee pump house has just one duplex receptacle on the wall (Figure 16). There is electric baseboard heat with settable temperature switches (Figure 17). There is venting in the top tiers of the CMU by the block not being there. The overall size of the pump houses are adequate for what is currently installed but could be cleaned out. There is an Intermatic timer installed in the #2 tee pump house, but its use is unclear what it is for and is probably not being used (Figure 18).

Power to the pump houses is 3 phase, 230 volts, 200-amps. Electric meters are located inside the pump houses on the walls (Figure 19). The supply transformers (single pot) are pole mounted, with one behind the #2 pump house (Figure 20) and the other across the road at the #14 pump house.

There is one circuit breaker box in each pump house (Figure 21). The breaker box for the #2 tee pump house includes four individual 20 amp breakers, two dual 40 amp breakers and two dual 60 amp breakers, all unlabeled. The breakers are for pump controls, lights, heat, receptacles and irrigation controllers. The breaker box for the #14 tee pump house includes four individual 20 amp breakers, one dual 20 amp breakers and one dual 60 amp breakers, all unlabeled. The breakers are for pump controls, lights, heat and receptacle. The #2 tee pump house includes an additional 60 amp, 240 disconnect but it's not wired to anything.

There are no pressure relief valves on the pump systems to protect the piping system and no forced air ventilation. There is no pressure maintenance pump or VFD drives. There is no way to read the flow meters. The booster pump systems have not operated for a number of years and the system operates off the available street water pressure of 80 to 90 psi.

PIPE AND FITTINGS:
Mainline pipe ranges in size from 2 inches to 6 inches. The booster pump stations discharge pipe is 4-inch steel pipe changing to 6-inch PVC pipe outside the pump houses. Mainline pipe is thought to be PVC, Class 200, SDR 21 gasketed, but the older original pipe may be Class 160, SDR 26. Lateral pipe to the green and tee the sprinklers is Class 200. PVC solvent weld. 200 psi rated.

Mainline pipe is installed down the center of the fairways on most holes with the three double row holes, (#1, #2 and #18) having two mainline in the rough. Greens are 3-inch feeds with 2-inch pipe that is looped around the green. Tees feeds are 2 or 3-inch with some of the new tees 1-1/2 inch. Single row fairway sprinklers are tapped off the mainlines with an isolation valve at each. Double row fairways are isolated on the mainlines as the mainline forms one side of the piping. Mainline fittings are PVC gasketed and possibly PVC solvent weld possibly as high as 6-inch in size on the old pipe. Newer pipe is ductile iron for fittings 3-inch and above. Lateral line fittings are Schedule 40 solvent weld cement. Brookline Golf Course has experienced no failures of the irrigation mainlines. Lateral pipe experiences six to eight breaks per year (some of which are repairs of repairs). When repairs are needed, they are currently fixed with PVC compression couplings on mainlines and compression or telescoping couplings on laterals. The parts inventory has up to 4 inch solvent weld fittings and threaded Schedule 40 fittings that are not a good idea to be used as they are the weakest part of any golf course irrigation system.

Proper irrigation design techniques limit velocity in PVC pipe systems to 5 feet per second (fps) to control surges, reduce pipe fatigue, and increase life expectancy. In order for the system to use the maximum flow, it must have pipe, which is large enough to distribute the water to all areas of the course, without sustaining significant pressure loss and exceeding pipe velocity limits. The 6-inch Class 200, PVC pipe at the booster pump stations discharge is capable of safely carrying 320 gpm at 5 fps. The booster pump stations are rated for up to approximately 600 gpm total, 300 gpm each, and operated at approximately 400 gpm total, which is within the standard of a maximum 5 fps velocity for the 6-inch PVC pipes. The 4-inch steel discharge pipe from the booster pump stations is capable of safely flowing up to approximately 248 gpm at 7.5 fps so it is just below the standard steel pipe velocity limitations. The Toro Site Pro software flow management database keeps the mainline pipe velocities within the limits recommended throughout the golf course.

The 200-psi rating for the PVC pipe (144 psi continuous operating pressure for 200 psi and 116 psi for Class 160). The 144 psi is withing the operating pressure of the system, but not the 1116 psi as recommended by ASABE standards so the system may or may not be operating within acceptable pressures from a pipe standpoint.

Ideally, the pressure on all of the Toro V1H sprinklers should be a minimum of approximately 90 psi plus so the sprinklers will regulate to their 80-psi design pressure and regulator setting. With an output of 80-90 psi at the pump, approximately 34 feet (14.7 psi) maximum elevation change from the pump house, static pressure (no water flowing) at the high point should reach a maximum of 70.4 psi. As the amount of water used on the golf course increases the pressure naturally drops due to the friction losses through the pipe and valve system. The booster pump stations are normally not operated so the pressure throughout the golf course is too low. The booster pump stations should have a minimum discharge pressure of 100-115 psi or more.

SPRINKLERS:
The sprinklers on Brookline Golf Course's irrigation system are a combination of Toro 734/735, 760/765, 754, FLX35 and FLX55 gear-driven, valve-in-head sprinklers with 80 psi operating settings. Greens have mostly five, (eleven or so) and the rest four sprinklers each. Sprinklers are full circle for the putting surface with no part circle sprinklers throwing out from the green for the surrounds, but some greens have part circles as opposed to full circle in areas where there is no large turf areas off the green. Most tees are irrigated as a group with valve-in-head sprinklers or individually with small black Toro 2001/Hunter I-20 sprinklers. Depending on the tee, the sprinklers are located on or off the tee surface. The fairway sprinklers are full circle in a single row configuration on all holes, except #1, #2, #9 and #18 which are double row. There are few areas with rough areas irrigated such as on the right side of #4 green hill. The left side of 18 fairway and around the clubhouse, but overall there is very little rough irrigated. The range tee and range area are completely irrigated.

Table 1 lists the sprinkler models in the irrigation system, along with their nozzle, flow in GPM and distance of throw at an 80-psi operating/design pressure. The sprinklers are not however receiving 80 psi at their base so the flows and distance indicated are lower and shorter respectively than indicated which results in poor distribution uniformity.

Table 1 – Assumed Sprinkler Spacing @ 80 psi
**60 psi*

Manufacturer	Sprinkler / Nozzle	Radius of Throw (Feet)	Flow (GPM)
Toro	674-74 (black)	94 feet	59.6 gpm
Toro	734-31 (yellow)	58 feet	15.9 gpm
Toro	734-33 (brown)	65 feet	20.0 gpm
Toro	734-36 (red)	76 feet	33.0 gpm
Toro	765-62	61 feet	14.9 gpm
Toro	765-63	65 feet	16.4 gpm
Toro	765-66	74 feet	29.4 gpm
Toro	FLX35-31 (yellow)	57 feet	17.4 gpm
Toro	FLX54-59 (beige)	96 feet	55.6 gpm
Toro	FLX55-59 (beige)	99 feet	57.5 gpm
Toro*	T7-6.0	48 feet	6.3 gpm
Toro*	2001-6 (yellow)	51 feet	7.1 gpm
Hunter*	I-20 – 6.0	44 feet	7.3 gpm

Collar or green surround systems as they are sometimes referred to are very popular with Golf Course Superintendents, Irrigation Consultants and Golf Course Architects. These systems consist of a separate set of sprinklers to water the areas surrounding the green (mounds, rough) without watering the green. They are installed at the green collar edge, spraying outward only. Surround systems allow the Superintendent to manage the turf around the green separately than the green turf itself, as they have different watering requirements. No surround systems as defined exist on the greens at Brookline Golf Course. There are however, block systems to water bunker faces on holes #4 (2), hole #7 (2), hole #11 (3) and hole #12 (2) consisting of Toro 2001 sprinklers and block valves, however these are too large a sprinkler for bunker irrigation.

Sprinkler spacing for any golf course should be consistent. For example, the sprinklers on a green might have 70-foot x 70-foot spacing or 65 x 70-foot spacing, but ideally the spacings stay very consistent. This would hold true for tees and fairways also. Consistent sprinkler spacing provides for a uniform application of water throughout the area the sprinkler covers. If the sprinklers are closer together, the application rate is higher. If the sprinklers are farther apart the application rate is lower and the sprinklers must be operated longer to make up the difference. The poor spacing may also show wet or dry spots in the turf. Spacings for fairways are 80 feet on the single row and 70 feet on the double row. Green sprinklers are 65 feet and tees approximately 50 to 65 feet.

There are some sprinkler-oriented problems with the irrigation system due to age such as bad seals and failure to turn. 140 sprinklers were replaced in 2022. There are no valve-in-head sprinklers that appear to be on slopes, but many are too low and resetting sprinklers to grade is a common maintenance practice each year at the golf course due to frost heaving. On the tees, many of the block sprinklers are installed on slopes. Many of the 670 sprinklers have leaking seals which is not unexpected given their age. 670 sprinklers are replaced with Toro TLX54 sprinklers when necessary.

CONTROL SYSTEM AND WIRING:

The irrigation system controls are comprised of ten (three 40 station, four 48 station and three 64 station) Toro LTC Plus controllers (Figure 22) in ten locations, that replaced the old Toro VTII controllers.

The system has a Toro Site Pro Version 7.0 computerized central controller with an uninterruptable power source (Figure 23) located in the Maintenance Facility. The central control system has a Toro National Support Network (NSN) service plan. The service plan will be updated in 2023 and the computer at the same time with a new 5 year subscription. There is remote control with two radios (Figure 24). The Toro app is sometimes used through the staff cell phones to operate the system, but with Site Pro it is very cumbersome. The central control communication from the Toro FIS interface installed in the maintenance facility to the field controllers is via radio. The maintenance facility has an antenna mounted on the roof for the field controller communication (Figure 25). Field controller antennas are under the controller lid (Figure 26). There is no weather station. There is no communication between the booster pump stations and the central controller. The booster pump stations have an overall capacity of approximately 600 gpm (300 each) and the Site Pro central system is programmed for approximately 400 gpm to allow a factor of safety during operation. The Toro LTC Plus controllers are mounted on the old VTII controller concrete pads and locations. There is now one controller where there use to be two or more.

Low voltage, 24-volt wiring is #14 AWG single strand from the controller to the sprinkler. The 24-volt control wire is blue, yellow, black, green and some red as well as other possible colors (Figure 27). Common wire is #14 AWG of various colors. Wire splices on the course are made with waterproof 3M DBR/Y connectors. Power wire is Romex. Sizing is not known, but probably #8/2 or #10/2 w/ground which would have been common for a mid-1980's installation. Power for three irrigation controllers come from the #2 tee pump house and the rest from the club house.

All sprinklers are operated one at a time except for the block zones sprinklers which vary in size. Greens, tees and fairways can be watered independently through the control system if it is programmed that way.

Controller grounding consists of two 8-foot copper clad rod with a clamp installed at the same time as the new controllers. Ground wire is bare #6 copper wire.

The database indicates 15 minute run times with a 100% ET. There have been some communication issues, but went away with new radios.

MISCELLANEOUS:

1. *Quick Couplers:* Quick coupling valves are Toro 474 with one or two located on each green. There are no quick couplers on the fairways and one on almost every tee. New quick couplers are installed on PVC swing joints with brass inserts and old or regular PVC swing joints with 4-inch black plastic caps.

2. *Isolation:* Isolation for mainlines is approximately every few holes if all the isolation valves were operable. Greens, tees and fairway laterals are all individually isolated. Single row fairway sprinklers are individually isolated with a valve beside the sprinkler. Mainline isolation is accomplished with ringrite gate valves with two-inch operating nuts installed in 10-inch round valve boxes (Figure 28). Many of the lateral isolation ball valve handles are breaking. The mainline valves are moving up higher over time due to the soil instability and frost heaving.

3. *Valve Boxes:* The valve boxes installed include a variety of manufacturers. None of the valve boxes have detection. Some of the valve boxes are full of water or dirt

4. *Electric Valves:* Block electric valves are Toro brass 216 valves old and new and some newer Toro P220 plastic valves.

5. *Air Release Valves:* Air release valves relieve air pockets and reduce water hammer and related damage. There is at least one air release valves installed on the pipe system.

6. *Swing Joints:* Swing joints are used to obtain the proper depth and grade of the sprinkler, along with absorbing the weight of the equipment running over them, preventing the pipe from being damaged. Prefabricated PVC swing joints are Toro (Dura).

7. *Drains/Flush:* If there are any drains on the system, they have been lost over time.

OTHER IRRIGATION:

There is some automatic landscape irrigation around the clubhouse.

MANAGEMENT:

The Brookline Golf Course irrigation management regime is reactive. There is a small parts inventory kept at the maintenance facility (Figure 29). The 2022 irrigation maintenance budget was $2,000 to $5,000, but in actuality is what is needed. Potable water costs for the irrigation system taps are normally in the range of $65,000 to $68,000 gallons per year. Irrigation and water management issues requires 15% to 20% of the superintendent's time (Mike) and another 15% to 25% of the assistant superintendent's time (John) who is basically the irrigation technician in season. Hand watering is used to make up for deficiencies in the irrigation system and to provide the right amount of water to

the right place at the right time. Hand watering is performed as needed throughout the day and averages two to three staff members, 3 to 4 hours a day in season (mid-May to the mid-September). The maintenance staff has no portable soil moisture sensor. There is an old as built of the irrigation system, but it is poor and not very accurate.

CONCLUSIONS/RECOMMENDATIONS:

The overall condition of the irrigation system at Brookline Golf Course is fair/poor. It operates but it is very out of date in terms of technology, equipment and expectations. The following list of major and minor problems with the current irrigation system was developed from our evaluation.

Minor Problems:

1. Meg the grounding to see if it meets the Toro requirements for Site Pro. Existing grounding should be located and megged to measure its ohms of resistance.
2. Fix minor existing wiring issues on #15 green.

Major Problems:

1. Water Supply – The two existing water supplies provide approximately 600 gpm, but the 12 hour water window is too long. In order to decrease the water window, additional capacity would be needed from the street taps or an alternative water source, such as a groundwater wells and a storage pond would need to be developed.. If a new system was to be installed, a larger flow capacity would be even more of a necessity.
2. Pump Stations – The pump stations are not being used and as a result, the sprinklers are operating at too low a pressure. The pump stations should be renovated with new controls and VFD drives as opposed to a pressure regulating valves. Most pipe, given its age should be replaced. The meter and backflows may be able to be reused depending on the final sizing
3. Isolation - The lateral isolation gate valves are starting to wear. The valve handles are breaking. And the valves cannot be easily opened or closed. This trend will continue with time as the valves have life cycled out. More valves will need to be fixed/replaced each year. Mainline isolation valves will also become a problem in the future.
4. Coverage – Single row coverage for fairways provides poor coverage as there is only one sprinkler. The single row configuration is very inefficient and has not been an acceptable way to water fairways for at least three decades. Double row irrigation provides better coverage as can be seen on holes #1, #2 and #18, providing more consistent watering, using less water and operating at a lower pressure. Double row is also better in the wind. Additional rough irrigation is needed in focal areas as very little rough is currently being irrigated. Tee coverage is also poor as there are a number of tees with one sprinkler on the tee. This also makes coverage even worse if there is any wind. The block control on some of the tees is also not efficient, but used for targeted watering. Valve in head sprinklers would be better than the blocks given some of the tee sizes. Greens irrigation look adequate, but would be better with all full circle sprinklers with parts out to water the surrounds. Dedicated approach sprinklers (90-degree arcs) could also be added to the greens for better turf conditions.
5. Age – The system is old from a technology, equipment and control standpoint. The design and therefore the installation are very dated. As discussed, single row fairway irrigation and sprinklers installed on the tees are no longer common practice. Additionally, mainline should be installed in the rough as oppose to the middle of the fairways and under tees.

COSTS:

Unfortunately, golf irrigation system costs continue to increase each year based on raw materials and labor, usually at a rate of 3-5%. Currently very high pricing due to material (pipe) and labor shortages and the amount of golf course irrigation systems being installed have increased costs more in the 15% to 30% range per year. Since this course subject to wage rates, costs are even higher. Irrigation installation costs are very dependent on the number of sprinklers to be installed and the water supply. In this case a larger water supply will need to be developed and if the system was to remain on potable water new larger taps and booster pump stations would be needed. A new double row system with ins and outs on the greens would be approximately 800 sprinklers at a cost of $2,250,000 to $2,5000,000. New water supplies would be approximately $300,000 to $350,000 each for a total of $600,000 to $700,000. $3,000,000 would be a good budget estimate at this time, but will increase each year.

Most of the existing irrigation system infrastructure is approaching 40 years old. It has surpassed its useful life although the green sprinklers and control systems have been upgraded, they are still 22/23 years old. The booster pump stations appear to be in good condition but are not being used, are too small and need a technology upgrade. As time goes by, there will be increased maintenance on isolation valves and continuing sprinkler repair and replacement. Additionally, the current sprinkler and control technologies are out of date and areas of the golf course lack proper coverage. The current irrigation control is controller based, but the industry has moved away from this type of technology to a more interactive, 2-wire, data signal control system technology offered by the major golf course irrigation system manufacturers. This technology is easily expandable and self-troubleshooting. One thing to keep in mind is if the irrigation system is to be expanded rather than replaced, so that more of the turf is to be irrigated, the water supply and piping infrastructure is too small to support the increased flows necessary.

All this said, the irrigation system is not in danger of failing in the near future. The irrigation could continue to be used, but with an increased level of maintenance and reduced turf conditions. Golf course irrigation systems are considered to last about 25 years, some less and some more depending on the level of maintenance and how well the system was originally installed.

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

Figure 6

Figure 7

Figure 8

Figure 9

Figure 10

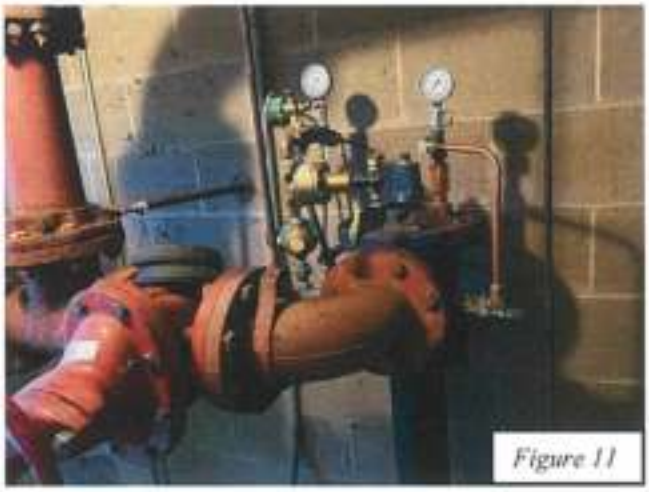

Figure 11

Figure 12

Figure 13

Figure 14

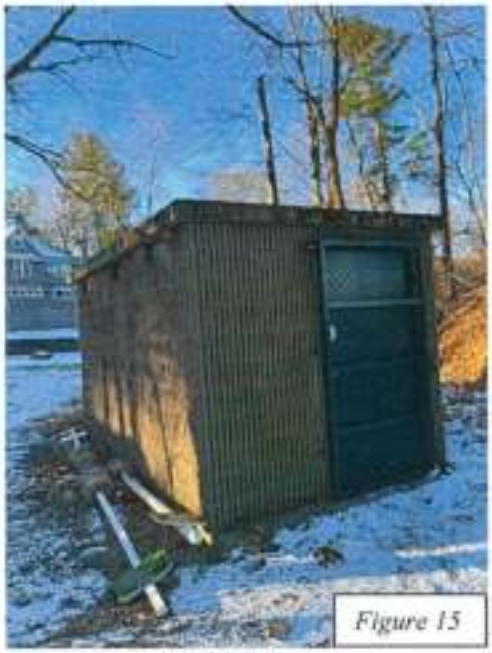

Figure 15

Figure 16

Figure 17

Figure 18

Figure 19

Figure 20

Figure 21

Figure 22

Figure 23

Figure 25

Figure 24

Figure 26

Figure 27

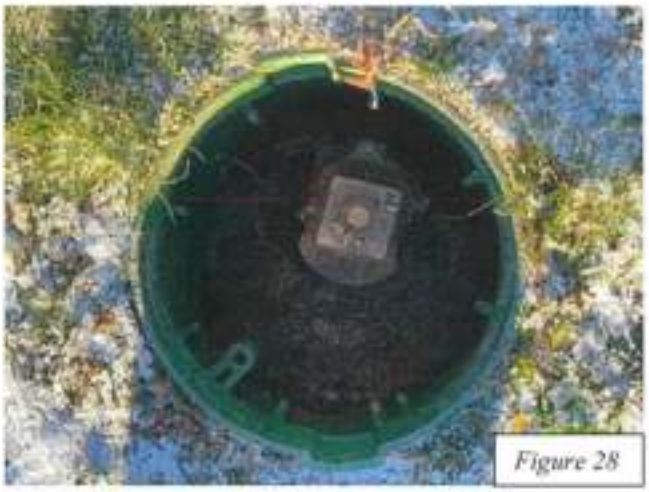

Figure 28

Figure 29